

## **DEGREE: BSc Computer Science and Digitisation**

### **Module: Simulation Technique**

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**Assignment Title:** Discrete Event Simulation for Emergency Department Patient Flow Optimization

**Assignment Type:** Portfolio

**Word Limit: 3000 words (+/- 300)**

**Weighting:** 100%

**Issue Date: 20/05/2025**

**Submission Date: 17/06/2025**

**Feedback Date: 08/07/2025**

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#### **Plagiarism:**

When submitting work for assessment, students should be aware of the InterActive/Canvas guidance and regulations in concerning plagiarism. All submissions should be your own, original work. Please note that you must not submit the same assignment for two different modules within your course.

**You must submit an electronic copy of your work. Your submission will be electronically checked.**

#### **Learner declaration**

**I certify that the work submitted for this assignment is my own and research sources are fully acknowledged.**

**Student signature:**

**Date:**

#### **Harvard Referencing:**

The Harvard Referencing System must be used. The Wikipedia, UKEssays.com or similar websites must **not** be used or referenced in your work.

## Introduction

This assignment challenges you to apply Discrete Event Simulation (DES), a core technique discussed in this module, to model and analyse patient flow within a hypothetical hospital Emergency Department (ED). Efficient patient flow is critical in healthcare for ensuring timely care and resource optimisation. By simulating the ED processes, you will identify bottlenecks, evaluate potential interventions, and propose evidence-based recommendations for improvement. This exercise will enhance your practical skills in model building, simulation execution, data analysis, and interpreting complex system behaviour, directly relevant to real-world operational challenges.

### Learning Outcomes:

**LO1.** Explain the techniques for computer-based simulation and implement a variety of simulation and data analysis libraries and programs.

**LO2.** Implement and test a variety of simulation and data analysis libraries and programs.

**LO3.** Implement tools to view and control simulations and their results.

**Assessment Criteria: Weighting 100%**

**3000 words**

### Objectives:

The primary objective is to design, implement, analyse, and report on a Discrete Event Simulation model of an Emergency Department patient flow process. You will use the simulation to understand system dynamics, identify areas for improvement, and evaluate the impact of proposed changes.

### Scenario: Emergency Department Simulation

Imagine you are a consultant hired by City General Hospital to address overcrowding and long waiting times in their Emergency Department (ED). The ED process involves patient arrival, triage (categorisation by urgency), registration, waiting for consultation, consultation with a doctor, potential diagnostic tests (like X-rays or blood tests), treatment, and finally, discharge or admission to the hospital. Resources (doctors, nurses, beds, diagnostic equipment) are limited.

### Task Description:

You need to build a DES model to simulate this ED process, analyse its performance, and test strategies to improve patient throughput and reduce waiting times. This will help you understand the potential variability in project outcomes and make informed decisions.

### Requirements and Instructions:

### 1. Conceptual Model and Data Definition (30 Marks) (LO1)

- **Define the System:** Clearly outline the boundaries, components (patients, staff, rooms, equipment), and key processes (arrival, triage, registration, consultation, testing, treatment, discharge/admission) of the ED system you are modelling. Create a process flow diagram.
- **Identify Key Performance Indicators (KPIs):** Define the metrics you will use to evaluate ED performance (e.g., average patient waiting time for consultation, average total time in ED, resource utilisation rates (doctors, beds), queue lengths).
- **Data Assumptions:** Since real data is unavailable, define realistic assumptions for patient arrival patterns (e.g., using a Poisson distribution), triage category distribution, process durations for each step (e.g., using triangular or exponential distributions for consultation, tests), and resource availability (number of doctors, nurses, beds). Justify your choices.

### 2. Simulation Implementation (40 Marks) (LO2, LO3)

- **Choose Simulation Tool:** Select an appropriate simulation tool or library (e.g., Python with SimPy, AnyLogic PLE, Arena, MATLAB SimEvents). Justify your choice.
- **Model Development:** Implement the DES model based on your conceptual design and data assumptions. Ensure your model includes entities (patients), resources (staff, beds), queues, and process logic reflecting the flow described.
- **Verification and Validation:** Describe the steps taken to verify your model logic (does it run as intended?) and conceptually validate its behaviour (are the initial results plausible for an ED scenario?).
- **Simulation Experiments:** Run the simulation for a sufficient duration and number of replications to obtain statistically meaningful results for your chosen KPIs. Document your experiment setup (run length, warm-up period if applicable, number of runs).

### 3. Analysis, Interpretation, and Recommendations (30 Marks) (LO1, LO3)

- **Baseline Analysis:** Analyse the output data from your baseline simulation runs. Present and interpret the results for your defined KPIs using appropriate statistical summaries (mean, standard deviation, confidence intervals) and visualizations (histograms, time series plots). Identify the main bottlenecks in the system.
- **Scenario Testing:** Propose at least two distinct interventions to improve ED flow (e.g., adding more doctors during peak hours, changing triage protocols, implementing a separate fast-track for minor cases, adding more diagnostic capacity). Implement these changes in your model and run new simulation experiments.
- **Comparison and Recommendations:** Compare the KPI results from the intervention scenarios against the baseline. Discuss the effectiveness of each proposed change. Provide clear, data-driven recommendations to the hospital management on how to improve ED patient flow based on your simulation findings. Discuss any limitations of your model.

**Submission Instructions:**

- Submit your assignment as a single document following the BSBI assignment template provided in Canvas.
- Ensure clear and concise writing with proper grammar and spelling.
- Use headings and subheadings to organize your work logically according to the tasks above.
- Include visuals like diagrams (process flow, conceptual model sketches), tables (data assumptions, results), and graphs (simulation output) where appropriate to enhance understanding.
- Address each part thoroughly, demonstrating your understanding of DES concepts and their application to the ED scenario.
- Provide relevant examples and details of your model implementation and calculations.
- Use Harvard referencing style for your bibliography.
- Discuss your findings, insights, and the implications of your recommendations.
- Submit your assignment electronically by the specified deadline.

## GUIDANCE ON ASSESSMENT

All materials must be properly referenced under Harvard conventions. The length required is 3000 words with tasks equally weighted. The writing style should be formal academic / report writing style with in-text referencing to support your comments and observations. Originality, quality of argument and good structure are required. The report should demonstrate sound understanding and ability to apply knowledge and theory of Simulation Techniques. Additional marks being awarded for juxtaposition and insight of issues.

## Grading Criteria

	Generic Criteria	90 - 100	80 - 89	70 - 79	60 - 69	50 - 59	40 - 49	30 - 39	0 - 29
Level 6	<b>Knowledge of contexts, concepts, technologies and processes</b> The extent to which: <i>relevant contextual or theoretical issues are identified, defined and described</i> <i>historical or contemporary practices are identified, defined and described</i> <i>appropriate technologies, methods and processes are identified defined and described</i>	Exceptional breadth and depth of knowledge of contextual and theoretical issues, some of which are at the forefront of the discipline, and their relationship to a range of historical and contemporary practices  Exceptional knowledge of a range of relevant specialist techniques and processes	Outstanding breadth and depth of knowledge of contextual and theoretical issues, some of which are at the forefront of the discipline, and their relationship to a range of historical and contemporary practices  Extensive knowledge of a range of relevant specialist techniques and processes	A breadth and depth of knowledge of contextual and theoretical issues, some of which are at the forefront of the discipline, and their relationship to a range of historical and contemporary practices  Significant knowledge of a range of relevant specialist techniques and processes	Confident knowledge of a range of contextual and theoretical issues, some of which are at the forefront of the discipline, and their relationship to a range of historical and contemporary practices  Confident knowledge of a range of relevant specialist techniques and processes	Familiar with a range of contextual and theoretical issues, at least some of which are at the forefront of the discipline, and their relationship to a range of historical and contemporary practices  Sound knowledge of a range of relevant specialist techniques and processes	Familiar with a range of contextual and theoretical issues and their relationship to a range of historical and contemporary practices  Adequate knowledge of a range of relevant specialist techniques and processes	Some knowledge of a range of contextual and theoretical issues and their relationship to a range of historical and contemporary practices  Limited knowledge of a range of relevant specialist techniques and processes	Limited knowledge of contextual and theoretical issues and their relationship to a range of historical and contemporary practices  No significant knowledge of a range of relevant specialist techniques or processes
	<b>Understanding through application of knowledge</b> The degree to which research methods are demonstrated: <i>relevant knowledge and information is compared, contrasted, manipulated, translated and interpreted</i> <i>knowledge and information is selected, analysed, synthesized and evaluated in order to generate creative ideas, practices, solutions, arguments or hypotheses</i>	Exceptional application of a range of research methodologies to projects and problems and hypotheses, with evidence of highly focused independent thought and some new insights into the subject  Exceptional ability to produce a range of creative practices and to critically evaluate them in a wider context, generating sustainable arguments and highly effective and individual results	Systematic and thorough application of a range of research methodologies to projects and problems and hypotheses, with evidence of highly focused independent thought and some new insights into the subject  Outstanding ability to produce a range of creative practices and to critically evaluate them in a wider context, generating sustainable arguments and highly effective and original results	Rigorous application of a range of research methodologies to projects, problems and hypotheses with evidence of highly focused independent thought and critical analysis  Strong ability to produce a range of creative practices and to critically evaluate them in a wider context, generating sustainable arguments and highly effective results	Confident ability to apply a range of research methodologies to projects, problems and hypotheses with clear evidence of independent thought and critical analysis  Strong ability to produce a range of creative practices and to evaluate them in a wider context, generating effective results	Sound ability to apply a range of research methodologies to projects, problems and hypotheses and to demonstrate independent thought and critical analysis  Sound ability to produce a range of creative practices and to evaluate them in a wider context, generating effective results	Competent ability to apply a range of research methodologies to projects, problems and hypotheses with some element of independent thought and critical analysis  Competent ability to produce a range of creative practices and evaluate them in a wider context to generate effective results	Ability to apply a limited range of research methodologies to projects, problems and hypotheses with little evidence of independent thought or critical analysis  Limited ability to produce a range of creative practices and to evaluate them in a wider context to generate effective results	No significant ability to apply research methodologies to projects, problems and hypotheses, and no evidence of independent thought or critical analysis  No significant ability to produce a range of creative practices or to evaluate them in a wider context to generate effective results

	<b>Application of technical and professional skills</b> The degree to which: <i>appropriate materials and media are selected, tested and utilised to realise and present ideas and solutions</i> <i>appropriate technologies, methods and processes are demonstrated</i> <i>transferable, professional skills are effectively demonstrated</i> <i>self management and independent learning are demonstrated</i>	Exceptional, individual and fluent application of a range of specialist practical and technical skills  Outstanding accomplishment of a range of advanced transferable and professional skills applied to complex situations and problems  Exceptional ability to manage own learning in a sustained manner and to critically evaluate own progress, making use of a wide range of feedback sources	Accomplished, original and fluent application of a range of specialist practical and technical skills  Outstanding accomplishment of a range of advanced transferable and professional skills applied to complex situations and problems  Outstanding ability to manage own learning in a sustained manner and to critically evaluate own progress, making use of a wide range of feedback sources	Accomplished and original application of a range of specialist practical and technical skills  Accomplished application of advanced transferable and professional skills to complex situations and problems  Very high ability to manage own learning in a sustained manner and critically evaluate own progress making effective use of feedback	Confident and imaginative application of a range of specialist practical and technical skills  Confident application of advanced transferable and professional skills to challenging situations and problems  Strong ability to manage own learning in a sustained manner and to critically evaluate own progress making effective use of feedback	Sound application of a range of specialist practical and technical skills  Sound application of advanced transferable and professional skills  Sound ability to manage own learning in a sustained manner and critically evaluate own progress making effective use of feedback	Competent application of a range of specialist practical and technical skills  Competent application of advanced transferable professional skills  Competent ability to manage own learning in a sustained manner and make effective use of feedback	Basic application of a range of specialist practical and technical skills  Limited application of advanced transferable and professional skills  Basic ability to manage own learning in a sustained manner and make use of feedback	Rudimentary application of a range of specialist practical and technical skills  Ineffective application of advanced transferable and professional skills  Evidence of a basic ability to manage own learning
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