How can AI be surprised to magic?

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Abstract

While humans can readily comprehend and be surprised by magic, the same is not straightforward for AI. AI must acquire a diverse skill set to understand different magic tricks. Examining several magic instances reveals that AI must understand the physical processes the capability boundaries of the audience, and the relationships between people. Achieving this demands parsing, reasoning, and simulation of scenes, objects, and agents.

1 Introduction

Magic shows are the art of producing things that defy commonsense, captivating audiences worldwide. These shows often leave audiences in a state of awe and wonder, as they challenge conventional intuition and reasoning. Many people can't help but want to figure out how magic happens. Yet, once the secrets are unveiled, the shows often lose their charm because audiences who know the truth are no longer surprised. Consequently, most of the great magic shows remain secret, safeguarding their allure.

Some research hopes to use AI to reveal the secrets of magic. [2] have delved into the application of video analysis software to track the coin in a sleight of hand coin tricks, attempting to unveil the true location of the elusive coin. However, even with AI's superior analytical prowess, it remains susceptible to deception. Notably, visual tracking methods, while effective in certain cases, can only be useful in limited magic tricks. And such methods actually give the AI a strong prior: You have to reveal a visual magic trick.

Some people's ideal omnipotent AI would not be surprised by a magic show. This hypothetical AI would inherently understand the mechanics of a magic show upon witnessing it. Present-day AI, though advanced in various domains, is indeed not surprised when watching many magic shows. It is not because the AI has revealed the magic, but because the AI grapples with the fundamental question of why these performances defy conventional cognition. Therefore, before building an AI that can reveal magic tricks, we should first let the AI understand the magic of a magic show.

2 Analysis

Being surprised during magic performances demands many capabilities. This is due to the fact that understanding various forms of magic necessitates distinct sets of common sense and cognitive abilities. In the following, we will illustrate three magic instances, outlining several essential skills in magic appreciation that AI is anticipated to acquire.

2.1 Understanding physical process: Coin Disappearance Magic

In contrast to the magic trick involving the deceptive relocation of a coin discussed in Sec. 1, the magic trick here misleads the audiences about the material of the coin.

As illustrated in Fig. 1, the magician envelops a coin within a tissue, and then kneads the tissue and the coin inside into a small ball. The surprising thing about this magic show stems from the inherent

(a) (b)

Figure 1: Coin Disappearance Magic: (a) Wrap the coin made of tinfoil into a tissue, and then (b) Knead them into a small ball

implausibility of reshaping an object as rigid as a coin with mere human hands. A coin, typically composed of sturdy alloy, should resist deformation and remain unaltered in size. However, the “coin" in this scenario is, in reality, a replica crafted with tinfoil, permitting it to be easily compressed.

To evoke astonishment in AI when confronted with this illusion, some prerequisites must be met. Firstly, the AI system needs a profound comprehension of object interactions. In this performance, the coin becomes concealed within the tissue, making it visually inaccessible. The AI must discern that, under these conditions, the coin is situated within the tissue. Secondly, the AI must possess knowledge about the inherent attributes of objects. For instance, coins are generally fabricated from alloys, known for their rigidity and resistance to deformation. This information can be represented explicitly as an attribute associated with the coin, or it can be deduced from the coin’s classification as a metal object. The AI should retain knowledge about concealed items within the current frame and effectively analyze these components within the context of video input.

After the AI analyzes the scene and objects, it still needs to reason: Because the coins wrapped in the tissue are very hard, they cannot be crushed into a small ball like the performance shows, and thus be surprised. Even with formidable parsing capabilities, selecting the most relevant attribute among numerous options for reasoning remains a challenge. Parsing and reasoning may be complementary processes. As the need for a specific attribute arises during the reasoning process, parsing can be initiated to acquire the requisite data. The information parsed makes the reasoning process continue.

Nonetheless, reasoning is not the only path. Humans instinctively detect incongruities when they witness a coin being compressed into a small ball. During the magical performance, audiences do not consciously engage in analytical reasoning to debunk the implausible occurrence. Instead, it resembles a mental simulation in which humans envision the expected outcomes of the magician’s actions. The audiences are surprised when these mental simulations deviate from reality. For AI to implement this process, the incorporation of a physics engine or intuitive physics engine [1] becomes essential. This engine enables the AI to predict and simulate how objects should behave during the magician’s actions, creating a feedback loop that complements the parsing process.

2.2 Understanding the audience’s capability boundaries: Math Magic

Using math magic tricks as shown in Fig. 2, one can unveil your birthday without directly requesting this information.

For individuals who take math classes seriously during their middle school years, this may not appear as a magical feat. They recognize that this sequence of arithmetic operations is just designed to confuse the audience. Even if the solution isn’t immediately apparent, it becomes evident after a brief process of derivation that the outcome of these mathematical manipulations equates to the month of one’s birthday plus 0.01 times the day of their birth. In reality, a sizable category of math magic tricks adheres to this pattern: the magician conducts calculations involving the concealed information,

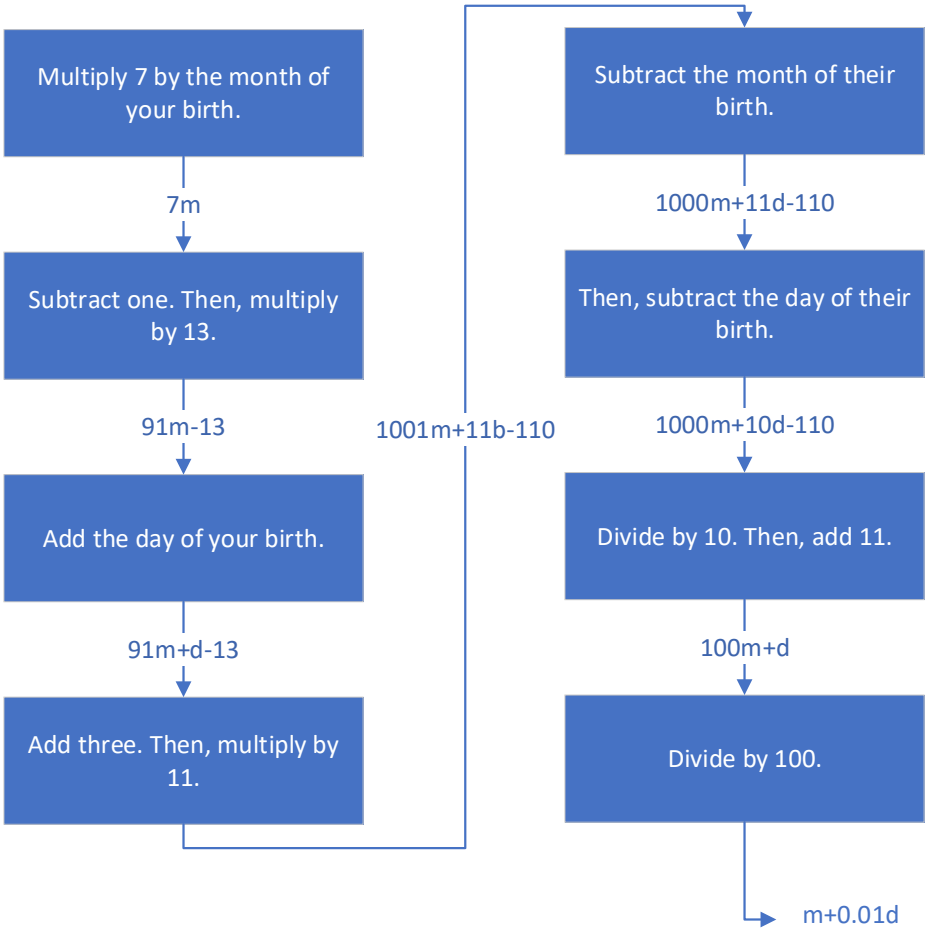

Figure 2: Math magic: Confuse the audience through a series of calculations and get the results the magician wants. m denotes the month of your birth and d denotes the day of your birth.

ultimately deducing the hidden details through inverse operations. The underlying principles are generally not complicated. But we can also understand that for certain individuals, such as students recently introduced to basic arithmetic, this can still be called magic, because these audiences may may lack an in-depth grasp of mathematics.

Such mathematical operations are not complicated for AI, and AI is unlikely to be confused by complicated operations like humans. Consequently, unveiling mathematical magic poses no significant challenge for AI. But how should AI understand that this is a magic? One perspective suggests that when AI can elucidate these tricks, it is no longer magic tricks to the AI. Yet, akin to witnessing a revealed magic trick, though it may lose its sense of wonder for one who knows the truth, it's important to acknowledge that these mathematical feats can continue to astonish others.

For AI to identify these as magic tricks, it necessitates a comprehension of its potential audience. Some individuals lack the capacity to discern these tricks as effortlessly as AI does. AI must also model human society, because only when there are a sufficient number of people in the society [1] cannot see through the trick, it can be called a magic trick. Thus, AI must develop the ability to model the boundaries of human capabilities and possess a degree of social commonsense.

When AI encounters a magic show, it confronts the challenge of selecting the relevant aspects of societal common sense to apply. While simulators, as discussed in Sec. 2.1, offer a potential solution, social simulation presents a distinct and intricate challenge compared to physical simulation. Alternatively, implementing an attention mechanism to trigger specific commonsense in particular scenarios emerges as another prospective approach. Nonetheless, this is also very difficult to implement because of the huge space for social commonsense.

[1]The precise threshold for this audience size, or whether one even exists, needs further examination.

2.3 Understanding relationships between people: The Berglas Effect

The Berglas Effect stands as one of the most iconic card magic tricks ever conceived, attributed to the ingenious magician David Berglas. The following requirements need to be met: The magician prepares a deck of cards in advance and invites the spectators randomly. Subsequently, the magician refrains from any further contact with the cards. One spectator randomly assigns a card, another spectator randomly assigns a number. Then, a spectator - potentially a newcomer or one of the two initial participants - commences counting from the top of a pre-arranged deck of cards. When this count corresponds to the chosen number, the designated card miraculously appears. Importantly, it's imperative to emphasize that the selected participants are not secret assistants of the magician.

This display of artistry appears nearly implausible, primarily because, from the spectators' viewpoint, the magician can no longer manipulate the cards once the cards and numbers are known. This magic appears to hinge solely on an improbable coincidence [2] to achieve success.

Given the interactive nature of this performance, akin to numerous magic acts, it's pivotal for AI to grasp the dynamics between individuals. The selection of participants occurs arbitrarily, without any predetermined connections to the magician. Thus, the combinations of cards and numbers chosen emerge as genuinely random, rather than orchestrated to expose specific cards within the deck.

At the same time, the AI also needs to parse the attributes of the deck of cards, with card order being of paramount significance. This is an abstract concept with uncertainty, unlike the physical attributes we analyzed in Sec. 2.1. It is precisely the uncertainty of this attribute that brings about the magic.

If we can analyze the relationship between people and the attributes of cards, then we can understand the magic through reasoning or simulation. AI can generate outcomes that defy the expectations of reality, effectively capturing the essence of magic. It's worth noting, however, that these "contradictions" might necessitate interpretation through a probabilistic model, as there remains a finite likelihood that the results derived from reasoning and simulation may coincidentally align with reality.

3 Conclusion and Discussion

Magic hinges on the artful manipulation of the audience's perception. If the AI wants to be surprised by magic, it must also be successfully controlled by the magician, just like humans. This necessitates a mastery of physical and social common sense, adept parsing of scenes, objects, and agents, as well as the timely application of its stored knowledge. In addition to the capabilities outlined in Sec. 2, AI may require additional skills to comprehend various forms of magic, including grasping the laws of physics and understanding the magician's intentions.

Relying solely on a data-driven approach might not suffice for comprehending magic. Given the constant evolution of new magical techniques, data-driven models face substantial challenges in generalization. Moreover, processing video input adds an additional layer of complexity. It is an interesting topic to explore how well a large multi-modal model, equipped to handle video input, can grasp the intricacies of magic. For revealing magic, data-driven will be even more powerless, because truly classic magic is often not revealed, making the generation of learning data challenging.

A promising approach to understand magic involves a system that combines parsing, reasoning, counterfactuals, and commonsense. Once these components are integrated, the system may find itself proficient in addressing a wide array of real-world scenarios. Thus, understanding the surprise of magic is, I believe, one of the ultimate tasks of AI.

References

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[2] With 1/54 probability.