Stevens Institute of Technology

SYS-611 Homework #1

Due Feb. 17 2021

Submit the following using the online submission system: 1) Cover sheet with name, date, and collaborators, 2) Written responses in PDF format, 3) All work (e.g. .xlsx or .py files).

1.1 Systems Modeling and Simulation [5 points]

Imagine Stevens is considering constructing a new academic building on the corner of 5th Street and Sinatra Drive. A new building would alleviate space constraints on research and educational activities; however, it would also add significant debt and interest payments to the budget. You have been contracted to study this problem by the Board of Trustees. Figure 1.1 shows several approaches to study a system that you are considering.

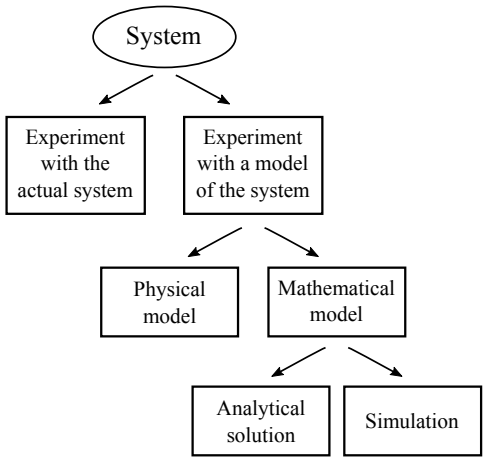

Figure 1.1: Ways to study a system (from Law and Kelton, 2000, p. 4).

(a) 2 pts Explain how a *non-simulation* analysis method could study part of the problem.

(b) 2 pts Explain how a *simulation* analysis method could study part of the problem.

(c) 1 pt Explain whether your simulation analysis would be characterized as static/dynamic and deterministic/stochastic and why.

1.2 Interacting with Model State [10 points]

This question builds on the Tic-Tac-Toe model developed in class.

(a) 2 pts Using simple words, explain the logic that determines whether a Tic-Tac-Toe model state contains a winner.

(b) 2 pts Implement the Tic-Tac-Toe `get_winner` derived state function in a computational modeling tool (e.g. Python or Excel). Inspect the model state and display the string `"x"` or `"o"` if there is a winner, otherwise display a blank string `""`.

(c) 2 pts Using simple words, explain the logic that determines whether a Tic-Tac-Toe model state contains a tie.

(d) 2 PTS Implement the Tic-Tac-Toe `is_tie` derived state function in a modeling tool (e.g. Python or Excel). Inspect the model state and display a boolean `True` or `False`.

(e) 2 PTS Describe the test cases that should be included in a comprehensive test plan to verify the correct implementation of these two functions.

1.3 Modeling a Board Game as a Simulation [10 points]

Kalah (a variation of Mancala) is a two-player board game described as as[1]:

> played on a board with two rows, each consisting of six round pits. The rows have a large store at either end called kalah. A player owns the six closest pits and the kalah on their right. Players start with 3 seeds per pit and take turns.
>
> A move takes the seeds from a player's pit and distributes them one by one, counterclockwise, in the pits and their own kalah (but not the opponent's kalah). If the last seed is dropped into an opponent's pit or the player's own non-empty pit, the move ends. If the last seed falls into the player's own kalah, they must move again. If the last seed is put into a player's own empty pit, they capture the contents of the opposite pit and put it with the capturing piece into their kalah. If the opposite pit is empty, nothing is captured. A capture ends the move.
>
> The game ends when one player has no seeds in their pits. The remaining pieces are captured by the adversary and whoever captured the most pieces wins.

(a) 3 PTS What is the elementary *Kalah* model state? Describe it in sufficient detail to allow someone to create a mathematical (symbolic) model. (*hint: think of what information is necessary to "save" a game and later recreate it*)

(b) 1 PTS Explain the logic of derived state function `get_winner` which identifies the winning player, if any, in terms of the elementary state in (a). What pre-condition is necessary to identify a winner, and how do you determine which player is the winner?

(c) 3 PTS Describe the logic of the following state changes in *Kalah*. For each, describe any required pre-conditions or player inputs and explain model state changes.

(i) Player Move

(ii) Capture

(iii) End Game

(d) 3 PTS Draw an activity diagram to show the end-to-end *Kalah* game progression at a sufficient level of detail to determine which player has the next move after each action.

[1] `https://boardgamegeek.com/boardgame/2448/kalah`

