Assignment 9

COMPSCI 2CO3: Data Structures and Algorithms–Fall 2025

Deadline: November 21, 2025

Department of Computing and Software
McMaster University

Please read the *Course Outline* for the general policies related to assignments.

Plagiarism is a *serious academic offense* and will be handled accordingly.
All suspicions will be reported to the *Office of Academic Integrity*
(in accordance with the Academic Integrity Policy).

This assignment is an *individual* assignment: do not submit work of others. All parts of your submission *must* be your own work and be based on your own ideas and conclusions. Only *discuss or share* any parts of your submissions with your TA or instructor. You are *responsible for protecting* your work: you are strongly advised to password-protect and lock your electronic devices (e.g., laptop) and to not share your logins with partners or friends!

If you *submit* work, then you are certifying that you are aware of the *Plagiarism and Academic Dishonesty* policy of this course outlined in this section, that you are aware of the Academic Integrity Policy, and that you have completed the submitted work entirely yourself. Furthermore, by submitting work, you agree to automated and manual plagiarism checking of all submitted work.

Late submission policy. Late submissions will receive a late penalty of 20% on the score per day late (with a five hour grace period on the first day, e.g., to deal with technical issues) and submissions five days (or more) past the due date are not accepted. In case of technical issues while submitting, contact the instructor *before* the deadline.

Problem 1. Consider a road map in which each section of a road (the part between two consecutive crossings) has a cost associated with it that represents the duration of traveling along that road. In any road map, there can be many routes from a given starting point A to a given end point B with the same, minimal, total cost. Not all these routes are the same, however: some have few crossings, others have many crossings. As traffic is typically most-dangerous around crossings, we want to provide *safe shortest routes*: routes that have a minimal cost and minimize the number of crossings encountered.

P1.1. Model the above problem as a graph problem: what are the nodes and edges in your graph, do the edges have weights, and what problem are you trying to answer on your graph?

P1.2. Provide an algorithm FindBestRoute to find the best routes starting at a given crossing A.

P1.3. Explain which graph representation you used for your algorithm and what the complexity of your algorithm is using this graph representation.

P1.4. What is the worst-case complexity of your solution if you use the other graph representation? Explain your answer.

Problem 2. Typically, route planning tries to minimize the duration or fuel cost of a route. Minimizing fuel cost for an electric car introduces an interesting problem, however: an electric car that drives downhill can regenerate energy via regenerative braking (and, hence, gain energy).

Now consider a road map in which each road has a cost associated with it that represents the energy consumption (or gain) of an electric car. We are tasked with finding the most energy-efficient path from a starting point to all other points in the map.

P2.1. Model the above problem as a graph problem: what are the nodes and edges in your graph, do the edges have weights, and what problem are you trying to answer on your graph?

P2.2. Argue whether it is possible to drive in circles indefinitely (hence, driving from point A to point A while gaining energy).

P2.3. Provide an algorithm FINDEFFICIENTROUTES to find the best routes starting at a given point A.

P2.4. Explain which graph representation you used for your algorithm and what the complexity of your algorithm is using this graph representation.

P2.5. What is the worst-case complexity of your solution if you use the other graph representation? Explain your answer.

Assignment Details

Write a report in which you solve each of the above problems. Your submission:

1. must start with your name, student number, and MacID;
2. must be a PDF file;
3. must have clearly labeled solutions to each of the stated problems;
4. must be clearly presented;
5. must *not* be hand-written: prepare your report in LaTeX or in a word processor such as Microsoft Word (that can print or export to PDF).

Submissions that do not follow the above requirements will get a grade of zero.

Grading

Each problem counts equally toward the final grade of this assignment.