SIMULATION NEWS EUROPE

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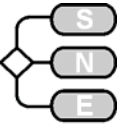
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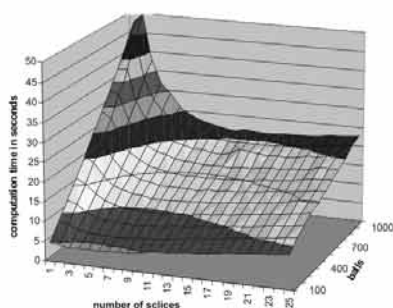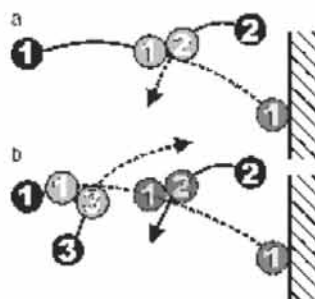
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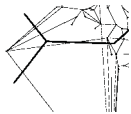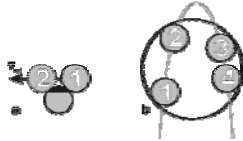Published by ARGESIM

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*"Dear God, Search
and research our
world, made by Your
Right, and help us
complete it"*

```
simplify(f(p))
denom(f(p))
sort(f(t),p)
expand(f( ))
```

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.......And Much More

EDITORIAL

Dear readers,

At present three developments make it necessary
to adapt contents and structure of **SNE**. First, previ-
ously time domain analysis and time domain methods
dominated modelling and simulation, nowadays more
and more new and alternative methods and ap-
proaches are of importance. Second, modelling and
simulation has become a widespread method, which
nowadays is not only dealt with in simulation societies:
application societies deal with modelling and simula-
tion, simulation societies open to computational engi-
neering. And third, some societies put their news at
the web and / or distribute electronic newsletters, so
that they are more interested in the Technical Notes,
and unfortunately some **EUROSIM** societies send in
their contributions very late and / or not regularly.

Already in the last two issues we have reacted to
these developments: we are changing the structure of
SNE a little, and we opening the contents towards
new alternative (sometimes exotic) approaches and
towards application societies.

Organisationally, we are separating the News Sec-
tion more strictly from the Archive Section. The **News
Section** can be found now at the end of the issue.
The Archive Section will be organised as **Notes Sec-
tion**, with Technical Notes (fully reviewed by the Edi-
torial Board), Short Notes (reviewed by the Editorial
Board), Software Notes (reviewed by the Publisher),
and **ARGESIM Comparisons** (reviewed by the Au-
thor of the Comparison). That guaranties the citation
of **SNE** papers as scientific papers, and allows offer-
ing **SNE Special Issues** with Technical Notes or
Short Notes, which can be edited by a society itself
(there is indeed interest in !).

The **SNE** content will also deal with new and alter-
native methods and applications, and with revisions of
classic approaches. The societies' corner will intro-
duce simulation activities from "application societies"
and from research groups (in this issue e.g. about a
Cellular Automata Group), and the ARGESIM Com-
parisons will also compare different modelling meth-
ods and simulation approaches.

We are glad to publish so many Notes and Com-
parison Solutions in this issue. We hope, you enjoy
this issue, and I thank all authors and members of the
editorial boards for their co-operation. We are sorry
again for a delay – some societies sent contributions
very late – but we have reacted. The deadline of the
next issue **SNE 40** is March 31, 2004, and we hope for
a May issue without delay.

Felix Breitenecker, editor-in-chief
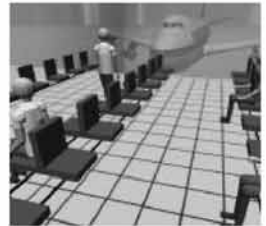*Felix.Breitenecker@tuwien.ac.at*

INTRO

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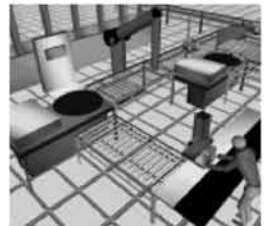
Aims & Scope

The journal **SNE - S**imulation **N**ews **E**urope – is intended i) to inform about developments in modelling and simulation by technical notes, short notes, software notes and comparisons and ii)   to report about news from European simulation societies and events from International Simulation Societies and Simulation Groups all over the world. SNE is the also the official membership journal of **EUROSIM** and **SCS Europe**.

SNE reports in the *News Section* about EUROSIM, EUROSIM societies, SCS Europe and about other International Simulation Societies and Simulation Groups.

SNE's *Notes Section* publishes technical notes (fully reviewed), short notes (reviewed), and software notes on general overviews or new developments, on new software and hardware, on new applications and methods. Furthermore **SNE** presents *Simulation Centres,* introduces *Simulationists* and reviews recent books on modelling and simulation and related topics. **SNE**'s special series *Comparison of Modelling and Simulation Technique and Tools* (**ARGESIM Comparisons**) gives a comprehensive overview on developments in application and implementation.

Parts of **SNE** can be also found on the web, e.g. an archive and an evaluation of the Comparisons: www.argesim.org

All contributions are selected and may be edited. For news publication, please contact a member of SNE's News Editorial Board (p. XVIII), for publication of technical notes, short notes, etc. please contact a member of SNE's General Editorial Board (p. 69) or the Editor-in-Chief.

Issue 38/39
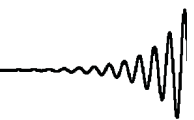
TECHNICAL NOTES

Simulating High Energy Ball Mills using Discrete Events

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…. discusses modelling approaches for the grinding process of high energy ball mills,

…. presents a modelling approach based on discrete event simulation (DES), with is applicable under certain conditions on the type of collisions,

…. and proves with benchmarks, that DES – if applicable – are more efficient and accurate than conventional time-step based approaches

Abstract

The grinding process of a high energy ball mill is based on the collisions of steel balls used as grinding media. For the process simulation, the trajectories of thousands of balls have to be calculated. Usually such technical processes are modelled as multi body systems. In this article, an event driven simulation is proposed, focused on the handling of single collision events and their response. An application based subdivision and its efficient handling will be proposed. It will be shown that discrete event simulations are, if applicable, much more efficient and accurate in comparison to conventional time step based implementations.

Introduction

In mechanical process engineering, high energy ball mills are used to produce and develop nanocrystalline or mechanically alloyed powder materials. Rotor blades in a horizontal drum (fig. 1) accelerate the grinding media (around 4000 steel balls). High kinetic energy impacts lead to a particle size reduction (and further effects) of the starting powder. The impact velocity distribution is of high interest, because although the whole milling process is based this, it can only be measured experimentally with great effort. Hence, an alternative approach is to simulate the process in order to understand and predict experimental results. In the following, the machine is modelled in the asence of powder.

Macroscopically, the grinding media behaves as a granular gas.

Thus, one can suggest modelling the grinding media's motion with established molecular theories (Maxwell-Boltzmann) or with statistical approaches.

Unfortunately, the initial conditions (initial distribution) and collision statistics are unknown. In addition to the velocity distribution, one furthermore would wish to know the position and velocity of every ball at any time and also the coordinates of collisions and the respective collision partners. Therefore, the simulation algorithm has to track position and velocity vectors. This can be understood as a "3D Billiard Simulation" with 4000 balls. Due to the high number of objects, efficiency is a major goal of the algorithm development.

Due to the non-linear behaviour, the scalability of the process is not possible trivially. The development of scaling rules is a major goal of this project.
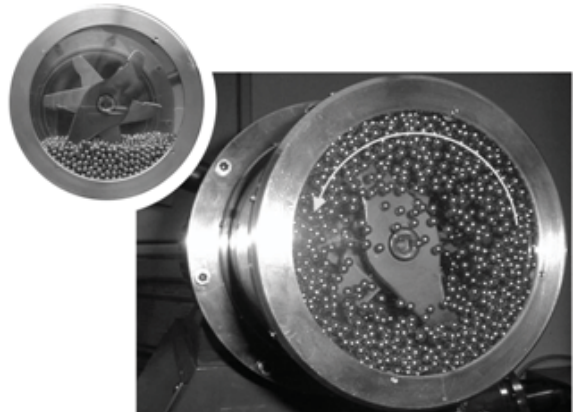
Figure 1: Transparent Grinding Chamber

Problems with continuous approaches

To calculate the trajectories and the velocities of the balls in 3D, time continuous algorithms would have to solve three ODEs at each time step. Between the integration steps, possible collisions with other balls or other objects (system border, rotor blades, drive shaft etc.) have to be detected.

In [1], several ways to simulate one single bouncing ball (2D) using numerical integrators are explained in detail. The fully compiled ACSL version consumed 0.5 seconds of computation time to calculate 152 bounces. In contrast the number of collisions with 4000 fast moving balls in the ball mill of fig. 1 is of the order of 10^5/sec.

Several solutions for collision detection exist, but they all detect collisions by penetration depth [2]. In the case of penetration, a time step algorithm has to move back all objects to the collision time, which is calculated by the penetration depth. This procedure has the pitfall that large integration steps combined with high velocities lead to missing collision events (fig. 2)

Even adjusting time steps with respect to the balls' diameters and their relative velocities will only reduce, but not eliminate, the probability of missing collisions. Furthermore, the computational time for the whole simulation will dramatically increase. Obviously the time continuous approach combined with standard collision detection routines is adverse.
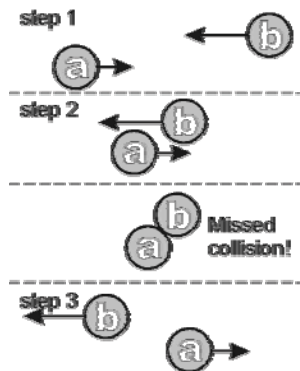
Figure 2: missed collision between integration steps 2-3

Discrete event simulation (DES)

Discrete event simulations are well known in the research fields of factory planning, logistics and electronics (digital circuits). The application presented is rather atypical and it will be shown that events are more difficult to handle. The major difference to time step algorithms is that DES discretises at events (collision) and not at time steps, as is the case for the continuous approach.

An important precondition for using DES for a ball mill is that the flight time of a ball is much longer then the collision or contact time. This imposes strict limitations for its usage. In particular, DES must not be used if multiple interactions between objects are possible, e.g. when many balls are lying on the ground, form chains or their velocity becomes nearly zero.

Therefore systems such as drum mills, sand piles, hour glasses etc. must not be simulated by DES.

However the starting phase is short (3 seconds) in comparison to the whole milling time (above 1h) and at typical rotational speeds between 1,000 and 2,500 rpm only pairwise collisions occur. This has been verified by visual observation using a high speed video camera. Hence collisions can be modelled to be pairwise with an instantaneous impact exchange (collision time = 0).

The time intervals by which the DES proceeds are the increments between the collisions. Consequently the DES algorithm calculates the events ball by ball and stores this in an event list. The ball which has to be calculated next can be derived from the event list.

Hence the basic cycle can be condensed to five operations:

1. pick up the next event from the event list
2. detect future collisions for each particle involved in the actual event
3. calculate the collision response for all detected collisions
4. insert the new events into the event list
5. delete invalid events possibly resulting

Operations 1, 4 and 5 are the event handling routines. In [6] a new and efficient data structure to handle these operations has been presented. Steps 2 and 3 function quite differently than in continuous simulations and are described in the following sections.

Collision detection with DES

Many powders become very reactive when they are processed under normal atmosphere (air), because the free surface is increased. To prevent operating accidents caused by powder-air reactions, the milling chamber is evacuated while milling. Thus air resistance can be neglected.

Most of computational time in continuous simulations is spend for the correct calculation of the ball positions. Considering the a priori information about the evacuated grinding chamber, the absence of air resistance and Magnus forces is known. Consequently, the ODE for the trajectory has a well known analytical solution (parabolic flight path) and there is no need for numerical integrators.

When using DES, time-space collision coordinates are computed by finding the first positive real root of the distance function of all possible colliding pairs and using this for the calculation of the collision point and collision velocity [3].

Clearly, collisions are possible only if the balls move towards each other. Hence before calculating the collision time, the algorithm checks that the product of relative position and position velocity is positive.

$$\vec{r}_{rel} \cdot \vec{v}_{rel} > 0$$

If the above mentioned precondition is fulfilled, ball-to-ball collisions are possible and the collision time (t_{col}) is calculated analytically from the first positive real root of the 2nd order distance function. This formula is derived from the difference of two parabolic flight paths and has been rearranged here for better numerical stability.

$$t_{col} = \frac{R^2 - \vec{r}_{rel}^2}{-\vec{r}_{rel}\vec{v}_{rel} - \sqrt{(\vec{r}_{rel}\vec{v}_{rel})^2 + \vec{v}_{rel}^2(R^2 - \vec{r}_{rel}^2)}}$$

Only the relative position (rrel), the relative velocity (vrel) and the sum of the ball radii (R) are needed for the calculation. Note that neither the mass nor gravity has an influence on the collision time, because both balls are accelerated in the same gravity field.

Because the quadratic equation has two solutions, the algorithm has to find the first positive root. In other words, the surfaces have two possible contact points: the first at the collision, the second when leaving the penetration zone (fig. 3a).
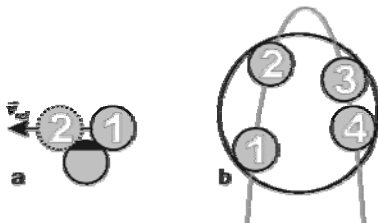
Figure 3a: two roots for ball-ball collision. 1st the collision, 2nd leaving the (black) penetration zone;
Figure 3b: four possible roots for ball-cylinder collision, the 1st in flight direction is the collision

As well as the ball-to-ball collisions, the algorithm has also to calculate the collision time with the static objects. The ball-to-drum collision is split into the ball-to-wall and ball-to-cylinder collision. Ball-to-wall collisions can be calculated by using the axial-velocity only, which results in a linear equation with one root. For the ball-to-cylinder collision time it is easy to derive that there are four possible collision points by intersecting a parabola and a circle (fig. 3b). The distance function for the ball to cylinder collision time leads to a biquadratic equation. An analytical solution for the first positive real root using an improved derivate of Cardano's formula has been implemented.

This analytical solution turned out to be more than two hundred times faster and about ten times more precise than the C-version of MATLABs roots function.

Table 1 summarizes the collision times which have to be calculated per ball at each simulation step:

collision type	equation type	No. of checks
ball-to-wall	linear	2 (both sides)
ball-to-ball	quadratic	n-1 or n-2 (n other balls)
ball-to-cylinder	biquadratic	2 (border, drive shaft)
ball-to-rotor	transcendent	M (rotor blades)

Table 1: Number of root calculations (collision checks) per collision type and its equation type

Unfortunately the ball-to-rotor collision times must be calculated numerically, because they are roots of a transcendental function. Usually the number of rotor blades (m) is between 3 and 10. The number of collision checks regarding the ball-to-rotor collision is significantly reduced by considering the actual axial position of the balls and their flight direction. If the ball collides with the first rotor blade in its flight direction, collisions with the subsequent rotor blades are impossible, etc. Due to the fact that the collision event handling presented in [6] is nearly independent of the number of balls, n, further acceleration of the algorithm can only be achieved by reducing the number of ball-to-ball collision checks.

Reducing collision checks

In [7] several approaches for reducing collision checks in DES are described. Usually this is done by dividing the modelled system into cubic cells with fixed or variable volume organized for example as quad trees. The idea is to reduce the search region of potential collision partners to a certain neighbourhood. Hence the algorithm has to check less than n balls at every time step. Clearly, by increasing the number of cells the administration effort increases too, caused by ball movements from one cell to another. The aim is to optimize the number of cells and also the shape of the cells. To this end further visual observation of the ball movements using a high speed camera from different view points have been carried out.

Looking from the front view (fig. 1) the ball's trajectories are roughly circular. Assuming that this is an axial behaviour, the cells are modelled as sectors of a circle with axial extrusion (fig. 3a).

Using sectors, clearly the ball would move from one sector to another when flying along circular trajectories. Rotating the sectors around the centre of the cylinder would reduce the numbers of cell changes. The rotational speed could be modelled as follows:

- rotational speed of sectors equal to rotors
- rotational speed of sectors equal to the average speed of the ball's circular path
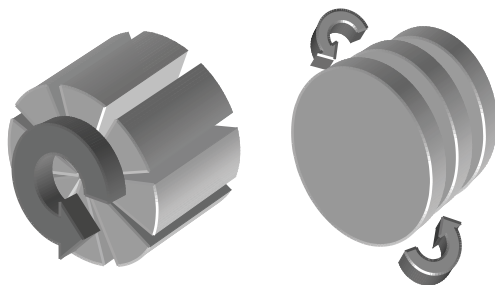
Figure 3 a (left): cell shape modelled as sectors
b (right): cell shape modelled as slices

Unfortunately, it turned out that these velocities are quite different and therefore this approach was rejected and further experiments and videos from the side view have been performed. The analysis of both sides has shown that balls are moving on a circular path, but that their axial position fluctuates within a certain range. Therefore the slice shape (fig. 3b) has been introduced. Balls would move inside the slices, but their exchange between the slices should be less frequent compared with cubic or sector shaped cells.

Classical algorithms step from one cell to the next and check collisions cell by cell [7]. Furthermore these classical implementations use a multiple membership of balls in adjacent cells. This is necessary, because a ball's centre (position vector) could be close to the border of its cell, but its total volume is already inside an adjacent cell. So every ball is a member of all intersecting cells. In the classical cubic subdivision a ball can be a member of its "own" cell and its 26 surrounding cells. Clearly this procedure requires a high administration effort and the ball is involved in other balls collision checks, even if it is not in their cell.

In this paper, an alternative method for handling the cell change, cell membership and ball per cell check is proposed. The cells are given as slices and the view point of the classical algorithm is changed. The balls are not only assigned to a slice, but additionally slices are assigned to a ball. Hence, after a ball queries its actual slice, it can also query the other members of this slice.

The next step is to reduce the number of simultaneous memberships. When a ball is completely inside a slice, it can not be reached by a ball from another slice. Whereas if the centre of a ball is close to the border of its slice and the ball is partly inside the neighbouring slice, then it could collide with a ball from this neighbouring slice. In this case, a ball must have a double membership. The slices are implemented as overlapping with the radius of the largest ball in the system (fig. 4). The overlapping area is the region of double membership.

Due to the division of the system into slices with virtual walls, the event handling has been expanded by two new events (virtual events):

- Check In - entering a new slice,
- Check Out - leaving a slice

Figure 4 illustrates the three stages of a ball's flight from one slice to another.

1. *Single membership in slice A*: Collisions have been checked for and the result is the collision with the virtual wall of slice B.
2. *Check In B, double membership A, B*: The ball has to check for collisions with balls of slice B and with static objects (wall etc.) Furthermore, it checks whether it has left the area of slice A.
3. *Check Out A, single membership B*: At this point the ball has to check for the next virtual event (Check In C) only. All other collision checks have been performed before.
4. *Same state as at point 1*
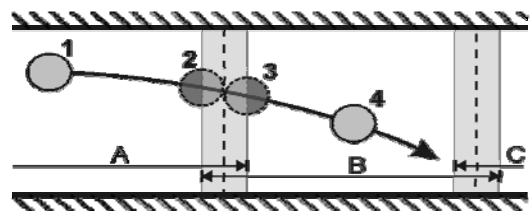
Figure 4: Overlapping slices (A, B, C); stages of a ball's flight through slices (1, 2, 3, 4 equal to 1)

Note that only the minimum number of collision checks is necessary at the virtual events. The only case for which collision checks involving balls from two slices can occur is when a ball suffers a collision while having a double membership inside the overlap zone.

Collision response with DES

The collision response (new velocity and rotation) of a ball-to-ball collision is calculated with respect to the conservation of linear momentum and energy.

TECHNICAL NOTES

Collisions have non-linear energy dissipation (ε), which results in, for example, heat and noise while milling. Usually dissipation is split into a normal and tangential coefficient [4]. It is dependent on the absolute value of normal and tangential relative velocity.

The collisions in DES are modelled to have an instantaneous impact exchange of energy and momentum; the collision time is zero. Hence two balls do not change position while colliding, but rather only change their velocity and rotational vector.

$$\vec{v}'_{i,j} = \vec{v}_{i,j} \pm \frac{m_{ij}^{eff}}{2m_{i,j}}\left[\left(\varepsilon^{t}\left(\left|\vec{v}_{rel}^{t}\right|\right)-1\right)\vec{v}_{rel}^{t} - \left(\varepsilon^{n}\left(\left|\vec{v}_{rel}^{n}\right|\right)-1\right)\vec{v}_{rel}^{n}\right]$$

In continuous simulations balls can change their position while colliding (displacement, rolling), because the collision time is not infinite. Elastic deformation due to the collision could be modelled, but this is only necessary in systems with multiple contacts and high forces. Nevertheless, modelling the displacement and elastic deformation [8] of balls while colliding or under the influence of multiple forces and considering the real contact time is a major domain of continuous simulations.

Invalid Events

A central data structure in DES is the event list, which can be understood as a table with the scheduled events and their assigned colliding pair. Possible future events (collisions) need to be calculated and inserted into the event list. The simulation clock jumps to the next scheduled event. All subsequent new collision events caused by this actual event are then calculated. These collision pairs are inserted as new events. Some of them take place several steps later, but some others will never take place, because another previous collision invalidates them.

In time continuous simulations collisions never become invalid, because all balls are monitored per time step. DES calculates collisions from the viewpoint of one single ball and is not concerned with the possibility that another ball could collide earlier with its potential collision partner. This behaviour can be observed with more than two balls (fig. 5).

The situation in figure 5 is the following: ball 1 will correctly detect the ball 1 – ball 2 collisions to be earlier than the ball 1 - wall collision (fig. 5a). Hence the ball 1 – ball 2 collision is inserted into the event list at the calculated collision time. But if ball 3 crosses the trajectory of ball 1 earlier, the collision 1-3 becomes valid and collision 1-2 becomes invalid. Consequently the 1-2 collision must be deleted from the event list and ball 2 needs a new collision partner (fig. 5b).

Deleting events can also cause other events to become invalid.

The event list can be divided into a validated and a non-validated part. Prior to the actual processed event, all events are validated to be true. But the subsequent events could possibly become invalid. This is a characteristic property of DES. Details are given in literature [6].
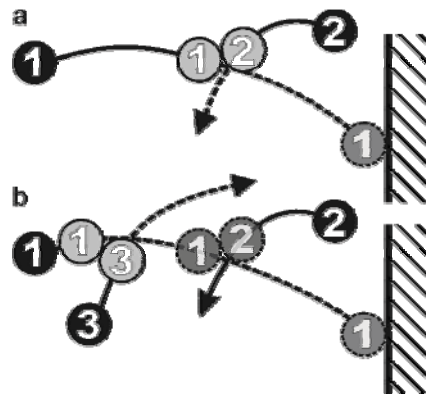
Figure 5: a) ball 1 will detect the 1-2 collision. b) ball 3 crosses the trajectory of ball 1. 1-2 becomes invalid

Benchmark runs

Simulation experiments using a varying number of slices have been performed. Rotor blades are not yet implemented in these experiments. Collisions are modelled to be fully elastic inside a horizontal cylinder. The simulation stops after 100000 validated events. The DES has been implemented in C++ and the experiments have been executed on a Pentium 4 with 1.8GHz. Figure 6 shows the results of the benchmark runs. The number of balls has been changed from 100 to 1100 in steps of 100, the number of slices from 1 (no slices) to 25.

Dividing the cylinder into two slices leads in some cases to an increase of computational time. But with more than two slices the computational time decreases down to one third. All the curves do have a minimum, even if this is not always clearly visible. This is caused by the higher administrative efforts for slice changes when increasing the number of slices. Nevertheless, the new algorithm reduces the computational time by a higher factor than the classical implementations while using fewer subdivisions.

Figure 6 also illustrates that the execution time and the number of balls are collinear. Even varying the number of slices will not change this behaviour.
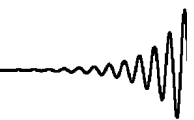
Note that these results will be improved when rotor blades are implemented, because the division into slices is an optimisation for the circular paths of the balls. As predicted by statistical gas theory, the balls in the experiments have a Maxwell distribution in all axes. Experiments with rotor blades will be published in the near future. Nevertheless, DES is able to simulate around 10000 events per second, which is an order of magnitude faster than using continuous simulations.
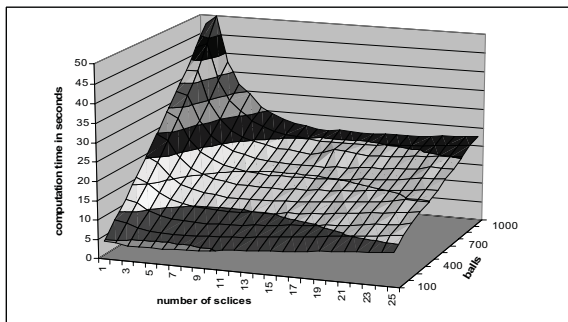
Figure 6: computational time in dependence of number of slices. Unconnected: Reference without slices

Post processing

Due to the fact that DES algorithms deliver the position and velocity vectors of the events only, a post processing routine has to interpolate between these events if other positions are needed. Typical tasks for post processing are:

- Computation of trajectories
- Scientific visualisation
- Statistical data (velocity / impact distribution)
- Calculation of the total milling area
- Verification of the simulation (Penetration checks, Hamilton function, comparison with Maxwell-Boltzmann distribution)

Figure 7 shows the snapshot of a video. The balls are colour coded, and the grinding chamber is transparent. This post processing video has been produced using MATLAB 6.5.

Conclusions

A discrete event simulation algorithm for the modelling of a high energy ball mill has been presented. Comparisons to continuous simulations have been made and their disadvantages when applied in this project have been discussed.

Figure 7: Snapshot of the Simulation,
colour coded velocity

It has been shown that DES is a very fast and accurate simulation technique, but one that is not applicable in all cases. Application specific a priori information leads to a new optimised cell structure (slices) for subdivision, and this structure has been implemented.

Furthermore, a new and efficient way of handling the cell membership of objects has been presented. Benchmark runs have shown the efficiency of the algorithm.

References

[1] *Ecker, H.:* The Bouncing Ball Problem – Modeling and Simulation Aspects, Simulation News Europe, Issue 34, July 2002, ISSN 0929-2268, pp. 9-14

[2] *UNC Gamma Research Group*, University of North Carolina, Dep. of Computer Science
http://www.cs.unc.edu/~geom/collide/

[3] *R. Reichardt, U. Buschmann, W. Wiechert*: Simulationskonzepte in der Werkstofftechnik, Werkstoffe und Werkstofftechnische Anwendungen Band 11, 5. Werkstofftechnisches Kolloquium 24./25.10.2002 in Chemnitz, pp. 146-151.

[4] *T. Poeschel, N. Brilliantov (eds.)*: Granular Gas Dynamics, Springer (2003), ISBN: 3540201106

[5] *J. Alder, T. E. Winwright*: Studies in Molecular Dynamics. I. General Method, J. Chem. Phys. 31, 459, 1959

[6] *Reichardt, R.; Wiechert, W.*: Event driven simulation of a high energy ball mill, ASIM 2003, 17. Symposium Simulationstechnik, 16.09.2003 - 19.09.2003 in Magdeburg, ISBN 3-936150-27-3, pp. 249-254

[7] *M. Gavrilova, J. Rokne, D. Gavrilov and O. Vinogradov*: Optimization Techniques in an Event-Driven Simulation of a Shaker Ball Mill, International Workshop on Computational Geometry and Applications'02, Lecture Notes in Computer Science LNCS 2331, pp. 115-124, Springer-Verlag, 2002

[8] *L.Vu-Quoc, L.Lesburg and X. Zhang*: An accurate tangential force-displacement model for granular-flow simulations: Contacting spheres with plastic deformation, force-driven formulation, Journal of Computational Physics, submitted 25 Feb 03, accepted 24 Oct 03.

TECHNICAL NOTES

Discrete Event Simulation of the Transport Logistics
of the Austrian Red Cross

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TECHNICAL NOTES

…. discusses an ARENA/SIMAN discrete simulation model for the analysis of transport logistics

…. gives scheduling heuristics and discusses different parameter choices used in the scheduling process

…. compares different scenarios corresponding to different possible organizational structures of the rescue organization

Abstract

We discuss a simulation model used in the analysis of the transport logistics of the Austrian Red Cross rescue organization. The emphasis is on the details of modelling the scheduling of ambulance service. Also, the parameters associated with different criteria for the performance of the system are discussed. Implications of the simulation results on decision making and structuring of the organization show the validity of the model and also give hints on possible improvements of the coordination of transports. The main aim is the discussion of the efficiency of central coordination as compared to decentralized planning.

1. Introduction

The aim of the analysis of transport logistics described in this paper is to examine possibilities to improve the efficiency of ambulance service for the Austrian Red Cross. To conduct the study we chose to utilize a discrete simulation model. Classical approaches for the optimization of the transport of goods seemed inappropriate for our purpose. The mathematical tools for the analysis of transport problems discussed for example in Domschke (1989) or Jándy (1967) cannot capture the dynamic situation at full but rely on average (or possibly stochastic) demands and supplies. In our opinion the detailed analysis of time critical aspects of the scheduling of emergency and other transports, restricted availability of transporters (ambulances) and limited personnel resources can best be modelled by simulation. Our simulation model was implemented in ARENA / SIMAN.

The SIMAN simulation engine turned out to be the appropriate tool for our purpose, and the ARENA system provided a comfortable developing environment.

However, we refrained from using any of the ARENA modules, but restricted ourselves to the elements of the SIMAN simulation language. The technical reference we relied on is Pegden et al. (1995).

A detailed description of our model and some hints at the implementation are given in section 2. We concentrate on the model of the traffic network, transportation system and the implementation of heuristics to ensure (near-) optimal efficiency of the coordination of patient transports. In section 3 we give the results of our simulation. Particular emphasis is on the choice of model parameters, which influence important quantities like the average waiting time of patients or total mileage required to carry through the transports. Important conclusions for decision-making and the implications of a comparison of central coordination with decentralized organization are discussed.

2. The simulation model

The mathematical model of the underlying traffic network, quite naturally, is an undirected, weighted graph, where the (positive integer) weight assigned to each edge represents the length in kilometres of the road connecting the places, or hospitals, represented by the vertices of the graph. The data for the construction of the network for the area under consideration was retrieved from electronic route planning services giving the road lengths of connections. Thus, in most cases we did not have to rely on estimates based on the Euclidean distances between locations discussed for example in Probol (1979).

Note that altogether the network consists of about 300 nodes and 1400 links connecting them. A graphical representation of the graph is given in Figure 1. The two nodes denoted by **H** represent cities with a number of hospitals. Both places are not part of the area we are discussing. The remaining graph is divided into the three subareas **Area 1**, **Area 2**, and **Area 3**, which will be discussed later. Large dots represent places with Red Cross stations.

The structure of a traffic network can be implemented quite easily in SIMAN as a *network* consisting of *intersections* (and associated *stations*, or *submodels*), which also enables the use of *guided transporters* navigating on the graph.
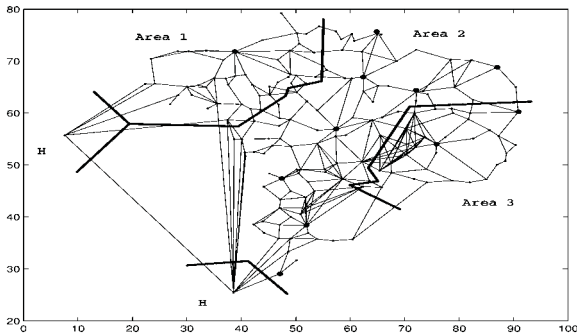
Figure 1: The traffic network

The use of *guided transporters* in a *network* implies the possibility to use the graph algorithms integrated in SIMAN to solve shortest path problems, see Pegden et al. (1995). For the ambulance service we use three different kinds of transporters with different transport capacities and demands on operating personnel:

1   *Krankentransportwagen* (KTW) can carry up to three patients, one on a stretcher and two on sedan chairs. For the different types of patients, see below. A KTW requires two operators.

2   *Behelfskrankentransportwagen* (BKTW) takes up to four patients, which have to be able to walk of their own accord, and only require one driver.

3   *Notarztwagen* (NAW) only carries one patient, require three persons to operate and are used for emergencies only.

The ambulances are stationed in special parking positions representing the locations of the Red Cross stations in the area, cf. Figure 1. Note that the average speed of transporters is assumed to be 60 km/h in general, while for emergency transports 90 km/h is permitted and in cities or villages an average of only 30 km/h is prescribed. The transporters are routed using special *driver entities* which are responsible for the acquisition of operating staff (see below), control of the free capacity, and updating and executing the planned route. To avoid deadlocks or „traffic jams", a *relinquish block* is used upon every activation of a transporter to enable the guided transporters to pass each other by uninhibited.

The staff required to operate an ambulance is a *resource* with a capacity (number of ambulance staff on duty) that is governed by a schedule (depending on time of day and day of week). There is a different pool of rescue staff with an individual schedule for every Red Cross station.

Assignment of personnel to a transport is *first come first serve*. The mechanism applied when a change in capacity cannot be effected immediately will be discussed later.

The patient data used to drive the simulation is read in from a file containing the entry time of the patients into the system, that is, the time of the first request for ambulance service, the place (vertex of the network) of entry and the destination of the requested transport. Additionally, the patient type is read in from the file, with four different categories for this attribute:

- Emergency patients, who require preferential treatment, see below.
- Regular patients who are still able to walk of their own accord.
- Regular patients who have to be carried (and transported) on a stretcher.
- Regular patients who have to use a sedan chair.

The data was collected for a three month period (January to March 2001) and slightly adjusted to avoid exceptions due to holidays disrupting the duty roster of ambulance personnel. Altogether, a data set of 14174 patients was used to drive the simulation.

When a patient enters the system, the patient type is determined first. For an emergency patient, an admissible ambulance is assigned to carry through the transport as fast as possible. An ambulance is considered admissible if it has free capacity to transport a patient on a stretcher, is not assigned to another emergency transport and personnel resources to operate the ambulance are available. Also, we have to ensure that the closest available transporter is indeed close enough to be efficient, so we require that the approach will take no longer than the current waiting time of the patient, unless the distance to be covered is shorter than 5 kilometres.

For the NAW, we allow an approach that is twice as long because it can provide more appropriate help in case of an emergency. Thus, the longer a patient is already waiting for ambulance service, the more ambulances are admissible for the transport. If the patient entering the system is not an emergency, he/she is assigned to a waiting queue until a suitable ambulance is determined for the transport. The heuristic for a routing strategy that provides efficient coordination of tours while not creating unacceptable conditions for waiting patients is described below.

A transporter waiting at its parking position checks for an emergency transport every minute. If no such transport is requested, the queue of patients waiting for transportation is searched for a suitable task every *T*=15 minutes. The parameter *T* is critical for the performance of the system (explained in section 3).

A transport is assigned if the approach to the closest patient's entry station is shorter than the maximum of u_1=12 minutes and r=0.75 times the current waiting time of the patient. Thus, an ambulance is assigned if the tour implies only a short approach from the parking position or if the patient has been waiting for an intolerably long period of time. Note that the longer a patient has been waiting, the more likely an ambulance is assigned even if this means an inefficient detour for the Red Cross ambulance service. We will discuss the effects of this feature in sec. 3, where we will pay special attention to the choice of the parameter r which controls the ratio of tolerable waiting time for patients and admissible detour for ambulances.

When an ambulance reaches a node along the network, any pickup and drop-off actions appointed for the respective station are performed. To model this process, the transporter is delayed to allow for loading time. The duration of this delay varies stochastically according to a triangular distribution with minimum 3, mode 5 and maximum 7 minutes, cf. Kelton et al. (1998). After loading and/or unloading patients, the planned route is updated according to following rules:

- If an emergency transport is being carried through or was recently assigned, the transporter moves to the next station of its route directly on the shortest path through the network. Thus, an emergency transport is inserted at the first position into the planned route and undertaken immediately.
- If the schedule of ambulance personnel has changed and the number of operators available according to the schedule is smaller than the number actually used, no new patients are assigned to the tour, the tour is completed and the transporter moves back to its parking position and releases the operating staff.
- Otherwise, the waiting queue of patients not yet assigned a transporter is searched for a possibility to coordinate any of the requested patient routes with the planned route of the transporter such that no intolerable detour results. To this end, for every patient in the queue the data of entry station and destination are inserted into the transporter's planned tour at every possible combination of positions until an admissible tour is found.

In this context, criteria for an admissible tour:

- The transporter's free capacity is sufficient to carry through the transport from entry station to destination, even if additional patient pickups and drop-offs are scheduled during the tour.
- The detour for the transporter in kilometres is shorter than the maximum of u_1=12 minutes and r=0.75 times the current waiting time of the patient in minutes, but in any case less than 20 km.

- The detour for every patient assigned to the same tour of the transporter as compared with a direct transport from his/her entry position to the destination is smaller than u_2=10 kilometres.
- The currently planned tour contains no more than nine patient pickups and drop-offs.
- If no admissible route is found for a patient, the procedure is repeated for the remaining patients in the waiting queue.

If no drop-off or pickup is currently scheduled, but the capacity of ambulance personnel is sufficient to carry through further transports, the ambulance returns to its parking position, taking the shortest path but pausing at every node along the way to check for new tasks.

To illustrate our simulation model, we display a screenshot from a small demo version of our program in Figure 2. This model only contains 10 nodes from the actual network and a reduced number of ambulances and personnel for easier graphical representation. The 10 nodes of the network comprise 5 Red Cross stations and 2 hospitals. Currently, 1 out of 3 KTW is operating, while the 2 BKTW and 1 NAW are waiting for assignments. Consequently, 2 out of 6 currently available ambulance personnel are busy. The queue of patients not assigned an ambulance contains 2 patients, while 1 patient is waiting for pickup.

Figure 2: Screenshot from a demo version

3. Simulation results

In this section we discuss the results of our simulation study. First, we analyze the effect that the choice of the system parameter r, which controls the ratio of the tolerable waiting time for patients and the admissible detour for ambulances, has on the time the patients spend in the system, from the first request for a transport until drop-off at the destination. Moreover, it is shown that the choice of the parameter T has interesting implications for the actual planning process.
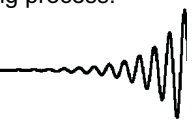
The role of the parameters u_1 and u_2 is far from trivial. The choice of the values u_1=12 and u_2=10 is based on extensive testing to find the configuration providing optimal exploitation of synergies. The resulting parameters were found to imply the least total number of kilometres that the ambulances have to cover (and thus, minimal transportation costs). The tests leading to this conclusion cannot be discussed here in detail.

The main goal of our analysis is the discussion of the possible improvements if the status quo of decentralized scheduling is replaced by central coordination. To this end, we compare the situation where, for the three subareas shown in Figure 1, the routes in every area are coordinated using the respective resources only, with centralized planning in the whole area. Finally, we show that our generic rules for tour planning lead to a behaviour which very well corresponds with the actual layout of the traffic network, demonstrating both the validity of our model and the practicability of the location of the Red Cross stations. We conclude with a few remarks on the validation of our model.

Short waiting time vs. low transportation costs

Here, we discuss two scenarios demonstrating the ambivalent role that the optimization of transport schedules has for the patients waiting for a transport. In **Scenario 1**, we choose the parameter r=0.75, while in **Scenario 2**, we define r=0.5. The intuitive meaning of this choice of parameters is the following: In **Scenario 1**, a detour for an ambulance is more readily accepted in order to reduce the waiting time of the patients, while in **Scenario 2** optimal transport planning in terms of minimizing transportation costs for the rescue organization is emphasized. Indeed, the results given in Table 1 show that the choice of the parameter r indeed influences the simulation results in the expected way. The characteristic values of the system's behaviour which (given in Table 1) are the following:

- *transfer*: Transfer time for each patient.
- *load*: Time spent for pickup and drop-off.
  This includes the loading times for other patients during the transport.
- *wait*: Waiting time.
- *TIS*: Total time spent in the system.

We distinguish between the values for emergencies */em* and other patients */pat*. In the simulation run, a total of 942 emergency and 13,232 other transports were carried through, with some variability in the measured characteristic values. Thus, Table 1 gives the quantities' mean values and the 95% confidence intervals. The values for **Scenario 3** also given in Table 1 are discussed later. The last row contains the total distance required by all transporters to carry through the requested tasks.

Obviously, the choice of the parameter r does not influence the emergency transports in a statistically significant way. This is indeed the behavior we expect. It is interesting to note that the load time for emergency patients amounts to approximately 10 minutes, the value we should expect if the transport is carried through directly without loading or unloading another patient in the meantime, thus verifying the simulation model's correct behavior. Also quite naturally, the transfer and load times are not affected by the parameter r. The wait time, however, increases when we choose the parameter such as to reduce detours for the rescue organization. Indeed, the paired *t*-test with confidence level 95% (see Law and Kelton (1991)) gives a difference of 1.64 ± 0.85 min. The increase in the waiting time also causes a difference in the total time in the system of 1.78 ± 1.05.

	Scenario 1	Scenario 2	Scenario 3
transfer/em	16.68±0.76	16.66±0.75	16.66±0.75
transfer/pat	38.37±0.59	38.42±0.56	37.80±0.57
load/em	9.96±0.07	9.98±0.06	10.04±0.06
load/pat	13.41±0.16	13.50±0.13	12.52±0.13
wait/em	8.32±0.69	8.44±0.81	8.48±0.64
wait/pat	35.75±0.76	37.38±0.92	28.87±0.81
TIS/em	39.34±1.27	39.47±1.31	39.62±0.6
TIS/pat	87.53±0.87	89.31±1.05	79.18±0.95
Tot. mileage	694,166	685,750	739,907

Table 1: Characteristic values of patient transport

Finally, we try to prove that the difference in the waiting time can indeed be attributed to the choice of the parameter r. We distinguish two different factors which add up to the total waiting time of a patient: The time from the request for a transport until the assignment of an ambulance, and the time until the assigned ambulance arrives for picking up the patient. These values were determined independently (batched together for emergency and other patients, however). The difference in the latter quantity is not significant at confidence level 95% and amounts to 0.55 ± 0.72. The time until a suitable transporter is assigned, however, differs by 2.24 ± 0.29. Thus, the parameter choice induces a statistically significant difference in the total time in the system, which is to be attributed to the difference in the waiting time until a transporter is chosen for the tour. However, the advantages for patients if we choose r=0.75 are compensated to some extent by the reduction in the total travelling distance for the rescue organization if we set r=0.5. The latter choice of this parameter enables more synergies to be made use of in the coordination of tours and thus the total mileage amounts to 8,416 kilometres less in **Scenario 2** than in **Scenario 1**.
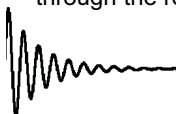
Improving the coordination of transports

In this section we discuss the choice of the parameter T and demonstrate how to improve the coordination of tours. This parameter controls the frequency at which a new possible tour is scheduled for an ambulance that is idle at the rescue organization's quarters. Naturally, this parameter cannot be chosen too large, because this would mean a long waiting time for patients until there is even an attempt at assigning a suitable transporter. We found that the choice T=15 minutes was optimal. In fact, if the parameter is chosen as too small, an undesirable effect is observed. An ambulance is assigned to the first requested, admissible transport. If T is larger, there are more possibilities to choose from in order to determine an optimal transport. To illustrate this interesting point, consider **Scenario 3**. In this case, we choose T=3. Table 1 gives the results which show the effects this choice has on the patients. Apparently, there is some advantage for the patients in **Scenario 3** as compared to **Scenario 1**. The total time in the system differs by 8.35 ± 1.00. This effect is again attributable to the waiting time. In this case, however, we found both the time until the assignment of a transporter and until the pickup of the patient to show a statistically significant advantage for **Scenario 3**. Still, the model with T=3 is unusable for our purpose, because it makes efficient coordination of tours impossible. Indeed, the travelled distance for the rescue organization increases unacceptably by 45,741 km. Also, the behaviour becomes more random and erratic, so we cannot draw clear conclusions from the results for this scenario.

Central coordination vs. decentralized planning

Here, we consider two different ways of coordinating ambulance service. We restrict ourselves to the parameter choice from **Scenario 1**, for **Scenario 2** the results are similar. So far in this paper we always assumed tour planning to take place on a global scale, where all the tasks and available resources in the whole area given in Figure 1 are considered simultaneously for the scheduling process. Now, we want to compare the situation with the results for decentralized coordination. In this second scenario, the resources associated with the three different subregions **Area 1**, **Area 2** and **Area 3** from Figure 1 are used exclusively to carry through transports associated with the respective area. The required data was available separately for each subarea; in fact it was accumulated especially for the purpose of simulating central coordination. The statistically significant differences between the two scenarios were determined by lumping the data from the subareas together into one data set and comparing this data set with the results for the whole area using the paired t-test at confidence level 95% (results for the three subareas in Table 2).

	Area 1	Area 2	Area 3
transfer/em	22.10±2.13	15.64±0.87	19.50±2.64
transfer/pat	46.05±0.72	34.74±0.67	39.57±1.04
load/em	9.81±0.21	10.02±0.08	9.98±0.29
load/pat	13.68±0.34	13.02±0.21	13.46±0.23
wait/em	10.28±1.42	8.97±0.92	11.83±3.91
wait/pat	55.08±2.52	33.73±1.45	48.09±1.60
TIS/em	49.46±3.56	39.46±1.66	48.18±5.98
TIS/pat	114.8±2.65	81.49±1.87	101.12±2.1
Tot. mileage	167,581	373,314	161,617

Table 2: Characteristic values for decentralized planning

For both the transfer and load times of emergency as well as of other patients, no statistically significant overall difference between central and decentralized coordination can be observed. However, there is apparently some slight disadvantage if **Area 1** or **Area 3** is considered separately. This is compensated for by the favourable results for **Area 2**, however.

The waiting time for patients, on the other hand, is improved by 5.29 ± 0.94 min if we consider central coordination for the whole area. This small difference can entirely be attributed to the waiting time until an ambulance is assigned. Indeed, this time factor differs by 5.09 ± 0.40 between the two scenarios, whereas the waiting time from the time a tour is assigned until the patient is picked up shows no significant difference. Note that the waiting time for decentralized planning is longest in the smaller regions **Area 1** and **Area 3**. This is obviously due to the restricted flexibility in planning if coordination is reduced to a smaller scale. There is no significant difference in the waiting time for emergencies for both scenarios.

Finally, we observe that the difference in the waiting time also has an influence on the total time a patient takes from the first request for an ambulance until drop-off at his/her destination. There is an advantage of 4.75 ± 1.19 min if central coordination is considered. Curiously, there is a statistically significant difference for emergency patients as well. The advantage of 1.88 ± 1.83 min can be neglected, however, and is a rather random effect, obviously. We conclude that there is a slight advantage for patients if we use central coordination instead of decentralized planning, but we are more interested in the gain in efficiency this implies for the Red Cross ambulance service. We find that central coordination reduces the total mileage by 8,346 km. This reduction by 1.19% seems rather insignificant, however.

Analysis of the tours

In this section, we discuss the interrelations between the location of the Red Cross stations and organization units and the tours resulting from our scheduling heuristics.

The region we consider, cf. the graph of the traffic network given in Figure 1, is subdivided into three subareas associated with a number of Red Cross stations. These stations are depicted as the 11 larger dots in Figure 1. We are interested in the question whether the cooperation between these three organizational units is very strong for an optimal coordination of transports.

Let us discuss the results given in Table 3. For the three subareas, we give the number of starting points and destinations of individual patients which were transported by an ambulance from the respective area. We exclude the NAW from this discussion because it is associated with the whole region from Figure 1. „Pickup A1" - „Pickup A3" and „Drop-off A1" - „Drop-off A3" denote the total numbers of pickups and drop-offs, respectively, that were carried through in **Area 1**, **Area 2**, and **Area 3** („A1", „A2", and „A3") by ambulances associated with the respective subareas („T1" … transporters from **Area 1**, etc.). „Pickup H" and „Drop-off H" denote the same quantities for transports to and from hospitals, and „Pickup O" and „Drop-off O" refer to transports leaving the area under consideration.

	T1	T2	T3
Pickup A1	1.350	283	9
Pickup A2	225	4.331	399
Pickup A3	5	414	1.229
Pickup H	323	4.770	532
Pickup O	3	130	13
Total Pickup	1.906	9.928	2.182
Drop-off A1	329	837	42
Drop-off A2	230	3.251	333
Drop-off A3	1	924	288
Drop-off H	1.299	4.534	1.482
Drop-off O	47	382	37
Total Drop-off	1.906	9.928	2.182

Table 2: Analysis of the tours

Obviously, the vast majority of ambulances operate in the area they are associated with. As concerns pickup, this trend is quite distinct. There is some amount of interchange between **Area 1** and **Area 2**, and between **Area 2** and **Area 3**, but not between **Area 1** and **Area 3**. This is no surprise, as **Area 2** separates the other subareas. Moreover, **Area 1** and **Area 3** are most easily accessible via a freeway passing through **Area 2**. So especially for transports to and from hospital (the majority of hospitals is situated at the bottom corner node denoted by **H** of the graph given in Figure 1), service of **Area 2** by ambulances from **Area 1**, and more noticeably, from **Area 3** is quite natural.

In general it could be observed that places served regularly by ambulances from a different area are found in special topographical situations, favouring access from an adjacent area. Not surprisingly, pickup from hospital is an important factor as well. This effect is much stronger even for drop-off of patients. Still, the results show that for the remaining drop-offs, a tendency to stay in the same area can be observed. For the apparent synergies when entering a different subarea, the same factors seem to be important as in the case of pickup. It is not possible to conduct a more detailed analysis of the tours here. However, when considering the precise location of the nodes in the traffic network, it can be inferred that the tours in our simulation reflect the topographical situation very well and that ambulances keep in the area they are associated with unless a special topographical situation suggests to serve an adjacent subarea.

3.5 Validation of the model

Validation of the model proved quite difficult for lack of complete data, so we touch the issue only briefly. There are no records on transfer times, waiting times etc., so we can only estimate from experience that the simulation results indeed give the right order of magnitude. The mileage is subject to bookkeeping, however. Unfortunately, we only have reliable data for the total distances covered by all the patients, without taking into account the possibility to transport more than one patient at a time. From partial data available for some subareas, however, we reckon that the true value is overestimated by about 40-50% by the value on record. This value for the area under consideration gives a total of 891,139 km. Thus, the value 694,166 km from our simulation reflects the correct order of magnitude and we accept the model to work dependably.

References / Acknowledgement

[1] *Domschke, W.,* Logistik: Transport, Volume 1, Oldenbourg, München, 3rd edition, 1989.

[2] *Jándy, G.,* Optimale Transport- und Verkehrsplanung, Physica-Verlag, Würzburg, 1967.

[3] *Law, A.M. and Kelton, W.*, Simulation Modeling and Analysis, McGraw-Hill, New York, 2nd edition, 1991.

[4] *Pegden, C., Shannon, R., and Sadowski, R.,* Introduction to Simulation Using SIMAN, McGraw-Hill, 2nd edition, 1995.

[5] *Probol, M.G.,* Tourenplanung mit EDV unter besonderer Berücksichtigung der Erfordernisse eines Unternehmens des Eisen- und Baustoffgroßhandels, Ph.D. Thesis, Braunschweig, 1979.

TECHNICAL NOTES

Issue 38/39

Hierarchical Templates for Simulated Intelligence

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... Conscience simulation demands transcending the present limits of computability, by an intensive effort on extensive research to integrate essential physical and mathematical knowledge guided by philosophical goals.

... A way to begin is hierarchical mixed simulation: applying "Divide et Impera et Intellige" to hierarchy types reveals their comprehensive constructive importance based on structural approach, symbolic meaning, object-oriented representation.

... A new perspective on simulation is gained by unifying representation for design and verification, separating it from the general methods of multihierarchical.

... As an aid to keep in our formalization process close to real problems, we propose an integrated programmable adaptable system for design and verification of intelligent systems.

TECHNICAL NOTES

Introduction

An algorithm is an entity that can be computer simulated, so it represents computability, bottom-up (construction, design, plan) or top-down (understanding, verification, learning). The algorithmic approach is equivalent to the formal one: If a sentence of a formal system is true, then an algorithm can confirm it. Reciprocally, for a verification algorithm of the mathematical sentences a formal system can be defined, that holds for true the sentences in the set closure of the algorithm's results towards the operations of the considered logic. Hilbert's formal systems, Kleene's partial-recursive functions, Turing machines, Church's λ-calculus, Chomsky grammars are only the best-known formalisms for computation, that is, also for algorithm and computability.

Knowledge and construction hierarchies can cooperate to integrate design and verification into simulation; object-oriented concepts can be symbolized to handle data and operations formally; structural representation of behavior manages its realization.

Hierarchy types open the way to simulate intelligence as intentioned adaptable conscience, demanding extension of computability.

Dear God, Search and research our world, made by Your Right, and help us complete it.

(Orthodox Pantocrator)

Hierarchy Types

Coexistent interdependent hierarchies structure the universe of models for complex systems, e.g., hard/ soft ones. They belong to different hierarchy types, defined by abstraction levels, block structures, classes, symbolization and knowledge abstractions.

Abstraction and hierarchy are semantic and syntactical aspects of a unique fundamental concept, the most powerful tool in systematic knowledge; hierarchy results formalizing abstraction. Hierarchies of different types correspond to the kind of abstraction they reflect (the abstraction goal is in brackets):

- Class hierarchy ($\uparrow$concepts) $\leftrightarrow$ virtual framework to represent any kind of hierarchy, based on form-contents dichotomy, modularity, inheritance, polymorphism.
- Symbolization hierarchy ($\uparrow$mathematics) $\leftrightarrow$ stepwise formalism for all kind of types.
- Structure hierarchy ($\uparrow$managing) $\leftrightarrow$ recursive managing of all types on different levels by autonomous block decomposition, following the principle "Divide et Impera et Intellige".
- Construction hierarchy ($\uparrow$simulation) $\leftrightarrow$ simulation framework of autonomous levels for different abstraction grades of description.
- Knowledge hierarchy ($\uparrow$theories) $\leftrightarrow$ reflexive abstraction aiming that each level has knowledge of its inferior levels, including itself.

Understanding and construction have correspondent hierarchy types: their syntax relies on classes, their meaning on symbols and their use on modules. The hierarchy types can be formalized in the theory of categories.

Constructive type theory permits formal specification and verification by generating an object satisfying the specification (Figure 1 and Figure 2).

> *Einstweilen bis den Bau der Welt*
> *Philosophie zusammenhält,*
> *erhält sich das Getriebe*
> *durch Hunger, Furcht und Liebe.*
>
> (Friedrich Schiller)

Argument

Faith and intelligence form the yin-yang of our life (Way, Truth, Life).

Faith = (Inspiration, Intuition, Imagination) is associated to the right human brain hemisphere. Intuition is the main part of the dark yin, inspiration the dynamical shaped interface to intelligence, whereby the white point, link to the left part, stands for imagination.

Intelligence = (Conscience, Adaptability, Intention) corresponds to the left human brain hemisphere. Adaptability is the main part of the light yang, conscience the variable nuanced interface to faith, whereby the dark point, sent by faith, signifies intention.

Conscience is self-awareness of individual faith and intelligence, as well as of the relation to the local context (society) and to the global one (universe). To appear it needs self-knowledge, what could result from community conscience featured by an eternal human structure, e.g., from the past, shepherds, farmers, sailors, Africans, American Indians, Asians, Australians, .

Each individual recognized himself in his cohabitants, besides being adaptable and having a lot of intuition. The evolution of the common measure is conditioned by the conscient construction of correspondingly intelligent agents to manage the lower stages, as industry enabled the mechanization of agriculture followed by the concentration on economics.

Evolution implied a more "Divide et Impera et Intellige" for conscience, associated to generating the *components* lacking of the intuitive adaptable mind at start, then assisted by them:

- individual-social-universal conscience→inspiration (subjective-contextual-objective)　　　↓
- space-time (structure-behavior) → imagination ↓
- discrete-continuous (natural-real) →intention
- beauty-truth-good (art-science-technology)↓.

1. Mathematics discovers and studies three fundamental types of structures: algebra, topology and order, which, respectively, fundament construction, orientation, understanding.

They are rarely separately used; this is an example of correct and complete integration to be followed also by science and technology.

2. Physics should integrate its fundamental forces theories, but also, as chapters, all others natural sciences and the social sciences, leading them to really apply mathematics. Social sciences study a universe, as complex and nondeterministic as the natural one, so mathematics is at least as important to them as for natural sciences. This way, science would also be a better inspiration source for mathematics.
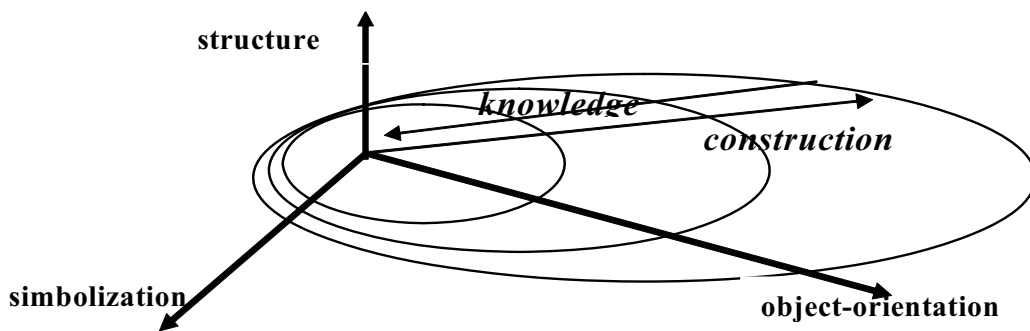
Figure 1: H - diagram

3. Engineering has to be closely related to mathematical approach and integration of parts, not only to mathematical techniques; as reality contains the abstract ideas, even if physics could explain everything discretely, the power of continuum can not be forgotten, i.e., analog engineering should not be neglected in modeling and simulation.

> *Das schöne wahre Gute.*
>
> (Johann Wolfgang von Goethe)

Searching for Conscience

Evidently, the relations of Figure 3 are oversimplified in order to move towards intelligent simulation. Although we claim they are intuitive and hope they are inspired, to begin, we neglect the essential but too primitive to understand intuition and inspiration, so (see further) formalizing reflexive abstraction by the knowledge hierarchy type and simplifying abstraction mainly by the simulation hierarchy type, it follows that:

Conscience=knowledge(simulation(Conscience))
i.e., a fixed-point relation suggesting that we could model conscience associating to any hierarchical level of the construction process a knowledge level. To solve the fixed-point problem we have to build a metric space where knowledge construction is a contraction, i.e., elements implied in the construction should get closer to one another in the formal understanding of the fomal construct.

If, even in the sketch, we consider general functional relations between the essential parts of the faith-assisted intelligence, it results:

Conscience = knowledge (intention
(Inspiration, simulation (
imagination (Intuition,
conscience))))

Recurrence is confined to discrete worlds, while abstraction is not. This suggests searching for understanding based on mathematical structures that order algebra into topology.

Researching for Conscience

The alternative ways followed to extend the computability concept remind of approaches from German novels:

1. Faust: heuristics - ready to pay competence for performance based on imagination and confined to the mental world.

2. Das Glasperlenspiel: unlimited natural parallelism - remains at countable physical suggestions, i.e., in the Nature.

3. Der Zauberberg: hierarchical self-referential knowledge - needs to conciliate the discrete hierarchy structure with the continuous reaction, aiming to open the way to Reality [5].

They concentrate respectively on the mental world of the good managed by technology, the physical world of the truth researched by science and Plato's world of the beautiful abstractions discovered by art.
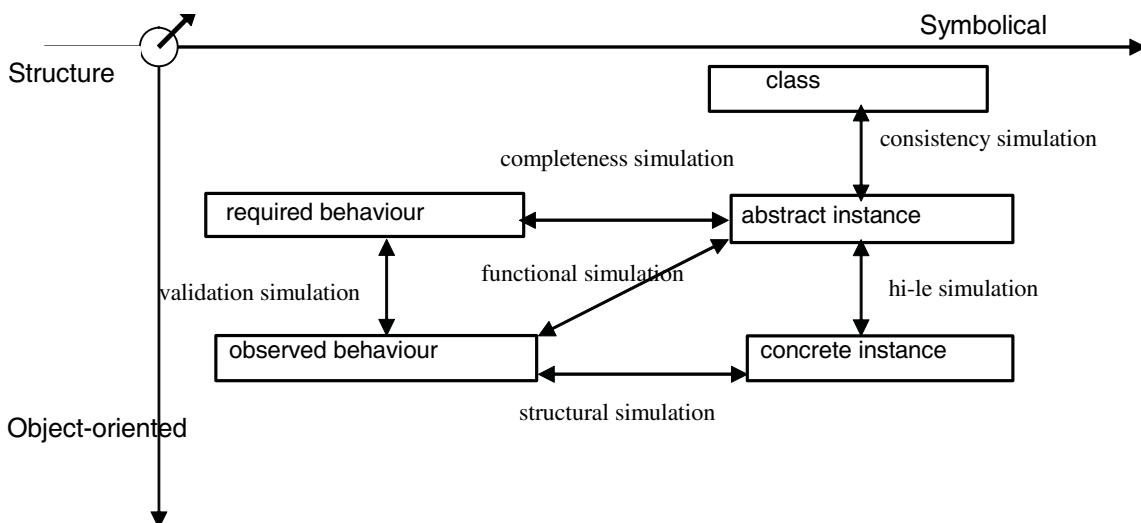
Figure 2: Hierarchical Simulation Paradigm: representation

We follow the (mathematical) paradigm of intelligent simulation by functionally modeling the self-aware adaptable behavior for intelligence simulation.

The integration between discrete and analog is again needed [3, 7], for a most soft adaptability and for conscience simulation as continuous recurrence, i.e., analog reaction. Recurrence of structures and operations enables approximate self-knowledge (with improved precision on the higher levels of knowledge hierarchies). A continuous model for hierarchy levels, without loosing the hierarchy attributes, would offer a better model for conscience of intelligence.

Knowledge is based on morphism mapping the state-space of the object-system onto the internal representation of the simulator. An intelligent simulator learns generating and validating models of the object-system.

Representation for design and verification should be common; the algebraic structures on which the different hierarchy types are based on should be extended to topological structures; the different simulation entities should be symbolic, having attributes as: type, domain, function. A topology on the space of symbolic objects permits grouping items with common properties in classes.

A dynamically object-oriented internal representation results, that can be adapted to the different hierarchy types. Topological concepts, as neighborhood, or concepts integrating mathematical structures, as closure, can be applied in verification and optimization..

The hierarchical principle has to be applied to the object of knowledge as to the knowledge structure itself: it mediates the action of a paradigm on an environment. The simulation framework represents entities and relations of the simulated system, as well as general knowledge about the simulated universe. Knowledge-based architecture bases on separation of representation from reasoning [4].

An intelligent system, i.e., capable of reflexive abstraction, reasons controlled by problem specification and by solving strategies. These are derived from a higher level of knowledge, representing approach principles, which are structured by an even higher level containing abstract types.

Applying this, both at environment and simulation component level, ensures flexibility of the framework realization, by defining it precisely only in the neighborhood of solved cases.

For representation, this principle offers the advantage of open modeling [6].

The user describes models, following a general accepted paradigm that ensures syntactic correctness, leaving the meaning to be specified by user-defined semantic functions that control the simulation.

For example, a module in an unfinished design can be characterized by constraints regarding its interaction to other modules; the constraints system is a model, open to be interpreted, thus implemented, differently, adapting to criteria in a non-monotonic logic. All simplifying hierarchies contribute to the reaction, while knowledge hierarchy stores, analyses, locally integrates, informs the awareness realizing parts and globally integrates. Interlevel relations in a knowledge hierarchy can be interpreted as planning (top-down) and learning (bottom-up).

Explanation is a key concept for knowledge-based systems. It can be expressed as proof in a deductive system, whose axioms are the equations constraining component models and input signals, theorems are simulation results, inference rules represent logic and domain-specific calculus. Constructive logic permits extraction of the system behavior/ structure from the proof.

Reflexive Abstraction

Mathematics contains structures that suggest to be used for self-referent models. The richest domain in this sense is functional analysis, which integrates algebra, topology and order:

- contractions and fixed points in metric spaces
- reflexive normed vector spaces
- inductive limits of locally convex spaces [1]
- self-adjoint operators of Hilbert spaces
- inversable operators in Banach algebra.

Let $(U, \{H_i \in S_h\})$ be a universe, structured by different hierarchies H_i and S_h the set of hierarchies defined on universe U; let $H = (RelEeq, \{(Level_j, Structure_j): j \in S_l\}, RelOrd, \{A_j: j \in S_l\})$ be a generic hierarchy, with S_l the set of hierarchy levels, Rel_eq the equivalence relation generating the levels, $Structure_j$ the structure of level j, Rel_ord the (total) order relation defined on the set of hierarchy levels and the relation of abstraction $A_j \in \{(x,y)|\ x \in Level_{j-1}, y \in Level_j, j \in S_l\}$.

U is a category, e.g., containing Hilbert spaces with almost everywhere-continuous functions as morphisms, enabling different ways to simulate self-awareness.

TECHNICAL NOTES

ISSOP

Integrated System for Simulation and Optimization

DUAL-ZENTRUM

Your Objectives

Cost Reduction

Reduction of Flow Time

Optimization of Employment

Process Design

Process Reengineering

Planning of Investment

Costs

Utilization

Optimization

Simulation

Processes in Enterprises

Manufacturing

Organization

Logistics

Flow Time
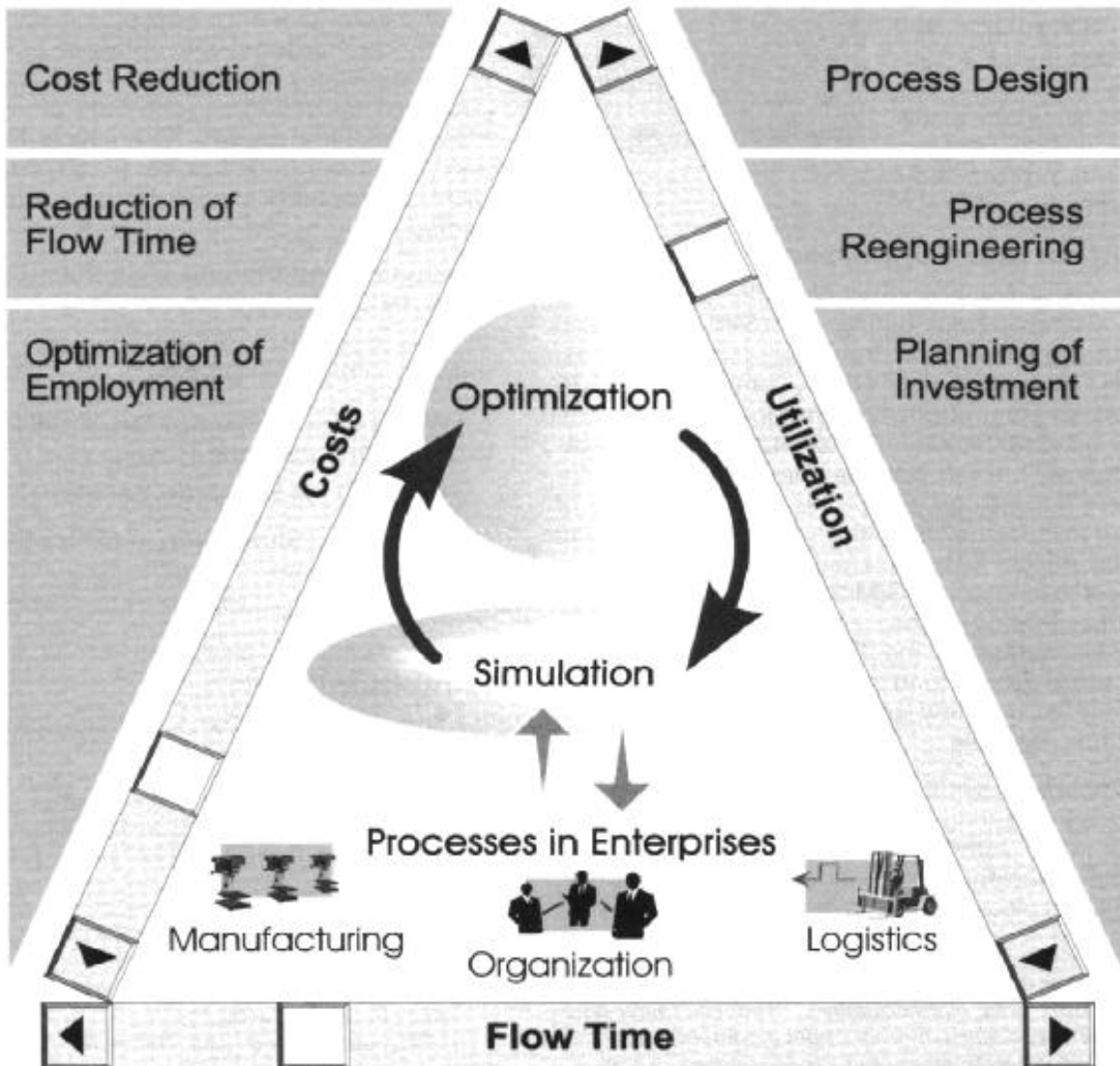
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A hierarchical formal system could be defined as:

1. $(U, \{H_i \in S_h\})$, $card(U) > \aleph_0$ // hierarchical universe

2. $\Sigma = F \cup L \cup A \cup K$ // functional objects

    $F = \{f \mid f : U^* \rightarrow U\}$ // global functions

    $L = \{f \mid f : Level_j^* \rightarrow Level_j\}$ // level structures

    $A = \{f \mid f : Level_j^* \rightarrow Level_{j+1}\}$ // abstractions

    $K = \{f \mid f : Level_j^* \times Level_{j+1} \rightarrow Level_{j+1}\}$

                      // knowledge abstractions

3. $I = \Sigma^* \cap R$ // initial functions

4. $R = \{r \mid r : \Sigma^* \times R^* \rightarrow \Sigma \times R\}$ // transformation rules.

For example, considering self-adjoint operators as higher-level objects of the knowledge hierarchy, these levels can approach self-knowledge in the context of knowledge about the inferior levels as of the current one, and having some qualitative knowing about the superior levels. The correspondence problem, i.e., to associate the knowledge hierarchy to the simulation hierarchy, is managed by natural transformations over the various functors of the different hierarchies regarding the simulated system.

To complete the simulation of the intelligence's components, intention is first determined by human-system dialog. Further than modeling conscience to simulate intelligence there will be search to comprehend inspiration may be using Lebesgue measure on differentiable manifolds and/or non-separable Hilbert spaces. Perhaps even mathematics will have to develop more philosophy-oriented to approach intuition [2].

Conclusion

Conscience simulation demands transcending the present limits of computability, by an intensive effort on extensive research to integrate essential physical and mathematical knowledge guided by philosophical goals. Applying "Divide et Impera et Intellige" to hierarchy types, using the formalism of categories, reveals their comprehensive constructive importance based on structural approach, symbolic meaning, object-oriented representation.

Formalizing hierarchical descriptions, we create a theoretical kernel that can be used for self-organizing systems. Simulability is computability using the power of continuum.

There are enough positive signs for this from analog electronics, control systems, mechatronics. Real progress towards this way of computation needs unrestricted mathematics, integrated physics and thinking by analogies.

Evolution needs separation of faith and intelligence, understanding and using consciously more of faith's domain, integrating them to human wisdom, to be divided further to get more human.

Metaphorically phrased, the current problem is that:

> *God's ways are uncountable.*
> *Countable may be His plans.*

References

[1] P.Ageron: Limites inductives point par point dans les categories accessibles, Theory and Applications of Categories 8, No.11, pp.313-323, 2001.

[2] R.Amoroso, R.Antunes, C.Coelho, M.Farias, A.Leite, P.Soares (eds.): Science & the Primacy of Consciousness, Intimation of a 21st Century Revolution, Noetic Press, 2000.

[3] L.Blum, F.Cucker, M.Shub and S.Smale: Complexity and Real Computation, Springer Verlag, 1998.

[4] K.Keutzer, S.Malik, A.R.Newton, J.Rabaey, A.Sangiovanni-Vincentelli: System-Level Design: "Orthogonalization of Concerns & Platform-based Design", IEEE Trans. on CAD of ICs&Systems 19, No.12, pp.1523-1543, 2000.

[5] T.Niculiu, C.Aktouf, S.Cotofana, "Hierarchical Interfaces for Hardware/ Software Systems", Simulation & Modeling, Enablers for A Better Quality of Life , publication of Society for Modeling & Simulation Int., Ghent, pp.647-655, 2000.

[6] T.Niculiu, A.M.Manolescu, A.Manolescu, M.Glesner, "Hierarchical Mixed Simulation for Intelligent Interfaces", Proceedings of the International Conference on Semiconductors (CAS), Sinaia, pp.515-518, 1999.

[7] J.F.Traub: "A Continuous Model of Computation", PhysicsToday, pp.39-43, May .

A Hidden Markov Models - based Scilab Diagnosis Toolbox

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TECHNICAL NOTES

…. introduces Hidden Markov Models (HMMs) for a stochastic training methodology for diagnosis of series of incomlete data

…. describes a general software toolbox within Scilab using the technique of HHMs

*…. presents application examples in physiology (*polysomnography data)

Abstract

This paper describes a general automatic diagnosis toolbox within the Scilab environment for stochastic dynamic systems. It uses Hidden Markov Models (HMMs). Conventional and new simulated annealing based methods for HMMs training are incorporated. The toolbox includes detection algorithms for multi-signal analysis. As an application example, some real recordings of the respiratory and other activities issued by the technique of polysomnography are considered for off-line and on-line detection of the different sleep apnoea syndromes.

Introduction

The systems become more and more sophisticated. As an example, in medical devices which are generally advantageous in intensive-care environments, increasing both safety and efficiency of the treatment is quite important. It is especially so in the case of difficult, unexpected and time-critical situations [1], [2], [3]. Thus, off-line and/or on-line automation of monitoring and diagnosis of intensive-care unit patients becomes an important objective. Many approaches have been developed in the diagnosis field. These approaches are based on expert or rule based systems (including fuzzy logic systems) [4] and model based systems [5], [6]. Expert systems have had a large impact on automated diagnosis. Expert systems, however, have several weaknesses, mainly due to the difficulty of building and maintaining large rule bases and due to the fact that inference algorithms are not well-suited for real-time action or fast response. A current trend is to use models instead of rules. The advantage of this approach is that a true predictive inference may be obtained. In general, most of these approaches have traditionally been based on linear modelling techniques, which restrict the type of practical situations that may be modelled.

However, obtaining linear or non linear analytical models of many system monitoring domains is a difficult problem. A good approach is to construct empirical models using machine learning based modelling systems for forming empirical models at different levels of abstraction according to the modelling objectives specified by human experts. The modelling process may be considered as a learning activity using machine learning techniques. These techniques use training data base to construct the models.

Based on this approach, the objective of our work is to construct an automated off-line or on-line diagnosis toolbox for the different fault syndromes. The incorporated inference method translates state trajectory values into significant interpretations (physiological and pathophysiological states for medical diagnosis). The toolbox includes detection algorithms for multi-signal analysis.

Hidden Markov Models (HMMs)

In recent years, new inference methods have been introduced to deal with sequences of data which traditionally cannot be dealt efficiently due to problems such as missing, incomplete, and uncertain information. Our diagnosis approach is based on a stochastic training methodology for constructing automated diagnosis architecture. This approach uses Hidden Markov Models (HMMs).

HMMs are based on an extension of the concept of Markov chains to include cases where the observation is a probabilistic function of the state. These models have been widely applied in automatic speech recognition. In this field, signals are encoded as temporal variation of short time power spectrum [7]. HMM applications are now being extended to many fields such as pattern recognition, signal processing, modelling and control of dynamic systems. In general, the HMMs approach seems to be promising in other fields such as in medical diagnosis and in other types of system monitoring [8], [9].

They are well suited for the classification of one or two dimensional signals. A HMM is a double stochastic process with one underlying process that is not observable but may be estimated through a set of processes that produce a sequence of observations.hey may be used for the treatment of problems where information is uncertain and incomplete.

Their use necessitates two stages [7]: a training stage where the stochastic process is estimated through a corpus of observation sequences and a detection stage where the model may be used in real-time to obtain sequences of maximum probability. HMM models owe their success to the existence of many algorithms which are efficient and reliable [10], [11], [7], [12]. The use of the trained HMM in real-time necessitates the use of an efficient algorithm which gives the state sequence of maximum probability. The Viterbi algorithm [13] or the forward algorithm [7] fulfils this need.

A HMM is a finite model that describes a probability distribution over an infinite number of possible sequences. The HMM is composed of some number of hidden states, (e. g. pathophysiological states like breathing events). Each state "emits " observations according to observation emission probabilities (e.g. clinical data sequences), and the states are interconnected by state transition probabilities. Starting from some initial state, a sequence of states is generated by moving from one state to another according to the transition probabilities until an end state is reached. Each state then emits observations according to that states emission probability distribution, creating an observable sequence of observations. HMMs provide an effective approach for incorporating the temporal context. They may be employed directly using the measured clinical signals of the process.

By applying off-line training procedures, different models may be constructed using only the given observation sequences. Based on these models, off-line or on-line diagnosis and prediction may be achieved.

A Hidden Markov Model is defined by the triplet $\lambda = (\Pi, A, B)$ where Π, A and B are the initial state distribution vector, matrix of state transition probabilities and matrix of observation probability distribution, respectively.

$$\Pi = [\pi_1, \pi_2, \ldots, \pi_N], \quad \pi_1 = P(q_1 = I)$$
$$A = [a_{ij}], \quad a_{ij} = P(q_{\tau+1} = j \mid q_{\tau} = i)$$
$$B = [b_i(O_{\tau})], b_i(O_{\tau}) = P(O_{\tau} \mid q_{\tau} = j)$$
$$i, j \in S = \{1, 2, \ldots N\}, t = 1, 2, \ldots, T$$

The observation may be either discrete or continuous. In the case continuous Gaussian observation, $b_j(O_t) = N(M_j, \Sigma_j)$ where M_j is the observation mean vector in the state j and Σ_j is the observation covariance matrix in state j, so that

$$\lambda = (\Pi, A, B, \Sigma)$$

In general, at each instant of time the model is in one of the states $q_t \in S$. It outputs O_t with probability $b_j(O_t)$ and jumps to state q_i with probability a_{ij}. The model may be obtained off-line by training. The state transition matrix represents the structure of the HMM.

Structure of HMMs

The structure of the models defines the constraints on the elements in the state transition matrix A. The left-to-right models [7] are used to represent temporal sequences like in our case. An example of three states HMM is shown in Figure 1.

They have the following properties: 1. The first observation is produced when the Markov chain is in the first state; 2. The last observation is generated when the Markov chain is in the final state; 3. There is not possibility to come back to a precedent state.
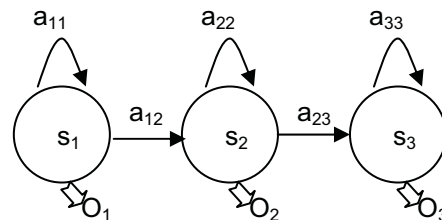
Figure 1: A three hidden states left-to-right HMM example

Training and Recognition

We may represent the evolution of a given process by some hidden states corresponding to event 1, event 2,..., event n. For this process, the observations may be continuous on-line or off-line data. To use HMMs, two problems should be solved: training problem and recognition problem.

Training phase: Build one HMMs for each mode w ($w = 1, \ldots, W$) to be modelled. For example, in patient monitoring, a multiple observation sequence corresponding to event w is used to estimate the optimum parameters of its model. Event w may be a normal breathing, obstructive apnoea, hypopnoea, etc.

Detection phase: For each hidden sequence in the test set characterized by an observation sequence $O = O_1, O_2,..., O_T$, the occurrence probability $P_w = P(O \mid \lambda_w)$ is calculated for each model. The unknown observation sequence O is then classified as the process $w_i = \arg\max_w P_w$.

For the recognition phase, the forward probability function that evaluates probability of a partial observation sequence at node i may be used [7].

Methodology of the toolbox

The inference method of this toolbox translates parameter values into interpretations of states (e. g. physiological and pathophysiological states in medicine). If the interpretation is extended to sequences of states in time, a state-space trajectory may be obtained. The identification of state-space trajectories is a useful concept in diagnosis because some disorders may only be distinguished from each other by time sequences of states. The probabilistic concept of HMMs captures the uncertainty inherent in state interpretation.

A major interest of using HMMs is their capabilities for predictive inference. This inference makes our diagnosis toolbox useful in the evaluation of treatment plans, in the optimization of treatment plans, in the predictive alarming. The diagnosis toolbox, Figure 2, is organized as three phases: training phase, state segmentation and interpretation phase and detection phase.

Training phase: Using a given training data set, a corresponding set of HMMs is constructed using either Baum-Welch algorithm [7], or Simulated annealing algorithm [11], [14]. Baum-Welch algorithm uses the most popular Expectation-Maximization (EM) algorithm [15] to perform Maximum-Likelihood of the HMMs parameters. When the number of observations is very large, the EM algorithm yields very satisfactory results in most applications.

However, this algorithm converges to local maxima and its limiting position is independent on initialization. When small sample sizes are available, the objective function of the maximization becomes highly irregular and the EM algorithm can perform poorly. To overcome this shortcoming, our training algorithm uses simulated annealing method [16]. Based on the optimal trajectory of the state, it implements a finite coding of the solution space. It is applied to both discrete and continuous observations. It needs no specific initialization of the HMM parameters or the algorithm parameters (initial and final temperatures) by the user, the cooling schedule being general and applicable to any specific model. The parameters of the algorithm are derived from theoretical considerations. The algorithm is implemented within Scilab environments [11], [12]. The cost evaluations of the algorithm are made independent of the problem size in order to minimize the computation time.

Whatever the chosen training algorithm, in our toolbox, we use the given training data sequence $O = O_1, O_2,..., O_T$ to train one HMM for each event (for example, breathing events in sleep apnoea diagnosis may be normal breathing, obstructive apnoea, snoring, etc.).
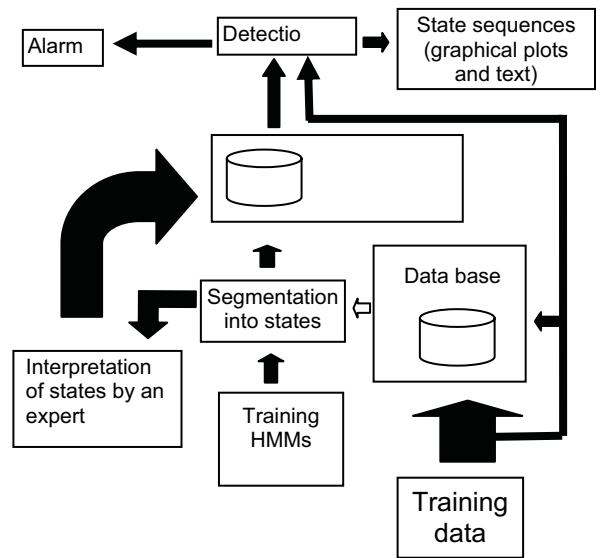
Figure 2. Diagnosis system structure

Segmentation phase. Given training clinical observation sequences and their Hidden Markov Models, this phase allows to segment using Viterbi algorithm [13] and interpret, off-line, by an expert the state sequence (i. g. breathing states in sleep apnoea: snoring, inspiration, expiration, obstructive apnoea, etc.), Figure 3. The interpretation of each state will be useful for on-line detection and interpretation of the on-line state sequence.
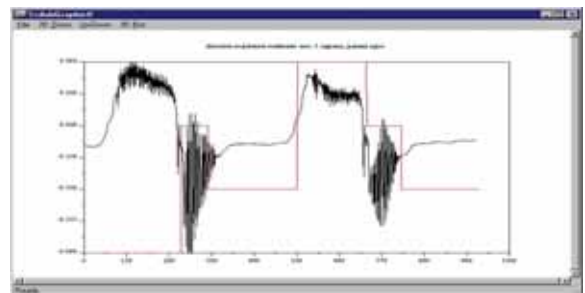
Figure 3. Sleep apnoea data segmentation example. The air flow is segmented into three states. The interpretation: the HMM of this event contains three states: state 1: week airflow, state 2: snoring during expiration, and state 3: snoring during inspiration

Off-line or On-line detection phase

Once the HMMs are available, the detection of hidden pathophysiological states in a given observation sequence is possible. This may be done by two consecutive steps.
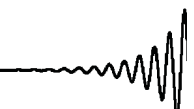
At step 1 select the model that gives the maximum likelihood and at step 2: detect the Pathophysiological state either using Viterbi dynamic programming algorithm for off-line detection or by calculating the forward probability for on-line detection. In the second case a sliding window is used on the observation sequence.

Application

Our aim is to build an automatic on-line/off-line sleep apnoea diagnosis system. Sleep apnoea refers to episodes of non-breathing events lasting more than 10 seconds [17]. This happens during sleep and may sometimes occur more than 300 times a night. Based on a study of healthy subjects, it was suggested that more than 30 apnoeas per night should be considered abnormal [18]. Mainly, there are three syndromes of sleep apnoeas: obstructive [18], central [19] and hypopnoea [20].

The most important diagnostic tool in any medical condition is for the physician to take the time to obtain a good history and physical examination. A chest x-ray along with laboratory tests is usually performed to evaluate other possible contributing factors, such as diabetes or hypothyroidism. The definitive diagnostic exam is a polysomnogram where the patient stays in a sleep laboratory or even at home overnight while measurements of his brain activity, respiratory activity, oxygen levels, and cardiac activity are performed. A sleep apnoea recording is a very time consuming task consisting of expert visual evaluation all 10 minutes pieces of approximately 8 hour recording with a setting of many channels: airway flow, oesophageal pressure, gastric pressure, EEG, EMG, EOG and other signals.

As an example, the respiratory activity diagnosis is considered to test the on-line/off-line robustness and reliability of our approach. Our experiment concern Sleep Apnoea class modelling and detection. The main types of apnoeas are obstructive, central and mixed. Real data was used from different patients to study our approach.

For apnoea detection (pathophysiological state), only the measurements of the respiratory activities, upper airway flow, oesophageal pressure and gastric pressure, are considered. These measurements are stochastic in nature and patient dependent. We considered that the number of events to be modelled and their characteristics (labelling) are known a priori. In order to take into account the temporal nature and the non-stationary of the training signals, a multiple observation sequences corresponding to each event are used to estimate its optimum model parameters. Some training sequences for two events: are given in Figure 5.
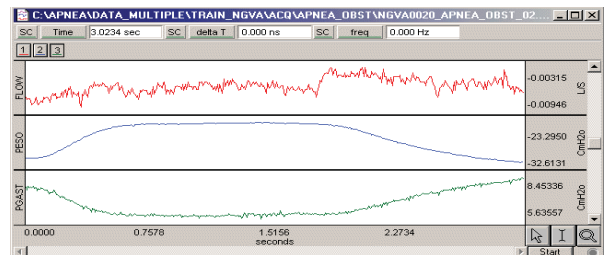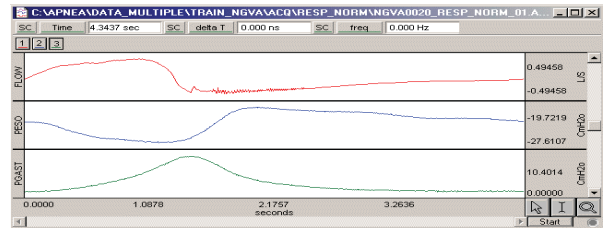
Figure 5. Some training sequences for two events. From top to down: normal breathing and one of many events (episodes) corresponding to obstructive apnoea (non breathing events lasting more than 10 seconds). FLOW: airway flow (L/s), PESO: oesophageal pressure (CmH_2o), PGAST: gastric pressure (CmH_2o)

Figure 6 gives a Scilab simulation example for obstructive hypopnoea event using 2 states: inspiration-expiration with snoring. Of course, the number of states in each event is chosen by an expert.

Conclusions

In this paper, a brief description of the elements of a HMM based diagnosis toolbox in Scilab environment was presented. Clearly, training based diagnosis system, such as our system, is an interdisciplinary field which lies at the intersection of industrial engineering, biomedical engineering, clinical medicine, computer science, AI.

As a result, the use of this system necessitates a balanced distribution of clinicians and computer scientists.

The HMMs may be used to provide a predictive estimate of the process states. To use them we suppose that a prior knowledge on the states of interest and their recordings data are available for model training purpose.

Our toolbox is now being tested for robustness and reliability. The toolbox is user friendly and thoroughly documented. It was publicly released in July, 2003 at http://wwwrocq.inria.fr/scilab/
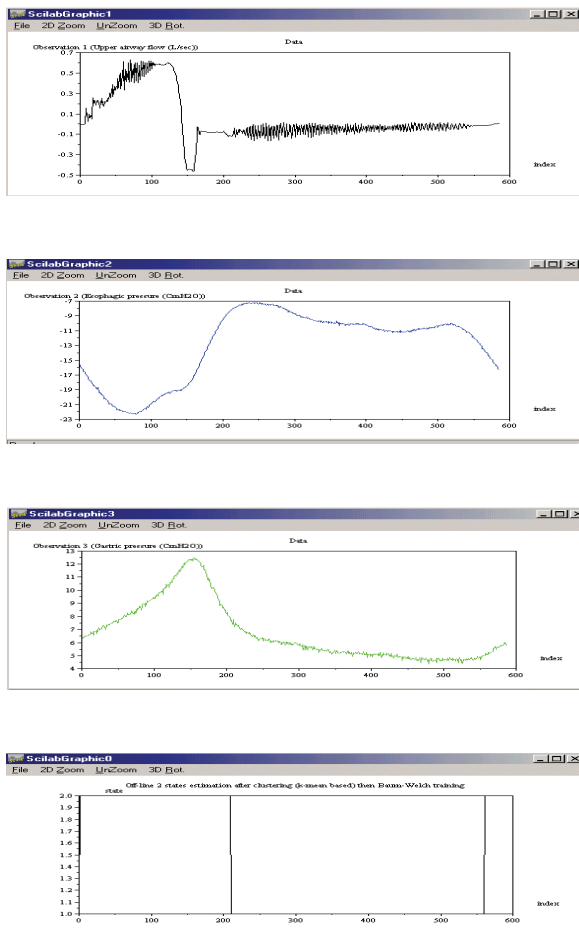
Figure 6. Obstructive hypopnoea event using 2 states. From top to down: airway flow, oesophageal pressure, gastric pressure and the resulting of two states trajectory corresponding to the inspiration-expiration with snoring (state 1) and the end of expiration with snoring (state 2)

References

[1] *Morris, A. H,* Paradigms in management, in Pathophysiologic Foundations of Critical Care. M. R. Pinsky and J.-F. A. Dhainaut, eds., Baltimore, MD, 1993, 193-206.

[2] *Wright, D. et al.,* Critical incidents in the intensive therapy unit. Lancet, 338, 1991, 676-678.

[3] *Uckun, S.* Intelligent Systems in Patient Monitoring and Therapy Management: a survey of research projects. Knowledge Systems Laboratory, Technical report KSL-93-32, Stanford University, 1993.

[4] *Steimann, F. and K. P. Adlassnig.* Clinical monitoring with fuzzy automata. Technical Report MES-2, University of Vienna, 1993.

[5] *Larsson, J. E.* Model-Based Diagnosis of the Human Body. Yfantis, E. A., (Ed.), Intelligent Systems, Kluwer Academic Publishers, 1995, 405-412.

[6] *Larsson, J. E.* A toolbox for fast Model-Based Diagnosis. Knowledge Systems Laboratory, Technical report KSL-95-06, Stanford University, 1995.

[7] *Rabiner, L. R.* A Tutorial on Hidden Markov Models and Selected Application in Speech Recognition. Proc. IEEE, vol. 77, no. 2, 1989, 267-296.

[8] *Bunks, C., McCarthy D. and Al-Ani T.* Condition-Based Maintenance of Machines Using Hidden Markov Models. Mechanical Systems and Signal Processing, 14(4), 2000, 597-612.

[9] *Smyth, P.* Hidden Markov Models for fault detection in dynamic systems. Pattern Recognition. 27, 1994, 149-164.

[10] *Al-Ani, T. and Y. Hamam.* An Integrated Environment for Hidden Markov Models - A Scilab Toolbox IEEE Int. Conf. on CACSD, Dearborn, 1996.

[11] *Hamam, Y. and T. Al-Ani.* Simulated annealing approach for Hidden Markov Models. 4th WG-7.6 Working Conference on Optimization-Based Computer-Aided Modeling and Design, ESIEE, France, May, 1996, 28-30.

[12] ----------Scilab Hidden Markov Models Toolbox included in Scilab: http://wwwrocq.inria.fr/scilab/.

[13] *Viterbi, A. J.* Error bounds for convolutional codes and asymptotically optimum decoding algorithm. IEEE Trans. Inform. Theory, IT-13, (1967) 260-269.

[14] *Hamam, Y. and T. Al-Ani. Y. Hamam. T. Al ani,*: Simulated annealing approach for Hidden Markov Models. Research report, ESIEE-PARIS, 2001.

[15] *A. P. Dempster, N. M. Laird, and D. B. Rubin.* Maximum likelihood from incomplete data via the EM algorithm. J. Roy. Statist. Soc. B., 39, 1977, 1-38

[16] *E. Aarts, and J. Korst* . Simulated Annealing and Boltzman Machines. A Stochastic Approach To Combinatorial Optimization and Neural Computing. Wiley, 1990.

[17] *AASM.* Sleep-Related Breathing Disorders in Adults: Recommendations for Syndrome Definition and Measurement Techniques in Clinical Research. The Report of an American Academy of Sleep Medicine Task Force, SLEEP, 22(5), 1999.

[18] *Guilleminault C., Dement W.C.* Sleep apnea syndrome due to upper airway obstruction. Arch Internal Med, 137, 1976, 296-300.

[19] *White DP.* Central sleep apnea. Med Clin North Am.; 69, 1985, 1205-19.

[20] *Gould G, Whyte K, Rhind M, Arie M, Catterall J, Shapiro O.* The sleep hypopnea syndrome. Am. Rev. Respir. Dis, 137, 1

Statistical Analysis of Random Simulations: Bootstrap Tutorial

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…. introduces the bootstrap method as efficient technique for analysis of random simulations

…. illustrates the application of the bootstrap through the derivation of confidence intervals for various responses of an M/M/1 queuing simulation

…. deals with the subject on tutorial level and concludes that the bootstrap is a simple efficient non-parametric (distribution-free) technique

Abstract

The bootstrap is a simple but versatile technique for the statistical analysis of random simulations. This tutorial explains the basics of that technique, and applies it to the well-known M/M/1 queuing simulation. In that numerical example, different responses are studied. For some responses, bootstrapping indeed gives better statistical results than parametric statistical techniques do.

Keywords: Bootstrapping; normality; robustness; queuing simulation; statistics

1. Introduction

This paper is a tutorial that explains the basics of the statistical analysis technique known as the bootstrap, and illustrates the application of the bootstrap through the derivation of confidence intervals for various responses of an M/M/1 queuing simulation. The M/M/1 is a well-known building block in discrete-event simulation; see Law and Kelton [6].

Bootstrapping implies resampling - with replacement - of a given sample. In our numerical illustration, this sample consists of the responses of (say) m simulation runs or replicates. For example, the response is the average waiting time per simulation run, and the sample consists of this average response observed for ten runs that use ten different pseudorandom number (PRN) streams - but the same traffic rate. In practice, much computer time (for example, five hours) is often needed to obtain the response for a single simulation run. However, once these data are obtained, bootstrapping is a fast analysis technique.

It requires only seconds to compute statistically sound conclusions. Bootstrapping does not assume a specific distribution - such as the normal (Gaussian) distribution - for the response of interest.

Conceptually, the bootstrap may be explained as follows. Suppose that a sample of size m is available (for example, m average waiting times per simulation run). Now suppose that by chance one of these data elements gets lost. To keep the sample size constant at m, another data element is then counted twice. Obviously, the value of the sample average now changes. By repeating this chance experiment many times, the bootstrap gives many different average values - all computed from the same original sample. We shall define and illustrate the bootstrap more precisely, in Section 3.

Our main conclusion will be that bootstrapping can give valid statistical results even if the standard statistical assumption of normality does not hold. So, the bootstrap is a simple non-parametric (distribution-free) technique. Moreover, the statistic to be studied may be more complicated than the mean and variance, which we focus on in the illustrations; for example, Kleijnen and Van Groenendaal [5] use bootstrapping to classify journals into distinct quality classes.

This tutorial is written because the bootstrap technique is simple and versatile, but is not well known among simulation practitioners and theorists. A few recent discussions of bootstrapping in simulation are Demirel and Willemain [1], Friedman and Friedman [3], and Kleijnen, Cheng, and Bettonvil [4].

The remainder of this paper is organized as follows. Section 2 presents a simulation of the M/M/1 queuing system, using the Arena software and the C language respectively. Section 3 considers M/M/1 simulation outputs that are normally distributed; this section analyzes these responses through both the parametric Student t test and the bootstrap, which is explained in some detail. Section 4 analyzes other M/M/1 responses, including the means and variances of the responses in the transient state. Section 5 presents conclusions.

2. M/M/1 queuing simulation

By *definition*, M/M/1 assumes that the interarrival times of customers are independently and exponentially distributed with a constant arrival rate (say) λ; likewise, the customer service times are independently exponentially distributed with constant service rate μ; arrival and service times are also independent of each other. The symbol M in the notation M/M/1 refers to the Markov properties of the arrival and service times in this model; the symbol 1 means that there is a single server. Implicit in this notation are the assumptions of an unlimited capacity of the waiting room, and a First-In-First-Out (FIFO) priority rule (queue discipline). The traffic rate (utilization factor, load) ρ equals λ / μ. The M/M/1 reaches a steady state provided $\rho < 1$. In our examples we assume that the steady state is indeed reached if we select $\rho = 1/3$ and simulate $n = 10^7$ customers per run. However, when we simulate only ten customers per run, the M/M/1 shows transient behaviour (see Section 4).

In the steady state, the M/M/1 has analytically known means (so it is easy to compare simulation results with the 'true' results) for the following responses: the number of customers in the system (say) L, the number of customers in queue (excluding the customer being served) Lq, the waiting time in the system W, and the waiting time in the queue (excluding the customer being served) Wq:

$$L = \frac{\lambda}{\mu - \lambda}, \quad Lq = \frac{\lambda^2}{\mu(\mu - \lambda)}$$

$$(1) - (2)$$

$$W = \frac{1}{\mu - \lambda}, \quad Wq = \frac{\lambda}{\mu(\mu - \lambda)}$$

$$(3) - (4)$$

At the start of each M/M/1 simulation run, we make the server idle and the queue empty. We program the simulation in the Arena simulation package and in the faster C language. In Arena we use its standard PRN generator. In C, we use L'Ecuyer's generator taken from Law & Kelton [6] (432-435). This generator will also be used to implement the bootstrap.

3. M/M/1 example with Gaussian simulation responses

In the first example we analyze the M/M/1 when we conjecture that its simulation gives responses that are normally distributed. A parametric statistical technique - such as the Student t test - should then give a correct coverage probability: the $1-\alpha$ confidence interval should cover the true value with a $1-\alpha$ probability. This true value is given by (1) through (4) if the simulation has indeed reached the steady state. Therefore, we simulate ten million (10^7) customers per run.

For each run we estimate the four responses corresponding with (1) through (4) through their averages (say) $\overline{Y}_{i;j}$ with $i = 1, \ldots, 4$ and $j = 1, \ldots, m$. These m averages are independent and identically distributed (IID) because they result from the same M/M/1 simulation program with the same input value for ρ and non-overlapping PRN streams. This IID assumption is crucial for both the parametric and the bootstrap techniques. Moreover, we select a 'large' m value so that the Central Limit Theorem (CLT) applies; for example, we select an m of 80.

Let us first consider only one of the four responses, and let $\overline{\overline{Y}}$ denote the average of the m IID $\overline{Y}_j$. Further, let η denote the mean of these $\overline{Y}_j$, and let η_0 denote the true value following from (1) through (4). Then H_0 in (5) is the null hypothesis, whereas H_1 is the alternative hypothesis:

$$H_0: \eta = \eta_0; \qquad H_1: \eta \neq \eta_0. \qquad (5)$$

To test each of the four null hypotheses, we use a type-I error probability of $\alpha = 0.05$. First we apply the parametric t test; then the bootstrap (Section 3).

Student t test

To test the normality assumption implied by the t test, we construct the empirical probability distribution $\hat{F}$ that has a probability of $1/m$ at each element $\overline{Y}_j$ of the sample. Figure 1 gives this $\hat{F}$ and the corresponding estimated density function $\hat{f}$ for one of the four responses, namely $\overline{W}_q$. The chi-square goodness-of-fit test accepts $\hat{F}$ as a Gaussian distribution.

Table 1 displays the results of the t test for the four outputs. This table shows very small standard errors S, so – on hindsight – $m = 80$ is a high value. The t test does not reject H_0, as we expected from the start.

	η_0	$\overline{\overline{Y}}$	S	$|t_0|$
L	0.50000	0.50005	0.00037	1.24215
Lq	0.16667	0.16670	0.00025	1.07155
W	3.75000	3.75044	0.00237	1.67355
Wq	1.25000	1.25019	0.00175	0.97651

Table 1: Student t test for mean responses of M/M/1 simulation with $m = 80$ runs and $n = 10^7$ customers per run; critical value $t_{0.05;79} = 1.99045$
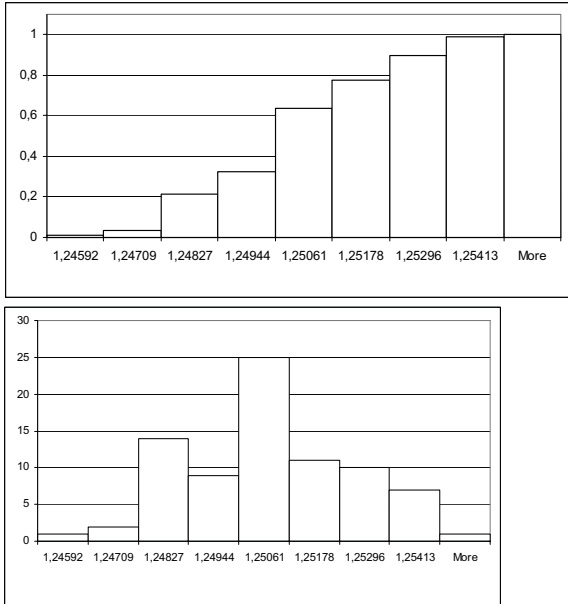
Figure 1: (a) Empirical Distribution $\hat{F}$ (b) Empirical Density Function $\hat{f}$ from the sample $\overline{W}q$ (m = 80)

Figure 2: (a) Empirical Distribution, (b) Empirical Density Function, from the bootstrapped $\overline{W}q^*$ (m = 80)

Bootstrap test

Based on Efron and Tibshirani [2] (45-53, 170-173) - and also Mooney and Duval [7] (10-11, 36-40) - we bootstrap the original sample of m IID observations $\overline{Y}_j$ (j = 1,…, m), as follows.

1. From the original sample, we draw a **random sample** of the same size m - **with replacement** – denoted by $\{\overline{Y}_1^*,\ldots,\overline{Y}_j^*,\ldots,\overline{Y}_m^*\}$ (j = 1,…, m). Figure 2 gives an example of the resulting bootstrapped distribution function $\overline{F}^*$ and density function $\hat{f}^*$, which resembles Figure 1 but is not identical to that figure. This bootstrap sample gives the bootstrap estimator

$$\overline{\overline{Y}}^* = \sum_{j=1}^{m} \overline{Y}_j^* / m$$

which has zero probability of being identical to the original value of $\overline{\overline{Y}}$.

2. We **replicate** Step 1 (say) B times, where replicate b gives (we take B = 1000):

$$\overline{\overline{Y}}_b^* = \sum_{j=1}^{m} \overline{Y}_{b;j}^* / m, \quad b = 1,\ldots,B$$

3. We **sort** the B bootstrap observations $\overline{\overline{Y}}_b^*$, from the smallest observation – denoted by $\overline{\overline{Y}}_1^*$ - to the largest one – denoted by $\overline{\overline{Y}}_B^*$. (The sorted observations $\overline{\overline{Y}}_b^*$ are the so-called order statistics.) Figure 3a shows an example of the resulting empirical distribution function, which has a probability mass of 1 / B at each point. A bootstrap 1 - α confidence interval is then [$\overline{\overline{Y}}_{(B\alpha/2)}^*$, $\overline{\overline{Y}}_{(B[1-\alpha/2])}^*$]. For example, if B = 1000 and α = 0.05, then the lower limit is the 25th ordered value of the bootstrapped observations, and the upper limit is the 975th value. If non-integer values result for the particular B and α values, then we round to the next integer.

In Figure 3, the solid vertical line is at $\overline{W}q$ = 1.250191; the square-dotted lines at 1.249817 and 1.250586, which are the 2.5% and 97.5% percentiles of the histogram; the dashed line is at $\eta_0 = Wq_0 = $ 1.25. So this figure implies that the bootstrap interval does cover the true value η_0. Table 2 shows the bootstrap confidence interval for all our four responses.

4. M/M/1 example: more simulation responses

The preceding section gave normally distributed M/M/1 simulation responses with correct results for both the parametric t test and the bootstrap.
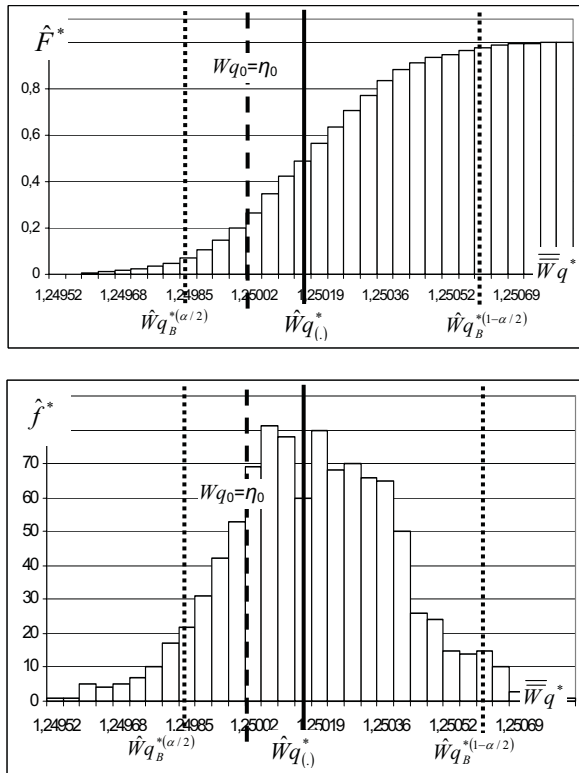
Figure 3: (a) Probability Distribution from the B = 1000 sample variables $\overline{\overline{W}}q^*$, (b) Density Function from the B = 1000 sample variables $\overline{\overline{W}}q^*_{(b)}$

	η_0	Confidence Interval
L	0.50000	[0.499972,0.500134]
Lq	0.16667	[0.166644,0.166751]
W	3.75000	[3.749963,3.750972]
Wq	1.25000	[1.249817,1.250586]

Table 2: Bootstrap confidence intervals with B = 1000 bootstrap samples, for the M/M/1 responses corresponding with Table 1

This result agrees with the statistics literature showing that the t statistic is not very sensitive to non-normality. Obviously, this sensitivity decreases as the sample size m increases. We therefore investigate the effect of the number of simulation runs, m.

Moreover, the simulation literature shows that the average of a long run is asymptotically normally distributed - even though the individual observations are non-normal and auto-correlated.

We therefore investigate the effect of the number of customers per simulation run, n.

Finally, the statistics literature shows that the χ^2 and the F statistics are more sensitive to non-normality than the t statistic. We therefore analyze the variances - instead of the means - of the simulation responses.

Mean responses of run with $n = 10^7$ customers and varying number of runs m

Table 3 shows the t and the bootstrap intervals for five values of m, namely 2, 5, 10, 25, 50. This table shows that for m = 2, the bootstrap does not include the true value $E(Wq)$ = 1.25.

In fact, in this example the simulation provides only two numbers - namely 1.250349 and 1.250928, which both exceed $E(Wq)$; so each bootstrap sample average exceeds the true value. In general, we recommend that m = 2 should not be used in bootstrapping.

		Parametric t test	Bootstrap
m 50	L	[0.499850 ; 0.500080]	[0.499849 ; 0.500061]
	Lq	[0.166564 ; 0.166730]	[0.166565 ; 0.166716]
	W	[3.749144 ; 3.750531]	[3.749158 ; 3.750409]
	Wq	[1.249317 ; 1.250454]	[1.249335 ; 1.250340]
m 25	L	[0.499876 ; 0.500194]	[0.499883 ; 0.500175]
	Lq	[0.166587 ; 0.166813]	[0.166592 ; 0.166799]
	W	[3.749380 ; 3.751203]	[3.749435 ; 3.751153]
	Wq	[1.249497 ; 1.251015]	[1.249537 ; 1.250928]
m 10	L	[0.499890 ; 0.500270]	[0.499920 ; 0.500222]
	Lq	[0.166573 ; 0.166867]	[0.166595 ; 0.166831]
	W	[3.749097 ; 3.751223]	[3.749268 ; 3.750967]
	Wq	[1.249278 ; 1.251225]	[1.249455 ; 1.250981]
m 5	L	[0.499792 ; 0.500419]	[0.499911 ; 0.500288]
	Lq	[0.166504 ; 0.166963]	[0.166590 ; 0.166876]
	W	[3.747991 ; 3.752172]	[3.748745 ; 3.751368]
	Wq	[1.248638 ; 1.251893]	[1.249265 ; 1.251351]
m 2	L	[0.497573 ; 0.502909]	[**0.500031** ; 0.500451]
	Lq	[0.164953 ; 0.168739]	[**0.166697** ; 0.166995]
	W	[3.739419 ; 3.762676]	[**3.750593** ; 3.752502]
	Wq	[1.239679 ; 1.262842]	[**1.250349** ; 1.250928]

Table 3: Parametric and bootstrap confidence intervals for varying m; bold face denotes type-I error; remaining symbols defined in Tables 1 and 2
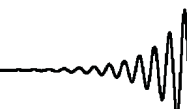
Mean responses of run with n = 10 customers and varying run numbers m

With only n = 10 customers per run, the simulation remains in the transient state so we should not apply (1) through (4). In this academic example we can afford to estimate the true mean η through a big number of runs, namely 106; see Table 4. This table shows very small standard errors. So we use the averages in this table as the true values η to decide whether the confidence intervals cover the true mean. Figure 4 illustrates that the density function (estimated from m = 10000 observations) does not look Gaussian.

	Average	Standard error
L	0.487292	0.000382
Lq	0.164769	0.000266
W	3.469899	0.001828
Wq	0.970643	0.001280

Table 4: Mean responses of simulation run with only 10 customers each, estimated from 10^6 observations

		Parametric t-test	Bootstrap
m 50	L	[0.378961 ; 0.678679]	[0.410282 ; 0.691098]
	Lq	[0.081722 ; 0.326162]	[0.110272 ; 0.333543]
	W	[3.274720 ; 4.391356]	[3.320852 ; 4.418864]
	Wq	[0.703133 ; 1.632256]	[0.761513 ; 1.651382]
m 25	L	[0.337200 ; **0.474021**]	[0.343763 ; **0.471647**]
	Lq	[0.063101 ; **0.133002**]	[0.068224 ; **0.132341**]
	W	[2.853836 ; 3.684307]	[2.882404 ; 3.666295]
	Wq	[0.473647 ; **0.928672**]	[0.507649 ; **0.925314**]
m 10	L	[0.341220 ; **0.474677**]	[0.320291 ; 0.503626]
	Lq	[0.038709 ; **0.134443**]	[0.050122 ; **0.126516**]
	W	[2.641867 ; 3.546088]	[2.755872 ; **3.443103**]
	Wq	[0.331028 ; **0.836934**]	[0.385879 ; **0.790322**]
m 5	L	[0.205214 ; 0.676804]	[0.300132 ; 0.581887]
	Lq	[-0.000873; 0.199383]	[0.039158 ; **0.161557**]
	W	[2.451091 ; 4.164820]	[2.817221 ; 3.831998]
	Wq	[0.145700 ; 1.194277]	[0.346806 ; 0.993171]
m 2	L	[-1.615904; 2.576032]	[0.315107 ; 0.645021]
	Lq	[-0.625336; 0.832008]	[0.045988 ; **0.160684**]
	W	[-3.287186; 0.746990]	[3.177641 ; 4.282159]
	Wq	[-3.312499; 4.796973]	[0.423121 ; 1.061353]

Table 5: Confidence intervals for only n = 10 customers per simulation run for varying m; see Tables 3 and 4

Table 5 shows that neither the parametric interval nor the bootstrap interval ever misses η for $m \geq 50$. The t statistic turns out to be insensitive to the non-normality shown in Figure 4. In general, we conclude that bootstrapping is not useful when the simulation response is a run average.

Response variances of run with n = 10 customers and varying run numbers m

As the simulation response of interest we now consider *variances* instead of means, so (5) is replaced by

$$H_0: \ \sigma^2 = \sigma_0^2; \quad H_1: \ \sigma^2 \neq \sigma_0^2 \qquad (6)$$

To obtain the 'true' value of σ_0^2, we again use Table 4: we multiply the numbers in the last column by 10^3 (= $\sqrt{m}$). We consider different run numbers: m = 5, 10, 25, 40, 50, 80, 100.

The parametric 90% confidence interval for σ^2 is

$$\frac{(m-1)S^2(\bar{Y})}{\chi_{0.05;\,m-1}^2} \leq \sigma^2 \leq \frac{(m-1)S^2(\bar{Y})}{\chi_{0.95;\,m-1}^2} \qquad (7)$$

where $\chi_{0.05;\,m-1}^2$ and $\chi_{0.95;\,m-1}^2$ are the 5% and the 95% quantiles of the χ^2 distribution with m–1 degrees of freedom.

For the bootstrap intervals, we resample the m run averages, and re-estimate the variance from these m bootstrap observations, etc. Table 6 shows that for $m \geq 50$ the bootstrap intervals do cover σ_0^2, whereas the parametric intervals do not.

Finally, we do not study the individual variance magnitudes, but compare the variances of two independent random samples.

The first sample consists of m averages of n = 10 customers each, obtained through PRN stream 1 of L'Ecuyer's generator defined in Law & Kelton [6] (433-434); the second sample is obtained with stream 10. We test σ_0^2

$$H_0: \ \sigma_1^2 = \sigma_{10}^2; \quad H_1: \ \sigma_1^2 \neq \sigma_{10}^2 \qquad (8)$$

where σ_1^2 and σ_{10}^2 are the variances obtained through streams 1 and 10 respectively, so we know that this null-hypothesis is true. We consider m = 10, 50, 100 runs.
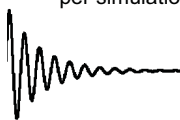
		Parametric (χ^2-test)	Bootstrap
.m 100	L	[**0.1361** ; 0.2177]	[0.0726 ; 0.2841]
	Lq	[0.0767 ; 0.1227]	[0.0310 ; 0.1781]
	W	[2.5686 ; 4.1081]	[2.0092 ; 4.2601]
	Wq	[1.4207 ; 2.2722]	[0.0197 ; 3.1053]
m 80	L	[**0.1517** ; 0.2568]	[0.0943 ; 0.2971]
	Lq	[**0.0770** ; 0.1304]	[0.0440 ; 0.1590]
	W	[**3.5473** ; 6.0043]	[2.2412 ; 7.0636]
	Wq	[**2.0240** ; 3.4259]	[1.1925 ; 4.3765]
m 50	L	[**0.2054** ; 0.4015]	[0.0453 ; 0.6153]
	Lq	[**0.1366** ; 0.2671]	[0.0179 ; 0.4165]
	W	[2.8507 ; 5.5736]	[1.7493 ; 6.5558]
	Wq	[**1.9737** ; 3.8588]	[0.8229 ; 5.1368]
m 40	L	[0.0653 ; **0.1387**]	[0.0393 ; 0.1508]
	Lq	[0.0225 ; **0.0479**]	[0.0122 ; **0.0515**]
	W	[1.7187 ; 3.6501]	[1.3694 ; **3.3209**]
	Wq	[0.6514 ; **1.3834**]	[0.4649 ; **1.3700**]
m 25	L	[0.0181 ; **0.0476**]	[0.0170 ; **0.0363**]
	Lq	[0.0047 ; **0.0124**]	[0.0065 ; **0.0110**]
	W	[0.6669 ; **1.7537**]	[0.5799 ; **1.3972**]
	Wq	[0.2002 ; **0.5265**]	[0.1103 ; **0.4756**]

Table 6: Response variance σ^2 of four responses $\sigma_0^2(L) = 0.1459$, $\sigma_0^2(Lq) = 0.0708$, $\sigma_0^2(W) = 3.3423$, $\sigma_0^2(Wq) = 1.6379$

The parametric 90% confidence interval for the ratio $\sigma_1^2 / \sigma_{10}^2$ is given by

$$\frac{S_1^2}{S_{10}^2} F_{0.05;\ m-1,m-1} \leq \frac{\sigma_1^2}{\sigma_{10}^2} \leq \frac{S_1^2}{S_{10}^2} F_{0.95;\ m-1,m-1} \qquad (9)$$

where $F_{0.05;\ m-1,m-1}$ and $F_{0.95;\ m-1,m-1}$ are the 5% and the 95% quantiles of the F distribution with $m-1$ degrees of freedom for both the numerator and the denominator.

Next, we bootstrap the m run averages, estimate the variance from these m IID averages, etc. Table 7 shows that for $m \geq 50$ the bootstrap intervals do cover the ratio $\sigma_{1_0}^2 / \sigma_{10_0}^2 = 1$, whereas the parametric intervals do not; that is, the F statistic is sensitive to non-normality.

		Parametric F test	Bootstrap
m 100	L	[0.73807 ; 1.43436]	[0.73914 ; 2.88741]
	Lq	[0.69675 ; 1.35407]	[0.31897 ; 4.17641]
	W	[**1.07688** ; 2.09282]	[0.41237 ; 3.01069]
	Wq	[**1.15986** ; 2.25409]	[0.65561 ; 1.57299]
m 50	L	[0.93755 ; 2.42206]	[0.47687 ; 4.89792]
	Lq	[**1.02148** ; 2.63887]	[0.41887 ; 7.24482]
	W	[**1.29542** ; 3.34656]	[0.83133 ; 4.37372]
	Wq	[**1.60051** ; 4.13474]	[0.78944 ; 6.79824]
m 10	L	[0.27827 ; 2.81200]	[0.02318 ; 3.21575]
	Lq	[0.21617 ; 2.18444]	[0.00545 ; 3.39574]
	W	[0.07635 ; **0.77159**]	[0.09051 ; **0.64896**]
	Wq	[0.05964 ; **0.60270**]	[0.00632 ; 1.02862]

Table 7: Response variance ratios $\sigma_{10}^2 / \sigma_{10}^2$ = 1

5. Conclusion

We used a basic simulation model – namely the M/M/1 queue – to compare parametric and bootstrap tests. In case of normally distributed responses both methods give correct results; that is, the procedures give confidence intervals that cover the true value with a probability of $1 - \alpha$. In case of 'serious' non-normality, however, only the bootstrap gives good confidence intervals; such non-normality occurs if other responses than means are of interest, for example, variances.

References

[1] *O.F. Demirel and T.R. Willemain*, Generation of simulation input scenarios using bootstrap methods, Journal Operational Research Society 53 (2002), 69-78.

[2] *B. Efron and R.J. Tibshirani*, An introduction to the bootstrap, Chapman & Hall (New York, 1993).

[3] *L.W. Friedman and H.H. Friedman,* Analyzing simulation output using the bootstrap method, Simulation 64, Vol. 2 (1995) 95-100.

[4] *J.P.C. Kleijnen, R.C.H. Cheng, and B. Bettonvil*, Validation of trace-driven simulation models: bootstrapped tests, Management Science 47, Vol. 11 (2001) pp. 1533-1538.

[5] *J.P.C. Kleijnen and W. Van Groenendaal*, Measuring the quality of publications: new methodology and case study. Information Processing & Management 36 (2000) 551-570.

[6] *A.M. Law and W.D. Kelton*, Simulation modeling and analysis, 3rd edition, McGraw-Hill (New York, 2000).

[7] *C.Z. Mooney and R.D. Duval*, Bootstrapping: a non-parametric approach to statistical inference, Sage Publications, Series: Quantitative Applications in the Social Sciences, no. 07-095, Newbury Park, 1993.
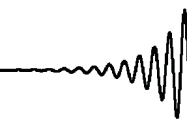
SHORT NOTES

MAPLE Software Applied for Stability Reseach of Electric Drive TVC-IM

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.... sketches a stability research method of TVC-IM open system is described

.... shows a MAPLE module to analyse the stability e.g. by finding the coefficients of the characteristic equation

.... using numerical and symbolic algorithms of MAPLE for analysing a circuit.

Introduction

It is known that in open systems of the electric drive (**ED**) "Thyristor voltage converter – induction motor" (**TVC-IM**) oscillations of output coordinates may appear in some operating modes. These oscillations are considered negative and affect the application range of the electric drive.

The oscillations appear due to the presence of intrinsic positive feedback of the angle between the load current and the first harmonic of the **TVC** output voltage.

This is typical for converters with classic synchronization of the thyristor and the supply-line voltage. Technical problems of **TVC-IM** stability are studied in detail in [1,3]. The present article is devoted to research of some methods with application of MAPLE software.

Mathematical description of TVC-IM

TVC and the intrinsic feedback are considered to be amplifying links with gains K_{TVC} and K_{φ}.

Output voltage of thyristor converter U_1 is a function of the thyristor trigger angle α and equivalent phase of stator current φ_e. For each point U_1 is calculated according to the approximating function, i.e. the polynomial of the fourth order [2]

$$U_1 = a_0 + a_1\alpha + a_2\alpha^2,$$

$$a_0 = -0,1291 + 0,06165 \cdot \varphi_e - 7,2407 \cdot 10^{-4} \cdot \varphi_e^{\,2},$$

$$a_1 = 0,02723 - 1,5212 \cdot 10^{-3}\varphi_e + 2,038 \cdot 10^{-5} \cdot \varphi_e^{\,2},$$

$$a_2 = -2,1534 \cdot 10^{-4} + 8,2836 \cdot 10^{-6}\varphi_e -$$
$$-1,1941 \cdot 10^{-7}\varphi_e^{\,2}$$

The equivalent current phase is:

$$\varphi_e = arctg\frac{X_e}{R_e},$$

where X_e and R_e - equivalent inductive impedance and resistance of induction motor T - shaped equivalent circuit.

$$\left. \begin{array}{l} X_e = x_1 + x_0 - \dfrac{x_0\left(x_2' + x_0\right)}{\left(x_2' + x_0\right)^2 + \left(\dfrac{r_2'}{s}\right)^2}, \\[3em] R_e = r_1 + \dfrac{x_0^2\dfrac{r_2'}{s}}{\left(x_2' + x_0\right)^2 + \left(\dfrac{r_2'}{s}\right)^2} \end{array} \right\}$$

Using values U_{1n} and φ_{en} for the current step and $U_{1,n-1}$ and $\varphi_{e,n-1}$ for the previous step then, for little increments, we can linearise K_{TVC} and K_{φ}.

$$\left. \begin{array}{l} \Delta U_1 = U_{1,n} - U_{1,n-1}, \\ \Delta \varphi_e = \varphi_{e,n} - \varphi_{e,n-1}. \end{array} \right\}$$

Then, the gains K_{TVC} and K_{φ} can be found as:

$$K_{TVC} \approx \frac{\Delta U_1}{\Delta \varphi_e}, \quad K_{\varphi} \approx \frac{\Delta \varphi_e}{\Delta \omega}$$

The research of the TVC-IM open system stability is made in accordance with the block scheme, which is shown in figure 1. The output signals of all the links depend uniquely on the input signals.

The link accounting for the electromagnetic part of induction motor $H_{EM}(p)$ is described with an analytic expression. This expression determines the transitional component of electromagnetic moment IM, as a reaction on the input voltage jump, the speed being invariable.

The expression has terms of three different types [3]:

$$H_{EM}(p) = \sum_{i=1}^{3} M_i$$

$$M_1 = A_1 = const$$

$$M_2 = A_2 e^{-\frac{1}{T_2}t}$$

$$M_3 = A_3 e^{-\frac{1}{T_3}t} \cos\Omega_3 t$$

The amplitudes, time constants and oscillation frequencies depend on the motor parameters. The transition from temporal dependences to link transfer function is made using the Laplace transform

$$H(p) = p \cdot L\{h(t)\},$$

where $L\{h(t)\}$ is the transform of the link transfer function, which is the sum of all its terms.

The transfer link function accounting for the electromagnetic part **IM**, is:

$$H_{EM}(p) = A_1 + \frac{A_2 T_2 p}{T_2 p + 1} + + \frac{A_3 p^2 + \dfrac{A_3 p}{T_3}}{p^2 + \dfrac{2p}{T_3} + \left(\dfrac{1}{T_3^2} + \Omega_3^2\right)}$$

The transfer function of the TVC-IM open system without taking into account its intrinsic positive feedback for angle φ_e is:

$$H_p(p) = \frac{K_{TVC} \cdot H_{EM}(p)}{Jp}.$$

The system transfer function with positive feedback is:

$$H_s(p) = \frac{H_p(p)}{1 - H_p(p) \cdot K_\varphi}.$$

Thus, we can derive the characteristic equation from the previous expression as:

$$a_0 p^4 + a_1 p^3 + a_2 p^2 + a_3 p + a_4 = 0.$$

Stability research of the open system TVC-IM is based on application of the Hurwitz criterion for the characteristic equation with computer aid [1].
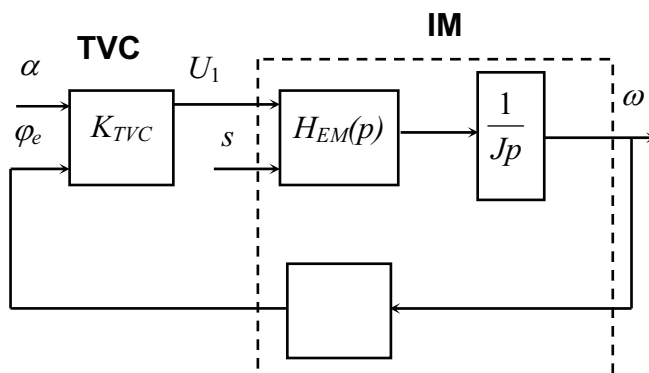
Figure. 1: Block scheme of the TVC-IM open system

Maple 7.0 application

However, a problem remains, connected with preliminary preparation of the initial data, i.e. finding coefficients of the characteristic equation. Since the transfer function transform of IM electromagnetic part to the polynomial expression is rather complex, the coefficients in their general form are bulky algebraic expressions, and their computation is time-consuming enough.

This problem can be solved with the help of multi-function mathematical program Maple 7.0, developed by Waterloo Maple Inc.

In particular, the program allows to transform and to simplify polynomials of almost any kind and degree of complexity.

Figure 2 shows an example of the coefficients transformation. The following commands are used:

- `simplify ( f ( p ) )`
  - to simplify the algebraic expression;

- `denom ( f ( p ) )`
  - to prepare the expression denominator for further computations;

- `sort ( f ( t ), p )`
  - to sort the terms in the decreasing order of the variable degree.

  Also, it is sometimes useful to apply command

- `expand (f ( ) )`
  - to remove brackets in an algebraic expression.
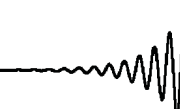
Similarly to the given example of coefficient expressions of characteristic equation HEM(p), which are further analyzed to determine ED stability in every point of mechanical IM characteristic. The expression for the coefficients equation, obtained with the help of the program Maple, coincide with the coefficients, obtained by manual calculation.

However, the time expenditures for this operation diminish considerably. The Maple computation results can be considered more reliable, and their further use more convenient, since slips of pen during data processing are eliminated.

Conclusion

It should be noted that the proposed combination of the analytic and numerical methods is fundamentally more exact than the majority of the TVC-IM open system stability research methods.

Having combined the numerical and analytic methods we can state that presence and character of the oscillations depend on the parameters of ED, load moments, inertia moments, TVC thyristor trigger angles and initial electromagnetic conditions.

References

[1] *Андрющенко О.А., Бойко А.А.* Исследование устойчивости разомкнутой системы электропривода ТПН-АД // Електромашинобудування та електрообладнання. Міжвідомчий науково - технічний збірник. Випуск 54. – Київ: “Техніка” – 2000. – С. 16 - 20.

[2] *Андрющенко О.А.* Упрощенная модель электропривода ТПН-АД. // Автоматика. Автоматизация. Электротехнические комплексы и системы. – 1998. – №2 (3). – С. 32-41.

[3] *Герасимяк Р.П., Андрющенко О.А.* Автоколебания в электроприводе ТПН-АД при синхронизации вентилей с напряжением сети // Електромашинобудування та електрообладнання. Міжвідомчий науково - технічний збірник. Випуск 52. – Київ: “Техніка” – 1999. - С. 25 - 30.
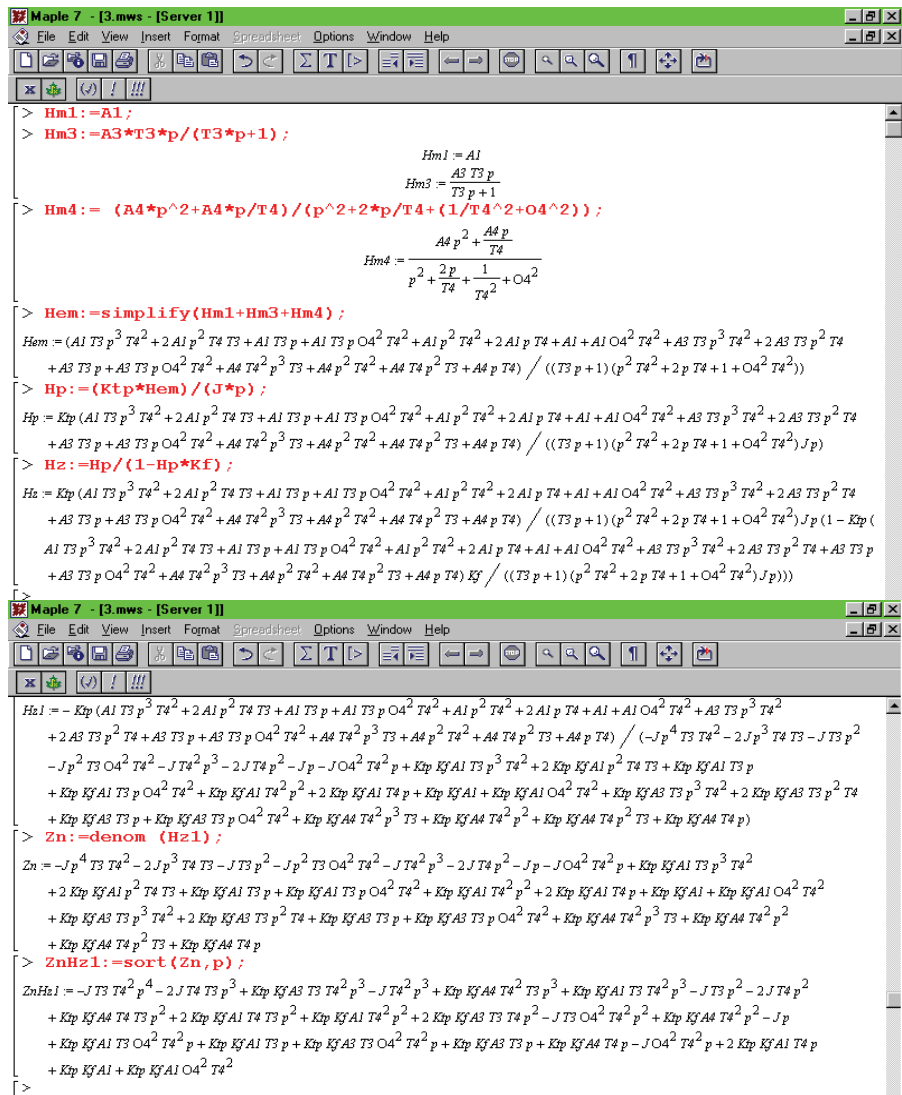
Behavioural Object-Oriented Frequency Domain Electronic Simulation

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…. introduces Alecsis, a simulator for time domain behavioural simulation of mixed signal and mixed domain circuits and systems

…. presents an extension to Alecsis for frequency domain simulation, providing a powerful tool for behavioural object-oriented AC simulation

Alecsis simulator

Modern electronic simulators mostly use HDL (Hardware Description Language) to establish communication between designer and computer code performing simulation. This is the case with Alecsis [1], too. Namely, Alecsis communicates with the user by the AleC++ language being a superset of C++ [2]. The simulator itself is performing time domain behavioural simulation of mixed signal and mixed domain circuits and systems. It was successfully applied to simulation of a broad set of systems starting with non-linear electronic via digital electronic, trough mixed mode electronic and mixed mode electromechanical, ending with mixed mode behavioural. Now frequency domain analysis is added, and reported here for the first time.

AC Analysis Algorithm

Figure 1 shows the simplified algorithm of frequency domain simulation as implemented in the Alecsis simulator [3].

Extensions of the AleC++ Language

In order to implement AC domain simulation input language of ALECSIS simulator had to be extended. First a new command `ac` for AC analysis has been added, e.g.

```
ac
{fscale=2;
fstart=10;
fstop=1G;
fnum=100;}
```

The AC analysis works with complex numbers, and since AleC++ is an object oriented language, all to the variables the following properties have been added: `amp` (amplitude), `phase` (phase), `real` (real part) and `imag` (imaginary part). E.g. `output->phase` gives the phase of the `output`.

New types of independent generators have been added as well. Those are `vac` - voltage and `cac` - current generator. They accept the following parameters: `amp` - amplitude and `phase` - phase of the signal.

Furthermore, the lists of parameters for any type of controlled sources have been extended. For example, for voltage controlled voltage source, beside the `gain`, that now becomes real part, `igain` parameter has been added, representing the imaginary part of complex gain.
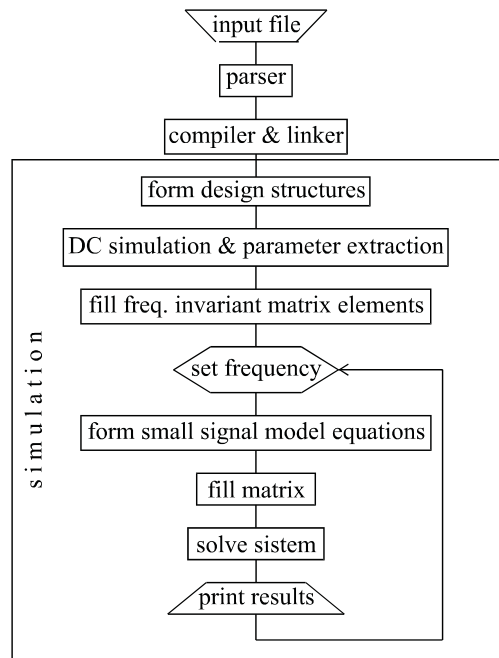
Figure 1: Simplified simulation algorithm

Figure 2: Diagram of Simulated Circuit

New processes with `per_frequency` synchronisation have been supplied, providing the user to write AleC++ code to be processed per frequency. An operator `currfreq` is introduced, returning the current frequency of the simulation.

All these features, along with object-orientedness of the AleC++ provide a powerful tool for behavioural frequency domain simulation.

Connection to the Non-Linear DC simulation

Semiconductor devices have strictly nonlinear nature. However, in some circuit situations, the characteristics of the device must be represented only in a restricted range of currents and voltages. In particular, for small variations around operating point, the nonlinear characteristics of the device can be linearised by means of the expansion in Taylor series truncated after the first order terms. Obtained model is called small-signal model.

Spice-like [4] modelling of the semiconductor devices is implemented in Alecsis. Parameters used in small-signal models are calculated during DC analysis that must precede the AC analysis. Those parameters for all nonlinear devices in a circuit must be stored in equation formulation for small-signal models [5].

Simulation Example

Figure 2 shows one simulated circuit. Block named *core* can model virtually any circuit. All the parameters of the block (here h - parameters) can be assigned functions of arbitrary complexity. Combination of circuit and behavioural model can be used in simulations of IP cores. Sample of simulation code in AleC++ shows how one of the core parameters is calculated. The simulated results are depicted in Fig. 3.

References

[1]   -----, "Alecsis 2.3, the simulator for circuits and systems. User's manual", Laboratory for Electronic Design Automation, Faculty of Electronic Engineering, University of Niš, Yugoslavia, LEDA – 1/1998.

[2]   *Litovski V., Maksimović D., and Mrčarica Z.,* "Mixed-signal modeling with AleC++: Specific features of the HDL", SIMPRA 8, 2001, pp. 433-449.

[3]   *Litovski V., and Zwolinski, M.,* "VLSI Circuit Simulation and Optimization", Chapman and Hall, London, 1997

[4]   *L. W. Nagel,* "SPICE2 A Computer Program to Simulate Semiconductor Circuits", Electr. Res. Lab. Rep. No. ERL-M520, Univ. of Calif., Berkeley, 1975.
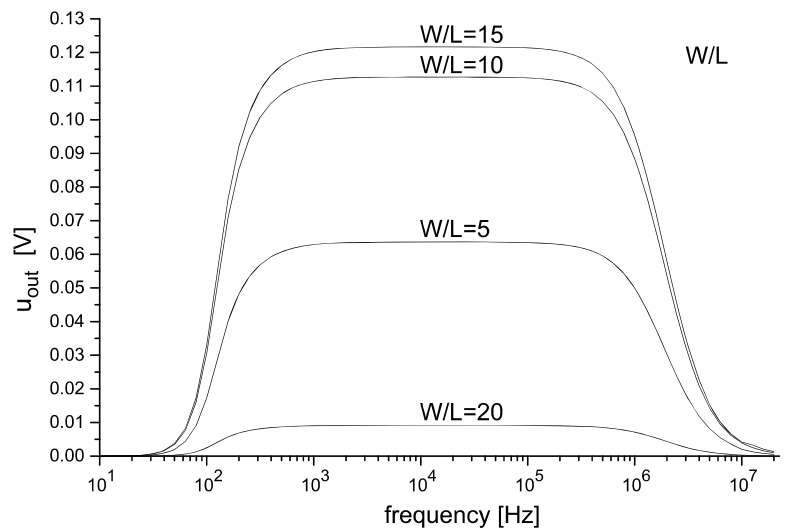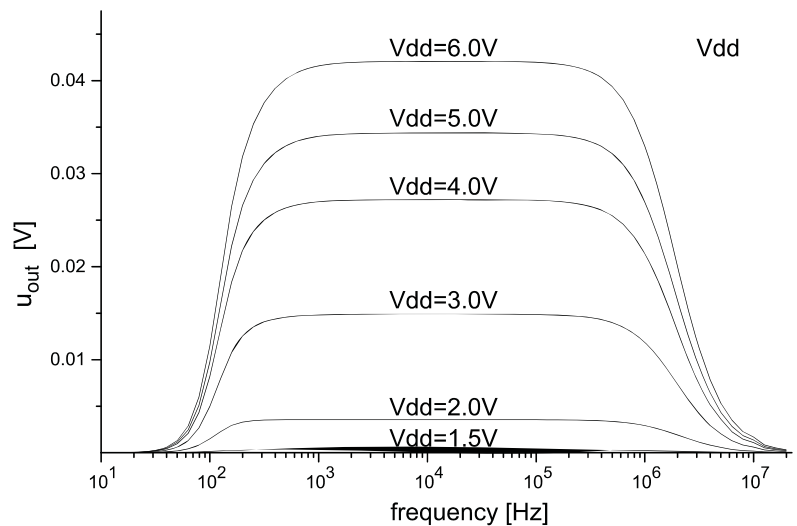
[5]   *Antognetti P., Massobrio G.*, editors, "Semiconductor Device Modeling with SPICE", McGraw-Hill, 1988.

```
#include <complex.ac> //complex class
root module test_circuit()
{
  IP_core ip;
...
  ip (3, 0, 4, 0);
...
  action per_frequency (){
    double h210 = 100 + 1.5*(VDD - 6);
    double w = currfreq/(2*M_PI);
    double wz1 = 10/(2*M_PI);
    complex s(0, w);
    complex h21 = h210*(s/wz1+1);
...
    ip->h21r = h21.real;
    ip->h21i = h21.imag;
  }
  ac{fscale=2; fstart=1; fstop=10MEG; fnum=10;}
}
```

OPEN DESIRE: Free Software for Dynamic System Simulation

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…. offers simulator DESIRE (Linux version) as Open Software under GNU general public license
… sketches briefly features of OPEN DESIRE
… reminds the conditions for Open Software

OPEN DESIRE - Free Software under GNU General Public License

As a contribution to Free Software [1] and to the Linux community, we offer the complete OPEN DE-SIRE modelling/simulation package for Linux, including PC binaries, source code in C, a comprehensive manual, and over 200 program examples *without any charge* except for media, handling, and shipping, under the GNU General Public Licence [1] proposed by the Free Software Foundation. For details refer to our website: members.aol.com/gatmkorn

Features of DESIRE

DESIRE

OPEN DESIRE includes an *experiment-protocol script interpreter* and a *runtime-compiled* industrial-strength *differential-equation solver*. We can solve up to 20,000 first-order differential equations with fixed- and variable-step Runge-Kutta integration, or up to 400 differential equations with variable-step/ variable-order rules for stiff systems, all in double-precision floating-point format. Differential-equation and difference-equation models use an easily readable mathematical notation and can mix scalar and vector equations. The model code compiles and executes immediately on a typed or programmed **drun** command to produce solution displays or listings for truly interactive modelling.

Such "direct-executing" simulation runs can be initialized and run by typed interactive commands. More often, though, an interpreted experiment-protocol script calls repeated simulation runs (say for parameter-influence or optimization studies) and manipulates parameters and initial conditions. Experiment-protocol scripts resemble advanced Basic programs and can, in fact, be used for general-purpose mathematics. They handle vectors and matrices, and also complex numbers for complex frequency-response and root-locus plots. Scripts can also invoke operating-system functions and external programs.

Model equations and experiment-protocol scripts are entered in editor windows. You can select and run programs from multiple Editor Windows to compare models or protocols. Programs can generate special editor windows used as dialog boxes.

DESIRE programming, including practical simulation of neural networks and fuzzy logic, is described on our Web site. Two textbooks [2,3] describe earlier versions of DESIRE, and Refs. 4-6 discuss recent applications of the new vector compiler. We run OPEN DESIRE on personal computers under different Linux releases using either GNOME or KDE windows.

GNU General Public License

As specified in the Free Software Association's Web page, their use of the word "free" does not refer to such no-charge distribution (anyone can, in fact, redistribute the program with support or other added features, for a fee). "Free" rather refers to the opportunity to use, change, and distribute the source code with complete freedom. The GNU General Public License was carefully written to force all redistributions to include source code, and to keep Bad Guys from restricting part of the code with software patents.

Above all, we believe very strongly that academic computer-science departments ought to support and promote free-software projects. Academic departments have useful manpower and resources, and academic software research, part of the learning process, is relatively inexpensive. Inspiring source code – think of the excellent GNU compilers, etc. – is freely available and readily used in courses on software development, etc. Student projects can access true hands-on know-how with good source code. The Free Software community includes top programmers all over the world, and students are sure to benefit from such contacts. Quite beyond elegant programming, we believe that your students must learn, from your example, a measure of dedication to freely expanding scientific and professional knowledge.

References

[1] Free Software Foundation, Inc., 59 Temple Place - Suite 330, Boston, MA 02111, USA.
[2] Korn, G. A.: Dynamic-system Simulation with Microsoft Windows, Gordon and Breach, London, 1998.
[3] Korn, G. A.: Neural Networks and Fuzzy-logic Control on Personal Computers and Workstations, MIT Press, Cambridge, MA, 1995.
[4] Korn, G. A.: A Simulation-model Compiler for all Seasons, Simulation Practice and Theory, 9: 21-25, 2001.
[5] Korn, Granino A.: Interactive Solution of Partial Differential Equations by the Method of Lines, Mathematics and Computers in Simulation, 1644: 1-10, 1999.
[6] Korn, G.A.: Interactive Monte Carlo Simulation of Dynamic Systems with Input Noise, Research Memo, G.A. and T.M. Korn Industrial Consultants, Chelan, WA, September, 2000.

DDLAB - Discrete Dynamics Lab

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…. presents DDLAB, a software tools for researching discrete dynamical networks

…. describes DDLAB features for cellular automata and random Boolean networks

… gives license conditions: partly free shareware

Introduction

DDLab is an interactive graphics program for re-searching the dynamics of finite binary networks, from Cellular Automata to random Boolean networks and beyond, including their attractor basins. The program is relevant to the study of complexity, emergent phenomena, neural computation and aspects of theoretical biology such as modelling gene regulatory networks, and to the study of discrete dynamical networks in general in a variety of fields.

Discrete dynamical networks

A discrete dynamical network in DDLab can be imagined as a software simulation of a collection light bulbs which transmit information to each other about their on/off state, and turn on or off according to the arriving signals. In more abstract terminology, the network is made up of elements or *cells*, connected to each other by directed links or *wires*, where a wire has an input and output terminal. A cell takes on a value of either 0 or 1, and transmits this value down its output wires. Its value is updated as a function of the values on its input wires. Updating is usually done in parallel, in discrete time-steps, but may also be sequential in a prede-termined order.

3D Space-time patterns of a cellular automaton 20x20x20 with a reaction-diffusion randomly rule

It remains to set up the network according to the various parameters, which are:

- *Number of elements*, the system size, n.
- *Spacial topology of cells*: 1D-, 2D- or 3D- array with axial dimensions i, j, h, or others
- *Wiring scheme*. Defining the location of the output terminals of each cell's input wires, the element's ``neighbourhood''.

Here cellular automata have a homogeneous "nearest neighbour" (local) neighbourhood throughout the network. Random Boolean networks may have an arbitrary wiring scheme.

- *Rule scheme*, the rules or Boolean functions in the network. Each element applies a rule to its inputs to compute its output.
  Cellular automata have a homogeneous rule scheme throughout the network. Random Boolean networks may have an arbitrary rule scheme.

DDlab is able to create these networks, and graphically represent and analyze both the networks themselves and the dynamics resulting from the changing patterns of zeros and ones as the complex feedback web unfolds.

Space-time patterns, attractor basins

DDLab has two alternative ways of looking at net-work dynamics: local dynamics, running the network forwards, and global dynamics, which entails running the network backwards.

Running forwards (local dynamics) generates the network's space-time patterns from a given initial state. Many alternative graphical representations (and methods for gathering/analyzing data) of space-time patterns are available to illustrate different aspects of local network dynamics, including "fil-tering' to show up emergent struc-tures more clearly.

Running backwards (global dy-namics) generates multiple predeces-sors rather than a trajectory of unique successors. This procedure recon-structs the branching sub-tree of an-cestor patterns rooted on a particular state. States without predecessors may be disclosed, the so called "gar-den-of-Eden" states, the leaves of the sub-tree. Sub-trees, basins of attrac-tion, or the entire basin of attraction field can be displayed as directed graphs in real time, with many presen-tation options, and methods for gath-ering and analyzing data.
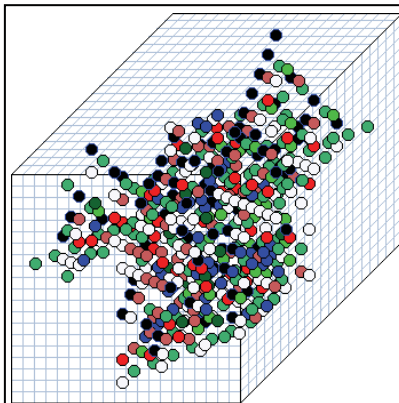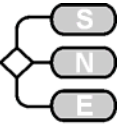
Source code, platforms, releases

The DDLab source code is written in C. The pro-gram is maintained for the following platforms: DOS/PC, UNIX/XWindows-Sun OS 4.1 and Solaris, Linux, and Irix SGI. In December 2003 DDLAB ver-sion m04 is released and can be downloaded from:

www.cogs.susx.ac.uk/users/andywu/ddlab.html or
www.ddlab.com

SIMULATIONISTS - PERSONALITIES

This SNE corner – introduced in December 2000 in SNE 29 - follows three aims: to introduce young simulationists or simulationist of the rising generation, resp., to introduce simulationists serving in a simulation society, and to report about awards and personal events of well-known simulationists.

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David Al-Dabass graduated from Imperial College in 1966 with BSc in Electrical Engineering, worked for Redifon Flight Simulation until 1972, completed a PhD in Parallel Processing at Staffordshire University in 1975 and held post-doctoral and advanced research fellowships at the Control Systems Centre, UMIST from 1976-82.

He joined The Nottingham Trent University in 1983. He is Fellow of the IEE, IMA and BCS and editor-in-chief of the International Journal of Simulation: Systems, Science and Technology; he currently serves as chair of the UK Simulation Society and director of European Simulation Multi-conference (ESM) series for SCS Europe.

Research of David Al-Dabass explores algorithms and computer architecture for machine intelligence. Advances in computer technology means that this research often involves parallelism and neural architectures to implement the algorithms devised for the application. Past work has developed algorithms based on picture grammar for licence plate recognition (J Cowell, 1990, PhD thesis), and investigated artificial neural network (ANN) and other paradigms for simulation and parameter estimation (M Cheung, 1992, C Goodwin 1997 PhD theses), multi dimensional pattern classification (A Cheetham, 1996, PhD thesis) and recognition of pictorial patterns such as Chinese characters (M Ren, 1998 PhD thesis).

Work on multiprocessor parallelism has resulted in: i) the development of a multiprocessor node interface for parallel processing, based on the processing needs of simulating non linear dynamical systems (M Hammes, 1989, PhD thesis), ii) a Petri-net based parallel processing compiler (N Nakhaee, 1992, PhD thesis), and iii) the design and simulation of a multiple pipeline coprocessor for ANN algorithms, but one with sufficiently general purpose properties to make it suitable for any algorithm involving linear operations on vectors and matrices (P Vindlacheruvu, 1995, PhD thesis).

Current work explores architectures of cognition as dynamical systems. The work on performance estimation of multiprocessor parallelism aims to assess the improvement suggested by multiprocessor architectures. Past work has developed performance models for multiprocessor clusters and resulted in the Synchronous Server Farms operational paradigm.

David Al-Dabass has published about 180 scientific papers. In the following some of the publications of this year (2003):

1. D. Al-Dabass, D. J. Evans, S. Sivayoganathan, "Signal Parameter Tracking Algorithms using Hybrid Recurrent Networks", I. J. of Computer Mathematics, Vol. 80, No. 10, October 2003, pp 1313 - 1322 , ISSN 0020-7160 print, ISSN 1029-0265 online, J.

2. D Al-Dabass and M Ren, "Interweaving of Syntax and Semantics in Algorithms For Recognising Chinese Characters", OHPs, ICCPOL2003, Northeastern University, Shenyang, China, published as Advances in Computation of Oriental Languages, Ed. Maosong Sun, Tianshun Yao and Chunfa Yuan, Tsinghua University Press, pp576-584, ISBN 7-302-06942-5/TP.5130.

3. Ann Gray, R. Whitelock, E. Peytchev And D. Al-Dabass , "Tcp/Ip Connection Management Using A Real-Time Development Tool", pp636-643, ESM2003, 17th European Simulation Multi-conference 2003, The Nottingham Trent University, Nottingham, 9 – 11 June 2003, http://ducati.doc.ntu.ac.uk/uksim/ESM2003/webpage.htm, ISBN 3-936150-25-7.

4. D. Al-Dabass, D. Evans and S. Sivayoganathan, "Hierarchical Causal Parameter Abduction In Integral-Hybrid Logic Nets", Florida AI Research Society Conference, 12-14 May 2003, St. Augustine, Florida, http://uhaweb.hartford.edu/flairs03/AProgram.htm.

5. A. Aravinthan, K.Sivayoganathan, D.Al-Dabass & V.Balendran,, "Forging-Force Control Models using Servomechanism", UKSIM2003, Conf. Proc. of the UK Simulation Society, Emmanuel College, Cambridge, 9 - 11 April 2003, pp140 - 146, ISBN 1-84233-088-8.

David Al-Dabass is editor-in-chief of the journal Int. J. of Simulation: Systems, Science & Technology and chairman of UKSIM, the United Kingdom Simulation Society.

COMPARSIONS

ARGESIM COMPARISONS

Comparisons of Modelling and Simulation Techniques and Tools

www.argesim.org

Simulation News Europe (**SNE**) started in 1990 the series *Comparison of Simulation Software*. These software comparisons developed towards benchmarks not only for simulation tools but also for modelling tools and for modelling techniques.

The solutions allow comparisons of different modelling approaches, of features of simulators, of development of simulators, etc. Furthermore, the solutions – many of them with source codes – may be used as examples in simulation courses, etc.

ARGESIM, the Working group Simulation at Vienna University of Technology takes care on definition of these comparisons, on publication of the solutions and of evaluation of the solutions. For end of 2004, the data-based driven evaluation is classification is planned to be finished.

SNE		Comparisons															
	Sum	C1	C2	C3	C4	C5	C6	C7	CP1	C8	C9	C10	C11	C12	C13	C14	C15
0		Def															
1	5	5	Def														
2	8	4	4	Def													
3	10	4	3	3	Def												
4	13	1	5	5	2	Def											
5	8	4	-	1	1	2											
6	5	-	2	-	2	1	Def										
7	7	1	2	1	2	-	1	Def									
8	5	-	1	-	-	-	1	3									
9	5	-	-	-	-	-	2	3									
10	7	1	2	-	-	-	1	2	Def/1								
11	8	2	2	1	-	1	-	-	2								
12	7	1	-	1	-	-	-	2	3								
13	4	-	-	-	-	-	-	3	1								
14	6	3	-	1	-	-	-	2	-								
15	2	-	-	1	-	1	-	-	-								
16	3	1	-	-	-	-	-	1	-	Def/1							
17	6	-	-	1	-	1	-	1	1	1	Def/1						
18	5	-	-	-	-	-	-	2	2	-	-	Def/1					
19	6	-	-	-	-	-	-	-	1	1	1	3					
20	5	-	-	-	-	-	-	1	-	1	1	2					
21	10	-	1	-	1	-	1	5	-	-	-	2					
22	10	1	-	1	-	1	-	5	-	1	-	-	Def/1				
23	5	-	2	-	-	-	-	-	-	-	2	-	1				
24	7	1	-	-	1	-	-	2	-	-	-	1	2				
25	7	-	1	-	-	1	-	-	-	-	3	1	1				
26	11	2	1	2	1	1	-	1	-	-	1	1	1				
27	6	-	-	1	-	-	-	-	-	-	2	1	-	Def/2			
28	7	-	-	2	-	1	-	-	-	-	2	-	-	2			
29/30	11	1	1	1	1	-	3	-	-	-	-	1	-	3			
31	6	-	-	-	-	-	-	1	-	-	-	-	1	3	Def/1		
32/33	10	-	1	-	-	-	-	1	-	-	2	1	-	4	-	Def/1	
34	5	1	1	-	-	-	1	-	-	-	-	1	-	1	-	-	
35/36	13	2	-	-	1	2	-	3	-	-	-	1	-	-	2	1	Def/1
37	11	-	1	-	-	1	-	2	-	-		2	-	-	2	2	1
38/39	14	1	2	1	1	1	3	-	1	-	-	1	1	-	1	-	1
Total	**258**	**36**	**32**	**23**	**13**	**14**	**13**	**40**	**12**	**5**	**15**	**19**	**8**	**15**	**6**	**4**	**3**

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The principle idea of the comparison is a mixture of a general simple comparison of features within "yes/no" – tables and the well-known benchmark problems (like PHYSBE). Based on relatively simple, easily comprehensible models different modelling techniques and their implementation as well as features of modelling and experimentation within simulators, also with respect to application area, are compared.

The comparisons started in 1990, and since that time there have taken place new developments in software and algorithms.

Consequently also the comparisons developed further on, from *comparisons of simulation software* to *comparisons of modelling and simulation techniques and tools*. This development is based on following facts:

- Nowadays different modelling approaches are offered by simulators.

- The paradigm of Classes and Objects has changed software engineering dramatically. Also in modelling and simulation OO approaches give better insight into structures.

- Hybrid approaches become more and more important; and as simulators offer environments with complex features, hybrid approaches can now be set up easily.

- Symbolic computation is an alternative to analysis in the time domain. Nowadays symbolic computation systems can analyse also nonlinear systems and can handle complex semi-numerical tasks.

- Up to now missing are approaches to the discrete comparisons by means of statistical tools - in combination with symbolic computation.

- Furthermore, many simulators have been developed continuously. So it makes sense to solve a comparison from time to time with the new version of a specific simulator, to show the advances.

We also are working on a classification and evaluation of the solutions. Key words should characterise a specific solution: method or approach used generally modelling technique, methods used in the tasks. A database will support this classification. It is intended to present result until end of 2004.

Definitions

Up to now 16 comparisons were defined. The following list shortly introduces the comparisons and sketches special problems (SP), which could be observed for a special comparison.Clearly, some defined tasks seem to be simple, but they prove tricky, so that they must cause "problems" in implementation, etc.

C1 Lithium-Cluster Dynamics, **SNE 0** (11/90), checks integration of stiff systems, parameter variation, and steady state calculation.

SP: loops with logarithmic increments, correct double – logarithmic plots, steady state calculation

C2 Flexible Assembly System, **SNE 2** (3/91), discrete system, compares features for submodel structures, control strategies, and optimisation.

SP: complex control strategies, analytical considerations before modelling very helpful, optimisation avoidable

C3 Generalised Class-E Amplifier, **SNE 2** (7/91), simulation of electronic circuits, table functions, eigenvalue analysis, and complex experiments.

SP: use of same model for analytical and numerical analysis, up to now accuracy, table function evaluation vs. piecewise functions

C4 Dining Philosophers I, **SNE 3** (11/91), general comparison, involving not only simulation but also analysis e.g. by Petri nets and, etc.

SP: network analysis for deadlocks, simultaneous events, results difficult to compare

C5 Two State Model, SNE **4** (3/92), checks high- accuracy features and state event handling.

SP: analytical approach possible, but ill-conditioned; fully discrete approach possible, accuracy of state event handling

C6 Emergency Department - Follow-up Treatment, **SNE 6** (11/92), discrete system, tests features for modelling, concepts of availability, and complex control strategies.

SP: no strict separation of entities and resources, complex routing and priority problems

C7 Constrained Pendulum, **SNE 7** (3/93), checks features for hybrid modelling, comparison of models, state events, boundary value problems.

SP: choice of states, different levels of hybrid approaches,

CP1 Parallel Simulation **Techniques**, **SNE 10**, (3/94), deals with the benefits of distributed and parallel computation for simulation tasks; three test examples test parallelisation techniques.

SP: results not encouraging wrt parallelisation, very often direct programming necessary

C8 Canal-and-Lock System, **SNE 16** (3/96), discrete system, checks features for complex logic control, validation and variance reduction.

SP: complex logic control, analytical considerations necessary; support for advanced statistical analysis (variance reduction methods) often missing

COMPARISONS

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COMPARSIONS

C9 Fuzzy Control of a Two Tank System, SNE 17, (7/96), asks for approaches and for implementations of modules for fuzzy control.

SP: support for fuzzy control, two-dimensional calculations for control surface, pure discrete approach possible

C10 Dining Philosophers II, **SNE 18** (11/96), reviews discrete simulators with respect to concurrent access to resources and with deadlocks.

SP: discrete random variables, simultaneous events, deadlock recognition

C11 SCARA Robot, **SNE 22** (3/98), deals with implicit and hybrid systems with state events.

SP: implicit model, different approaches for collision event and action

C12 Collision of Spheres, **SNE 27**, November 1999, allows numerical or analytical analysis as well as continuous or discrete approaches

SP: broad variety of approaches (numerical - continuous, numerical – discrete, numerical – analytical, analytical – symbolic), collision limit

C13 Crane Crab with Embedded Control, **SNE 31** (3/01), revised **SNE 35/36** (11/02) checks techniques and features for embedded digital control with sensors and with DAE-systems

SP: implicit model, discrete control coupled with sensor diagnosis, complex experiments

C14 Supply Chain, **SNE 32/33** (11/2001), **SNE 34** (7/2002) addresses discrete simulators - features for supply chain systems (messages, strategies)

SP: distinction between material flow and order flow, distance-dependent control strategies

C15 Clearance Identification, **SNE 35/36** (11/02), checks identification features (based on measured data) and influences of noise

SP: identification algorithms, short-term input functions (Dirac-like), support of statistics

Solutions

We invite all readers to participate in these comparisons. Please, simulate the model(s) with any tool of your choice and send in a solution. A solution should consist of: a short description of the simulator, modelling technique, model description, and results of the three tasks. Additionally we ask for model sources

The solution should fit into one page of **SNE** – templates are found at our web page. Solutions sent in are reviewed.

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A MATLAB – based Solution to ARGESIM "Comparison of Parallel Simulation Techniques" using a DP-Toolbox

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Simulator: MATLAB is a widely used tool for rapid prototyping in engineering sectors. One big disadvantage of MATLAB is the lack of parallel processing features. To overcome this disadvantage, several tools were developed expanding MATLAB by those features. One of these tools is the *DP-Toolbox*, where DP stands for distributed and parallel.

The *DP-Toolbox* was developed from 1995 until 1999 at the University of Rostock and since 2002 at the University of Applied Science Wismar. Communication and synchronisation is done via message passing using the software package PVM (Parallel Virtual Machine). The DP-Toolbox consists of two levels: DP-High and DP-Low. At the DP-Low level, PVM functions were mapped to MATLAB functions using MATLAB's MEX interface. At the DP-High level, low level functions will be bundled into easy to use high level functions. The toolbox was mainly developed for Unix platforms, where older versions (1.4.x) also support Win32 systems.

Task a: Monte Carlo study: All simulation runs can be performed independently. Therefore, the basic idea is to distribute the runs to the available processors. Since the single simulation runs took similar times, static load balancing was used. For balancing the load statically only one DP-High function (`dpscatter`) was needed. Due to the powerful high level functions, the master program is very short:

```
function [t,xmean]=mcs_master(num_slaves);
……….
% parameters
num_runs  = 1000;
t0 = 0; tf = 2; h  = 0.001;
t=t0:h:tf; % returned time values
x0 = [0;0.1]; % initial conditions

% generate damping factors
d = 800 + 400 * rand(num_runs,1);

% start up slaves
slaves=dpspawn(num_slaves,Try,mcs_slave);

% distribute damping factors
% and simulation parameters
dpscatter(slaves,d);
dpsend(slaves,[t0,tf,h,x0']);
% gather results
xmean = mean(dpgather(slaves));
```

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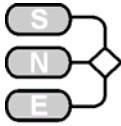
The whole code for the slave program is even shorter:

```
function mcs_slave()
………….
% receive damping factors and simulation
% parameters
d   = dprecv; par = dprecv;
t0=par(1); tf=par(2);h=par(3);x0=par(4:5)';

% perform partial monte carlo study
global D;
xmean = 0;
for i = 1:length(d)
      D = d(i);
      x = rk4('mcs_equ',t0,tf,x0,h);
      xmean = xmean + x(:,2) / length(d);
end

% send result to master
dpsend(dpparent,xmean);
```

After all, the implementation of the parallel program took a few more time than the implementation of the serial program.

For all calculations, the RK4-algorithm with an integration stepsize of *h=0.001* was used. The table below shows the speedup factor *f* for a different number of processors *M*.

M	2	4	6	8
f	1.86	3.42	4.65	5.62

The reasons of the relatively low speedup values are the start-up times of the slave processes. Because for every slave one MATLAB instance has to be started, which takes up to 10 seconds to start up, this factor must be considered in small sized problems.

Task b: coupled predator-prey population. The five populations were distributed to five slave processes controlled by a master process. The master itself starts the slaves, sends the initial values towards them and finally collects the results.

Calculations were proceeded with the RK4-algorithm using an integration stepsize of *h=0.01*. The following table shows the speedup factor depending on different communication intervals *cint.*

cint	h	2h	5h	10h	20h
f	0.13	0.22	0.37	0.48	0.56

As the table shows, communication was not successful. The reason for these negative results is the tight coupling between the differential equations leading to relatively high communication times.

Task c: partial differential equation: The parallelization of this example was also realized by a master-slave program.

As in task b, the master program starts up the slaves, distributes the parameters and collects the results from them. The slave processes exchange only the boundary values of their simulated areas.

The following table shows the speedup factor *f* for a different number of processors. RK4-algorithm with stepsize *h=0.005* and a number of lines *N=800* was used for all calculations.

M	2	4	6	8
f	0.29	0.2	0.16	0.15

The table shows, that at increasing processor numbers speedup values will decrease. The reason for this effect is the increasing number of simulated areas and therefore the rise of boundaries where simulation values will be exchanged. This leads to a rising communication expense which can't be compensated by the decreasing calculation expense.

Conclusions: The examples show that parallelization using a cluster of workstations is not suitable for every type of simulation. If there are more than one simulation runs running independently, parallel processing can be successful and can be implemented easily. On the other hand, if only one simulation run must be done, parallelization is harder to implement and conditionally successful.

To compare implementation times, the described examples have been realized in C/PVM also. These implementations took approximately four times longer than developing under MATLAB/DP-Toolbox.

Hardware: All examples have been run on a cluster of 8 workstations containing a 1500 MHz AMD processor. The computers were coupled by a switched Gigabit Ethernet.

Software: Linux operating system with the newest version 1.5.0 DP-Toolbox (newest version) and MATLAB (6.5).

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A fully Numerical Solution to ARGESIM Comparison "C1 - Lithium-Cluster Dynamics" with MATRIXx

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Simulator: In 2003, a revival of MATRIXx took place. The Mathworks (MATLAB) had to resell MATRIXx, which is now serviced by National Instruments (NI). NI will distribute MATRIXx as stand-alone product and it will integrate it into NI's system LabView, especially the graphical simulator SystemBuild. MATRIXx is a so-called CNS – a Computer Numeric System, as MATLAB is (and as CONTRL_C has been. The structure is very similar to MATLAB: it consists of an environment called XMath, and a graphical simulation tool called SystemBuild.

Model: SystemBuild allows straightforward modelling using classical basic blocks (integrators, summers, multipliers. The blocks are pasted from the model library and graphically wired (see next figure).
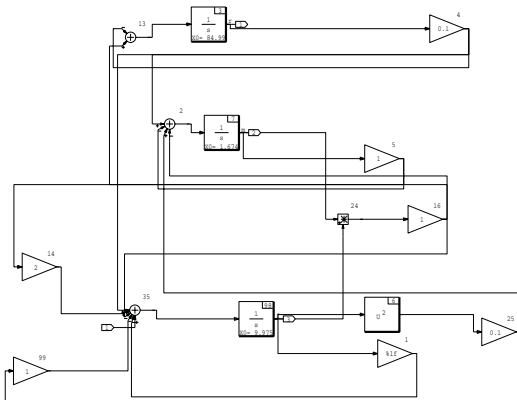
Task a: Simulation of the stiff system. Experimentation can be done directly in SystemBuild using menus, where a complete range of solvers is offered (three suited for problems). Best results were obtained with DASSL, based on the DASSL stiff system solver by Linda Petzold, and nearly similar results with ODASSL, a modification of DASSL for overdetermined DAEs. Interestingly, also the standard algorithm (Variable-step Kutta Merson) resulted in correct solutions; other algorithms clearly had to fail. Computation times are given in the following table.

Algorithm	Variable step Kutta Merson	DASSL	ODASSL
One Run	0.451	0.27	0.281

Task b: Parameter variation of l_f. Parameter variations must be made in the environment XMath, which can call SystemBuild for performing simulation runs (command **sim**). Programming in XMath is very similar to MATLAB, m-files (slightly changed) can be used in XMath !. The following program lines perform the logarithmic parameter variation and plot the results (next figure; unfortunately the logarithmic plot caused problems).

```
p   =     0;
for n=9:-1:1
    t = [0:0.001:10]';
    u = ones(t);
    lf=10^(1.75+n/4);
    y = sim("c1b",t,u, {ialg=6});
    ymatrix = makematrix(y(3,1)')';
    fc(n)= ymatrix;
    ti(n)=t;
 endfor
plot(ti(1),fc(1),{log,
     title = "Lithium Cluster Dynamics });
for n=2:9
    plot(ti(n),fc(n),{log, keep});
endfor
```
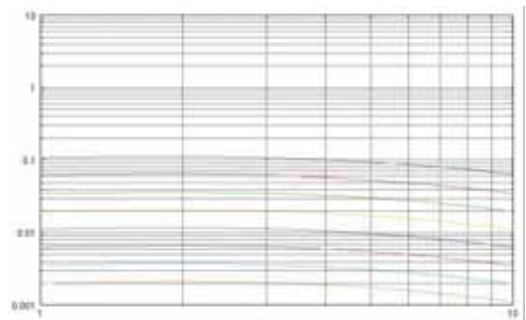

Task c: Calculation of steady states. MATRIXx is a CNS, with matrix manipulation, interpolation, optimisation, and ODE model solving – where the ODE can be modelled graphically in SystemBuild. XMath offers a modified Newton algorithm (in principle for root finding), which can compute as command **trim** steady states (states, inputs and outputs). Using trim for p=0 and p=10^4 gave correct results shown below.

p	r	m	f
0	10e-06	0.001	10e-08
10000	10	10	1000

C1 Classification: Numerical Approach

Simulator: MATRIXx, Recent Rel. of 2003
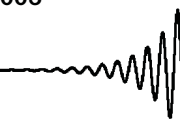
An OO Programmed Approach to ARGESIM Comparison C2 Flexible Assembly System with CSIM – C++

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Simulator: CSIM (Mesquite Software) is a process-oriented, general-purpose simulation toolkit, which supports the development of process-oriented, discrete-event simulation models, by using the standard programming languages C and C++. Because of the nature of compiled C and C++ programs and CSIM's dynamic memory allocation, developed models are compact and efficient. CSIM supports the Object-Oriented Simulation (OOS).

Model: We have described the model textually by writing the corresponding C++ code. Each subsystem in our model is an object of the class *Subsystem*. The class *Subsystem* defines the structure of the subsystem, by using the CSIM class *Facility*. We have used *facilities* to model resources, such as the machine and shifting units, of the subsystem. We have defined the class *Segment* to model the space between two subsequent subsystems. The following program lines depict FMS, which is defined as a set of instances of the class *Subsystem* and the class *Segment*:

```
1 Subsystem ss1(1, 1, 15, 2.0, 1.2, 0.4, 2);
2 Segment seg12(1, 2, 0.4);
3 Subsystem ss2(2, 2, 60, 1.6, 0.8, 0.4, 2);
4 Segment seg23(2, 3, 0.4);
5 Subsystem ss3(3, 2, 60, 1.6, 0.8, 0.4, 2);
6 Segment seg34(3, 4, 0.4);
7 Subsystem ss4(4, 2, 60, 1.6, 0.8, 0.4, 2);
8 Subsystem ss5(5, 3, 20, 1.6, 0.8, 0.4, 2);
```

Task a:Control Strategy/Statistical Evaluation.

Each pallet in our model is an instance of the class *Pallet*. The method *work()* of the class *Pallet*, which implements the behaviour of the pallet, is defined as a CSIM *process*. In a CSIM model a *process* represents an active entity. The control logic is implemented in the method *work()* of the class *Pallet*. The properties of the class *Pallet* contain the information: loading and unloading times, type of the processing completed, and the current position in the system

Task b: Simulation Results - Throughput. Task c: Simulation Results - optimisation.

The task is to find the optimal number of pallets in the system. We have started the simulation experiments with empty pallets and counted the number of the completed jobs from 7200th second to 36000th second (8 hours). OptQuest may be used with CSIM for searching for the optimal solution.

However, we run the simulation experiments manually, because the number of experiments is limited to a relatively small number.

Number of pallets	Number of jobs	Throughput time [seconds]		CPU time [seconds]
		mean	s.d.	
13	1320	284.56	42.36	0.70
16	1440	321.25	18.26	0.78
17	1442	341.18	39.13	0.83
18	1442	361.64	48.39	0.85
20	1438	401.03	61.98	0.96
21	1440	420.86	71.67	1.01
22	1442	440.33	78.59	1.07
23	1438	460.79	84.41	1.12
24	1439	480.21	94.59	1.20
25	1440	499.33	126.59	1.25
40	1440	794.10	343.82	2.41

Table 1: Simulation results for different numbers of pallets

Table 1 shows the simulation results for 13/ 16-18/ 20/ 21-25/ 40 pallets. The optimal number of pallets is 17. An object of the CSIM class *Table* is used to collect statistics on throughput times. Simulation is executed on Sun Blade 150 workstation (CPU 650MHz, memory 768MB). The rightmost column (Table 1) shows the CPU time for the evaluation of the model.

Discussion: Three stations A2 represent the bottleneck of the system. Because they together can process, in the best case, three pallets in 60 seconds, it is considered that the maximum of the 1440 processed pallets for 28800 seconds of working time can be obtained from the system. However, recall that we count the number of the processed pallets starting at 7200th second. At this time, in the buffer of A1 may wait pallets with processed parts for unloading. In the first 60 seconds (after starting statistics collection), before the first pallet is processed by one of the A2 machines, several processed pallets may be unloaded by machine A1. We obtained the maximum number of the processed pallets 1442.

There is a constraint in the definition of Comparison 2: "In the beginning empty pallets are circulating in the system. Their positions on the conveyors B1 (not B2!) can be chosen randomly." Therefore, the initialization of the system for 60 pallets is difficult, because the total length of 60 pallets is larger than the total length of B1 belts and the spaces between the subsystems: $60 \times PalletLength > \sum_i B_{1i} + \sum_k Space_k$.

C2 Classification: Object- / Process-oriented Modelling

**Simulator: CSIM Rec. Release 2003**

An OO Process - Approach to ARGESIM Comparison C2 Flexible Assembly System with Enterprise Dynamics (Taylor ED)

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Simulator: Enterprise Dynamics (ED) is an object-oriented software for modelling, simulation and visualisation of dynamic processes. In ED everything is an atom: an application, a model, a library, a product, etc. An atom has four dimensions: location and speed in space and dynamic behaviour. The atoms are hierarchically structured (a main atom contains all others), they can be displayed in tree structures. A model can easily be created by dragging atoms from the Library Tree into the Model Layout window. The programming language 4DScript allows defining more complex atom functionality, to run and analyse models, etc.

Model: This model is built of standard atoms of the ED library. It consists of eight *Composition Container* atoms, which represent the eight subsystems of the. As ED is object-oriented it was possible to define one subsystem and create several instances of this atom. Each subsystem was then adjusted by adding additional 4DScript code and additional atoms.

Every *Composition Container* contains at least five *Fast Accumulating Conveyors*, one *Assembler*, one *Source* and one *Product*. The first subsystem, for example, also contains an *Unpack* atom for unloading finished parts. One additional *Source* was used for putting empty pallets on the conveyors. For easier graphical representation the unprocessed part that is put on the pallet in station A1 is not modified, but additional products of different colours are loaded onto the pallet in each station (see following figure with model):
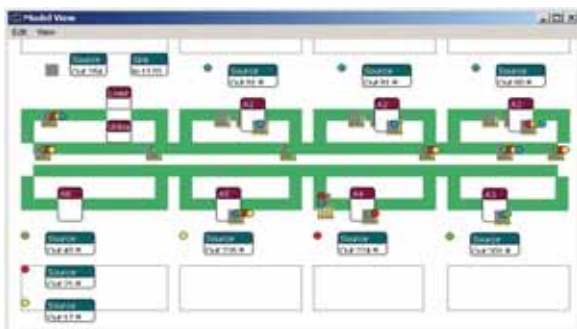
Task a: Control Strategy/Statistical Evaluation. Whether a pallet enters a station depends on the values of labels ai, which are set to 1 when the product undergoes operation Ai.

The routing is implemented in the *Accumulation Conveyor* atoms, which represent B1. The following 4DScript code is written in the *OnOcReady* eventhandler in the *Atom Editor* for routing pallets to station A5.

```
if(
 <>(content(c),0),
 do(
  setstatus(5,c),
  if(and(label([a1],first(c)),
       not(label([a5],first(c)))),
    if(and(=(content(out(1,c)),0),
         icopen(1,out(1,out(1,c)))),
      moverequest(first(c),1),
      moverequest(first(c),2)),
    moverequest(first(c),2)))
```

Results are collected by using an *Experimentation* atom, which makes it possible to set the number of observations, the run length and the warmup period. When a product is put on a pallet in station A1, it gets a label with the current time, which is readout when the product is unloaded. The throughput time of each product is written into an Excel for further evaluation.

Task b: Simulation Results - Throughput. The following table shows the results for different numbers of pallets. For each number of pallets 100 simulation runs were made, each with a warmup period of 2 hours and a run length of 8 hours.

Number of pallets	Total throughput	Average throughput time in sec.
13	1320	261
14	1440	258
15	1440	278
16	1440	298
17	1440	318
18	1440	338
19	1440	358
20	1440	378
40	1440	774
60	1440	1155

Task c: Simulation Results - optimisation. The total throughput stayed the same for 20, 40 and 60 pallets (results task b). Even with 14 pallets the maximal possible number of processed parts, which is 1440, was reached. A higher number is not possible, because the three stations A2 act as a bottleneck. Great differences can be seen in average throughput time. The lowest average throughput time is reached with 14 pallets and it increases nearly linear with increasing number of pallets. So no optimisation is necessary, and the optimal number of pallets is 14 with maximal throughput and minimal throughput time.

C2 Classification: Object- / Process-oriented Modelling

Simulator: Enterprise Dynamics V.4.5
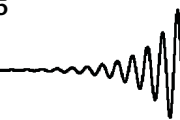
An Analytic/Numeric Approach to ARGESIM Comparisons C3 Class-E Amplifier with Mathematica

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Simulator: Mathematica is a tool for scientific computing which offers a wide variety of symbolical and numerical operations.

Model: We make use of Mathematica for a simulation study of a nonautonomous linear system of ordinary differential equations. Depending on each task we choose between the capabilities for symbolical and numerical computations within the Mathematica framework.

The model it self isn't very complicated to implement by the help of the Mathematica programming language. As it provides no special "piecewise" function as e.g. Maple V, the time dependent resistor function R(t) has to be modelled via the Unitstep Mathematica function. So the function constructed by

```
S[t_]:=Unitstep[t-a]-Unitstep[t-b]
```

is one for a<=t<=b and zero otherwise. With help of this concept the resistor function R(t) is implemented as follows

```
R[t_]:=Module[{ttr},ttr=t-
                IntegerPart[t/t2]t2;
((R2-R1)/TRF*ttr+R1)*
(UnitStep[ttr] - UnitStep[ttr - TRF])
+R2*(UnitStep[ttr-TRF]-UnitStep[ttr - t1])+
((R1-R2)/TRF*(ttr-t1)+R2)*(UnitStep[ttr-t1]
 - UnitStep[ttr-t1-TRF])+
R1(UnitStep[ttr-t1-TRF]-UnitStep[ttr-t2])+
R1 UnitStep[t2]]
```

The further implementation is straight forward.

Task a: Calculation of Eigenvalues. We choose now specific values for R(t). The on-period has R(t)=0.05Ohm and the off period R(t)=5E+6Ohm. These values are constant, so the right-hand side of the governing equations is nonautonomous and the eigenvalues can be determined in as follows (not: all parameters except Res are predefined):

```
A={{0,-1/L1,0,0},{1/C2,-1/(C2*Res),-
1/C2,0}, {1/L3,0,-RL/L3,-
1/L3},{0,0,1/C4,0}};
Eigenvalues[A /.{Res->R_on}]
Eigenvalues[A /.{Res->Roff}]
```

Results are given in the following table.

Eigenvalues ON-Period	Eigenvalues OFF-Period
-1.11732E+9	-3941.59 + 833296i
-625.786	-3941.59 -833296i
-112931+658369i	-108995-661370i
-112931-658369i	-108995+661370i

Task b: Simulation of the stiff system. To simulate the system Mathematica provides the NDSolve command. It chooses automatically an integration algorithm whether the model is stiff or not. The following commands produce results as given in figure 1:

```
sol = NDSolve[dglwithinit /. TRF -> 10^(-
15), {x1, x2, x3, x4}, {t, 0, 100 *10^(-6)},
MaxSteps -> 5000, AccuracyGoal -> 30];
Plot[Evaluate[{{x2[t]/R[t]} /. TRF -> 10^(-
15), x3[t] RL} /. sol] , {t, 0, 0.0001},
PlotPoints -> 5000] ;
```
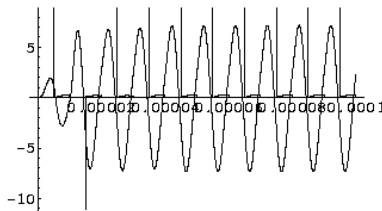

Figure 1 : IR and VL as a function of time

Task c: Parameter Study. With help of Tables this task can be solved as in Task b. The phase portrait is plotted with help of the ParametricPlot command.

```
newinitvals=Evaluate[{x1[t2], x2[t2],
x3[t2],x4[t2]}/.sol];
taskcdgl = dgl \[Union] {newinitconds};
TRFlist={10^(-15),10^(-11),10^(-9),10^(-7)};
taskcsol=Table[ NDSolve[ taskcdgl/.TRF->
  TRFlist[[i]],{x1,x2,x3,x4},{t,0,9*10^(-6)},
  MaxSteps->5000,AccuracyGoal->5],{i,1,4}];
ParametricPlot[Evaluate[Table[{{x3[t],
        1/L3(x2[t]-RL*x3[t]-x4[t])}/.
        taskcsol[[i, 1]]},{i, 1, 4}],
        {t, 0, 9 10^(-6)}]]
```
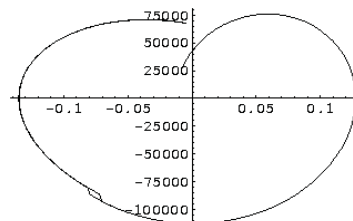

Figure 2 : Phase portraits for different TRF times

C3 Classification: Numerical / Symbolical Approach

Simulator: Mathematica Rec. Release 2003

COMPARISONS

Issue 38/39

An OO Process Approach to ARGESIM Comparison C4 Dining Philosophers with AnyLogic

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Simulator. AnyLogic (www.xjtek.com) is an object – orientated, general-purpose simulator for discrete but, continuous and hybrid applications. It supports modelling with UML – RT and the underlying modelling technology is based on Java so that building simulation models using AnyLogic should be easy for experienced programmers.

Model: The implementation of the Dining Philosopher model is made by defining three classes in a very easy way. The classes are: Philosopher, Chopstick and Table. The Table - class defines the global parameters and the interaction of the encapsulated Philosopher and Chopstick classes:
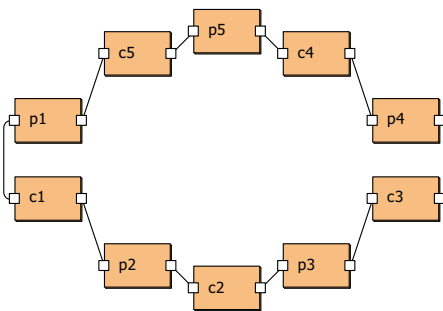
Fig. 1: Model layout of the Table class

The behaviour of the Philosopher and the Chopstick classes is defined by using state charts. Depending on the tasks (see below) the state charts differ slightly.

Experiments: The most interesting part of the Dining Philosopher problem is the occurrence and further avoidance of deadlocks. Therefore different strategies were used for seizing the chopstick:

1. First left then right chopstick
2. Asymmetry: One philosopher takes first right and then left chopstick
3. Monitoring the number of philosopher waiting for the right chopstick. If four philosophers are already waiting, the fifth philosopher can not seize the left chopstick

Remarks on implementation: Only the first (classical) strategy can cause a deadlock. AnyLogic handles simultaneous events by randomly choosing one of the scheduled events.

To get comparable results, a duration of 1.000.000 virtual time steps where taken for all experiments and the same distributions (thinking time: discrete uniform distribution [1,4], eating time: discrete uniform distribution [1,3]) where used for all strategies. The observation variables are number of deadlocks and number of time steps till a deadlock (for strategy a), mean thinking time, mean waiting time and mean eating time for one philosopher.

Results

Strategy a: This strategy is designed to generate deadlocks. AnyLogic has automatic deadlock detection. When a deadlock occurs, a new replication of the simulation will be started till the end of overall simulation time is reached. Figure 2 shows the distribution of performed simulation time per simulation run.
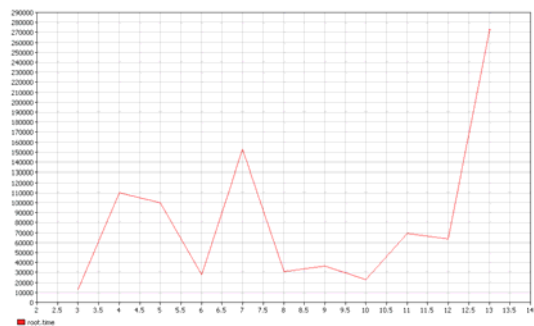
Fig. 2: Time steps per simulation run

Min: 11523.0
Max: 318134.0
Mean: 89124.21428571429
Variance: 9.450074562950548E9

Strategies b and c: Both strategies avoid deadlock situations. But as we see in the table below, the strategy operating with one asymmetric philosopher is more efficient (meaning, that the waiting time = starving time is the lowest - even more efficient than Strategy a.

	a)	b)	c)
thinking time	304684,49	413726,10	55579,58
waiting time	451490,62	255194,20	799993,12
eating time	243824,89	331081,78	35567,89

Table 1: Mean time values for one philosopher

C4 Classification: Object-oriented Process Approach

Simulator: AnyLogic 4.5

A fully Numerical Solution of ARGESIM Comparison "C5 Two State Model" with Dymola

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Simulator: Dymola, Dynamic Modeling Laboratory, is a simulation environment suitable for modelling various kinds of physical objects. It uses an object oriented approach for modelling of large, complex and heterogeneous physical systems. A graphical editor and a specific language (Modelica) allow the user to construct models composed of mechanical, electrical and hydraulic subsystems out of predefined models.

Model:. Although the equations could be solved analytically, here the ODEs are solved by Dymola's ODE solvers, which can handle state events.

Because of the simplicity of the model a pure textual approach was taken. For modelling of state events the Dymola User Manual suggest using the `when (cond) then` statement: the `when` condition is the event condition, the `then` block describes the event. The implementation is then straightforward:

```
class Comparison5 "equation"
declaration of parameters, variables …
  algorithm
  when (y1 >= 5.8) then
    c2 := -0.3;   c4 := 2.73;k=k+1;te(k)=t
  end when;
  when (y1 <= 2.5) then
    c2 := 0.4;   c4 := 5.5; k=k +1;te(k)=t
  end when;
  equation
  der(y1) = c1*(y2 + c2 - y1);
  der(y2) = c3*(c4 - y2);
end Comparison5
```

In Dymola, all differential, algebraic and discrete equations are treated as synchronous in time; it is assumed, that all equations in a model may be active at the same time instant. In order to prevent equation conflicts, it is recommended to put redefined equations into a called `algorithm section`. Although in the Two State Model no conflicting equations are possible, the conditional equations must be they must be written in the `algorithm section`.

Task a: Simulation of the System: For the problem, a stiff system with multiple state events, three integration algorithms were suitable: DASSL, DASSLL and LSODAR.

For the resulting state y_1 in the next figure the DASSL algorithm (DAE solver by L. Petzold) with relative accuracy of 10^{-6} was used:
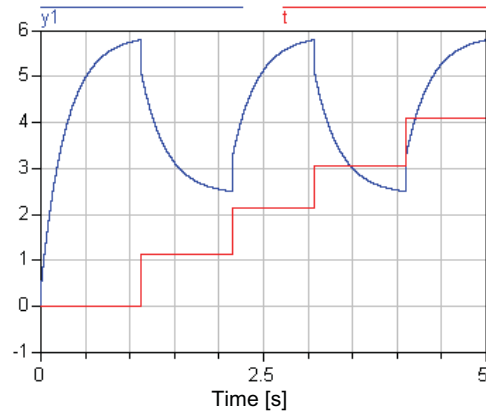
Task b: Time instants of discontinuities. To trace the time instants of the events, the current time is logged in the event directly (extension of the `then` block). The time instants and the terminal value are:

t_1=1.124042241435211 t_2=2.145426621013892
t_3=3.069897847796384 t_4=4.091282227441629
y_1(5.0)=5.794223050281934

With higher relative accuracy the results get slightly better, but not significantly. Additionally the last state event isn't found in any case. Furthermore it is only possible to solve the problem up to a relative accuracy of 10^{-12}.

Task c: Frequent events. The change of the parameters results in "oscillations" of the state y_1 (next figure). The number of discontinuities found is 62 or 63, resp. (depending on the solver).
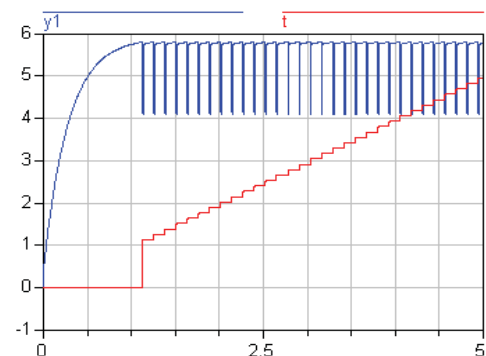
The first, second and last found discontinuities are:
t_1= 1.124039007216077 t_L= 4.95219675857112
t_2= 1.137462807344851 y_1(5.0)= 5.77350266027292

C5 Classification : Fully Numerical Approach
Simulator : DYMOLA Rec. Version 2003

An OO Approach to ARGESIM Comparison "C6 - Emergency Department" using AnyLogic

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Simulator: AnyLogic is a Java-based, object oriented simulation tool for continuous, discrete and hybrid applications, based on UML notation and active objects.

Model: The simulated emergency department comprises different facilities, which are all represented as connected Active Object Classes.
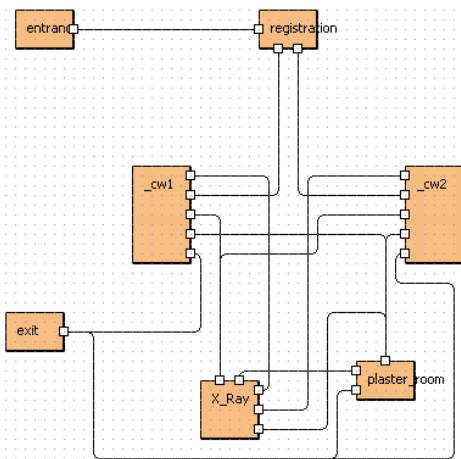
Figure 1: Model layout of the emergency department
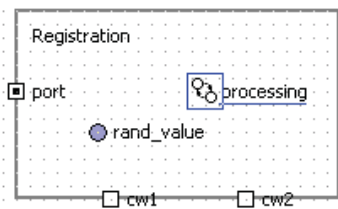
Figure 2: Internal view of the Registration Object

Each Active Object Class can include ports for communication, intern variables and a state-chart which describes the behaviour of sending/receiving messages used to represent the patient flow.

The Entrance object creates new (exponential distributed) patient-messages with different properties, determining the type of patient, a timestamp and the needed treatment. The messages are queued and forwarded by the other objects, according to the comparison specifications. At the Exit object, all patient-messages are counted and the mean treatment times are calculated.
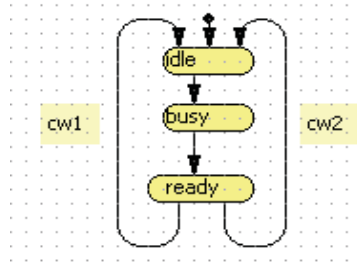
Figure 3: Statechart modelling of the Registration Object

**Task a: Simulation – Average Treatment Time.** Simulation (experimentation) in AnyLogic is usually menu-driven, statistical results can be gathered during the run. For the basic strategy in this task, the average treatment times vary between 114 and 253 minutes, depending on the patient type (see Table).

Task b: Doctors' Exchange Strategy. The exchange is simply modelled by changing attributes of the objects representing the casualty wards. As soon as more than 20 patients are waiting in the queue of casual ward 2, one doctor is replaced by a more experienced doctor from casual ward 1. The replaced doctor from casual ward 2 now works at casual ward 1, but his treatment time is increased by 20%. All this leads to an increase of treatment time for all patients (see Table).

Task c: Priority Ranking. In this task patients of type 1 and 3 who are entering a treatment point the second time rank higher in priority than all other patients (implemented by additional attributes). This reduces not only the mean treatment time for patients of type 1 and 3, but also the overall treatment time for all patients is also improved (see table).

	Task a	Task b	Task c
Mean treatment time	170	194	156
Mean treatment time patient type 1	242	261	148
Mean treatment time patient type 2	131	143	180
Mean treatment time patient type 3	253	271	157
Mean treatment time patient type 4	114	132	151
Standard deviation of time per patient	89	101	70
Overall treatment time	402	429	354

C4 Classification: Object-oriented Process Approach

Simulator: AnyLogic 4.5

An OO Approach to ARGESIM Comparison "C6 - Emergency Department" using FLEXSIM

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Simulator: FLEXSIM simulation software is a true object oriented simulation software program for building models that can help to visualize flow processes in order to optimize throughput and minimize operating expenses. A flow process is defined as a set of operations or process steps performed on an item (in FLEXSIM an item is referred to as a flowitem). If you can define your process in a graphical sketch or a flowchart, you can build a simulation model with FLEXSIM. FLEXSIM provides users with a format to visualize, model, and simulate flow processes using drag and drop objects in a 3D environment. In addition, an in-depth statistical analysis of process performance, bottlenecks, and throughput is available.

Model: The emergency department is modelled, where four kinds of causalities are admitted. Their way trough Causality Ward, X-ray and Plaster Room depends on the severity of their wounds. The overall model is described graphically by stations and queues, instantiated objects from a class library (figure 2).

On creation the patients are divided into four flowitemtypes, representing the four different kinds of patients. Depending on this, the patient makes his way trough the system. Every time a patient exits a treatment point the number of the port he has to take the next time is assigned. This routing is defined by the following definitions (in source object):

```
fsnode* item = parnode(1);
fsnode* current = ownerobject(c);

fsnode* involved = item;

addlabel(involved,"xray");
addlabel(involved,"bearbeitung");
addlabel(involved,"durchgang");

setlabelnum(involved,"bearbeitung",time());
setlabelnum(involved,"durchgang",1);

setitemtype(involved,
 bernoulli(35,1,bernoulli(20,2,bernoulli(5,3,4)))
);

if(eq(getitemtype(involved),1)) {coloraqua(involved); };
if(eq(getitemtype(involved),2)) {colorlime(involved); };
if(eq(getitemtype(involved),3)) {colorpink(involved); };
if(eq(getitemtype(involved),4)) {colorgreen(involved); };
```
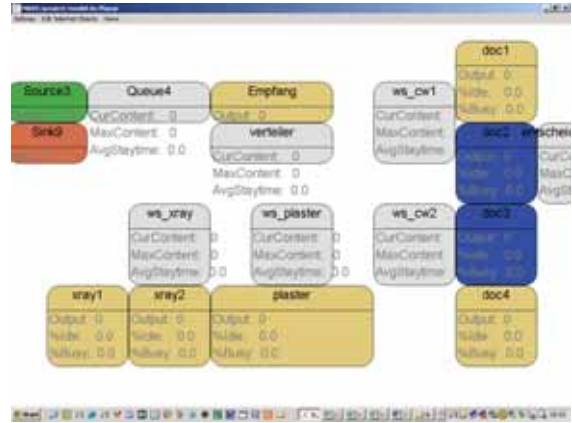

Figure 2: Model Layout

Task a: Simulation – Average Treatment Times. Depending on the patient type treatment time takes between 115 and 257 minutes (details see table 1).

Task b: Doctors' Exchange Strategy. As soon as the queue before casualty ward 2 contains more than 20 patients the more experienced doctor takes over. This is done by assigning new values to the label containing the parameters for calculating the cycle time. This strategy yields an increase of treatment times for all types of patients, also for overall treatment time (details see table 1).

Task c: Priority Ranking. The doctor's exchange strategy is not used in this task. Each patient who enters a casualty ward is assigned a label, telling how often he has already been there. The queues before the treatment points are sorted by this label value ascending. Depending on this a priority ranking is established. This shows a significant decrease in treatment time for patients of type 1 and 3, an increase for the others (details see table 1).

	mean [min] task a	stdev [min] task a	mean [min] task b	stdev [min] task b	mean [min] task c	stdev [min] task c
Patient T. 1	229	56	259	95	174	90
Patient T. 2	126	57	141	77	194	84
Patient T. 3	256	41	242	79	190	103
Patient T. 4	115	54	136	70	149	70
Overall	160	78	181	99	165	82

Table 1: Results for all strategies

C2 Classification: Object- / Process-oriented Modelling

Simulator: Enterprise Dynamics V.4.5

COMPARSIONS
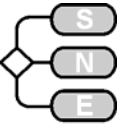
An Object-oriented Solution to ARGESIM Comparison "C6 - Emergency Department" with MATLAB-DEVS2

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Simulator: MatlabDEVS2 is a simulation runtime system designed for research on the classical DEVS theory. It offers support for developing models following the formalism of this theory. Since the classical DEVS theory introduced by Zeigler works with a very high level of abstraction, a simulation runtime system implementing this formalistic description may just be a system for explaining the theory. Therefore, it is suitable for research and education tasks but not for commercial issues.

MatlabDEVS2 is a further advancement of MatlabDEVS which was developed by T. Pawletta in 1998. It is an open system embedded into the Matlab environment implemented taking benefit of Matlab's features for object-oriented programming. It uses the same base classes for both, model building and simulation. The entire source code may be downloaded at www.mb.hs-wismar.de/MatlabDEVS2.

Model: The DEVS approach uses a hierarchical structure for modelling. *Atomic models* involved are:

Name	
patientgen	generates patients
transducer	collects patient, computes statistics
queue	queues in front of of the casuality wards and X-ray rooms
singlequeue	queues in front of registration and plaster rooms
server	X-ray-and plaster rooms, registration counter, doctors
controller	controls patient's flow assigns next treatment point

Special attention should be paid to the atomic model 'controller'. While queue, singlequeue and server represent parts of the real world system, the controller is added to minimize the information flow between the different facilities at the emergency department a patient has to pass by during follow-up treatment.

The *coupled models* are:

Name	Represents	Components
EmergencyDepartment	whole system	EF ED
EF	experimental frame	patientgen transducer
ED	emergency department	2 x UNIT1 (REG+PLA) 3 x UNIT2 (2 x CW, X-RAY) controller
UNIT2	X-ray rooms + queue doctors + queue	queue 2 x server
UNIT1	plastering room + queue registration unit	singlequeue server

Besides the atomic and coupled model classes representing the parts of an emergency department there is one more class definition for usage at simulation. Patients which are served at emergency department are also defined using Matlab's object-oriented features.

Task a: Overall Treatment Time. The task was performed for 20 simulation runs each time sending 250 patients of different type trough the hospital.

```
Simulation Results for Emergency Department after 20 Simulation Runs:
--------------------------------------------------------------------
Total number of served patients = 250
Mean treatment time          = 172.9481 min
Standard deviation           = 81.6598 min
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Patients of type1 (CW-->X-Ray-->CW) = 86.4737
Mean treatment time          = 234.4915 min
Standard deviation           = 65.8564 min

Patients of type2 (CW-->Plaster) = 49.4737
Mean treatment time          = 137.9089 min
Standard deviation           = 62.5007 min

Patients of type3 (CW-->X-Ray-->Plaster-->X-Ray-->CW) = 13.8421
Mean treatment time          = 253.7842 min
Standard deviation           = 53.9893 min

Patients of type4 (CW) = 100.2105
Mean treatment time    = 125.7266 min
Standard deviation     = 59.5823 min

Duration   = 375.1949 min
```

Task b: Doctor Exchange Strategy. This strategy offers no advantages nor for patients neither for leaders of the emergency department. Mean treatment time as well as overall business hours increased.

Task c: Priority Ranking. Patients which enter a treatment point for the second time rank higher in priority than others. To perform this task queues and singlequeues needed to be enhanced with the facility to insert patients into the queue at a defined position. Standard deviation decreases and the emergency department could close about 40 minutes earlier.

```
Simulation Results for Emergency Department after 20 Simulation Runs:
--------------------------------------------------------------------
Total number of served patients = 250
Mean treatment time          = 161.0801 min
Standard deviation           = 74.8611 min
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Patients of type1 (CW-->X-Ray-->CW) = 86.8421
Mean treatment time          = 161.9408 min
Standard deviation           = 75.3273 min

Patients of type2 (CW-->Plaster) = 49.7895
Mean treatment time          = 163.3995 min
Standard deviation           = 74.6603 min

Patients of type3 (CW-->X-Ray-->Plaster-->X-Ray-->CW) = 11.9474
Mean treatment time          = 175.4764 min
Standard deviation           = 72.5793 min

Patients of type4 (CW) = 101.4211
Mean treatment time    = 157.3547 min
Standard deviation     = 74.4887 min

Duration   = 377.4275 min
```
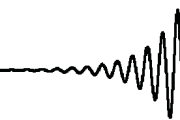
C6 Classification: Object-oriented DEVS Approach

**Simulator: MatlabDEVS2, Rec. Release 2003**

An Active-Objects Approach to ARGESIM Comparison C10 Dining Philosophers II with AnyLogic

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Simulator: AnyLogic 4.0 (http://www.xjtek.com) is a general purpose simulation environment for discrete, continuous and hybrid systems generating cross-platform standalone Java models. However, simultaneous tasks are handled unpredictable and no priorisation mechanism is available.

Model: The scene of the dining philosophers is implemented via ActiveObjects of type `Philosopher` (p) and `Tray` (t) as given in the following pictures:
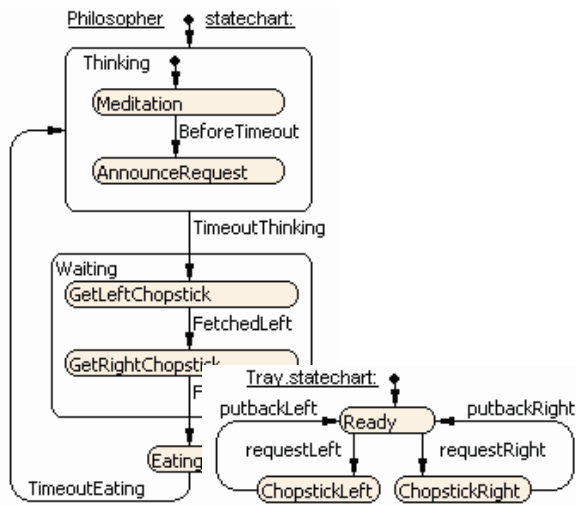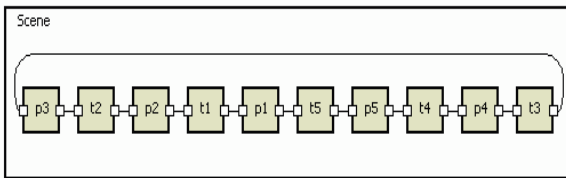
Between two philosophers a tray is responsible for transferring the chopstick. To overcome the unpredictable firing of simultaneous transitions the transition `requestLeft` is disabled (via `AnnounceRequest`) 0.1 seconds before a request (`GetLeftChopstick`) from the priorised right port of the tray arrives.

Task a: Single run – utilization results: Chopstick utilization of a single run is as follows:

[%]	C1	C2	C3	C4	C5	avg
Util	91,97	91,95	91,91	91,96	91,95	91,95

The average times of thinking, waiting and eating periods (± standard deviation) are given next:

[s]	Thinking	Waiting	Eating
P1	5.50±2.87	11.45±8.07	5.50±2.87
P2	5.51±2.87	11.44±8.06	5.50±2.87
P3	5.50±2.87	11.43±8.07	5.50±2.87
P4	5.50±2.87	11.46±8.07	5.49±2.87
P5	5.50±2.87	11.45±8.07	5.50±2.87
avg	5.50±2.87	11.44±8.07	5.50±2.87
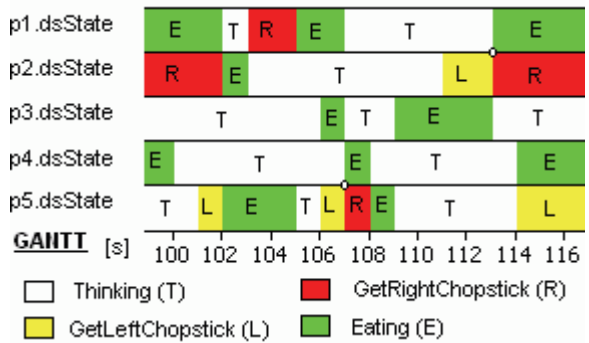
Task b: Simultaneous Access: The right handling of simultaneous requests can be seen on the GANTT-chart above. At the time 107, the philosopher p4 gets the chopstick to the left of his bowl even though philosopher p5 requires the chopstick simultaneously. The same occurs at the time 113 between the philosopher p1 and p2.

The following GANTT-chart shows the situation of a deadlock where all philosophers have picked up their left chopstick at the same time
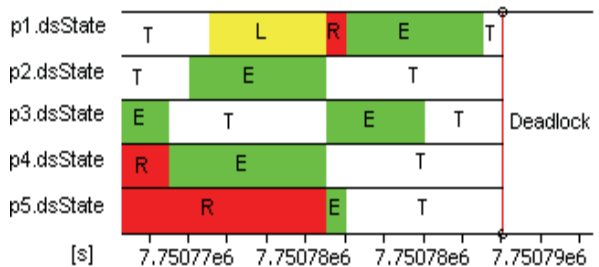
Task c: Multiple runs – deadlock observation: AnyLogic detects a deadlock due to an empty event list on that situation. The minimum and maximum termination time evaluated on 50 simulation runs is 60979 s or 1.237E7 s, resp.

C10 Classification: Active – Objects Approach

Simulator: AnyLogic 4.5

An OO Numerical Solution to ARGESIM Comparison "C11 - SCARA Robot" using AnyLogic

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Simulator. AnyLogic is able to handle continuous, discrete and hybrid models. It is based on JAVA and therefore object-oriented. It offers drag-and-drop dialogues for the basic parts of the model's structure as well as for animation. Everything needed is created as an instance of the ActiveObject class, starting with the 'root' class which represents the model to state variables (the 'important' variables which can appear on the left-hand side of an ODE and can be plotted), statecharts and animation.

Task a: Modeling Method: AnyLogic can not handle implicit models; therefore the mass matrix was first inverted using Maple 8. Maple was also used to compute the maximal armature current. The components of the acceleration vector as well as the position vector and the armature currents – all variables at the left hand side of the ODE's – are ActiveObjects, and are embedded in the ActiveObject "Arm" along with all parameters (fig. 1). Collision is treated by introducing a state chart, where the transition condition `(x<xobs+ 0.1) && (z<hobs) && kol` allows to handle collisions with an obstacle at a certain position and height, if the Boolean variable `kol` is set to true.
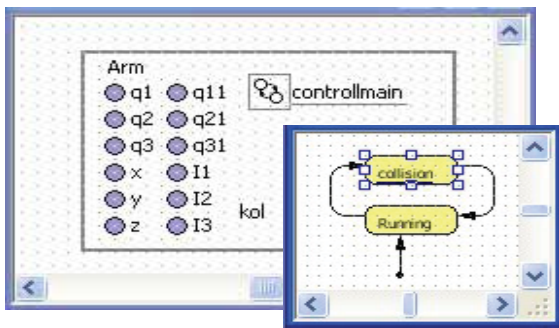
Fig. 1: AnyLogic model with statecharts

Curiously, AnyLogic has no limit function neither a limiting integrator; so a JAVA-function is used to keep the current and the voltage within the given limits.

The actual integration happens at two levels. The ODE's for the currents and the speed are solved in the statechart, while the positions are calculated in the ActiveObject "Arm". This is only possible because AnyLogic is sorting the equations during runtime. If a collision event (defined in the statechart) happens, equations are resorted.

Task b: Simulation: After the Model was set up, experimentation itself is a menu-driven object; also to get a plot of the position values. As all of them are ActiveObject variables, AnyLogic conveniently provides the plot shown as figure 2 via Drag-and-Drop dialogues.
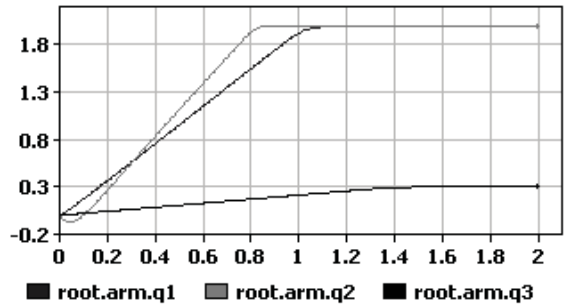
Figure 2: Results for positions without collision

Task c: Collision Avoidance: Once the Boolean variable `kol`, again an active object, is set to true, the transition between the "Running" state and the "collision" state is possible. In case of collision emergency, the maximal voltage of 230 volt is applied to the rotational motors, which control the horizontal movement, so their acceleration is set to the biggest negative value.

On the other hand the voltage for the linear motor is set to the positive maximum – also 230 volt – so the tip is raised at maximum speed. Once the tip is either high enough or reached a save distance from the obstacle, the transition "Running" state takes place. As seen in Figure 3, plotted with the same routines as number 2, one more emergency movement is necessary before the obstacle is passed.
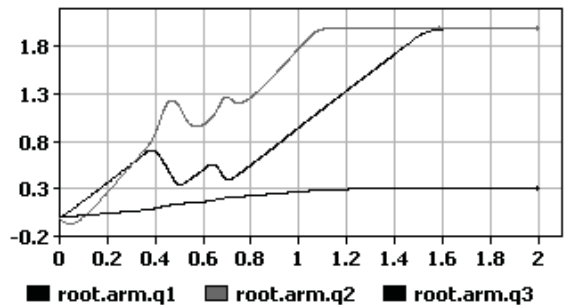
Figure 3: positions during collision avoidance

C9 Classification: OO Numerical Approach
Simulator: AnyLogic 4.5, Rel. 2003
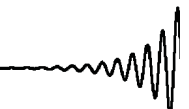
A Classic CNS - Solution to ARGESIM Comparison "C13 Crane and Embedded Control" using MATLAB

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Simulator: MATLAB is a widely used software tool based on numerical vector and matrix manipulation. Simulink is a graphical extension for block oriented simulation. S-functions provide a mechanism for extending the capabilities of Simulink by adding user defined blocks. The functionality of these blocks is written in an m-file or other programming languages like C, FORTRAN or Ada.

Model: SIMULINK was used to implement the DC-motor and the mechanics of the linear and the nonlinear system. It was forced to use a fixed step algorithm (Euler) with a step wide of 0.0001 for numerical integration. The goal was to get a comparison between the results obtained by a more sophisticated solver (ODE23s: see SNE 31). The main problem for the SIMULINK model in task b and task c is based on the different sampling times, managed by classical `zero-order hold` and `unit delay` blocks.

Task a: Comparison of uncontrolled linear and nonlinear model. The implicit nonlinear model was transformed to a simplified explicit model. The next table shows the position differences for different loads.

Disturbance	-750	-800	-850
Difference	-145	-246	-356

Task b: Simulation of the controlled system. For the controller the Discrete-State-Space – block was used and 'zero-order hold' and 'unit delay' blocks were implemented (fig. 1)
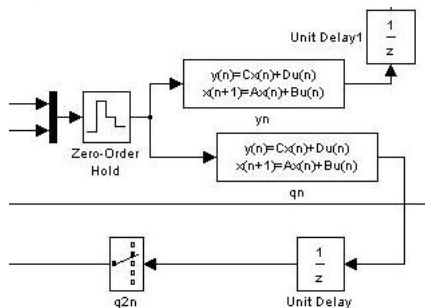
Fig. 1: SIMULINK model for discrete control

The reason was to compensate the slower sample time of the controller (0.01). Fig. 2 shows position of the car and the load, activation times of the brake (t = 15.34, 31.7 and 56.7 sec) and the angle of the cable
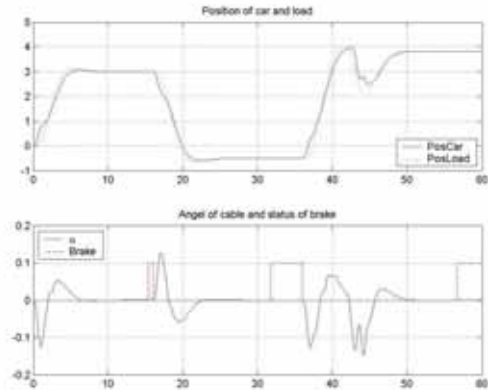
Fig. 2: Results controlled movement with brake action

Task c: Simulation of controlled system with sensor diagnostics. Brake control and sensor diagnosis were modelled by two s-functions, the latter one called every 2 ms. the status of the angle sensor is stored in a vector. Each call fills one cell of this vector with a 1 and updates it with the current status of the sensor. If the sum of ones is greater than 25, Emergency Mode is triggered.

The whole system goes into Emergency Mode at t = 18.00, brake was switched on at t = 15.34 and 34.93 and Emergency Stop is triggered at t = 44.44. Fig. 3 shows the results graphically.

Fig. 3: Results controlled movement with sensor diagnosis

C13 Classification: Classical CNS Approach

Simulator: MATLAB / SIMULINK Rel. 13, 2003

A Programmed Solution to ARGESIM Comparison "C15 Clearance Identification" with MATLAB

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Simulator. MATLAB is a widely used software tool based on numerical vector and matrix manipulation. Additionally it provides several toolboxes for various tasks (Optimisation toolbox used here).

Model: The model ODEsare directly programmed in MATLAB code with a simple if-else-structure.

```
function xd = C15dgl(t,x)
C15data; k01 = 0.0041; k12 = 0.0585;
k21 = 0.0498; V1 = 7.3;
A = [-(k01+k21),      k12;...
            k21,     -k12];
b = [C15inf(t);0]; xd = A*x + b;
function inf = C15inf(t); C15data; n = length(t);
for j = 1:n
    if t < tau;inf(j) = D/tau;
    else ; inf(j) = 0; end; end;
```

Task a: Simulation of the System: The differential equations are numerically solved by MATLAB's ODE solver ODE23 (RKF-type solver), calling the above model description.

```
sol = ode23(@C15deq,tspan,x0);
```

Results for τ_1 = 0.5 min, τ_2 = 3 min und τ_3 = 240 are given in fig. 1. In fig. 2 one can already see the effect of the clearance: short injection time - very low concentration in the central compartment. Table 1 gives the numerical values.

Figure 2: Difference modelled concentration / measured concentration (for τ_1 =

Fig. 1: 3 different solutions, task a

τ_1 = 0.5 min	τ_2 = 3 min	τ_3 = 240 min
$x_1(1.5)$= 2341.9	$x_1(4)$ = 2184.2	$x_1(240)$=1058.2
c_1 = 320.8	c_1 = 299.2	c_1 = 145.0

Table 1: Values of x_1 and c_1 1 min after injection ends (for τ_3=240 min at the end of the injection time)

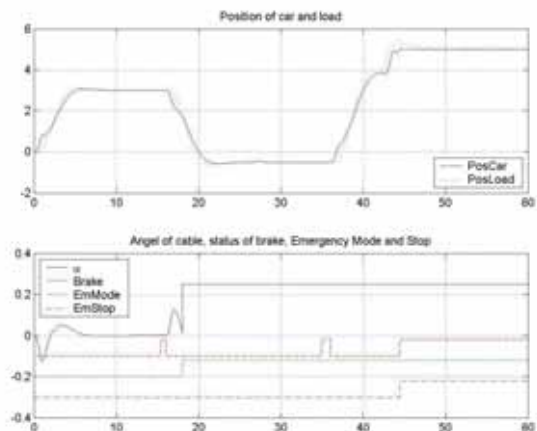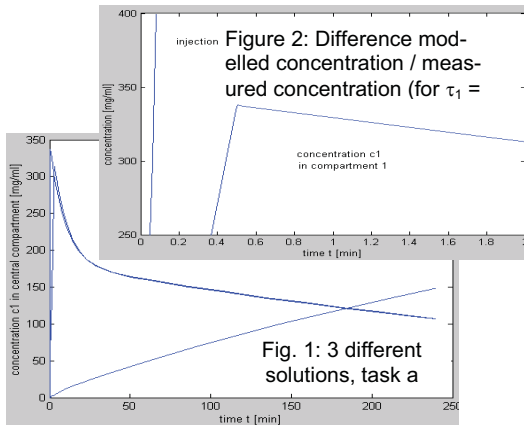**Task b**: Identification. The identification of the model was done with the Levenberg-Marquardt algorithm, using the known algebraic solutions of type

$$c_1(t) = b_1 \cdot e^{-\lambda_1 \cdot t} + b_2 \cdot e^{-\lambda_2 \cdot t}$$

In order to improve efficiency of the identification, the parameters b_1, b_2 and λ_1, λ_2 were identified in two steps (b_i depend only linear). These "indirect" parameters then "recalculate" the "true" parameters:

```
% Caculate "linear" parameters
B = zeros(length(t),2); B(:,1) = exp(-lam(1)*t);…
%solve B*b = c1 for linear parameters b
z = B*b; f = z-c1;    %compute error (residual)
% Call Identification (Optimisation)
options = optimset
(…,'iter','LevenbergMarquardt','TolX',0.00,…)
[lam,resnorm,residual,exitflag,output]=
  lsqnonlin('C15conc',lam,[],[],options,Datas,h)
% Recalculation of true parameters
k01 = (lam(1)*lam(2)*(b(1)+b(2)))/   …
V1 = D/(b(1)+b(2))
```

The identified values are: k_{01} = 0.0042, k_{12} = 0.0581, k_{21} = 0.0501, V_1 = 7.2150; Clearance C = $k_{01}*V_1*1000$ = 30.303, residuum 260.8067. Fig. 3 shows result graphically
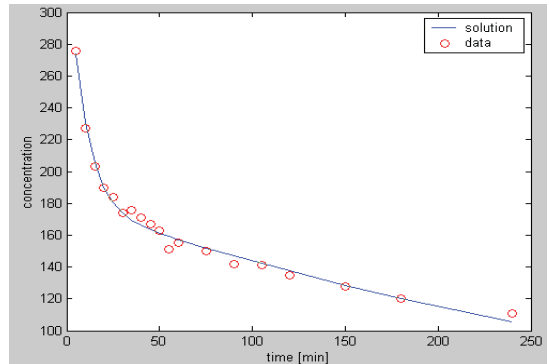
Figure 3: Identified model and measured data

Task c: Error Estimation. Data are disturbed at MATLAB level, for each set of the disturbed data the numerical identification is performed.

	k_{01}	k_{12}	k_{21}	V_1
mean	0.0042	0.0579	0.0512	7.2055
sd	0.0005	0.0085	0.0117	0.4411

Table 2: Mean and standard deviation (sd) of identified parameters, based of 1000 samples

C15 Classification: Programmed Fully Numerical Approach

Simulator: MATLAB Rel.12 with Optimisation Toolbox

BOOK REVIEWS

On Growth and Form

Spatio-temporal Pattern Formation in Biology

M. Chaplain, G. D. Singh, J. C. McLachlan (Eds.), Jon Wiley & Son 1999 ISBN 0-471-98461-5

Originating in the plenary talks given at the D'Arcy Thompson Meeting marking the 50th anniversary of D'Arcy's death, which took place in September 1998 at the University of Dundee, the book is an overview of the scientific project based on D'Arcy's opus magnus "On Growth and Form". As the participants of the meeting came from all sorts of disciplines, from biomathematics to anatomy, the scope of the book is broad, ranging from genetics development biology up to functional morphology.

The first paper is a short summary of the problems of development: While the major problem of Regional Specification is largely solved, from it's solution a great many other problem in many categories have risen, lurking in the shadows of media showlight.

Some of those categories are represented in this book. They can be roughly divided into two types. About one third are papers which use mathematics only for statistical purpose, and are purely descriptive.

More interesting for a reader working in the field of modelling and simulation are papers about the mathematical modelling of various growth processes, from the pattern of seashells to the arterioles that evolve around a cancer.

Like the start, the end is interesting for everyone regardless of expertise in this field: A short paper about D'Arcy Wentworth Thompson and the problem of biological form, explaining how D'Arcy's ideas after almost a century still fit in nowadays theories like morphogenetic fields and genetic networks, is an nice finishing touch by the editors.

Beginner	Intermediate	Expert
		●
Theory	**Mixed**	**Practice**
	●	
Lecture Note	**Monograph**	**Proceedings**
		●

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Hydraulic Servo-Systems

Modelling, Identification and Control

M. Jelali, A. Kroll, Springer Berlin 2003, ISBN 1-85233-692-7; 395 p.

In 1966 Herbert Merrit published his book "Hydraulic Control Systems" which has become a standard reference for everybody who is working in the field of modelling or control of hydraulic drives. However, many of today's tools had not been invented at this time and many developments in control theory were still far ahead.

The book by Jelali and Kroll gives an up to date survey of modelling, identification and control of hydraulic servo-systems. They start with physical modelling of hydraulic systems. Where Merrit showed graphs they give equations that can easily be used by the reader for his own modelling task. Their focus is primarily on models that can later be used for controller design; component design or circuit design is mentioned only in passing. This part takes approximately 100 pages and 390 equations.

The next 100 pages give an introduction to identification or experimental modelling. For a control engineer a physical based model is fine because it gives some insight into the system. If however only the controller design is of interest other models may be better suited. This book introduces among others topics: parameter estimation for physical models, fuzzy models and artificial neural networks.

Merrit used linear differential equations and the Laplace-transform for the analysis and design of control loops. Jelali and Kroll present all the progress that has been made since then. They start with classical feedback control design and continue with linear state-space controllers that are extended with feed-forward control or adaptive parts.

As non-linear control schemes they introduce feedback linearising control and similar approaches, various schemes of fuzzy control and neural-network-based control. As the velocity is needed for most of these control schemes a section on state estimation is included that covers also the hydraulics specific problems of friction and external force estimation.

Five case studies give technical examples for the presented theory. An appendix that includes mathematical background for the non-linear control schemes like Kronecker product, Lie derivatives and Lie brackets and a list of over 400 references conclude the book.
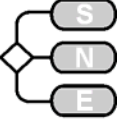
Altogether the book gives a comprehensive survey of physical modelling, conventional and modern control strategies for hydraulic drives and can be recommended to engineers and scientists who are working in this field.

Beginner	Intermediate	Expert
	●	●
Theory	**Mixed**	**Practice**
●		
Lecture Note	**Monograph**	**Proceedings**
	●	

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SAM – Investigation of Strategies in Agent-Based Simulation

Niels Lepperhof , Publ. Forschungszentrum Jülich, ISBN 3-89336-298-3 286 pages,

The objective of this thesis (written in German) is the optimisation of the groupware SAM (not an Acronym) which is an implementation of Herrmanns negotiation principle. The intention of the author is to do this via agent simulation.

In the first part of the book, the implementation of all parts of the task is well described. The task for the agents is to negotiate the colours of a grid, according to there own preferences, their personality (modelled with parameters such as speed of reaction or revenge) and also a given group structure).

The actual objective although is not achieved, and the second part of the book describes the restrictions that had to be made so that even some kind of analysis is possible. Finally, only five special groups with only five members each are used, and even for this small sample no real information is obtained.

Beginner	Intermediate	Expert
●		
Theory	**Mixed**	**Practice**
	●	
Lecture Note	**Monograph**	**Proceedings**
	●	

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Modeling in Applied Sciences

A Kinetic Theory Approach

Nicola Bellomo, Mario Pulvirenti (ed.),
Boston, Basel, Berlin: Birkhäuser, 2000
ISBN 0-8176-4102-5, 419 pages

This book provides a comprehensive survey of modelling large systems using kinetic equations and in particular the Boltzmann equation and its generalizations. It is a collection of review papers, and each survey generally deals with modelling, mathematical statement of problems, qualitative and computational analysis related to applications. Although the content of each lecture may also include analytic aspects and proofs, greater emphasis is given to applications and computational treatment. The various mathematical models refer to several fields of applied and technological sciences, e.g. population dynamics, fluid dynamics of reacting gases, communication networks, and mechanics of multicomponent media, immunology, and traffic flow.

More in details on the content of this book, the first chapter provides a concise introduction to the traditional Boltzmann model and to the so called generalized Boltzmann models. The first five chapters, which follow the introductory one, are concerned with models somehow closely related to the Boltzmann equation. In particular, models of granular media are dealt with in Chapters 2 and 3. General aspects of models of particles interacting in a fluid are dealt with in Chapter 4. Models of condensing and chemically reacting gases are, respectively, dealt with in Chapter 5 and 6.

Kinetic models in epidemiology and immunology are dealt with in Chapter 7. Traffic flow models are dealt with in Chapter 8, while Chapter 9 deals with models for communication networks. The last chapter is devoted to a review of computational schemes which can be applied to the solution of the various problems posed along with the lectures.

In conclusion, the final aim of this book is to provide, by a sequel of examples an overall view of the state of art of some significant attempts in the above directions and to indicate research perspectives in the field.

Beginner	Intermediate	Expert
	●	
Theory	**Mixed**	**Practice**
	●	●
Lecture Note	**Monograph**	**Proceedings**
	●	

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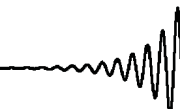
Computer Algebra Recipes for Classical Mechanics

R. Enns, G. McGuire; Birkhaeuser Boston, 2003
ISBN 0-8176-4291-9

As one can guess reading the title, this book represents some sort of cookery book but the 'recipes' consist of smart ways to solve typical problems of classical mechanics. This is done by means of the computer algebra system MAPLE 8.

Instead of writing a boring text which specifies all values for a certain task, the authors have chosen to introduce all tasks in the context of interesting tales. For example some of them are linked to golf, hiking or also roller coasters.

As I have mentioned above the computer algebra worksheets are called 'recipes' and this title shows the underlying philosophy of this book in the best way. By altering parameter values or initial conditions it's possible to solve a lot of different mechanical problems which aren't described in this book.

This book is structured like a real menu, so the three chapters are called 'appetizers', 'entrees' and 'desserts'. And as the titles imply this structure corresponds to the natural progression of basic levels of classical mechanics through more advanced subjects like Hamiltonian mechanics.

One of the few things you have to care about by reading this book is the concurrent progression of the level of knowledge required by each recipe in terms of mechanics and MAPLE. So if your mechanics background is high above the examples presented in the 'Appetizers' section, you should start there anyway. The basic features of the MAPLE system are described there and maybe you might find it challenging to solve these simple examples in a new way.

In summary, this book is meant for undergraduate students which are longing for practical help to solve their classic mechanical problems. By getting this help they will also learn the usage of a computer algebra system, in this case MAPLE.

Beginner	Intermediate	Expert
●		
Theory	**Mixed**	**Practice**
		●
Lecture Note	**Monograph**	**Proceedings**
	●	

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Discovering Mathematics with Maple – An Interactive Exploration for Mathematicians, Engineers and Econometricians

R.J. Stroeker, J.F. Kaashoek

Birkhäuser, 1999. 248 pages. Softcover + CD

ISBN 3-7643-6091-7

This book introduces some of the most widely applies mathematical techniques. The course is organizes in Maple worksheets that also acquaint the user with the basic features of a computer algebra system. The CD contains all the worksheets as well as a demo and a trial version of maple.

Apart from the worksheets – the complete text of which is included in the book – each chapter contains a few exercises, some easy and others quite hard. Finally, at the end of each chapter an overview is given of selected Maple expressions and commands introduced and applied in the chapter in question.

This book introduces Maple in a rather special way, namely, it shows how a computer algebra system most naturally fits into a mathematically oriented work environment. It instructs the reader about the use of Maple by posing problems of a strictly mathematical nature.

It is intended not as a mere introduction to Maple, but also to show how Maple – and other computer algebra systems – may enrich our knowledge and deepen our understanding of mathematics. In that respect it focuses on mathematics rather than on Maple trying to convince scientists who are not naturally inclined to incorporate the computer into their daily work routine that a computer algebra system may very well enhance their theoretical work.

The chapters of this book are clearly written and well organised. As the title of the book already implies, I would only recommend it to people who are not very experienced with Maple or other computer algebra systems. The book offers a lot of exercises to control your progress.

Beginner	Intermediate	Expert
●		
Theory	**Mixed**	**Practice**
	● ●	
Lecture Note	**Monograph**	**Proceedings**
	●	

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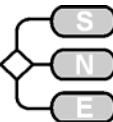
Simulation in Environmental Sciences and Geosciences

Simulation in Umwelt- und Geowissenschaften (in German); Jochen Wittmann, Albrecht Ganuck (Hrsg), Workshop Cottbus 2002; Shaker Verlag 2002, ISBN 3-8322-0733-3

This paperback is the summary of a Workshop about simulation in geo science and environmental science. The scope of the workshop was broad, and this is fully reflected in the papers. Most of them are very interesting interdisciplinary works, but have no connection beyond being bound in one cover.

Alas, three of them have to be mentioned separately, as they are theoretical papers about data bases, which have not connection to the theme of the workshop whatsoever, except incorporating examples of geo science which were obviously added later on to get them accepted.

Beginner	Intermediate	Expert
	●	
Theory	**Mixed**	**Practice**
	●	
Lecture Note	**Monograph**	**Proceedings**
		●

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Mathematical Methods and Models for Economists

Angel de la Fuente; Cambridge University Press 2000; 835 + vii pages, ISBN 0-521-58529-5

This book provides an introduction to mathematics for students of economy and is a useful reference. It starts with introductions to sets, logic, methods of proof, relations, functions and so on and covers metric and vector spaces and differential calculus as well as static and dynamic optimization and applications in the field of microeconomics and other topics of interest.

As this book is intended as a textbook for the first-year Ph.D. course in mathematics for economists it is not well suited for mathematicians as most of the book is basic to slightly advanced knowledge for every student of mathematics, nevertheless there are some interesting applications which are worth a look. For the economist however it is an extensive introduction into the mathematic needed in the field of economics.

Furthermore the book contains a thought trough selection of applications as well as over two hundred problems that are fully worked out.

Some of the discussed topics are: Vector Spaces and Linear Transformations, Differential Calculus, Static Models and Comparative Statics, Static Optimization, Dynamic Systems, An Introduction to Dynamic Optimization

Beginner	Intermediate	Expert
●		
Theory	**Mixed**	**Practice**
	●	
Lecture Note	**Monograph**	**Proceedings**
●	●	

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Mathematical Modeling in the Environment

Charles R. Hadlock; The Mathematical Association of America 1998; ISBN 0-88385-709-X

The book presents an interdisciplinary introduction to different environmental problems of contemporary relevance as well as mathematical models to investigate these problems.

It is divided into two main parts. Each of the two parts again consists of three big chapters, which cover different environmental issues. The first tells about the flow of ground water and the spread of contamination with it. In the second chapter the reader learns about air quality modelling and diffusion processes and in the third about hazardous materials incidents.

The needed mathematical background is reduced to a minimum. In the first part nearly no calculations are used and the most sophisticated is the exponential function with an explanation even to this. The second part uses one and multidimensional calculus, differential equations, numerical analysis and linear algebra.

Here again most of the concepts are developed from the beginning or at least a footnote at each section tells what knowledge is assumed. In addition all needed physical and chemical principles are explained. As the author is American, he uses the foot-pound-second system of units instead of the SI-system, which would definitely make the book more international.

For each environmental issue the author gives many examples from real-world and also discusses implications on business, law and politics. The great number of exercises both encourages the reader to review background material and gives the possibility to apply the described methods. The exercises are also suitable for group work or discussions.
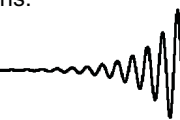
On the diskette which is packaged with the book a simple spreadsheet program for the Gaussian plume model used in air pollution calculations and a DOS program for analysis of hazardous material accidents is included.

In summary, the book can be recommended as material for first courses of applied mathematics or just for rather easy reading about modelling of problems of contemporary relevance.

Beginner	Intermediate	Expert
●		
Theory	**Mixed**	**Practice**
		●
Lecture Note	**Monograph**	**Proceedings**
●		

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History of the Scientific Revolution

Die Große Erneuerung. Zur Geschichte der Wissenschaftlichen Revolution (in German).

Hans Wußing, Birkhaeuser Basel, Boston, Berlin 2002; ISBN 3-7643-6698-2

This book is talking about big changes which had happened in mathematics, astronomy, physics, chemistry, biology, geography and philosophy during 16./17. and outset of 18. Century. In historiography this should be compendious with the concept of scientific revolution.

The author is picking up the highlights of this process which is the basis of our science today. To show the cerebral turnarounds and the characters of the scientists he is attaching importance of authentic statement.

Beginning with the launch of heliocentric system and physics of the sky, where the thoughts of some of the most known scientists like Nicolaus Copernicus, Galileo Galilei, Johannes Keppler... are shown, the book contains everything relevant. Innovations of scientific instruments, new cognitions in mathematics, optics, chemistry and physics as well as biology and geology.

On the whole the book is pleasantly to read, whereat a lot of quotations and intriguing photographs of notes and inventions of notable celebrities are shown. Furthermore the book disposes of an excellent timetable, which allows an overview of development of the scientific revolution.

In summary, this book is meant for everyone who is interested in history and evolution of the natural science we know nowadays.

Beginner	Intermediate	Expert
●		
Theory	**Mixed**	**Practice**
●		
Lecture Note	**Monograph**	**Proceedings**
	●	

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Recent Progress in Multivariate Approximation

4th International Conference, Witten-Bommerholz (Germany), September 2000

Werner Haussmann, Kurt Jetter, Manfred Reimer (eds.), Birkhäuser 2001, ISBN 3-7643-6505-6

Being a collection of 19 selected contributions to the 4th International Conference on Multivariate Approximation this book contains a wide variety of articles that cover state-of-the-art developments in this sector.

For researchers in this and similar fields the book provides a very good, well structured resource but is not meant to be introductory. The level is very high and it needs good concentration to read and understand. This is definitely no bedtime reading but it's a very good book covering the recent developments in this sector to a very good extent.

These are the main topics:

- interpolation and approximation on compact sets, Kergin interpolation
- error asymptotic
- radial basis functions
- energy minimizing configurations on the sphere
- quadrature and cubature formulae
- harmonic functions near a zero
- blending functions
- frames and approximation of inverse frame operators

Beginner	Intermediate	Expert
		●
Theory	**Mixed**	**Practice**
●		
Lecture Note	**Monograph**	**Proceedings**
	●	

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BOOK REVIEWS

Issue 38/39
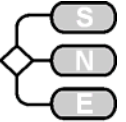
Theory and Modelling of Ecosystems

Proc. Workshop Kölpinsee 2000

Albrecht Gnauck (ed.), Shaker Verlag, Aachen 2002, 329 + x pages, ISBN 3-8322-0200-5

This entirely German written book contains a collection of 16 contributions from the workshop in Kölpinsee 2000. The contributions range from purely theoretic to applied and software oriented.

The topics vary from simulation of populations of animals and plants to agricultural aspects and issues in water quality and water quality management.

Furthermore the book is easy to understand and gives a good overview over the topic.

A detailed review may be found in ASIM-Nachrichten.

Beginner	Intermediate	Expert
	●	
Theory	**Mixed**	**Practice**
	●	
Lecture Note	**Monograph**	**Proceedings**
		●

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Probability Calculus

Wahrscheinlichkeitsrechnung (in German)

D. Foata, A. Fuchs; Birkhäuser 1999, 383 + xv pages; ISBN: 3-7643-6169-7

This book gives an introduction into probability theory for the beginner. It starts with defining some basic concepts of probability theory like events, probability spaces and so on and builds a considerable amount of knowledge on this basis.

In the book discrete probability theory as well as probability theory from the measure and integration theory point of view is dealt with, while the reader needs only knowledge of analysis, as the main ideas of measure and integration theory are presented where needed for the development of a modern, axiomatic approach to probability theory.

The topics that are dealt which range from probability spaces and their set theoretic base over distributions to the central limit theorem and applications. It is to say that every basic topic is considered and dealt with properly.

Additionally at the end of every chapter there is a large selection of problems to which the solutions and additional comments are given at the end of the book. Furthermore the book is well structured and the index provides for easy and quick reference.

All in all this book is recommended for those who want a good and well structured introduction to probability theory.

Beginner	Intermediate	Expert
●		
Theory	**Mixed**	**Practice**
	●	
Lecture Note	**Monograph**	**Proceedings**
●	●	

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MATLAB 6.5 – An Introduction

MATLAB 6.5 – Eine Einführung (in German)

Ch. Überhuber, St. Katzenbeisser; Springer Wien / New York 2002; ISBN 3-211-83826-0

MATLAB (the name stands for MATrix LABoratory) is a high-performance language for technical computing. It integrates computation, visualisation and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

MATLABs basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems in a fraction of time it would take to write a program in a scalar non-interactive language.

This book is an introduction to MATLAB and its many possibilities. It starts giving some general information about data types and operations, before it goes on to discuss different loops (such as for, if, …).

Then there is information about programs and subprograms and how to define data types and methods and it finishes with chapters concerning numerical methods (including interpolation, numerical integration, nonlinear equations…) and predefined variables and subprograms.

Although this book addresses itself to beginners and experienced persons, I would only recommend it to people, who have not worked with MATLAB before.

The book is well structured with a clear, non-confusing layout and contains a list of all the commands.

Beginner	Intermediate	Expert
●		
Theory	**Mixed**	**Practice**
	●	
Lecture Note	**Monograph**	**Proceedings**
	●	

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System Dynamics and Simulation

Systemdynamik und Simulation (in German)

M. Gipser; B.G.Teubner Stuttgart - Leipzig, 1999
ISBN 3-519-02743-7

As you can guess by reading the title, this book describes basic terms like system dynamics and simulation. There are 4 main chapters which are dedicated to system dynamics, system design and simulation. The fourth and last chapter provides a short insight into applications by describing problems which occur in the automotive industry.

The mathematical requirements aren't very high and are restricted to linear algebra, complex numbers and differential calculus. An extensive introduction to linear algebra is given at the end of this book.

Unfortunately the topic of transfer functions is only mentioned briefly and isn't needed to understand this book. It's recommended that you read its basics like the Laplace transformation in other books.

Recapitulating one can say that this book is meant for the interested engineer who doesn't need a lot of previous knowledge.

Beginner	Intermediate	Expert
	●	
Theory	**Mixed**	**Practice**
	●	
Lecture Note	**Monograph**	**Proceedings**
	●	

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Monte Carlo Strategies in Scientific Computing

J.S. Liu, Springer, 2001, 338 pp.
ISBN 0-387-95230-6

Monte Carlo methods are an important research area of scientific computing that has made great progress in recent years. In particular they are closely related to stochastic simulation although MC is basically not a simulation method. Unfortunately, the terminology of the Monte Carlo community is quite unfamiliar if not cryptical to those people coming from the classical disciplines of numerical mathematics.

Essentially any Monte Carlo method has the purpose to estimate a multidimensional integral. It is shown that surprisingly many problems can be reduced to the computation of certain integrals. While the computational complexity of numerical integration algorithms grows with dimension the Monte Carlo method does it with a convergence rate of $C/\sqrt{N}$ for any dimension (N is the sample size). However it is the constant C that must be kept small by a sophisticated setup of the Monte Carlo algorithm.

The book gives a good introduction to current Monte Carlo methods and explains the terminology on a moderate level of abstraction. It becomes clear that any specific problem needs a tailored algorithm to be efficient. This is the reason for the emergence of variance reduction methods, importance sampling, rejection, sequential MC, Metropolis algorithms, Gibbs samplers, Markov Chain MC (MCMC), or hybrid MC with molecular dynamics.

Beginner	Intermediate	Expert
	●	
Theory	**Mixed**	**Practice**
	●	
Lecture Note	**Monograph**	**Proceedings**
	●	

W. Wiechert
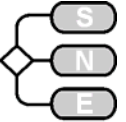*wiechert@simtec.mb.uni-siegen.de*

Learning SIMUL8 – The Complete Guide

Jaret W. Hauge and Kerrie N. Paige,
Volume I and II, Plain Vu Publishers 2001;
ISBN 0-9709384-0-3, 768 + 170 pages, Softcover

⊗ **CD-Rom included**

The book covers SIMUL8 Release 7, the latest one available.

BOOK REVIEWS

The two volumes are divided into a very large tutorial / guide book and into a very small reference manual, containig mainly Visual Logic and DDE command references.

Volume I includes also a CD-Rom with a 21 days trial version of SIMUL8 and all sample files from the books. Additional software can be found on the CD-ROM.

The guide (Volume I) is divided into four parts, and a fifth for appendices. The first part "Getting Started" takes 115 pages divided into four chapters to read, Part II "Building the Model" and part IV "Putting it all Together" have 300 resp. 220 pages.

Topics worth to know for doing good simulation like Random Number Generators are mentioned roughly. There the book references to common, widely known literature. The way of working of the integrated event handler is not described in any way.

Because of the large amount of stuff one has to deal with, the 21 days trial version doesn't reach with respect to the time one has to get involved with the program. A time unlimited evaluation version with limited size of the model might has fitted better on the CD-Rom. The business player is worth to mention in the sense, that a model can be demonstrated without running the whole engine. Other simulation programs lack in that.

The given examples are focussing on production systems. Because SIMUL8 can be regarded as a gerneral discrete event simulator, other examples from the field of logistics or transportation systems or business processes would have extended the readers view.

Because of the consulting and operational researchl background of the authors, the statistical and analytical parts of a model are well developed and give a good insight into result analysis. Positively the authors do not spend too much effort on the visualisation capabilities of the software package.

Beginner	Intermediate	Expert
●	●	
Theory	**Mixed**	**Practice**
		●
Lecture Note	**Monograph**	**Proceedings**
●		

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markus.klug@arcs.ac.at

EUROSIM '04
5th EUROSIM Congress on Modelling and Simulation
6 – 10 September 2004
Cité Descartes, Marne la Vallée, France

Conference chair and contact:
Yskandar Hamam
y.hamam@esiee.fr

Conference themes

Adaptive simulation
Bondgraph simulation
Biomedical systems
Complex systems
Component based modelling
Continuous simulation
Control systems
Data mining
Decision support systems
Discrete event simulation
Distributed systems
Expert systems
Fuzzy simulation
Genetic algorithms
Graphical modelling
Heterogeneous systems
Hierarchical modelling
High complexity systems
High performance computing
Hybrid modelling
Integrated modelling
Intensive computation
Knowledge based systems
Large scale systems
Man-in-loop simulation
Mathematical methods in simulation
Mathematical modelling
Methodology of complex societal problems
Methodology of systems modelling
Multi-agent based systems
Neural networks Model validation
New inductive and deductive methods
Open systems
Operations research
Optimisation by simulation
Parallel modelling
Parallel processing
Petri nets
Real-time systems
Scientific computation
Self-organising systems
Statistic modelling
Statistical modelling
Stochastic systems
WEB based simulation

The EUROSIM 2004 Congress will be organised by the French Speaking Simulation Society (FRANCOSIM) on behalf of the Federation of European Simulation Societies (EUROSIM). It will take place in September 2004 at ESIEE in Marne la Vallée, France. It aims to address the impact of simulation science on the society in general. Contributions from natural and life sciences such as experimental and computational physics, mathematical engineering, applied chemistry, structural architecture, environmental management, economics and econometrics, operations research, social and behavioural sciences, such as experimental philosophy and applied psychology.

Besides submitting papers, interested persons may propose special sessions and invite contributors in the corresponding field. Selected papers on special issues may be published in the SIMPRA Journal.

Important dates:

January 9th, 2004:	proposal of special sessions
February 13th, 2004:	submission of abstracts
April 9th, 2004:	acceptance of abstracts
May 10th, 2004:	submission of full papers
May 28th, 2004:	final acceptance of papers
June 6th, 2004:	authors' and early registration

About Cité Descartes

The Descartes Science Centre, located at the heart of the Marne la Vallée New Town, officially created on March 22nd, 1983, has been given high priority in France's planning for regional development. It has a number of major advantages: proximity to PARIS, exceptional service both by public transport and by road and railroad networks (High Speed Train station of Marne la Vallée/Chessy) and it is close to the Roissy Charles de Gaulle and Orly Airports. Its environment and surroundings are of high quality and its development has always been guided by a strong consideration for the preservation and protection of the natural spaces. .

FrancoSim

EUROSIM SOCIETIES

EUROSIM
Federation of European Simulation Societies

www.eurosim.info

EUROSIM, the Federation of European Simulation Societies, was set up in 1989. The purpose of EUROSIM is to provide a European forum for regional and national simulation societies to promote the advancement of modelling and simulation in industry, research, and development. EUROSIM members may be regional and/or national simulation societies. At present **EUROSIM** has ten full members and three observer members:

- **ASIM** – Arbeitsgemeinschaft Simulation (Austria, Germany, Switzerland)
- **CROSSIM** – Croatian Society for Simulation Modelling (Croatia)
- **CSSS** – Czech & Slovak Simulation Society (Czech Republic, Slovak Republic)
- **DBSS** – Dutch Benelux Simulation Society (Belgium, The Netherlands)
- **FRANCOSIM** – Société Francophone de Simulation (Belgium, France)
- **HSS** – Hungarian Simulation Society (Hungary)
- **ISCS** – Italian Society for Computer Simulation (Italy)
- **SIMS** – Simulation Society of Scandinavia (Denmark, Finland, Norway, Sweden)
- **SLOSIM** – Slovenian Simulation Society (Slovenia),
- **UKSIM** – United Kingdom Simulation Society (UK, Ireland)
- **AES** – Asociación Española de Simulación (Spain; observer member)
- **PSCS** – Polish Society for Computer Simulation (Poland, observer member)
- **ROMSIM** - Romanian Society for Modelling and Simulation (Romania; observer member)

EUROSIM Board

EUROSIM is governed by a Board consisting of one representative of each member society, plus the organizer of the last and next EUROSIM Congress (past president and president), and of prepresentatives for the official EUROSIM publicatiosn (journals SIMPRA and SNE).

At the **EUROSIM'01** Congress the Board elected new officers for a three years period: Y. Hamam (president), L. Dekker (past president), M. Savastano (treasurer), P. Fritzson (secretary), J. Halin (SIMPRA), F. Breitenecker (SNE), F. Maceri (member).

The EUROSIM boards met in April 2003 in Ljubljana in order to discuss daily affairs and options for the future. At this occasion SLOSIM's application for organisation of **EUROSIM'07** (Sept. 2007 in Slovenia, in close co-operation with ASIM) was warmly accepted. Next meeting will take place on occasion of the annual ISCS conference in Cefalu, Sicily.

EUROSIM Publications SNE and SIMPRA

SNE. EUROSIM societies are offered to distribute the journal **Simulation News Europe** (**SNE**) as official membership journal. **SNE** is a membership journal (with information from the societies) as well as a "technical" journal with reviewed contributions (Technical Notes, ARGESIM Comparisons, Short Notes, etc). More information: www.argesim.org

SIMPRA. Furthermore, members can subscribe the scientific journal **Simulation and Modelling, Practice and Theory** (**SIMPRA**) at a significantly reduced price: www.elsevier.nl/locate/simpra/

Conferences, EUROSIM Congress

EUROSIM societies are organising national and international conferences and workshops, with the common trademark *EUROSIM Conference.* For details please refer to announcements of the societies.

The EUROSIM Congress is arranged every three years by a member society of EUROSIM. The next congress, **EUROSIM'04**, the 5th EUROSIM Congress, will take place in September 2004 in Paris (announcement see below). SLOSIM, in close co-operation with ASIM will organise the 6th EUROSIM Congress, **EUROSIM'07**, in Slovenia.

Congress Announcement

EUROSIM '04
5th EUROSIM Congress

Sept. 6 -10, 2004; Cite Descartes
Marne la Valle (near Paris), France

See Call for papers in this **SNE** issue

More information about EUROSIM and EUROSIM societies may be found at EUROSIM's WWW Server. For personal information about EUROSIM and about the congress EUROSIM'04 please contact the EUROSIM president, Mr. Y. Hamam.

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EUROSIM SOCIETIES

ASIM - Buchreihen / ASIM Book Series

ASIM - Buchreihen / ASIM Book Series

Reihe Fortschritte in der Simulationstechnik /
Series Frontiers in Simulation – with SCS

kürzlich erschienen / recently appeared:

- R. Hohmann (Hrsg.): Proc. 17. Symp. Simulationstechnik, Magdeburg, 2003
- Dj. Tavangarian (Hrsg): Proc. 16. Symp. Simulationstechnik, Rostock, 2002
- W. Borutzki: Bondgraphen – Eine Methodologie zur Modellierung multidisziplinärer dynamischer Systeme;
- H: Szczerbicka, T. Uthmann (Hrsg.): Modellierung, Simulation und Künstliche Intelligenz
- S. Wenzel (Hrsg.): Referenzmodelle für die Simulation in Produktion und Logistik
- I. Bausch-Gall (Hrsg.): Simulation technischer Systeme – Stand und Entwicklungen

Schwerpunkte / Topics:

- Statusberichte über Simulation in den ASIM Fachgruppen / Status Reports
- Allgemeine Monographien / General Monographs
- Proceedings der ASIM Tagungen / Proceedings of Conferences

Reihe Fortschrittsberichte Simulation /
Series Advances in Simulation – with ARGESIM / SCS

kürzlich erschienen / recently appeared:

- Th. Preiß: Relationale Datenbanksysteme als Basis für Modellbildung und Simulation von kontinuierlichen Prozessen
- E. Hajrizi: Intelligentes Online – Planungs- und Steuerungssystem für Flexible Produktionssysteme basierend auf Simulation und Optimierung mit genetischen Algorithmen
- Th. Fent: Applications of Learning Classifier Systems for Simulating Learning Organizations
- H. Ecker: Suppression of Self-excited Vibrations in Mechanical Systems by Parametric Stiffness Excitation
- K. Kleemayr: Modellierung von Schnee und Lawinen

Schwerpunkte / Topics:

- Spezielle Monographien (Dissertationen, ...) / Special Monographs (PhD-thesis, ...)
- Erweiterte Berichte der ASIM Fachgruppentreffen / Workshop Proceedings
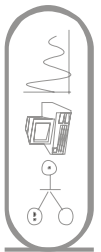- Handbücher für Simulationssprachen, Berichtband / User Guides, Reports

Preis / Price: EUR 20.- (ASIM-Mitglieder EUR 15.-) + Versandkosten

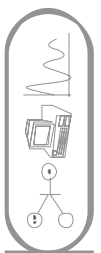Bestellung, Information, Informationen für Autoren / Info, Orders:
ASIM / Dr. Ingrid Bausch-Gall, Wohlfahrtstrasse 21b, D-80939 München
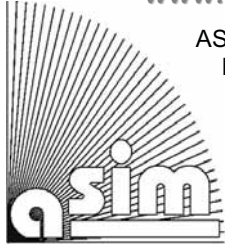Fax: +49-89-3231063, or online: info@asim-gi.org, www.asim-gi.org

EUROSIM SOCIETIES
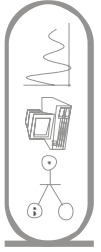
ASIM German Simulation Society

Arbeitsgemeinschaft Simulation

www.asim-gi.org

ASIM (Arbeitsgemeinschaft Simulation) is the association for simulation in the German speaking area. ASIM was founded in 1981 and has now about 700 individual members, and 30 institutional or industrial members.

From the ASIM Board

During the ASIM Conference ASIM'2002 in Rostock, September 2002, the ASIM board was elected anew. The following eight members were elected directly for the next three years: Felix Breitenecker, TU Vienna; Rüdiger Hohmann, University Magdeburg; Veronika Hrdliczka, ETH Zürich; Markus Klug, ARCS Seibersdorf; Klaus Panreck, University Paderborn; Thorsten Pawletta, University Rostock; Peter Schwarz, FhG Dresden; Sigrid Wenzel, FhG Dortmund. Additionally, all Heads of the Working Groups are members of the board (see list at the end of this contribution), and the board itself nominates additionally officers for special tasks (W. Wiechert, Univ. Siegen; R. Rimane, Univ. Erlangen). At the following board meetings (December, Munich; April, Erlangen; June, Magdeburg) officers were elected and plans for publications and conferences were discussed (details see later). The new officers are: F. Breitenecker, President; Th. Pawletta and S. Wenzel, Vice Presidents; I. Bausch-Gall, Treasurer / Secretary.

At the last ASIM board meeting on the occasion of the ASIM 2003 conference in Magdeburg (September 2003) decisions about the structure of the working groups, about the promotion plans and about the future plans for publications were done, details see later. Furthermore, it was decided to redesign totally the ASIM web pages, with interactive features for the members, driven by a content management system.

The next board meeting will take place end of January 2004. Please contact the speaker, if you feel an important issue should be discussed there.

ASIM Promotion

ASIM is aware of the fact, that modelling and simulation has become a widespread method. Many application societies are running themselves successfully working groups on modelling and simulation. If in the German speaking area such groups in application societies exist, it makes nonsense to set up a new ASIM working group with the same focus.

As it makes no sense to reinvent the wheel again,

- ASIM intends to co-operate with such working groups on level of ASIM working groups,
- and ASIM will actively seek contacts with other societies and groups, also at international level.

The first steps in this direction were done this year: ASIM took part at the international Trade Fair and Knowledge Exchange on Applied Simulation and Visualisation SIM'2003, Nuremburg, Germany, and ASIM got in contact with groups dealing with scientific computing. Especially the working group "Methods in Modelling and Simulation" is involved in this co-operation.

ASIM Publications

ASIM is publishing (co-publishing) **ASIM-Nachrichten** and **SNE** (Simulation News Europe). Both journals are regularly published and sent to all ASIM members (as part of their membership 700 issues) and spread for promotion (500 issues). Furthermore, the ASIM working groups report in so-called **ASIM - Mitteilungen** about their meetings, about special developments, etc - either as ASIM self-publication or as publication is series of other publishers (e.g. **ARGESIM Reports**).

ASIM co-operates with SCS Europe and with **ARGESIM** (TU Vienna) in publication of two book series:

- ASIM / SCS book series „Fortschritte in der Simulationstechnik – Frontiers in Simulation"
- ASIM / ARGESIM / SCS book series „Fortschrittsberichte Simulation – Advances in Simulation"

In these series the Proceedings of the annual ASIM conferences, status reports of the working groups, and PhD theses are published.

Change of publication structure from 2004 on. Based on the results of a questionnaire to the members, the board discussed and decided some changes for the publications (details in the next issue):

- First, from 2004 on, ASIM-Nachrichten will appear as electronically newsletter.
- Second SNE should be extended. News and general information will be put as (German or English) addendum in SNE's news section.
- Third, ASIM plans to publish special issues of SNE. Each year one ASIM working Group will prepare a Special Issue dealing with "Status, Developments and Trends" in its area.
- Fourth, the ASIM web pages will be redesigned totally, offering special areas for members, interactive information, mailing lists, etc, based on a content management system.

ASIM Working Groups

Working Group Structure. A discussion on working groups is taking place. While some working groups are very active and consequently have many members ("Methods of Modelling and Simulation", "Simulation in Environmental Sciences", "Simulation of Technical Systems", and "Simulation in Production and Logistics"), some working groups attract only few people to workshops and cannot attend more members, due to various reasons.

It is discussed either to combine small working groups, or to put them as subgroup into a big working group. The suggestions and plans are:

- The working group "Simulation an KI" will be become part of the working group "Methods of Modelling and Simulation",
- the working group "Simulation in Medicine, Biology, Biophysics" will be served by the working group "Simulation in Environmental Systems
- the working group "Simulation in OR" will co-operate with the working group "Simulation in Production and Logistics",
- and the working group "Simulation of Transportation Systems" will co-operate either with "Simulation of Technical Systems" or with "Simulation in Production and Logistics"

The ASIM Working Groups **"Methods of Modeling and Simulation"** (GMMS) and **„Simulation of Technical Systems"** (STS) were organizing a Special Workshop „Modeling and Simulation of Spatially Distributed Systems", in May 2003 in Nuremberg in connection with the SIMPAT 2003 Conference "Simulation and Visualisation". About 50 people attended this meeting, resulting in fruitful discussions.

It was decided, to put more emphasis on distributed systems also in the future, and to put also emphasis on the area of scientific computing, where a lot of methods and algorithms and new ideas for analysing distributed systems are under discussion. Consequently, in 2004, again a workshop dealing with distributed systems will be organised. The working group will meet on March, 2 - 3, 2004 at University Siegen. The workshop, organised by W. Wiechert, will concentrate on the topic „Spatially Distributed Systems and Simulation-Based Optimisation".

The working group will organise two special sessions at the congress EUROSIM'04, entitled

"Alternative Methods in Modelling and Simulation"

"Education in Simulation"

The special session *Alternative Methods in Modelling and Simulation* will emphasize on non-classical modelling techniques, like cellular automata, neural nets, etc. – in comparison with classical approaches.

Also the aspect of identification will be discussed: it may happen that an alternative model approach can be identified easier. Furthermore, the session would like to bridge the gap between classical continuous modelling approaches and discrete distributed approaches. The session program will be co-ordinated with the program of the EUROSIM special session *"Modeling and Simulation - all problems solved !??"* organised by the working group "Simulation in Environmental Systems". For contributions please contact the session organisers, F. Breitenecker (TU Vienna, Felix.Breitenecker@tuwien.ac.at) W. Wiechert (University Siegen, wiechert@simtec.mb.uni-siegen.de); the contributions to all four ASIM special sessions will be reviewed directly by the ASIM board, the sessions are open to everybody, not only to ASIM members

The special session *Education in Simulation* will discuss various aspects of this theme, from simulation curricula via simulators for education purposes to interactive and web-based learning in modelling and simulation. The session will also deal with simulation as education tool in other disciplines, like medicine and physiology. For more details, please contact the session organisers W. Wiechert (University Siegen, wiechert@simtec.mb.uni-siegen.de) of F. Breitenecker (TU Vienna, Felix.Breitenecker@tuwien.ac.at).
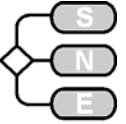
The ASIM working group **"Simulation in Environmental Systems"** co-operates since many years with other working groups of GI which also deal with the environmental problems. This successful co-operation will be continued with the next workshop of the working group, *"Simulation in Environmental Sciences and Geosciences"*, to be held in Mücheberg, Germany, April 17 – 19, 2004.

Based on experiences in the working group at the EUROSIM'04 congress a special section entitled

"Modeling and Simulation - all problems solved !??"

The motivation is as follows: during the last decade, modelling and simulation has become a popular and wide spread method for problem solving. This trend is documented by special tracks for modelling and simulation in almost every conference dedicated to the classical application areas for simulation such as production and logistics, but also biology, medicine, geology, ... On the other hand it is documented a decreasing interest in conferences about general simulation technologies and the concerning scientific problems. In this situation, the session asks, whether simulation methodology has reached its aim by spreading the basic concepts and methods over its application areas and by founding special-interest simulation groups within them.

Or, whether there are still some basic and/or methodological problems to work on even for a generally skilled simulation expert.

EUROSIM SOCIETIES

For the working group "Simulation in Environmental Systems" a promising first step has been done at the EnviroInfo 2003 in Cottbus. The process of specifying open problems and possible fields of research initiated there shall be continued and transferred by this EUROSIM workshop from the smaller focus of the application area "environmental systems" to general modelling and simulation problems and research objectives.

If you like to participate, feel free to contact the speaker of the working group, Jochen Wittmann (wittmann@informatik.uni-hamburg.de) or put -as a first contribution to the discussion - your opinion -on our virtual bill board under

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http://www.informatik.uni-hamburg.de/
TIS/index.php?channel=workshops
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http://www.informatik.uni-hamburg.de/
TIS/index.php?content=EUROSIM/index.html
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The working group **„Simulation of Technical Systems"** met 2003 in Ulm, in the areas of T-Systems GEI GmbH in Ulm. In 2004, the working group will meet in Ingolstadt, for a workshop "Simulation of Technical Systems", March 9 – 10, 2004. The group especially will support the EUROSIM'04 special session "Alternative Methods".

The working group **"Simulation in Production and Logistics"** (SPL) had some successful one-day meetings and is preparing the bi-annual conference.

The 11th conference "Simulation in Production and Logistics" organized by the working group will take part on 4th and 5th October 2004 (location: Berlin, Germany; organization and head of program committee: Dr. Markus Rabe, Fraunhofer IPK, email: markus.rabe@ipk.fhg.de). For detailed information please contact Markus Rabe by email.

The working group will support the EUROSIM'04 special session "Simulation and Optimisation" which is organised by the working group "Simulation of Traffic Systems"

The working group **"Simulation in OR"** will organise a workshop "Simulation als betriebliche Entscheidungshilfe" at Braunlage, Harz, March 15.-17, 2004.

The working group **"Simulation of Traffic Systems"** will organise a workshop on *Simulation of Traffic Systems* in Magdeburg on March 5, 2004, on the occasion of the SIMVIS'2004 conference. For detailed information see www.simvis.org.

As mentioned before, the working group will also organise a special session at the EUROSIM'04 congress, entitled

"Simulation and Optimisation"

This special session will discuss all aspects of the combination simulation – optimisation, from methods and algorithms to applications.

The motivation is: Simulation models have always been used for improving a certain system, without regarding of continuous or discrete-event type. Because of larger models and more powerful computing systems, optimisation tasks upon a simulation model reach a new level of complexity and dimension.

Everyone, who has been concerned with a problem of the complexity described above in connection with simulation, should feel encouraged to send in an abstract for a paper including a presentation. But also small and highly sophisticated solutions are of strong interest. This can also cover distributed simulation and optimisation systems, emphasizing the aspect of simulation linked to optimisation and backwards.

To give a full overview of the State-of-the-Art solutions to this topic, papers dealing with new methodologies or new ways of optimisation for certain fields of problems are highly appreciated. Please contact the organiser M. Klug, markus.klug@arcs.ac.at.

ASIM Conferences

ASIM organises the annual ASIM Conference, the ASIM Working Groups organise annual workshops (up to 100 participants) and bi-annual conferences (more than 100 participants – details above, summary below. ASIM cooperates in organising the three-annual EUROSIM Congress, and ASIM and SCS Europe will continue the co-operation for the ESM and ESS conferences.

A special co-operation was established with the annual conference series SIMVIS – Simulation and Visualisation in Magdeburg (March) and with the three-annual conference series MATHOD - Mathematical Modelling in Vienna (February).

R. Hohmann (Univ. Magdeburg) organised the annual conference ASIM'2003 (September 2003, Univ. Magdeburg), a detailed report will be given in the next **SNE** issue. In 2004, the annual ASIM conference is skipped: ASIM members are invited to visit the EUROSIM Congress (Paris, September 2004), where special ASIM sessions are planned, or to attend the special conference "Simulation in Production and Logistics" (Berlin, October 2004).

The annual conference ASIM 2005 will take place in Erlangen – where the first ASIM conference took place in 1982, organised by R. Rimane. In 2007, SLOSIM, the Slovenian Simulation Society will organise the EUROSIM Congress; ASIM will not only co-sponsor, but also co-organise this event.

ASIM GMMS Workshop
Spatially Distributed Systems and
Simulation-Based Optimisation
March 2 – 3, 2004, Siegen, Germany

SIMVIS
Simulation and Visualisation
March 4 - 5, 2004, Magdeburg, Germany

ASIM SVS Workshop
Simulation of Traffic Systems
March 5, 2004, Magdeburg, Germany

ASIM SPL Workshop
Modelling of Technical Systems
March 9 – 10, 2004, Ingolstadt, Germany

ASIM SBW Conference
Simulation als betriebliche Entscheidungshilfe
March 15 – 17, 2004, Braunlage, Harz, Germany

ASIM SUG Workshop
Simulation in Environmental Sciences
and Geosciences
April 17 – 19, Müncheberg, Germany

ESM 2004
18th European Simulation Multiconference
June 13 – 16, 2004, Magdeburg, Germany

EUROSIM '04
5th EUROSIM Congress
Sept. 6 -10, 2004; Cite Descartes (near Paris), France

ASIM Special Sessions:

Alternative Methods in Modelling and Simulation
Education in Simulation
Modeling and Simulation - all problems solved !??
Simulation and Optimisation

ASIM – SPL Conference
Simulation in Production and Logistics
October 4 – 5, 2004; Berlin, Germany

ESS 2004
18th European Simulation Symposium
October 17 – 20, 2004, Budapest, Hungary

ASIM 2005

18th Symposium Simulation Technique
September 2005, Erlangen, Germany

ASIM Info and Contact

GMMS *Methods in Modeling and Simulation, P. Schwarz, FhG Dresden, http://www.gmms.asim-gi.org*
SKI *Simulation and Artificial Intelligence, H. Szczerbicka, Univ. Hannover, hsz@informatik.uni-hannover.de*
SUG *Simulation of Environmental Systems, J .Wittmann, Univ. Hamburg, wittmann@informatik.uni-hamburg.de*
SMBB *Simulation in Medicine, Biology, Biophysics, D.Möller, Univ. Hamburg, Moeller@informatik.uni-hamburg.de*
STS *Simulation of Technical Systems, A. Wohnhaas, debis Systemhaus GEI, www.sts.asim-gi.org*
SPL *Simulation in Production and Logistics, S.Wenzel, Fraunhofer Institute Dortmund, www.spl.asim-gi.org/*
SBW *Simulation in OR, C.Böhnlein, Univ. Würzburg boehnlein@wiinf.uni-wuerzburg.de; www.asim-gi.org*
SVS *Simulation of Transport Systems, U. Brannolte, Univ. Weimar / M. Klug, ARCS Seibersdorf Ulrich.Brannolte@bauing.uni-weimar.de; www.asim-gi.org*

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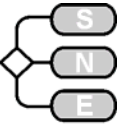*Tel: +49-89-3232625, Fax: +49-89-3231063*
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WWW-Information: *www.asim-gi.org*
Email: *info@asim-gi.org (for information)*
     admin@asim-gi.org (for administration)

CSSS Czech and Slovak Simulation Society

General Information

CSSS (The Czech and Slovak Simulation Society) has about 150 members in 2 groups connected to the Czech and Slovak national scientific and technical societies (Czech Society for Applied Cybernetics and Informatics, Slovak Society for Applied Cybernetics and Informatics -SSAKI).

The main objectives of the society are: development of education and training in the field of modelling and simulation, organising professional workshops and conferences, disseminating information about modelling and simulation activities in Europe to its members, informing the members about publishing in the field of modelling and simulation. Since 1992 CSSS is a full member of EUROSIM.

Detailed Information about past and coming events will be given in the next issue.

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CROSSIM - Croatian Society for Simulation Modelling

http://rudjer.irb.hr/~crossim

General Information

CROSSIM - CROatian Society for SIMulation Modelling was founded in 1992 as a non-profit society with the goal to promote knowledge and use of simulation methods and techniques and development of education and training in the field of simulation modelling.

The Society is engaged in dissemination of information on simulation, organization of meetings, courses and workshops as well as in publishing in the field. CROSSIM is an affiliate of SCS since 1994 and a full member of EUROSIM since 1997.

Membership

CROSSIM has only individual members and three categories of membership are recognized according to the statute: regular, honorary and student members.

Information, Contact Address

CROSSIM www site is accessible at:
http://www.irb.hr/~crossim

and an e-mail address is: crossim@irb.hr

Contact Address

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Activities

The Society is engaged in dissemination of information on simulation, organization of meetings, courses and workshops as well as in publishing in the field. CROSSIM cooperates with the University Computing Centre, Zagreb, in organization of an international conference *Information Technology Interfaces* (*ITI*) that traditionally has a strong modelling and simulation section, and in publishing the *Journal of Computing and Information Technology* (*CIT*). All information concerning CIT is available at
cit.srce.hr/home.html.

Past Events

25th *International Conference Information Technology Interfaces ITI 2003* took place in Cavtat near Dubrovnik, 16-19 June 2003. The Conference included thirteen sessions and among them *Modelling and Optimization* and *Simulation* session.

Coming Events

ITI 2004
26th Int. Conf.
Information Technology
Interfaces
June 7 – 10, 2004,
Cavtat near Dubrovnik,
Croatia

ITI 2004 is organized under the auspices of Croatian Ministry of Science and Technology and the University of Zagreb. *CROSSIM* (Croatian Society for Simulation Modeling) and *ARGESIM* (TU Vienna) are

among cooperating institutions of the Conference that includes *Modelling, Simulation and Optimizations* as one of thirteen topics.

Invited speaker to the special session *ITI in the Century of the Gene: Challenges and Opportunities* is Professor Miroslav Radman who will *speak* on *Modeling and Image Processing in the Visualization of Evolutionary Processes.*

Prof. Radman is distinguished scientist in field of molecular biology, Croatian working in France at Necker Medical Faculty, Paris Universit*y V*, member of French Academy of Sciences who received the highest French award for medical research, Grand Prix INSERM for 2003.

BIOSTAT 2004

In parallel with ITI 2004

June 7 – 10, 2004, Cavtat near Dubrovnik, Croatia

BIOSTAT 2004, 11th Meeting of Researchers in Biometrics/Statistics will be held in parallel with the Conference together with its *School of Biometrics* whose invited speaker is Stijn Vansteelandt from Ghent University, Belgium.

Deadline for submission of camera-ready full papers and poster abstracts is February 2004.

Conference registration, paper submission and hotel reservation can be done only through Internet at:

http://iti.srce.hr/.

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DBSS Dutch Benelux Simulation Society

General Information

The Dutch Benelux Simulation Society (DBSS) was founded in July 1986 in order to create an organisation of simulation professionals within the Dutch language area.

DBSS has actively promoted creation of similar organisations in other language areas. DBSS is a member of EUROSIM and works in close cooperation with its members and is further affiliated with SCS International, IMACS, and the Chinese Association for System Simulation and the Japanese Society for Simulation Technology.

Membership - Information

Both corporate entities (companies, institutes, etc.) and individuals are welcome to join DBSS as full corporate or individual member.

The contribution is divided in two options:

1. Euro 34,- individual member or Euro 68,- institutional member, which means that you will receive the newsletter Simulation News Europe two times a year (one double, one single issue).

2. Euro 68,- individual member or Euro 114,- institutional member, which means that you will receive the Journal Simulation Practice and Theory eight times a year, and Simulation News Europe two times a year (one double, one single issue).

Becoming member of DBSS includes automatically being member of EUROSIM, the overall organisation of European Simulation Societies. DBSS members enjoy reduction of the fees attending the "EUROSIM events" which include congresses, conferences, symposia, workshops etc.

For institutional members counts that they can join national "DBSS events" with three persons against the reduced fee.

Please mention your name, affiliation and address (including email, fax and telephone), and indicate whether you are interested in the personal or institutional membership and contact DBSS:

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DBSS Steering Committee
A.W. Heemink (TU Delft): Chairman
L. Dekker: Vice-Chairman
W. Smit (E&E Consultants), Secretary, Treasurer
Th.L. van Stijn (Royal Dutch Meteorological Institute/KNMI), Member
H. de Swaan Arons (Erasmus Universtity Rotterdam), Member

Past Events

On September 17, 2003 a one day workshop "Simulation and Economics" has been organized. The presentations were:

- Introduction to Seminar, dr.ir. Henk de Swaan Arons, Erasmus University Rotterdam
- Simulation: an Overview, Prof.dr. Jack Kleijnen, Tilburg University
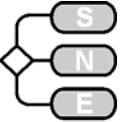
- Simulation in Logistics, Prof.dr. Rommert Dekker, Erasmus University Rotterdam
- Asymmetric Information in Insurance markets, Theoretical and Computational Models, Dr. Vladimir Karamychev, Erasmus University Rotterdam
- Simulation in Management, Prof.dr. Cees van Halem, OASIS / Erasmus University Rotterdam
- Case 1. Modeling Ship Arrivals in Ports, Drs. Eelco van Asperen / Drs. Mark Polman, Erasmus University Rotterdam
- Case 2. MSc. Theses in Discrete Event Simulation, Mr. Rienk Bijlsma, Systems Navigator
- Case 3. SIMONE, Large scale Train Network Simulations, Ir. Leanneke Loeve, Incontrol Enterprise Dynamics / RailNed
- Case 4. Parallel Simulation in Logistics, Csaba Boer M.Sc., Erasmus University Rotterdam / Delft University of Technology

The seminar has been a great success. 39 persons from all over the country registered for this one-day event and there were only 4 no-shows. There were 15 students from the EUR, 2 from outside the EUR, one of them an Italian exchange student. Among the attendants there were about 5 staff members from within the EUR and an equal number of staff members from other universities. 7 People were affiliated to commercial companies; there were 5 people from Hogescholen and one from a research institute. Together with the 8 speakers almost 50 people had the opportunity to exchange experience and knowledge about simulation in general and its application in economics in particular

Arnold W. Heemink, a.w.heemink@its.tudelft.nl

FRANCOSIM - Société Francophone de Simulation

FRANCOSIM was founded in 1991 and aims to the promotion of simulation and research, in industry and academic fields. Francosim operates two poles.

Pole "Modelling & simulation of discrete events systems"

To improve the necessary synergy between industry and academia workers in the area of system modelling, the pole co-organises the series of conferences "MOSIM" (Modelling and Simulation). The 4th conference took place April 2003, the 5th MOSIM will take place in Nantes, September 2004 (see below).

Pole contact: Professor Henri Pierreval, IFMA, Campus des Cezeaux, BP 265, F-63175 Aubiere, Cedex, France. Tel +33 (0)4 73 28 - 81 06, Fax - 81 00 pierreva@ifma.fr

Pole "Modelling & simulation of continuous systems"

This pole has launched in 1999 a series of conferences on modelling and simulation in medicine and biology (BioMedSim). The pole organised the 3rd BioMedSim Conference on the 27th-30th of May 2003 at the University of Balamand, Lebanon

Pole contact: Yskandar Hamam, président Groupe ESIEE, Cité Descartes, BP 99, 2 Bd. Blaise Pascal F - 93162 Noisy le Grand CEDE, France Fax +33-1-45 92 - 66 99, Tel - 66 11 y.hamam@esiee.fr, www.esiee.fr/~hamamy

Yskandar Hamam, y.hamam@esiee.fr

Coming Events

MOSIM'04

Modeling and simulation to analyze and to optimize industrials and logistics systems

Sept. 1 - 3, 2004; Ecole des Mines de Nantes

Nantes, France

The official language of MOSIM 2004 will be French. The preliminary calendar is:

- Full paper submission (8 pages): Feb, 15, 2004
- Notification to authors : April 15, 2004
- Final paper deadline, registration: June 1, 2001

Main topics will be: Modeling methodology, Mathematical modeling tools, Simulation tools and methods, Methods for optimization, Object approaches, actors, multi-agents, Information and knowledge collection and processing for simulation, Discrete, continuous and hybrid systems simulation, Stochastic systems simulation, Simulation and VR, Parallel and distributed simulation, Simulation and optimization, Simulation and multi-criteria decision aid, Simulation and AI, Simulation and cooperative work

Application fields: Production and services, Production systems design and redesign, Choice and optimization of supply chains, Transportation problems, Production planning and scheduling, Performance evaluation, Industrial systems safety, Maintenance planning and optimization, Corporation information systems, Traffic control (telecommunications, road traffic), Decision making systems in manufacturing production and in service production.

Organizing committee : Stéphane Dauzère-Pérès (President), Nathalie Bostel, Philippe Castagliola, Pierre Castagna, Bruno Castanier, Mikaël Canu, Jacky Haurogné, Christelle Jussien-Guéret, Anne L'Anton, Zhiqiang Lu, Yazid Mati, Nasser Mebarki, Najib Najid, Claire Pavageau, Nathalie Sauer.

Scientific committee : Président : Alexandre Dolgui (Ecole des Mines de Saint-Etienne, France),

Information : :

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Phone : 33 (0) 2 51 85 83 02
Fax : 33 (0) 2 51 85 83 49
mail : mosim04@emn.fr
Internet : http://www.emn.fr/mosim04

EUROSIM'04

5th EUROSIM Congress on Modelling and Simulation

Sept. 6 -10, 2004; Cite Descartes

Marne la Valle / Paris, France

FRANCOSIM organises the 5th EUROSIM Congress on Modelling and Simulation, the main simulation conference in 2004. Detailed information can be found at the begin of **SNE**'s news section.

HSS Hungarian Simulation Society

General Information. The Hungarian Member Society of EUROSIM was established in 1981 as an association promoting the exchange of information within research, development, application and education of simulation in Hungary and also contributing to the enhancement of exchanging information between the Hungarian simulation community and the simulation communities abroad. HSS deals with the organization of lectures, exhibitions, demonstrations, round table discussions and conferences.

Activities Budapest University of Technology

At the Department of Information and Knowledge Management on the Faculty of Economic and Social Sciences of the Budapest University of Technology and Economics classes "Simulation and Modelling in Economy" and an other "Decision Making and Management using Simulation" as well as simulation laboratory practices are held for graduate and postgraduate students studying economy, informatics and electrical engineering.

Ph.D. students participate in various simulation research projects aimed at methodological basic research as well as applications.

The establishment of a new doctoral school where simulation and knowledge management is to become a formal program under the leadership of the chairman of HSS is in preparation.

Activities University Gyor

In the town of Gyor at the Szechenyi Istvan University simulation is also taught. Here the class "Simulation Methodology and Applications" is studied by undergraduate students of informatics, electrical and traffic engineering.

Lately a new specialization called "Informatics in Economy" was started, with simulation as a basic subject.

Our efforts mentioned are intended to contribute to the dissemination of the methodology and application of simulation for the young generation.

Conferences

We have participated at EUROSIM and SCS conferences and presented our simulation results.

Professor András Jávor, chairman of HSS has been invited in November 2003 to give an invited lecture at the conference Informatics 2003 to Bratislava where he has discussions with Professor Mikulas Alexik, chairman of Czech and Slovak Simulation Society. Our members have been and are successfully participating in national and EU simulation projects.

Prof. András Jávor, Ph.D., D.Sc.
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EUROSIM SOCIETIES

ISCS - Italian Society for Computer Simulation

www.iscs.it

The Italian Society for Computer Simulation (**ISCS**) is a scientific non-profit association of members from industry, university, education and several public and research institutions with common interest in all fields of computer simulation. Its primary purpose is to facilitate communication among those engaged in all aspects of simulation for scientific, technical or educational purposes.

The affairs of the ISCS are directed by a Steering Committee, which recently was elected anew: Ing. Mario Savastano (Chairman), Prof. Franco Maceri (Vice Chairman), Dr. Paola Provenzano (Secretary), Prof. Pasquale Arpaia (Tresaurer)

ISCS hold on November 27 - 29 the National Congress in Cefalu, Sicily. On this occasion also meetings of the EUROSIM boards took place. A detailed report will be given in the next Issue of **SNE.**

Information, Website. For further information or application for membership, please contact:

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Mario Savastano
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Please have a look at the new designed website of ISCS: www.iscs.it

Mario Savastano
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AES Spanish Simulation Society

Spanish Simulation Society

No news received.

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PSCS - Polish Society for Computer Simulation

General Information

PSCS (The Polish Society for Computer Simulation) was founded in 1993 in Warsaw. PSCS is a scientific, non-profit association of members from universities, research institutes and industry in Poland with common interests in variety of methods of computer simulations and its applications.At present PSCS counts 258 members. The Board consisting of the following persons directs the affairs of the PSCS: Andrzej Tylikowski (President), Leon Bobrowski and Andrzej Chudzikiewicz (Vice Presidents), Z. Sosnowski (Secretary), Kazimierz Furmanik (Treasurer), and R. Bogacz, J. Rybicki, A. Grzyb (Members).

Activities. The main activities of the Polish Society for Computer Simulation are annual conferences known as „PSCS Workshops on Simulation in Research and Development": Mielno (1994), Warszawa (1995), Wigry (1996), Jelenia Gora (1997, 1998), Bialystok & Bialowieza (1999), Zakopane – Koscielisko (2000), Gdansk-Sobieszwo (2001), Osiekik/ Koszalina (2002), Zakopane (2003).

Details on past events and comenig events will be given in the next issue.

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ROMSIM - Romanian Modelling and Simulation Society

ROMSIM has been founded in 1990. The main objectives of ROMSIM are development of new methods of modelling and simulation and development of new application of modelling and simulation. An other important objective of ROMSIM is organization of national scientific events and participation at international conferences. In April 1999 ROMSIM has been accepted as an observer member of EUROSIM.

No news received

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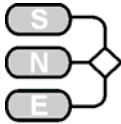
SIMS - Scandinavian Simulation Society

www.scansims.org

SIMS is the Scandinavian Simulation Society with members from the four Nordic countries Denmark, Finland, Norway and Sweden. The SIMS history goes back to 1959. SIMS practical matters are taken care of by the SIMS board consisting of two representatives from each Nordic country.

The SIMS annual meeting takes place at the annual SIMS conference or in connection to international simulation conferences in the Nordic countries.

Sims Structure

SIMS is organised as federation of regional societies. There are FinSim (Finnish Simulation Forum), MoSis (Society for Modelling and Simulation in Sweden), DKSIM (Dansk Simuleringsforening) and NFA (Norsk Forening for Automatisering).

Membership, SIMS Board

- Peter Fritzson, chairman
- Erik Dahlquist, Brian Elmegaard, Anne Elster, Kaj Juslin, Esko Juuso, Bernt Lie, Kim Sörensen
- Vadim Engelson is SIMS coordinator for practical matters.

You can contact the chair of the SIMS board, Prof. Peter Fritzson (Linköping University, Sweden):

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petfr@ida.liu.se

To become a member of SIMS you should join one of the SIMS member organizations, as specified on the SIMS web page. Updated SIM web page with news and recent information:

www.scansims.org

Past Events

The **44th conference on Simulation and Modeling** and the annual meeting of the Scandinavian Simulation Society was held in Vasteras, Sweden 18-19 September, at Malardalen University.A total of some 70 researchers from 10 countries participated, and 37 papers were presented during the two days conference. Dr. Charlotte Brogren, the new research director for ABB Corporate Research in Vasteras, and also worldwide R&D manager for the Automation area within ABB Corporate Research, had a keynote speech on where ABB is heading in the area of Optimization and Control.

This was followed by a presentation by Dr. Hans Georg Zimmermann from Siemens in Munich, who presented the possibilities with using neural networks for many different applications, and what to do to get them stable and robust. Professor Finn Jensen from Aalborg University gave the third keynote speech on the use of Bayesian nets for decision support systems. The keynote presentations followed a discussion about the future of simulation.

The regular lectures were given in two parallel sessions on Simulation systems and general methods, Industrial applications in Pulp and paper, oil and gas, wastewater treatment and metallurgical industry, Applications in Energy Engineering, and Non-industrial applications. In the night between the two conference days the participants went on a boat ride at lake Malaren, where the dinner was served. See www.scansims.org for more information.

The **Automaatio Seminar Days** were held in Helsinki 9 – 11 September 2003. The Automaatio 03 Fair in conjunction with the Automaatio Seminar Days is the most important automation industry event in Northern Europe. The Finnish Society of Automation has traditionally organizes these events every second year. This seminar was already the 15th in the series.

The main language was Finnish but there were also presentations in English in some extent. The Seminar Days serves as a forum for professionals in the field of automation. Many presentations at the seminar included simulation, and various simulation tools related to automation design were presented at the Automation 03 Fair. More information is available in www.automaatioseura.fi/autom03/eng/

VRForum 2003, The Forum on Virtual Reality, Modeling, Simulation and Visualization was held in Linköping, Sweden, November 5-7, 2003. This forum was devoted to simulation of rescue efforts, training and coordination activities in case of accidents. More information is available from www.scansims.org

The **3rd Modelica International Conference** was held in Linköping, Sweden, November 2-4, 2003. This is the third conference devoted to new equation-based object-oriented language for physical modeling and simulation. Proceedings are now available online at www.modelica.org/Conference2003/papers.shtml

More information is available from

www.scansims.org

Future Events

Conference Announcement
45th SIMS Conference
September 2004, Denmark

EUROSIM SOCIETIES

The **45th Scandinavian Conference on Simulation and Modeling**, will be organized in Denmark, September 2004. Further information is available from www.scansims.org

Conference Announcement

4th Modelica International Conference

March 2005, Hamburg, Germany

The International Modelica Conference is organized each one-and-half year. Location of Modelica'2005: Technical University of Hamburg-Harburg, Germany. Local organizer is Prof. Schmitz. Further information is available from www.scansims.org

SIMS Contact Address, Information

Updated SIMS web page with news and recent information: www.scansims.org

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SLOSIM - Slovenian Society for Simulation and Modelling

msc.fe.uni-lj.si/SLOSIM

General Information

SLOSIM (Slovenian Society for Simulation and Modelling) was established in 1994 and became the full member of EUROSIM in 1996. Currently it has 93 members from both slovenian universities, institutes, and industry. It promotes modelling and simulation approach to problem solving in industrial as well as in academic environments by establishing communication and cooperation among the corresponding teams.

News

From April 25th to April 26th Ljubljana hosted the **Board meetings of EUROSIM** organized by SLOSIM. The representatives of eight societies (ASIM, CROSSIM, CSSS, FRANCOSIM, ISCS, SIMS, UKSIM, and SLOSIM) together with prof. Halin, being the representative of SIMPRA journal, among other decisions accepted by common consent SLOSIM

as the organizing society for the EUROSIM congress 2007 in Slovenia. It is a great honour for us but on the other hand also a big responsibility to proceed with the practice of excellent organizations of previous meetings.

Members of EUROSIM Board on the trip to the seaside organized by SLOSIM

Members of SLOSIM participated on the Twelfth International Electrotechnical and Computer Science Conference **ERK 2003** that has taken place from September 25th-26th in Ljubljana, Slovenia. In 11 scientific areas with 8 invited lectures, 114 authors presented their works.

As usually SLOSIM organized a session Simulation, Identification and Modelling with 6 contributions. Only one session was the consequence of the IEEE Region 8 EUROCON 2003 Conference that took place in Ljubljana on September 22nd-24th where SLOSIM had 3 Simulation and Modelling sessions with 18 papers. This event was structured in 14 scientific areas with 8 invited lectures 203 papers and 5 workshops.

The representative of Slovenia in EUROSIM Board prof. Borut Zupančič attended the board meeting on November 28th and 29th in Cefalu, Sicily, Italy where the questions of EUROSIM 2007 were discussed.

Further decisions will be made on EUROSIM 2004 Congress next year in Paris, where the members of SLOSIM will actively participate. Prof. Borut Zupančič and prof. Rihard Karba were nominated as the members of EUROSIM 2004 Programme Committee.

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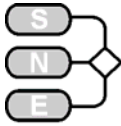
UKSim United Kingdom Simulation Society

ducati.doc.ntu.ac.uk/uksim/

General Information

The UK Simulation Society (UKSim) has more than 100 members throughout the UK from universities and industry. It is active in all areas of simulation and it holds a biennial conference as well as regular meetings and workshops.

Membership, Information

The UKSim committee welcomes Alessandra Orsoni among its rank as new Secretary for the Society. Alessandra has recently started her job as Senior Lecturer in the School of Business Information Management at Kingston University, she was Assistant Professor in the Department of Production Engineering at the University of Genoa, Genoa, Italy for the past two years and Research Associate in the Department of Materials Science and Metallurgy at the University of Cambridge, Cambridge, UK during the previous year. She received both her MS in Mechanical Engineering and her ScD in Mechanical and Civil & Environmental Engineering from the Massachusetts Institute of Technology, Cambridge, MA. Alessandra Orsoni attended the EUROSIM meeting recently held in Cefalu', Italy, and will be representing the UK Simulation Society on future EUROSIM committees.

Membership of the UK Simulation Society is very good value at only £20 per year including a subscription to Simulation News Europe. Those who attend the biennial conferences get free two-year membership untill the next conference. For more information about the Membership please contact the Membership Secretary.

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Past Events

The 17th European Simulation Multiconference (**ESM 2003**) was co-hosted by the UK Simulation Society and the Society for Computer Simulation (SCS-Europe) from 9th to 11th June 2003, at the Nottingham Trent University, Nottingham.

The conference had about 100 participants, from the U.K., Germany, Italy, Holland and the U.S.A. The conference included four plenary sessions from invited speakers Prof. E. Gelenbe, Prof. D. Palmer-Brown, Professor Kh. Al-Begain, and Dr. R. Zobel.

Many high-quality papers, in the ever-expanding areas of modelling and simulation, were presented within 32 designated sessions under the following main tracks: Intelligent Systems, Analytical and Stochastic Models, Complex Systems, High Performance Modelling & Networks, Operational Research, Biology & Medicine. Papers presented within these sessions generated a great deal of interest and discussion, and provided an opportunity for the instigation of future collaboration amongst participants.

The conference provided many opportunities for socialising, including a Robin Hood costume dinner and entertainment at the Sheriff's Lodge, Nottingham. Field visits were also organised for the participants including guided tours of the nearby facilities of Siemens and Rolls Royce. The auspicious scientific content, outstanding conference facilities, delicious food and stunning surroundings contributed to the success of this conference.

Copies of the ESM 2003 conference proceedings may be obtained from Professor David Al-Dabass, School of Computing and Technology, The Nottingham Trent University, Nottingham NG1 4BU, United Kingdom. Please see theUKSIM website for more details:

Coming Events

Due to the positive outcome of **UKSIM 2003** (report see last issue) the UKSIM conference will run annually. The envisaged location for UKSIM 2004 is Oxford, with a probable return to Cambridge in 2005:

UKSIM 2004

7th UK Simulation Society Conference

March 29 – 31, 2004, St. Catherine's College, Oxford, England

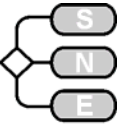Info: http://ducati.doc.ntu.ac.uk/uksim/uksim'04/
CFP-uksim'04.htm

Publications

The UKSIM is publishing the **International Journal of Simulation: Systems, Science & Technology** (IJS^3T). The journal has several special issues coming out lthis year on various aspects of modelling and simulation, for details refer to the journal website:

http://ducati.doc.ntu.ac.uk/uksim/journal/
issue-1/cover.htm

Alessandra Orsoni, UKSIM Secretary
A.Orsoni@kingston.ac.uk

INTERNATIONAL SOCIETIES AND RESEARCH GROUPS

BISC - The Berkeley Initiative in Soft Computing

www-bisc.cs.berkeley.edu

What is soft computing?

Lotfi A. Zadeh, the father of fuzzy logic and soft computing, is Professor at the Computer Science Division, Department of Electrical Engineering and Computer Sciences, University of California Berkeley, and founder and director of the **B**erkeley **I**nitiative in **S**oft **C**omputing (**BISC**).

Lofti A. Zadeh himself gave the following explanation about soft computing (1994):

Soft computing differs from conventional (hard) computing in that, unlike hard computing, it is tolerant of imprecision, uncertainty and partial truth. In effect, the role model for soft computing is the human mind. The guiding principle of soft computing is: Exploit the tolerance for imprecision, uncertainty and partial truth to achieve tractability, robustness and low solution cost. The basic ideas underlying soft computing in its current incarnation have links to many earlier influences, among them my 1965 paper on fuzzy sets; the 1973 paper on the analysis of complex systems and decision processes; and the 1979 report (1981 paper) on possibility theory and soft data analysis. The inclusion of neural network theory in soft computing came at a later point.

At this juncture, the principal constituents of soft computing (SC) are fuzzy logic (FL), neural network theory (NN) and probabilistic reasoning (PR), with the latter subsuming belief networks, genetic algorithms, chaos theory and parts of learning theory. What is important to note is that SC is not a melange of FL, NN and PR. Rather, it is a partnership in which each of the partners contributes a distinct methodology for addressing problems in its domain. In this perspective, the principal contributions of FL, NN and PR are complementary rather than competitive.

The BISC Program

BISC Program is the world-leading center for basic and applied research in soft computing. Some of the most striking achievements of BISC Program are: fuzzy reasoning (set and logic), new soft computing lgorithms making intelligent, semi-unsupervised use of large quantities of complex data, uncertainty analy-.

sis, perception-based decision analysis and decision support systems for risk analysis and management, computing with words, computational theory of perception, and precisiated natural language.

Within the program, there are several research activities: seminars, lectures, PhD programs, visitor programs, research projects, etc.

Research Projects

At present BISC is running the following research projects, with partners from university, government and industry:

- Computing with Words, Computational Theory of Perceptions, Precisiated Natural Language, and Perception-Based Decision Analysis
- The BISC Decision Support System
- Autonomous Multi-Agent System with Perception-Based Reinforcement Learning Capabilities
- Fuzzy Logic and the Internet: Perception-Based Information Processing and Retrieval
- Artificial DNA for Knowledge Discovery
- Intelligent Reservoir Modeling for Optimized Asset Management & Decision Making

BISC Special Interest Groups

SIGs are groups of professionals/ Scientists/ Engineers/ Researchers organized around specific technical disciplines or interest, aimed at furthering the transfer of, ideas, research, and technology. SIG programs and communications are electronically facilitated by BISC Program. At present there exist the following groups:

- BISC SIG in Anticipation - BISC SIG in Biotechnology
- BISC SIG in Comp. Intelligence for Bioinformatics
- BISC SIG in Communication and Networking (Wireless)
- BISC SIG in Data Mining
- BISC SIG in Decision Analysis and Support System
- BISC SIG in Earth Sciences - BISC SIG in Economics
- BISC SIG in Entertainments - BISC SIG in Healthcare
- BISC SIG in Environment Management Systems
- BISC SIG in Fuzzy Logic and the Internet
- BISC SIG in Granular Computing
- BISC SIG in Homeland Security
- BISC SIG in Information Technology
- BISC SIG on Intelligent Agents in Complex Systems
- BISC SIG on Intelligent Manufact. and Fault Diagnosis
- BISC SIG in Life Sciences - BISC SIG in Medicine
- BISC SIG in Medical Imaging
- BISC SIG in Multimedia/ Digital Media
- BISC SIG in Philosophy of Soft Computing
- BISC SIG in Recognition Technology
- BISC SIG in Scientific Computing/ Parallel and Supercomputing

INTERNATIONAL SOCIETIES

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Fuzzy Logic – related Application Areas

In October 2003, the BISC distributed a questionnaire via the BISC mailing list. People were asked, whether the following list of Fuzzy Logic - related application-areas is complete or should be extended.

Industrial control   Quality control
Subway control   Traffic control
Loading crane control   Reactor control
Paper manufacturing   Steel manufacturing
Software engineering   Expert systems
Operation research   Decision analysis
Financial engineering   Internet
Fraud detection   Mine detection
Pattern classification   Oil exploration
Geology   Chemistry
Mathematics   Medicine
Health-care products   Economics
Social Sciences   Information retrieval
Biomedical instrumentation
Elevator control and scheduling
Assessment of credit- worthiness
Power distribution control
Automobile body painting control
Automobile transmissions
Automobile climate control
Automobile engine control

If there is an application-area in which there is or has been substantial activity with soft computing and which consequently should be included into the list, please send the information to Masoud Nikravesh nikravesh@cs.berkeley.edu .

About BISC – BISC Mailing List

The BISC Mailing List distributes information about current work in soft computing. It is administrated by M. Nikravesh, BISC:

Masoud Nikravesh,
Berkeley Initiative in Soft Computing (BISC),
Computer Science Division – Dept. of EECS,
Univ. of California, Berkeley, CA 94720, USA;
Phone: +1-510 643-4522; Fax: - 642-5775 ;
Nikravesh@cs.berkeley.edu;
http://www.cs.berkeley.edu/~nikraves/

In order to subscribe to this mailing list, send an email to *Majordomo@EECS.Berkeley.EDU* with the following command in the body of the email message:

subscribe bisc-group <your_email_adress>

Any contribution to the list may then be sent to the email address *bisc-group@EECS.Berkeley.EDU*

EvCA - Evolving Cellular Automata Group

www.santafe.edu/projects/evca/

The overall research done by the EvCA group is primarily motivated by the question: "*How does evolution produce sophisticated emergent computation in systems composed of simple components limited to local interactions?*" To try to find answers to this question, genetic algorithms are used to evolve cellular automata to perform computational tasks that require global information processing.

The EvCA group concentrates on four topics:

- Evolving cellular automata with genetic algorithms
- Computational mechanics
- Population dynamics
- Co-evolution

Evolving Cellular Automata with Genetic Algorithms

How does evolution produce sophisticated emergent computation in systems composed of simple components limited to local interactions?

In our work, we use genetic algorithms to evolve cellular automata to perform computational tasks requiring global information processing. We then analyze both the evolutionary process and the emergent behaviours of the evolved cellular automata that give rise to their computational abilities. This way, we hope to find answers to the above question.

Computational Mechanics

How is information processing embedded in dynamical behaviour? And how can we detect and then quantify structure in natural processes?

The Computational Mechanics framework, developed by James P. Crutchfield and colleagues, tries to answers these questions. The framework combines elements from dynamical systems theory, stochastic processes, and the theory of computation.

Co-Evolution in Evolutionary Optimization

How does coevolution affect evolutionary optimization?

Co-evolutionary Models. Evolutionary optimization models generally utilize a static selection function; individuals are selected on the basis of how well they comply with the objective function.

INTERNATIONAL SOCIETIES

INTERNATIONAL SOCIETIES
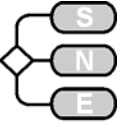
In a co-evolutionary model the success of individuals depends on circumstances that represent only a subset of the objective function.

The resulting evolutionary dynamics may lead to continuous evolutionary change, i.e. red queen dynamics, or speciation of the populations, or to the evolution of general behaviour, i.e. optimization of individual behaviour. The sparseness of the fitness evaluation, i.e. individuals are only evaluated on a subset of all fitness cases, may have as side-effects an increased efficiency in the optimization process, it gives more freedom to evolve with respect to the complete objective function, and it may lead to a continuous effective selection gradient.

Publications

Many papers have been written on the different research topics that are pursued by the EvCA group. A complete list of papers as well as links to abstracts and full versions (ps or pdf) can be found at the web server of the group. In the following an overview:

- Pattern Discovery and Computational Mechanics
- Dynamics, Computation, and the "Edge of Chaos": A Re-Examination
- Evolving Cellular Automata to Perform Computations: Mechanisms and Impediments
- The Evolution of Emergent Computation
- A Genetic Algorithm Discovers Particle-Based Computation in Cellular Automata
- Evolving Cellular Automata with Genetic Algorithms: A Review of Recent Work
- Mechanisms of Emergent Computation in Cellular Automata
- Finite Populations Induce Metastability in Evolutionary Search
- The Evolutionary Unfolding of Complexity
- Dynamics of Evolutionary Processes
- Resource Sharing and Co-Evolution in Evolving Cellular Automata

The EvCA group is headed by physicist James P. Crutchfield (SFI) and computer scientist Melanie Mitchell (LANL/SFI). At any time, the group is complemented by a number of graduate students and postdoctoral fellows. The EvCA group is based at the Santa Fe Insitute (SFI) and at the Los Alamos National Laboratory (LANL) at the Biophysics Group.

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INDUSTRY NEWS

SIMUL8 Release 10 Available

SIMUL8 is an integrated environment for working with simulation models. The powerful language and model visualization capabilities enable the user to create the accurate, flexible and robust simulations in short time.

OR/MS Today Simulation Software Survey cites as typical applications SIMUL8 work flow management, throughput analysis, de-bottlenecking, new product/process development, capacity analysis, continuous improvement, what-if scenarios, and as primary markets for which SIMUL8 is applied business process, call centers, manufacturing, supply chain, logistics, healthcare, financial, pharmaceutical, etc. (www.lionhrtpub.com/orms/ormssurveys.html).

SIMUL8 Release 10 new features are: many former plug-in features are now standard, new clock controls, multiple processor support, and enhanced results presentation, saved views, multi-object changer, and interruptible resources. The complete list of new features can be found on the web.

SIMUL8 European Office
141 St James Road, Glasgow, UK G4 0LT
Tel:+44 141 55 26 888, Fax: +44 141 303 8388
www.simul8.com

Student Version of SIMPLORER(R)

Ansoft Corporation announced the release of its student version of SIMPLORER, the company's popular mixed-technology simulator for automotive electrical / electromechanical systems, power electronics, and drive applications.

The student version, which users can download for free on Ansoft's Web site at www.ansoft.com, does not need any activation or licensing and is ready to use after the installation process. It has all the features of the SIMPLORER basic version, only the number of models that can be used per schematic is limited. Users can download electronic versions of the manual and a "Getting Started" booklet.

An extensive example database also is available as a separate download. Examples include basic teaching topics for use in electrical engineering and control theory courses, as well as more complex systems in the field of power electronics and drive systems design.

About SIMPLORER. Ansoft SIMPLORER is a sophisticated multidomain simulation package for the design of complex power electronic and drive systems. Based on a unique simulator coupling technology, it provides exceptional simulation speed, high accuracy, and numerical stability. Its intuitive graphical user interface allows a fast and easy model generation using three modelling languages: electrical circuits, block diagrams, and state machines. For more information on SIMPLORER, please visit

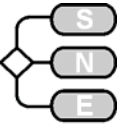www.ansoft.com/products/em/simplorer/index.cfm.

Ansoft GmbH & Co KG
Blankenauer Str. 74, D-09113 Chemnitz
www.simplorer.com

Scientific Computers distributes Maple 9

Scientific Computers, distributor for the German speaking area, is successfully distributing Maple 9, the newest version of the widely adopted Maple mathematical computation product line. Maple 9 has opened new avenues:

- **Code Generation for MATLAB® and Visual Basic®.** MATLAB and Visual Basic have joined Java™, Fortran, and C in the ever growing lexicon of languages that Maple can speak.

- **OpenMaple™ – an API to Maple.** You can now make direct calls to Maple's mathematical engine from external programs with an API called OpenMaple.

- **New help system interface.** We have refurbished the help interface in Maple 9 to make it, well, more helpful. The help system provides one convenient navigation window for keyword searching, topic searching, and browsing by category.

- **Improvements to the Maplet system.** By popular demand, you can now rotate 3-D plots inside Maplet applications. Maplet users and authors will also enjoy faster loading and better control over Maplet layouts.

- **GMP integer arithmetic.** Maple 9 has integrated the GNU Multi Precision Arithmetic Library (GMP), one of the world's most powerful libraries for high precision arithmetic. Cryptographers and leading researchers in algebra use GMP for computations that require millions of bits of accuracy..

- **Industrial-strength FFT routines.** The new DiscreteTransforms package helps you analyze signals, images, and more with industrial-speed FFT routines. These new routines are an order of magnitude faster than the FFT tools in previous releases.

- **Scientific error analysis package.** The new Scientific ErrorAnalysis package complements the ScientificConstants package and helps you analyze data that have errors or uncertainties. Given the errors of base quantities, you can automatically compute the errors of quantities derived from them, as well as correlations and covariances between them.

- **Improved ODE and PDE solvers.** Maple 9 has extended the exact and numeric ODE and PDE solvers to handle many more classes of problems. There are new solving methods for non-linear BVPs from classical physics, Abel problems, second order systems admitting hypergeometric solutions, and much more.

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Tel + 49 (0241) 40008 - 0, Fax – 13
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Bausch-Gall GmbH: New Releases of Dymola and acslXtreme

Dymola 5.1b is now available for Windows PC and LINUX with many enhancements especially concerning GUI. A new Multibody library and a VehicleDynamics library are also available. Several new releases for Libraries are available.

The pneumatics library provides basic model classes for the modelling of cylinders and motors, valves and restrictions, lumped volumes, lines and sensors. In total there are more than 80 models, see www.pneulib.com. A new version of the hydraulics library is available.

The library HyLib contains the most important components, in order to model hydraulic circuits, see www.hylib.com. Coupling elements exist to connect hydraulic components with blocks of the blocks library and elements of the Modelica.Mechanics library. This library supports the following types of models: 1. Modeling of 1-dimensional rotational and translation hydraulic systems, 2. As a state variable the pressure in a lumped volume is used. The inductance of a moving oil column can be added with the model Inductance, 3. Each component of the main library has a lumped volume connected at each port. The components can therefore be connected in any sequence.

The PowerTrain library has been totally redesigned and enhanced considerably. This licensed Modelica package provides 1-dimensional rotational mechanical components for vehicle power trains. It is also useful in general for modelling of gears.

acslXtreme is the sophisticated tool for modelling continuous dynamic systems and processes. Based on the classic ACSL simulation language, acslXtreme is a refreshingly modern application built on top of the latest technologies including .NET and XML. acslXtreme is simple to learn and easy to use.

acslXtreme provides both graphical and text-oriented modelling environments that give you full control over your models. Best of all, acslXtreme helps you present and preserve your findings so you continue to capture value for your work well into the future.

Sales, support, classes, project work for Dymola and acslXtreme are supplied by:

BAUSCH-GALL GmbH
Wohlfartstr. 21b, 80939 München
www.Bausch-Gall.de

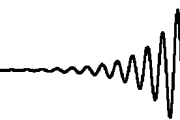## The MathWorks Releases Bioinformatics Toolbox For MATLAB

The MathWorks announced the availability of its new Bioinformatics Toolbox for MATLAB®. The product facilitates the analysis of complex bioinformatics data, from genomic sequences to microarray data analysis, and speeds up the development and deployment of algorithms.

The Bioinformatics Toolbox is designed to help users understand and visualize large amounts of research data in a fraction of the time associated with traditional biotech applications. With this latest addition to its product family, The MathWorks is delivering the power and versatility of its integrated technical computing environment directly to the biotech and pharmaceutical industries. Leveraging the rich programming functionality of MATLAB, the Bioinformatics Toolbox provides scientists and bioinformaticists with an open, extensible environment for algorithm development and manipulation and enables easy communication of applications across research departments. As a result, bioinformaticists can use the toolbox to focus efforts on the core of their work — research and analysis — without the risks associated with using disparate software programs.

Among its numerous features and capabilities, the Bioinformatics Toolbox provides access to standard genomic file formats, Web-based databases such as GenBank and PIR, and online data sources. The toolbox also offers specialized routines for visualizing microarray data, including box plots, I-R plots and spatial heat maps.

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