

The Tree-of-Thought approach to Prompt Engineering

At its core, 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.

There are some limitations, however. In a research paper (i.e., arXiv:2305.10601), 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, anecdotically, great results. I particularly like how he incorporates the Persona pattern and recommend you approach ToT prompting using his prompts or similar variations you might develop yourself.

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

The question many LLM fail to address is the following. Let's consider the following prompt.

```
1. 1
2. 2
3. 3
4. 4
5. 5
6. 6
```

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

Copied!

If you try the GPT 3.5 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 cup, which is currently in the garden.

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-3.5 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:

```
1. 1
2. 2
3. 3
4. 4
```

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

Copied!

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

```
1. 1
2. 2
3. 3
4. 4
5. 5
6. 6
```

```
1. Bob is in the living room.
2. He walks to the kitchen, carrying a cup.
3. He puts a ball in the cup and carries the cup to the bedroom.
```

4. He turns the cup upside down, then walks to the garden.
5. He puts the cup down in the garden, then walks to the garage.
6. Where is the ball?

Copied!

The output I got from GPT 3.5 is as follows:

Expert 1: Based on the information given, the ball is in the bedroom. Bob carried the cup with the ball from the kitchen to the bedroom.

Expert 2: I agree with Expert 1. Bob put the ball in the cup in the kitchen and then carried the cup to the bedroom. So the ball should still be in the cup in the bedroom.

Expert 3: Yes, I also agree. Bob turned the cup upside down in the bedroom, so the ball should still be inside the cup in the bedroom.

Although this isn't entirely accurate (the ball is in the bedroom but not in the cup,) 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:

1. 1
1. Simulate three brilliant, logical experts collaboratively answering a question. Each one verbosely explains their thought process in real-time, consi

Copied!

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

Finally, let's try the third option:

1. 1
2. 2
3. 3
4. 4
5. 5
6. 6
7. 7
1. Identify and behave as three different experts that are appropriate to answering this question.
2. All experts will write down the step and their thinking about the step, then share it with the group.
3. Then, all experts will go on to the next step, etc.
4. At each step all experts will score their peers response between 1 and 5, 1 meaning it is highly unlikely, and 5 meaning it is highly likely.
5. If any expert is judged to be wrong at any point then they leave.
6. After all experts have provided their analysis, you then analyze all 3 analyses and provide either the consensus solution or your best guess solution
7. The question is...

Copied!

I tried this with a GPT4 model I had access to, and I'm pretty impressed with the answer I received, reported below:

Expert 1: Detective

Thinking: I'll approach this like I'm solving a mystery. It's about piecing together evidence and ensuring there are no gaps in the narrative.

Step 1: Bob starts in the living room and walks to the kitchen with a cup. There's no mention of the ball at this point.

Thinking: Right now, the cup is empty.

Step 2: In the kitchen, Bob puts a ball in the cup.

Thinking: The cup now contains the ball.

Step 3: Bob carries the cup with the ball to the bedroom.

Thinking: Ball is still in the cup.

Step 4: He turns the cup upside down in the bedroom.

Thinking: Turning the cup upside down implies the ball falls out.

Step 5: He walks to the garden and puts the cup down, then moves to the garage.

Thinking: The ball wasn't mentioned in the garden, so the last known location of the ball is in the bedroom.

Detective's Conclusion: The ball is in the bedroom.

Score for other experts based on this step: [will be given after their analysis]

Expert 2: Physicist

Thinking: Let's use the laws of physics and make some assumptions about the world.

Step 1: Bob moves from the living room to the kitchen with a cup.

Thinking: Nothing special here, just motion.

Step 2: Ball is put in the cup in the kitchen.

Thinking: The cup has mass m_1 , ball has mass m_2 . Now it's $m_1 + m_2$.

Step 3: Bob carries this combined mass to the bedroom.

Thinking: Movement of objects but they remain together.

Step 4: Cup turned upside down in the bedroom.
Thinking: Gravity acts on the ball, and it falls out.

Step 5: Walks to garden, then garage. Cup’s motion is mentioned, but not the ball’s.
Thinking: There’s no external force mentioned that would make the ball teleport or move to another location. Ball remains where it was last influenced by gravity.

Physicist’s Conclusion: The ball is in the bedroom.
Score for other experts based on this step: [will be given after their analysis]

Expert 3: Storyteller
Thinking: Stories are about narrative and flow, and sometimes, about misleading the reader. Let’s see if there’s a twist.

Step 1: Simple setup. Bob moves from living room to kitchen.
Thinking: Introducing the character and his journey.

Step 2: Ball enters the picture. It’s in the cup.
Thinking: Key element introduced.

Step 3: Journey continues to the bedroom.
Thinking: Suspense. Where is this going?

Step 4: Plot twist! Cup is turned upside down.
Thinking: This is the climax of the story. The ball is dropped.

Step 5: Bob goes to the garden and then garage. No mention of the ball.
Thinking: Deliberate omission to make reader think.

Storyteller’s Conclusion:

The ball is in the bedroom.
Score for other experts based on this step: [will be given after their analysis]

Scores: (Given by each expert based on the final conclusion)
Detective: Physicist (5), Storyteller (5)
Physicist: Detective (5), Storyteller (5)
Storyteller: Detective (5), Physicist (5)

ChatGPT’s Analysis:

All three experts independently arrived at the conclusion that the ball is in the bedroom. Their methodologies varied but the consensus is clear.

Consensus Solution:

The ball is in the bedroom.

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:

1. 1
1. Define a marketing plan for my online store, which sells shoes.

Copied!

Adopting the Persona Pattern we have:

1. 1
1. Acting as a marketing expert, define a marketing plan for my online store, which sells shoes.

Copied!

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

1. 1
2. 2
3. 3
4. 4
5. 5
1. Imagine three different experts are answering this question.
2. All experts will write down 1 step of their thinking,
3. then share it with the group.
4. Then all experts will go on to the next step, etc.
5. If any expert realizes they're wrong at any point then they leave.

Copied!

For the prompt, we can use our original question:

1. 1
1. Define a marketing plan for my online store, which sells shoes.

Copied!

The output I got was as follows:

Expert 1:

Step 1 - Market Research and Target Audience Identification

In this step, we need to conduct thorough market research to understand the current trends in the shoe market. We'll analyze the competition, customer preferences, and emerging styles. This will help us identify our target audience based on demographics, psychographics, and buying behavior.

Expert 2:

Step 2 - Unique Selling Proposition (USP) and Product Selection

With the target audience in mind, we need to determine our online store's Unique Selling Proposition (USP). What sets our shoe store apart from others? It could be anything from offering a specific type of shoe not easily found elsewhere, emphasizing sustainable materials, or providing exceptional customer service. Once the USP is defined, we can curate a selection of shoes that align with our chosen positioning.

Expert 3:

Step 3 - Website Development and User Experience

Creating an engaging and user-friendly online platform is crucial. We'll design a website that reflects our brand's identity and makes it easy for customers to browse and purchase shoes. This involves optimizing the website for mobile devices, ensuring fast loading times, and implementing intuitive navigation. High-quality product images and detailed descriptions are essential to help customers make informed purchasing decisions.

Expert 1:

Step 4 - Digital Marketing Strategy: Content Creation and SEO

To attract organic traffic, we'll focus on creating valuable content related to shoes, fashion, and lifestyle. This could include blog posts, videos, and social media content. Implementing effective search engine optimization (SEO) techniques will improve our website's visibility in search engine results, driving relevant traffic to our online store.

Expert 2:

Step 5 - Social Media and Influencer Marketing

We'll leverage various social media platforms to showcase our shoes and engage with our audience. Collaborating with influencers in the fashion and footwear niche can amplify our brand's reach and credibility. Their endorsements can introduce our products to a larger audience and generate buzz around our store.

Expert 3:

Step 6 - Email Marketing and Customer Retention

Building an email subscriber list is valuable for nurturing customer relationships. We'll implement an email marketing strategy to send personalized recommendations, exclusive offers, and updates to our subscribers. This approach helps in customer retention and encourages repeat purchases.

Expert 1:

Step 7 - Paid Advertising: Google Ads and Social Ads

Investing in paid advertising can accelerate our store's visibility. We'll run targeted Google Ads campaigns to capture potential customers actively searching for shoes. Additionally, strategic social media advertising on platforms like Facebook and Instagram will allow us to reach a wider audience based on demographics, interests, and behaviors.

Expert 2:

Step 8 - Analytics and Continuous Improvement

Constantly monitoring our marketing efforts is essential. We'll use web analytics to track key metrics such as website traffic, conversion rates, and customer engagement. This data will guide us in making informed decisions to optimize our marketing strategies and improve overall performance.

Expert 3:

Step 9 - Feedback Utilization and Adaptation

Listening to customer feedback helps us understand their needs and preferences better. We'll gather reviews, comments, and suggestions from customers and use this information to adapt our product offerings, customer service, and marketing strategies. This iterative approach ensures our online shoe store remains relevant and customer-centric over time.

(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, etc.) 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:

1. 1
1. Next steps

Copied!

This further expands the plan, building on top of each expert's thoughts and previous steps. It's like having a panel of experts doing the work for us!

Expert 1:

Step 10 - Partnerships and Collaborations

Exploring partnerships with other relevant businesses or brands can expand our reach. We can collaborate on co-branded products, joint marketing campaigns, or even participate in events or pop-up shops. These partnerships can introduce our shoe store to new audiences and create mutually beneficial relationships.

Expert 2:**Step 11 - Customer Engagement and Community Building**

Creating a sense of community around our shoe store can foster strong customer loyalty. We can establish online forums, social media groups, or interactive features on our website where customers can share their experiences, style tips, and even user-generated content showcasing our shoes. This engagement not only builds a loyal customer base but also encourages word-of-mouth marketing.

Expert 3:**Step 12 - Diversification and Expansion**

As the online shoe store gains traction, consider diversifying our product offerings. This could involve adding complementary products such as shoe accessories, socks, or related fashion items. Additionally, expanding into international markets can open up new opportunities for growth. However, careful research and planning are essential when entering new markets to understand cultural differences and customer preferences.

Expert 1:**Step 13 - Seasonal and Trend-based Campaigns**

Staying up-to-date with seasonal trends and fashion cycles is crucial. Designing marketing campaigns around specific seasons, holidays, or fashion trends can capture the attention of customers looking for relevant styles. These campaigns can include limited-time offers, themed collections, and creative promotions that resonate with our target audience.

Expert 2:**Step 14 - Customer Experience Enhancement**

Continuously improving the customer experience will set us apart. This involves streamlining the purchasing process, offering multiple payment options, providing exceptional customer support, and hassle-free return policies. Positive customer experiences not only lead to repeat purchases but also encourage positive reviews and recommendations.

Expert 3:**Step 15 - Competitor Analysis and Innovation**

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.

Additional Thoughts

Specificity in Instructions: In a real-world scenario, while the generic steps are valuable, for more actionable results, you can be more specific in your instructions. 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.

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.

Author(s)

[Antonio Cangiano](#)

© IBM Corporation. All rights reserved.