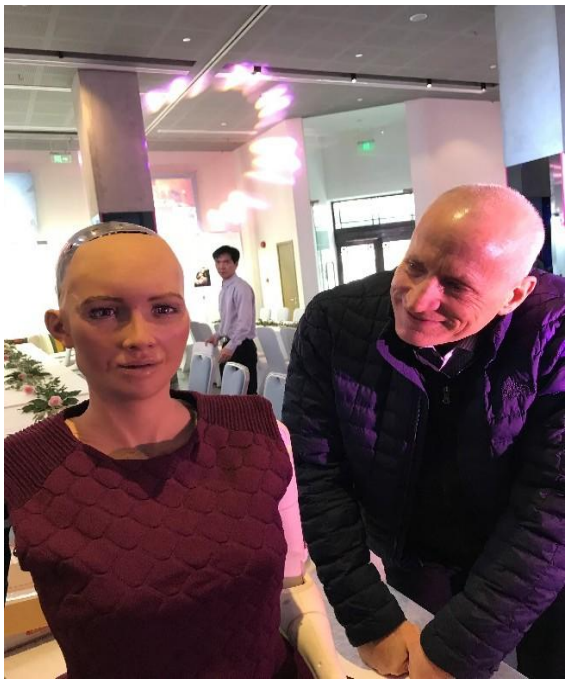
ARTIFICIAL INTELLIGENCE (AI)

Natural intelligence (NI) is displayed by humans and other animals. By contrast, AI is machine-based. Contemporary AI systems are increasingly capable of learning, adaptation, self- correction. Most dramatic, recent AI applications are capable of generating written content, images, videos, and music.

1. INTRODUCTION

Alan Turing,[1] a British mathematician, is credited as the founder of AI. In 1935, Turing described "an abstract computing machine consisting of a limitless memory and a scanner that moves back and forth through the memory, symbol by symbol, reading what it finds and writing further symbols."[2] In his 1950 paper "Computing Machinery and Intelligence,"[3] he asked: Can machines think? He believed that future machines would improve its programs and algorithms.

Some prior commentary emphasized that the AI developments were slow. (Rf. "Steeper than Expected", *The Economist Technology Quarterly*, June 13, 2020.) But there were notable advances: IBM's *Watson,* introduced in 2010, demonstrated that AI dominates NI in many settings. Improved chess algorithms competed against grand masters. Sophia – a robot created by Hanson Robots – captured the attention of many (including your professor) in 2017.



[1] The protagonist of Academy Award-winning *The Imitation Game* (2014).
[2] https://www.britannica.com/technology/artificial-intelligence/Alan-Turing-and-the-beginning-of-AI.
[3] Published in an academic journal *The Mind*; for the article, see https://academic.oup.com/mind/article-pdf/LIX/236/433/9866119/433.pdf.

AI has been applied successfully in the financial sector. Bryan Kelly (Professor of Finance, Yale School of Management) has demonstrated that the combination of powerful computers and vast amounts of data that feature a low signal-to-noise ratio is a perfect context for AI do yield insights. AI has been used to value assets and manage portfolios. It is also being used by financial institutions to monitor transactions and detect fraud. Hence, there is no doubt that AI has reached a threshold of viability and utility.

In Section 2 we review major breakthroughs in AI technologies and then in Section 3 focus on *generative* AI. In Section 4 we consider whether we are at a fundamental turning point in human history. In Sections 5 and 6 we address AI's impact on industries and on business and society.

Please note that the Appendix provides information on current applications.

2. AI BREAKTHROUGHS IN HISTORY

In the early 17th Century when philosopher René Descartes discussed the idea of machines capable of human-like thinking. As mentioned, Alan Turning's 1950 paper, Computing Machines and Intelligence, regarded as the starting point of the modern AI history.

John McCarthy organized Dartmouth Workshop in 1956, formulating the conjecture that "Every aspect of learning or any other feature of intelligence can be so precisely described that a machine can be made to simulate it."[4] A few notable systems were created during this time:

- Arthur Samuel wrote a program that could play checkers at a strong amateur level**.**
- Alan Newell and Herbert Simon's Logic Theorist could prove theorems. Later, they developed the General Problem Solver, first useful AI program.[5]
- SNARC represents a machine that used a simulated neural network to navigate a maze[6].
- ELIZA, created in the 1966, was the first AI chatbot designed to imitate a therapist.[7]

In the late 1980s, AI research towards statistics and machine learning in two areas:

- Bayesian networks provides a framework for reasoning under uncertainty.
- Support Vector Machines (SVMs) improved upon neural networks and became the favored tool in machine learning.

In 1997, IBM's Deep Blue defeated world chess champion Garry Kasparov, highlighting the growing capabilities of AI in complex tasks. In 2016, AlphaGo showcased AI's strategic decision-making by defeating Go world champion Lee Sedol 4-1.

The early to mid-2010s saw the rise of AI voice assistants like Siri, revolutionizing human-device interaction through advanced voice recognition and machine learning algorithms.

Self-driving cars became a reality in 2018 when Waymo's autonomous taxi service launched, demonstrating the commercial viability of AI in transportation.

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[4] https://home.dartmouth.edu/about/artificial-intelligence-ai-coined-dartmouth
[5] http://web.cse.ohio-state.edu/~stiff.4/cse3521/gps.html
[6] https://historyof.ai/snarc/
[7] https://onlim.com/en/the-history-of-chatbots/

3. GENERATIVE AI

The emergence of ChatGPT in late 2022 and other AI tools changed the narrative from "AI is yielding some interesting advances" to "we are at the beginning of profound AI-induced changes in business and society.

OpenAI's ChatGPT was released on November 30, 2022,[8] and reached 100 million users by January 2023. AI tools like ChatGPT are first trained on large amounts of data scraped from the Internet. ChatGPT-like tools represent a big step in the development of AI because they are capable of understanding *natural language* and output answers also in natural language that is nearly indistinguishable from human text. For example, ChatGPT has been successfully used to write emails, college applications, term papers, fix bugs in code, make Spotify playlists, and even to design parts for spaceships or write wedding vows.[9] ChatGPT represents a potentially revolutionary advancement over traditional search engines like Google or Baidu, whose output links to websites or files based on search terms and user location.[10]

4. ARE WE AT A FUNDAMENTAL TURN IN HUMAN HISTORY?

One can make the case that development of AI represents a fundamental turn in human history. Going forward, AI will progress *alongside* natural intelligence.

Here are three key questions:

1. Will AI be a complement to, and controlled by, natural intelligence?
2. Will AI substitute humans?
3. Can anyone set rules to control the development of AI?

Let's try to put the turning point issue – *before-AI* and *after-AI* – into perspective. The Earth was formed 4.54 billion years ago, and life on our planet began 3.80 billion years ago. Homo sapiens, our species, have been around only for the last 300,000 years and only in the last 200,000+ years did we migrate around and out of Africa.

During our short slice of history of life on Earth, each generation of humans has developed a *flow* of new knowledge in a vast array of domains, including the arts, music, mathematics, science, philosophy, and physics. Fortunately, successive generations have not had to "reinvent the wheel."[11] A substantial portion of our knowledge has been recorded in stories, song, text, and in practices that are observable by others. Humans have written over 130,000 million books and have created even more pieces of art. Hence, much of the *stock* of human knowledge has been recorded in forms that are accessible by others.

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[8] https://www.nytimes.com/2023/03/28/technology/ai-chatbots-chatgpt-bing-bard-llm.html.
[9] https://www.nytimes.com/interactive/2023/04/14/upshot/up-ai-uses.html.
[10] The proliferation of ChatGPT has caused huge changes in stock prices of education-focused companies such as Chegg, Duolingo and Pearson. https://www.wsj.com/articles/chegg-stock-nearly-cut-in-half-after-warning-that-chatgpt-is-hurting-growth-98a172cc.
[11] That phrase refers to the idea that in some circumstances, individuals or teams of individuals need to develop knowledge that others had developed before them.

No individual has even a vague understanding of the stock of human knowledge. (This statement is true even for some economists who think otherwise!) As a result, we must choose what to learn and what not to learn.

Gary S. Becker authored the book, *Human Capital*, in 1992 and developed the field known by the same name. Central questions in the field include:

i. How we learn from others including parents, coaches, teachers, and peers, and from knowledge that is recorded in books and by other means, and
ii. How decide what knowledge and skills to develop.

Regarding (i), the transfer of knowledge is critically important to a society because an individual's human capital is lost when a person dies.

Regarding (ii), an important factor – but far from the only factor – is that individuals make investments in human capital that yield pecuniary benefits, i.e., income and wealth. Gregory Mankiw of Harvard has demonstrated that differences in wealth within and across societies are due in large part to differences in human capital.

With that background on NI, an overarching question is how will AI affect NI and human capital? The after-AI period is likely to be a fundamental departure in three related respects.

> *First,* NI will not be the only form of intelligence.
> *Second,* AI will reside in machines that are potentially much more long lasting than humans with life expectancies – less than 80 years in most countries. Even as machines become obsolescent, their knowledge can be transferred to newer and probably smarter machines.
> *Third,* AI will exert a profound influence on how most industries function and innovate.

5. AI'S IMPACT ON HIGH-TECH INDUSTRIES

Mobility

Recent developments in computing power, data storage, and communication networks have enabled AI and ML to impact the transportation market in various ways. The global market for transportation-related technologies was $1.2 -$1.4 billion in 2017, and this is expected to grow to $3.1 - $3.3 billion in 2023 (EMCompass, 2019).

The single largest driver of the market viability of autonomous vehicles and full-self driving technology is artificial intelligence. While not considered to be fully autonomous, Tesla's autopilot feature[12] is an advanced driver assistance system that reduces workload for the human driver. Some features of this autopilot system include auto steering, auto park, auto lane change, and smart summon. Drivers still need to be attentive, but full-self driving models are not far off.

[12] Tesla has launched a beta *Full Self-Driving* program in 2020; U.S. safety regulators have forced Tesla to abandon the program in 2023 over safety concerns. https://www.pbs.org/newshour/nation/regulators-force-tesla-to-recall-363000-full-self-driving-vehicles.

BOX 1 Examples of AI models finding their way into the transport sector

1. Artificial neural networks (ANNs):

Description: They are inspired by the neural networks found in a human brain. They use previous experience and data points with varying weights to make decisions. ANNs can handle complex problems as they operate with large amounts of data, detecting nonlinear relationships. *(Gharehbaghi, Koorosh, 2016. "Artificial Neural Network for Transportation Infrastructure Systems." MATEC Web of Conferences, 81 (05001), 2016.)*

Uses: Some more sophisticated Global Position Systems (GPS) use ANN to determine the mode of transportation being used by gathering data from a GPS, an accelerometer, and a magnetometer. This is analogous to humans "feeling" distance by considering several data points. Furthermore, ANN models can be used in public transport to help predict arrival times for buses at stop areas. *(Gurmu, Zegeye Kebede, and Wei Fan, 2014. "Artificial Neural Network Travel Time Prediction Model for Buses Using Only GPS Data." Journal of Public Transportation, 17(2), 2014.)*

2. Artificial Immune System (AIS)

Description: This algorithm takes its inspiration from human biology, specifically, how human bodies react to disease-causing agents known as antigens. AIS models the feature extraction, pattern recognition, learning, and memory of human immune systems.

Uses: AIS are useful for pattern recognition, anomaly detection, clustering, optimization, planning, and scheduling. Engineers have used AIS to create a real-time regulation support system to help public transport networks find solutions when the network experiences a disturbance. *(Masmoudi, Arij, Sabeur Elkosantini, Sabeur Darmoul, and Habib Chabchoub, 2012. "An Artificial Immune System for Public Transport Regulation." HAL, August 2012.)*

3. Fuzzy Logic Model

Description: Modeled after human decision-making, fuzzy logic assigns data with numeric values between 0 and 1 to denote uncertainty. TutorialsPoint. "What is Fuzzy Logic?" Artificial Intelligence Tutorial. This system has been used for over 30 years and is best for situations with ambiguous conditions where the consequence for each action is unknown. *(Chattaraj, Ujjal, and Mahabir Panda. "Some Applications of Fuzzy Logic in Transportation Engineering." Lecture, Department of Civil Engineering, National Institute of Technology, Rourkela. Scientific American, 1999. "What is 'Fuzzy Logic'? Are There Computers That Are Inherently Fuzzy and Do Not Apply the Usual Binary Logic?" October, 1999.)*

Uses: Fuzzy logic has potential for modelling traffic and transportation planning problems as they are ambiguous and vague. It also has traffic control applications, as it can signal time at a four-approach intersection and determine for how much time cars should be stopped. *(Chattaraj, Ujjal, and Mahabir Panda. "Some Applications of Fuzzy Logic in Transportation Engineering." Lecture, Department of Civil Engineering, National Institute of Technology, Rourkela.)*

4. Ant Colony Optimizer (ACO)

Description: This algorithm simulates ant colony behavior: the way ants choose their paths based on their own wish to take a short route and pheromones that relay the experience of other ants with each path. *(Kazharov, Asker, and V Kureichik, 2010. "Ant Colony Optimization Algorithms for Solving Transportation Problems." Journal of computer and Systems Sciences International, 49(1) pp. 30–43.)* This mechanism helps ants find the quickest course between two points. In computer science, this problem is also called the Traveling Salesman Problem, in which a salesman must visit X towns and return to the starting point using the path with the minimum cost.

Uses: ACOs can be used for better routing of public transport buses, as well as ride-sharing platforms that pick up various users, such as Via or Uber Pool.

5. Bee Colony Optimization (BCO)

Description: Similar to ACO, this algorithm takes the collective foraging movements of honey bees as an example of organized team work, coordination, and tight communication. The bees' movements inside the hive help scientists optimize movements for machines. *(Kaur, Arvinder, and Shivangi Goyal, 2011. "A Survey on the Applications of Bee Colony Optimization Techniques." International Journal on Computer Science and Engineering, 3(8) 2011.)*

Uses: BCO can be used to optimize travel routes, diminishing travel times, number of waits, delays, and air and noise pollution.

AI trained neural networks will speed up the development of full-self driving technology.

Currently, Tesla uses a camera-based autopilot system called Tesla Vision. Previous iterations of full-self driving have used radar-based systems, but Tesla Vision allows its drivers to see what the car sees. AI is applied through the use of deep neural networks – helping systems process and identify data on the road in real time, and subsequently reacting to this data appropriately. These overlapping neural networks are trained through experience, with capabilities ranging from reading signs, turn signals, road hazards, and ambulance/police lights.

Regarding ride sharing, AI already has had profound effects on the business model and operations on companies like Uber. AI is a central technology to the business - two notable applications of AI are matching and route optimization. With real world issues such as traffic jams, matching algorithms apply batched matching to reduce wait times. Batched matching bundles multiple riders based on distance together, allowing the algorithm to make better matches between driver and rider. In terms of route optimization, routing algorithms go beyond presumption and availability; it takes into effect traffic jams and weather to predict the fastest route.

In addition to route optimization and matching, AI affects other aspects of operations, including "fraud detection, risk assessment, safety processes, marketing spend and allocation, and driver onboarding" (Forbes). Customer support systems are also aided by AI agents who handle customer queries and lead to faster response rates than human agents.

AI applications will also affect manufacturing, e.g., optimizing production lines, improving quality assurance, and managing supply chains. AI based algorithms "can digest masses of data from vibration sensors and other sources, detect anomalies, separate errors from background noise, diagnose the problem, and predict if a breakdown is likely or imminent" (McKinsey). AI can and will reduce capital costs and improve manufacturing efficiency, lowering total annual maintenance by up to 10 percent (McKinsey).

Current quality control processes in manufacturing are performed by humans. As you can imagine, this process is slow and prone to false positives. AI-based visual quality control technologies filter out all external factors such as lighting and can detect defects up to 90 percent more accurately than humans (McKinsey). In addition, these capabilities are constantly improving through feedback, and will provide superior quality control on machine parts, car bodies, and raw materials. For example, manufacturers like Audi have implemented computer vision to identify cracks in sheet metal, while other manufacturers have used AI-based hardware for product prototyping.

Video Streaming and Related Activities

An estimated eighty percent of American households own at least one internet-connected device for video streaming, and almost as many subscribe to at least one video-streaming platform (Statista 2022[13]). AI-powered technologies may disrupt the way we stream videos, from the technical quality of the video itself to personalized recommendations.

AI is good at finding the signal within a noisy context. In the context of video, super-resolution is the act of recovering a high-resolution image from the corresponding low-resolution counterpart (Liu et al.). Deep Learning Models leverage inter- frame information to align neighboring frames.

[13] https://www.statista.com/statistics/274192/streaming-services-penetration-rates-in-the-us/.

AI/ML in Streaming

Super-resolution models use these trained deep learning models to enhance video quality. In doing so, video streaming services like Netflix can leverage this technology to improve the quality of old movies and shows and improve the streaming experience for consumers. AI also can improve streaming by optimizing these video streaming workflows. AI models calculate bitrates to optimize bandwidth requirements.

AI also enables "content-aware encoding" in which an AI can "understand what kind of content is being streamed, and optimize bitrate, latency, and protocols, accordingly" (Haivision). In doing so, optimal video quality can be achieved via the minimum bits necessary; as a result, video quality is enhanced with significantly less buffering time.

Of course, the big issue is content creation. AI models contribute to content creation and virtual realities. Netflix leverages AI and ML models in the initial identification of potential projects. For example, Netflix "combines and analyzes various data sets to predict the cost of numerous attributes of the production process, such as content, location, and schedule, and optimizes decisions given resource constraints such as time, cast, and locations" (HBS). In doing so, Netflix can greatly reduce identification and production costs for their original content.

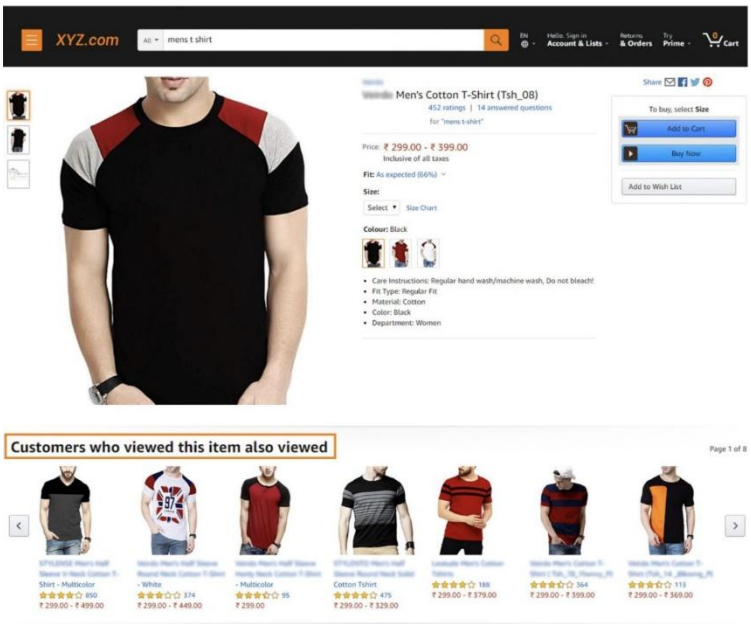
AI may also affect our choices of what to watch. Video streaming services rely on these algorithms to acquire and retain customers. Newer AI algorithms use implicit and explicit data to produce personalized recommendations for each customer. Implicit data is customer data that is shared, such as like/dislike feedback while explicit data is behavioral data such as what shows were watched and for how long. AI identifies trends within this data and matches the tastes of customers to content.

One identified issue of the on-demand video streaming business is the use of shared accounts. An

account paid by one customer can be shared and used by multiple individuals, and lead to lost revenue. To combat this, Netflix can utilize AI to analyze explicit data and consumer data such as taste preferences to identify customers who are "leeching" off a single account and create a business strategy to remove and mitigate these behaviors.

eCommerce

With the rise of online retailers like Amazon and Alibaba, e-Commerce has made shopping exponentially more convenient and changed buying tendencies and preferences. The COVID-19 pandemic has accelerated the shift to online retail, increasing the U.S. e- commerce market penetration from ~15% in 2019 to ~35% by Q1 of 2020. Going forward AI will create personalized shopping experiences for consumers and reduce costs by, for example using robots connected through the IoT to package and load inventory efficiently.



When you shop online, you may notice recommended products when you buy an item. How do online retailers determine what products to recommend? AI powered eCommerce platforms analyze previous buying behaviors and trends to forecast future buying decisions, and subsequently recommends products based on this forecast. Recommendation AI have improved key performance metrics such as click-thru rates, conversion rates, and revenue per customer that online retailers rely on.

ChatGPT and other generative AI tools are a potential game changer for eCommerce as they could automate writing product descriptions, highlighting key information given customers' preferences, and even write description in a language customized to particular consumer.[14]

AI leverages purchase history, buying patterns, and search history to create personalized recommendations. Leads to higher cross-sell/upsell revenue, customer retention, faster turnover.

[14] https://www.insiderintelligence.com/content/3-ways-fashion-ecommerce-will-evolve-through-generative-ai-chatgpt.

Payment Systems

Reflecting the ability of AI to sift through large volumes of noisy data and find signals, AI has already been incorporated into fraud prevention.[15]

AI can aggregate and analyze data driven by an individual's IoT network to improve ecommerce insights. Payment systems may develop whereby individuals are prompted to identify what goods and services need to be purchased and when.

Finally, AI is likely to become useful in managing credit risks. Algorithms can find patterns and offer overall guidance, but AI can complement those patterns with analysis of high volumes of discrete data about, for example, whether individuals are increasing their debt because they are buying necessities or luxuries.

6. AI'S IMPACT ON BUSINESS AND SOCIETY

Most believe that AI technologies will yield great benefits, but also pose risks. George Hinton, mentioned above, decided to depart from Google in April 2023 so that he could speak more freely on the risks of AI. In his first major interview on PBS, he cited major risks, including:

- More "fake news" from AI-generated photos, video, and audio.
- Great political polarization.
- Social dislocations from job losses.

In his recent visit to Yale SOM, Ken Griffen (founder of Citadel) underscored the potential job losses from AI..

Of course, economics has taught that major innovations create new jobs and greater income. Will AI be different? One can make a good case that never before in human history has a new technology impacted so many industries (health, financial management, transportation, professional services, agriculture, textiles, etc.) at the *same* time.

Almost no one is arguing that AI can or should be stopped. Given that we will have two types of intelligence (natural and artificial) going forward, a fundamental question is how markets will address the risks associated with AI. Some of the types of risks associated with AI, e.g., increased risk of fake information, are quite similar to the risks from counterfeit products. Markets have responded with investments in brand name capital and monitoring. Other risks are addressed by contracts.

Here is a question is for each of us: How will we position ourselves in a post-AI world? Leveraging the insights from Section 3, it is useful to consider that the last few centuries divide into three different periods:

1. NI only with limited access to information.
2. NI only with easy access (Google, Wikipedia, etc.) to information.
3. NI and AI with both easy access to information and access to "knowledge" from Large Language Models.

[15] https://www.paymentsjournal.com/using-ai-to-combat-financial-crime-in-real-time-payments/ (April 3, 2023).

Given that we are shifting to (3), our individual incentives to invest in HC and different types of HC should change dramatically.

The big question for governments concerns regulation.[16] Other issues concern infrastructure support and technical standards. Will China, the EU, or the US move more quickly?[17]

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Glossary:

- *Generative AI* describes algorithms (such as ChatGPT) that can be used to create new content, including audio, code, images, text, simulations, and videos. Examples of generative AI include ChatGPT (text) and DALL-E (images).[18]
- *Machine learning* is a branch of artificial intelligence concerned with the construction of programs that learn from experience[19].
- *Deep learning* is a form of machine learning based on learning data representations rather than performing task-specific algorithms.

Readings:

- https://www.britannica.com/technology/artificial-intelligence/Alan-Turing-and-the-beginning-of-AI
- Winston, Patrick Henry. Artificial intelligence. Addison-Wesley Longman Publishing Co., Inc., 1984
- McCarthy, John. "What is artificial intelligence." (2007) 2020, https://www.diochnos.com/about/McCarthyWhatisAI.pdf
- https://en.wikipedia.org/wiki/Template:Artificial_intelligence
- https://en.wikipedia.org/wiki/Glossary_of_artificial_intelligence
- Gary S. Becker, *Human Capital*, University of Chicago Press, 1992.
- Russell, Stuart J. *Artificial intelligence a modern approach*. Pearson Education, Inc., 2010.
- https://aitopics.org/search A dynamic library of internet resources on AI
- Haenlein, Michael, and Andreas Kaplan. "A brief history of artificial intelligence: On the past, present, and future of artificial intelligence." *California Management Review* 61, no. 4 (2019): 5-14;
- Chen, Lijia, Pingping Chen, and Zhijian Lin. "Artificial intelligence in education: A review." *IEEE Access* 8 (2020): 75264-75278.

Commentary News:

- https://finance.yahoo.com/news/the-stock-market-has-its-eggs-in-one-basket--ai-morning-brief-130026958.html (April 26, 2023)
- Artificial Intelligence and the Future of Employment,

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[16] NYT early May 2023.
[17] https://www.japantimes.co.jp/opinion/2023/05/03/commentary/world-commentary/china-av-technology/.
[18] See https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-generative-ai for a more thorough discussion.
[19] "machine learning." In *A Dictionary of Computer Science*, edited by Butterfield, Andrew, Gerard Ekembe Ngondi, and Anne Kerr. : Oxford University Press, 2016. https://www.oxfordreference.com/view/10.1093/acref/9780199688975.001.0001/acref-9780199688975-e-3056.

https://www.wsj.com/articles/artificial-intelligence-and-the-future-of-employment-college-students-education-jobs-ai-d4470007 (April 25, 2023)

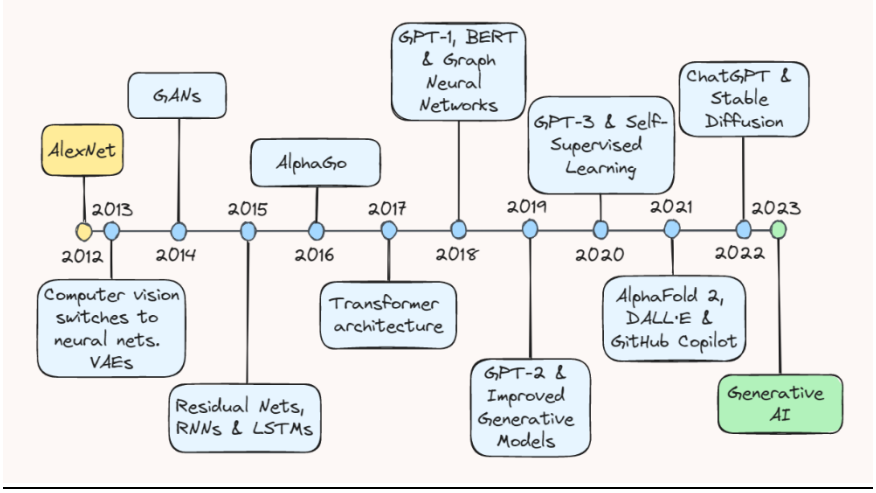
- https://www.wsj.com/articles/dr-chatgpt-physicians-are-sending-patients-advice-using-ai-945cf60b (April 28, 2023)

APPENDIX

RECENT DEVELOPMENTS AND APPLICATIONS

The Appendix explores in detail AI developments and applications across China, EU, and US within four verticals. AI and generative technologies are driving innovation and sparking entrepreneurial opportunities, paving the way for an unprecedented era of technological progresses and economic growth.[20]

1. TECHNOLOGICAL ADVANCES IN THE LAST DECADE[21]



AlexNet: Introduced in 2012, AlexNet is a pioneering convolutional neural networks (CNN) revolutionized the field of image recognition and classification. It significantly outperformed all prior models and establish deep learning as a dominant approach in AI.

Computer Vision to Neural Networks: Progressing from CNNs, advancements in computer vision have led to neural networks capable of mimicking human visual perception. Techniques such as object detection, segmentation, and recognition have greatly improved, making AI more accurate in interpreting and interacting with the world.

Revolutionary Architectures: The progress of residual networks (ResNets) solve the problem of vanishing gradients and allow training of deeper neural networks by introducing skip connections or shortcuts to layers. Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) models revolutionized data processing in time-series analysis and natural language processing, paving the way of LLMs today.

The Transformer: Introduced in 2017, the Transformer model marked a shift from recurrent models. Its flexibility, scalability, and accuracy make it suitable for a broad range of applications and sequential tasks. Transformers power state-of-the-art models in NLP, like BERT and GPT, with their self-attention mechanism.

[20] Bill Zhang, Yale Class of 2024 and Teaching Assistant for 960 wrote this Appendix.
[21] Ten Years of AI in Review, T. A Dorfer, Towards Data Science

GPT-1, BERT, and Graph Neural Networks (GNNs): GPT-1 and BERT made significant progress in understanding and generating human-like text. GNNs expanded deep learning scope and enabled more nuanced analysis of graph-structured data.

GPT-2 & Improved Generative Models: GPT-2 improved over GPT-1 in generating more coherent and contextually relevant sentences. Generative models have also improved, enabling creation of high-quality synthetic data such as images and music.

GPT-3 & Self-Supervised Learning: With 175 billion parameters, GPT-3 pushed the envelope for language models. It generated remarkably coherent texts and demonstrated strong NLP performance. Self-supervised learning, where models learn from unlabeled data, also emerged as a promising approach and reduced the need for extensive labeling.

ChatGPT & Stable Diffusion: Introduced in 2022, ChatGPT offers a high-quality conversational model. Stable diffusion offers a latent text-to-image diffusion model to generate realistic images from text descriptions.

Generative AI: Generative AI has progressed significantly, capable of creating art, music, or writing in the style of a human.

In Section 2 to Section 5, we will briefly examine the impact of AI on our four verticals – mobility, video streaming and metaverse, ecommerce, and payment systems. We will also discuss the power of emerging generative AI platforms and the regulations AI in Section 6 & Section 7.

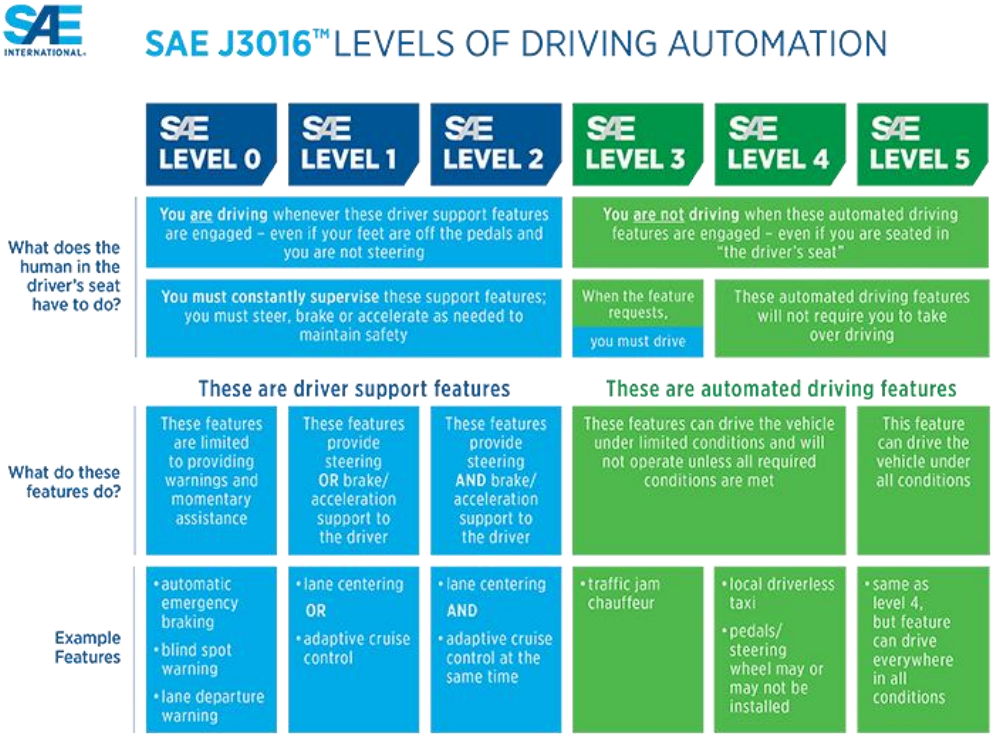
2. IMPACTS ON INDUSTRIES

Mobility

Artificial Intelligence facilitated the progress of autonomous driving, robotaxi, and automatic manufacturing in the car industry. It became a significant source of competitive advantages among players, with ample opportunities for scaling. In this section, we will briefly examine the application of AI in mobility from the three perspectives.

Driving Automation Metric

There are six levels of driving automation as defined by SAE International, formerly known as the Society of Automotive Engineers. It scales from L0 to L5, across various vehicle autonomous driving capabilities. As of mid-2023, we are currently in the transitioning stage between L2 and L3.



Car Manufacturers

Car manufacturers across US, EU, and China are the most active players in autonomous driving technology. They use AI to arm vehicles with various self-driving systems and provide advanced driving assistance experience to end-users. Some of the firms even have provided automated driving features that don't require the driver actually drive under limited conditions. Following is a list of representative players in each market:

Tesla's Autopilot includes an advanced suite of driver-assistance features. It employs a combination of radar, cameras, ultrasonic sensors, and advanced machine learning to enable the car to sense its environment, make decisions, and navigate safely. It released full self-driving package for customers in north American in November 2022. The system holds a distinctive edge over its competitors due to its extensive data collection, hardware-software integration, and advanced neural network approach. Tesla's one of the largest fleets on the roads ensure the company to gather and analyze a wide range of real-world driving datapoint, and continuously refine the self-driving algorithm through machine learning. The synergy achieved through the integration of Tesla's hardware and software development enhanced the overall effectiveness of the system and user friendliness.

Mercedes pioneered the development of autonomous driving technology by developing Drive Pilot, a conditionally automated driving system that secured a Level 3 automated driving license in the US (California and Nevada). This achievement signifies that under approved road conditions, drivers can remove their hands from the steering wheel, allowing the vehicle itself to take full control. Furthermore, announced that it will take legal responsibility for accidents involving its Level 3 autonomous drive system, a step that goes beyond Tesla's Autopilot system.

Xpeng's Advanced Driving Assistance Systems (ADAS) is lauded for its capabilities in complex

urban driving environment. Once the city NGP is activated and a destination is set, the vehicle autonomously performs a wide range of driving tasks, including cruising with safe distances, lane changing, navigating margining or splitting roads, circumventing stationary obstacles, etc. The system also responds to traffic lights, roundabouts, viaducts, and tunnels, as well as avoids hazards such as pedestrians, cyclists, and construction zones.

NOMI is one of the first leading in-car AI assistant designed by **NIO** that offers car owners the ability to control car functions through voice commands. Like Apple's Siri, but designed specifically for the automotive environment, NOMI uses natural language processing and AI to improve driving experience and safety. Users can instruct NOMI to turn on the massage seat, capture a selfie, play music, or navigate. This innovative tool significantly elevates NIO's in-car interactivity.

Autonomous Mobility Solutions

Autonomous mobility solutions integrate artificial intelligence with advanced sensors to redefine travel, offering safer and more efficient transit options for both people and goods. US and China appears to be the pioneers in this sector with most competitive platforms. The representative firms include Waymo, Cruise, Pony.ai, and AutoX.

As a part of Google, **Waymo** is known for its innovative technology includes LiDAR, radar, and high-resolution cameras. It established early compared with competitors and benefits from Google's extensive resources in AI. A representative application of Waymo spans in self-driving ride-hailing service, Waymo One. Waymo also supports trucking and local delivery services in cities.

Backed by car manufacturing giants GM and Honda, **Cruise** is a San Francisco based self-driving car company focus on urban mobility. It aims to provide an efficient, safer, and cheaper alternative to city transportation methods. Cruise has accumulated over 1 million driverless miles until April 2023.

On the Chinese market side, **Pony.ai** focuses on developing both the hardware and software for autonomous vehicles, allowing for better system optimization. Accessible to both trucks and robotaxi, Pony.ai is the first company to have test autonomous driving cars in both US and China.

Another leading player is **AutoX**, which stands out with its high-level AI and robotaxi technology. Its products cover a full set of hardware and software with potential for extending to the L4/L5 domain, possessing capabilities in the electronic and electrical architecture of unmanned vehicles. AutoX's technology is utilized in various robotaxi service and autonomous delivery services. Both Pony.ai and AutoX received Chinese license to execute self-driving cars in Shanghai Pudong.

Fundamental Infrastructure

NVIDIA is the unquestionable leading player in AI mobility infrastructure sector. Its powerful AI computing platform and software development kit, **Nvidia Drive**, equipped with GPUs and SoCs for autonomous driving.

Nvidia first launched its Drive CX and Drive PX automotive platforms in 2015, focusing on digital cockpit solutions and image-processing. The platform updated in 2016 with Drive PX2, touted as the world's first in-car AI supercomputer. Nvidia's latest generation, Drive Thor, combines multiple intelligent functions – automated and assisted driving, parking, driver monitoring, infotainment, etc. – into a single architecture. It delivers up to 2,000 teraflops (1012) of performance, illustrating Nvidia's substantial evolution in autonomous driving domain.

The improved performance is attributed to advancements in Nvidia's GPU architecture, with Thor being based on the 5nm Ada Lovelace architecture. It is believed that Thor will pave the way for full autonomy in vehicles, eliminating the need for human intervention. Major automakers such as Mercedes-Benz, Volvo, BYD, and Hyundai are already utilizing Nvidia's self-driving AI technology, which is expected to convert into substantial revenue growth for Nvidia as these companies bring their products to market.

Ride-sharing and Robotaxi

As top two ride sharing platforms in the world, **Uber** and **Didi** have significantly invested in artificial intelligence to spearhead the development of robotaxi. Both companies aim to deploy fleets of self-driving taxis. The vision for the revolution is that robotaxi could seamlessly navigate city streets and offer safe, efficient, and on-demand transportation anywhere anytime to fundamentally reshape the way people commute and interact with urban environments.

Partnership with autonomous mobility solutions such as **Waymo** and **Motional**, Uber aim to start self-driving Ubers in 2023 in Phoenix, Arizona. It will provide a set number of Waymo's vehicles to its ride-hailing and food delivery services fleet in the Phoenix metropolitan area. Riders can either hail Waymo vehicles from the Waymo One app, or request a Waymo vehicle through the Uber app if one is available.

Uber's Motional Robotaxi

DiDi Concept Car "Neuron"

On the other hand, the Chinese ride-hailing giant aims to supplement its existing network of millions of human-driven cars and plans to make these autonomous vehicles available to the public 24/7 by 2025. In 2020, DiDi established an autonomous driving subsidiary, that has since received substantial funding from SoftBank. To build its fleet of autonomous vehicles, DiDi has forged strategic partnerships with original equipment manufacturers (OEMs) such as Lincoln, BYD, Nissan, and Volvo. This collaboration reinforces DiDi's commitment to becoming a significant player in the autonomous driving sector.

Manufacturing

As the pillar of artificial intelligence in manufacturing and notion of global collaboration between US and China, Tesla Shanghai Gigafactory produces the Model 3 and Model Y. Its AI capability helps Tesla to yield tangible benefits, including streamlining production, reducing wastes, improving quality. The Gigafactory's key innovations include automated machinery for efficient parts assembly, AI-driven quality control systems, and predictive maintenance algorithms to minimize equipment downtime. These improvements have resulted in more competitively priced electric vehicles. The success of Tesla's Shanghai Gigafactory substantiated the market leading position of Tesla and encourages the wider adoption of AI in manufacturing globally.

Video Streaming and Related Industries

Content Creation

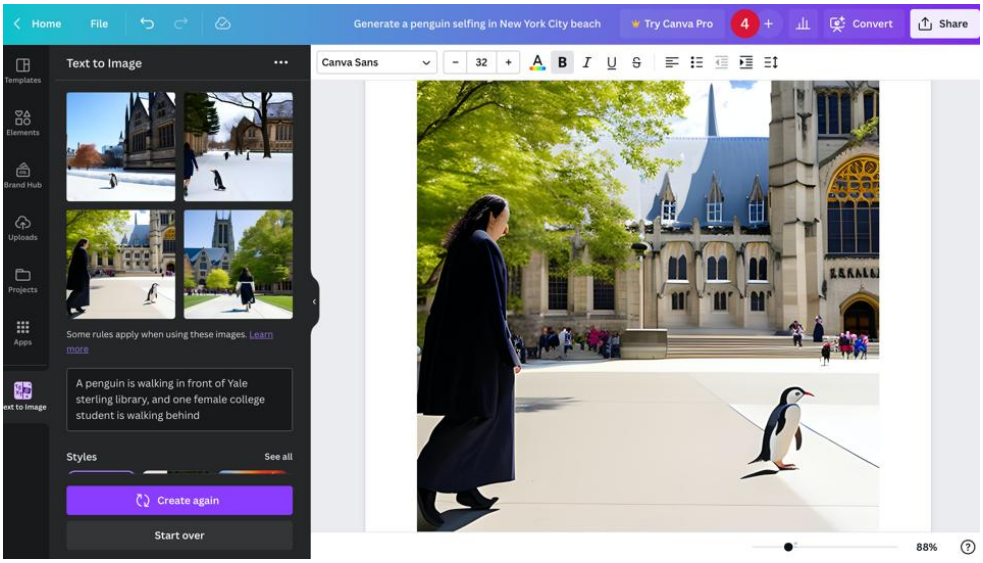
AI content creation tools are most popular among video and image creation domains. The right content creation tool can boost users' productivity and help them quickly met rising demands in real life. The more users are able to embed AI into content creation, the more ROI will be generated. Here, we are introducing some popular tools in either segments (there are many!).

Colossyan is an AI-powered video platform designed for workforce learning. It enables users to create personalized avatar and auto-generated video within minutes using AI. Its innovative features include text-to-video conversion, automatic language generation and translation, as well as synchronization of avatar mouth shapes to match the spoken language.

HeyGen is another innovative video platform that leverages generative AI to simplify video

creation process. With no need for camera and production crew, HeyGen enables easy, collaborative video generation with simple actions and texts. By streamlining the process, HeyGen enhances video creation efficiencies, proving invaluable for both businesses and individuals.

In image generation domain, Canva is a popular entry-level tool. Originally a graphic design platform, Canva can quickly turn texts into simple pictures and try ideas. Now it uses AI to improve designers' productivity and lower the bar for non-professionals to generate own images. The following picture is generated on Canva with following text: *A penguin is walking in front of Yale sterling library, and one female college student is walking behind*.



For more sophisticated tools, **Midjourney** is arguably the leading platform in the realm of generative AI image creation now. Its first version was introduced in February 2022 and have iterated for version five since then. The platform distinguishes itself with its high-resolution outputs, superior quality, accuracy, and richness of detail.

Midjourney is available through Discord server, where users can interact and send direct message to the Discord bot to create images. This could be done individually or collaboratively by inviting other people from Discord or third-party servers. To generate images, users input a series of prompts with "/imagine" orders to describe the desired image. Users can then select and enhance AI-generated images to best suit their needs. The following picture is a sample created from Midjourney.

Personalized Recommendation - Tiktok

Popular examples for personalized AI recommendation comes from social media platforms. For example, Tiktok tailors its content recommendations after taking into account preferences that users expressed through interactions with the app. ByteDance, has successfully pioneered the shift in user browsing behavior from active searching to passive recommendations. Such approach has significantly contributed to ByteDance's rapid growth among other tech giants, making it one of the fastest-expanding social media platform in the history. The primary AI algorithm that powers this revolutionary recommendation system is named as 'Monolith'.

TikTok's recommendation algorithm is revealed to be based on certain factors. The most significant factor Tiktok captures is users' interactions with app's contents, such as accounts following, comments posted, video liked or shared or marked as "Not Interested", video completion rate, etc. It correlates users actions with video information such as captions, Hashtags, Sounds, trending topics, etc. to provide the best future contents. Some settings such as language preference and device type will also be included in the algorithm.

Challenges with Recommendation Systems

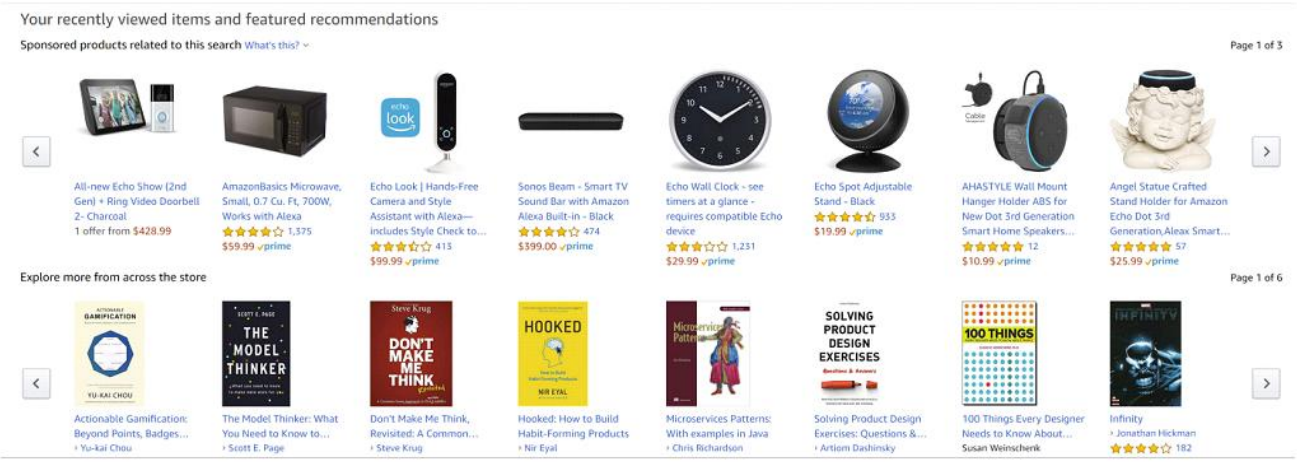
One challenge of personalized recommendation systems is to avoid repetitive patterns. While the algorithm aim to keep users engaged by providing contents aligned with their interest, it is likely to continuously suggesting similar content, which can lead to user fatigue. It's essential for AI to strike a balance between consistent recommendations based on user preferences and avoiding redundancy.

Another challenge is the potential for trapping users in a "filter bubble," where users are only exposed to content that aligns closely with their past behavior. To ensure users have the opportunity to discover new contents and expand their interests, the system need to diversifying recommendations and deliver a mix of known preferences and potential new interests. AI should be sophisticated enough to introduce variety while still maintaining relevance.

Lastly, as the sophistication of harmful content enhances, AI models must continuously learn and adapt to ensure user safety and platform integrity. This involves safeguard contents from violence, spams, threats, etc.

eCommerce

The use of AI in smart shopping recommendations has revolutionized the consumer experience. It not only streamlines the shopping process but also enhances customer satisfaction and increases the likelihood of repeat purchases." For example, AI entrenched Amazon's leading positions in ecommerce in USA: 89% of the surveyed buyers says they are more willing to use Amazon compared with other online shopping platforms. (Source: Statista). Specifically, Amazon's recommendation engine us AI and big data to analyze the buying behavior of customers, products in the cart, items viewed, and most searched items within accounts to predict and suggest products catering to people's preferences.



On top of front-end, AI also acts as a powerful tool backends for Amazon. Its AI optimization model is used for efficiently manage warehouses with functions. Typical capabilities include: predict consumer demand, evaluate product availability, optimize delivery routes, track supply chain and storage management, and personalize customer communications.

Payment Systems

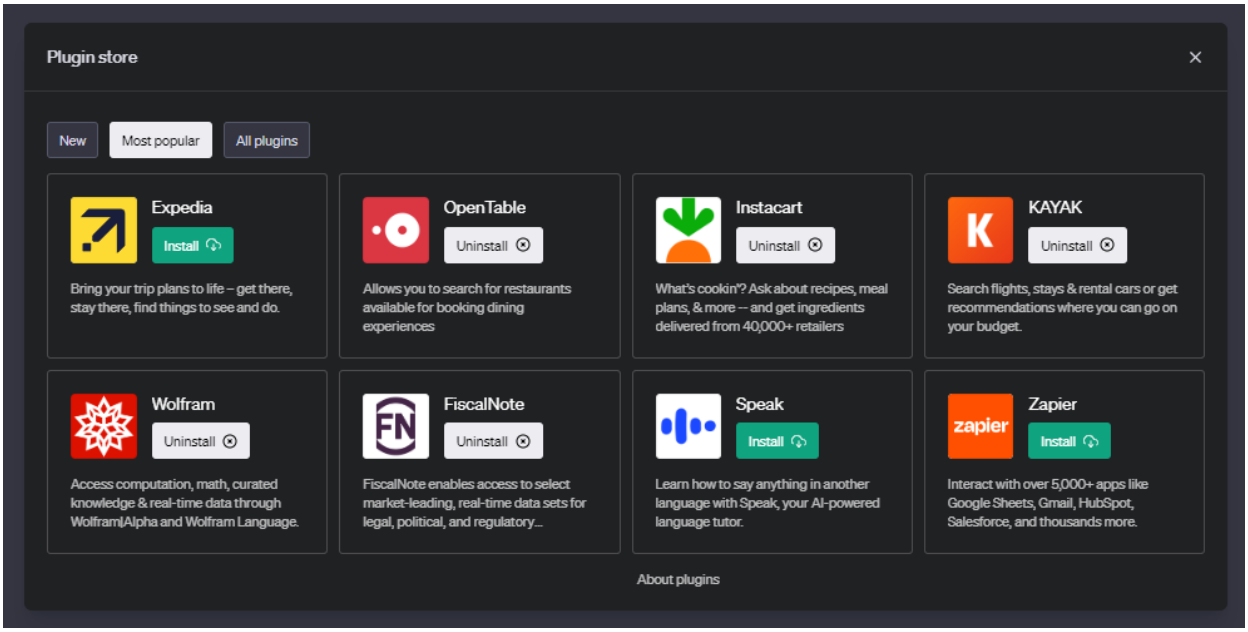
Artificial Intelligence reshaped the world of finance by changing the way people buy and pay. Ant Financial leverages its strong artificial intelligence system to establish the world's largest digital payment and financial management platform. It uses algorithm to automatically calculate credit limits and interest rates for its end users. Given that nearly half of China's population utilizes Ant's products and services, it uses AI and machine learning capabilities to monitor and evaluate a range of datapoints, including consumer spending patterns, payment records, and other personal profiles to generate a personal credit score (Zhima Score as showed on the right). This score represents a reliable measure of a customer's creditworthiness and allows Ant to offer tailored financial services and promotions. This innovative approach to financial services demonstrate the strong potential of AI to shape the future of financial and payment industry.

Ant Financial (Alipay User Interface)

3. GENERATIVE AI & GPT PLUG-INS

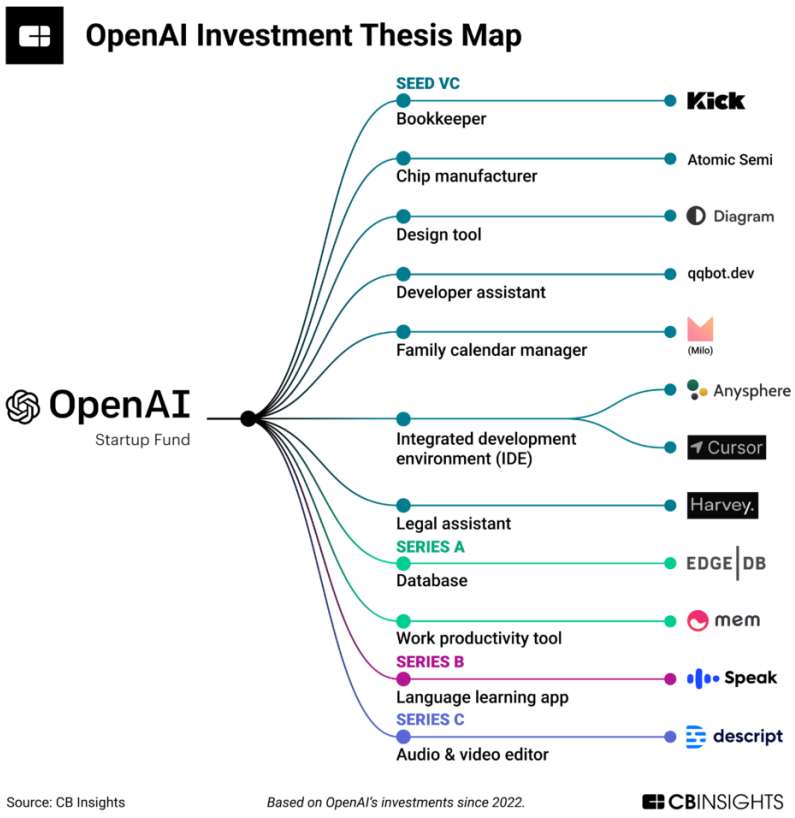
ChatGPT 4 Plugin & Integrations

As an evolution of OpenAI's groundbreaking language model, ChatGPT offers an expanded array of features and integrative capabilities, designed to seamlessly fit into various applications and platforms. This new suite of tools empowers developers and businesses to tap into advanced AI solutions with unparalleled ease and versatility. Microsoft, the owner of OpenAI, built ChatGPT * Bing and **ChatGPT * Shopify (Shop App)**.



ChatGPT Plugin Store

Generative AI startups



OpenAI Investment Roadmap

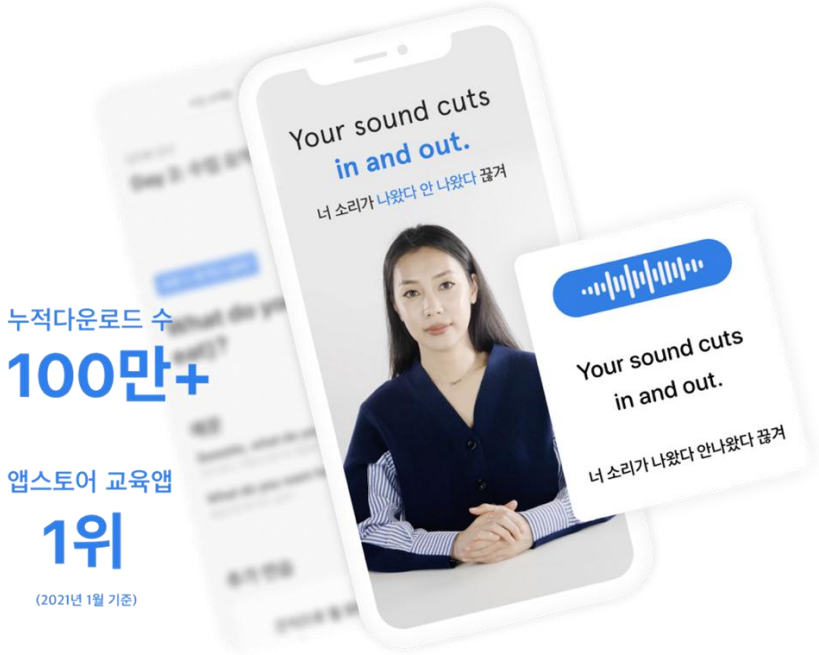
Representative OpenAI-backed startups across verticals

Under work productivity market, OpenAI invested in office and learning assistants Mem.ai. Mem enables users to capture quick notes share links, and save pictures, no matter where they are, using text messages, chat apps, or its mobile app. It also enables teams work together by sharing and editing notes. Users can even link notes to shared calendars for faster reference. Mem's search technology uses AI to understand which note is the most relevant for a particular user. The platform is designed to augment knowledge works in their typical responsibilities, said Kevin Moody and Dennis Xu, founders of Mem.ai.

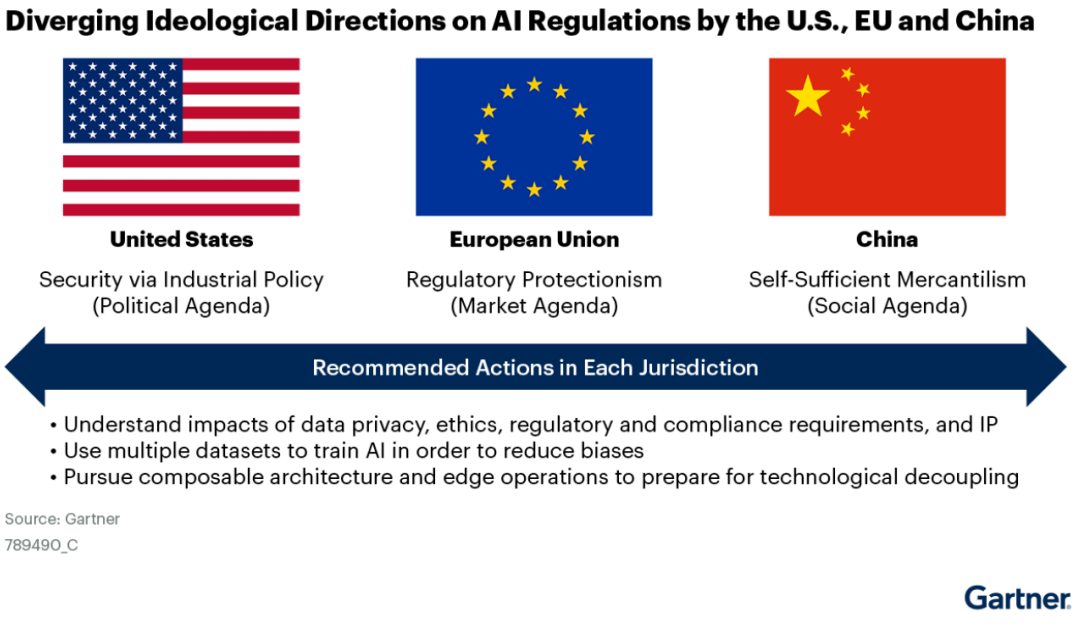
On the legal side, Harvey.ai is a leading startup backed by OpenAI. Based on the GPT, Harvey is further trained with general dataset within the legal vertical such as case laws and references through partnership with major law firms. Harvey can be trained using a firm's specific dataset, work products or templates to fit the firm's demand. It just like a super new employee's onboarding.

Speak is a leading player in language learning platform using generative AI technologies to power study. It is designed to assist individuals to boost their language abilities through real-time dialogues. Speak uses interactive videos to provide a personalized learning journey, simulating real-world interactions in several languages.

Speak provides a diverse range of conversational situations, suitable for various levels of language proficiency and interests. The platform leverages techniques like natural language processing and machine learning to comprehend and examine the user's speech, offering immediate feedback and improvement suggestions. This includes advice on pronunciation, grammar, and vocabulary expansion, enabling users to effectively strengthen their language proficiency.



4. AI ON BUSINESS & SOCIETY – REGULATIONS OF AI[22]



The ideological differences among leaders of the three giant economic entities implies geopolitical consequences for AI regulations. Rapid and superior innovation will be key in the competition

[22] Gartner – Geopolitics Is Shaping Generative AI (and Vice Versa)

between nations, particularly the U.S. and China, and AI stands at the forefront. Here we briefly summaries the regulatory progress of AI among different governments.

i. United States

The White House Office of Science and Technology Policy unveiled a blueprint for an AI Bill of Rights in October 2022. However, it is only a framework and thus is nonregulatory and nonbinding. On July 21st, 2023, the White House published Whitehouse safeguard agreements with tech giants. Amidst rising concerns about AI tools, legislators are exploring the necessity for a comprehensive data privacy bill. Concurrently, the National Institute of Standards and Technology (NIST) has introduced a voluntary AI Risk Management Framework. This initiative aims to help organizations deploying AI systems enhance towards trustworthiness, bias reduction, and safeguarding individual privacy.

ii. China

Censorship is a longstanding practice of the Chinese internet industry. The Chinese regulation prohibited people from generating and sharing AI-created fake news. In various sectors, from gaming to social media, users must authenticate their identities before accessing generative AI tools. This fact restrict users' behavior and lead to more responsible user of AI, while also calls questions regarding the free usage and creation of data. China has also pioneered regulation of recommendation algorithms with its "Internet Information Service Algorithmic Recommendation Management Provisions," implemented in March 2022. This groundbreaking regulation empowers users with options to decline recommendation algorithms and erase their data.

iii. EU

The EU has been a front-runner in data regulation and AI governance, with the GDPR taking effect in 2018. The EU is in the progress of preparing regulations for generative models through its upcoming AI Act, which will go into effect in 2024. The act provides a holistic framework for governing AI and use of IT in society. The act offers overarching guidelines for developing and using AI applications, services and systems. The regulation requires platforms to be accountable of mitigating disinformation or manipulation, ensuring freedom of expression, and undergoing independent audits.