

Prompt Engineering with Gemini Seminar

For Cybernetics & AI Laboratory © CAIL



Duration: 4 Weeks (12 Sessions, 3 hours each)

Level: Beginner to Intermediate

Contact: cail@ba.uoa.gr (Ms. Zoi Dimaki)

Contents

Prompt Engineering with Gemini Seminar.....	1
For Cybernetics & AI Laboratory © CAIL.....	1
1. Course Overview.....	3
1.1. Target Audience	3
1.2. Prerequisites.....	3
1.3. Learning Objectives	3
2. Seminar Outline & Exercises.....	4
Week 1: Introduction to AI, Large Language Models, and Prompt Engineering. 4	
Week 1 Exercises: Foundations and Basic Prompting	7
Week 2: Prompt Engineering Techniques – From Theory to Practice.....	9
Week 2 Exercises: Advanced Prompting & Multimodal Inputs.....	12
Week 3: Applications and Advanced Prompt Engineering Strategies.....	15
Week 3 Exercises: Managing Outputs & Ethics	18
Week 4: Ethics, Security, Evaluation, and Certification in Prompt Engineering	20
Week 4 Exercises: Collaboration & Integration.....	23
3. Summary Table of Exercises.....	25
4. Additional Teaching Tips	27
5. Assessment Criteria (Suggested).....	28
6. Materials & Support.....	28
7. Certification	28
8. Indicative Schedule	28
9. Indicative Bibliography.....	29
10. Self-Assessment Questions (Comprehensive)	29

1. Course Overview

This seminar introduces the fundamentals and advanced techniques of **Prompt Engineering**, focusing specifically on leveraging **Gemini**—a powerful AI platform integrating multiple large language models (LLMs) and multimodal capabilities. Participants will learn how to craft, refine, and optimize prompts to extract precise, relevant, and creative outputs from AI for research, writing, problem-solving, and workflow automation. The course balances theoretical understanding of LLMs with hands-on practice using Gemini's unique features such as advanced search capabilities, multimodal inputs, and collaborative features.

1.1. Target Audience

This seminar is designed for members of a Cybernetics & AI Laboratory, including graduate students, researchers, and faculty, who wish to enhance their proficiency in utilizing advanced AI tools for academic and research purposes.

1.2. Prerequisites

- Basic understanding of Artificial Intelligence concepts.
- Familiarity with general research methodologies.
- Access to Gemini (a trial or full subscription is recommended for hands-on exercises).

1.3. Learning Objectives

By the end of this seminar, participants will be able to:

- Understand the principles of prompt engineering and how LLMs process language inputs.
- Write clear, context-rich, and task-specific prompts that maximize AI output quality.
- Apply advanced prompting techniques including zero-shot, few-shot, chain-of-thought, and persona prompting.
- Identify and mitigate AI hallucinations, biases, and conflicting outputs.

- Use Gemini's advanced search and multimodal features effectively.
- Collaborate using Gemini's features and integrate AI outputs into academic workflows responsibly.

2. Seminar Outline & Exercises

Week 1: Introduction to AI, Large Language Models, and Prompt Engineering

Topics Covered: Definition, History, and Current State of AI; Large Language Models (LLMs): What they are and how they work; Introduction to Prompt Engineering; Applications of LLMs and Prompt Engineering; Practical Exercise: First Steps with Language Models; Challenges and Limitations of LLMs; The Ethical and Social Dimension of AI.

Key Skills Developed: Prompt writing fundamentals, LLM understanding, basic AI concepts.

Hands-On Activities: Creating your first prompt in Gemini, experimenting with prompt variations, refining prompts for clarity and focus.

Session 1: Introduction to Artificial Intelligence

- **1.1.1. Definition of Artificial Intelligence (AI)**
 - Artificial Intelligence (AI) is the field of computer science that aims to create systems capable of performing tasks that require human intelligence. These tasks include learning, reasoning, problem-solving, language understanding, vision, and decision-making.
 - **Basic AI Categories:**
 - **Narrow (or Weak) AI:** Specialized systems for specific tasks (e.g., image recognition, text translation).
 - **General AI (AGI):** A hypothetical form of AI with capabilities equivalent to or superior to humans in every cognitive domain.
- **1.1.2. Historical Evolution of AI**
 - **1950s-1970s:** First theoretical foundations (Alan Turing, Turing Test, logical systems, early AI programs).

- **1980s-1990s:** Spread of expert systems, development of neural networks, initial steps in machine learning.
- **2000s-2010s:** Rapid progress due to increased computational power, big data, and the development of deep learning.
- **2020s:** Emergence and widespread adoption of large language models (LLMs) like GPT-3, GPT-4, Claude, Gemini, Llama.
- **Hands-on:** Creating your first prompt in Gemini.

Session 2: Large Language Models (LLMs) and Prompting Basics

- **1.2.1. Definition and Basic Principles of LLMs**
 - **Large Language Models (LLMs)** are artificial intelligence systems trained on vast amounts of text, aiming to understand, generate, and process natural language. LLMs are primarily based on neural network architectures, especially the **Transformer** type.
 - **Characteristics of LLMs:**
 - Trained on billions of words/paragraphs from books, articles, websites.
 - Ability to generate text, translate, summarize, answer questions, generate code, etc.
 - Adaptability to different styles, languages, and topics.
- **1.2.2. How LLMs Work**
 - **Training:** Models learn to predict the next word in a text sequence (next word prediction).
 - **Generation:** They receive a "prompt" and produce a response based on their training and context.
 - **Improvement through Reinforcement Learning from Human Feedback (RLHF):** A combination of machine learning and human evaluation for better results.
 - **Main LLM Platforms:** Google (Gemini), OpenAI (GPT-3, GPT-4, ChatGPT), Anthropic (Claude), Meta (Llama).
- **1.3.1. What is Prompt Engineering?**

- **Prompt engineering** is the process of designing, formulating, optimizing, and evaluating the instructions (prompts) given to an LLM, with the aim of maximizing the quality and accuracy of the responses.
- **Why it's important:** The performance of an LLM largely depends on how the prompt is formulated. Small changes in wording can lead to entirely different results.
- **Hands-on:** Experiment with prompt variations and observe outputs.

Session 3: Prompting Best Practices and LLM Applications

- **1.3.2. Basic Concepts of Prompt Engineering**
 - **Prompt:** The instruction or text given to the model.
 - **Completion:** The response generated by the model.
 - **Zero-shot prompting:** The model receives only the instruction, without examples.
 - **Few-shot prompting:** The model receives examples to improve its response.
 - **Chain-of-thought prompting:** The prompt encourages the model to explain its thought process step-by-step.
- **1.3.3. Examples of Prompt Engineering**
 - **Example 1: Simple Prompt**
 - **Prompt:** “Write a summary about the greenhouse effect.”
 - **Completion:** [The model generates a short, understandable summary.]
 - **Example 2: Few-shot Prompting**
 - **Prompt:**
 - “Example 1: Question: What is the capital of France? Answer: Paris.
 - Example 2: Question: What is the capital of Spain? Answer: Madrid.
 - Question: What is the capital of Italy? Answer:”
 - **Completion:** Rome.
 - **Example 3: Chain-of-thought Prompting**
 - **Prompt:** “Question: If I have 3 apples and buy 2 more, how many apples do I have in total? Think step-by-step.”

- **Completion:** “I have 3 apples. I buy 2 more, so in total I have $3 + 2 = 5$ apples.”
- **1.4. Applications of LLMs and Prompt Engineering**
 - **1.4.1. Education:** Automatic generation of exercises, corrections, personalized teaching. Examples: Gemini as a teaching assistant, quiz creation.
 - **1.4.2. Business:** Automated customer service (chatbots), analysis of large data volumes, report generation, content production (articles, advertisements, emails).
 - **1.4.3. Research & Innovation:** Assistance in writing scientific papers, extracting/summarizing knowledge from large datasets, code generation, automatic software documentation.
 - **1.4.4. Creative Arts:** Production of stories, poems, scripts, dialogue generation for video games or movies, visual art generation (via multimodal LLMs).
- **Hands-on:** Refining prompts for clarity and focus.

Week 1 Exercises: Foundations and Basic Prompting

Exercise 1.1: Simple Query Refinement

- **Task:** Write a prompt to get a concise summary of the concept of cybernetics.
- **Example Prompt:** “Explain the concept of cybernetics in 3-4 sentences suitable for a graduate student new to the field.”
- **Goal:** Practice clarity and specificity.
- **Instructor Notes:**
 - Emphasize the importance of clear, concise language.
 - Discuss how specifying audience (e.g., graduate student) guides tone and complexity.
 - Encourage students to avoid vague or overly broad prompts.
- **Suggested Solution:** Expected output: A succinct explanation mentioning feedback, control systems, and interdisciplinary nature.

Exercise 1.2: Experiment with Prompt Length

- **Task:** Ask the same question with a short prompt and then with a detailed prompt including context. Compare the outputs.
- **Example Prompts:**
 - **Short:** “What is AI?”
 - **Detailed:** “Define Artificial Intelligence, highlighting its core principles and historical origins, in about 150 words.”
- **Goal:** Understand how context and prompt length affect responses.
- **Instructor Notes:**
 - Show how minimal context leads to generic answers.
 - Longer prompts with explicit instructions yield richer, more relevant responses.
 - Discuss token limits and how to balance detail with brevity.
- **Suggested Solution:**
 - **Short prompt output:** Basic definition of AI.
 - **Detailed prompt output:** Historical context, core principles like perception, reasoning, learning, autonomy.

Exercise 1.3: Role Instruction

- **Task:** Use a system instruction to make the AI respond as a cybernetics professor.
- **Example Prompt:** “You are a cybernetics professor explaining to students. Describe how feedback loops work in biological systems.”
- **Goal:** Learn to set tone and role for tailored responses.
- **Instructor Notes:**
 - Introduce “persona prompting” to influence style and depth.
 - Highlight how role instructions help tailor responses for specific audiences or purposes.
- **Suggested Solution:** Expected output: Explanation of negative and positive feedback in homeostasis, with examples like temperature regulation.

Week 1 Practical Exercise: First Steps with Language Models

- **1.5.1. Tool Access:**

- Gemini (Google): <https://gemini.google.com>

- **1.5.2. First Tests:**

- **Exercise 1:** Give Gemini the prompt: “Write a short biography of Nikos Kazantzakis.” Observe the result. What would you change in the wording to get a more detailed or shorter answer?
- **Exercise 2:** Ask Gemini: “Give me three reasons why recycling is important.”
- **Exercise 3:** In Gemini, try: “Translate the following text into English: "Η τεχνητή νοημοσύνη αλλάζει τον κόσμο.””

- **1.5.3. Observations and Conclusions:**

- The wording of the prompt directly affects the quality of the response.
- The use of examples (few-shot) improves accuracy in more complex tasks.

Week 2: Prompt Engineering Techniques – From Theory to Practice

Topics Covered: Introduction to Prompt Engineering Techniques; Basic Prompt Formulation Techniques (Zero-Shot, Few-Shot, Chain-of-Thought, Instruction-based); Advanced Prompt Engineering Techniques (Prompt Chaining, Self-Consistency, Role-based, Contextual); Best Practices in Prompt Formulation; Common Mistakes and How to Avoid Them; Practical Examples & Exercises; Prompt Evaluation – Qualitative and Quantitative Criteria.

Key Skills Developed: Few-shot, persona prompts, multimodal querying, prompt optimization.

Hands-On Activities: Construct zero-shot and few-shot prompts for research queries, role-play prompts and fact-checking exercises, analyze a research paper PDF and image data using AI, experimenting with various techniques.

Session 4: Introduction to Prompt Engineering Techniques & Basic Techniques

- **2.1. Introduction to Prompt Engineering Techniques**

- Prompt engineering is a rapidly evolving skill, essential for any professional

or researcher utilizing large language models (LLMs). The formulation of the prompt largely determines the outcome – whether it's text generation, problem-solving, data analysis, or code production. This week, we will delve into basic and advanced techniques, with practical examples and exercises.

- **2.2. Basic Prompt Formulation Techniques**

- **2.2.1. Simple (Zero-Shot) Prompting:** The most basic form of prompting, where the model receives only the instruction, without examples.

- **Example: Prompt:** “Write a short biography of Aristotle.” **Completion:** [The model produces a biography.]

- **Note:** The zero-shot approach is suitable for simple tasks but often yields general or vague answers.

- **2.2.2. Few-Shot Prompting:** The model is provided with 1-3 examples to understand the desired style, structure, or level of detail.

- **Example: Prompt:**

- “Example 1: Question: What is the largest island in Greece? Answer: Crete.

- Example 2: Question: What is the capital of Italy? Answer: Rome.

- Question: What is the capital of Spain? Answer:”

- **Completion:** Madrid.

- **Comment:** The few-shot approach improves accuracy, especially in tasks requiring specific formatting or logic.

- **Hands-on:** Construct zero-shot and few-shot prompts for research queries.

Session 5: Advanced Prompting Techniques & Best Practices

- **2.2.3. Chain-of-Thought Prompting:** Encourages the model to explain its thought process step-by-step before arriving at the final answer. Very effective in logical or mathematical problems.

- **Example: Prompt:** “Question: If I have 5 oranges and buy 3 more, how many do I have in total? Think step-by-step.” **Completion:** “I have 5 oranges. I buy 3 more, so in total I have $5 + 3 = 8$ oranges.”

- **2.2.4. Instruction-based Prompting:** We give clear, structured instructions to the model about what we want it to do.
 - **Example: Prompt:** “Please, write a summary of the following text in 3 sentences, using simple language.” [Text follows]
- **2.3. Advanced Prompt Engineering Techniques**
 - **2.3.1. Prompt Chaining:** We break down a complex problem into successive steps, where the result of each step feeds the next prompt.
 - **Example:** 1st Prompt: “Give me the main points of article X.” 2nd Prompt: “For each point, write a comprehension question.” 3rd Prompt: “Provide answers to the above questions.”
 - **2.3.2. Self-Consistency Prompting:** We ask the model to provide multiple answers and choose the most frequent or logical one.
 - **Example: Prompt:** “Solve the following problem in two different ways and explain your reasoning.”
 - **2.3.3. Role-based Prompting:** We assign a role to the model (e.g., professor, journalist, programmer) to guide the tone and level of the response.
 - **Example: Prompt:** “Act as a university professor. Explain the concept of artificial intelligence to first-year students.”
 - **2.3.4. Contextual Prompting:** We provide the model with extensive context to better understand the request.
 - **Example: Prompt:** “The following text is about climate change. Read it carefully and answer the questions below.”
- **Hands-on:** Role-play prompts and fact-checking exercises.

Session 6: Multimodal Prompting & Prompt Evaluation

- **2.4. Best Practices in Prompt Formulation**
 - **2.4.1. Clarity and Accuracy:** Use clear language, avoiding ambiguity. Define the desired length, style, and format of the response.
 - **Example:** “Write a 100-word summary about the greenhouse effect.”
 - **2.4.2. Iterative Experimentation:** Try different formulations for the same

task. Evaluate which prompts yield the best results.

- **2.4.3. Use of Examples:** Provide the model with 1-2 examples (few-shot) to better understand the request.
- **2.4.4. Avoiding Bias and Prejudices:** Formulate neutral prompts. Check for bias in responses and adjust accordingly.
- **2.5. Common Mistakes and How to Avoid Them**
 - **Vague prompts:** “Write something about artificial intelligence.” (too general)
 - **Lack of examples:** For tasks with specific formatting, always provide an example.
 - **Overly complex prompts:** Break down tasks into smaller steps.
 - **Unclear instructions:** Always specify the desired outcome.
- **2.8. Prompt Evaluation – Qualitative and Quantitative Criteria**
 - **2.8.1. Qualitative Evaluation:**
 - Accuracy and correctness of response
 - Completeness and clarity
 - Consistency with the request
 - Lack of bias
 - **2.8.2. Quantitative Evaluation:**
 - Response time
 - Percentage of successful responses in repeated tests
 - Number of corrections required
- **Hands-on:** Analyze a research paper PDF and image data using AI.

Week 2 Exercises: Advanced Prompting & Multimodal Inputs

Exercise 2.1: Few-shot Prompting

- **Task:** Create a prompt that includes two examples of converting plain text into formal academic style, then ask the AI to rewrite a new sentence.
- **Example Prompt:** “Example 1: ‘AI helps machines learn.’ → ‘Artificial Intelligence facilitates machine learning processes.’ Example 2: ‘Neural networks

mimic brains.’ → ‘Neural networks emulate the structure and function of biological brains.’ Rewrite: ‘Cybernetics studies control systems.’”

- **Goal:** Practice few-shot prompting to guide style.
- **Instructor Notes:**
 - Explain few-shot prompting as providing examples to guide AI behavior.
 - Encourage clear, consistent examples to avoid confusion.
 - Emphasize the power of style transfer.
- **Suggested Solution:** Output: “Cybernetics studies control systems.” → “Cybernetics investigates the principles and mechanisms of control systems.”

Exercise 2.2: Chain-of-Thought Prompting

- **Task:** Prompt the AI to explain step-by-step how an LLM processes a prompt.
- **Example Prompt:** “Explain step-by-step how a large language model like Gemini processes and generates a response to a user prompt.”
- **Goal:** Encourage detailed reasoning in AI output.
- **Instructor Notes:**
 - Teach students to ask for step-by-step reasoning to improve answer quality.
 - Discuss how this technique helps in complex or multi-step questions.
- **Suggested Solution:** Output:
 - Tokenization of input text.
 - Embedding tokens into vectors.
 - Passing vectors through transformer layers with attention mechanisms.
 - Predicting next tokens based on learned probabilities.
 - Generating output tokens sequentially until completion.

Exercise 2.3: Multimodal PDF Analysis

- **Task:** Upload a short academic paper PDF on AI ethics and ask the AI to summarize the key ethical challenges discussed.
- **Example Prompt:** “Summarize the main ethical challenges presented in the uploaded PDF on AI ethics.”
- **Goal:** Gain experience with Gemini’s multimodal file upload and analysis.

- **Instructor Notes:**
 - Demonstrate uploading PDFs and querying their content.
 - Stress the importance of clear instructions to focus AI on relevant sections.
- **Suggested Solution:** Output: Summary mentioning bias, transparency, accountability, privacy concerns, and AI misuse.

Exercise 2.4: Image Interpretation

- **Task:** Upload a diagram of a neural network architecture and ask the AI to explain its components.
- **Example Prompt:** “Explain the components and flow of information in the uploaded neural network diagram.”
- **Goal:** Practice combining visual data with text prompts.
- **Instructor Notes:**
 - Show how to upload diagrams and ask targeted questions.
 - Encourage students to combine visual and textual prompts for clarity.
- **Suggested Solution:** Output: Description of input layer, hidden layers, weights, activation functions, output layer, and data flow.

Week 2 Practical Examples & Exercises

- **2.6. Practical Examples & Exercises**
 - **2.6.1. Example 1 – Prompt Rephrasing:**
 - **Initial Prompt:** “Write about the environment.”
 - **Improved Prompt:** “Write a 200-word article about the importance of recycling in environmental protection, with examples from Greece.”
 - **2.6.2. Example 2 – Few-shot Prompting:**
 - **Prompt:**
 - “Example 1: Question: Who is the author of the Odyssey? Answer: Homer.
 - Example 2: Question: Who wrote the Iliad? Answer: Homer.
 - Question: Who is the author of the Divine Comedy? Answer:”
 - **Completion:** Dante.

- **2.6.3. Example 3 – Role-based Prompting:**
 - **Prompt:** “Act as a career counselor. Give three tips for developing skills in artificial intelligence.”
- **2.6.4. Example 4 – Prompt Chaining:**
 - 1st Prompt: “Give me the main points of the article on climate change.”
 - 2nd Prompt: “For each point, write a comprehension question.”
 - 3rd Prompt: “Provide answers to the above questions.”
- **2.7. Workshop: Experimenting with Prompt Engineering Techniques**
 - **2.7.1. Task 1:** Formulate three different prompts for the same topic (“The contribution of artificial intelligence to medicine”), using:
 - Zero-shot
 - Few-shot
 - Role-based (e.g., as a doctor)
 - Compare the results and comment on the differences.
 - **2.7.2. Task 2:** Create a prompt chain for generating educational material (e.g., summary, questions, answers).
 - **2.7.3. Task 3:** Identify bias in model responses and rephrase the prompt to minimize bias.

Week 3: Applications and Advanced Prompt Engineering Strategies

Topics Covered: Introduction: The Transition from Theory to Application; Applications of Prompt Engineering in Text, Code, Image, and Data; Integrating LLMs into Applications and Workflows; Advanced Prompt Engineering Strategies; Case Studies; Practical Workshop: Prompt Creation and Integration; Challenges and Best Practices in LLM Integration.

Key Skills Developed: Prompt engineering for text, data analysis, code, image; LLM integration via API and automation; prompt chaining, self-reflection, RAG, tool use.

Hands-On Activities: Designing LLM applications, optimizing prompts for quality and reliability, integrating external sources.

Session 7: Introduction to Applications & Text/Code Applications

- **3.1. Introduction: The Transition from Theory to Application**
 - Prompt engineering is maturing as a science and practice. From simple prompt formulation, we move to their strategic utilization for solving complex problems, automating processes, and creating innovative applications. This week focuses on applying prompt engineering in real-world scenarios, integrating LLMs into tools and services, and advanced techniques that maximize performance and reliability.
- **3.2. Applications of Prompt Engineering in Text, Code, Image, and Data**
 - **3.2.1. Text Applications:** Automatic writing of articles, summaries, emails; Creation of educational material, quizzes, comprehension questions; Translation, paraphrasing, sentiment analysis.
 - **Example: Prompt:** “Write a 100-word summary about the greenhouse effect in simple language, suitable for middle school students.”
 - **3.2.2. Code Applications (Code Generation):** Automatic code creation and correction; Commenting and documenting programs; Converting pseudocode to actual code.
 - **Example: Prompt:** “Write a Python function that calculates the sum of a list of numbers.”
- **Hands-on:** Prompt chaining and scenario walkthroughs.

Session 8: Image/Data Applications & LLM Integration

- **3.2.3. Image Applications (Multimodal Prompts):** Creating image descriptions (image captioning); Converting text to image (text-to-image, e.g., DALL-E, Stable Diffusion); Image content analysis.
 - **Example: Prompt:** “Create an image depicting a scientist in an artificial intelligence laboratory.”
- **3.2.4. Data Applications:** Analysis and summarization of datasets; Creating graphs from data; Automatic extraction of insights.
 - **Example: Prompt:** “Analyze the following sales data and identify the three main trends.”

- **3.3. Integrating LLMs into Applications and Workflows**

- **3.3.1. Using APIs:** LLMs (e.g., Gemini, OpenAI, Anthropic) offer APIs for integration into applications, websites, chatbots, analysis tools, automations.
 - **Steps:** Register and obtain an API key from the provider. Connect the application with the API (e.g., via Python, JavaScript). Create dynamic prompts based on user input or data. Process and present responses.
 - **Example (Python):**

```
import google.generativeai as genai  
genai.configure(api_key="YOUR_API_KEY") # Replace with your actual  
API key  
model = genai.GenerativeModel('gemini-pro')  
response = model.generate_content("Write a summary about artificial  
intelligence.")  
print(response.text)
```
 - **3.3.2. Automations with Zapier, Make, Power Automate:** Connecting LLMs with email, Google Sheets, Slack, CRM; Automatic report generation, notifications, content.
 - **3.3.3. Integration into Educational Environments:** Creating smart assistants for students; Automatic assignment grading; Interactive quizzes and personalized learning.
- **Hands-on:** Analyze outputs for factual accuracy and bias.

Session 9: Advanced Strategies & Challenges

- **3.4. Advanced Prompt Engineering Strategies**

- **3.4.1. Prompt Chaining in Real-World Applications:** Sequential prompts for complex tasks (e.g., analysis, summarization, question generation, answer evaluation); Using tools like LangChain for managing prompt chains.
 - **Example (in an educational application):**
 - Prompt 1: “Read the following article and write down the main points.”

- Prompt 2: “For each point, formulate a comprehension question.”
 - Prompt 3: “Provide answers to the above questions.”
- **3.4.2. Self-Reflection & Self-Critique Prompts:** We ask the model to check and improve its own answer. Enhances reliability and quality.
 - **Example: Prompt:** “Answer the question and then evaluate if your answer is complete and accurate.”
- **3.4.3. Retrieval-Augmented Generation (RAG):** Combining LLM with external databases/knowledge. The model retrieves information from specific sources before answering.
 - **Example: Prompt:** “Based on the following article, answer the question...”
- **3.4.4. Tool Use & Function Calling:** LLMs can call external functions for calculations, searches, updated data. Integration with tools (e.g., calculator, calendar, databases).
- **3.7. Challenges and Best Practices in LLM Integration**
 - **Security and Data Protection:** Ensuring user data is handled securely.
 - **Bias and Fairness Management:** Continuous monitoring for biases in responses.
 - **User Information:** Transparency about LLM capabilities and limitations.
 - **Continuous Prompt Improvement:** Iterative experimentation and evaluation.
- **Hands-on:** Draft ethical prompt guidelines for lab use.

Week 3 Exercises: Managing Outputs & Ethics

Exercise 3.1: Conflict Resolution

- **Task:** Provide two contradictory AI-generated answers about AI safety and ask the AI to reconcile them.
- **Example Prompt:** “Given these two statements about AI safety: ‘AI systems are inherently unpredictable.’ ‘AI safety can be guaranteed through formal verification.’ Reconcile these views and explain how both can be true.”

- **Goal:** Practice iterative prompting and critical analysis.
- **Instructor Notes:**
 - Teach iterative prompting and critical thinking to reconcile conflicting info.
 - Encourage students to ask AI to weigh pros and cons or provide nuanced views.
- **Suggested Solution:** Output: Explanation that AI systems have unpredictable elements due to complexity, but formal methods can improve safety guarantees in specific contexts.

Exercise 3.2: Detecting Hallucinations

- **Task:** Ask the AI a factual question about a recent AI event and verify the accuracy of the response.
- **Example Prompt:** “Describe the key features of the latest Gemini model as announced recently.”
- **Goal:** Identify hallucinations and learn verification techniques.
- **Instructor Notes:**
 - Discuss hallucinations as AI fabrications or inaccuracies.
 - Train students to verify facts via external sources or cross-checking.
- **Suggested Solution:** Expected: AI may hallucinate or provide speculative info. Students should identify unsupported claims and verify with trusted sources.

Exercise 3.3: Ethical Prompt Drafting

- **Task:** Draft a prompt that instructs the AI to avoid biased or harmful language when discussing sensitive topics.
- **Example Prompt:** “Respond to questions about gender diversity in tech while avoiding stereotypes and promoting inclusivity.”
- **Goal:** Develop responsible prompting habits.
- **Instructor Notes:**
 - Emphasize the role of prompt engineering in mitigating bias and promoting fairness.
 - Discuss inclusive language and respectful framing.

- **Suggested Solution:** Output: Balanced, respectful responses emphasizing diversity benefits and avoiding generalizations.

Week 3 Practical Workshop: Prompt Creation and Integration

- **3.6.1. Task 1: Designing an LLM Application:** Choose a scenario (education, business, health, creativity). Formulate a chain of prompts that covers the entire workflow. Implement the workflow using an API or tool (e.g., Zapier, LangChain).
- **3.6.2. Task 2: Prompt Optimization for Quality and Reliability:** Experiment with different techniques (role-based, chain-of-thought, self-critique). Evaluate responses for accuracy, completeness, clarity, and lack of bias.
- **3.6.3. Task 3: Integrating External Sources (RAG):** Combine a prompt with external content (articles, data). Evaluate the improvement in response accuracy.

Week 4: Ethics, Security, Evaluation, and Certification in Prompt Engineering

Topics Covered: Ethical and Legal Issues in Prompt Engineering; Security and Risk Management; Prompt Evaluation and Optimization; Social Impacts and Responsible Use; Practical Workshop: Creating a Comprehensive Prompt Engineering Project; Exams and Certification.

Key Skills Developed: Team workflows, research integration, ethical AI use, project management.

Hands-On Activities: Group project using collaborative features, workflow design, final project development.

Session 10: Ethical and Legal Issues & Security

- **4.1. Ethical and Legal Issues in Prompt Engineering**
 - **4.1.1. Ethical Dilemmas in LLM Use:** The use of large language models (LLMs) and prompt engineering raises significant ethical questions:
 - **Transparency:** How are model decisions and responses explained?
 - **Reliability:** How much can we trust the responses?
 - **Responsibility:** Who is responsible for incorrect or harmful responses?

- **Human Oversight:** How much should human results be controlled?
 - **Reinforcement or Reduction of Bias:** How is impartiality ensured?
 - **Example:** An LLM used in a medical application gives incorrect advice. Who is responsible? The developer, the user, or the model provider?
- **4.1.2. Legal Issues and Regulatory Framework:**
 - **Personal Data Protection (GDPR):** Prompts must not contain personal data without consent.
 - **Copyright:** LLMs may produce content that infringes copyrights.
 - **Accountability:** The need for clear record-keeping of AI use and decisions made through AI.
- **4.2. Security and Risk Management**
 - **4.2.1. Risks in Prompt Engineering:**
 - **Prompt injection attacks:** Malicious prompts that bypass restrictions or lead to undesirable responses.
 - **Data leakage:** Disclosure of sensitive information through prompts.
 - **Hallucinations:** Production of false or non-existent information.
 - **4.2.2. Security Measures:**
 - Input/output filtering and control.
 - Detection and prevention of malicious prompts.
 - Training users and administrators for safe use.
 - **Example Measure:** Integration of filters that prevent the recognition or disclosure of personal data.
- **Hands-on:** Group project kickoff using Gemini's collaborative capabilities.

Session 11: Evaluation, Social Impacts & Project Development

- **4.3. Prompt Evaluation and Optimization**
 - **4.3.1. Qualitative Evaluation:**
 - **Accuracy:** How correct is the answer?
 - **Completeness:** Does the prompt cover all requirements?
 - **Clarity:** Is the answer understandable?

- **Consistency:** Does the model give consistent answers to similar prompts?
 - **Lack of Bias:** Is the answer impartial?
- **4.3.2. Quantitative Evaluation:**
 - Percentage of successful responses in repeated tests.
 - Response time.
 - Number of corrections required.
- **4.3.3. Tools and Optimization Techniques:**
 - **A/B testing:** Comparing different prompts for the same task.
 - **Iterative refinement:** Iterative improvement based on results.
 - Use of evaluation tools (e.g., Gemini's internal evaluation tools, LangChain Evaluators).
 - **Example:** Testing three different prompts for summary generation and selecting the most effective one based on accuracy and clarity.
- **4.4. Social Impacts and Responsible Use**
 - **4.4.1. Impacts on Employment and Education:**
 - **Task Automation:** Transformation of professions, need for new skills.
 - **Lifelong Learning:** Prompt engineering as a new core skill.
 - **Digital Illiteracy:** Risk of exclusion for those without access or training in AI use.
 - **4.4.2. Reinforcement or Reduction of Inequalities:**
 - **Access to Knowledge:** LLMs can enhance equality, but also widen the gap if there is no equal access.
 - **Transparency and Accountability:** Essential for public trust.
- **Hands-on:** Build a research workflow incorporating Gemini outputs.

Session 12: Final Project & Certification

- **4.5. Practical Workshop: Creating a Comprehensive Prompt Engineering Project**
 - **4.5.1. Final Project Guidelines:**

- **Goal:** Design and implement a comprehensive prompt engineering scenario that solves a real-world problem (education, business, health, creativity).
- **Steps:**
 - Selection of topic/application field.
 - Formulation of clear and effective prompts.
 - Use of advanced techniques (e.g., chain-of-thought, role-based, prompt chaining).
 - Integration of security and ethical measures.
 - Evaluation and optimization of results.
 - Project presentation (written or oral).
- **Example Topics:** Smart assistant for students, automatic report generation from data, customer service chatbot with secure personal data handling.
- **4.6. Exams and Certification**
 - **4.6.1. Weekly Quizzes (20%):** Multiple-choice and short-answer questions for all weekly sections.
 - **4.6.2. Final Written Examination (40%):** Theoretical and practical questions (e.g., prompt analysis, bias detection, improvement suggestions).
 - **4.6.3. Final Project (40%):** Presentation of a comprehensive prompt engineering project. Criteria: clarity, innovation, security, ethics, results evaluation.
 - **4.6.4. Certification:** Certificate of successful attendance and examination, with a detailed description of skills and topics.
- **Hands-on:** Final Project Presentations and Course Wrap-up.

Week 4 Exercises: Collaboration & Integration

Exercise 4.1: Collaborative Feature Setup

- **Task:** Create a shared context or project in Gemini for your lab group, upload a dataset or paper, and collaboratively generate a summary.

- **Goal:** Practice teamwork and knowledge sharing using Gemini's collaborative features.
- **Instructor Notes:**
 - Guide students on creating and managing shared contexts in Gemini.
 - Encourage sharing context and iterative refinement within teams.
- **Suggested Solution:** Students create a shared context, upload a dataset or paper, and collaboratively generate a summary or analysis, demonstrating teamwork and AI-assisted co-creation.

Exercise 4.2: Research Workflow Automation

- **Task:** Use Gemini to generate a literature review outline on AI fairness, export it, and import into a document editor or reference manager.
- **Goal:** Integrate AI outputs into academic workflows.
- **Instructor Notes:**
 - Show exporting AI outputs in formats compatible with citation managers and document editors.
 - Teach integration with tools like Zotero, Notion, or Jupyter.
- **Suggested Solution:** Students generate a literature review outline, export it, and import into a reference manager or document editor, demonstrating seamless workflow integration.

Exercise 4.3: Final Project Prompt Design

- **Task:** Design a comprehensive prompt or prompt sequence for a research question relevant to your lab (e.g., “How can cybernetic principles improve AI interpretability?”). Include context, instructions, and expected output format.
- **Goal:** Synthesize course skills into a practical research tool.
- **Instructor Notes:**
 - Encourage comprehensive prompt design including context, instructions, examples, and expected output format.
 - Assess creativity, clarity, and alignment with research goals.
- **Suggested Solution:** Example prompt: “You are an expert in cybernetics and

AI. Explain how cybernetic feedback principles can improve interpretability in modern AI models. Provide examples and suggest future research directions. Format your answer as a structured report with headings.”

- **Output:** Detailed, structured explanation with references to feedback loops, explainability techniques, and open challenges.

3. Summary Table of Exercises

Week	Exercise #	Focus Area	Description	Example Prompt Highlight
1	1.1	Basic Prompt Clarity	Summarize cybernetics concisely	“Explain cybernetics in 3-4 sentences.”
1	1.2	Prompt Length & Context	Compare short vs detailed prompts	“What is AI?” vs detailed definition
1	1.3	Role Instruction	AI as cybernetics professor	“You are a professor explaining feedback loops.”
2	2.1	Few-shot Prompting	Guide style with examples	Rewrite sentence in academic

				style
2	2.2	Chain-of-Thought Prompting	Step-by-step reasoning	Explain how LLM processes prompts
2	2.3	Multimodal PDF Analysis	Summarize uploaded academic paper	Summarize AI ethics PDF
2	2.4	Image Interpretation	Explain neural network diagram	Explain components of uploaded diagram
3	3.1	Conflict Resolution	Reconcile contradictory AI outputs	Reconcile opposing AI safety statements
3	3.2	Hallucination Detection	Verify factual accuracy	Describe the latest Gemini model features
3	3.3	Ethical Prompting	Avoid bias and harmful language	Inclusive language on gender diversity

4	4.1	Collaboration	Use Gemini's collaborative features for shared research	Collaborative summary generation
4	4.2	Workflow Integration	Export AI outputs to reference managers	Literature review outline export
4	4.3	Final Project Prompt Design	Comprehensive prompt for lab research question	Cybernetics & AI interpretability prompt

4. Additional Teaching Tips

- **Prompt Iteration:** Encourage students to iteratively refine prompts based on AI outputs. This is a crucial skill for effective prompt engineering.
- **Peer Review:** Use group sessions to critique and improve prompt designs collaboratively. This fosters a supportive learning environment and exposes students to diverse prompting strategies.
- **Ethics Discussions:** Integrate ethical considerations throughout exercises, not just in dedicated sessions. Emphasize the responsibility of prompt engineers in shaping AI behavior.
- **Hands-On Practice:** Allocate sufficient time for live Gemini use and experimentation. Direct interaction with the tool is paramount for skill development.
- **Real-World Application:** Encourage students to connect the exercises and concepts to their ongoing research or real-world problems within the lab.

5. Assessment Criteria (Suggested)

- **Weekly Quizzes (20%):** Multiple-choice and short-answer questions for all weekly sections.
- **Final Written Examination (40%):** Theoretical and practical questions (e.g., prompt analysis, bias detection, improvement suggestions).
- **Final Project (40%):** Presentation of a comprehensive prompt engineering project. Criteria: clarity, innovation, security, ethics, results evaluation.
- **Prerequisite for Success:** Overall score $\geq 60/100$.

6. Materials & Support

- Detailed slides and notes in English.
- Access to AI platforms (e.g., Gemini).
- Bibliography and links for further study.
- Instructor support via forum/email.

7. Certification

Upon successful completion of the seminar and examinations, an official **Certificate of Successful Attendance & Examination in Prompt Engineering** will be awarded, with a detailed description of skills and topics.

8. Indicative Schedule

Week	Theory (hours)	Workshop (hours)	Self-study (hours)
1	3	2	3
2	3	2	3
3	3	2	3
4	2	3	3

9. Indicative Bibliography

- Russell, S., & Norvig, P. (2021). *Artificial Intelligence: A Modern Approach*. Pearson.
- Vaswani, A., et al. (2017). *Attention is All You Need*. NeurIPS.
- Brown, T. B., et al. (2020). *Language Models are Few-Shot Learners*. NeurIPS.
- Floridi, L., & Cows, J. (2021). *A Unified Framework of Five Principles for AI in Society*. Harvard Data Science Review.
- European Union AI Act (2024).
- Bender, E. M., & Gebru, T. (2021). *On the Dangers of Stochastic Parrots: Can Language Models Be Too Big?* FAccT.
- Wei, J., et al. (2022). *Chain-of-Thought Prompting Elicits Reasoning in Large Language Models*. arXiv:2201.11903.
- Lewis, P., et al. (2020). *Retrieval-Augmented Generation for Knowledge-Intensive NLP Tasks*. arXiv:2005.11401.
- Andrew Ng & Isa Fulford, "ChatGPT Prompt Engineering for Developers" (Note: concepts are transferable to Gemini).
- LearnPrompting.org.

10. Self-Assessment Questions (Comprehensive)

- What is artificial intelligence and what are its basic types?
- What are large language models and how do they work?
- What is the role of prompt engineering in using LLMs?
- Give an example of zero-shot and a few-shot prompt.
- What are the basic ethical issues related to the use of LLMs?
- What is the difference between zero-shot and few-shot prompting?
- What is chain-of-thought prompting and in what cases is it useful?
- How can role-based prompting improve response quality?
- What are the basic steps to optimize a prompt?
- Give an example of prompt chaining for educational use.
- What are the basic applications of LLMs in text, code, image, and data?

- How is an LLM integrated into an application via API?
- What is prompt chaining and how is it used in real workflows?
- What are the benefits of the Retrieval-Augmented Generation technique?
- What are the challenges in integrating LLMs into enterprise environments?
- What are the basic ethical issues in using LLMs and how do we address them?
- What are the main security threats in prompt engineering?
- How do we evaluate the quality and reliability of an LLM response?
- What are the basic steps for creating a comprehensive prompt engineering project?
- How does prompt engineering contribute to lifelong learning and social equality?