Description, Objectives, Ethics, Resources

18000518

24th January 2023

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
As part of the primary objectives, I focus on implementing a couple of algorithms of various categories. I will then compare/analyze the algorithms which could involve (as well as from testing): graphing run-times on various edge-weighted directed graphs, comparing complexities, possible optimisations, edge cases, ect.

Primary Objectives

1. Implement in GAP and compare
   (a) Three Shortest Path Algorithms.
   (b) Two Maximal Flow Algorithms.
   (c) Two Minimum Spanning Tree Algorithms (MST).
2. Implement a new object type for edge-weighted digraphs in GAP, compatible with the Digraphs package, and include appropriate constructors.

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

Secondary Objectives

1. Implement a further algorithm for each group and compare to the other relevant algorithms (implemented in the primary objectives).
2. Write GAP code to allow for the shortest path / MST to be highlighted during visualisation of graphs.
3. Implement and compare (similarly to primary objectives) a new group of algorithms related to Maximal Flow, called Minimum Cut.
4. Implement a working algorithm for The Travelling Salesman problem.
5. Integrate a selection of the implemented algorithms into the Digraphs package for GAP including appropriate documentation and tests in the standard style used by the GAP community.
6. Write the code in various languages (Python or Java or C) and compare the performance to that of GAP.

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.