

Survey on Generative AI

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Abstract: *Generative AI has witnessed remarkable growth in recent years, resulting in a diverse array of applications across various domains. In this comprehensive survey, we explore over 350 generative AI applications, providing a structured taxonomy and concise descriptions of both unimodal and multimodal generative AIs. The survey covers a wide range of applications, including text, images, video, gaming, and brain information. Our goal is to serve as a valuable resource for researchers and practitioners, aiding them in navigating the rapidly expanding landscape of generative AI. By fostering a better understanding of the current state-of-the-art, we hope to encourage further innovation in this field.*

Keywords: Generative AI

I. INTRODUCTION

Generative AI refers to artificial intelligence that can generate new content, rather than simply analyzing or acting on existing data like expert systems. Generative AI models, equipped with large data sets and complex design, they have an extraordinary ability to create new and diverse content. They can process and learn from information gathered from many sources, e.g. such as Wikipedia, GitHub and others. By leveraging this wealth of data these models can generate a wide variety of multimedia formats, including video, audio, and text.

More recent work has explored LLM and generative artificial intelligence, discusses various applications of the technology. Unlike previous surveys, this comprehensive review aims to offer a unique perspective by emphasizing not only the most prominent generative models and their basic technology, but also emphasizing all the different uses this technology. In addition, we give an up-to-date competitive outlook in this a growing industry and the models behind this growth. This resource includes 15 categories that include text, images, video, 3D, code and software, speech, AI understanding, business, games, music, biotechnology, brain, other and multimodal. There is a detailed taxonomy in each section

current technologies are presented with a detailed description of the models and available tools.

The survey offers a systematic survey of these various applications of artificial intelligence serves as an essential reference for researchers, academics, and professionals to better understand the evolving landscape of generative artificial intelligence and its far-reaching consequences.

For example, a 3D game designer may have different AI generative needs for his project. It can find solutions for its 3D AI needs in both 3D and playing games, getting more specific results and different answers. It can also find solutions for more of his business needs in both commerce and text. With that

we believe that users will gain a very good insight into how generative AI is taking shape and where they can find the necessary technologies.

Previous Research:

A report from Cornell University discusses GenAI in academic research, emphasizing cultural norms and practical guidelines for researchers, team leaders, and research administration staff.

It addresses GenAI use across different research stages:

Research Conception and Execution Stage:

GenAI aids in literature review, research infrastructure, data collection, and hypothesis generation.

Research Dissemination Stage:

Researchers can leverage GenAI for effective communication of findings.

Research Translation Stage:

GenAI facilitates translating research outcomes into practical solutions.

Positive Implications in Professional Realm:

Prior research by Noy and Zhang (2023) emphasizes the synergy between humans and machines in enhancing productivity.

GenAI tools contribute to analyzing large volumes of text data, sentiment analysis, data mining, and research design guidance.

Qualitative Research and ChatGPT:

A study found that GenAI tools like ChatGPT significantly impact qualitative research.

Benefits include assisting in text analysis, sentiment analysis, and providing research design guidelines.

Transforming Science and Society:

Stemming from a Science/Business roundtable, a special report discusses how GenAI transforms researchers' work. It highlights opportunities for translating research outcomes into solutions for policy and society.

Harvard's Generative AI Resources:

Harvard provides basic guidance and resources for researchers and scholars using GenAI.

In summary, GenAI holds immense potential for advancing research, but ethical considerations and cultural norms must guide its use. Researchers should stay informed about evolving policies and responsibilities throughout the research process.

II. LITERATURE REVIEW

How a Generative AI Works: Generative AI can be thought of as a machine learning model that is trained to generate new data rather than predicting a specific data set. A generative AI system is a system that learns to generate multiple objects that look like the data it was trained on.

"When it comes to the actual machine that underlies generative artificial intelligence and other types of artificial intelligence, the distinctions can be a bit blurred. Often the same algorithms can be used for both," says Phillip Isola, associate professor of electrical engineering and computer science at MIT and member of the Computer Science and Artificial Intelligence Laboratory (CSAIL).

• Increasing complexity

In this huge corpus of text, words and sentences appear in sequences with certain dependencies. This repetition helps the model understand how to split the text into statistical chunks that have some predictability. It learns the patterns of these blocks of text and uses that knowledge to design what might come next.

• More powerful architectures

In 2017, Google researchers introduced the transformer architecture, which is used to develop large language models such as those that power ChatGPT. In natural language processing, the transformer encodes each word in the text corpus as a token and then generates an attention map that captures the relationships of each token to all other tokens. This attention map helps the transformer understand the context when generating new text.

• Several applications

although generative models can achieve incredible results, they are not the best choice for all types of data. For tasks that involve making predictions on structured data, such as spreadsheets, generative AI models tend to outperform traditional machine learning methods, says Devavrat Shah, the MIT Andrew and Erna Viterbi Professor of Electrical Engineering and Computer Science. and a member of IDSS and the Laboratory for Information and Decision Systems. Ethical use and development of artificial intelligence technologies:

What steps can be taken to enable safer AI products? One key is to change the way the development cycle works. Sweeney notes, "A lot of times the clash between technology and society can be avoided in the design phase (of these products), but it's much harder to solve these problems once the products are in the market."

Another way to promote the safe use of AI is to change the narrative and recognize the limits of AI. Reddi works with companies like Google and within higher education to promote the idea that "Safe AI is better AI for everyone."

Generative AI Statistics and Predictions:

Over the past decade, concepts like machine learning and artificial intelligence have entered the mainstream and remained a mystery to many until the launch of ChatGPT. The ChatGPT AI chatbot is available to the public for free. It simulates human-like conversations in a chat window where the user can ask the bot for help with a variety of tasks, including writing emails, essays, code, and more. The launch of ChatGPT in November 2022 sparked widespread curiosity about natural language processing and raised questions about the practical and ethical implications of these technologies.

"[ChatGPT] appears to be creative, but it's actually building on the creativity of the people who came before it," says Latanya Sweeney, professor of the practice of government and technology at the Harvard Kennedy School and the Harvard School of Philosophy and Science.

Bharat N. Anand, Vice Provost for Educational Advancement, adds, "What has fascinated me over the past 3 years in distance learning has been the degree to which many teachers have begun to think about how online tools have affected the delivery of content in the classroom, forcing them to think about reasons why we need to meet in person. They began to consider ideal mixes for synchronous and asynchronous and online and face-to-face learning. These technologies will require us to consider similar questions and outcomes for our workplaces, classrooms, and lives.

Advantages and limitations of generative artificial intelligence:

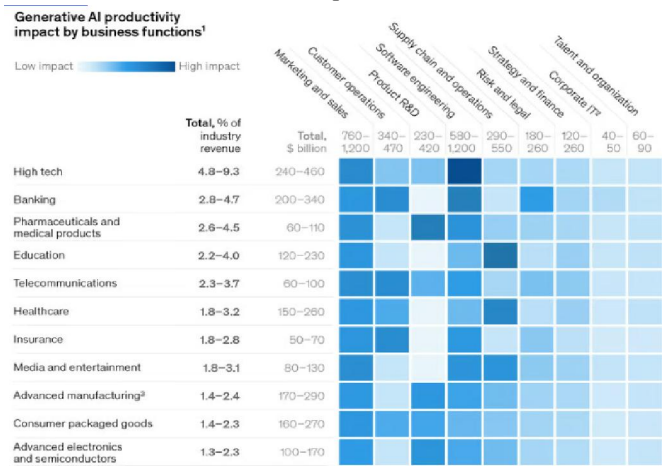
"When we think about the future of the Internet, I would guess that 90% of the content will no longer be generated by humans. It will be generated by robots," says Latanya Sweeney, professor of the practice of government and technology at the Harvard Kennedy School and the Harvard Faculty of Arts and Sciences.

Recent developments in artificial intelligence technologies are forcing us to rethink how we engage with the world around us. Digital technology and privacy experts have been keeping up with the latest developments in AI and the limitations of AI, and many, like Latanya Sweeney, have noted that the introduction of ChatGPT could signal a major shift in how we interact with the internet. and the world.

Statistical Review:

Generative AI use case along with impact on various business:

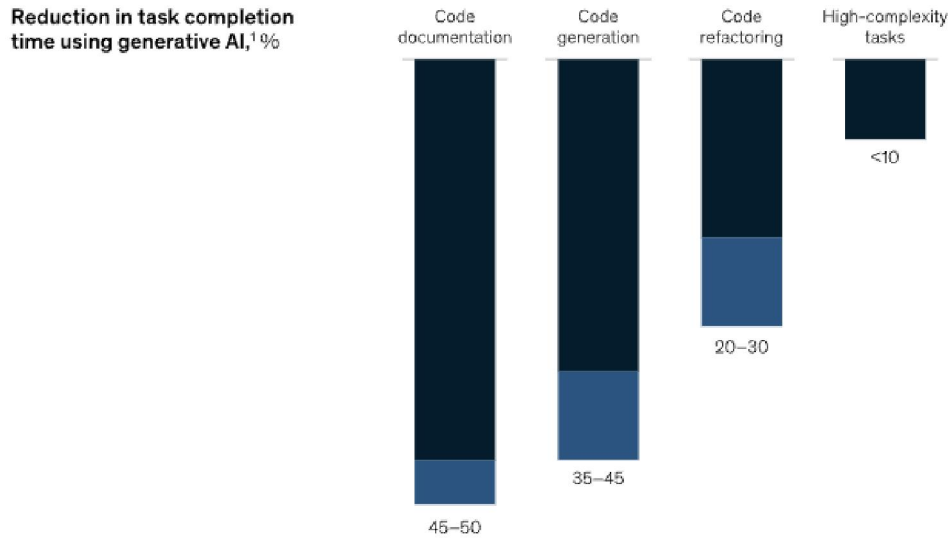
Gen AI's precise impact will depend on a variety of factors, such as the mix and importance of different business functions, as well as the scale of an industry's revenue. Nearly all industries will see the most significant gains from deployment of the technology in their marketing and sales functions. But high tech and banking will see even more impact via gen AI's potential to accelerate software development.



Note: Figures may not sum to 100% because of rounding. ¹Excludes implementation costs (eg, training, licenses). ²Excluding software engineering. ³Includes aerospace, defense, and auto manufacturing. ⁴Including auto retail. Source: Comparative Industry Service (CIS), IHS Markit; Oxford Economics; McKinsey Corporate and Business Functions database; McKinsey Manufacturing and Supply Chain 360; McKinsey Sales Navigator; Igrilo, a McKinsey database; McKinsey analysis.

Statistics for generative AI for Software Engineer:

Generative AI can increase developer speed, but less so for complex tasks.



¹Compared with task completion without the use of generative AI.

Statistics for Generative AI related risk:

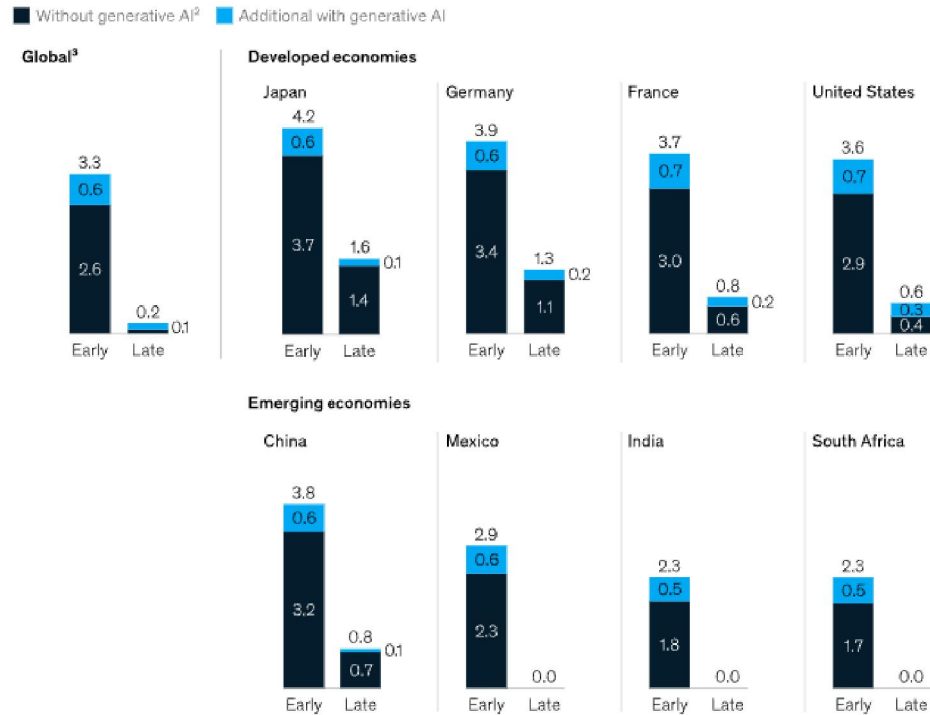
Generative AI-related risks that organizations consider relevant and are working to mitigate, % of respondents¹



¹Asked only of respondents whose organizations have adopted AI in at least 1 function. For both risks considered relevant and risks mitigated, n = 913.

Statistics for Generative AI Boost in global GDP:

Productivity impact from automation by scenario, 2022–40, CAGR,¹%



Note: Figures may not sum, because of rounding.
¹Based on the assumption that automated work hours are reintegrated in work at productivity level of today.
²Previous assessment of work automation before the rise of generative AI.
³Based on 47 countries, representing about 80% of world employment.
 Source: Conference Board Total Economy database; Oxford Economics; McKinsey Global Institute analysis

III. SURVEY RESULT

• Find out where gen AI co-pilots can give you a real competitive advantage

The great excitement surrounding gen AI and its relative ease of use has led to an explosion of experimentation across organizations. However, most of these initiatives will not provide a competitive advantage. For example, one bank bought tens of thousands of GitHub Copilot licenses, but because they didn't have a clear idea of how to work with the technology, progress was slow. Another unfocused effort we often see is when companies move to incorporate gen AI into their customer service capabilities. For most companies, customer service is a commodity function that is not part of the core business. While gene AI can help with productivity in such cases, it will not create a competitive advantage. To create a competitive advantage, companies should first understand the difference between being a "taker" (a user of available tools, often through APIs and subscription services), a "shaper" (an integrator of available models with proprietary data), and a "maker" (creator LLM). For most companies, the maker approach is too costly for now, so the best place for businesses is to implement an adoption model to improve productivity when building apps to shape for a competitive advantage.

• Set up the technology architecture to scale

Creating an AI gen model is often relatively simple but making it fully functional at scale is another matter entirely. We've seen engineers build a basic chatbot in a week, but release a stable, accurate, compliant version that can take four months to scale. This is why our experience shows that the actual cost of the model can be less than 10 to 15 percent of the total cost of the solution.

• **Ensure data quality and focus on unstructured data to support your models**

A business's ability to generate and scale value from gen AI models will depend on how well it leverages its own data. As with technology, targeted upgrades to the existing data architecture are needed to maximize the future strategic benefits of gen AI:

- Be intentional about improving data quality and data augmentation efforts. While data quality has always been an important concern, the scale and scope of data that gen AI models can use—particularly unstructured data—has made this a much more pressing issue. That's why it's important to get the data foundations right, from clarifying decision rights to defining clear data processes to establishing taxonomies so that models can access the data they need. Companies that do this well tie their data quality and scaling efforts to a specific AI/gen AI application and use case – you don't need that data base to spread to every corner of the enterprise. This could mean, for example, developing a new data repository for all equipment specifications and reported issues to better support copilot maintenance applications.
- Understand what value is locked in your unstructured data. Most organizations have traditionally focused their data efforts on structured data (values that can be organized into tables, such as prices and features). But the real value of LLMs comes from their ability to work with unstructured data (such as PowerPoint slides, videos, and text). Companies can map which unstructured data sources are most valuable and implement metadata tagging standards so that models can process the data and teams can find what they need (tagging is especially important to help companies remove data from models when needed). Be creative when thinking about data opportunities. For example, some companies interview senior employees at retirement and feed the institutional knowledge gained into the LLM to help improve the performance of their co-pilot.
- Optimize for cost reduction at scale. There is often a tenfold difference between what companies pay for data and what they could be paying if they optimized their data infrastructure and related costs. This problem often stems from companies scaling their proof of concept without optimizing their approach to data. Generally, two costs stand out. One is the storage costs of companies uploading terabytes of data to the cloud and wanting to have that data available 24/7. In practice, companies rarely need more than 10 percent of their data to have this level of availability and accessing the rest within 24 or 48 hours is a much cheaper option. Additional costs relate to calculations with models that require access to thousands of processors to run. This is especially the case when companies create their own models (maker archetype), but also when they use pre-trained models and run them with their own data and use cases (shaper archetype). Companies could take a close look at how they can optimize computing costs on cloud platforms—for example, queuing up some models to run when processors aren't being used (for example, when Americans go to bed and consumption of computing services like Netflix reduces) is a much cheaper option.

• **Build trust and reusability to support adoption and scale**

Because many people are worried about gen AI, the bar for explaining how these tools work is much higher than for most solutions. People who use tools want to know how they work, not just what they do. So, it's important to invest extra time and money in building trust by ensuring model accuracy and making it easy to check responses.

For example, one insurance company has created a gen AI tool to help manage insurance claims. Within the tool, all barriers that were put in place were listed, and for each response a link was provided to the sentence or page of the relevant policy documents. The company also used LLM to generate multiple variations of the same question to ensure consistency of responses. Among other things, these steps were essential to help end users build trust in the tool.

Part of the training for maintenance teams using the gen AI tool should be to help them understand the limitations of the models and how best to get the right answers. This includes teaching workers strategies to get to the best answer as quickly as possible by starting with broad questions and then narrowing them down. This gives more context to the model and also helps remove any bias from people who might think they already know the answer. Model interfaces that look and feel the same as existing tools also help users feel less pressured to learn something new every time a new application is introduced.

IV. CONCLUSION

Gen AI holds immense promise in empowering sustainability initiatives across industries – from revolutionizing business models to tackling environmental challenges. As we enter a new level of unpredictability, I believe in allowing the new tools to become partners rather than hindrances to development. Sure, there are challenges to overcome – including trust issues, intellectual property dilemmas and ethical concerns – but companies that hesitate to adopt Gen AI risk falling behind.

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