

ND Venture Capital: Generative AI Industry Thesis

Executive Summary

Generative AI encompasses a variety of sectors and touches on various applications. This thesis aims to paint a broad stroke across 1) market dynamics defining the industry, 2) headwinds impeding development, 3) tailwinds driving growth, and 4) opportunities awaiting disruptive innovation. The goal is to expand our knowledge among specific applications and approaches within generative AI by having this thesis serve as a living document of our shared knowledge throughout the Notre Dame community. Our shared knowledge will help curious students understand the fundamentals of the industry and learn how they can play a part in the next wave of change. This document is not intended to be comprehensive.

1. Market Dynamics

Concise Overview

Generative AI refers to a type of artificial intelligence that can create or generate new data that is similar to the training data it was fed. In other words, a generative AI model is capable of creating new content that has not been seen before, such as images, music, or text. The process of generating new data involves the use of algorithms and statistical models that are trained on a large dataset. These models learn to recognize patterns and relationships in the data and can then use this knowledge to create new content that is similar in style and format to the original data.

Generative AI Models / Techniques

1. Variational Autoencoders (VAEs): VAEs are a type of neural network that can learn to encode and decode complex data. They are often used in image and video generation.
2. Generative Adversarial Networks (GANs): GANs consist of two neural networks - a generator and a discriminator - that are trained together. The generator creates new data, while the discriminator tries to distinguish between the generated data and real data. Over time, the generator learns to create more realistic data that can fool the discriminator.
3. Autoregressive models: These models generate new data by predicting the next value in a sequence based on the previous values.

Market Size

The generative artificial intelligence market size on a global scale, in 2022, was valued at USD \$8.1B with a projected 7 year CAGR of 34.6%. It's estimated to reach \$110B by 2030. These technologies are used in an array of industries including healthcare, BFSI, law, retail, advertising and media, transportation and automotive, agriculture, manufacturing, and others, with media holding the largest market share (19.5%). Tech giants are driving research, development, and widespread adoption of AI technologies.

North America generated the largest revenue share and dominated the generative AI market globally in 2021. The market share in North America is projected to increase due to the internal investments in generative AI from large American corporations including Microsoft, Meta, and Google. There is anticipated growth in the Asia-Pacific region due to large investments in the industry. About 10 established companies currently dominate the industry, and these key players are engaging in consolidation through mergers and acquisitions and strategic partnerships with other companies.

2. Industry Headwinds

Legal Complications

The use of generative AI software in various industries has led to a range of legal complications that are still being addressed. One of the primary concerns is the issue of intellectual property as generative AI algorithms may create works that are similar to existing copyrighted material which raises questions about who owns the rights to the generated content and how it can be used. In addition, there are concerns around privacy and data protection as generative AI models may require large amounts of personal data to be trained effectively. This leads to complications around how such data can be collected, stored, and used in compliance with applicable data protection laws. Moreover, the use of generative AI in certain fields, such as healthcare or finance, may be subject to additional regulatory requirements and standards which can vary across different jurisdictions.

Computational Costs

Simple artificial intelligence applications are relatively low cost and are becoming commoditized as consumers and businesses become more tech-savvy. However, generative AI is different. Because these models are much more complex, they require a tremendous amount of computing power which comes at an extremely high operational cost. For example, OpenAI's ChatGPT is estimated to cost around \$100K per day to run even while still having to turn potential customers away when high traffic occurs and computing power is stressed. The reason for this is that a single question asked to ChatGPT uses at least 8 GPUs, meaning a massive amount of computation power will be required to launch any application of this sort to the entire public. This cost barrier will be a hurdle to start-ups looking to enter the space who will struggle to raise the kind of money necessary to launch quickly and iterate.

Algorithmic Biases

In-built bias in artificial intelligence algorithms has been an issue since the dawn of the industry, however, these biases are drastically greater with generative AI because the algorithms are designed to give more human-like output. This means that any biases in the data used to train the model are amplified to give an answer, image, or other output similar to that which would be given by a biased human being. OpenAI has already announced publicly that it is aware of racial and gender bias in Dall-E 2, its image generation AI. Bias has been the cause of much pushback already from many minority group representatives who feel as though generative AI will

exaggerate issues such as institutional racism and gender equity. That said, there are a range of interesting start-ups looking to act as an automated ethics auditor for generative AI creators.

3. Industry Tailwinds

Generative AI Hype After ChatGPT's Launch

The recent launch of ChatGPT has taken the nation by storm. Although AI was a topic often discussed prior to ChatGPT and its applications, the widespread usage of sites such as TikTok and Instagram made the generative AI industry jump on everyone's radar. ChatGPT took 5 days to reach 1M users and 2 months to reach 100M users, making it the fastest growing web app in history. Over 13 million unique users visited the site on average in January. Given the exponential increase in popularity, several other new apps were released. Generative AI can create advanced forms of text such as Frase IO which creates slogans, summaries, and descriptions. Generative AI can also interestingly make code, which is a huge help for software engineers with many using products such as Tabnine and Kite. Given the offering expanding into a multitude of new spaces, generative AI is affecting the way consumers approach work and life.

Advancements Across Verticals

In recent years, deep learning algorithms such as convolutional neural networks and recurrent neural networks have made great strides in areas like computer vision, natural language processing, and speech recognition. The expansion across verticals allows for increased interdisciplinary opportunities. The field of AI draws on a variety of disciplines, including computer science, mathematics, and statistics. The increased collaboration among these fields is helping to drive advancements in AI. Computer science majors at many top universities can take various pathways that incorporate AI and machine learning into their education. While these courses cover the technical fundamentals, they are also starting to incorporate social science elements. Students are beginning to apply these themes into the political, health, and journalism fields as a variety of use cases emerge.

Increased Investment

There has been a large increase in the investment of generative AI startups. Over \$35B has been invested into generative AI for the past 5 years which is only expected to grow especially with the emergence of ChatGPT and similar platforms. In 2022, equity funding topped \$4.74B across 279 deals. Out of all generative AI companies, OpenAI, which is backed by Microsoft, is the most highly valued generative AI company at \$20B. Other positives include the fact the generative AI market is extremely buoyant, with over 100 small startups securing VC funding and the largest deals increasingly focused on later-stage startups that can deliver proven results and revenue growth. Generative AI funding is distributed in multiple different areas as well, with most of the deals being focused on Visual Media and Text generative AI, followed by generative interfaces, speech & audio, and coding.

4. Investable Opportunities

Addressing Computational Costs

Traditional computing methods may not be enough to handle the vast amount of data that GAI applications require as the amount of compute required to train these models nearly doubles every three months. To address this issue, cloud computing has emerged as a possible solution, allowing users to access computing resources, such as processing power, storage, and software applications, over the internet. Moreover, AI-specific cloud computing takes this one step further by providing computing resources tailored specifically for AI applications. AI-specific cloud computing uses specialized hardware, such as graphics processing units (GPUs) and tensor processing units (TPUs), which are specifically designed to handle the complex computation required for machine learning. This will be further driven by a large demand in semiconductors optimized to handle peak workloads. Other types of data center infrastructure such as networking, data storage, off-computer computing, and distributed computing will also become increasingly relevant to help AI models combat computational costs. The development of ML-specific architectures designed to train AI models on GPUs and TPUs will be an integral focus of the industry as it expects to scale.

Generative Entertainment

Frame interpolation involves using AI to fill in the gaps between frames of a video. For example, if you have a video of a sword swinging, it might take 20 frames to animate it. However, by only drawing the starting and ending frames, the computer can interpolate and generate the in-between frames. Games like No Man's Sky already employ this technology to create unique and dynamic environments that are based on preprocessed, desired ideas.

Procedural generation is also changing the way entertainment is created. This technology involves using GAI algorithms to generate content, such as game levels, music, or images, based on a set of prompts, rules, or parameters. The global video game market is expected to grow at a CAGR of 12.9% from 2022 to 2030 to reach \$584B. In the past, game developers had to create every level manually. Now, with procedural generation, the computer can create thousands of unique levels in a fraction of the time it would take a human to create them. 40% of a gaming studio's budget is in their digital assets with costs stemming from development time.

Procedural generation not only shrinks the game design process but also democratizes game development so anyone can build a video game, leaving the differentiating factor to be the creative storyline. This might unlock the potential for studios to transition to a gaming-as-a-service model given the quicker time-to-market.

Generative Education

Generative AI could also make significant developments in the field of education. Problem generation is one area where AI can be particularly useful. Machine learning algorithms can be used to generate training examples, educational write-ups, and even new questions and problems to use in textbooks. One of the concerns about this technology is that it may make it easier for students to cheat, but if the questions and problems are generated in real-time, it could be more difficult for students to cheat. Additionally, the use of generative AI in education is not limited to problem generation. In fact, it can also play a significant role in interview preparation and landing opportunities for students by helping them prepare for job interviews using AI-generated mock

interviews. These interviews can simulate the actual interview experience, allowing students to practice their responses and get feedback on their performance. There are full industries dedicated to designing practice problems and providing interview practice which generative AI stands to disrupt.

Generative Copywriting

Generative AI is set to revolutionize the way we approach copywriting across various industries. The success of AI-powered copywriting is evidenced by the rapid growth of companies like Jasper which launched 18 months ago and is projected to do \$75 million in revenue this year. However, the potential for generative AI in copywriting extends far beyond website copy and social media posts. It could also automate outbound emails from sales development representatives (SDRs), handle email correspondence with prospective customers as they move through the sales funnel, and provide real-time coaching and feedback to human sales agents on calls. This would free up human representatives to focus on customer empathy and relationship building, leaving the mundane, repetitive copywriting tasks to AI. In the legal industry, generative AI is poised to largely automate contract drafting, reducing the back-and-forth between legal teams on deal documents. In government, lawmakers will rely on LLMs to help draft legislation, while regulators will employ them to help translate laws into detailed regulations and codes. In academia, generative language models will be used to draft grant proposals, to synthesize and interrogate the existing body of literature, and even to write research papers by students and professors. The use of generative AI in copywriting and other industries will largely automate repetitive tasks, improve efficiency, and allow humans to focus on tasks that require creativity and empathy.

Generative Manufacturing

AI is also making significant strides in the field of computer-aided design (CAD). AI algorithms can be used to generate specialized components or products based on a text query. Industries such as manufacturing, automotive, aerospace, and defense are empowered by generative AI to design parts that are tailored to meet specific objectives and constraints. These objectives can include factors such as performance, materials, and manufacturing methods. An instance of this is the use of generative design by automakers to create lighter designs, which supports their drive towards producing more fuel-efficient cars.

[Link to Screening Use Cases Document](#)