**CS5002 Project Proposal:**  Optimizing project management using Graph Theory

**Topic:** Optimizing Project Management Using Graph Theory

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**Relevance to Qiuying:** Before starting the CS-Align program, Qiuying worked as an Investment Banker specializing in the TMT sector. Her work mainly involved time-sensitive IPO (Initial Public Offerings) or M&A (Merger & Acquisitions) projects, which required close cross-team and cross-company coordination. Efficient work arrangements were crucial, as inefficiencies could lead to missed deadlines or even deal breakers.

**Relevance to Zhiwei:** Before starting the CS-Align program, Zhiwei was an architectural designer and real estate development professional. Project management is a critical aspect of the architectural design industry as it involves managing various design phases, permit applications, construction schedules, and administration tasks. Additionally, there are numerous precedents that need to be considered before starting specific tasks in the overall development process.

**Importance Beyond Personal Experience:**

The importance of project management extends beyond individual experiences and can greatly benefit students majoring in Computer Science. As project-based work becomes increasingly prevalent in various industries, it is crucial for CS students to develop strong project management skills to effectively manage tasks, timelines, and resources. By utilizing graph theory to optimize project management, this project can provide valuable insights and strategies for Qiuying, Zhiwei and other CSA students to improve their ability to manage projects and multi-tasks, regardless of the industry they choose to work in.

**Main Theory Employed:**

1. Graph theory can be used to optimize project management in a variety of ways, including:
   * ***Scheduling projects:*** Graph theory can be used to model the dependencies between tasks in a project, and to identify the critical path, which is the longest sequence of tasks that must be completed to complete the project. This information can be used to create a schedule for the project that minimizes the time required to complete it.
   * ***Allocating resources to tasks:*** Graph theory can be used to model the availability of resources, such as people, equipment, and materials, and to assign resources to tasks in a way that minimizes costs and maximizes efficiency.
   * ***Optimizing project budgets:*** Graph theory can be used to model the costs of different project options, and to identify the option that minimizes costs while meeting the project's objectives.
2. The Graph under study must satisfy several conditions:
   * Must be a Directed Acyclical Graph (DAG) i.e., no cycle.
   * Must be weighted (used to represent the days needed to complete a specific task)
3. Explanation of Critical Path Method (CPM) and its importance in determining project completion:
   * Represent tasks as nodes and dependencies as directed edges.
   * Assign weights to edges for task completion time.
   * Identify the longest path (critical path) from the starting point to the ending point (the reverse of what we have covered in class: finding the shortest path).
   * Prioritize tasks accordingly.

**Clearly Defined Question:**

* The clearly defined question for this project is: How can Graph Theory be applied to optimize project management in various industries, especially in time-sensitive projects?
  + First, what is the earliest completion time for the project?
  + Second, which activities can be delayed, and by how long, without affecting the minimum completion time?

**Project Scope:**

The project scope includes the following:

* Application of graph theory in project management: The project will mainly focus on project management scenarios that can be represented as Directed Acyclic Graphs (DAGs). This is a common representation in project management. These dependencies can be represented as directed edges in a graph, with tasks represented as nodes.
* Use event planning, such as a conference or a wedding, as a general example that people can easily understand to illustrate the application of graph theory in project management.
* Supplement with real-life examples and case studies from specific industries such as architectural design, finance, software development, etc. (to be determined)

The project scope does not include the following:

* While Graph Theory has various applications in real-life project management, including scheduling projects, allocating resources to tasks, and optimizing project budgets, this project will primarily examine the role of Graph Theory in time management.
* Not all project management scenarios can be represented as Directed Acyclic Graphs (DAGs). There can be scenarios where the task dependencies in project management form cycles. They are not covered in the current study. For example, in agile or iterative software development methodologies, tasks can overlap or be revisited, creating a cyclic dependency (Requirement Analysis → Design → Coding → Testing → Deployment → (Feedback) → Requirement Analysis).
* In-depth analysis of all possible industries: The project will not comprehensively analyze all industries that utilize project management. Instead, it will focus on identifying representative steps in specific industries where graph theory can be effectively applied. These industries may include event planning, architectural design, finance, and software development, among others.
* Implementation of project management software: The project will not include the development or implementation of project management software. Instead, Python and other visualization tools recommended by the professor will be utilized to explore the application of graph theory in optimizing project management processes and techniques.

**Project Progress and Plan:**

What has been done thus far:

* Discussion and determination of three potential topics (Car buying decision, Table Seating Arrangement, Optimizing Project Management).
* Reason moved from Car buying: 1. the car price is a market driven factor that is difficult to be regarded as “reasonable”. 2. It will be tough to obtain real sales price from car dealers and MSRP can’t reflect real mark-up and mark-down on trade. 3. To make prediction on price, the technique will be related to machine learning, which is beyond what we have learned so far on the class.
* Reason moved from Table Arrangement: The algorithm seems way complicated than the level we have reached so far.
* Identification of the main theory (Graph Theory) and its application in project management.
* Collection of relevant literature and resources.

Plans for the next week:

* Further exploration of graph theory and project management methodologies
* Analysis of case studies/examples. If possible, leveraging existing data or real-life tasks from the team’s previous experience.
* Development of a Python program to implement CPM using graph theory.
* Use of matplotlib, seaborn, and/or networkx for visualization (possibly Gantt charts too).
* Other than the base case, test the code by different data input. Apply case studies from specific industries such as architectural design, finance, software development, etc. (to be determined).
* Preparation of the Final Project Presentation.