Project Overview

This project has two options that you can choose between. Option 1 includes a programming component and a presentation component. Option 2 includes a written component and a presentation component. Both project options are equally weighted towards your final grade; it will make no difference which one you choose.

Each project can be completed either individually or in a group. If completed in a group, additional requirements will be added to the project. Additionally, any group will need to evaluate the contributions of the members of the full group independently.

Project Option 1: Turing Machine Simulator

For Project Option 1, you will create a Turing machine simulator for a deterministic, single-tape Turing machine.

To begin, you will need to create functions that control the behavior of the Turing machine's read/write head: the ability to move left and right on the tape, and to read and write to the current location on the tape. At every step through a computation, the simulator should print the following:

- Step number
- The current configuration of the machine (tape state, head location, machine state).
- The last operation performed (which character, if any, was read; which character, if any, was written; movement direction).
Your Turing machine simulator will need to recognize whether or not an input string belongs to three of the following six languages:

- \{w#x \mid x = w^R \text{ and } w \in \{0, 1\}^*\}
- \{ww \mid w \in \{0, 1\}^*\}
- \{w#w#w \mid w \in \{0, 1\}^*\}
- \{w \mid w \text{ does not contain twice as many } 0\text{s as } 1\text{s and } w \in \{0, 1\}^*\}
- \{w \mid w \text{ contains an even number of } 0\text{s and } w \in \{0\}^*\}
- \{w \mid w \text{ has a length that is a power of } 2 \text{ and } w \in \{0\}^*\}

Note that the input alphabet of all six languages is either \{0, 1\}^* or \{0\}^*. If you implement one of the select one of the languages that contains only \{0\}^*, it should not break when tested with a string from \{0, 1\}^* - always check your input string. You are welcome to introduce any additional tape symbols to the alphabet as you deem necessary.

Your system should test a given input string against all three languages you select. It is possible that a given input string could be accepted by more than one language. After execution, your simulator should clearly identify which languages accepted the string and which languages rejected the string.

Your simulator should also allow for the empty string as input. You can assume that input strings will be no longer than 25 characters in length.

Presentation Requirement
Each individual or group must give a 5-minute presentation to the class. This presentation will consist of the following:

- A short explanation of how the simulator was implemented.
- A short discussion of challenges faced during implementation.
- A short sample run on two input strings that will be provided during the presentation.

Extra Requirements for Groups
Groups of 2 must choose one of the following two options to complete:

- Implement a graphical user interface for your simulator. In addition to sequentially displaying the output to the console, you should have a window displaying the current step, current configuration of the tape, location of the head, and state of the machine. The precise design of the GUI is up to you.
• Implement your simulator such that it recognizes all six of the languages listed above.

Groups of 3 must implement both of the above requirements: GUI and all six languages. Groups larger than 3 are not permitted.

During the presentation, each group member should have equal speaking time, and any group member should be able to field any question asked by myself or the class.

Project Option 2: Special Topic in Theory of Computation

For Project Option 2, you will research some topic relevant to the Theory of Computation area, provide a written report on your research, and give a brief presentation to the class on what you have learned. You may propose a topic to research, or you can have one assigned to you. Topics can be interesting sections from the Sipser textbook that we did not cover during the course, or they can be external topics that apply to Theory.

For the written report, you will submit a 3-4 page, single-spaced formal paper, detailing the knowledge that you have acquired during your research. Sections of the paper should include an introduction, new definitions, the actual content of your research, and why it represents an interesting topic of research to Theory and to Computer Science as a whole.

Presentation Requirement

Along with the written report, so must also prepare a short lesson for the class regarding the topic that you have researched. This presentation should last roughly 8-10 minutes, including time for questions. Your presentation will be evaluated by the class for quality and clarity.

Extra Requirements for Groups

For groups of 2, the paper will be increased to 7 pages in length, and the presentation will be increased to 15 minutes. For groups of 3, the paper will be increased to 10 pages in length, and the presentation will be increased to 20 minutes. Groups larger than 3 are not permitted. During the presentation, each group member should have equal speaking time, and any group member should be able to field any question asked by myself or the class.
Deadlines

• Tuesday, 25 November - Decide which of the two project options you wish to complete. If you choose Option 2, meet with me to discuss what topic you will be researching.

• Tuesday, 25 November - Decide whether you will work alone or with a partner. If you work with a partner, please inform me of your group.

• Tuesday, 2 December - Provide me a short status update. This status update can be a simple 2-3 paragraph email. Included should be: (1) What have you completed so far? (2) What do you still have remaining to complete? (3) What has your biggest challenge been to this point? (4) Any open issues that I should be aware of or questions that you have?

• Tuesday, 9 December - Project is due.