Faculty of Science

Course:	CSCI 3010U: Simulation and Modelling
Component:	Project Requirements

Overview

This project involves developing a complete model, and processing the resulting data into a visualization. The primary goal of the project is for you to gain a practical understanding in the entire process for a significant scientific, engineering, or business problem. Secondary goals include practical experience with a modelling platform and/or graphics API, development of a showcase portfolio item for your resume, and encouraging interdisciplinary work. Between now and the end of term, you will conduct background research, plan a model, execute and tweak a simulation of that model, and analyze the resulting data.

It is recommended that this project be done on an individual basis. Groups of two (2) may be approved, provided that the topic is sufficiently complex that two group members are required. Groups of more than two students are strongly discouraged, since team development is not one of the learning objectives for this project and the potential issues that arise from large groups will more than likely result in reduced productivity.

Outline

In this project, you will follow the standard procedure (textbook, p. 9) for modelling and simulation (except for maintain):

1. Analyze the problem
    - understand the domain
    - identify the objective
    - classification (continuous vs. discrete, stochastic vs. deterministic)
2. Formulate a model
    - gather data about system's behaviour
    - make simplifying assumptions and document them (e.g. eliminate irrelevant variables)
    - determine variables
        - independent: often time
        - dependent: all other variables (complex expressions can sometimes be simplified into a single var)
    - if we have submodels, describe the relationships between their variables
    - determine equations for dependent variables (e.g. difference equations)
3. Implement the model
    - write a program to iterate on the independent variable, update the dependent variables
    - record and/or visualize the variable values generated
4. Verify and intepret the model's solution
    - verify: does the implementation work as we intended?
    - validate: does the implementation achieve our objective?
    - were our assumptions valid?
5. Report
    - document each stage
    - show results (tables, graphs, animations)
    - reach conclusions, make interpretations, make suggestions

Domain Research and Model Planning

For the first part of the project, you will choose a domain from the areas of science, engineering, or business. In order to navigate this simulation, it is imperative that you fully understand the domain (the specific area within science, engineering, or business which relates to your planned model). To this end you will create the Domain Research document. This document will contain 3-5 pages of background on the domain surrounding your project topic, explained in terms understandable by fellow 3rd year science or engineering students.

Once you understand enough of the domain, you will choose a behaviour to model, and will then proceed to create the Model Plan document. This document will be 2-3 pages, and will describe:

- The behaviour that you intend to model
    - Clearly state the objective of your simulation
- The classification of your simulation
    - Stochastic vs. deterministic
    - Continuous vs. discrete event
- A description of the interactivity involved with the simulation (if any)
- An outline of the simulation loop
- The input variables used to configure your simulation
- The state variables required for the simulation
    - For each state variable, include the difference/update equation that describes the change (including how those equations were derived)
- The output variables produced by the simulation
- A description of the process and tools you intend to use to visualize the data
- A description of the process you intend to use to interpret, summarize, verify, and validate

Simulation and Visualization

Beginning with your Model Plan, you will then begin the process of implementing that model, and running the simulation. You will need to determine how to collect input variable data, how to handle user interaction (if any), and how to collect the output data. You will also need to implement your data visualization.

You will be submitting your model/simulation code to the instructor during the last week of lectures. It is imperative that the instructor be able to run your simulation with minimal effort related to configuration, setting up the environment, installing packages, etc. Please create a file called README.txt in the main directory for your project which describes the process in adequate detail.

It is strongly recommended that you use some sort of version control package (e.g. Git) during development. If you do, you will be able to submit your source code at the end of term by merely submitting the Git URL and other relevant data (e.g. credentials, README.txt). The version control package will also serve as a backup, in case something happens to your laptop or its files. For projects done by groups of two, the use of Git (or another version control system) will be even more useful. Be sure to include all the files (source code, data, libraries) required to execute your simulation (aside from programming language and IDE) in your repository (or whatever you use to submit your source code).

Analysis, Verification, and Validation

Once you have generated your data, you will conduct a detailed analysis of your findings. You will create an Analysis document, which will be a 3-5 pages including your interpretation of the data, along with a conclusion related to your original objective. This document will also include a verification and validation on your simulation, to ensure that the generated data can be trusted.

Presentation

In the final week of lectures, students (or groups) will give a 10-minute presentation. The presentation should match the following format:

1. Introductions
    - Title
    - Objective
    - Author name(s), distribution of work
2. Domain research
    - Background
    - Description of the problem you tried to solve
3. Model
    - Assumptions
    - Input, state, and output variables
    - Update equations
4. Demo
    - Highlight the features of your simulation
    - Identify any shortcomings of your simulation
5. Conclusions and (hypothetical) future work
    - What did you find?
    - What more is needed?

Tools

While you may be required to learn some new tools in this course, the aim should be to spend a little time on that task as possible, while providing you will an adequate set of tools. To this end, you may use any programming language covered in UOIT's core curriculum (Java, C++, Python), as well as several others (e.g. JavaScript). For any other languages, check with the instructor before proceeding. As for simulation/visualization/graphics APIs, again you can choose.

Evaluation

The end result will be evaluated based on the instructor's estimation of the work done on the project, as well as its quality, which will be based on the choices you have made with regard to simplifying assumptions, the relevance of the collected data and conclusions, as well as the appropriateness of the visualization. The total value of the project is 35% of your final grade.

Component	Due Date	Weight (total: 35%)
Domain Research	March 6th, 2015	8%
Model Plan	March 6th, 2015	6%
Analysis	April 10th, 2015	8%
Source Code	April 10th, 2015	8%
Presentation/demo	April 8th and 10th, 2015	5%

How to Submit

Your Domain Research and Model Plan documents will be submitted electronically, together, to the instructor via a Blackboard drop box, mid-semester. Your Analysis document and source code for your model/simulation will be submitted to the instructor via a Blackboard drop box during the final week of lectures, when the presentation takes place.