I am a teacher of software project management. In my course, Master's students act as project managers of teams composed of Bachelor's students of the software engineering course. In the Bachelor's course, students have to deliver a project following a Waterfall model, starting from requirements elicitation till testing. Please provide me with examples of prompts they can use to support each of the phases. Please also report which prompt engineering technique can be suitable to reach a higher quality.

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Here’s a set of detailed prompts for each phase of the Waterfall model, accompanied by prompt engineering techniques to improve the quality of responses when using LLMs.

1. Requirements Elicitation

- **Prompt Example 1:** *"Given a university course management system where professors and students interact, generate a list of functional requirements that cover user registration, course creation, student enrollment, and grading. Please ensure the requirements are clear and unambiguous."*
    - **Prompt Engineering Technique:** Use **specific constraints** to guide the LLM. Including clear contexts like system type and key functional areas (user registration, course creation, etc.) improves the precision of generated requirements.
- **Prompt Example 2:** *"What are some potential non-functional requirements for a university course management system? Focus on performance, security, and usability."*
    - **Prompt Engineering Technique:** Apply **category focus** by specifying key aspects (performance, security, usability). This narrows down the focus to those areas, ensuring the model provides relevant non-functional requirements.

2. Design Phase

- **Prompt Example 1:** *"Based on the following functional requirements, generate a high-level system architecture for a university course management system. The architecture should include key components, such as the user interface, database, and authentication system."*
    - **Prompt Engineering Technique:** Use **contextual inputs** to provide a list of functional requirements, allowing the LLM to generate architecture aligned with

those specifications. The model responds better when it has specific components to integrate into the architecture.

- **Prompt Example 2:** *"Create a UML class diagram for a course management system. Include classes such as 'User,' 'Professor,' 'Student,' 'Course,' and 'Assignment.' Specify attributes and methods for each class."*
  - **Prompt Engineering Technique:** Leverage **structured requests** by asking for outputs in a specific format (e.g., UML class diagram with predefined classes). The LLM will adhere to this structure and generate outputs in the desired format.

3. Implementation

- **Prompt Example 1:** *"Generate Python code for a class 'Student' that has attributes for student ID, name, and enrolled courses. Include methods to add or remove courses from the student's enrollment list."*
  - **Prompt Engineering Technique:** Use **detailed input requests** by describing specific attributes and methods. This allows the LLM to generate code directly aligned with the requested implementation details.
- **Prompt Example 2:** *"Optimize the following Python code to improve its time complexity. Ensure the code remains readable and includes comments explaining the changes."*
  - **Prompt Engineering Technique:** Incorporate **optimization goals** within the prompt (e.g., time complexity). This encourages the model to focus on both functional improvements and code clarity.

4. Testing

- **Prompt Example 1:** *"Generate unit test cases in Python for the 'Student' class that tests methods for adding and removing courses. Ensure coverage for edge cases, such as trying to remove a course that the student is not enrolled in."*
  - **Prompt Engineering Technique:** Apply **coverage focus** by asking for edge cases and specifying the methods to test. This technique ensures that the LLM generates test cases that cover typical and exceptional scenarios.
- **Prompt Example 2:** *"Given the following functional requirements for a university course management system, create a test plan. Focus on functional and performance testing, ensuring that all major functions of the system are tested."*
  - **Prompt Engineering Technique:** Use **contextual reinforcement** by providing a list of functional requirements. This ensures that the generated test plan is aligned with the actual requirements of the system.

5. Maintenance

- **Prompt Example 1:** *"Analyze the following system logs from a course management system and identify potential maintenance issues, such as performance bottlenecks or security vulnerabilities."*
    - **Prompt Engineering Technique:** Incorporate **contextual data input** by feeding the LLM with specific system logs. The model will generate insights based on the input, focusing on maintenance-related aspects.
- **Prompt Example 2:** *"Suggest strategies to improve the maintainability of a course management system. Focus on code modularity, documentation practices, and version control."*
    - **Prompt Engineering Technique:** Employ **solution-driven prompting** by specifying areas of interest (modularity, documentation, version control). This helps the model provide relevant, actionable strategies in those domains.

Prompt Engineering Techniques Summary

To achieve high-quality outputs from the LLM, consider these strategies:

1. **Specific Constraints** – Define clear parameters for the LLM to focus its responses (e.g., requirements or components).
2. **Category Focus** – Narrow the scope of the LLM by focusing on specific categories (e.g., security, usability).
3. **Contextual Inputs** – Provide sufficient background or functional requirements for better alignment with the system you're working on.
4. **Structured Requests** – Ask for outputs in structured formats, such as UML diagrams or class definitions, to guide the LLM's responses.
5. **Detailed Input Requests** – Be explicit about what the output should include (e.g., specific attributes and methods in code generation).
6. **Optimization Goals** – When asking for improvements (e.g., code optimization), set clear goals, like improving time complexity or readability.
7. **Coverage Focus** – Request test cases or edge cases explicitly to ensure thoroughness in testing.
8. **Contextual Reinforcement** – Provide contextual elements like logs or requirements to enhance relevance.

9. **Solution-driven Prompting** – Direct the LLM towards generating actionable solutions by focusing on specific aspects of the task at hand.

These examples and techniques will help your students understand how LLMs can assist them throughout each phase of the software development lifecycle, from planning to testing and maintenance.

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What about the project management activities? Can you provide examples and prompt patterns for those as well?

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For project management activities, LLMs can assist in several aspects, such as planning, task delegation, risk management, and communication. Below are examples and prompt patterns tailored to each project management phase, along with suitable prompt engineering techniques to ensure high-quality outputs.

1. Project Planning

- **Prompt Example 1:** *"Create a project plan for developing a university course management system. Include key milestones, deadlines, and deliverables from requirements gathering to testing."*
    - **Prompt Engineering Technique:** Use **structured input requests** by specifying deliverables and phases. This helps the LLM generate a detailed project plan aligned with key project stages.
- **Prompt Example 2:** *"Generate a Gantt chart for a software project that involves requirements elicitation, design, implementation, testing, and deployment phases. The project should last three months with a two-week buffer for each phase."*
    - **Prompt Engineering Technique:** **Explicit time constraints** help guide the LLM to provide outputs with realistic deadlines and buffers, improving the accuracy of the generated Gantt chart or timeline.

2. Task Delegation

- **Prompt Example 1:** *"Assign tasks to team members for the initial requirements elicitation phase of a software project. The team consists of five people: two developers, one tester, one project manager, and one business analyst."*
    - **Prompt Engineering Technique: Role-based prompting** ensures that the LLM assigns tasks based on the specific roles in the team, distributing the workload appropriately.
- **Prompt Example 2:** *"Generate a task breakdown for a three-week sprint where the focus is on coding the user authentication system. Assign tasks to developers, testers, and the project manager."*
    - **Prompt Engineering Technique: Sprint-focused breakdown** helps the LLM generate tasks within a specific sprint period, ensuring the tasks align with agile methods or time-boxed development periods.

3. Risk Management

- **Prompt Example 1:** *"Identify potential risks for the software development project of a course management system, and suggest mitigation strategies for each risk. Focus on technical, financial, and scheduling risks."*
    - **Prompt Engineering Technique: Risk category focus** helps the LLM focus on technical, financial, and scheduling risks, ensuring a well-rounded risk assessment covering various dimensions.
- **Prompt Example 2:** *"Generate a risk management plan for a software project where the team is inexperienced with the technology stack. Provide steps for risk identification, analysis, mitigation, and monitoring."*
    - **Prompt Engineering Technique:** Use **contextualization** by providing specific challenges (e.g., inexperience with technology) to ensure that the generated risk management plan is relevant to the specific project context.

4. Communication Management

- **Prompt Example 1:** *"Draft an email to the client providing an update on the current progress of the software project, including any delays or challenges encountered during the requirements elicitation phase."*
    - **Prompt Engineering Technique:** Use **formal communication structure** by specifying the format (email) and focusing on updates and challenges, ensuring that the generated output adheres to a professional tone.

- **Prompt Example 2:** *"Summarize the key decisions made during the last project meeting about the design of the user interface. Include action items and responsible team members."*
    - **Prompt Engineering Technique: Decision-based prompting** helps the LLM focus on summarizing decisions and assigning action items, ensuring clear, concise meeting minutes.

5. Resource Allocation

- **Prompt Example 1:** *"Create a resource allocation plan for a software project with 10 team members. The project has a tight deadline of six months, and each team member has a specific role: developer, tester, UX designer, or project manager."*
    - **Prompt Engineering Technique: Role-specific allocation** helps the LLM focus on assigning resources based on the specified roles, ensuring each team member's capacity and responsibilities are considered.
- **Prompt Example 2:** *"Optimize the resource allocation for a project where the budget has been reduced by 20%. Suggest strategies to reassign roles and manage workload without sacrificing project quality."*
    - **Prompt Engineering Technique: Constraints-based prompting** (e.g., budget reduction) guides the LLM to produce practical solutions that consider project limitations and resource efficiency.

6. Progress Tracking and Reporting

- **Prompt Example 1:** *"Generate a weekly status report for a software project. Include sections for project progress, completed tasks, upcoming milestones, and any risks or issues identified."*
    - **Prompt Engineering Technique: Pre-defined structure** ensures that the LLM follows a specific format (progress, tasks, milestones, risks) for clear and professional reporting.
- **Prompt Example 2:** *"Based on the project's current progress and task completion rates, forecast when the project will likely be completed. Include considerations for any known risks or delays."*
    - **Prompt Engineering Technique:** Use **data-driven forecasting** by providing task completion data or progress metrics, helping the LLM generate a realistic forecast based on project velocity.

7. Project Closure

- **Prompt Example 1:** *"Write a project closure report for a software development project. Include sections on lessons learned, final deliverables, client feedback, and recommendations for future projects."*
    - **Prompt Engineering Technique:** Use **lessons-learned focus** by explicitly asking the LLM to reflect on key takeaways and recommendations for future projects. This ensures the closure report is insightful and forward-looking.
- **Prompt Example 2:** *"Summarize the achievements and challenges faced during the course management system development project. Include what went well, what could have been improved, and suggestions for future improvements."*
    - **Prompt Engineering Technique:** **Reflection-based prompting** ensures that the LLM provides a balanced view of both successes and challenges, making the summary insightful for future learning.

Prompt Engineering Techniques Summary for Project Management

1. **Structured Input Requests** – Guide the LLM by defining clear sections or elements that should be included in plans, reports, or summaries.
2. **Explicit Time Constraints** – Set specific deadlines or time frames to ensure the outputs align with realistic schedules.
3. **Role-based Prompting** – Directly mention roles in the team to ensure tasks or responsibilities are aligned with individual expertise.
4. **Sprint-focused Breakdown** – For agile environments, focus prompts on sprints or time-boxed development periods to generate specific tasks and deliverables.
5. **Risk Category Focus** – Specify categories (e.g., technical, financial, scheduling) to ensure a broad yet relevant risk assessment.
6. **Formal Communication Structure** – Specify the format (e.g., email, meeting summary) and tone for professional and concise communication.
7. **Constraints-based Prompting** – Provide specific constraints (e.g., budget reduction) to generate practical, constraint-aware solutions.
8. **Pre-defined Structure** – Use a structured format (e.g., for status reports) to guide the LLM's outputs for consistency and clarity.
9. **Reflection-based Prompting** – Encourage the LLM to reflect on successes, challenges, and lessons learned for more meaningful project closure insights.

These prompts and techniques will help students understand how LLMs can be used to streamline and optimize project management tasks, ensuring more efficient planning, communication, and monitoring of project activities.