MinT-Net: Novel and Scalable Network-enabled Comparative Tools for Stress Studies of Microbiomes in Transition
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Background and Motivations
Community detection is the process of analyzing graphs to distinguish different groups of nodes from one another. These communities exist within the species, gene, and protein networks of a microbiome. Many different algorithms have been developed to detect these communities. The project as a whole is intended to track communities in dynamic networks using known community detection algorithms. An initial effort created implementations of different algorithms for community detection to test for community quality with respect to computational time, focusing on the Girvan-Newman algorithm and the Louvain algorithm.

Initial Algorithm Analysis

Girvan-Newman Algorithm

\[ c_B(e) = \sum_{s,t \in V} \frac{\sigma(s, t)}{\sigma(s, t)} \quad e \text{ represents each edge} \]

\[ \sigma(s, t) = \text{the number of shortest (s, t) paths} \]

Louvain Algorithm

\[ Q = \frac{1}{2m} \sum_{i,j} \left[ A_{ij} - \frac{k_i k_j}{2m} \right] \delta(c_i, c_j) \quad A_{ij} \text{ is the edge weight between i and j} \]

\[ k_i = \text{the sum of the weights of the edges attached to i} \]

\[ m = \text{the sum of edge weights in the graph} \]

Initial Algorithm Analysis

Methods

Trials were run on assortative planted partition models to test the accuracy of the algorithms with respect to their computational time.

Results

Accuracy Comparison

Figure 3. Transition from a network with more assortativity to less assortativity

Application on Dynamic Graphs

Methods

Detection efforts on dynamic networks with community structure were performed on models using the framework of the Chinese Restaurant stochastic process.

Results

Preliminary results using the Jaccard Index and Pointwise Mutual Information to track communities seem promising for identifying changes in the communities of dynamic networks, including the splitting and merging of communities, shown below. Leveraging these preliminary results, we plan on developing a set of formal rules to track communities in dynamic graphs.

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