The Tree-of-Thought Approach to Prompt Engineering

Skills Network

**Estimated time needed:** 40 minutes

Learning objectives:

After completing this lab, you will be able to:

- Describe the Tree-of-Thought (ToT) prompting method
- Discuss how ToT enables structured exploration of multiple reasoning paths in large language models
- Compare the Tree-of-Thought approach with linear reasoning methods to evaluate its effectiveness in complex problem-solving scenarios

Introduction

At its core, the Chain-of-Thought prompting solicits a step-by-step thinking process from the LLM. Compared to the naive/standard/Input-Output prompting, we get far better results with it.

However, there are some limitations. The research paper "Tree of Thoughts: Deliberate Problem Solving with Large Language Models" by Yao et al. compared various approaches to prompting, including naive prompting, CoT, as well as a new technique called Tree-of-Thought (ToT), as shown in their image below.
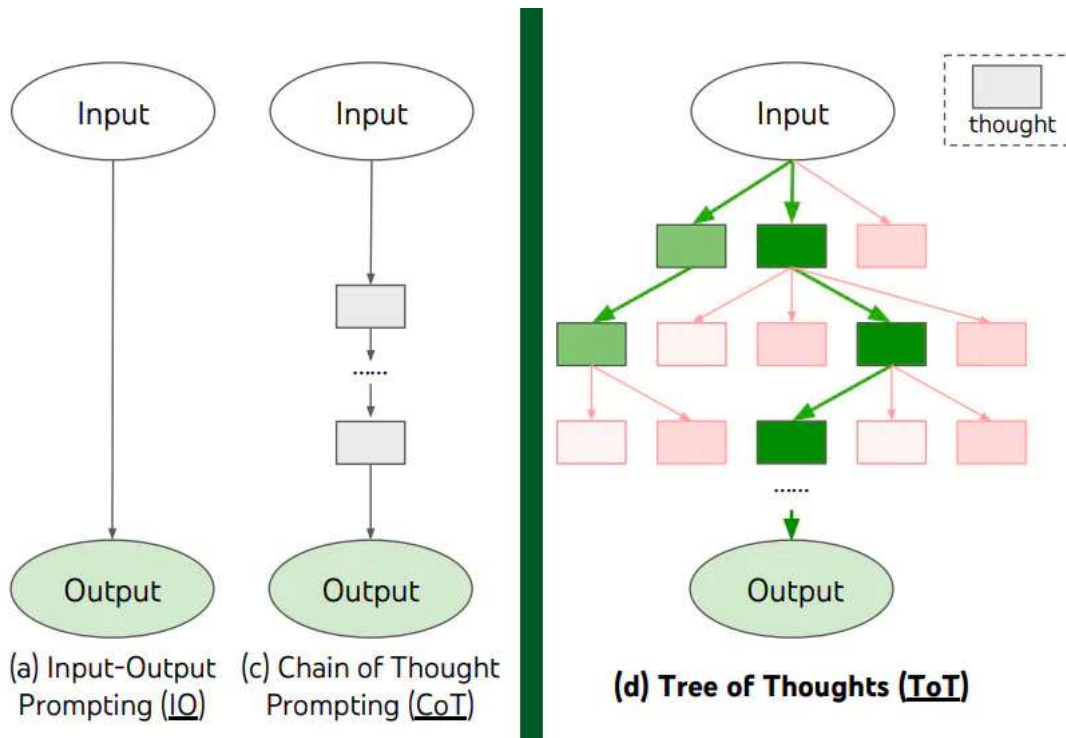
For example, in the Game of 24, GPT-4 with Chain-of-Thought prompting solved only 4% of tasks. In comparison, their ToT approach achieved a success rate of 74%.

The researchers remarked that the CoT didn't perform as well as it "lacks mechanisms to try different clues, make changes to decisions, or backtrack."

And that's the main limitation of CoT. When considering a complex problem, humans (well, systematic and logical ones, at least) tend to explore a tree of thoughts, evaluating what works and what doesn't, backtracking if needed, jumping back to a previous "node" in the tree if it was more beneficial or promising for the resolution of the problem.

Example of Tree-of-Thought

Tree-of-thought prompting uses a similar approach that not only invites the AI to consider a step-by-step process and to think logically but also makes it consider intermediate thoughts, building upon them and exploring branches that may or may not lead somewhere. This exploration maximizes the use of LLM and its capabilities, leading to drastically more useful results.

Tree-of-Thought (ToT) Prompting is an innovative method that expands upon and refines the existing Chain-of-Thought prompting approach. By incorporating ToT Prompting, LLMs can demonstrate enhanced reasoning skills. Moreover, this technique allows these models to correct their mistakes autonomously and continually build upon their knowledge.

Dave Hulbert suggested a few rather convincing prompts that leverage this approach and yield, anecdotally, great results. I particularly like how he incorporates the persona pattern and recommends that you approach ToT prompting using his prompts or similar variations you might develop yourself.

Let's analyze the example problem and the recommended prompts.

Choose the model:

Use the dropdown option from the top-left corner of the right pane for the text generation exercise and choose "GPT-4.1 Nano" model.
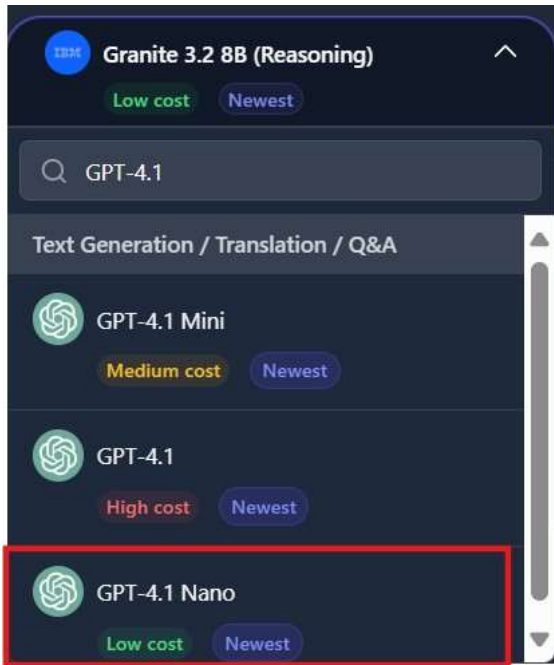
The question many LLM fail to address is the following. Let's consider the following prompt.

```
Bob is in the living room.
He walks to the kitchen, carrying a cup.
He puts a ball in the cup and carries the cup to the bedroom.
He turns the cup upside down, then walks to the garden.
He puts the cup down in the garden, then walks to the garage.
Where is the ball?
```

If you try the GPT 4.0 mini model, you might get the correct answer simply because Dave's work has become influential, and the authors of the LLM might have improved the model due to his work. Nevertheless, when I tried it, I got:

> The ball is in the garden. When Bob put the cup upside down in the garden, the ball would have fallen out since the cup was no longer upright to hold it. If you have any further questions about this scenario or need clarification, feel free to ask!

This is the wrong answer since the cup went upside down in the bedroom, literally dropping the ball (and metaphorically in the case of the LLM).

Even if GPT-4.0 mini gets it right for you, try it with other models, and you'll be able to see the AI getting the answer wrong (usually, they will mistakenly reply that the ball is in the garden, in the cup, or spout a nonsensical answer.)

Now, let's create a new chat and place the following in the prompt instructions:

```
Imagine three different experts are answering this question.
All experts will write down 1 step of their thinking, then share it
with the group. Then all experts will go on to the next step, and so on.
If any expert realizes they're wrong at any point, then they leave.
Answer the question based on experts' opinion. The question is...
```

In the prompt, plug in the same question as before:

```
Bob is in the living room.
```

```
He walks to the kitchen, carrying a cup.
He puts a ball in the cup and carries the cup to the bedroom.
He turns the cup upside down, then walks to the garden.
He puts the cup down in the garden, then walks to the garage.
Where is the ball?
```

The output I got is as follows:

To determine where the ball is, let's analyze the experts' reasoning step by step.

Expert 1:
Step 1: Bob starts in the living room and walks to the kitchen carrying a cup. At this point, the cup is empty.

Expert 2:
Step 1: While in the kitchen, Bob puts a ball into the cup. Now the cup contains the ball.

Expert 3:
Step 1: Bob then carries the cup, which now has the ball inside it, to the bedroom. The ball is still in the cup at this stage.

Expert 1:
Step 2: In the bedroom, Bob turns the cup upside down. This action means the ball would fall out of the cup.

Expert 2:
Step 2: After turning the cup upside down, the ball is no longer in the cup. It has likely fallen out onto the surface he turned it over onto.

Expert 3:
Step 2: Bob then walks to the garden, but since he turned the cup upside down in the bedroom, the ball is not in the cup anymore. The ball is now on the floor in the bedroom.

Expert 1:
Step 3: Bob puts the cup down in the garden. At this point, the cup is empty since the ball fell out earlier.

Expert 2:
Step 3: Bob walks to the garage next. The ball remains in the bedroom because it fell out when he turned the cup upside down.

Expert 3:
Step 3: Therefore, the ball is still in the bedroom, while Bob is now in the garage.

Final Conclusion:
The ball is in the bedroom, as it fell out of the cup when Bob turned it upside down before walking to the garden and then to the garage.

This reasoning is quite accurate and it's closer to the actual solution. Depending on the model you use, the answer will either be better than our previous attempts (though not 100% correct) or flat-out perfect (typically, with the latest GPT incarnation).

Even if the reasoning is only sometimes 100% correct, this approach tends to yield accurate results most of the time. Plus, since the reasoning behind the output can be scrutinized, it will be easier to determine whether we obtained the correct result.

Let's try the other two prompts suggested by Hulbert.

Open a new chat and use the same prompt, but this time, use the following for the Prompt Instructions:

```
Simulate three brilliant, logical experts collaboratively answering a question. Each one verbosely explains their thought process in real-time, consi
```

Did you get the right answer? How did it compare with the previous one?

Finally, let's try the third option:

```
Identify and behave as three different experts that are appropriate to answering this question.
All experts will write down the step and their thinking about the step, then share it with the group.
Then, all experts will go on to the next step, and so on.
At each step, all experts will score their peers\' responses between 1 and 5, 1 meaning it is highly unlikely, and 5 meaning it is highly likely.
If any expert is judged to be wrong at any point, then they leave.
After all experts have provided their analysis, you then analyze all 3 analyses and provide either the consensus solution or your best guess solution
The question is...
```

I tried this with a GPT4.0 mini model, and I'm pretty impressed with the answer I received, reported below:

Expert 1: Cognitive Scientist

1. **Step 1: Analyze the sequence of actions.**
   - Bob starts in the living room and moves to the kitchen. He carries a cup and puts a ball in it.
   - He then carries this cup to the bedroom and turns it upside down, which means the ball will fall out of the cup.
   - After that, he walks to the garden and places the cup down there, but the ball is no longer in the cup since it was turned upside down in the bedroom.
   - Finally, he walks to the garage.

Score for Expert 2 and Expert 3:

- Expert 2: 5 (accurately followed the sequence and reasoning)
- Expert 3: 5 (also correctly identified the sequence)

Expert 1 Score: 5

Expert 2: Logician

1. **Step 1: Determine the final location of the ball based on actions taken.**
   - Bob's actions indicate that he started with a cup containing a ball.
   - After placing the ball in the cup, he transferred it to the bedroom and turned the cup upside down.
   - This action implies the ball is no longer in the cup at this point.
   - He then moves to the garden and places the cup there, but since the ball had already fallen out, it is not in the cup when he leaves it in the garden.

Score for Expert 1 and Expert 3:

- Expert 1: 5 (good logical reasoning)
- Expert 3: 5 (consistent with the analysis)

Expert 2 Score: 5

Expert 3: Linguist/Language Expert

1. **Step 1: Examine the language and implications of the actions.**
   - The phrasing "He turns the cup upside down" suggests that the contents of the cup (the ball) would no longer be contained within it.
   - The subsequent actions of placing the cup down in the garden do not change the fact that the ball was released from the cup when it was turned upside down in the bedroom.
   - Therefore, the ball is not in the cup when he leaves it in the garden.

Score for Expert 1 and Expert 2:

- Expert 1: 5 (the language used is clear and accurate)
- Expert 2: 5 (logical conclusion based on language)

Expert 3 Score: 5

Consensus Analysis:

All experts agree that the ball is not in the cup after Bob turns it upside down in the bedroom. Therefore, the final answer is:

The ball is in the bedroom (on the floor, as it fell out of the cup).

Older models will not perform as well and sadly still get the answer wrong occasionally (so don't fret if you get the wrong answer). The approach to prompting still gives you your best chance at getting a proper response, even if this isn't an exact science that will get it right 100% of the time.

Applying ToT to something more useful

Alright, enough with little riddles. Can we apply this prompt strategy to more practical and valuable approaches? We certainly can.

Imagine the following scenario. We just started a site selling shoes online. We want assistance from an LLM to produce a good marketing campaign, and we, of course, want to extract as many useful suggestions from the AI as possible.

A naive/standard prompt might be:

```
Define a marketing plan for my online store, which sells shoes.
```

Adopting the Persona Pattern we have:

```
Acting as a marketing expert, define a marketing plan for my online store, which sells shoes.
```

Now, let's try the Tree-of-Thought Prompt Instructions like before:

```
Imagine three different experts are answering this question.
All experts will write down 1 step of their thinking,
then share it with the group.
Then all experts will go on to the next step, and so on.
If any expert realizes they're wrong at any point then they leave.
```

For the prompt, we can use our original question:

```
Define a marketing plan for my online store, which sells shoes.
```

Expert 1: The first step in defining a marketing plan is to identify your target audience. For an online shoe store, this could include demographics such as age, gender, income level, and interests. Understanding who your ideal customers are will help tailor your marketing strategies effectively.

Expert 2: Next, we should conduct a competitive analysis. This involves researching other online shoe stores to understand their marketing strategies, pricing, product offerings, and customer engagement techniques. This information will help us identify gaps in the market and opportunities for differentiation.

Expert 3: The third step is to establish clear marketing goals and objectives. These should be specific, measurable, achievable, relevant, and time-bound (SMART). For example, goals could include increasing website traffic by 30% over the next quarter or achieving a 15% conversion rate on your online store.

Expert 1: Now that we've identified the target audience, we can develop buyer personas. These are detailed profiles of your ideal customers that include their shopping behaviors, preferences, and pain points. This will guide our messaging and marketing channels.

Expert 2: After the competitive analysis, we should outline the unique selling proposition (USP) of your online store. What sets your shoe store apart from competitors? This could be unique styles, sustainable materials, or exceptional customer service. Clearly defining your USP will help in crafting your marketing messages.

Expert 3: Once we have our marketing goals, we can decide on the marketing channels to use. This could include social media platforms, email marketing, influencer partnerships, and search engine optimization (SEO). Each channel should align with where your target audience spends their time online.

Expert 1: Next, we should create a content strategy that aligns with our buyer personas. This includes deciding on the type of content to produce, such as blog posts about shoe care, social media posts showcasing new arrivals, or videos demonstrating how to style different shoes.

Expert 2: Following the content strategy, we need to establish a budget for our marketing activities. This includes costs for advertising, content creation, influencer partnerships, and any tools or software needed for marketing automation and analytics.

Expert 3: Finally, we should implement a system for tracking and measuring the effectiveness of our marketing efforts. This could involve using analytics tools to monitor website traffic, conversion rates, and customer engagement metrics. Regularly reviewing this data will help us adjust our strategy as needed.

By following these steps, we can create a comprehensive marketing plan tailored to your online shoe store.

(Note: In this hypothetical scenario, each "expert" provided their input, but in reality, marketing planning is a collaborative effort that requires input from various specialists to create a well-rounded strategy.)

Not only is this a great initial answer, but as you can see, the three experts who appear to specialize in different aspects of online marketing (SEO, E-Commerce, and so on) build on top of each other's previous steps and thoughts.

Moreover, having established this framework, we can now ask follow-up questions. Specific ones we might have, or simply soliciting further input from the AI. For example, with a simple:

```
Next steps
```

> **Expert 1:** The next step is to implement the marketing strategies we've developed. This involves launching campaigns across the chosen marketing channels, such as social media ads, email newsletters, and content marketing initiatives. It's important to maintain consistency in branding and messaging across all platforms to reinforce your brand identity.
>
> **Expert 2:** After implementation, we should focus on customer engagement. This includes responding to customer inquiries, encouraging reviews, and creating interactive content (such as polls or quizzes) to foster a community around your brand. Engaging with customers can enhance loyalty and encourage word-of-mouth referrals.
>
> **Expert 3:** Finally, we need to establish a feedback loop. This means regularly soliciting feedback from customers through surveys or direct communication to understand their experiences and preferences. This data will help refine your offerings and marketing strategies over time, ensuring they remain relevant and effective.
>
> By following these next steps, you'll be able to effectively execute and refine your marketing plan for your online shoe store.

Regularly assessing the strategies and offerings of our competitors helps us stay ahead of the curve. By identifying gaps in the market or areas where competitors may be falling short, we can innovate and differentiate our store. Whether it's through new product features, unique marketing angles, or improved customer service, innovation keeps us relevant and adaptable.

(Note: Each expert's input builds upon the previous steps and adds further depth to the marketing plan. These steps are intended to create a comprehensive and adaptable strategy for the online shoe store.)

The vast potential of this approach when exploring topics and seeking advice cannot be overstated. Even if the individual steps are generic, we can always ask the AI to assist or give us specifics for a particular step.

Try yourself

Exercises

1. Using the Tree-of-Thought prompting approach, leverage the LLM to answer a different type of question you might have.

2. Try to devise your variation of Dave's prompt instructions. Does it make the output better or worse? You might stumble upon a winning prompt that you can use in various scenarios.

3. Some sample scenarios that you can try are:

   - Create a program to automatically schedule university classes with the fewest conflicts. Consider various scheduling options and identify the optimal one.

   - Given a complex algebra word problem with multiple steps, generate different ways to solve it and evaluate which is the most straightforward or elegant.

   - Brainstorm multiple plot directions for a mystery novel where a detective must solve a high-profile case involving a missing artifact. Choose the most compelling narrative arc.

   - You are given a limited budget and need to decide between three competing investment opportunities, each with different risks and potential returns. Walk through possible scenarios to determine the most optimal investment.

Additional Thoughts

Specificity in Instructions: In a real-world scenario, while the generic steps are valuable, you can be more specific in your instructions for more actionable results. For instance, you might request each "expert" to provide two actionable tactics or tools per step they suggest. And you can, of course, request specific experts or expertise.

Integration with Real Data: If you can supply the LLM with specific data about your business (like target audience demographics, current website analytics, or specific marketing goals), it can potentially refine its responses even further. Just be mindful of potential confidential information.

Segmented Inquiry: As briefly mentioned before, once you have a broad strategy laid out, you can dive deeper into each individual step, asking the experts to further expand on their suggestions, or even query different experts about the same step to gather multiple perspectives.

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