Applying Large Language Models to Optimize Job Shop Scheduling in Industry

Course Title: CS504070 – Service-Oriented Architecture

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1. Project Overview

Efficient scheduling is a critical challenge in industries such as manufacturing, logistics, and service operations. The Job Shop Scheduling Problem (JSSP) involves assigning jobs to machines or resources while respecting constraints such as job order, machine availability, and delivery deadlines. Poor scheduling can lead to production delays, high costs, and underutilized resources.

This project explores how Large Language Models (LLMs), such as LLM-based agents, can be applied to enhance decision-making in job shop scheduling. Instead of replacing traditional optimization algorithms, the project focuses on building a practical decision-support tool that leverages LLMs for flexible scheduling, scenario analysis, and clear communication between managers and technical scheduling systems.

2. Objectives

Industry-Oriented Understanding of JSSP

- Review real-world scheduling challenges in manufacturing and service industries.
- Identify common bottlenecks such as conflicting job priorities, machine downtime, and urgent rescheduling needs.

LLM-Powered Scheduling Assistance

- Develop a system where managers can describe scheduling constraints in natural language (e.g., "Machine A must finish Job 3 before Job 5 starts").
- Use LLMs to generate feasible schedules or recommendations that adapt quickly to unexpected changes.

Decision Support and Human-Readable Explanations

- Provide clear, natural language explanations of why certain schedules are recommended.
- Enable managers without technical backgrounds to understand scheduling trade-offs.

Prototype Development

- Build a simple user interface for inputting scheduling requirements.
- Connect LLM outputs to scheduling visualizations (e.g., Gantt charts).
- Demonstrate the tool with example industry scenarios (manufacturing, hospital operations, or logistics).

3. Expected Outcomes

- A decision-support prototype that translates natural language input into practical schedules.
- A demonstration of how LLMs can quickly adapt schedules when priorities or constraints change (e.g., machine breakdowns or rush orders).
- A set of best practices for integrating LLMs with traditional scheduling systems in industry.
- Improved communication between technical scheduling outputs and non-technical managers.

4. Skills Developed

- Practical knowledge of scheduling problems in industrial contexts.
- Application of AI and natural language technologies to real-world business operations.
- Experience in building decision-support systems with a focus on usability and explainability.
- Hands-on skills in designing prototypes that combine optimization, AI, and information systems.