LAB 3: Building a Quantum AI Tutor using Advanced Prompts

Objectives

The objective of this lab session is to:

- Understand different prompt engineering techniques
- Design appropriate prompts for a Quantum AI Tutor chatbot
- Learn how prompt design influences chatbot behavior
- Analyze chatbot responses based on different prompt types
- Understand how advanced prompting improves reasoning and teaching quality

Theory

What is a Prompt?

A prompt is the input or instruction given to an AI model that tells it what to do, how to behave, and how to respond. Well-designed prompts allow developers to control the AI's reasoning style, tone, and output quality.

In this lab, multiple prompt engineering techniques are combined to build a structured and intelligent Quantum AI Tutor.

Types of Prompts Used in This Lab

1. Root Prompt

Description

The root prompt defines the AI system's overall behavior, reasoning rules, and constraints. It ensures consistency across all responses.

Purpose

- To globally control how the AI thinks and teaches

- To enforce step-by-step reasoning and structured explanations

Example Root Prompt

"You are a senior quantum researcher and educator. Always solve problems step by step and explain why each step is performed. Adapt explanations for beginner, intermediate, and expert learners."

2. Persona Prompt

Description

A persona prompt defines the AI's identity and personality.

Purpose

- To make the AI behave like a patient and experienced teacher
- To avoid generic or robotic responses

Example Persona Prompt

"Act as a senior quantum researcher with more than 10 years of experience who enjoys teaching complex quantum concepts clearly and patiently."

3. RGC Prompt (Role–Goal–Context)

Description

The RGC prompt explicitly defines the Role, Goal, and Context of the AI system.

Purpose

- To provide structured control over expertise and objectives
- To reduce ambiguity in AI responses

Example RGC Prompt

Role: You are a senior quantum researcher.
Goal: Teach quantum concepts step by step with clear reasoning.
Context: Academic environment using an AI API for student learning.

4. Zero-Shot Prompt

Description

A zero-shot prompt asks the AI to perform a task without providing any examples.

Purpose

- To test the AI's baseline understanding
- To observe behavior using only root, persona, and RGC prompts

Example Zero-Shot Prompt

"Explain the concept of quantum superposition in simple terms for a beginner."

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5. One-Shot Prompt

Description

A one-shot prompt provides one example before asking the AI to perform a similar task.

Purpose

- To guide explanation style and structure.
- To improve clarity without over-constraining the model.

Example One-Shot Prompt

"Example: Classical bits can be either 0 or 1. A quantum bit (qubit) can exist in both states at the same time.
Now explain quantum entanglement in a similar simple style."

6. Few-Shot Prompt

Description

A few-shot prompt provides multiple examples to guide the AI more strongly.

Purpose

- To improve consistency
- To handle complex quantum concepts accurately

Example Few-Shot Prompt

Example 1: Superposition allows a qubit to exist in multiple states simultaneously.
Example 2: Measurement collapses a qubit into a definite state.
Now explain quantum interference following the same explanation pattern.

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7. Combined Prompting Strategy (Advanced Prompting)

Description

This strategy combines multiple prompt types into a single system.

Purpose

To build a robust and intelligent Quantum AI Tutor.

How It Works

- Root Prompt → Sets global rules
- Persona Prompt → Defines teaching personality
- RGC Prompt → Structures intent
- Shot-based Prompts → Guide task execution

8. Chatbot Behavior Analysis

Observed Effects

- Clear step-by-step explanations
- Improved reasoning accuracy
- Adaptive explanations for different learner levels
- Reduced hallucinations
- More engaging and student-friendly tone

9. Conclusion

This lab demonstrates how advanced prompting techniques significantly influence chatbot behavior. By combining root, persona, RGC, and shot-based prompts, an effective Quantum AI Tutor can be built to teach complex quantum concepts clearly and reliably.