

Prompt engineering can be defined as a design process whereby questions or instructions are created to help an AI model give better answers. It is possible to make the response more comprehensible, precise and useful based on the way we word a prompt. We can find out the level of control we are able to control the model output through trial and error.

I evaluated four prompt engineering methods with LLaMA 3.2 model (3B) through Ollama in this lab:

Simple prompting - asking simple direct questions.

Structured output prompting - prompting the answers, including in a structured format, e.g., a bullet point or a table or a JSON.

Few-shot prompting - conditioning the style by providing the model with examples on the prompt.

Chain-of-thought prompting - prompting the model to think through the problems step by step, providing reasons why it did so.

The purpose was to research the effect of these techniques on the accuracy, thoroughness, clarity and logical ability.

I took Ollama to Windows CMD in order to run the LLaMA 3.2 (3B) model.

Prompts were typed in either interactive mode or in one-shot mode.

The responses were documented using .txt files and screenshots.

Each of the steps included running three prompts that were concerning:

- Photosynthesis
- Newton's First Law of Motion
- The French Revolution

Step 1:

Basic Prompting

Prompt 1

```
>>> What is photosynthesis?
Photosynthesis is the process by which plants, algae, and some bacteria convert light energy from the sun into chemical energy in the form of organic compounds, such as glucose. This process is essential for life on Earth, as it provides the energy and organic compounds needed to support the food chain.

During photosynthesis, plants use energy from sunlight to drive a series of chemical reactions that involve water, carbon dioxide, and light-harvesting pigments (such as chlorophyll). The overall equation for photosynthesis is:

6 CO2 + 6 H2O + light energy → C6H12O6 (glucose) + 6 O2

In this process, plants absorb carbon dioxide from the atmosphere and release oxygen as a byproduct. Glucose is then used by the plant to fuel its metabolic processes, such as growth and development.

Photosynthesis also occurs in some algae and cyanobacteria, which are capable of photosynthesizing using energy from sunlight or other light sources.

There are two main types of photosynthesis:

1. **C3 photosynthesis**: This is the most common type of photosynthesis, used by plants such as oak trees and lettuce.
2. **C4 photosynthesis**: This type of photosynthesis is found in plants such as corn and sugarcane, which have adapted to hot, dry environments.

Overall, photosynthesis is a vital process that supports life on Earth and is essential for the production of oxygen and organic compounds.
```

Prompt 2

```
>>> Explain Newton's first law of motion.
Newton's First Law of Motion, also known as the Law of Inertia, states
that:

"An object at rest will remain at rest, and an object in motion will
continue to move with a constant velocity, unless acted upon by an
external force."

In simpler terms, this law means that:

1. Objects tend to maintain their state: An object at rest will
stay at rest, and an object in motion will keep moving in the same
direction and speed, unless something else stops or changes it.
2. External forces are required for change: To change an object's
motion, an external force must be applied to it.

This law applies to all objects with mass (i.e., not just small
particles, but also large ones like cars, planets, and even you!).

Examples of Newton's First Law in action:

* A car will keep moving forward on a straight road until the brakes
are applied or the gas pedal is pressed.
* A ball will roll across the floor until something (like friction or
gravity) slows it down.
* You will remain seated in a chair unless an external force (like a
push or pull) acts upon you.

The three main concepts related to Newton's First Law are:

1. Inertia: The tendency of an object to maintain its state of
motion (rest or motion).
2. Velocity: The rate at which an object moves.
3. Force: An external agent that can cause a change in an object's
motion.

Newton's First Law is often used to predict the behavior of objects
under different conditions, such as:

* Predicting how an object will respond to a given force
* Understanding why some objects move more easily than others (e.g.,
wheels vs. feet)
* Describing the behavior of complex systems (like traffic flow or
population dynamics)

Overall, Newton's First Law provides a fundamental understanding of
the relationship between motion, forces, and inertia, which is
essential for physics, engineering, and many other fields.
```

Prompt 3

```
>>> Summarize the French Revolution in two sentences.
The French Revolution was a tumultuous period of social and political
upheaval that began in 1789 with the storming of the Bastille prison,
marking the start of a decade-long struggle for liberty, equality, and
fraternity against the absolute monarchy and feudal aristocracy.
Ultimately, the revolution led to the overthrow of King Louis XVI and
Queen Marie Antoinette, the establishment of the First French
Republic, and the Reign of Terror under Maximilien Robespierre, before
finally giving way to Napoleon Bonaparte's rise to power and the
eventual re-establishment of a monarchy in 1815.
```

Documentation

Prompt	Correctness	Completeness	Clarity
Example: <i>“Explain Newton’s first law of motion”</i>	The facts presented by the model are correct.	The explanation is complete, covering inertia and examples.	Clear and structured.
Example: <i>“Summarize the French Revolution as bullet points”</i>	Historically accurate.	Covers major events but slightly more detailed than expected for a brief summary.	Very clear due to the use of bullet points, easier to read than a paragraph.
Example: <i>“Describe photosynthesis in a table with inputs and outputs”</i>	Scientifically correct.	Captures the main inputs (CO ₂ , H ₂ O, light) and outputs (glucose, O ₂), though may miss variations (C3/C4).	Clear; the tabular format improves readability compared to plain text.

Step 2

Prompt 1:

```
>>> Describe the process of photosynthesis in a table with two columns: "Inputs" and "Outputs".
Here is a table describing the process of photosynthesis:

| **Inputs** | **Outputs** |
| --- | --- |
| Light energy from sunlight | Glucose (C6H12O6) and oxygen (O2) |
| Carbon dioxide (CO2) | Water (H2O) |
| Chlorophyll and other pigments in chloroplasts | ATP and NADPH produced through light-dependent reactions |
| H2O absorbed from soil through roots | Energy stored in glucose molecule for plant growth and development |

Note: The outputs of photosynthesis are the result of both the light-dependent and light-independent (Calvin cycle) reactions.
```

Prompt 2:

```
>>> Explain Newton's First Law of Motion in JSON format, with keys for "Law", "Key Concepts", and "Examples".
Here is Newton's First Law of Motion explained in JSON format:
{
  "Law": {
    "Name": "First Law of Motion",
    "Formula": "An object at rest remains at rest, and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an external force.",
    "Summary": "Also known as the law of inertia, this law states that an object will maintain its state of motion unless a force is applied to it."
  },
  "Key Concepts": {
    "Inertia": "The tendency of an object to resist changes in its motion",
    "External Force": "A force applied to an object from outside the object's system"
  },
  "Examples": [
    "A rolling ball will continue to roll unless a force is applied to it, such as by friction or gravity.",
    "An air molecule moving at rest will remain at rest unless another molecule collides with it and transfers momentum.",
    "An athlete running down a track will maintain their speed until they reach the end of the track or encounter an external force that slows them down."
  ]
}
```

Prompt 3:

```
>>> Summarize the French Revolution as plain text bullet points using "-" for bullets.
- The French Revolution was a complex and multifaceted event that began in 1789 and lasted until 1799.
- The immediate cause of the revolution was a financial crisis, with France deeply in debt from years of costly wars, including the Seven Years' War and the American Revolutionary War.
- In May 1789, the Estates-General, a representative assembly that had not met since 1614, convened in Versailles. The Third Estate (representing commoners) broke away to form the National Assembly, which drafted the Declaration of the Rights of Man and of the Citizen.
- In June 1789, the National Assembly adopted the Tennis Court Oath, vowing to create a new constitution and end the privileges of the nobility.
- The National Assembly forced King Louis XVI to return to Paris in May 1789, marking the beginning of the end of absolute monarchy.
- Over the next several years, radical factions such as the Jacobins, led by Maximilien Robespierre, gained influence and pushed for more extreme measures, including the execution of King Louis XVI and Queen Marie Antoinette.
- In 1792, the monarchy was officially abolished, and the First Republic was declared. However, power struggles between rival factions continued, leading to a series of violent conflicts, including the Reign of Terror.
- The fall of Robespierre in July 1794 marked a turning point in the revolution, as moderates and royalists began to gain ground against the Jacobins.
- Napoleon Bonaparte, a successful military general, seized power in a coup d'état in November 1799, marking the end of the French Revolution and the beginning of the Napoleonic Empire.
- The legacy of the French Revolution is complex and multifaceted, with its ideals of liberty, equality, and fraternity continuing to influence politics and society around the world.
```

Analysis

The prompts were organized and had a clear effect on the manner in which the model gave its answers. It enhanced clarity most of all: the use of tables, JSON and bullet points allowed structuring the information much easier and easier to read compared to plain paragraphs. As an illustration, the French Revolution response in Step 1 was in a long and dense format whereas in Step 2 it was separated into distinct bullet points.

There was comparable accuracy in Step 1 and Step 2. The correctness of the facts in both instances was accurate and therefore, the structured format did not drive the facts down.

Completeness was mixed. The structured structure occasionally resulted in the model overlooking the minor details (e.g., the answer to photosynthesis in Step 2 did not mention C3 and C4 variations, which Step 1 did). Nevertheless, this trade-off enhanced the level of readability, since the information became less voluminous, and it was easy to process.

To conclude, categorized prompts ensured more trustworthy answers to study or reference since the information was arranged and simpler to scan. Although a degree of depth was lost, the increased clarity was of more use in most practical applications.

Step 3

Prompt 1:

```
>>> Example 1: Define respiration in one sentence:
... "Respiration is the process by which cells break down glucose and oxygen to release energy in the form of ATP."
...
... Example 2: Define fermentation in one sentence:
... "Fermentation is a process that allows cells to produce energy without oxygen, usually creating byproducts such as alcohol or lactic acid."
...
... Now define photosynthesis in one sentence.
Here's a definition of photosynthesis:
"Photosynthesis is the process by which cells use light energy from the sun, carbon dioxide, and water to produce glucose and oxygen, releasing energy that can be stored and used by the cell."
```

Prompt 2:

```
>>> Example 1: Newton's Second Law: "Pushing a shopping cart-the harder you push, the faster it moves, showing that force equals mass times acceleration."
...
... Example 2: Newton's Third Law: "When you jump off a small boat, the boat moves backward-every action has an equal and opposite reaction."
...
... Now explain Newton's First Law with a real-world example in the same style.
...
Here's an explanation of Newton's First Law:
"Leaving a moving car - Newton's First Law states that if you're sitting in a moving car, you'll continue to move forward unless there's an external force acting upon you. For example, if you leave a moving car on the highway and don't engage the parking brake, it will keep moving until something like friction from the pavement or air resistance slows it down, illustrating that an object at rest (in this case, the car) remains at rest unless acted upon by an external force."
```

Prompt 3:

```
"Leaving a moving car - Newton's First Law states that if you're sitting in a moving car, you'll continue to move forward unless there's an external force acting upon you. For example, if you leave a moving car on the highway and don't engage the parking brake, it will keep moving until something like friction from the pavement or air resistance slows it down, illustrating that an object at rest (in this case, the car) remains at rest unless acted upon by an external force."
>>> Example 1: American Revolution: "The American Revolution was a war from 1775 to 1783 in which the thirteen colonies broke away from British rule and formed the United States."
...
... Example 2: Russian Revolution: "The Russian Revolution of 1917 ended centuries of imperial rule and led to the creation of a communist government under the Bolsheviks."
...
... Now summarize the French Revolution in one sentence.
...
... The French Revolution, which began in 1789 and lasted until 1799, was a period of violent social upheaval that saw the overthrow of the monarchy, the execution of King Louis XVI and Queen Marie Antoinette, and the rise of Napoleon Bonaparte to power."
```

Evaluation and differences

Prompt	Correctness	Completeness	Clarity	Difference from Step 1
Define photosynthesis in one sentence (with examples given first)	The answer was correct.	It gave the main idea in a short form, without extra details.	Very clear and easy to follow.	Step 1 gave a long, detailed explanation, while Step 3 kept it short and neat.
Explain Newton's First Law with a real-world example (with examples of other laws first)	The answer was correct.	It explained the law well with the car example, though a little wordy.	Clear and understandable because of the real-life example.	Step 1 felt formal and heavy, while Step 3 was more relatable and easier to connect with.
Summarize the French Revolution in one sentence (with examples of other revolutions first)	The facts were correct.	It included the main events but skipped smaller details.	Clear and simple to read.	Step 1 gave too much detail for "two sentences," while Step 3 matched the one-sentence style from the examples.

Step 4

Prompt 1:

```
>>> Question: How does photosynthesis support life on Earth?
... Please think step by step before giving the final answer.
Photosynthesis is a vital process that supports life on Earth in several ways. Here's a step-by-step explanation:

1. **Production of glucose**: During photosynthesis, plants, algae, and some bacteria convert carbon dioxide (CO2) and water (H2O) into glucose (C6H12O6), a type of sugar.
2. **Release of oxygen**: As a byproduct of photosynthesis, these organisms release oxygen (O2) into the atmosphere.
3. **Energy source for life**: The glucose produced during photosynthesis serves as an energy source for many living organisms, including plants themselves, animals, and microorganisms.
4. **Supports food chain**: The glucose produced through photosynthesis is consumed by herbivores, which are then eaten by carnivores. This energy transfer supports the entire food chain on Earth.
5. **Oxygenation of atmosphere**: The oxygen released during photosynthesis is essential for the survival of most living organisms, as it provides the necessary oxygen for cellular respiration (the process by which cells generate energy).
6. **Supports aquatic life**: Photosynthesis in aquatic plants and algae supports the entire aquatic food chain, from phytoplankton to fish and other aquatic animals.
7. **Regulates Earth's climate**: Through photosynthesis, plants absorb CO2 and release O2, helping to regulate the Earth's atmosphere and mitigate the effects of climate change.

In summary, photosynthesis is the foundation of life on Earth, providing energy, oxygen, and supporting complex food webs and ecosystems.
```

Prompt 2:

```
>>> Question: Why do passengers move forward when a car suddenly stops?
... Think step by step and explain clearly.
...
Let's break it down step by step:

1. **Initial Motion**: When the car is moving, all passengers are in motion with it, sharing the same velocity (speed and direction).
2. **Loss of Forward Momentum**: When the car suddenly stops, its forward momentum comes to an end.
3. **Inertia Takes Over**: According to Newton's First Law of Motion, an object at rest will remain at rest, and an object in motion will continue to move with a constant velocity, unless acted upon by an external force.
4. **Passengers' Inertia Remains**: Since the passengers were initially moving forward with the car, their bodies retained this momentum, which is now unbalanced due to the sudden stop of the vehicle.
5. **Conservation of Momentum**: The total momentum (mass x velocity) of the system remains constant. When the car stops, the momentum it had in motion must be conserved elsewhere. In this case, the passengers' momentum is transferred forward to keep them moving, albeit quickly and often with a loss of control.
6. **Body Orientation and Reaction Time**: Passengers' bodies tend to resist changes in direction or motion due to inertia (conservation of angular momentum). This means their heads and upper bodies will continue moving forward for a brief moment after the car stops, while their lower bodies react more slowly due to the lag between head and foot movement.
7. **Floor Reaction Force**: The sudden deceleration also creates a force reaction from the floor on passengers' feet, which helps to keep them upright and moving forward.

In summary, when a car suddenly stops, passengers move forward because of their retained momentum, inertia, and the conservation of momentum within the system.
```

Prompt 3:

```
>>> Question: Why did the French Revolution happen?
... Think step by step and explain the causes in order.
...
Here's a step-by-step explanation of the causes leading to the French Revolution:

**Step 1: Financial Crisis ( Late 18th century)**
The French government was deeply in debt from years of costly wars, including the Seven Years' War and the American Revolutionary War. This led to a significant increase in taxes, which burdened the common people.

**Step 2: Social Inequality (Early 18th century)**
France was divided into three estates: the nobility, the clergy, and the commoners (Third Estate). The nobility and clergy held most of the power and wealth, while the Third Estate was heavily taxed but offered little representation or influence.

**Step 3: Enlightenment Ideas ( Late 17th to Early 18th centuries)**
The writings of Enlightenment thinkers such as Jean-Jacques Rousseau, Voltaire, and Denis Diderot spread ideas of liberty, equality, and democracy. These ideas challenged the traditional social hierarchy and fueled discontent among the common people.

**Step 4: Food Shortages and Economic Hardship ( Late 18th century)**
A series of poor harvests and economic downturn led to widespread poverty, hunger, and discontent among the population. This created a sense of desperation and frustration among the common people.

**Step 5: Rise of the Bourgeoisie ( Late 18th century)**
The growing middle class, known as the bourgeoisie, became increasingly influential in French society. They were educated, wealthy, and ambitious, and they began to demand more rights and representation.

**Step 6: Enlightenment Philosophers' Influence ( Late 17th to Early 18th centuries)**
Thinkers like Rousseau, Voltaire, and Diderot's ideas about the social contract, natural rights, and the sovereignty of the people further fueled the growing discontent among the population.

**Step 7: Royal Family's Financial Mismanagement ( Late 18th century)**
King Louis XVI and Queen Marie Antoinette's financial mismanagement exacerbated the country's economic problems. Their lavish spending and failure to address the crisis led to widespread resentment.

**Step 8: The Estates-General and National Assembly (May 1789)**
The Third Estate, frustrated by their lack of representation in the old system, broke away to form the National Assembly. This marked a turning point in the Revolution, as it represented a new era of popular participation and direct democracy.

These steps demonstrate the complex interplay of causes that led to the French Revolution. The Revolution was not just one event but rather a culmination of years of growing discontent, economic hardship, and the spread of Enlightenment ideas about liberty, equality, and democracy.

>>> End a response (2 for help)
```

Evaluation

Prompt	Reasoning Complexity	Accuracy	Clarity	Difference from Step 1–3
How does photosynthesis support life on Earth? (step by step)	Broke the answer into 7 logical steps (glucose, oxygen, energy, food chain, climate).	Correct all points were scientifically valid.	Very clear and systematic.	Step 1 gave facts, Step 2 put them in a table, Step 3 shortened it; Step 4 explained the whole chain of effects in detail.
Why do passengers move forward when a car suddenly stops? (step by step)	Carefully explained motion, inertia, and momentum step by step.	Correct physics.	Clear, with real-world reasoning.	Step 1 was a plain definition of Newton's Law; Step 4 actually applied reasoning to explain the situation in detail.
Why did the French Revolution happen? (step by step)	Listed multiple causes in order: debt, inequality, Enlightenment, food shortages, bourgeoisie, monarchy's failures, Estates-General.	Accurate historically.	Very clear, because each cause was explained separately.	Step 1 gave a compact summary; Step 4 laid out a clear cause-and-effect sequence that's easier to follow.