Prompt Engineering Principles

Building Effective Prompts Through Iteration

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Our Goal for Today

Building a Paper Extraction Prompt

By the end of today, you'll have:

- A systematic understanding of prompt engineering principles

- A working prompt for extracting paper information

- Experience with iterative refinement

- Confidence to tackle other prompting tasks

Key insight: We'll build ONE prompt together, adding complexity step by step

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The Seven Building Blocks

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Prompting Fundamentals

The Components of Effective Prompts

A well-structured prompt typically includes:

1. **Role and Objective** - Define the AI's persona and goal

2. **Instructions / Response Rules** - Clear, specific directives

3. **Context** - The relevant background information

4. **Examples** - Few-shot prompting for guidance

5. **Reasoning Steps** - Chain-of-thought prompting

6. **Output Formatting** - Structure and constraints

7. **Delimiters** - Clear organization of prompt sections

Reference: See the full guidelines in `resources/prompt_fundamentals.md`

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Why These Building Blocks?

Addressing the Gulf of Specification

Remember the Three Gulfs from Day 1?

Gulf of Specification: The gap between what you want and what you communicate

These building blocks help you:

- Make your intent explicit

- Reduce ambiguity

- Get consistent outputs

- Bridge that gulf systematically

Our Iterative Approach

How We'll Work Today

We'll build a paper extraction prompt in cycles:

1. **Start simple** - Basic instruction only

2. **Add complexity** - One building block at a time

3. **Test and observe** - What changed?

4. **Refine** - Based on what we learned

Important: This is how real prompt engineering works - iteration, not perfection on the first try

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Cycle 1: Basic Instruction

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Building Block: Instructions

Starting at the Simplest Level

The core component: Clear, specific directives for the task

For paper extraction, a basic instruction might be:

> "Summarize this scientific paper."

or

> "Extract key information from this paper."

Question: What's missing from these instructions?

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What Makes Good Instructions?

Key Characteristics

- **Specific:** Define exactly what to do

- **Unambiguous:** One clear interpretation

- **Actionable:** The AI knows what action to take

- **Complete:** Covers the full scope of the task

But even good instructions alone aren't enough…

Hands-On: Cycle 1

Your Turn - Basic Instruction

Task: Create a basic instruction-only prompt for paper extraction

See: `session-2c-hands-on.md` for detailed guidance

Time: 15 minutes

Remember to note:

- What output did you get?

- What was good?

- What was missing or inconsistent?

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Debrief: Cycle 1

What Did We Learn?

Group discussion:

- What worked with basic instructions?

- What problems did you encounter?

- What would you want to improve?

Common pattern: The AI gives you *something*, but probably not quite what you wanted

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Cycle 2: Adding Role & Objective

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Building Blocks: Role and Objective

Setting the Context

Role: Define the AI's persona

- Helps the AI "understand" its perspective
- Influences tone and approach

Objective: State the overall goal

- Provides purpose beyond the immediate instruction
- Helps prioritize what matters

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Example: Role & Objective

For Paper Extraction

Role:

> "You are a scientific literature extraction specialist with expertise in [domain] research."

Objective:

> "Generate a comprehensive, structured summary of the provided scientific paper optimized for literature review preparation."

Notice: This adds context *around* your instructions

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Why This Matters

Influencing AI Behavior

Adding role and objective:

- Activates relevant "knowledge" in the model

- Sets appropriate tone and detail level

- Provides decision-making criteria

- Makes the task feel more bounded

Key point: You're not just saying WHAT to do, but WHO is doing it and WHY

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Hands-On: Cycle 2

Your Turn - Add Role & Objective

Task: Enhance your Cycle 1 prompt by adding: - An appropriate role - A clear objective

See: `session-2c-hands-on.md` for guidance

Time: 15 minutes

Compare: How does the output differ from Cycle 1?

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Debrief: Cycle 2

What Changed?

Group discussion:

- How did adding role/objective affect the output?

- Was it more aligned with what you wanted?

- What issues persist?

Next challenge: The output might be better, but is it *structured* the way you need?

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Cycle 3: Output Formatting

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Building Block: Output Formatting

Defining Structure and Constraints

The challenge: Even good content isn't useful if it's not structured properly

Output formatting specifies:

- Structure (sections, lists, tables)

- Format (JSON, Markdown, plain text)

- Constraints (length, level of detail)

- Required elements

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Example: Output Formatting

For Paper Extraction

```
**Format required:**
— Title and citation information
— Abstract (original, verbatim)
— Key takeaways by section (bullet points)
— Methodology summary
— Main results with statistics
— Figures and tables described
— Maximum 2000 tokens
```

Critical: Be explicit about structure - don't assume the AI will guess correctly

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Why Formatting Matters

Consistency and Usability

Explicit formatting requirements:

- Ensure consistency across multiple papers

- Make outputs machine-readable (if needed)

- Enable comparison and synthesis later

- Reduce variability in results

This directly addresses: Gulf of Specification AND Gulf of Generalization

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Hands-On: Cycle 3

Your Turn - Add Output Formatting

Task: Add detailed formatting requirements to your prompt

See: `session-2c-hands-on.md` for guidance

Time: 20 minutes

Pay attention to: How much more consistent is the output now?

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Debrief: Cycle 3

Progress Check

Group discussion:

- Is the structure now what you need?

- Are outputs more consistent?

- What would still improve it?

Pattern emerging: More specific prompts → more consistent outputs

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Cycle 4: Context & Examples

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Building Blocks: Context and Examples

Providing Background and Guidance

Context: Relevant background information

- Domain-specific knowledge

- Constraints or requirements

- What the output will be used for

Examples (Few-shot): Sample input-output pairs

- Shows exactly what you want

- Clarifies ambiguous instructions

- Demonstrates edge cases

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When to Use Examples

The Power of Few-Shot Prompting

Examples are especially valuable when:

- Instructions are complex or nuanced

- You want a specific style or format

- Edge cases need to be handled

- The task has implicit requirements

Trade-off: Examples take up token space but can dramatically improve results

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Example: Adding Context

For Paper Extraction

Context example:

```
**Context:** These summaries will be used as input for
literature review synthesis. Focus on:
- Quantitative results with statistical measures
- Methodological approaches that could be compared
- Key findings relevant to [specific research question]

**Exclude:** Author affiliations, acknowledgments,
funding information
```

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Hands-On: Cycle 4

Your Turn - Add Context

Task: Add relevant context to your prompt

- What will the summary be used for?

- What should be prioritized?

- What should be excluded?

Optional: Add an example if helpful

See: `session-2c-hands-on.md` for guidance

Time: 20 minutes

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Debrief: Cycle 4

Refinement Continues

Group discussion:

- Did context help focus the output?

- If you used examples, how did they help?

- Is the output now "good enough" for your needs?

Key question: When is a prompt "good enough"? (It depends on your use case!)

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Advanced Building Blocks

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Reasoning Steps

Chain-of-Thought Prompting

When to use: - Complex analysis tasks - Multi-step reasoning needed - Want to see the AI's thinking process

Example: "Think step by step before answering"

For paper extraction: Less critical, but useful for evaluation tasks

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Delimiters

Organizing Complex Prompts

Purpose: Clear separation of prompt sections

Common markers: ###, ---, XML tags

For paper extraction: Helpful as prompts grow more complex

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When to Use Reasoning Steps

Chain-of-Thought Prompting

Best for tasks requiring:

- Multi-step analysis

- Comparison or evaluation, complex decision-making, verification of results

Example for evaluation task:

> "Before rating this paper's methodology, first identify the study design, then assess each component (sampling, measurement, analysis), and finally provide an overall rating with justification."

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Cycle 5 (Optional): Advanced Features

Your Choice

If time allows and interest exists:

Add reasoning steps or better organization with delimiters

See: `session-2c-hands-on.md` for guidance

Time: 15-20 minutes

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The Complete Picture

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From Simple to Sophisticated

Your Prompt Evolution

You've built a prompt from:

1. ✅ Basic instruction

2. ✅ + Role & Objective

3. ✅ + Output Formatting

4. ✅ + Context (& Examples)

5. ✅ (Optional) Reasoning Steps & Delimiters

This is the iterative process of real prompt engineering

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The Professional Version

Where This Can Lead

Example: The `prompt_paper_representation.md` shows a fully developed version

- All building blocks integrated
- Comprehensive specifications
- Error handling
- Quality standards

Important truth: This wasn't written perfectly from the start - it evolved through iteration

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Honesty Moment

How the Example Prompt Was Created

The truth about `prompt_paper_representation.md`:

1. I built an initial version using these principles

2. I tested it on several papers

3. I identified failure modes

4. **I asked Claude AI to refine it** based on my observations

5. I tested again and refined further

Lesson: Use AI to help refine prompts, but start with human-led iteration first

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Why Start Manual?

The Value of Doing It Yourself First

Manual iteration first teaches you:

- What you actually want to achieve

- Hidden requirements and edge cases

- How to recognize failure modes

- How to evaluate quality

Then AI refinement helps with:

- Phrasing and clarity

- Comprehensive coverage

- Formatting and organization

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Group Comparison

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Sharing Our Work

What Did We Build?

Activity: Let's see a few examples

- Volunteers share their final prompts

- What building blocks did you emphasize?

- What worked well for your domain?

- What challenges remain?

Time: 15-20 minutes

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Common Patterns

What We Typically See

Across different domains and approaches:

- **Variation in detail level** - Some want more, some less

- **Domain-specific requirements** - Different fields need different information

- **Trade-offs** - Comprehensiveness vs. token limits

- **Personal style** - There's no single "right" prompt

Important insight: Good prompts are tailored to YOUR specific needs

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Tomorrow: Evaluation

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The Next Challenge

How Do We Know It's Working?

Today you built prompts and observed outputs.

But:

- How do you evaluate systematically?

- What if you process 50 papers?

- How do you identify failure patterns?

- When is it "good enough"?

Tomorrow (Day 3): We'll tackle systematic evaluation

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Homework (Optional)

Continue Experimenting

If you'd like:

- Test your prompt on 2-3 different papers (or other use cases)

- Note what works and what doesn't

- Add observations to the shared doc

- Try refining your prompt further

Question to ponder: What would "good enough" look like for your actual research needs?

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Questions & Wrap-Up

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Key Takeaways from Day 2

What We Learned

1. **Seven building blocks** provide structure for effective prompts

2. **Iteration is essential** - start simple, add complexity

3. **Specificity matters** - explicit instructions reduce ambiguity

4. **No perfect prompt** - tailor to your needs and domain

5. **AI can help refine** - but understand the principles first

Tomorrow: We'll learn how to evaluate these prompts systematically

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Questions?

Before We Close

- Clarifications on any building blocks?

- Challenges with your specific use case?

- Questions about tomorrow?

See you tomorrow for Day 3!

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