# CSE 550 - Project Proposal


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## Bi-Connectivity Augmentation Approximation Algorithm

### Introduction:

The focus of this project is to address the bi-connectivity augmentation problem which is a NP-complete problem. Bi-connectivity is a fundamental concept in graph theory, and this problem has real-world applications in network design, transportation systems, and more. The main objective of this project is to develop an approximation algorithm for this problem and analyze its time and space complexity.

### Problem Description:

The bi-connectivity augmentation problem can be described as follows:
**INSTANCE:** Given a graph G = (V, E), weight w({u, v}) $\in Z^+$ for each unordered pair of vertices from V and a positive integer B which is the budget constraint.
**QUESTION:** Is there a set E' of unordered pairs of vertices from V such that Σ w(e) ≤ B, {e ∈ E'} and such that the graph G' = {V, E ∪ E'} is biconnected?
A graph is bi-connected if there are at least two distinct paths between any pair of vertices.
Bi-connectivity is crucial for ensuring network reliability and robustness, making this problem of practical importance in places like electric grids and computer networks.

### Significance:

Solving the bi-connectivity augmentation problem efficiently has applications in various fields, including network design, transportation planning, and computer science. Developing an approximation algorithm for this NP-complete problem can contribute to the optimization of real-world systems and networks.

### Real-life application:

Suppose we want to send a packet of data from a source to a destination. The data needs to pass through multiple routers in its path. If the graph from source to destination is not bi-connected then it might be possible that a single malfunctioning router might cause the data to not reach the destination since it might disconnect the path from source to destination. To prevent such single points of failure we need the graph to be biconnected so that any single router going down does not cause issues with the entire network. The Graph consists of the routers as the vertices, the connections between the routers as edges, and the cost of connecting the routers as the edge weights. The sum of the cost of connecting any two new routers should be less than or equal to the budget constraint.

### Conclusion:

The proposed project aims to address the NP-complete bi-connectivity augmentation problem by devising an approximation algorithm, evaluating its time and space complexity, and providing a running code for the approximation algorithm. By the end of this project, we will have a working algorithm and insights into its computational efficiency.