Onat Şahin
ITU Ayazağa Campus,
Vadi Dormitory, Block D
Sarıyer, ISTANBUL

Damien Jade Duff
ITU Ayazağa Campus,
ITU Faculty of Computer and Informatics,
Office 2316
Sarıyer, Istanbul

May 2, 2018

Dear Mr Duff:

This letter is written to provide you a summary of the attached project report and give information in a simplified way. The report is written by me and Alperen Kantarcı to describe our project "Runtime Comparison of Kruskal's and Prim's Minimum Spanning Tree Algorithms on Sparse and Dense Graphs" and present the results.

Finding the minimum spanning tree is a problem in the field of computer science and important for field such as communication, transportation and construction. Think of a country with multiple cities and various roads connecting the cities. Connecting all the cities with the minimum possible total length of roads is the problem of finding the minimum spanning tree of this country, and the roads used to connect the cities form the minimum spanning tree. In computer science, we represent the problems like the one described on structures called graphs. Basically, cities are represented by points called "nodes" and roads are represented by lines called "edges".

Our project compares the performances of two most known minimum spanning tree finding algorithms: Prim's algorithm and Kruskal's algorithm. Performances of these algorithms highly depend on the density of the graph, which is basically the ratio of number of edges of the graph and the maximum number of edges possible with the node number of the graph. If this ratio is relatively high, the graph is considered dense. Otherwise, it is considered sparse. The purpose of our project is to compare the speed of Prim's and Kruskal's algorithm on dense and sparse graphs to present which one should be preferred on a given situation.

To do the experiment, we implemented Kruskal's and Prim's algorithms. Also, we generated two data sets, one of which contains dense graphs and the other contains sparse graphs with 100 nodes. We ran our implementations of the algorithms on these two datasets and plot the time it takes for the algorithm to find the minimum spanning tree. Figure 1 contains the plot for the sparse data set and Figure 2 contains the plot for the dense data set. These plots are taken from the attached report. The horizontal axis of these plots represents the density in a numerical way. The vertical axis represents the time it takes for the algorithm to finish in seconds. The data points represent the average runtime of the algorithm on ten different graphs with the given density. The top and bottom points of the vertical line that passes through the data points represent the maximum and minimum of these ten runtimes, respectively.

From these plots, it can be inferred that Prim's algorithm works faster than Kruskal's algorithm on dense graphs. As the density increases, the time gap between the algorithms widens more and more. However, we were actually expecting Kruskal's algorithm to perform better than Prim's algorithm on very sparse graphs. But it can be seen that on very sparse graphs, Prim's algorithm still works

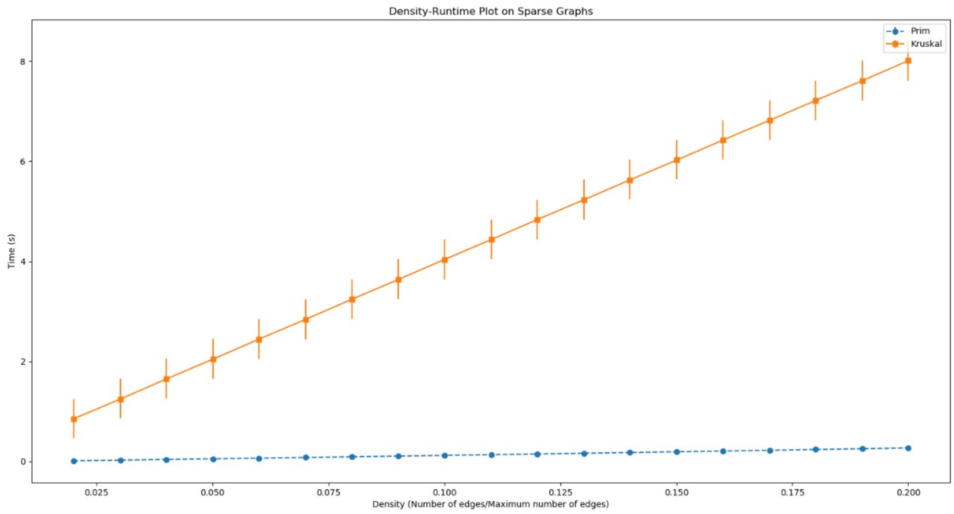

Figure 1: Density, runtime plot of Kruskal's and Prim's algorithms on the sparse graph dataset

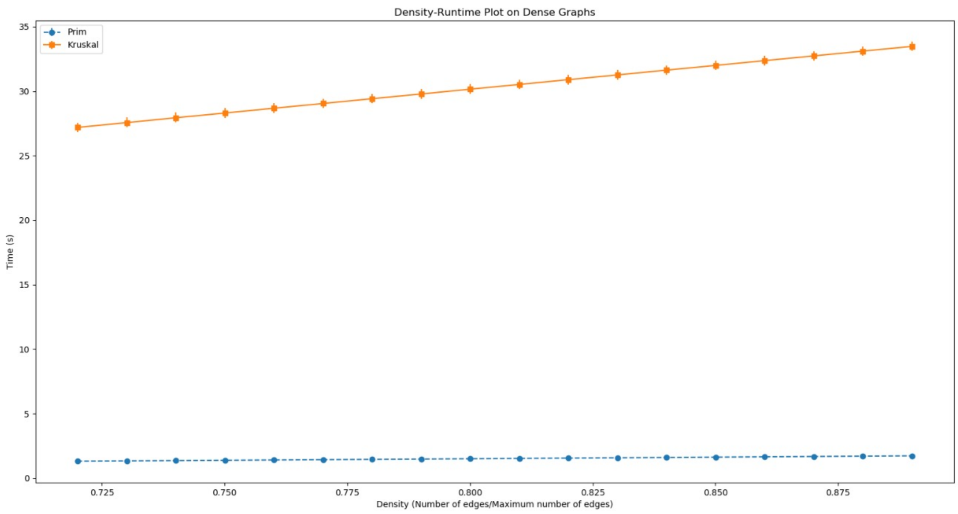

Figure 2: Density, runtime plot of Kruskal's and Prim's algorithms on the dense graph dataset

slightly better than Kruskal's. We expect this to be a result of our implementation of these algorithms. There are multiple ways to implement these algorithms and the performances of these implementations differ from each other. The main outcome of this project is that Prim's algorithm becomes more and more advantageous to use compared to Kruskal's algorithm as the density of the graph increases. Given the simplicity of its implementation, Prim's algorithm should be preferred over Kruskal's algorithm unless the graphs worked on are very sparse.

Tasks	Original Due Date	Finish Date
Research	20/03/2018	20.03.2018
Implementation	28/03/2018	12/04/2018
Experimentation	10/04/2018	19/04/2018
Documentation	18/04/2018	22/04/2018
Final Report	25/04/2018	02/05/2018
Presentation	01/05/2018	Expected to finish before 18/05/2018

Figure 3: Original due dates and finish dates of tasks of the project.

Thank you for accepting our project and giving us the chance to finish it. Me and my teammate believe that the project was mostly a success, with the only problem being Kruskal's algorithm working slower than expected. That being said, we were still able to come up with a clear outcome. Schedule of the project and our progress can be seen in Figure 3, which is taken from the attached report. For more information about the project and technical details, please refer to the attached project report.

With Regards,

Onat Şahin

Enclosed:

- Project Report