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Category: Combinatorics (Calculus not required)

Abstract: In the field of graph theory, a graph is a collection of vertices and edges. Graphs are powerful tools that can be used to model any real-world system. For instance, consider air traffic: each airport can be viewed as a vertex, and two vertices are connected by an edge if there is a flight that travels between the corresponding airports. Since there are so many flights from so many airlines at so many different times of day, it can be difficult to find the cheapest or quickest travel option. This is an issue across any large or complex system: how do we sift through the noise to find what we need? This project seeks to answer this question by using an active area of research within graph theory known as Ramsey Theory, which helps us find the basic structural properties common to even the most complex systems in existence.

In the aforementioned graph modeling air traffic, let us imagine that we take some large collection of edges and color them red. If we can find all subgraphs which contain many of these red edges, then we would know exactly how some cities are connected through air travel. We could then use this discovery to know with certainty the cheapest or quickest ways to travel between any two given cities. As such, the crux of the issue is to know how to find the subgraphs that contain these red edges, and that is what this research project seeks to do.