Innovation Insight for Generative AI

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Initiatives: Technology Innovation; CIO Leadership of Innovation, Disruptive Trends and Emerging Practices

> Generative AI can create original media content, synthetic data and models of physical objects to provide breakthrough innovation opportunities. Enterprise architecture and technology innovation leaders must evaluate the various use cases for applying generative AI in their organizations.

Additional Perspectives

- Summary Translation: Innovation Insight for Generative AI (16 June 2021)

More on This Topic

This is part of an in-depth collection of research. See the collection:

- Applying AI in Industries

Overview

Key Findings

- Generative artificial intelligence (AI) refers to algorithms that can create novel digital media content, synthetic data and digital models of physical objects for a wide range of use cases.
- Generative AI will have a direct impact on the pharmaceutical, manufacturing, media, architecture, interior design, engineering, automotive, aerospace, defense, medical, electronics and energy industries. It will also have an impact on marketing, corporate communications, training and IT functions in any organization.
- Malicious uses of generative AI creates deepfakes, which present significant reputational, counterfeit, fraud and political risks to individuals, organizations and governments.

Recommendations

Enterprise architecture and technology innovation leaders must:

- Determine the business impact of generative AI to their industry and organization by understanding the potential use cases described in this research.
- Work with various stakeholders to evaluate generative AI use cases for business opportunities and business model threats and to assess the technology feasibility, organizational readiness and external factors for adoption.
- Upskill data scientists in generative AI techniques and/or collaborate with top/nearby academic institutions and startups.
- Work with security and risk management leaders to proactively mitigate the risks of deepfakes and support legislation to regulate the malicious use of generative AI technology.

Strategic Planning Assumptions

By 2025, more than 30% of new drugs and materials will be systematically discovered using generative AI techniques.

By 2024, use of synthetic data created with generative AI will halve the volume of real data needed for machine learning.

In 2023, 20% of successful account takeover attacks will use deepfakes to socially engineer users to turn over sensitive data or move money into criminal accounts.

By 2024, 60% of AI providers will include a means to mitigate possible harm as part of their technologies.

Introduction

> **"Creativity is allowing yourself to make mistakes. Art is knowing which ones to keep."**
>
> *— Scott Adams, Cartoonist and Author*

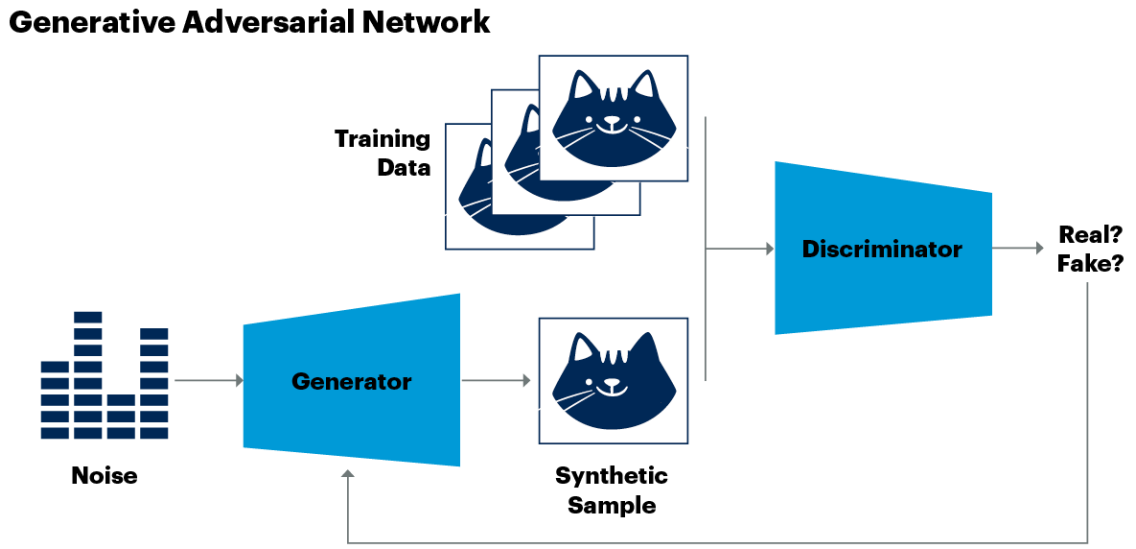
Until recently, creativity and art were the exclusive domain of humans. Generative AI challenges that, enabling computers to generate brand-new, completely original variations of content (including images, video, music, speech and text), improve or alter existing content, create new data elements, and create novel models of real-world objects. Generative AI works by generating a lot of variations of an object and screening candidates to select the ones that have useful target features. To paraphrase the Scott Adams' quote above, generative AI creates a lot of mistakes, but knows which ones to keep.

Description

Definition: Generative AI refers to AI techniques that learn a representation of artifacts from the data, and use it to generate brand-new, completely original artifacts that preserve a likeness to original data. Generative AI can produce totally novel media content (including text, image, video and audio), synthetic data, and models of physical objects. Generative models also can be used in drug discovery or for the inverse design of materials having specific properties.

The current primary AI techniques used in generative AI are generative adversarial networks (GANs) and variational autoencoders (VAEs), each with many variants. Additional techniques are used, such as transformers, recurrent neural networks (RNNs) and reinforcement learning (RL). A simplified description of GANs and VAEs is shown in Figures 1 and 2.

Figure 1: Generative Adversarial Network



Source: Gartner
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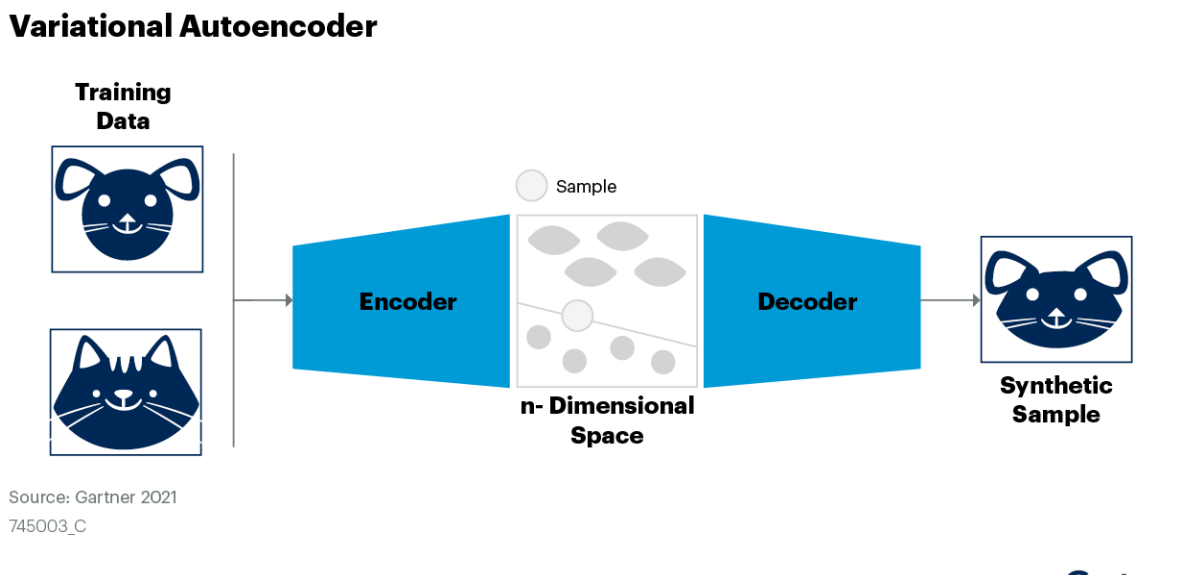
Gartner

GANs are formed with two neural networks: one, called the generator, specializes in generating objects of a specific type (e.g., images of human faces or dogs, or models of molecules); the other, the discriminator, learns to evaluate them as real or fake. The special setup is highly unsupervised and works with millions of examples without the need for extra labeling. The results can be stunning. For example, images of human faces can be generated that look surprisingly real — yet these humans do not exist in the physical world (see This Person Does Not Exist). An excellent introduction to GANs can be found on Google (see Introduction | Generative Adversarial Networks).

Figure 2: Variational Autoencoder



Source: Gartner 2021
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VAEs consist of an encoder and decoder. The encoder takes objects (e.g., images of dogs and cats) and compresses those into more condensed representations by retaining the main features. These high-dimensional representations can then be mapped onto a two-dimensional space where similar objects are clustered. New objects are generated by decoding a point in the dimensional space, say, between two objects. For example, a VAE could create an image that looks like a mix of a cat and a dog.

Benefits and Uses

Creativity is powerful, and we have only begun to explore the realm of possibilities for generative AI. It enables the exploration of many possible designs to find the right match. Generative AI will not only augment and accelerate design in many fields, it also has the potential to “invent” novel designs that humans may have missed otherwise. In certain fields such as marketing and media, generative AI has been making a considerable impact, but in other areas it is only emerging from the labs toward commercial use.

Generative AI will have a direct impact on the pharmaceutical, manufacturing, media, architecture, interior design, engineering, automotive, aerospace, defense, medical, electronics and energy industries. It will also have an impact on marketing, data science and business analytics roles in any organization.

There is a tremendous level of activity exploring the potential use cases for generative AI across various industries, including:

- Drug design
- Material science
- Generative engineering
- Generative design
- Creative content impacting media and marketing industries
- Content improvement
- Data science and business analytics — synthetic data

Drug Design

Generative AI is impacting the pharma industry — In a 2010 study, the cost from discovery to market for a drug was about $1.8 billion, of which drug discovery costs represent about a third, and the process took 13 years. [1] Just over a year ago, a drug to treat obsessive compulsive disorder (OCD) was designed using generative AI in less than 12 months. [2] Generative AI was also used to design a drug to treat Idiopathic Pulmonary Fibrosis (IPF), [3] and IBM is researching the generation of new and optimal antimicrobial peptides (AMP) that can fight against antibiotic-resistant bacteria and fungi. [4] Generative AI looks promising for the pharma industry, given the opportunity to reduce costs and time in drug discovery.

Material Science

Generative AI is impacting the automotive, aerospace, defense, medical, electronics and energy industries — It can be used to compose entirely new materials targeting specific properties. The process, called inverse design, defines the property requirements and discovers materials that are likely to have those properties rather than relying on serendipity to find a material with the correct properties. [5, 6]

Generative Engineering

Generative AI is impacting the manufacturing, automotive, aerospace and defense industries — Designs for parts can be generated that are optimized to meet specific goals and constraints such as performance, materials and manufacturing methods. [7]

Generative Design

Generative AI is impacting the architecture and interior design industries — Designs for buildings can be generated that are optimized for light, space and efficiency. [8]

Creative Content Impacting Media and Marketing Industries

Generative AI has made significant progress in the creation of images, text, music and video. [9] Some examples include using Miquela, an engineered social influencer who earns millions and is also in the upcoming film "Finding Jack;" James Dean will be resurrected more than 50 years after his death; and a deepfake image entitled "Portrait of Edmond Belamy" sold for $432,500 at a Christie's auction in 2018. [10]

Specific use cases include:

- Text generators like GPT-3 can be used to create marketing copy, news stories, poetry, resumes and application code.
- Images can be generated for logos; human images can be generated for modeling; and images can be altered for different poses, aging and many other aspects.
- Music can be generated with a preferred genre and artist's style.
- Video for simulated presenters/models (e.g., training, news, fashion), game backgrounds, multilingual videos, virtual dressing rooms and virtual influencers. [11, 12]
- Fine arts could be generated by AI. [13]

Content improvement

Generative AI is impacting the media industry — It can rewrite outdated text, cancel background noise, increase image resolution, perform super resolution and modify photos by adjusting, removing or adding artifacts.

Data Science and Business Analytics — Synthetic Data

Generative AI is one method (among several) of creating synthetic data that can be used to:

- Augment training data for building AI models when insufficient data is available [14]
- Protect privacy since synthetic data resembles real data but cannot be traced back to a person

- Mitigate bias in training data by using generated data to balance training data

Risks

No technology is inherently good or bad. However, when used with malicious intent, generative AI can bring great harm. Deepfakes are the result of generative AI when used for content creation with malicious intent. These fake images and videos have been used to attack celebrities with fake porn and individuals with revenge porn. Deepfakes are also used in video to create misleading information. [15] Examples include impersonations of actors and politicians such as Barack Obama saying things he would never say [16] and a synthetic Queen Elizabeth II with an alternative Christmas message. [17] In a recent case, a U.K. energy company fell victim to a fake voice on the telephone impersonating a senior executive that was used to order the transfer of €220,000 to a supplier in Hungary. [18, 19]

Deepfake images are also used by individuals to create fake accounts or take over and break into existing legitimate accounts with realistic but fake images. [20] Studies indicate that people can perceive AI-generated faces to be more real than real faces. [21]

Fake news stories are becoming more prominent, particularly with political content. Not only do deepfakes injure the target with defamation and harassment, they also undermine our trust. Disinformation has the potential to cause significant damage. For example:

- Altering a dashcam video to show the light was green before the accident
- Using a text generator to write a novel, falsely claiming it is original work
- Altering video of a criminal offense to switch faces and scapegoat an individual

Adversarial attacks, a variant of deepfakes, is when an AI model is obtained by an adversary and reverse engineered. As such, the AI can pretend to be nonfraudulent by actually being a fraud. Alternatively, the AI can pretend to be a good person, while actually being a known aggressor. [22]

Generative AI used for material design could create deepfake products that could become existential threats for some companies. For example, competitors of a leading food/beverage brand may develop a striking advantage with AI-driven material design and be able to generate a replacement formula for the brand's cola drink or chocolate spread at a lower cost.

As the technology improves, it is getting increasingly difficult to detect deepfakes, and some jurisdictions are moving forward with legislation to detect them. [23] Prominent organizations, such as Partnership on AI and DARPA, are pursuing detection of deepfakes to counteract fraud, disinformation, instigation of social unrest and other negative impacts of generative AI. [24, 25]

Generative AI can amplify bias. If the training data is biased, the generated data is likely to be even more biased, making the problem worse. This can be particularly disastrous in synthetic data generation where the synthetic data is being used to train AI models. [26]

Generative AI requires a unique set of skills that are difficult to source. Organizations must look to their existing AI resources to upskill with generative AI techniques or source skills from academia.

Adoption Rate

Generative AI is an emerging technology that has only begun to be exploited commercially. Most use cases have less than 1% of target market adoption, with some exceptions. Generative content creation has a significant presence in the marketing industry. Some of the more developed use cases, such as synthetic data generation and generative design, have commercial offerings, but they have not yet had significant market penetration. Other use cases such as drug discovery and material design are embryonic and still lab experiments with no real commercial products offerings. Significant activity in the development of deepfakes advances the research forward, but has few viable commercial opportunities.

Alternatives

Generated content (without AI) has existed for years, but has been limited to formulaic content such as sports news and financial reporting. Truly creative generation capabilities are new with generative AI, providing transformational opportunities.

Recommendations

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- Work with security and risk management leaders to proactively mitigate the risks of deepfakes and support legislation to regulate the malicious use of generative AI technology.

Evidence

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