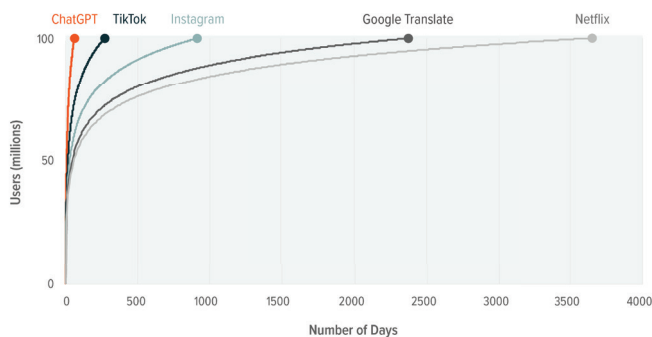# Generative AI, Explained

Authored by:
Pedro Palandrani

It's not often we see technologies gain exponential adoption and attention in a very short time frame the same way OpenAI's ChatGPT has since late 2022. ChatGPT is estimated to have reached 100 million users in just two months.[1] It took Netflix 10 years to reach 100 million users; six and half years for Google Translate; roughly two and a half years for Instagram; and about nine months for TikTok.[2,3]

TIME IT TOOK COMPANIES TO REACH 100 MILLION USERS
Sources: Global X ETFs with information derived from: BBC News. (2018, January 23). Netflix's history: From DVD rentals to streaming success; Cerullo, M. (2023, February 1). ChatGPT user base is growing faster than TikTok. CBS News.

Generative artificial intelligence (AI) is a rapidly evolving field that has the potential to revolutionize many industries. This powerful technology uses deep learning algorithms to create new and original content, ranging from text and images to music and 3D models. As a result, generative AI has garnered the attention of investors looking to capitalize on its vast potential. In this piece, we will explain generative AI and look at its history.

KEY TAKEAWAYS

- Generative AI is the most powerful and consumer-friendly AI model to date.

- Google's Transformer model paved the way for the development of more advanced generative AI models, such as BERT and GPT-3 — the underlying model that ChatGPT is based on.

- Generative AI has a wide range of current and future use cases across various industries, including content creation, virtual customer service, health care, finance, language translation, and gaming.

WHAT IS GENERATIVE AI?

Generative AI refers to artificial intelligence systems that are designed to create new and original content based on the data they are trained on. This can include generating text, images, music, and even 3D models. Unlike discriminative AI, which is used to classify and categorize data, generative AI creates new data by using probabilistic models to produce outputs based on patterns it has learned from the input data.

A HISTORY OF GENERATIVE AI: GOOGLE'S TRANSFORMER MODEL

Generative AI has a long and fascinating history, but it wasn't until the development of deep learning algorithms that it became a practical tool for creating new and original content. One of the most significant breakthroughs in this field was Google's Transformer model, which was introduced in 2017.

The Transformer model was designed to address the limitations of previous sequence-to-sequence models in natural language processing. It introduced a new way of processing sequential data, using self-attention mechanisms to capture the relationships between different elements in a sequence. This allowed the model to better understand and generate text, and it quickly became the state-of-the-art model for natural language processing tasks.

The success of the Transformer model led to the development of many new and improved generative AI models, including BERT and OpenAI's GPT-3. BERT, or Bidirectional Encoder Representations from Transformers, is a transformer-based model that uses a pre-training approach to learn the relationships between words in a sentence. OpenAI's GPT-3, on the other hand, is a language model that uses a deep neural network with 175 billion parameters to generate human-like text.[4]

In the context of generative AI, a parameter is a value that controls the behavior of a machine learning model. Machine learning models are mathematical algorithms that are designed to learn patterns in data and make predictions based on those data. The parameters of a model determine how it processes the data and how it generates predictions.

Parameters play a crucial role in controlling the output of the model. For example, in a text generation model, parameters can control the style, tone, and content of the resulting text. By adjusting the parameters of the model, one can influence the output of the model and generate text that meets specific criteria.

In general, the more parameters a model has, the more accurate and powerful it is. With more parameters, a model can learn a wider range of relationships and patterns in the data. This can lead to better performance and improved accuracy in predictions. However, having too many parameters can also be a drawback. With too many parameters, a model can become overfit, meaning that it is too closely tied to the training data and may not generalize well to new data. Overfitting can lead to poor performance on test data and can limit the model's ability to make accurate predictions.

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EXPLORING GENERATIVE AI'S USE CASES

Generative AI has a wide range of current and future use cases across a variety of industries. Here are some of the most important ones:

1. Content creation: Generative AI models are being used to create new and original content in areas such as text, music, art, and video. For example, AI-generated music and art can be used to create new and innovative forms of expression, while AI-generated text can be used to develop news articles, product descriptions, and marketing content.

2. Virtual customer service: Basic chatbots have been around for years, but generative AI models can deliver more robust virtual customer service agents to assist customers with increasingly complex inquiries. By using AI to generate responses to customers' questions, companies can improve the efficiency and quality of their customer service operations.

3. Health care: Modern society produces large amounts of health care data, including electronic medical records and imaging data. With the help of generative AI, these data could be used to develop new diagnostic tools, predict disease outcomes, and improve patient care.

4. Finance: In finance, generative AI models can be leveraged to form predictions about stock prices, exchange rates, and other financial metrics. This information could be used to make investment decisions and potentially improve financial planning.

5. Language translation: Generative AI models have the potential to vastly improve the accuracy and efficiency of language translation services. By using AI to generate translations, companies can improve the quality of their products and services and increase their global reach.

6. Gaming: New and innovative game experiences can also be created using generative AI models. For example, AI-generated characters, environments, and storylines can be used to create unique and engaging game experiences.

7. Search: The application of generative AI to search has the potential to significantly improve the search experience for users, making it more efficient, personalized, and conversational. Generative AI can understand natural language queries and provide relevant search results, allowing users to ask questions in a conversational format and receive answers in real time.

These are just a few of the many current and future use cases of generative AI. As this technology continues to evolve and improve, it has the potential to revolutionize many industries and have a major impact on the way we live and work. As a guiding framework, we can ask ourselves "Where does text exist today?", since this is where the technology has the strongest disruptive potential in the near term.

CONCLUSION:
GENERATIVE AI IS IN ITS INFANCY AND OPPORTUNITIES ABOUND

Generative AI has come a long way since its early beginnings, and it continues to evolve at a rapid pace. While the technology has already been incorporated into myriad applications, use cases are likely to expand quickly as it matures. From creating new and original content to revolutionizing industries, generative AI has the potential to shape the future in countless ways. Whether it's creating new forms of art and expression, improving health care outcomes, or making investment decisions, the possibilities for generative AI are virtually limitless. The outlook for generative AI appears bright, and we expect to see many exciting developments in this field in the years to come.

Generating Content and Profits: Examining the Potential Business Models of Generative AI

Generative artificial intelligence (AI) has the potential to transform many industries and revolutionize the way we live and work. As this technology continues to evolve and mature, there are many different business models that are emerging to take advantage of its capabilities. In this piece, we will explore what we believe are the three of the most important business models for generative AI: model-as-a-service, built-in apps, and vertical integration.

KEY TAKEAWAYS

- Model as a Service (MaaS) offers low-cost, low-risk access to generative AI, with limited upfront investment and a high degree of flexibility.

- Built-in apps offer highly customizable and specialized solutions with a high degree of scalability.

- Vertical integration leverages existing systems and apps to enhance their offerings with generative AI capabilities.

GENERATIVE AI MODEL-AS-A-SERVICE

Model-as-a-Service (MaaS) is one of the most popular business models for generative AI developers. This is what we're seeing today with OpenAI, which licenses its GPT-3 AI model (the platform behind its popular ChatGPT product) to Microsoft for use in its Bing search engine. OpenAI is also expected to charge consumers $20 a month for a premium version of ChatGPT.[5]

With MaaS, companies can access generative AI models through the cloud and use them to create new and innovative content. This business model is similar to the subscription-based model that exists today for most software. These subscriptions can be monthly, semi-annual, or annual, creating recurring revenues for the developers offering these services. One of the biggest benefits of MaaS is that it allows companies to access the latest and greatest generative AI models without having to invest in the infrastructure and resources necessary to build these models from scratch. This makes it easier and more cost-effective for companies to leverage generative AI to create new and innovative experiences. Additionally, MaaS offerings, such as OpenAI's GPT-3 and Google's BERT, are highly customizable, which allows customers to tailor these models to their specific needs and use cases.

Of note, it's likely that we'll eventually see an incremental fee based on the usage of the models. This is similar to what we see today from public cloud providers, or hyperscalers, such as Amazon's AWS or Microsoft's Azure. This is known as a pay-as-you-go pricing model, where customers only pay for the services they use. This model is flexible and allows customers to scale their usage up or down based on their needs, and only pay for what they use. It would also allow the model providers to manage their cost structure, as each query run through an AI model has an associated cost, currently estimated to be around two or three cents. OpenAI's DALL-E platform, a text-to-image AI model, currently implements this type of pricing structure.

For example, companies can use generative AI to build virtual customer service agents that can assist customers with their inquiries or use AI to generate news articles, product descriptions, and marketing content. Some of the most popular MaaS offerings for generative AI include OpenAI's GPT-3 and Google's BERT. These platforms can also create original work, such as social media content, video games, computer code, graphic designs, and more. As the models get better, they're starting to deliver human-level results and, soon enough, they could start delivering superhuman-level outcomes.[6]

VERTICAL INTEGRATION

With a vertical integration business model, companies can leverage generative AI to enhance their existing offerings and create new value for their customers. For example, companies can use generative AI to improve the accuracy and efficiency of their language translation services or analyze large amounts of data and make predictions about stock prices and other financial metrics. By leveraging generative AI to enhance their existing

GENERATIVE AI SYSTEMS TIMELINE

Sources: Global X ETFs with information derived from: Huang, S., Grady, P., & GPT-3. (2022, September 19). A powerful new class of large language models is making it possible for machines to write, code, draw and create with credible and sometimes superhuman results. Sequoia.*Estimates.

	PRE-2020	2020	2022	2023*	2025*	2030*
Text	Spam detection Translation Basic Q&A	Basic copywriting First drafts	Longer form Second drafts	Vertical fine-tuning gets good (scientific papers,etc.)	Final drafts better than the human average	Final drafts better than professional writers
Code	1-line auto-complete	Multi-line generation	Longer form Better accuracy	More languages More verticals	Text to product (draft)	Text to product (final) better than full-time developers
Images			Art Logos Photography	Mock-ups (product design, architecture, etc.)	Final drafts (product design, architecture, etc.)	Final drafts better than professional artists, designers, photographers
Video/3d/ gaming			First attempts at 3D/video models	Basic/first draft videos and 3D files	Second drafts	AI Roblox Video games and movies are personalized dreams

■ First attempts   ■ Almost there   ■ Ready for prime time

BUILT-IN APPS

Another important business model for generative AI is built-in apps. With this model, companies can build new apps on top of generative AI models to create new and innovative experiences. For example, companies can use generative AI to create unique and engaging gaming experiences or to generate music, art, and other forms of creative expression.

A good example of this use case is Jasper, an AI content platform founded in 2021 that aims to enable growing businesses to leverage AI to scale their content strategies.[7] The company has its roots in content creation. Its founders saw what a difference generative AI could make to their customers, allowing them to create and test ad variations quickly and efficiently, in order to discover which insight would have the biggest impact. When given a prompt, the platform automatically selects the best language model suited to the particular use case. The aim is to improve business outputs by adding context, reliable source citations and more current data, among other things.[8]

offerings, companies can create new and valuable experiences for their customers and improve their competitiveness in their respective markets.
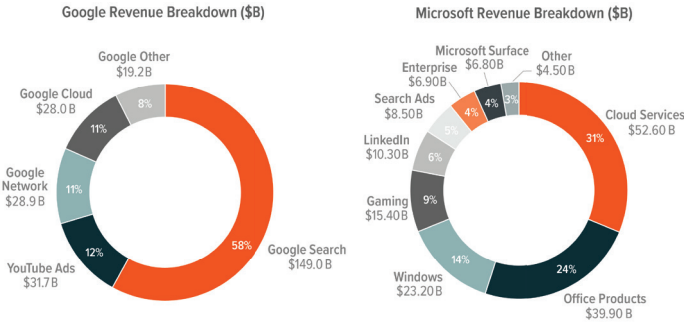
Search engines are a great example. Generative AI could lead to the development of search engines that can produce more accurate and personalized results for users, rather than relying solely on pre-existing web pages. This is already playing out with Microsoft integrating ChatGPT into Bing, in an attempt to challenge Google's dominant position in the search market. Google Search forms nearly 60% of the company's total revenue, which is why Google was quick to respond with announcing plans to launch its own version of ChatGPT and integrate into Google Search. Microsoft on the other hand, has a much more diverse set of revenue streams, with search only forming a small part of it.

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GOOGLE AND MICROSOFT REVENUE BREAKDOWN
Sources: Global X ETFs with information derived from: Bloomberg L.P. (n.d.) Companies Financials [Data Set], as of January 10, 2023.

Google Revenue Breakdown ($B)

- Google Other $19.2B
- Google Cloud $28.0B — 8%
- Google Network $28.9B — 11%
- YouTube Ads $31.7B — 11%
- 12%
- Google Search $149.0B — 58%

Microsoft Revenue Breakdown ($B)

- Microsoft Surface $6.80B
- Enterprise $6.90B
- Search Ads $8.50B
- LinkedIn $10.30B
- Gaming $15.40B — 9%
- Windows $23.20B — 14%
- Other $4.50B — 3%
- Cloud Services $52.60B — 31%
- Office Products $39.90B — 24%
- 4%, 4%, 5%, 6%

CONCLUSION: THERE ARE MANY WAYS TO LEVERAGE AND MONETIZE GENERATIVE AI

It is worth noting that these business models are not mutually exclusive, and many companies are using a combination of them in an effort to maximize the value that they can create with generative AI. For example, a company might use MaaS to access generative AI models, build new apps on top of these models to create new experiences, and then use vertical integration to enhance their existing offerings. In short, generative AI offers the potential for different monetization strategies, many of which hold the promise to be quite attractive.

Artificial Intelligence; Genuine Profit Opportunities: Generative AI's Potential Winners

The advent of generative artificial intelligence (AI) has the potential to revolutionize myriad industries, making this is a trend that investors should pay attention to. From an investment perspective, there are several companies and subsectors that are poised to potentially become winners of this technology.

In this piece, we will explore the different categories of companies that could benefit from generative AI and highlight some of the players that are worth keeping an eye on.
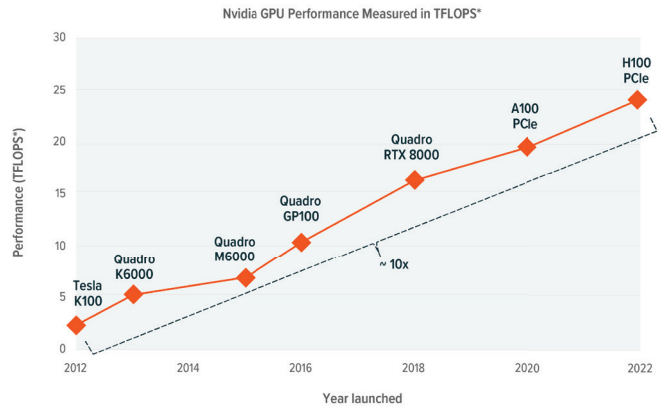
KEY TAKEAWAYS

- Companies that offer cutting-edge hardware, such as Nvidia, for example, may be poised to be some of the main winners emerging out of the growth in generative AI.

- The second group of potential winners is likely to be comprised of companies that have access to large amounts of data, along with strong internal capabilities to process those data, such as Google and Microsoft.

- Those with top talent to enable these technologies form the third group of potential winners of the generative AI trend, where IBM, OpenAI, and Baidu may be good examples.

GPU MANUFACTURERS, THE BACKBONE OF GENERATIVE AI

Generative AI models require vast amounts of computing power to train and generate new data. Graphics Processing Units (GPUs), specialized computer processors capable of processing large amounts of data simultaneously, are essential for this process, and companies that manufacture GPUs could stand to benefit significantly from the growth of generative AI. NVIDIA, Advanced Micro Devices, and Intel are some of the major players in this space and are well positioned to benefit from this trend. NVIDIA, in particular, has made significant investments in AI and is a leader in the GPU market. For example, Nvidia's GPU theoretical performance as measured in teraflops has been improving at an average rate of about 50% over each generation.[9] Upcoming GPU launches are expected to make a major leap in performance, and AI accelerators are anticipated to become even faster.[10]

PERFOMANCE IMPROVEMENT OF NVIDIA GPUS OVER TIME
Sources: Global X ETFs with information derived from: TechPowerUp. (2022, October 31). GPU specs database: K10. *TFLOP, or teraflop, is a direct mathematical measurement of a computer's performance.

Nvidia GPU Performance Measured in TFLOPS*

ChatGPT creator OpenAI, for example, through its partnership with Microsoft, uses Nvidia A100 GPUs. Since Nvidia is ramping up its next generation of GPUs, called H100, which delivers six times more throughput than the A100, we believe the demand for this technology could grow significantly in generative AI applications.[11] In fact, according to some estimates ChatGPT's revenue opportunity for Nvidia is between $3bn and $11bn for the first 12 months of operations.[12]
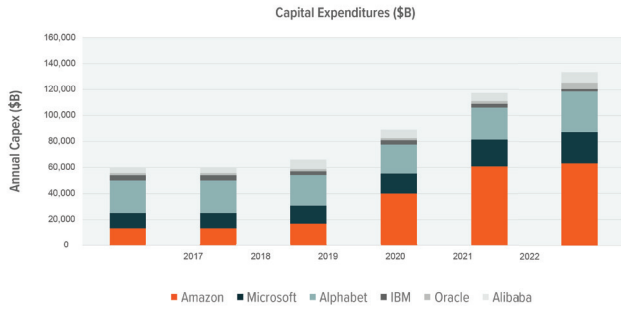
COMPANIES WITH LARGE AMOUNTS OF DATA

Data is the lifeblood of generative AI, and companies that have access to large amounts of high-quality data should have a significant advantage in this field. Companies such as Google, Amazon, and Microsoft have access to vast amounts of data and have the technical expertise to leverage these data to develop advanced AI models. These companies have already made significant investments in AI and have track records of successfully commercializing AI technologies, making them prime candidates for investment opportunities.

CAPITAL EXPENDITURE OF BIG CLOUD PROVIDERS

Source: Global X ETFs with information derived from: FactSet Research Systems. (n.d.). Capital expenditures in billions of dollars. Accessed on February 24, 2023.
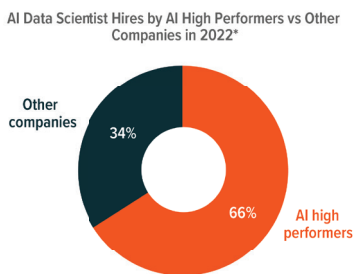

Capital Expenditures ($B)

The big cloud providers, such as Microsoft, Google, IBM, and Amazon, first started setting up their AI and machine learning (ML) capabilities back in 2014. It was becoming clear at that point that large language models (LLMs) needed to be trained over a number of years and over large sets of data to achieve a level of sophistication that would be good enough for commercial deployment. Now, as was the case back in 2014, these companies have a clear advantage in terms of their access to immense amounts of data, along with the ability to process them efficiently. Combined with access to top talent and strong investment capabilities, this was when the AI race really began.

COMPANIES WITH THE TALENT TO ENABLE AI

Another important factor for the success of generative AI is the availability of talent. Companies that have the technical expertise to develop and implement these complex models are well positioned to benefit from this technology. Some of the companies that are worth keeping an eye on in this space include OpenAI, IBM, and Baidu. These companies have already made significant investments in AI and have a deep pool of technical talent that is essential for the development and implementation of generative AI models. For example, according to a recent industry-wide survey conducted by McKinsey and Co, "AI high performers",defined by McKinsey and Co as "those organizations that respondents say are seeing the biggest bottom-line impact from AI adoption—that is, 20 percent or more of EBIT (Earnings Before Interest and Tax) from AI use", are much more likely to have hired AI top talent in 2022.[13]

BIG AI PLAYERS HIRE SIGNIFICANTLY MORE AI TALENT

Source: Global X ETFs with information derived from: McKinsey & Co. (2022, December 6). "The state of AI in 2022—and a half decade in review".

AI Data Scientist Hires by AI High Performers vs Other Companies in 2022*

*Survey findings based on online survey with 1,492 participants representing the full range of regions, industries, company sizes, functional specialties, and tenures.

CONCLUSION: BROAD-BASED EXPOSURE MAY LEND ITSELF WELL TO THIS VAST OPPORTUNITY

Generative AI is a technology that has the potential to revolutionize various industries, and investors should pay close attention to the companies and subsectors that are poised to become the potential winners of this trend. From GPU manufacturers to companies with large amounts of data and technical expertise, there are several opportunities for investors to consider. It's important to keep in mind that generative AI is still in its early stages, and there will likely be many more companies that will emerge as winners in the years to come.

Assessing the Field: Exploring the Competitive Landscape of Generative AI

The competitive landscape of generative artificial intelligence (AI) is rapidly evolving and becoming increasingly crowded, as companies and research institutions invest heavily in this cutting-edge technology. The goal of generative AI is to produce new, original content that can be used in a wide range of applications, such as image and video creation, natural language processing, and music composition.

There are several key players in the generative AI space, each offering different approaches and solutions. Some of the most prominent companies include OpenAI, Microsoft, Google, Meta Platforms, IBM, and others. These companies are investing heavily in research and development in this area and have produced some of the most advanced generative AI models to date. In this piece, we'll explore the competitive landscape of generative AI.

KEY TAKEAWAYS

- To fully understand the competitive landscape of generative AI, it is important to explore its origins and the technological advancements that led to it.

- Though Microsoft was first to announce ChatGPT's integration into Bing, potentially disrupting the search market, there are reasons to believe that the search engine is not currently posing a serious threat to Google's dominance.

- Other companies, including Meta Platforms, as well as China's big tech players, like Baidu, Alibaba and Tencent, have been developing similar projects internally, which they are planning to launch soon.

THE TECHNOLOGICAL ADVANCEMENTS THAT LED THE WAY TO CHATGPT

Though generative AI systems based on large language models (LLMs), such as OpenAI's extremely popular ChatGPT, may seem like sudden technological breakthroughs, these have been several years in the making. In fact, developments in the space accelerated soon after Ian Goodfellow, a former Google Brain research scientist, came up with the generative adversarial network (GAN), a type of machine learning framework, in 2014. This was when big heavyweights like Google, Microsoft and IBM kicked-started working on it.[14] This type of machine learning framework forms an important part of the development of generative AI, specifically when applied to image recognition. It is based on two neural networks – a generative network and a discriminative network, which contest with each other in a way that enables the model to learn in an unsupervised manner. This is an important building block of generative AI.

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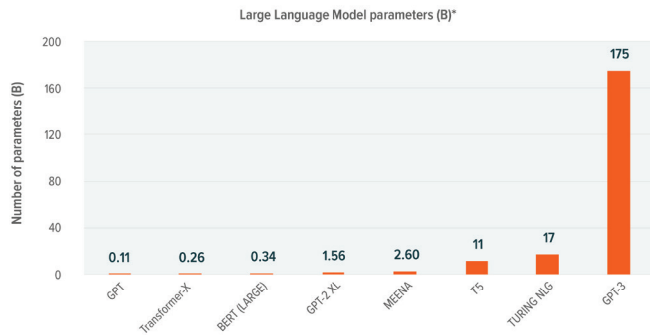1 (888) 493-8631
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Another technological advancement that became a significant enabler of generative AI was the introduction of the Transformer model in 2017, which was developed once again by a team of Google Brain researchers.[15] The Transformer is a deep learning model that improves on recurrent neural networks (RNNs) by being able to process an entire input of data, such as natural language, as opposed to processing the input data sequentially. This leads to a significant reduction in training times, and hence improved efficiency when applied to tasks such as text summarization and translation. This advancement is what formed the basis for the development of both Google's BERT (Bidirectional Encoder Representations from Transformers) and OpenAI's GPT (Generative Pre-trained Transformer) pretrained systems.

OpenAI's team built and improved upon GPT with GPT-3, which follows on from GPT-2 and contains a staggering 175 billion parameters.[16] (In this context, a parameter is a value that controls the behavior of a machine learning model.) This compares to GPT-2's one billion parameters. For reference, a model with six billion parameters is called "prompt engineering," which is where the model learns a little bit, while 30 billion is the level where models can generate sophisticated language-related output.[17] Finally, OpenAI's latest iteration, GPT-3.5, is what formed the basis for the now well-known ChatGPT.

LLM NUMBER OF TRAINABLE PARAMETERS
Source: Global X ETFs with information derived from: Cooper, K. (2021, November 1). OpenAI GPT-3: Everything You Need to Know.

Large Language Model parameters (B)*

Model	Number of parameters (B)
GPT	0.11
Transformer-X	0.26
BERT (LARGE)	0.34
GPT-2 XL	1.56
MEENA	2.60
T5	11
TURING NLG	17
GPT-3	175

*Top LLM models in the U.S.

BING IT? NOT SO FAST

Fast forward to today, OpenAI is one of the leading companies in the field of generative AI. Its GPT-3.5, which is considered one of the most advanced language models to date, is capable of generating coherent and grammatically correct sentences and paragraphs. OpenAI has also developed several other generative models, such as DALL-E, which can create unique images from textual descriptions, and Codex, which can write computer code. The success of these models, and Microsoft's billions of dollars in investment in OpenAI, started raising questions about Google's long-time dominance of the search market.

However, although Microsoft's recent announcement of integrating ChatGPT into its search engine, Bing, caused a stir in the market, there are several reasons why we believe that Bing will likely not pose a significant threat to Google's near-monopoly in the search market.

- First, ChatGPT is frozen in time, meaning that it was trained on a certain snapshot of the internet in 2021. Therefore, it doesn't know of recent events like the war in Ukraine, nor does it know or understand the implications that follow on from these events. To put this in the context of search – this is a service that requires relevancy and up-to-date information, with constant near-real-time updates. As of this moment, it is not clear when ChatGPT will be able to achieve this.

- Second, at present, the Google search engine has two main advantages over Bing: it is better at responding to obscure user search requests and providing relevant links, and it is better at inferring what the user is looking for when the search request is ambiguous or unclear. Together, these two characteristics form the main reason behind why Google search is still the preferred option for most users today.

OTHER EMERGING COMPETITORS

Meta Platforms has also been making significant strides when it comes to AI algorithms, though that has mostly gone under the radar. The company is also applying a slightly different approach called neuro-symbolic AI, on which its Cicero algorithm is based.[18] This approach combines disciplines that are already widely used within the field of AI, such as deep learning for specific tasks, as well as rules-base software that does the reasoning.[19]

This contrasts with the approach used by OpenAI, which involves using as much training data and computer processing power as possible. Recently, Meta's Cicero scored amongst the top 10% of human players at the online game Diplomacy, where it is faced with dealing with unstructured environments, such as dialogue, involving negotiation and persuasion.[20] This makes the neuro-symbolic AI approach perhaps better suited to solving complex problems.

China's tech giants, like Tencent, Baidu, and Alibaba, were also quick to join the generative AI trend, recently announcing plans to test and launch their own ChatGPT-like services soon. For example, Baidu, which dominates China's search engine market, announced plans to release Ernie Bot, its own version of ChatGPT, which caused the company's shares to surge to an 11-month high in February.[21] Baidu said the underlying technology has been in development since 2019 and that it plans to make the chatbot accessible to the wider public after completing internal testing in March.[22]

CONCLUSION

Currently, some of the largest tech companies, such as the ones discussed here, are investing heavily in generative AI and developing new products and services in this area. Due to their research capabilities, financial strength, and current market position, it is possible a handful of large companies could dominate the field for building generative AI models, though new players could also emerge, particularly in domain-specific areas. Also, there are likely to be a wide array of winners from this emerging technology, including hardware manufacturers. One thing that's clear is that generative AI has the potential to be a powerful tool for businesses and individuals, and that it will likely play an increasingly important role in a wide range of industries and applications in the future.

[1]Cerullo, M. (2023, February 1). ChatGPT user base is growing faster than TikTok. CBS News. [2]BBC News. (2018, January 23). Netflix's history: From DVD rentals to streaming success. [3]Cerullo, M. (2023, February 1). ChatGPT user base is growing faster than TikTok. CBS News. [4]VentureBeat.com (2020, May 29). OpenAI debuts gigantic GPT-3 language model with 175 billion parameters [5]Clark, M. (2023, February 1). OpenAI announces ChatGPT Plus at $20 a month. The Verge. [6]Global X ETFs. (2022, December 12). 'Charting Disruption' Thematic Outlook for 2023 and Beyond. [7]Y Compbinator.com. Jasper is a leader in creating content using Artificial Intelligence. Accessed on February 13, 2023. [8]Ibid. [9]Global X ETFs with information derived from: TechPowerUp. (2022, October 31). GPU specs database: K10. [10]Global X ETFs. (2022, December 12). 'Charting Disruption' Thematic Outlook for 2023 and Beyond. [11]Gopani, A. (2022, March 25). The state of AI in 2022—and a half decade in review. Analyticsindiamag. [12]King A., Wittenstein J. (2023, January 2023). Nvidia to Win Big From ChatGPT Hype, Wall Street Predicts. Bloomberg UK. [13]McKinsey&Co. (2022, December 6). The state of AI in 2022—and a half decade in review. [14]SyncedReview.com (2019, April 5). Father of GANs Ian Goodfellow Splits Google For Apple. [15]Uszkoreit, J. (2017, August 31). Transformer: A Novel Neural Network Architecture for Language Understanding. Google Research. [16]Alarcon, N. (2020, July 7). OpenAI Presents GPT-3, a 175 Billion Parameters Language Model. Nvidia Developer. [17]Romero, A. (2022, February 3). The New Version of GPT-3 Is Much, Much Better. Towardsdatascience.com [18]Marcus, G, Davis, E. (2022, November 25). What does Meta AI's Diplomacy-winning Cicero Mean for AI? [19]Maddula, S. (2022, February 4). Neuro-Symbolic AI. Medium.com.[20]Gent, E. (2022, November 28). Meta's New AI Ranked in the Top 10% at the Game 'Diplomacy'—and Human Players Were None the Wiser. SingularityHub.com.[21]Zhou, C. (2023, February 10). Alibaba, Tencent and Baidu join the ChatGPT rush.[22]Ibid.

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