THE UNIVERSITY of ADELAIDE

ASSESSMENT 3: PROJECT REPORT

Weighting: 40%

Word Count: 3,500 words (+/- 500). The word count does not include figures and tables. Total number of included figures and tables should be 15 (+/- 5) combined.

Purpose

This assessment will provide you with the opportunity to:

- Demonstrate your ability to use a simulation model to aid in decision making.
- Develop practical skills in Julia through reverse engineering Julia code.
- Improve your ability to communicate complex facts about simulation results.
- Demonstrate your ability to verify and validate your simulation.
- Practice and improve your skills in data analysis, specifically towards informing a simulations model and analysing the output of a simulation.

Outcomes

This assessment maps to the following course outcomes:

1. communicate how randomness and controlled variation can be used to model complex systems in a range of application domains such as industry, health and transportation
2. create a model of a real-world problem specified in words and implement it as a discrete-event simulation
3. validate results from a discrete-event simulation
4. explore scenarios using simulation to elicit and compare possibilities

5. systematically simulate to derive quantitative information with measures of confidence
6. design simulation-based workflows to support decision-making in real-world contexts.

Scenario

You are working for Factoriffic Custom Lamps, a manufacturing company. The company produces lamps in an old and inefficient factory—Factory X. You have just been employed to provide them with answers about how to improve the production line at Factory X, and how their current advertising campaign will impact their manufacturing schedules.

You aren't the first person to have had this remit. Your position is as a replacement for a previous staff member who started the project but left before it was finished. Your task is to continue and adapt their work to help make recommendations for improvements to Factory X, potentially responding to increased demand resulting from a new advertising campaign.

You should treat the exercise as if you are working for your company (rather than doing a student project). Your tutor is your SME (Subject Matter Expert). Your assessor is your manager (who is unreachably busy and will only look at your final report).

The system

The system under study (SUS) is a small production line with two critical stages referred to here as Machine 1 and Machine 2. Orders for lamps come in and are queued until Machine 1 is free to start manufacture. After being processed in Machine 1, the lamps are queued again, waiting for Machine 2. There is a limited space available for the lamps to be queued (only four orders can wait in this space at most), and if this space is filled, Machine 1 must stop working until there is space. After processing in Machine 2, lamps are shipped to the customer that ordered them.

Hint: The description of the SUS is deliberately vague. Part of your job is to determine a more detailed and accurate model of that system. Your tutor is the SME so you need to ask them good questions to find out more.

Questions of interest

The company wants to answer the following questions:

1. Is the space available for lamps waiting for Machine 2 sufficient?
2. Could the system be improved if Machine 1 or Machine 2 were made faster?

Note that the company only has enough money to improve one machine and can at most improve speed by a factor of two.

3. What would happen to the *current* system if the company's current advertising program were successful, and the rate at which orders arrived increases by 25%?

   Would the above improvements help?

Your Task

Your task is to work through all the steps in a simulation model and prepare a report to make informed recommendations based on the results of your simulation.

Associated files

Download the following files.

- Simulation code: `factory_simulation_2.jl`
- Example code to run a simulation: `factory_simulation_2_run.jl`
- Measurement data: `measured_times.csv`

Part 1

You are provided with Julia code that a previous staff member has written to simulate the system. However, they did not document the code well. That means you have a bit of work to do. The first part will be to conduct VV&A (Verification, Validation and Accreditation) on the simulation.

1. You must build an understanding of the code, and document it. That means you will need to reverse engineer the assumptions, the state model, the events, and entities in the system, as well as any assumptions built into the code. You will document it using techniques described in Module 3: Validation. Document your system state, events and create the various diagrams required.
2. Data has also been provided for the service time distribution for Machine 1 and Machine 2. You will need to use skills developed in Module 4: Including Data into Simulations to analyse this data. You will then need to improve the simulation model and the code to correct any assumptions that need correction.
3. Verify that the code has no bugs and that the output data is sound. Develop a set of unit tests to do so.

In performing these tasks, think of your tutor as an SME who can give you advice about the SUS. Assume they don't understand simulations, but can help you work on your understanding of the original simulation and how it may or may not be defective.

Hint: Remember to listen to advice from an SME critically. Ultimately, data is more valuable than advice. Your own determinations should make the best decisions based on all your resources.

Part 2

In the second part of this assessment, you will use your improved simulation code to explore the SUS and answer the questions of interest.

1. Write a simulation harness to automate running the simulation code over a range of parameters.
2. Explore the simulation parameters to determine: (i) how long to run each simulation, (ii) how many independent realisations you will use, and (iii) how much burn-in time is needed.
3. Explore the system parameters to determine: (i) what range of parameters you will include in your possibility space, and (ii) with what resolution you will explore those parameters.
4. Use the simulation to generate data that can answer the questions of interest.
5. Analyse the data from the simulations (using what you learned in Module 5) and generate plots to illustrate the answers.

Part 3

Having run the simulation, the third part of this project is to write a report from your point of view as an employee of the manufacturing company. The report should be written to your manager, and it should provide convincing results that they can use to make improvements to the production line.

The report should take the form shown in Module 6: Reporting and Communicating customised to the particular problem you are working on.

It should be concise, but contain enough detail for a reader to understand and be confident about:

1. your verification and validation process, and
2. your results and recommendations.

Ensure that the questions of interest are answered, and that the answers are very clear to a busy reader.

Requirements

You will submit your assessment as a report through MyUni. Save your report as a PDF and upload it to the assessment link. Your tutor will assess your work and provide feedback based on reading your report alone. The assessor will **not** look at:

1. your code, or
2. your data.

You do not need to include your Julia code or data in the report. Your report must be convincing without access to such details.

It is important to be concise so you will lose marks if the report wastes your manager's reading time. Assume your manager is very busy and will read the report quickly (and somewhat carelessly).

Consult the assessment rubric for more detail about preparing your submission.

Questions can be posted to the relevant assessment Discussion Board.

Grading Criteria

This assessment is worth 40% of your overall grade. Refer to the attached rubric for detailed information on the grading criteria for this assessment.

Rubric: Assessment 3 — Project Report

Component 1: Presentation					
Criteria	**Ratings**				**Points**
Overall report structure	**Points:** 3.0 **Name:** Full points	**Points:** 2.0 **Name:** Partial points	**Points:** 1.0 **Name:** Partial points	**Points:** 0.0 **Name:** No points	3 pts
	You have used the report template outlined in the course and enhanced where appropriate, for instance, by creating new sections. Sections, sub-sections, paragraph and other structures relate well to the material covered and help make the report more readable.	You have used the template, though it is not adapted to the given material, i.e., it might have been customised in some way to good effect. Document sub-structures are appropriate, but not edifying.	You have made some careless variations from the template, or failed to update obvious components such as skeleton section headings. Sections, paragraphs and other document structures are mostly appropriate, but are sometimes awkward, or material contained in them is not logically part of that section.	The template is not used or broken in some way. Sections or other structures are badly chosen, illogical or absent (e.g., paragraphs are not used to separate concepts).	
Use of English	**Points:** 3.0 **Name:** Full points	**Points:** 2.0 **Name:** Partial points	**Points:** 1.0 **Name:** Partial points	**Points:** 0.0 **Name:** No points	3 pts
	Grammar and spelling (standard Australian) are all correct, and stylistically appealing. A formal style is preferred, with some allowed variation for readability.	Grammar and spelling are all correct (barring a small number of minor typos). Style is consistent. Some sentences might be awkward.	There are more than a few typos. Style is reasonable, but sometimes inconsistent.	Frequent significant grammatical mistakes (e.g., inconsistent use of tense, incorrect or ambiguous pronouns, missing or incorrect definite and indefinite articles). Repeated spelling mistakes. Other poor use of language including overly informal language or overuse of, for instance, passive constructions or uninformative abstract nouns (e.g., ‘thing’).	

Conciseness of report	**Points:** 3.0 **Name:** Full points	**Points:** 2.0 **Name:** Partial points	**Points:** 1.0 **Name:** Partial points	**Points:** 0.0 **Name:** No points	3 pts
	Report is clear and expresses what is needed to be said without unnecessary words. Space is used well and all content (such as figures and tables) are essential for the reader.	Report is clear, but contains some additional text or one figure or table that is not important to the reader.	Report is unclear and there are multiple tables, figures or blocks of text are not required for the reader.	More than 20% of the report is irrelevant.	
Figures and tables	**Points:** 3.0 **Name:** Full points	**Points:** 2.0 **Name:** Partial points	**Points:** 1.0 **Name:** Partial points	**Points:** 0.0 **Name:** No points	3 pts
	The use of figures and tables adds to the enjoyment of reading the report and assists in effectively communicating the results of the simulation. All tables and figures are appropriate to the message(s) of the report, are well-captioned, clearly readable and explained in the text.	Tables and figures are appropriate to the message(s) of the report, well captioned, clearly readable, and explained in the text (as well as captions). However, one or two may be missing one of these elements.	Most tables and figures are appropriate, but there are some deviations, for instance, some figures that add little to the underlying message of the report.	Uncaptioned tables or figures. Unlabelled axes. Illegible labels or other data. Poor import of figures (e.g., resulting in pixelization).	
Executive summary	**Points:** 3.0 **Name:** Full points	**Points:** 2.0 **Name:** Partial points	**Points:** 1.0 **Name:** Partial points	**Points:** 0.0 **Name:** No points	3 pts
	Summary is clear, precise and concise. It provides concrete answers to the questions of interest.	Executive summary is not completely precise, or has extraneous details.	Executive summary is long-winded, and/or does not answer all questions of interest.	Executive summary is absent or fails to provide any concrete answers.	
				Section total:	**15 pts**

Component 2: Content

Criteria	Ratings					Points
Answering the questions (i) Is the space available for lamps waiting for Machine 2 sufficient? (ii) Could the system be improved if Machine 1 or Machine 2 were made faster? (iii) What would happen to the current system if the company's current advertising program were successful, and the rate at which orders arrived increases by 25%?	**Points:** 4.0 **Name:** Full points You have provided answers to the three questions posed and also answered the most obvious follow-up questions that your manager might ask.	**Points:** 3.0 **Name:** Partial points You have provided answers to the three questions that are summarised in the executive summary and referred to in the introduction and conclusion.	**Points:** 2.0 **Name:** Partial points You have partially provided answers to the three questions, or omitted the answer to one question.	**Points:** 1.0 **Name:** Partial points You have not provided clear answers to the three questions, or only provided the answer to one question.	**Points:** 0.0 **Name:** No points Assessment requirements for this step have not been met.	4 pts
Documentation 1. A description of the system in words	**Points:** 2.0 **Name:** Full points You have provided a valid description of the system in words.		**Points:** 1.0 **Name:** Partial points You have partially provided a valid description of the system in words.		**Points:** 0.0 **Name:** No points Assessment requirements for this step have not been met.	2 pts
Documentation 2. A schematic	**Points:** 2.0 **Name:** Full points You have provided a valid schematic of the system.		**Points:** 1.0 **Name:** Partial points You have provided a schematic of the system, with some errors.		**Points:** 0.0 **Name:** No points Assessment requirements for this step have not been met.	2 pts

Documentation 3. A flow diagram	**Points:** 2.0 **Name:** Full points	**Points:** 1.0 **Name:** Partial points	**Points:** 0.0 **Name:** No points	2 pts
	You have provided a valid flow diagram of the system.	You have provided a flow diagram of the system, with some errors.	Assessment requirements for this step have not been met.	
Documentation 4. A state-transition diagram	**Points:** 2.0 **Name:** Full points	**Points:** 1.0 **Name:** Partial points	**Points:** 0.0 **Name:** No points	2 pts
	You have provided a valid state-transition diagram of the system.	You have provided a state-transition diagram of the system, with some errors.	Assessment requirements for this step have not been met.	
Documentation 5. An event graph	**Points:** 2.0 **Name:** Full points	**Points:** 1.0 **Name:** Partial points	**Points:** 0.0 **Name:** No points	2 pts
	You have provided a valid event graph of the system.	You have provided an event graph of the system, with some errors.	Assessment requirements for this step have not been met.	
Documentation 6. In an appropriate section before the Results, you have included a list of modelling assumptions	**Points:** 2.0 **Name:** Full points	**Points:** 1.0 **Name:** Partial points	**Points:** 0.0 **Name:** No points	2 pts
	You have correctly provided at least three out of the following: • The distributions used for inter-arrival time and service times for each machine. • Independence between random variables. • Queue input ordering (LIFO, FIFO). • Sizes of available waiting space. • Notes that there are no priorities and no pre-emption.	You have partially provided at least three out of the following: • The distributions used for inter-arrival time and service times for each machine. • Independence between random variables. • Queue input ordering (LIFO, FIFO). • Sizes of available waiting space. • Notes that there are no priorities and no pre-emption.	Assessment requirements for this step have not been met.	

Verification techniques Evidence of three verification techniques including a written description of the types of testing used is provided	**Points:** 3.0 **Name:** Full points	**Points:** 2.0 **Name:** Partial points	**Points:** 1.0 **Name:** Partial points	**Points:** 0.0 **Name:** No points	3 pts
	You have provided evidence of three verification techniques from the list including a written description of the types of testing used: • Unit testing • Integration testing • Regression testing • Performance testing • Coverage testing	You have provided evidence of two verification techniques from the list including a written description of the types of testing used: • Unit testing • Integration testing • Regression testing • Performance testing • Coverage testing	You have provided evidence of one verification techniques from the list including a written description of the types of testing used: • Unit testing • Integration testing • Regression testing • Performance testing • Coverage testing	Assessment requirements for this step have not been met.	

Validation 1. SME discussion	**Points:** 1.0 **Name:** Full points		**Points:** 0.0 **Name:** No points	1 pt
	You have provided a summary of the discussion with your SME (your tutor).		Assessment requirements for this step have not been met.	
Validation 2. Testing assumptions against the data	**Points:** 2.0 **Name:** Full points	**Points:** 1.0 **Name:** Partial points	**Points:** 0.0 **Name:** No points	2 pts
	You have used an appropriate approach for testing assumptions against the data and obtained valid results.	You have used an appropriate approach for testing assumptions against the data, but have not obtained valid results.	Assessment requirements for this step have not been met.	
Validation 3. Sensitivity analysis of the system with respect to assumptions	**Points:** 2.0 **Name:** Full points	**Points:** 1.0 **Name:** Partial points	**Points:** 0.0 **Name:** No points	2 pts
	You have correctly conducted a sensitivity analysis of the system with respect to assumptions.	You have partially conducted a sensitivity analysis of the system with respect to assumptions.	Assessment requirements for this step have not been met.	

Validation 4. A statistical comparison of simulation results to historical data	**Points:** 2.0 **Name:** Full points	**Points:** 1.0 **Name:** Partial points	**Points:** 0.0 **Name:** No points	2 pts
	You have conducted a statistical comparison of simulation results to historical data using an appropriate approach and obtained valid results.	You have conducted a statistical comparison of simulation results to historical data using an appropriate approach but have not obtained valid results.	Assessment requirements for this step have not been met.	
Exploratory analysis results Number of simulations, length of simulation	**Points:** 1.0 **Name:** Full points		**Points:** 0.0 **Name:** No points	1 pt
	You have correctly determined a reasonable number of independent simulations and a reasonable length of simulation.		Assessment requirements for this step have not been met.	
Exploratory analysis results Burn-in	**Points:** 1.0 **Name:** Full points		**Points:** 0.0 **Name:** No points	1 pt
	You have correctly determined an appropriate burn-in period.		Assessment requirements for this step have not been met.	
Output data Charts provide insight into the questions of interest and/or the verification and validation process	**Points:** 1.0 **Name:** Full points		**Points:** 0.0 **Name:** No points	1 pt
	You have included charts that provide insight into the questions of interest and/or the verification and validation process.		Assessment requirements for this step have not been met.	
Output data Confidence intervals	**Points:** 1.0 **Name:** Full points		**Points:** 0.0 **Name:** No points	1 pt
	You have provided charts that include confidence intervals where needed.		Assessment requirements for this step have not been met.	
			Section total:	**30 pts**
			Assessment total:	**45 pts**