Description, Objectives, Ethics, Resources

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1 Description

I will working on algorithms for directed graphs using GAP (Groups, Algorithms and Programming- a system for computational discrete algebra with a particular emphasis on Computational Group Theory). I will be focusing on implementing various algorithms for different types of problems (Shortest Path, Maximal Flow and Minimum Spanning Trees) and comparing the algorithms within each group. The algorithms will have a focus on directed graphs with weighted edges which as of now has no implementation in the directed packages in GAP. Therefore, I will be able to implement a completely new set of algorithms and open the door for other algorithms in the future that require weighted edges. I would like to implement these algorithms and then analyse their performance in GAP which may include evaluating run time, comparing each algorithm, any optimisations, special use cases where the algorithms may not be desirable / be desirable ect. I will try to focus on one group of algorithm at a time and compare them before moving onto the next. The algorithms chosen are 'classic' algorithms and therefore will be useful to implement initially and analyse.

2 Objectives

Primary Objectives
These are the algorithms I will focus on implementing as part of the primary objectives. Comparing the algorithms could involve (as well as from testing): graphing runtimes on various graphs and types of graphs, comparing complexities, possible optimisations, edge cases, ect.

Shortest Path Algorithms

1. Implement and compare
   (a) Dijkstra's algorithm
   (b) Bellman-ford algorithm
   (c) Floyd-Warshall algorithm

Maximum Flow Algorithms

2. Implement and compare
   (a) Edmonds-Karp algorithm
   (b) Dinic's algorithm

Minimum Spanning Trees (MST) Algorithms

3. Implement and compare
   (a) Prim's algorithm
   (b) Kruskall's algorithm

Secondary Objectives
Upon completion of the primary objectives I will work towards some of these secondary objectives. These are not necessary to fulfil but can be seen more as stretch goals.

1. Implement a further algorithm for each group
   (a) Shortest Path: Johnson's algorithm
   (b) Minimum Spanning Tree: Borůvka's algorithm
2. Extend the graphviz package to allow for the shortest path / MST to be highlighted when 'Splash[ing]' (splashing to screen to create a PDF output of the graph)
3. Explore a new group of algorithms related to Maximal Flow, called Minimum Cut which uses algorithms such as Karger's algorithm.
4. Explore The Travelling Salesman problem.

3 Ethics

Upon completing the self assessment form; to which I answered no to all questions, this project has no ethical considerations.

4 Resources

I will primarily be using my personal Desktop, Laptop and Lab PCs for this project. I have GAP and all relevant packages installed already that I believe I will need and do not foresee this changing in the future. I therefore do not require any additional hardware, software, licenses, etc to the best of my knowledge.