

## Homework 4: Input Modeling, Verification, Validation

The objective of Homework 4 is for students to reinforce their understanding of verification and validation in Simulation Models. In addition, the homework asks students to review their work in the group project.

For submission, kindly submit your work for all questions in 1 PDF file (and 1 Excel file).

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### Exercise 1:

- a. Explain Verification and Validation in Simulation Models? Why are Verification and Validation important for Models in general and for Simulation Models in particular?
- b. Explain 3 techniques/approaches for Verification.
- c. Explain 3 techniques/approaches for Validation.

### Exercise 2:

- d. Explain the Inputs and Outputs of the simulation model in the example of “National Bank” (lecture 8)?
- e. What are the Inputs and Outputs of the simulation model of your group project? Are there any assumptions in collecting and interpreting these data?

### Exercise 3: Solve the following problems!

#### Problem 1

1. A simulation model of a job shop was developed to investigate different scheduling rules. To validate the model, the scheduling rule currently used was incorporated into the model and the resulting output was compared against observed system behavior. By searching the previous year’s database records, it was estimated that the average number of jobs in the shop was 22.5 on a given day. Seven independent replications of the model were run, each of 30 days’ duration, with the following results for average number of jobs in the shop:

18.9 22.0 19.4 22.1 19.8 21.9 20.2

- (a) Develop and conduct a statistical test to evaluate whether model output is consistent with system behavior. Use the level of significance  $\alpha = 0.05$ .
- (b) What is the power of this test if a difference of two jobs is viewed as critical? What sample size is needed to guarantee a power of 0.8 or higher? (Use  $\alpha = 0.05$ .)

Problem 2

2. System data for the job shop of Exercise 1 revealed that the average time spent by a job in the shop was approximately 4 working days. The model made the following predictions, on seven independent replications, for average time spent in the shop:

3.70 4.21 4.35 4.13 3.83 4.32 4.05

- (a) Is model output consistent with system behavior? Conduct a statistical test, using the level of significance  $\alpha = 0.01$ .
- (b) If it is important to detect a difference of 0.5 day, what sample size is needed to have a power of 0.90? Interpret your results in terms of model validity or invalidity. (Use  $\alpha = 0.01$ .)

Problem 3

3. For the job shop of Exercise 1, four sets of input data were collected over four different 10-day periods, together with the average number of jobs in the shop  $Z_i$  for each period. The input data were used to drive the simulation model for four runs of 10 days each, and model predictions of average number of jobs in the shop  $Y_i$  were collected, with these results:

$i$	1	2	3	4
$Z_i$	21.7	19.2	22.8	19.4
$Y_i$	24.6	21.1	19.7	24.9

- (a) Conduct a statistical test to check the consistency of system output and model output. Use the level of significance  $\alpha = 0.05$ .
- (b) If a difference of two jobs is viewed as important to detect, what sample size is required to guarantee a probability of at least 0.80 of detecting this difference, if it indeed exists? (Use  $\alpha = 0.05$ .)