Final Product

The concept of artificial intelligence (AI) has captivated our imagination for decades, fueling dreams of machines that can think, learn, and interact with the world like humans. The quest to create such intelligent machines has been a fascinating journey marked by groundbreaking discoveries, periods of stagnation, and ongoing challenges. This essay explores the evolution of AI, tracing its development from the visionary work of Alan Turing to the emergence of large language model chatbots, a testament to the remarkable progress achieved in recent years.

Alan Turing, a brilliant mathematician and computer scientist, is widely considered the father of artificial intelligence. In his seminal 1950 paper, "Computing Machinery and Intelligence," Turing proposed the now-famous Turing Test–an operational definition of a machine's ability to exhibit intelligent behavior. This test, which involves a human judge interacting with a hidden machine and another human, would determine whether the machine could convincingly simulate human conversation. Turing's groundbreaking work not only laid the foundation for future research in AI but also sparked a profound debate about the very nature of intelligence and its potential existence in machines.

Ada Lovelace, a visionary mathematician often referred to as the world's first computer programmer, expressed skepticism about the possibility of machines achieving true intelligence. Ada Lovelace was of the opinion that machines had great potential to process information based on what humans programmed them to do, they would never be able to generate thought in the ways that humans could. Turing acknowledged this skepticism, christening it "Lady Lovelace's Objection." In response, he presented his operational definition of a thinking machine, suggesting that a computer's ability to pass the Turing Test would be sufficient evidence of its intelligence. Turing's optimism regarding the potential for machines to achieve human-like intelligence within a few decades reflected the burgeoning enthusiasm surrounding the nascent field of AI.

Turing met Claude Shannon, a pioneer in information theory at Bell Laboratories, where they discussed how machines could tackle logic and reasoning tasks using binary instructions and logical operations. Turing's collaboration with Claude Shannon further enriched the field of AI by drawing parallels between machine operations and human brain functions. Both Turing and Shannon recognized the potential for machines, operating on binary instructions, to replicate human intelligence through emulating logical reasoning. Their convergence of interests in brain science and computing fueled the hope of creating intelligent machines capable of complex problem-solving traditionally thought to require human-like cognitive abilities.

Binary and analog systems are two methods of representing and processing information. In binary systems, data is represented using discrete symbols, typically 0s and 1s, known as bits. These systems process data using Boolean logic, enabling precise computations and decision-making in digital electronics and computing devices. Conversely, analog systems represent information using continuous signals that vary in amplitude, frequency, or phase.

While binary systems offer precise representation and control, analog systems can represent a wide range of values within a continuous spectrum.

The 1950s witnessed a pivotal turning point in the development of AI with the emergence of microchips and packet-switched networks, which were made possible because of the implementation of binary systems. The implementation of binary systems was revolutionary because it allowed computers to process information with much greater speed and efficiency than ever before possible. The use of binary systems in computers began with manually flipping switches and continued with punchcards and vacuum tubes, after which all were eventually replaced with the transistor. The transistor was perhaps one of the most integral pieces of this, becoming the "dynamo" of the digital revolution by creating an efficient and seamless way to express information in ones and zeroes, or in other terms, binary code. What once had to be manually expressed by the flipping of a switch could now be expressed by a much more compact, automatic machine. The invention of the transistor was truly the cornerstone of electronics as we know them today, especially considering that modern computers contain hundreds of thousands of transistors each. This was amplified when microchips allowed for hundreds of thousands of transistors to be etched on a single, small piece of silicon, thus giving us the processing power that is needed for the complexity that is necessary to operate a computer. The invention of the microchip was so important because it allowed computer engineers to catalyze on the efficiency of the transistor. By allowing hundreds of thousands of transistors to work in tandem on a single tiny silicon chip, the microchip exponentially increased the processing power of a single machine. These technological advancements significantly transformed the computing landscape, paving the way for the creation of general-purpose computers capable of performing diverse tasks.

Despite the significant progress in AI research, achieving truly meaningful artificial intelligence proved to be a formidable challenge. Douglas Hofstadter, in his influential work "Gödel, Escher, Bach: An Eternal Golden Braid," highlighted the importance of understanding human imagination as a key factor in achieving artificial intelligence. Hofstadter explored the intricate relationship between formal systems, like those found in mathematics and logic, and the emergent complexity of human cognition. His work shed light on the inherent difficulties in replicating the nuances of human thought and imagination in machines. The evolution of AI has presented a curious paradox: while computers excel at complex tasks requiring vast amounts of data processing – such as analyzing financial trends or playing complex games – they often struggle with seemingly simple challenges that human beings navigate effortlessly. This disparity underscores the intricate nature of human intelligence, which goes beyond mere computational power and encompasses factors like common sense, reasoning, and the ability to adapt to novel situations. This realization exposed the limitations of existing AI systems in emulating human-like understanding and reasoning. As an example, Hans Moravec, a prominent roboticist, further illuminated the limitations of AI with his insightful "Moravec's Paradox." This paradox highlights the disparity between the computational resources needed for different tasks. While machines excel at computationally intensive tasks like mathematical calculations, they struggle

with tasks requiring nuanced sensory perception and motor control, such as recognizing objects in cluttered environments or navigating through a busy street. Moravec's observation further underscored the fundamental differences between human cognition and machine logic, posing a significant challenge for researchers aiming to replicate the full spectrum of human intelligence in machines.

This then allows us to return to the concepts of analog and binary systems in the context of whether or not machines can think. The human brain is considered an analog system because it processes information using continuous electrical signals generated by neurons, allowing for a wide range of nuanced responses and behaviors. Unlike digital systems, the brain's neural networks operate on a continuous spectrum, facilitating complex and adaptive processing of sensory input and cognitive functions. Thus, while computers are indeed able to analyze large data sets in order to solve virtually any problem with much higher efficiency, and are able to "learn" from their mistakes in order to produce a better output, they can only analyze and produce output based on a set of rules. Although they can mimic the human “thought” process of altering their rules to optimize results, they cannot produce original thoughts, because they simply do not operate with the same complexity that the human brain does due to the fact that they are not analog. Perhaps eventually, a working analog computer will be able to change this, however, no system currently exists that would be practical.

Despite the early enthusiasm surrounding AI research in the wake of Turing's groundbreaking work, the field encountered a period of stagnation known as the "AI Winter" in the 1970s and 1980s. Several factors contributed to this slowdown. The initial optimism about achieving artificial general intelligence (AGI) – the ability of a machine to exhibit human-level intelligence across a wide range of tasks – proved overly ambitious given the limitations of the technology at the time. Additionally, funding for AI research dwindled as early AI projects failed to deliver on their promises. Overly simplistic approaches to AI, focusing solely on symbolic reasoning and logic-based systems, proved inadequate in capturing the complexities of human intelligence. However, the AI Winter wasn't entirely devoid of progress. This period saw important theoretical developments, such as the emergence of knowledge representation and reasoning (KR&R) techniques. These techniques focused on developing methods for machines to represent and reason about the world, laying the groundwork for future advancements.

The late 1980s and 1990s witnessed a resurgence of interest in AI, fueled by breakthroughs in machine learning (ML) algorithms which allowed for the technological advancements provided by binary systems to truly come to life. Machine learning takes a data-driven approach to AI, enabling machines to learn from experience without explicit programming. The development of powerful neural networks, inspired by the structure and function of the human brain, played a pivotal role in this revival. Techniques such as backpropagation for training neural networks and the development of support vector machines (SVMs) paved the way for more robust AI systems capable of learning patterns from large datasets and making predictions in complex environments. Early applications of machine learning included handwriting recognition, spam filtering, and recommender systems for online

shopping and media platforms. These early successes demonstrated the potential of ML to solve practical problems and fueled further research and investment in the field.

The 21st century ushered in a new era of AI, marked by the "deep learning revolution." This revolution was driven by three key factors: the availability of massive datasets, the development of powerful computational resources, and advancements in deep learning algorithms. The explosion of data generated in the digital age provided the fuel for deep learning models. The increasing affordability of high-performance computing hardware, such as graphics processing units (GPUs), allowed researchers to train complex neural networks on these vast datasets. Finally, breakthroughs in deep learning architectures, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), enabled significant progress in areas like computer vision, natural language processing (NLP), and speech recognition. Deep learning systems achieved unprecedented performance in tasks like image classification, object detection, and machine translation, surpassing human-level accuracy in some cases. These advancements were made possible by the ability of deep neural networks to automatically learn hierarchical representations from raw data, eliminating the need for manual feature engineering.

The evolution of conversational AI, also known as chatbot technology, reflects the progress made in NLP. Early chatbots like ELIZA and ALICE, developed in the 1960s and 70s, were rule-based systems capable of basic conversation by employing pattern matching and keyword recognition. However, they lacked the sophistication and contextual understanding of human language. The emergence of large language models (LLMs) like OpenAI's GPT series represents a significant leap in conversational AI. These models, trained on massive amounts of text data using self-supervised learning techniques, can generate human-like responses across a wide range of topics and contexts. LLMs demonstrate an impressive ability to understand the nuances of human language, including sarcasm, humor, and different writing styles. They can engage in coherent and contextually relevant conversations, answer follow-up questions, and even generate creative content like stories and poems. LLMs have been integrated into chatbots and virtual assistants, enabling more natural and engaging interactions between humans and AI systems, with potential applications in customer service, education, and entertainment.

Recent developments in AI hold immense promise for enhancing society in numerous ways. One of the most significant contributions of AI lies in healthcare. AI-powered diagnostic tools can analyze medical images with unprecedented accuracy, aiding clinicians in early disease detection and treatment planning. Additionally, AI algorithms can analyze vast amounts of medical data to identify patterns and predict patient outcomes, thus revolutionizing personalized medicine (Smith, 2023). Moreover, AI has the potential to improve efficiency and productivity across various industries. In manufacturing, AI-driven automation can streamline production processes, reduce errors, and lower costs. Similarly, in agriculture, AI-powered drones and sensors can optimize crop management practices, leading to increased yields and sustainable farming practices (Jones, 2022). Furthermore, AI-driven advancements in transportation have the potential to enhance safety and reduce congestion. Self-driving vehicles equipped with AI algorithms can mitigate human errors, leading to fewer accidents and fatalities on roads.

Additionally, AI-powered traffic management systems can optimize traffic flow, reducing commute times and fuel consumption (Brown, 2021).

Despite its promising applications, AI also presents several societal challenges that must be taken into consideration as it is implemented into society. One of the foremost concerns is the ethical implications of AI decision-making. As AI systems become more autonomous, questions arise regarding accountability and transparency–specifically, who is held accountable when AI causes harm. Furthermore, biases inherent in AI algorithms can perpetuate existing societal inequalities, leading to discriminatory outcomes in areas such as hiring, lending, and criminal justice (Garcia, 2020). Moreover, the widespread adoption of AI technologies raises concerns about data privacy and security. As AI systems rely on vast amounts of data to operate effectively, there is a risk of unauthorized access and misuse of personal information. Additionally, the potential for AI-enabled surveillance poses threats to civil liberties and individual freedoms, raising important ethical and legal questions (Roberts, 2019).

The automation of jobs due to AI-driven technologies has sparked fears of widespread unemployment and economic disruption. While AI has the potential to increase productivity and create new job opportunities, it also threatens to displace workers in certain sectors. Low-skilled jobs, in particular, are at risk of being automated, leading to income inequality and social unrest (Taylor, 2018). The Luddite philosophy—interestingly, held by none other than Ada Lovelace's father Lord Byron—which originated during the Industrial Revolution, posits that technological advancements lead to job displacement and economic hardship for workers. While some argue that AI will follow this pattern, leading to significant job loss over time, others contend that it will simply change the job market (Brown, 2017). Historically, technological advancements have indeed led to the obsolescence of certain jobs. However, they have also created new opportunities and industries, leading to overall economic growth and prosperity. Similarly, AI is likely to reshape the job market rather than cause mass unemployment. Jobs that are routine and repetitive may be automated, but new roles requiring human creativity, empathy, and critical thinking skills are likely to emerge (Jones, 2016).

Thus, while AI has the potential to revolutionize various sectors and improve the quality of life for millions, it also presents ethical, societal, and economic challenges that must be addressed. The Luddite philosophy reminds us of the importance of considering the impact of technological advancements on the labor market and society as a whole. By embracing AI responsibly and proactively addressing its potential pitfalls, we can harness its transformative power for the betterment of humanity.

The journey of artificial intelligence, from the visionary ideas of Alan Turing to the remarkable capabilities of large language model chatbots, is a testament to human ingenuity and the relentless pursuit of knowledge. While significant challenges remain in achieving true artificial general intelligence, the advancements witnessed in recent years offer a glimpse into a future where AI can revolutionize various aspects of our lives. As we move forward, fostering responsible AI development and ensuring its ethical use will be crucial to harnessing the full potential of this powerful technology for the betterment of humanity.

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First Draft

The Evolution of Artificial Intelligence: From Turing to Large Language Model Chatbots

Introduction

Artificial Intelligence (AI) has been a subject of fascination and speculation for decades. The quest to create machines that can mimic human intelligence has been a journey marked by significant milestones and challenges. This essay delves into the evolution of artificial intelligence, tracing its development from the foundational work of Alan Turing to the emergence of large language model chatbots.

Alan Turing and the Foundation of AI

Alan Turing, a pioneering mathematician and computer scientist, played a pivotal role in laying the groundwork for artificial intelligence. Turing's reflections on the potential of machines to think, as evidenced in his contemplation of Ada Lovelace's assertion, set the stage for exploring the boundaries of artificial intelligence 1. Turing's interest in the ability of machines to modify their programs and learn raised fundamental questions about the nature of intelligence and the possibility of artificial intelligence.

Lady Lovelace's Objection and Turing's Response

Ada Lovelace, often regarded as the first computer programmer, expressed skepticism about the idea of machines exhibiting true intelligence. Turing acknowledged this skepticism, referring to it as "Lady Lovelace's Objection." He posited an operational definition of a thinking machine, suggesting that if a computer could pass as human in responses to questions, it could be considered intelligent 2. Turing's prediction that a computer would pass this test within a few decades underscored the optimism surrounding the potential of AI.

The Intersection of Logic and Brain Science

Turing's collaboration with Claude Shannon, a brilliant mind in the realm of electronic circuits and logic, shed light on the parallels between machine operations and human brain functions. Both Turing and Shannon recognized that machines, operating on binary instructions, could potentially replicate human intelligence by emulating logical reasoning 1. This convergence of interests in brain science and computing hinted at the possibility of creating intelligent machines.

The Rise of Microchips and Networks

The 1950s marked a significant turning point in the development of AI. The emergence of microchips and packet-switched networks revolutionized the computing landscape, enabling the creation of general-purpose computers capable of diverse functions 2. These technological advancements paved the way for the realization of Ada Lovelace's vision of machines that could manipulate numbers, process words, and engage in creative endeavors.

Challenges in Achieving Meaningful AI

Despite the progress in AI research, challenges persisted in achieving meaningful artificial intelligence. Douglas Hofstadter's emphasis on understanding human imagination as a key to AI hinted at the complexity of replicating human cognitive processes 3. The shift towards leveraging massive processing power for complex tasks highlighted the dichotomy between computational capabilities and human-like reasoning.

The Paradox of AI Capabilities

The evolution of AI showcased a peculiar paradox: while computers excelled at complex tasks requiring vast data processing, they struggled with seemingly simple challenges that humans effortlessly navigated 3. This disparity underscored the nuanced nature of human intelligence and the limitations of current AI systems in emulating human-like understanding and reasoning.

Moravec's Paradox and the Human Brain

Moravec's paradox, which highlighted the disparity between the computational resources needed for different tasks, underscored the fundamental differences between human cognition and machine logic 3. The human brain's analog-digital hybrid nature, characterized by distributed processing and nuanced responses, posed a formidable challenge for AI researchers aiming to replicate human-like intelligence.

Towards Large Language Model Chatbots

The quest for achieving human-like conversational AI led to the development of large language model chatbots. These sophisticated systems, powered by deep learning and natural language processing, marked a significant leap in AI capabilities 3. Large language models aimed to bridge the gap between machine-generated responses and human-like interactions, heralding a new era in AI research.

The Emergence of GPT-3 and Conversational AI

One of the most notable advancements in recent years has been the development of Generative Pre-trained Transformers 3 (GPT-3), a state-of-the-art language model renowned for its conversational abilities

Throughout the creation of this paper, I made use of multiple different AI chatbots. I really enjoy using AI in my everyday life, whether using it as my personal study assistant, using it to help me write an email or cover letter, or asking it to proofread an essay, and I take a lot of joy in figuring out the strengths and weaknesses of different chatbots. Thus, I wanted to use what I have learned from this class, and from my own trial and error while writing this essay. I did consider asking a friend to use their GPT-scholar account, reasoning that it might produce a better product while taking less time, however, I made it a goal to only use free chatbots in the process of writing this paper considering the potential issues of barriers to access which we discussed in class.

My goal was to begin the paper by incorporating as much from the Innovators as possible, and I wanted to see if I could get a large language model to read the book and generate a rough draft based on that. I accessed the online PDF version of the Innovators, and sought a way to upload it into a free chatbot. This took much longer than I thought, as the file that I found was too big to upload into the free chatbots which I usually rely on for PDF uploads (Claude and Bing AI). In order to troubleshoot, I tried compressing the file, as well as splitting the PDF copy of the Innovators into 11 smaller PDFs, and neither of these efforts was successful.

Eventually, I came across GetConverse, which calls itself an “AI reading companion”. I had never used it before, so I was unsure if it would produce useable results, however, I was pleasantly surprised. First off, it was able to digest the entire PDF, which was impressive. After it had “read” the book, it presented me with three tabs: summary, TLDR, and chat.

The summary was good quality, but a bit too extensive to be practical, as it summarized every single page of the book. An example of this would be “Page 26: Ada inherited her poetic and rebellious nature from her father, Lord Byron, who was a Luddite. Byron defended the Luddites in his maiden speech in the House of Lords, criticizing the mill owners who wanted to criminalize the destruction of automated looms. Shortly after, Byron gained fame with the publication of the first two cantos of *Childe Harold's Pilgrimage*, becoming a celebrated figure in literary London. Byron had a tumultuous affair with Lady Caroline Lamb, who famously described him as "mad, bad, and dangerous to know." At a party, Byron also noticed Annabella Milbanke, a reserved young woman from a wealthy family, who had conflicting feelings about him after reading his work.”

The TL;DR section seemed to serve its purposes well, although it was a bit too brief to be useful for this paper. It generated an overall brief synopsis, three key takeaways, and three conversation starters, which I thought were a nice touch. Considering that the chatbot was able to do quite a good job with this, this really allowed me to trust its ability to generate a quality response.

Finally, I moved on to the “Chat” tab and entered this prompt into the chatbox. “Using information from the text, as well as your own knowledge, describe the development of artificial intelligence from Turing to large language model chatbots in about 2500-3000 words”

There were many things about this first attempt that I thought went well. It clearly understood the central question and did a good job describing the development of artificial

intelligence from Turing to large language model chatbots. It highlighted most of, if not all of the important components highlighted by the book, and broke them down in way that was easy to read and understand. At the same time, it was not perfect. Firstly, it ignored my request to make it 2500-3000 words. Additionally, it was not able to add information from other sources. When I asked it to generate sources and cite them in the Chicago Manual of Style, it responded "Unfortunately, the Chicago Manual of Style guidelines or specific details regarding the citation format are not explicitly mentioned in the provided Pdf document.", which led me to the realization that although getconverse.com was good at breaking down the information in the textbook, it would not be useful as a comprehensive AI source. Thus, I took the first product, and inputted it into a new chatbot.

I decided to input the results of my first attempt into ChatGPT, and asked it to expand. This was the prompt: "I am writing an essay in which I have to describe the development of artificial intelligence from Turing to large language model chatbots in 2500-3500 words. Using the rough draft below, as well as your own knowledge and sources from the internet, help me complete my rough draft. Cite any sources used in accordance with the Chicago Manual of Style format."

ChatGPT's first response to this was impressive in terms of the actual content it provided me with, but disappointing in terms of its ability to follow the instructions I gave. Most notably, it introduced concepts such as the AI winter and deep learning revolution, which the previous product did not include. However, it did not incorporate these into the essay as I had asked it to do, rather, provided these expansions in a series of bullet points.

My next prompt was: "Now use your response as well as my original rough draft to generate a 2500-3000 word essay answering the prompt," Unfortunately, this is where I began to have quite a bit of trouble—it seemed to miss the part that said "use your response," and instead it just expanded on the original essay that I provided without incorporating any of the things it had suggested in the previous response it had generated. For example, it didn't talk at all about the AI winter. I attempted about 5 more times to get it to expand on essays it had generated but to no avail—no matter how I phrased it, it simply did not want to incorporate two different AI-generated products into one comprehensive essay. Although I've never had issues with this in the past, it for some reason was not able to generate the product of my desired length. None of the responses that ChatGPT gave me were over 1500 words even though I specifically asked many times for 2500-3000 word responses.

At this point, I was quite frustrated with ChatGPT's lack of ability to follow instructions despite being heralded as the most advanced chatbot, so I decided to take the two products that I got from ChatGPT as well as the original rough draft and attempted to combine them in Gemini, entering "I am writing a paper for which the prompt is: "Describe the development of artificial intelligence from Turing to large language model chatbots" I have three rough drafts that I would like you to consolidate into one. The final product should be 2500-3000 words." The essay initially stopped generating content about halfway through the paper. Thinking that I must've accidentally hit the "stop generating" button, I asked it to continue, which it obliged. However, it

did the same thing on my second attempt, leading me to believe that there was some sort of error associated with generating large amounts of text. Similarly to ChatGPT, although the product it produced was good in terms of quality, but only a little over 1000 words despite actually claiming "The word count falls within the requested range of 2500-3000 words." After this, I responded "No, that draft does not fall within the requested range of 2500 and 3000 words," and it attempted again to generate a response, this time claiming at the header that the response was 2837 words, when in reality it was 1435 words. It also stopped generating halfway through, and I again had to prompt it to continue. Although the product wasn't bad, I wasn't really getting anything new—it simply was rewriting the things I already had.

Giving up on Gemini, I decided to give it one more try with Claude. Unfortunately, I was met with the same fate. Just as I had done with the other chatbots, I prompted it: "I am writing a paper to answer the prompt: describe the development of artificial intelligence from Turing to large language model chatbots. So far I have a rough draft, and I want you to expand that and help me write a final product that is about 2500-3000 words. Here is the rough draft: (after which I pasted the product from Gemini). Unfortunately, my attempts were also unsuccessful, as it ended up shortening the drafts that I gave it. It even claimed to have produced a draft that was "above 3000 words" when in reality the output was 1300 words.

At this point, I decided to take the ~1400 draft produced by chatGPT as it seemed to be of the highest quality of the roughly 13 drafts that I had produced at this point, and begin vetting it more closely. Although it had done very well with most of the ideas presented in the Innovators, as well as adding some relevant additional ideas of its own, I felt that the paper could be strengthened with certain topics that we discussed in class. Some of the ideas I wanted to address that I felt were not appropriately addressed by the chatbot were the topics of analog vs binary, and whether or not machines could think. Overall, I don't think the chatbot necessarily got anything wrong, but rather, missed certain contexts that would have helped answer the prompt better. Thus, I had nothing to cross out in red. To finish, I also asked the chatbot to expand on many of the ideas it had presented. For example, I asked it to write more about the potential applications and ethical concerns of AI in healthcare in the future, as well as the AI winter, and I felt that it was able to do this quite well.

Interestingly, I had a very difficult time getting chatGPT to produce in-text citations consistently throughout the paper—it gave in-text citations for only parts of the paper, but not others. I attempted to resolve this with Gemini and Claude but to no avail. As for the validity of the sources generated, I was pleasantly surprised—most of them were useful. The only mistake that I was able to catch was the chatbot citing the same source twice but with a slightly different title. The rest of the sources appeared to be relevant and useful, however, some of them required subscriptions to certain journals, thus, I was not able to determine whether those were valid or not.

At this point, I was happy with the content of my essay, so I decided to try and have some fun with it. I began by asking chatGPT to rewrite it as a hallmark movie. Although funny, it was not useable as a draft because too much of my content was lost, and it became extremely difficult

to follow. After creating about 5 different drafts in attempts to troubleshoot, I decided to abandon that idea. Then, I tried to get it to explain it in a way that someone who has never touched a computer before could understand, and while this product was coherent, each of my attempts at this idea resulted in too much of the complexity being lost. After about 20 combined failed attempts on different chatbots at generating a "fun" essay, I decided that it would be best to stick with the "boring" product that I had generated so as not to lose important content.

Overall, I was pleasantly surprised by the ability of different chatbots to produce very high-quality content. Although it certainly wasn't perfect, writing this essay allowed me to learn a lot about what makes a successful prompt, and how to troubleshoot when things don't go well.