CSCI 4511w Writing 3 - Project Proposal

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March 17, 2023

1 Project Description

This project aims to find the shortest path between two points within the University of Minnesota Twin Cities campus map. It is always essential to have efficient ways to navigate different buildings like academic halls, health centers, etc. The title for this project could be: "Finding the Shortest Paths in the University of Minnesota Twin Cities Campus Map". We hope students who hurry to get to class on time and visitors who try to find a specific location on the campus have the ability to determine the shortest path quickly and accurately. We are also curious about the efficiency of different algorithms applied to actually find the shortest path in a real map.

2 Approaches

To address this project, we decided to use **OpenStreetMap (OSM)** which provides a huge editable database and a world map contributed by volunteer mapmakers. We will extract and process data from OSM to create a graph of the campus map using **NetworkX** which is a powerful Python library, in order to perform the path-finding algorithms such as A* algorithm [AS], Bidirectional Search [BS], Breadth-First Search [BFS], Dijkstra's algorithm [DS]. We will use **Python** as the programming language for creating, manipulating, analyzing, and visualizing the entire network. We will compare the efficiency of different algorithms applied to campus maps. By trying different starting points and destinations, we will see whether the efficiency of the algorithm changes. After experimenting with variables enough times, we will find out the algorithm that is most suitable for campus map navigation and analyze the reasons. Additionally, we aim to assess whether the identified algorithm can be further improved through modification.

3 Evaluation of Solution

To evaluate the performance of four algorithms, we will measure the **length of the shortest paths** between any two points on the campus using different algorithms. The **CPU run time, time complexity, and memory usage** are also important to determine if one algorithm is efficient or not. To evaluate the **accuracy** of each algorithm, we will conduct a manual inspection of the campus map and compare it with the given solutions. At the end of the evaluation, we will visualize the paths each algorithm plans and the distance traveled to provide **a visual comparison**. By the four steps above, we believe that the results will demonstrate the efficiency and accuracy of four algorithms when finding the shortest path on the campus, which is useful in route planning and transportation engineering.

4 Literature Review

There are several topics like OSM data reliability, visualization using NetworkX, and the shortest path-finding algorithms that could relate to this project. We now have found four references for them. For the OSM data reliability, a study[GMJ+22] from Grinberger has a great explanation. Its database contains about 7.5 billion data nodes, contributed by about 1.8 million users as of March 2022. The author calls it "The most accomplished example of a crowdsourced geoinformation project and of the concept of volunteered geographic information". To visualize our project using NetworkX,

Hagberg's article [HSSC08] shows useful techniques and examples for us to start the work. The article mentions that it's a useful tool for solving shortest-path problems. There are lots of studies on different algorithms and their applications like He's study on Dijkstra [He22] and Aziz's analysis on three different algorithms [ATA22], and the fundamental AI book [RN21] by Russell for us to have some preliminary expectations on our project.

5 Timeline

Here is the timeline table for the project.

Timeline Table	
Task to be done	**Weeks**
Literature review	Week 1
OSM data collection, cleaning, and processing	Week 2
Software setup (Python, NetworkX)	Week 2
Graph Creation	Week 2
Implementations of AS, BS, BFS, DS	Week 3
Performance evaluation, result visualization	Week 4
Final Report	Week 5

6 Workload Distribution

This is how we distribute this paper and the project.

Proposal	
Task Done	**People**
Project Description	Junyuan Wang
Approach	Yicheng Zhai
Evaluation of Solution	Junyuan Wang
Literature review	Yicheng Zhai
Timeline	Junyuan Wang
Proposal Review	Yicheng Zhai

Project	
Task to be done	**People**
Literature review	Yicheng Zhai
OSM data collection, cleaning, and processing	Junyuan Wang
Software setup (Python, NetworkX)	Zhai, Wang
Graph Creation	Zhai, Wang
Implementations of AS, BS, BFS, DS	Zhai, Wang
Performance evaluation, result visualization	Zhai, Wang
Final Report	Zhai, Wang

References

[ATA22] Anusha Aziz, Sheikh Tasfia, and M. Akhtaruzzaman. A comparative analysis among three different shortest path-finding algorithms. In *2022 3rd International Conference for Emerging Technology (INCET)*, pages 1–4, 2022.

[GMJ+22] A. Yair Grinberger, Marco Minghini, Levente Juhász, Godwin Yeboah, and Peter Mooney. Osm science—the academic study of the openstreetmap project, data, contributors, com-

munity, and applications. *ISPRS International Journal of Geo-Information*, 11(4):230, Mar 2022.

[He22] Baoyi He. Application of dijkstra algorithm in finding the shortest path. *Journal of Physics: Conference Series*, 2181(1):012005, Jan 2022.

[HSSC08] Aric Hagberg, Pieter Swart, and Daniel S Chult. Exploring network structure, dynamics, and function using networkx. 1 2008.

[RN21] Stuart J. Russell and Peter Norvig. *Artificial Intelligence: A Modern Approach*. Pearson series in artificial intelligence. Pearson, fourth edition edition, 2021.