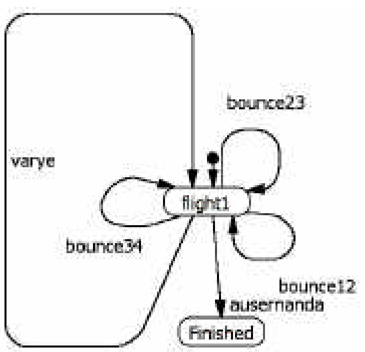
C12 Spheres' Collision – AnyLogic

Numerical simulation / Time-oriented Model

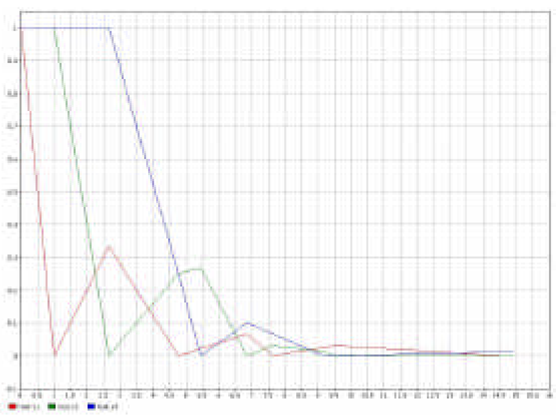
Simulator: AnyLogic (www.xjtek.com) is a simulator especially developed for large challenging systems with discrete, continuous and hybrid behaviour. The graphic model editor makes use of the UML-notation (state chart). The model description is translated into Java, and the resulting system is simulated in a graphical environment, the model viewer.

Model: The statechart below represents the motion of the spheres in *flight1,* which changes within the events *bounce12, bounce23* and *bounce34* (the bounces between sphere 1 & 2, etc.).

The big loop *varye* variates *e*, the restitution coefficient. AnyLogic does not make use of a separate experiment environment. Experiments can be implemented either in the model editor (parameter changes etc.) or directly in the resulting Java code. Here the variation of the restitution coefficient is modelled as parameter loop *varye* for tasks **a2**, **b** and **c**.



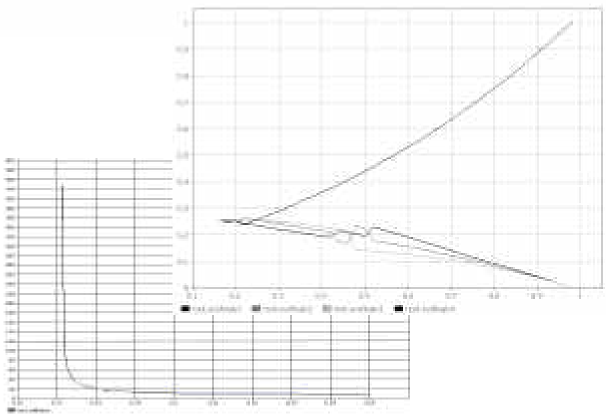
Task a: Simulation of the System. a1: Initial values are set in a workspace window. Simulation is started from a menu. The next figure shows the distance between the spheres in dependency on time by using the values *e*=0.2, *a*=1 and *v1(0)*=1.



Task a2. The quasi-plastic case is reached at *e*=0.171575. For *e*=1 final velocities are $vx_1=vx_2=vx_3=0$, $vx_4=1$. In the quasi-plastic case final velocities are $vx_1=vx_2=vx_3=vx_4=0.25$.

Task b: Variation of restitution coefficient: To solve the differential equations, the RK853 algorithm was used, *e* was decreased from 0.25 to 0.17 by steps of 0.002 and the collisions were counted, see next figure. The other figure shows the values of the final velocities *vx1, vx2, vx3* and *vx4* depending on *e* for the interval 0.17 < *e* < 0.25.

Task c1: Boundary value problem. The boundary value problem *vx4=v0/2* again was implemented as parameter loop with different stepsizes: working with a step of 1E-10 we got *e*=0.5874010518 and *vx4*=0.4999999998.



Task c2: Stochastic deviation of restitution. The restitution coefficient *e* is now a normally distributed stochastic variate with mean 0.5 and standard deviation 0.005.

A loop varied the restitution coefficient according to these parameters. The final velocities vx_{4final} were written into a *dataset.* Being an element of the dataset, the statistical data can be accessed with *getStatistics().*

5002 samples using this variate resulted in the following values for vx_{4final} :

mean vx_{4final} = 0.421868612455048
variance: σ^2 = 1.1196663217194136 E –6
standard deviation : σ = 0.00105814286
confidence interval :
[mean +/- 2.932435951694475E-5]

W. Weidinger, D. Schachinger, G.Langs
Dept. Simulation, Vienna Univ. of Technology
{e9725427,e9726351}@student.tuwien.ac.at
e9726130@student.tuwien.ac.at