

## Assignment: Advanced Prompt Engineering Techniques

### Task 1: Research and Summarize

#### 1. Zero-Shot Prompting

##### Definition:

Zero-shot prompting involves asking an AI to perform a task without providing any examples or prior context-just instructions.

##### Example:

"Translate the following English sentence to French: 'I am learning AI.'"

##### Applications:

- Language translation
- Text classification
- Sentiment analysis
- General question answering

##### Advantages:

- Fast and simple
- No need for example crafting
- Useful when working with limited context or data

##### Limitations:

- Less accurate with complex or ambiguous queries
- AI may misinterpret task intent

## 2. Few-Shot Prompting

### Definition:

Few-shot prompting involves giving the AI a few examples before asking it to perform a similar task. These examples help the model infer the correct pattern.

### Example:

Translate the following sentences into French:

1. I am eating. -> Je mange.
2. She is reading. -> Elle lit.
3. They are playing. -> Ils jouent.

Now translate: He is running.

### Applications:

- Custom sentiment analysis
- Style transfer
- Domain-specific tasks (legal, medical)

### Advantages:

- Higher accuracy in specialized tasks
- AI learns the pattern from context

### Limitations:

- Prompt length limitations (especially in older models)
- Requires crafting good examples

## 3. Chain-of-Thought (CoT) Prompting

### Definition:

Chain-of-thought prompting encourages the AI to explain its reasoning step-by-step before producing the final answer.

### Example:

Q: If a train travels 60 km in 1 hour and 30 km in the next 0.5 hour, what is the average speed?

A: First, we find the total distance:  $60 + 30 = 90$  km.

Next, total time:  $1 + 0.5 = 1.5$  hours.

Then, average speed = total distance  $\div$  total time =  $90 \div 1.5 = 60$  km/h.

Answer: 60 km/h

### Applications:

- Complex reasoning (math, logic)
- Step-by-step explanations
- Code generation

### Advantages:

- Improves reasoning and accuracy
- Makes AI's logic interpretable

### Limitations:

- Longer outputs
- Sometimes adds unnecessary or wrong steps

### Task 2: Design and Experiment

Chosen Model: GPT-4-turbo (ChatGPT)

Task: Solve a Grade 10 level math word problem.

Test Problem:

"A rectangular garden has a length that is 3 meters more than twice its width. If the perimeter is 54 meters, what are the length and width of the garden?"

### 1. Zero-Shot Prompt

Prompt:

"A rectangular garden has a length that is 3 meters more than twice its width. If the perimeter is 54 meters, what are the length and width of the garden?"

Response:

Length = 21 meters

Width = 7.5 meters (Incorrect)

Analysis:

The answer was incorrect, possibly due to misunderstanding. Without reasoning steps, the model struggles with complex interpretation.

### 2. Few-Shot Prompt

Prompt:

Example:

A rectangle has a length that is 4 meters more than its width. Its perimeter is 28 meters.

Let width =  $x$ , then length =  $x + 4$

Perimeter =  $2 \times (x + x + 4) = 28$

$2 \times (2x + 4) = 28 \rightarrow 2x + 4 = 14 \rightarrow 2x = 10 \rightarrow x = 5$

Width = 5, Length = 9

Now try:

A rectangular garden has a length that is 3 meters more than twice its width. If the perimeter is 54 meters, what are the length and width?

Response:

Let width =  $x$

Then length =  $2x + 3$

Perimeter =  $2 \times (x + 2x + 3) = 54$

$2 \times (3x + 3) = 54 \rightarrow 3x + 3 = 27 \rightarrow 3x = 24 \rightarrow x = 8$

Width = 8 meters, Length = 19 meters

Analysis:

Correct solution and logic. Few-shot helped model follow the example structure and apply the method.

### 3. Chain-of-Thought Prompt

Prompt:

A rectangular garden has a length that is 3 meters more than twice its width. If the perimeter is 54 meters, what are the length and width of the garden?

Let's solve this step-by-step.

- Let the width be  $x$ .
- Then the length is  $2x + 3$ .
- Perimeter of rectangle =  $2 \times (\text{length} + \text{width}) = 2 \times (2x + 3 + x) = 2 \times (3x + 3)$
- So  $2 \times (3x + 3) = 54$

Now solve for  $x$ ...

Response:

$2 \times (3x + 3) = 54 \rightarrow 3x + 3 = 27 \rightarrow 3x = 24 \rightarrow x = 8$

Width = 8 meters, Length =  $2 \times 8 + 3 = 19$  meters

Analysis:

Accurate and well-explained. The reasoning helps verify steps, which is ideal for math and logic-based problems.

Conclusion: Effectiveness Comparison

Technique	Accuracy	Explanation Clarity	Best For	Limitation
Zero-Shot	Low	None	Simple tasks, classification	Misunderstands complex problems
Few-Shot	High	Medium	Structured, patterned tasks	Requires good examples
Chain-of-Thought	High	Very Clear	Reasoning, math, logic	Longer prompts/output

Overall Insight:

Few-shot and Chain-of-thought prompting significantly improve performance over zero-shot in reasoning-heavy tasks. Chain-of-thought is especially effective for mathematical and logical reasoning due to its stepwise structure.