Comparison 8 - GPSS/H

Student GPSS/H, Release 3 (1995), was used to model the Canal-and-Lock System of Comparison 8. GPSS/H is a flexible and efficient general purpose simulation language. Models consist of "Transactions" that move from Block to Block, acting out either the flow of entities (barges) or the processing of information/decisions. Experiments are defined with "Control Statements" included as part of the model file.

a) Model Description:

While commonly used GPSS/H Blocks (e.g., SEIZE, ADVANCE, RELEASE) describe the flow of barges, GPSS/H elements such as Logic Switches and GATE and TEST Blocks are used to implement decision making. Block PUTPICs write out trace information for deterministic datasets.

The model consists of about 65 Blocks. About 35% of the model is devoted to expressing the logical complexities of the system.The experiments are described with about 20 Control Statements.

b) Validation with Deterministic Datasets:

The logic of the model was tested with the deterministic datasets. The results match those discussed in the definition. A sample model (configured for Common Random Numbers) is provided on SNE's WWW server (http://eurosim.tuwien.ac.at/sne/).

c) Results and Discussion of Probabilistic Datasets:

GPSS/H supports ARV methodology with RMULT Control Statements. Table 1 shows the six confidence intervals resulting from activities 1, 2 and 3, and grand confidence intervals for the respective sets of three replications. The table indicates the percentage by which use of Antithetic Random Variates reduces the width of the confidence intervals. The reduction ranges from about 20% to 38% and is about 25% for the grand confidence intervals. This is a worthwhile improvement in precision for the modest effort involved in using ARVs.

	Activities 1 and 2	Activity 3 (ARVs)	Decrease in CI
90% Conf Int 1	485.0 ± 43.7	554.2 ± 34.9	20.1%
90% Conf Int 2	506.7 ± 41.0	494.4 ± 25.4	38.0%
90% Conf Int 3	520.3 ± 37.4	480.6 ± 27.4	26.7%
Grand 90% Conf Int	504.0 ± 23.5	509.7 ± 17.5	25.5%

Table 1: 90% Confidence Intervals for Activities 1, 2 and 3

In Table 1, the average barge transit time is about 8 hours. To investigate the effect of randomness, a replication was performed with deterministic barge interarrival times set at 75 minutes, and with the first eastbound and westbound barges arriving at times 0 and 37.5, respectively. The aggregate barge transit time was reduced to 223 minutes, less than 50% of that in Table 1.

Table 2 shows the six confidence intervals resulting from activities 4, 5 and 6 and the grand confidence intervals for the respective sets of three replications. The table indicates the percentage by which the use of Common Random Numbers reduces the width of the confidence intervals. Each reduction is about 89%. This is a dramatic improvement in precision. CRN methodology is supported in GPSS/H by means of RMULT Control Statements.

	Activities 4 and 5	Activity 6 (CRNs)	Decrease in CI
90% Conf Int 1	39.4 ± 71.8	65.5 ± 8.3	88.4%
90% Conf Int 2	62.5 ± 73.6	58.9 ± 7.5	89.9%
90% Conf Int 3	139.0 ± 67.1	54.8 ± 7.4	89.0%
Grand 90% Conf Int	80.29 ± 41.1	59.7 ± 4.5	89.1%

Table 2: 90% Confidence Intervals for Activities 4, 5 and 6

If a 90% confidence interval for the difference in pooled barge transit times (5-barge maximums minus 6-barge maximums) falls entirely above zero, the null hypothesis that the average 5-barge transit time is less than or equal to the 6-barge transit time can be rejected with the probability of a Type I error set at 0.05. Confidence intervals 1 and 2 for activities 4 and 5 in Table 2 include zero, making it impossible to reject the null hypothesis for those simulations. In marked contrast, confidence intervals 1, 2 and 3 for activity 6 are each positioned far above zero and provide strong evidence that changing from 5-barge to 6-barge maximums will decrease the average barge transit time (by about 1 hour). With CRN the merits of the 6-barge maximum stand out sharply, whereas the non-CRN experiments provide inconclusive evidence and set up the need for additional experimentation.

The Table 1 and 2 summaries were produced by writing replication results from the GPSS/H model into ASCII files, then importing them into Excel 5 for analysis with Excel's Descriptive Statistics capability.

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