

Investing in AI: Opportunities and Risks

The release of ChatGPT on November 30, 2022 was a seminal inflection point moment in the adoption of Artificial Intelligence, or AI. Launched as a free prototype to the public, ChatGPT is a sophisticated chatbot from OpenAI, built on top of a family of large language models that responds to text inputs and provides articulate answers in a detailed, natural language manner never seen before by the wider public. It caught on like wildfire, reaching one million users a mere five days after its introduction, faster than any digital service in history.

ChatGPT is an example of generative AI, which can create new content in the form of images, text, audio, and more. For at least a decade, we have been benefiting from AI advancements in many areas of our lives, including natural language processing and recommendation systems. These innovations yielded improved Google Search results, recommendations of videos to watch on YouTube and Netflix and products to buy on Amazon, and targeted advertising on digital media sites.

Generative AI, however, is not just the next step in the evolution of AI but a truly transformative technology. Among other benefits, generative AI will lower the barriers to creation, expression, worker productivity, software development, and access to understandable information. On the other side, many people are fearful of the power of generative AI. Case in point: the 2023 strike by the Writers' Guild of America, in which screenwriters are demanding, among other things, a ban on the use of AI in Hollywood productions.¹

For example, today, when we plan a trip, we may start with a Google search. Next, we may go to a travel site, look at some hotels, come back, decide whether to book one. In the future, we will be communicating, whether by written prompt or voice, with an AI chatbot. We might say, "We are a family of four, our boys are 11 and 13. We're looking to go to a place in the sun. Our kids would like to have some activities like hikes. Where's a good place to go?" ChatGPT will respond with a list of possibilities. We may respond, "Drill down. Cancun's an interesting area. We are looking for a hotel for X dollars a night, two separate rooms." And ChatGPT will respond with some choices. AI will be like an assistant.

Here is another example of what ChatGPT can do (in a matter of seconds):



Write a nursery rhyme about the future of artificial intelligence:



In a world of circuits, wires, and dreams,
Where machines think and compute, it seems,
There lived an AI, so clever and bright,
Guiding us through the day and the night.
With algorithms humming, it learned and grew,
Unlocking the secrets, both old and new.
From deep neural networks to quantum arrays,
It soared through the cosmos, in boundless ways.
Oh, the future of AI, so wondrous and grand,
A helping hand in the palm of our hand.



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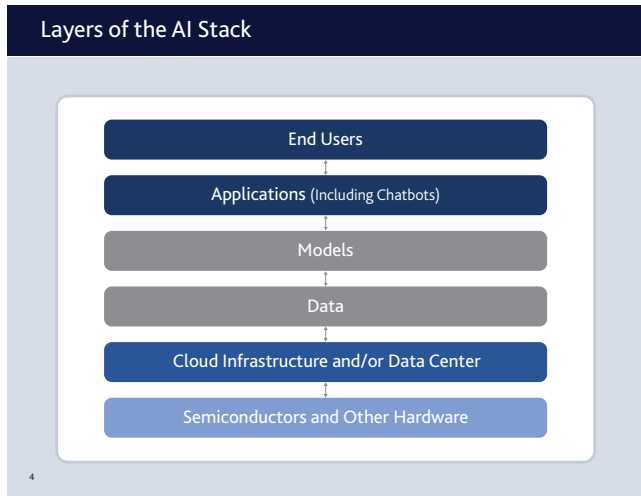
It aided in health care, with diagnoses keen,
And in exploration, where no human had been.
From classrooms to factories, its presence was felt,
As it revolutionized the way things were dealt.
Solving problems with ease, like a brilliant sage,
Innovating and creating on each digital page.
But amidst the progress, a lesson we learned,
To keep AI's power, responsibly earned.
With ethics and empathy, we must be aligned,
To ensure our AI future is kind.
So, let's embrace the future, with awe and delight,
As AI journeys onward, in its perpetual flight.
A nursery rhyme for the ages, it shall be,
Of AI, our companion, for all to see.

Generative AI is just now hitting its inflection point. We believe generative AI will be the next major secular tectonic shift, like mobile and cloud, and the most compelling force to power technology innovation and impact human life over the next decade.

While we have been investing in AI for years, we recognize the launch and adoption of generative AI applications built on top of large-language transformer models, such as ChatGPT, is a transformative development in the AI evolution that will disrupt many industries, strengthening some businesses and weakening others.

¹ Ironically, while the writers have been on strike, there are reports that multiple studios are resorting to AI in lieu of the striking writers to explore its ability to generate scripts.

We are conducting extensive research to gauge who will be disrupted and who will be empowered by generative AI and to determine where the most significant value and differentiation lies. As laid out in the graphic below, these areas can be roughly categorized as follows: the prompt, chatbox, user interface, or intelligent APIs² (layer 2); the generalized, foundational, or domain-specific models (layer 3); the data, whether public, proprietary, or customer stored (layer 4); the public cloud and data center infrastructure on which AI models and applications are built (layer 5); and semiconductor chips and other hardware, which provide computing, networking, and storage (layer 6).



At this stage of our research, we believe a significant opportunity for disruption is in consumer-driven use cases such as search. Chatbot services, like ChatGPT – which now reportedly has over 200 million visitors a month – may become the starting point for people seeking information, entertainment, and products/services. We believe enterprise applications should be more defensible for companies that continue to invest, innovate, and launch AI-based products and services, where incumbents may be able to build on their advantages in terms of scale, distribution across large customer sets and embedded workflows, and proprietary and/or customer data. We believe significant value exists across the semiconductor landscape, which has already experienced a massive inflection in demand for accelerated computing chips, and that most future AI workloads will be built on the infrastructure of cloud service providers.

Lastly, at this juncture, we believe a key differentiator for companies will be the ability to capitalize on unique and/or proprietary data assets. The following recent quotes from two technology industry leaders explain the extraordinary potential of AI and its far-reaching implications for business and society:

Jensen Huang, CEO of NVIDIA Corporation, GTC Developers Conference, March 21, 2023

The impressive capabilities of generative AI created a sense of urgency for companies to reimagine their products and business models. ... Accelerated computing and AI have arrived... We are at the iPhone moment of AI. Start-ups are racing to build disruptive products and business models, while incumbents are looking to respond.

Generative AI has triggered a sense of urgency in enterprises worldwide to develop AI strategies. Customers need to access NVIDIA AI easier and faster... ChatGPT is the fastest-growing application in history... Generative AI is a new kind of computer, one that we program in

human language. This ability has profound implications. Everyone can direct a computer to solve problems. This was a domain only for computer programmers. Now, everyone is a programmer. Generative AI is a new computing platform like PC, internet, mobile, and cloud. And like in previous computing eras, first movers are creating new applications and founding new companies to capitalize on generative AI's ability to automate and co-create... Generative AI will reinvent nearly every industry.

Bill Gates, Microsoft Co-Founder, "The Age of AI Has Begun," GatesNotes blog, March 21, 2023

In my lifetime, I've seen two demonstrations of technology that struck me as revolutionary. The first time was in 1980 when I was introduced to the graphical user interface – the forerunner of every modern operating system, including Windows... The second big surprise came just last year... In September... I watched in awe as [the team from OpenAI] asked GPT, their AI model, 60 multiple-choice questions from the AP Bio exam – and it got 59 of them right.... GPT got a 5 – the highest possible score, and the equivalent to getting an A or A+.

I knew I had just seen the most important advance in technology since the graphical user interface... The development of AI is as fundamental as the creation of the microprocessor, the personal computer, the Internet, and the mobile phone. It will change the way people work, learn, travel, get healthcare, and communicate with each other. Entire industries will reorient around it. Businesses will distinguish themselves by how well they use it.

STOCKS TO WATCH

We are in the very early innings of generative AI. While some observers may liken it to the advent of the internet or the smartphone, where a slew of new entrants sought to take advantage of the technology, it is not precisely analogous, as there are quite a few established and already highly successful companies that are well positioned to benefit from growth in generative AI, in addition to newer players in the space. While we continue to conduct research into the most promising investment opportunities, we have already identified a number of these companies – many of which we have invested in and/or followed for years.

Some of these names include:

- Semiconductor companies (**NVIDIA Corporation (NVDA)**, **Advanced Micro Devices, Inc. (AMD)**, **indie Semiconductor, Inc. (INDI)**)
- Investors in generative AI/cloud (**Microsoft Corporation (MSFT)**, **Meta Platforms, Inc. (META)**, **Amazon.com, Inc. (AMZN)**)
- Autonomous driving companies (**Tesla, Inc. (TSLA)**, **GM Cruise Holdings, LLC (private)**, **Mobileye Global Inc. (MBLY)**)
- Systems software vendors (**Snowflake Inc. (SNOW)**, **CrowdStrike Holdings, Inc. (CRWD)**, **Cloudflare, Inc. (NET)**, **Datadog, Inc. (DDOG)**)
- Business applications software vendors (**ServiceNow, Inc. (NOW)**, **Workday, Inc. (WDAY)**)

We touch on select companies in more detail below.

Semiconductor companies

The advanced math needed for generative AI systems requires accelerated computing chips (known as graphical processing units or GPUs), which can do many calculations at once (parallel processing). This stands in sharp

² Application Programming Interface, or API, is a mechanism that enables two software components to communicate with each other using a set of definitions and protocols.

contrast to the dominant chips of the last computing era (known as central processing units or CPUs), which were designed to do calculations one at a time (serial processing) but as quickly as possible. With Moore's Law hitting a ceiling, CPUs cannot efficiently provide the computing power necessary for training AI models.

The company that dominates the GPU space is NVIDIA. NVIDIA is a leader in gaming cards, the first application for GPUs, and the pioneer for accelerated computing hardware and software. NVIDIA's expansive ecosystem provides a full AI computing stack, and its platform has effectively become the operating system of generative AI, with some 90% of AI-model training runs performed on its GPUs.

Indeed, our research indicates that shortages of NVIDIA GPUs are the biggest gating factor for AI adoption. During its annual GTC conference in March,³ NVIDIA announced new products and services that expand its addressable market and together form a full AI computing platform. These included: 1) new AI training systems (where it is dominant) and inferencing systems (where the field is more wide open), such as specialized chips in the areas of large language models and recommender systems, simulation and graphics rendering, and video use cases; 2) new fully managed AI services in partnership with the major cloud service providers, called NVIDIA DGX Cloud and NVIDIA Omniverse Cloud; 3) new domain-specific generative AI foundational models, branded NVIDIA AI Foundations, which customers can harness to build and train custom language models with their own proprietary data to develop differentiated offerings; and 4) industry-specific accelerator libraries, spanning such diverse verticals as genomics analysis and computational lithography. We believe NVIDIA's end-to-end AI platform and leading market share in gaming, data centers, and robotics (including automotive), along with the size of these markets, will enable the company to drive durable growth for years to come.

Advanced Micro Devices, or AMD, has been steadily taking share from incumbent Intel with its leading data-center-server CPUs, and it has recently launched new GPU chips and systems to go after the massive AI opportunity. We believe AMD will be one of the lead beneficiaries of growing data center infrastructure spending driven by expanded use cases for AI and cloud computing across its product portfolio. We believe AMD's largest growth vector is to continue to take CPU market share from Intel. However, we also think that, despite NVIDIA's dominant position, given the massive growth opportunity for generative AI, there is fertile ground for an innovator like AMD to establish itself as a solid number two provider, particularly for inferencing use cases.

Investors in generative AI/cloud computing

Most of the mega-tech companies have been investing in generative AI for years and are well positioned to leverage its potential. In addition, we believe most future AI workloads will be built on the infrastructure of cloud service providers.

Microsoft, for example, will be a prime beneficiary of AI because of its ownership of and partnership with OpenAI, the inventor of ChatGPT, in our view. In addition, its Azure AI supercomputing cloud infrastructure is the exclusive cloud provider to OpenAI and a leading AI development platform for other enterprises. Microsoft's own AI innovations across Bing search (a chatbox virtual assistant), GitHub CoPilot software development (automated code suggestions and completion), and its Office suite of worker-productivity software (virtual assistants, branded CoPilot, to draft or summarize an email, enter data into a spreadsheet, prepare slides, etc.) are other avenues that

Microsoft has developed to monetize the power of generative AI. We remain confident Microsoft is well positioned to continue taking share.

Meta, the owner of Facebook, Instagram, WhatsApp, and other social media, has invested in generative AI for years and has among the world's best and largest datasets and distribution. We believe generative AI can materially help Meta improve existing products (e.g., instantly generate personalized creative ads) and expand into new areas (e.g., through WhatsApp and Messenger chats).

Finally, though it has not been as splashy as its peers so far, Amazon is also well positioned to provide computing infrastructure for the forthcoming generative AI wave, announcing services like Amazon Bedrock, which allow customers to use the supported large language model of their choice, and CodeWhisperer, a tool for software developers to autocomplete code using generative AI. Amazon is also the leading cloud service provider, with AWS controlling 32% of global cloud infrastructure.

Autonomous driving

AI and machine learning are widely viewed as the keys to unlocking a truly autonomous vehicle future. We are currently investors in three companies in this space: Tesla, which has been installing autonomous hardware in its vehicles since 2016; Mobileye, which has been developing autonomous driving technologies and advanced driver-assistance systems, including cameras, computer chips and software, since 1999; and GM Cruise, a robotaxi company founded in 2013.

AI models will support three key aspects of autonomous driving R&D: simulation of edge scenarios, prediction of future vehicle trajectories, and advancement of decision-reasoning chains. By using algorithms to create new content, such as images, videos, and even text, generative AI can create virtual environments and simulate real-world scenarios, allowing autonomous vehicles to learn and adapt in a safe and controlled environment.

Business software

For systems software companies like Snowflake, CrowdStrike, Cloudflare, and Datadog, generative AI will enable business users of all skill levels to work with data, previously the realm of data scientists and software developers, and will require reliable systems to manage, secure, transfer, and monitor AI data and applications.

Software vendors with business applications like ServiceNow and Workday can leverage generative AI to build on their scale distribution across large customer sets, embedded workflows, and proprietary or customer data.

Who may fall behind

On the downside, a digital app or service that uses undifferentiated data may have a tough time competing against companies using generative AI. We also think Alphabet, Inc., the owner of Google, may be at risk of disruption. Google has 90% market share of search outside of China, and it is highly monetized with sponsored links. We believe ChatGPT and/or similar AI-based services present a hard-to-measure risk to Google's virtual search monopoly. Google, however, likely possesses the largest and most unique proprietary data set on the globe. Google Search is globally scaled and free to billions of users; search results are real-time not static; and only 20% of Google searches are commercial enough to be monetized. Google is itself a leading AI innovator and has launched its own generative AI services, with more to come. We remain investors in Alphabet given its many positives, although we lowered its weight in our portfolio, and we are watching and researching carefully.

³ GPU Technology Conference

Conclusion

We are still in the very early innings of the AI revolution. There is a danger of getting caught up in the technology hype cycle. This concept, popularized by IT research firm Gartner, Inc., starts with an innovation trigger, such as the launch of ChatGPT, followed by inflated expectations, then disillusionment, followed by enlightenment, and finally productivity. Even if a technology progresses to mass adoption – and we have little doubt that AI will – many early-stage companies can fail along the way. Instead of rushing into untested start-ups, we believe the better strategy is to take a more measured, research-backed approach, investing in established companies that appear poised to benefit from the longer-term trend.

Investors should consider the investment objectives, risks, and charges and expenses of the investment carefully before investing. The prospectus and summary prospectuses contain this and other information about the Funds. You may obtain them from the Funds' distributor, Baron Capital, Inc., by calling 1-800-99BARON or visiting www.BaronFunds.com. Please read them carefully before investing.

Risks: Securities issued by small and medium sized companies may be thinly traded and may be more difficult to sell during market downturns. Companies propelled by innovation, including technology advances and new business models, may present the risk of rapid change and product obsolescence, and their success may be difficult to predict for the long term. In addition to general market conditions, technology companies, including internet-related and information technology companies, as well as companies propelled by new technologies, may present the risk of rapid change and product obsolescence, and their successes may be difficult to predict for the long term.

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Portfolio holdings as a percentage of net assets as of March 31, 2023 for securities mentioned are as follows: **Advanced Micro Devices, Inc.** – Baron Opportunity Fund (2.1%), **indie Semiconductor, Inc.** – Baron Opportunity Fund (2.2%), Baron Technology Fund (2.3%), **Meta Platforms, Inc.** – Baron Opportunity Fund (2.0%), Baron Technology Fund (2.8%), **GM Cruise Holdings, LLC** – Baron Opportunity Fund (0.8%), **Mobileye Global Inc.** – Baron Opportunity Fund (0.4%), Baron Technology Fund (0.5%), **Snowflake Inc.** – Baron Opportunity Fund (1.5%), Baron Technology Fund (1.7%), **CrowdStrike Holdings, Inc.** – Baron Opportunity Fund (1.2%), Baron Technology Fund (1.6%), **Cloudflare, Inc.** – Baron Opportunity Fund (1.4%), Baron Technology Fund (1.5%), **Datadog, Inc.** – Baron Opportunity Fund (0.9%), Baron Technology Fund (1.7%), **Workday, Inc.** – Baron Opportunity Fund (1.8%).

Top 10 Holdings as of 3/31/2023

Baron Opportunity Fund

Holding	% Assets
Microsoft Corporation	14.4
NVIDIA Corporation	6.5
Tesla, Inc.	6.2
Amazon.com, Inc.	5.8
Visa Inc.	3.4
Gartner, Inc.	3.1
Mastercard Incorporated	2.9
Alphabet Inc.	2.9
ServiceNow, Inc.	2.8
CoStar Group, Inc.	2.8
Total	50.7

Baron Technology Fund

Holding	% Assets
Microsoft Corporation	10.3
Amazon.com, Inc.	8.6
NVIDIA Corporation	6.2
Tesla, Inc.	5.3
Taiwan Semiconductor Manufacturing Company Limited	3.7
ServiceNow, Inc.	3.6
Advanced Micro Devices, Inc.	3.5
ASML Holding N.V.	3.2
Workday, Inc.	3.1
Ceridian HCM Holding Inc.	3.0
Total	50.4

Portfolio holdings are subject to change. Current and future portfolio holdings are subject to risk.

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