Graph Project

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1 Introduction

In this project we implemented the ability to create graphs. Graphs are an abstract data type that consist of a finite but mutable set of vertices(also called points or nodes). A directed graph contains ordered pairs of nodes, while an undirected graph contains unordered pairs of nodes. These pairs of nodes are referred to as edges. In this project we focused on implementing undirected graphs without self-edges, which means no vertex is in a pair with itself(has no edge with itself).

In this project, we explored further into the property of edges, in which we set a maximum threshold distance for which edges can be made between points. We use this distance threshold to discover the total number of edges in a graph and the connectedness of the graph are affected. We create edges between points if the distance between those points is less than or equal to the distance threshold that we set. We also see how probable a graph is of being connected at our threshold distance. We manipulate this threshold incrementally to find out where the probability of connectedness is 50%.

2 Procedure

We used an adjacency matrix made up of an integer vector of integer vectors to store and represent our graph's edges. Using vectors instead of arrays provides an easy way to add points to our graph. Our Graph class contained methods to create edges between points with a distance less than a set threshold and, get the total number of edges, and check whether or not a graph is connected. I used a Depth-First-Search(DFS) to accomplish this. We used incrementally increased our threshold distance from 1 to 25 for both of these relationships.For the plot in which we see how threshold distance affects total number of edges in a graph, we use a new graph with 100 random points(with x and y coordinates between -10.0 and 10.0) for every distance we test. For the plot in which we see how threshold distance affects probability of connectedness, we use a new graph with 3, 5, 10, 20, 30, 40, and 50 random points(with x and y coordinates between -10.0 and 10.0) for every distance we test. We expect to see a lower threshold distance where a probability of 50% exists as we increase the number of points in our graph, so we tested graphs with different numbers of points.

3 Data

Figure 1.

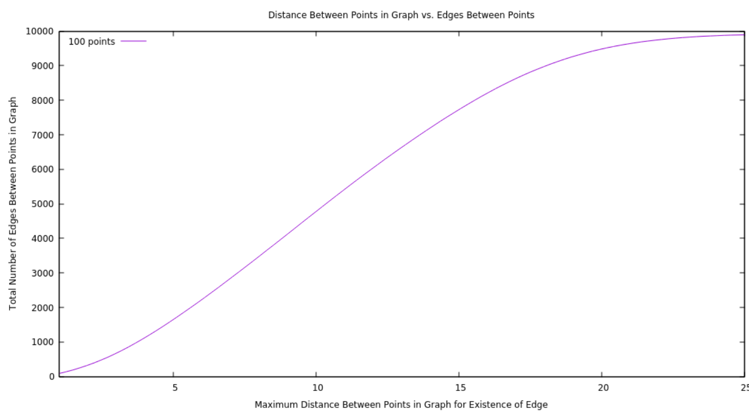
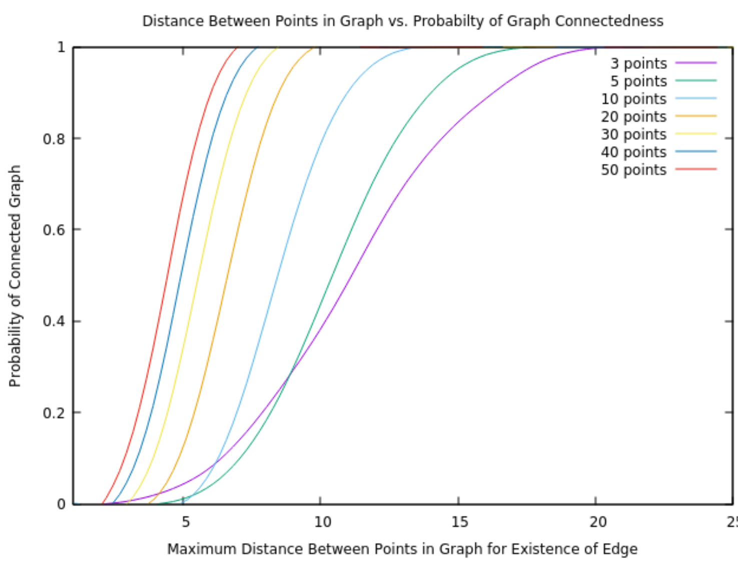


Figure 2.



4 Conclusion

Based on the data we collected, we find that both relationships can be modeled by a sigmoidal curve. We found that with 100 x 100 graph, the maximum number of edges asymptotically nears 10000. We find that the probability of connectedness asymptotically approaches 1. We also confirm our prediction that as we increase the number of points in a graph, the less the distance threshold is for when we see 50% probability of connectedness. The approximate distance thresholds for where we reach 50% probability of connectedness for 3, 5, 10, 20, 30, 40, and 50 points are 11.15, 10.41, 8.38, 6.57, 5.50, 4.90, and 4.40 respectively. In general, we can conclude that graphs with more points would generally have a higher probability of connectedness because the probability of connectedness increased more steeply as we increased the distance threshold.