CS 292F Project Proposal

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For our final project, we seek to analyze how the fiedler value scales with different graph structures. The fiedler value is an important measure of graphs, showing how connected a graph is, and has many applications in the physical world. However, it can vary wildly as one changes the general structure of a graph, as well as increasing or decreasing the number of edges and vertices. As such, we seek to study several graph classes and analyze how the fiedler value scales as its parameters change. While we know that varying size affects the fiedler value, we also want to focus on modifying other parameters that a graph class may have (such as the n in an n-ary tree), as we postulate that those will also have a strong effect.

Consider, for example, the Newman-Watts-Strogatz small-world graph. This graph is parameterized by three values. The first is the number of vertices in the graph. We obviously intend to study how the fiedler value scales as this is changed, but we also want to modify other values as well. The graph is also parameterized by a value k and a probability p. These parameters affect how the edges of the graph are generated. With a higher k value, each vertex will be connected to more of its neighbors, while with a higher p value, a new edge will be added with higher probability. Therefore, these parameters have an effect on the density of the graph, and thus likely on the fiedler value. We are interested in attempting to understand this relationship on several classes of randomized graphs that are parameterized by more than just the number of vertices.

Some graphs we want to focus on are the following:

- Connected Watts-Strogatz graphs (in addition to the Newman-Watts-Strogatz graphs described above). Watts-Strogatz graphs are similar to Newman-Watts-Strogatz, except each edge that is added takes the place of an edge that already exists.
- $G_{n, p}$: Chooses each edge on n vertices with probability *p*. We hypothesize that a connected $G_{n, p}$ graph could have very different fiedler values depending on structure, even with the same parameters.
- Powerlaw Cluster Graph: Uses Holme and Kim algorithm to generate graphs with powerlaw degree distribution

In terms of actual implementation, we plan on using the NetworkX package in Python to generate graphs with varying parameters. NetworkX offers a rich library of graph types, and makes performing computations on them syntactically simple. We hope to produce a lot of concrete data from this project, and will likely use numpy along with matplotlib/plotly or another similar visualization package to generate charts.