

A survey of Generative AI Applications

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Abstract. Generative AI has experienced remarkable growth in recent years, leading to a wide array of applications across diverse domains. In this paper, we present a comprehensive survey of more than 350 generative AI applications, providing a structured taxonomy and concise descriptions of various unimodal and even multimodal generative AIs. The survey is organized into sections, covering a wide range of unimodal generative AI applications such as text, images, video, gaming and brain information. Our survey aims to serve as a valuable resource for researchers and practitioners to navigate the rapidly expanding landscape of generative AI, facilitating a better understanding of the current state-of-the-art and fostering further innovation in the field.

1 Introduction

The emergence of groundbreaking generative AI models, such as ChatGPT [229] and DALL-E [247], has catalyzed a new era in the synthesis and manipulation of digital content. Concretely, these powerful machine learning algorithms have demonstrated unprecedented capabilities in synthesizing realistic images, audio, text, and other data modalities [153]. In particular, these state-of-the-art language and image generation models, leveraging the prowess of deep learning and transformer architectures, have enabled the generation of a vast array of fields.

Generative AI refers to artificial intelligence that can generate novel content, rather than simply analyzing or acting on existing data like expert systems [219]. Generative AI models, equipped with vast data sets and intricate designs, have the extraordinary capability to create new and diverse content. They can process and learn from information gathered from a multitude of sources, such as Wikipedia [262], Github [94] and others. By tapping into this wealth of data, these models can generate an extensive range of multimedia formats, including video, audio, and text.

During the recent years, the continuous growth in computing power has used deep neural networks [188], transformers and other innovative models like generative adversarial networks [113] and variational autoencoders [219]. All these models can effectively capture the complexity of data, making them adept at modeling high-dimensional probability distributions of language or images from specific or general domains. By complementing generative models with additional techniques that map the latent high-dimensional semantic space of language or

images to multimedia representations of text, audio, or video, it becomes possible to transform any input format, such as text, into a variety of output formats like video. This versatility allows for a seamless conversion between multimedia formats, making generative models invaluable in numerous applications. One of the most significant aspects of generative AI is its potential for endless applications. These models can be trained to generate genuinely different multimedia formats, like video, audio, or text, from various input formats. For instance, generative AI can be used to create realistic images from textual descriptions, produce video content from audio, or even generate music compositions based on specific styles or emotions. Furthermore, generative AI has the potential to revolutionize industries such as advertising, entertainment, and education by automating content creation and providing personalized experiences. With the ability to learn from diverse data sources and generate a wide array of multimedia outputs, these models can help businesses and individuals alike save time and resources while tapping into new creative possibilities. In conclusion, generative AI models, bolstered by their access to extensive data and complex designs, offer unparalleled potential in content creation and transformation. Their ability to learn from various sources, generate diverse multimedia formats, and convert inputs from one format to another opens up a vast array of applications in multimedia generation and conversion, making them indispensable tools in today's technology-driven world.

In more recent work, there have been surveys of LLMs, and of Generative AI, talking about different applications of the technology [328,85,323,326,324,68,325]. In contrast to prior surveys, this comprehensive review aims to offer a unique perspective by highlighting not only the most prominent generative models and their underlying technologies but also by emphasizing on all the different uses of this technology. In addition, we give an up-to-date competitive outlook in this growing industry and the models behind this growth.

This resource encompasses 15 categories, which include text, images, video, 3D, code and software, speech, AI understanding, business, gaming, music, biotech, brain, others, and multimodal. Within each section, a thorough taxonomy of the current technologies is presented, detailing both the models and tools available. By offering a systematic exploration of these diverse AI applications, the survey serves as an essential reference for researchers, academics, and professionals, enabling them to comprehend better the evolving landscape of generative AI and its far-reaching implications.

As an example, a 3D game designer may have various generative AI needs for a project of his. He may find a solution for his 3D AI needs under both 3D and gaming, getting more specific results and different answers. He may also find solutions for more business needs of his under both business and text. With this survey, we believe that users will get a very good outlook of how Generative AI is shaping up and where they may find their needed technology.

We introduce, in this article, the proposition of an extensive dictionary centered on the most sought-after generative AI applications, which are notably reshaping industries such as the videogames [199], design [183], and business op-

erations [2] sectors. The challenge users experience in identifying the developed programs within each distinct application field substantiates the demand for a comprehensive reference tool.

2 Basic Taxonomy of models

This article explores the burgeoning applications of generative AI, focusing on its transformative potential across diverse sectors, such as art, business, biotechnology, and design. We achieve this by dividing Generative AI into 13 parts by both the output that is produced, the context in which they are being used and the business use that this technology has. The reader may observe that many models could be placed in the text category as the output is text. Or that many copywriting models could also be placed under the text category. The classification that is shown below serves for a prospective user of generative AI technologies to quickly find the technology they shall be using based on the use case. In this first part, we introduce the categories in which we taxonomized current Generative AI technology. Here we present a summary of the different categories: Regarding text, Generative AI technologies in the text category aim to create and manipulate natural language text. These technologies include language models that can generate human-like text, such as OpenAI’s GPT models. While the most famous of these models are chatbots such as OpenAI’s ChatGPT or Google’s BARD, other types of models are included in this category. These include text-writing assistants, scientific language models or chatbots. The main criterion for this category was that the models produce text as an output. Concerning images, Generative AI technologies in the images category focus on the creation and manipulation of visual images. The main criteria in this category was that the final output was an image. This can include image creating models that can create images out of textual descriptions and image editing models. For simplicity, the category was divided into artistic image creation, realistic image creation and image editing. Some models that did two or more of these tasks are arbitrarily included in one of the categories. Other models of this category include text-to-layouts and text-to-molecular representations which could not be included in the aforementioned categories. Dealing with video, Generative AI technologies in the video category aim to create and manipulate video content. The main criteria for this category was that the final output was a video. This mainly includes video creation models that can generate new video content from textual descriptions. Other models include post production, text-to-scene generation, text-to-motion capture, image-to-video as well as video dubbing. Also working with 3D, Generative AI technologies in the 3D category focus on the creation and manipulation of three-dimensional objects and environments. The main criteria was using the output being a fully formed 3D model. Also included, there is a 4-D model and a 3-D model specially designed for metaverse purposes. Inputs include text, a single image, images and 2D models. Focusing on code and software, Generative AI technologies in the code and software category aim to automate the process of writing code and creating software. The main cri-

teria was that the final output be a code. This includes a variety of categories: text-to-code, text-to-websites, text-to-software and text-to-apps. Other less frequent models include designs-to-code, text-to-software, text-to-RPA and a code translator. The text-to-software category was designed to fit Adept, a company that wants users to communicate with computers via just a text input. This is why it is included here. Regarding speech, Generative AI technologies in the speech category focus on the creation and manipulation of spoken language. All of these technologies are able to transform an input into a speech output. This is divided into text-to-speech, speech-to-speech and speech editing. About AI understanding, Generative AI technologies in the AI understanding category are those models that convert an input into a text output. This particular category was drawn because of the need of a category which would summarize models that can turn many inputs into speech. Inputs cover: speech, images audio and video, images, video, metaphors, semi-structured data, structured data, movies and generative regions. Concerning business, Generative AI technologies in the business category focus on the application of AI to improve business processes and decision-making. Many of the said models in aforementioned categories such as chatGPT in the text category or Midjourney in the image category could very well be used by businesses. Despite, the means for this category is for people in general businesses to find models for their operations. These are divided into: marketing, new business models and business operations. Dealing with Gaming, Generative AI technologies in the gaming category aim to make game creation much easier for developers. They use text, 3d and image models for their purposes. They are divided into videogame creation and characters. About music, Generative AI technologies in the music category focus on the creation and manipulation of musical content. This category includes music generation, musical editing and a dance-to-music model. Regarding biotech, Generative AI technologies in the biotech category aim to apply Generative AI to biological research and medical applications. This can include models that can predict the structure of proteins or DNA sequences, as well as drug discovery tools that can identify new drug candidates. Some of these models could have been included in the Business category, but this category was drawn up because of the abundance of Generative AI applications in this field. Concerning the human brain, Generative AI technologies in the brain category focus on the application of Generative AI to help people communicate. This includes brain-to-text models and brain-to-images models. Finally, we include an others category, made in order to fit Alphasensor, a groundbreaking AI technology for the discovery of algorithms [180] as well as AutoGPT, an attempt at autonomous GPT [155].

Multimodal Category created for those models that either intake several kinds of inputs or can output several forms of data. Other mentioned models such as text-to-slides have this characteristic, but these others could not fit in any other of the aforementioned categories.

3 Generative AI Applications

In this section we will introduce a broad overview of generative AI applications divided in subsection according to every different topic.

3.1 Text

Text models specially those centered around conversational chatbots have revolutionized AI since the launch of ChatGPT. Helped by natural language processing and large language models, these models have many very useful capabilities like summarization, writing assistance, code generation, language translation and sentiment analysis. They have been the main focus in Generative AI because of the capabilities of ChatGPT, a application which millions of users are already taking advantage of.[163]

Conversational AI Conversational AI has been one of the most talked about topics in AI. These services act as chatbots capable of a wide variety of tasks converting text prompts into text outputs. They are powered by Large Language Models or LLMs. Large language models (LLMs) refer to Transformer language models that contain hundreds of billions (or more) of parameters, which are trained on massive text data, such as GPT-3, PaLM, Galactica, and LLaMA [328]. Some of their capabilities are text generation, common-sense reasoning, spatial reasoning,[177], mathematical reasoning or programming assistance. [298][142]. In terms of business operations, there are many applications such as demand forecasting, inventory optimization and risk management. [69]. Many of the capabilities are being researched at the time of writing these articles, just as the capabilities of LLMs are being discovered.

The most famous example is ChatGPT which was trained with data until 2021 and which now has a beta function for up-to-date data, including plug-ins [83]. Other chatbots which do not include updated information include Claude or Stanford Alpaca [63,278]. Models with updated information include Bing AI, Google's BARD powered by LaMDA, the Beta version of ChatGPT, DuckAssist, Metaphor or Perplexity AI. [83,128,207,236,237]

Text-to-Science Other applications can be seen in Science, where Galactica [293] and Minerva [191] have merged. Galactica is a large language model that can store, combine and reason about scientific language. Minerva is Large language model focused on quantitative reasoning tasks such as mathematics, science and engineering problems at the college level. Although the models are not at all able to replace human reasoning on these tasks, they show promising results.

Text-to-Author Simulation The models have recently shown abilities of recreating certain styles of writing. Examples recently show LLMs being able

to write as Daniel C. Dennett [263] or as H.P. Lovecraft [145]. Dennett’s paper shows that experts on Dennett’s work were succesful at a 51 percent rate at distinguishing between the philosopher’s work and the large language model’s work. Lovecraft’s paper shows that human readers without prior exposure to Lovecraft are unable to distinguish between texts written by the author and those written by ChatGPT. These are remarkable achievements and show great capabilities of Language Models in imitating writing through fine-tuning.

Generative AI can also be used for live-writing assistance. Previously mentioned chatbots such as ChatGPT can be used for this purpose, but specific applications have been created such as GrammarlyGO [154] and PEER [262]. GrammarlyGO is a writing assistant created by Grammarly, able to write drafts, outlines, replies and revisions. PEER is similar to Grammarly’s software but it provides explanation for its actions and it’s fine-tuned for an academic article.

Text-to-Medical Advice Large language models have also been proven useful for preliminary medical advice through fine-tuning. We need to state that these models are still not completely safe for this use and they should not be used for replacing a human at the moment. Some of these models are Chatdoctor [92], GlassAI [148], Med-PaLM 2,[270] and YourDoctor AI [317]. They have shown promising capabilities to retrieve medical knowledge, reason over it, and answer medical questions comparably to physicians. Med-PaLM 2 scored up to 86.5 on the MedQA dataset. These models again show a remarkable ability to create accurate responses through fine-tuning. The biggest found startup in this space in Hippocratic AI [159] which has developed LLM’s that outperform GPT-4 on medical datasets.

Text-to-Itinerary Other capabilities include travel itinerary creation, with application examples such as Roam Around [258], TripNotes [47] or ChatGPT’s Kayak plug-in. [3] The first two show the ability of creating a visiting schedule while the Kayak plugin is able to look for hotels, flights and more through natural language.

Doc-to-Text At last, Generative AI can also use natural language in order to retrieve information from documents. Two applications are ChatDOC [92] and MapDeduce [203]. They are able to quickly extract, locate and summarize information from PDFs through natural language queries.

3.2 Images

Image Generative AI has only grown since the launch of DALL-E 2 back in 2022. With both artistic and professional purposes, this technology has proved very useful in creating images from text prompts as well as in image editing. In terms of art creation, it has pushed creative boundaries and has been revolutionary. In image creation, photorealism seems nearer with cutting-edge applications such as Midjourney which have provided with very realistic images.

Image Editing Generative AI has proven useful in terms of image editing. Some useful applications include Alpaca AI [59], I2SB [198] and Facet AI [134]. Some capabilities of these applications are inpainting, outpainting, upscaling, super-resolution, deblurring and depth map generation. An example of an application using Generative AI for image editing is Photoroom AI [238], which is able to erase backgrounds and remove objects in images through this software.

Even face restoration can be achieved through Generative AI, as Tencent Face Restoration tool shows [309,294]. They achieve this through GANs, one of the pillars behind Generative AI and Deep Learning. For the purpose of creativity, Stable Diffusion Reimagine allows users to generate multiple variations of a single image [175].

Artistic Images In terms of artistic images, many platforms have been created for the creation of artistic images through text prompts. Some examples include OpenART [230] which uses DALL-E 2 [248], Midjourney [211], Stable Diffusion [124] and create images from text prompts, Mage.Space which uses Stable Diffusion for art generation and NightCafe, which uses Stable Diffusion, DALL-E 2, CLIP-Guided Diffusion, VQGAN+CLIP and Neural Style Transfer for artistic image generation. Other platforms include Wonder [312], which is a mobile application for artistic image creation and Neural.Love [170,224], an AI-powered platform for audio, video and image editing and enhancement which has the Art Generator, in which you can select from many styles such as Fantasy or Sci-Fi. In contrast to these other platforms, DALL-E [248] and Midjourney [211] use their own for image generation.

These models have also been proven useful for other artistic image tasks. Tattoo creation can be helped via Tattoos AI [290]. Moreover, meme creation is achieved through Supermeme AI [283]. Also, artistic avatars can be generated through Profile Picture AI, using samples of yourself.

Realistic Images LO MALO es que en la otra sección hablo de plataformas, aquí de modelos. In terms of realistic image creation, there has been a plethora of models which enable realistic image generation. They include Bing AI Image Creator [73], Craiyon [111], DALL-E 2 [248], GLIGEN [195] [194], Imagen [160], Midjourney [211], Muse [89] [88], Parti [318] Runway ML Text-to-Image [259] and Stable Diffusion ML [124]. Through text inputs, they attempt photorealistic generations.

Outside of simple text-to-image creation, there are many more uses to Generative AI. Through image samples, Generative AI can create photorealistic images. Booth AI [75] can quickly create lifestyle photographs through sample subject images. Other applications such as Aragon AI [6], Avatar AI [10] and PrimeProfile [243] can create headshots through sample images.

The process of design can be optimized through Generative AI. PLaY [97] shows how text can be converted into layouts using latent diffusion. As well, Autodraw [67] is a drawing-to-shapes model that turns simple drawings into shapes. Both of these applications can quickly optimize the design process.

3.3 Video

Video Generative AI helps producers with storytelling. Although still a developing field because of the complexity that video generation poses, listed use cases such as digital human videos, human motion capture and video dubbing are revolutionary uses which can quickly lead to technological change.

3.4 Text-to-Video

General Video Production Text-to-video models are still at an early stage, but there has been very many applications that have tried to be successful at video generation. The biggest models include Imagen Video, [160], Meta Make A Video [30], Phenaki [306] and Runway Gen-2 [259]. Imagen Video uses a cascade of diffusion models for the creation of video outputs. Meta Make a Video is a video generation model created by Meta Research that can do text-to-video, image-to-video and video-editing. Although they are far from creating realistic outputs, they have shown promising signs and they have been useful from simple videos. Phenaki creates multiple-minute long videos through text prompts. Moreover, Runway Gen-2 can generate videos through text, video and image inputs. Shorter videos in GIF form can be generated through CogVideo [104], trained by inheriting a pretrained text-to-image model, CogView2.

These video models have many applications in the creation of videos with digital humans. Applications like Colossyan AI [105], Elai AI [131], Heygen AI [158], Hour One AI [162], Rephrase AI [253] and Synthesia [285] can create professional videos through diverse avatars. Some of them such as Synthesia combine this technology with 120 different languages for speech creation. As well, you can use generative AI from transforming articles into video outputs. SuperCreator [282] is a mobile app that generates short videos for TikTok, Reels and Shorts through Generative AI with an article input. As well Synths Video [287] transforms articles into YouTube videos.

Generative AI can lead to deeper personalization of the videos, very useful for businesses. A very good example of this is Tavus AI [291], a video generation platform that personalizes videos of you to each audience member, automatically. As well, D-ID [123] uses generative AI technologies to create real-time video to create an immersive human-like experience.

They can also be useful for artistic video generation. An example is Kaiber [179], an application that creates artistic videos through text and image prompts. Even for movie creation, with Opus AI, [233] a text-to-video generator focused on everything from scenes, characters, dialogue and visual effects.

Generative AI can also be used for Image-to-Video generation, very useful for Virtual Reality. Two models that have been created through generative AI are GeoGPT [252] and SE3DS [182]. GeoGPT provided a novel approach to synthesize a consistent long-term video given a single scene image and a trajectory of large camera motions. SE3D is a method for high-resolution images and videos generation from novel viewpoints, including viewpoints that extrapolate

far beyond the input images while maintaining 3D consistency via the use of an image-to-image GAN.

Other notable video generation methods are Riverside AI [257] which is an AI-powered video production site with edition capabilities, Scenescape [141], a method for text-driven perpetual view generation and Human Motion Diffusion Model. [296]

3.5 3D

These technologies allow for easier 3D designs just with having a text prompt, an image or a video. They have varied applications such as game creation, the metaverse or urban planning for which 3d designs are fundamental.

3.6 Text-to-3D

3D model generation can be achieved through many types of inputs (text, image, images and 2D models) through generative AI. Regarding text inputs, some of the most important models are Adobe Firefly [5], Dreamfusion [242], GET3D [144], Magic3D [196], Synthesis AI [286] and Text2Room [267]. They created 3D textured shapes through text inputs. For animated 3D inputs, Mirage [214] is a 3D tool to generated animated 3D pieces. We can even be able to generate 4D models through generative AI, as MAV3D [269] shows with a dynamic scene generator.

In terms of image inputs, we can create 3d models with both a single image and with many images. For single-image inputs, popular models are GeNVS [87], Kaedim [178], Make-It-3D [289] and RealFusion[205]. For many image inputs, we have NVIDIA Lion [322], EVA3D [161], Neural-Lift-360 [315] and Scenedreamer [96]. Particularly for persons, we have PersoNeRF [311], which takes sample human images and generates a 3d model. We can also generate a 3D model through 2D images. We can as well transform video inputs into 3d models through Deepmotion [118] and Plask AI [241].Lastly, we can aslso create a 3d model through geometric points through NVIDIA LION [322].

A business this technology can be applied to is the metaverse. Two companies that have combined both Generative AI and the Metaverse are Metaphysic AI [208] and Versy AI [51].

3.7 Code and Software

Developers have been greatly assisted by these technologies by both Github Copilot and ChatGPT since this technologies inception. Through Natural Language, these models can help the user program and build websites. They can also help with more repetitive tasks of the programmer such as documentation. The most ambitious app, Adept, even says that NLP can lead to humans just using language to talk to a computer. The democratization of code can help many professionals without a technical background be able to move around these programs with ease, which could be a major technological advance.

3.8 Text-to-Code

Text-to-Multilingual Code There are many softwares for multilingual code generation through just text-inputs. Although ChatGPT is widely used for coding, there are many more generative AI applications that are being created for that purpose. While most of them work as coding assistants, they are also able to generate code through text prompts. Some of them are Alphacode [193], Amazon Codewhisperer [61], BlackBox AI [13], CodeComplete [101], CodeGeeX [329], Codeium [102], Mutable AI [221], GitHub Copilot [146], GitHub Copilot X [147], GhostWriter Replit [255] and Tabnine [53]. They are used to complete, explain, transform and generate code. They generate new lines based on context and syntax. As we can observe, it is one of the fields with the biggest amount of applications. They can be personalized to your writing style Codex [95] is the model behind GitHub Copilot, the most famous coding assistant. For coding documentation, both Mintlify [212] and Stenography [279] have emerged as great ways to use Generative AI for code documentation.

In terms of specific languages, excel has been widely explored for spreadsheet code generation through generative AI. Some applications are AI Office Bot [54], Data Sheets GPT [265], Excel Formulabot [140], Google Workspace AI- Sheets [150] and Sheets AI [42]. They generate formulas quickly through text prompts and AI Office Bot even explains them. Also, there have been applications for SQL code generation like AI2SQL [56] and Seek AI [41]. Code translation has also been made able through Generative AI, with Vercel AI Code Translator [299] being one of the most useful tools. Even cybersecurity can be helped through natural language through Microsoft Security Copilot [210], an AI-powered security analysis tool that enables to respond to threats quickly, process signals and assess risk exposure.

Regarding website creation, Durable [129] and Mutiny [222]. Both applications generate a website with images and text through text prompts. Specifically for User Interface generation, we have three applications, Diagram AI [121], Galileo AI [21] and Uizard AI [304], which use Generative AI for generating good user interfaces and optimize the customer's experience. The.com [297] even automates web page generation, so companies create personalized pages for each of their customers.

Concerning app creation, there are many applications which are very useful for app generation. With reference to apps, Flutterflow [138], Imagica AI [168] and Google Generative App Builder [151] generate enterprise-grade AI applications for users without a technical background. As for web apps, Debuild AI [116], Literally Anything IO [174] and Second AI [264] are examples of Generative AI technologies with which users can easily create web apps through text prompts. Even LLM app creation has become easily available to non-technical professionals through text and data inputs as we can observe with Berri AI [71] and Scale Spellbook [39]. Lastly, apps with private data can now be designed through natural language through Zbrain [321].

Other technologies have emerged in the field of coding. An example is design-to-code technologies, through Locofy [29], a tool that turns designs into code for

mobile apps and web. Furthermore, text-to-automation tools through Drafter AI [19], a platform to automate even the most advanced analytical tasks and Lasso AI [27] which builds any robotic process automation using natural language. Even Adept[4] has emerged with the project of making natural language able to interact with everything in your computer.

3.9 Speech

Speech technologies try to imitate human speech. Text-to-speech technologies have made it easier to develop speeches. Other speech-to-speech technologies have made voice cloning very easy through generative AI. This technology has endless future possibilities in podcasts, youtube videos or helping mutes to communicate.

3.10 Text-to-Speech

In terms of speech creation, Generative AI has made it easy to create speech recordings through a text prompts. A plethora of platforms have been created including Coqui [109], Descript Overdub [119], ElevenLabs [132] Listnr [197], Lovo AI [26], Resemble AI [256], Replica Studios [280], Voicemod [307] and Wellsaid [52]. The most important model is AudioLM [76], Google's framework for high-quality audio generation with long-term consistency.

As to speech-to-speech models, ACE-VC [166] and VALL-E [308] are the most important models. VALL-E specifically can take a three-second recording of someone's voice, and replicate that voice, turning written words into speech, with realistic intonation and emotion depending on the context of the text.

Other technologies that produce a speech output include Supertone AI [284], that is able to provide speech editing and Dubverse [127], with turns video recordings into speech, very useful for video dubbing.

3.11 AI Understanding

AI has reached a good level in terms of translating different types of information in texts, videos, speech and more into natural language. This is very useful because of the ability of AI to communicate and the ability to transform complex forms of communication into easier text. If we can transform any input into text, then we can easily understand it, and we can even use that output as an input in other technologies, making for much more complete AI models.

3.12 Speech-to-Text

One of the main fields has been speech-to-text technologies, as subtitles and transcriptions are very useful. Applications include Cogram AI [103], Deepgram AI [117], Dialpad AI [122], Fathom Video [135], Fireflies AI [137], GoogleUSM [327], Papercup [234], Reduct Video [305], Whisper [246] and Zoom IQ [331].

These technologies do not only do speech-to-text tasks, as some of them do much more. Deepgram AI identifies the speaker, the language and keywords. Dialpad AI includes real-time recommendations, call summaries and the automation of customer touchpoints. Papercup even translates and creates human-sounding voices over. Lastly, Zoom has integrated AI into their systems, including features such as chat summaries and e-mail drafts. By combining many generative AI technologies, we can observe how workflows can be optimized.

Other technologies even turn images into text. These technologies can be used through many fields such as computer vision and help AI better understand human-generated content. As for these technologies, some examples of applications are Flamingo [57], Segment Anything [181] and VisualGPT [93]. Flamingo is even able to achieve this task on video inputs. For video inputs, we have found TwelveLabs [184] and MINOTAUR [152]. TwelveLabs extracts key features from a video input such as action, object, text on screen, speech and people and it transforms all of that into vector representations. These vectors enable for quick search. Minotaur tackles query-based video understanding in long-form videos. In this space, another model called MOVIECLIP [77] was found very useful as it models the accurate recognition of visual scenes in movies. Through this technology, we can observe how computers are starting to understand unstructured sets of data effectively.

There are even platforms in which we can transform multiple forms of input into text. Primer AI [36] is a tool to understand and act on vast amounts of text, images, audio and videos in real time. It helps in understanding and acting on this information to protect security and democracy. As for Speak AI [40], it helps marketing and research teams turn unstructured audio, video and text into competitive insights using transcription and NLP. Through both technologies, we can see how generative AI can help us quickly analyze big and unstructured sets of data. We can even get to understand and act on it through Primer and quickly obtain insights through Speak AI.

Generative AI has also been found useful to transform tables of data into text. Some applications of Generative AI for this purpose are Defog AI [18], MURMUR [260] and TabT5 [62]. MURMUR specifically is capable of understanding unstructured data. If we are able to perfect this technology, this could have major effects on optimizing business decision-making, through quickly understanding table data.

This technology has also been applied to generative region-to-text modelling. GriT [314] is a transformer that aims for object understanding with region, text pairs, where region locates objects and text describes objects. This can be useful for object detection tasks.

3.13 Business

Generative AI has clear implications, using many of the listed technologies such as text, image and video in order to apply it to business. It can help businesses to cut costs reducing repetitive tasks, or even automating other more creative, costly processes such as designs, marketing documents or slidedecks. It can even

make new types of AI-powered businesses appear such as Harvey, which automates law, or Truewind, which automates accounting. Although young, we can only imagine how much generative AI will change the way in which businesses operate through the manners listed below.

3.14 Marketing

For marketing, generative AI has had a huge effect, as it is able to make creative region and image generation easier. In terms of copywriting, a plethora of applications have already been developed including Anyword [64], Copy AI [14], Google Workspace- Gmail and Docs [150], Hyperwrite [167], Jasper [25], Letterdrop [189], Regie AI [37], Simplified AI [268], Type AI [49] and Writesonic [313]. Some of the capabilities are writing emails, website contents, drafts, replies marketing content and product descriptions. We can easily see how the optimization of these processes would be very useful for many businesses. In fact, Regie AI even adapts the tone of the LLM to your company's tone, adapting even more to the business's needs. Here we again observe how businesses can combine many generative AI technologies in order to optimize their processes with Jasper, which does social media posts, emails, blogs and reports.

More specifically for social media content creation, there are some applications like Clips AI [100], Pictory AI [239], Predis AI [34], Tweethunter [303] and Tweetmonk [48]. Clips AI and Pictory AI repurposes long-form content into social media posting. Predis AI generated video and image posts in your brand language. Both Tweethunter and Tweetmonk generate tweets of your brand's content. We can observe how Generative AI adapts to your brand and quickly automates these processes. Enterprises can too use Generative AI to generate podcasts through Bytepods [320].

Advertisements can as well be created through generative AI, as we can see through many apps such as Ad Creative AI [112], Clickable [99], Omneky [228], Pencil [235] and Waymark [310]. The last of them Waymark is very useful as it generates videos based on a scan of the web for local business data. As well, LensAI [28] is as well useful as it fine-tunes ads by targeting through identifying objects, logos, actions, and context and matching them with relevant ads. Storytelling in these ads can as well be powered by Generative AI, with applications such as AI 21 Labs [55] and Subtxt [43] that help in this matter.

Generative AI can as well be used to automate communication with the customer. A series of apps achieve personalized chatbots to your business: One Reach AI [33], OpenSight AI [232], Brainfish [78] and Yuma AI [319]. E-mails can also be automatized through Generative AI with tools like InboxPro [169], Laverender [187], Smartwriter [273] and Twain [302]. Some of these technologies even include social media data and e-mail analytics that can optimize operations. Even platforms with voice assistance such as Poly AI [35] have been created.

Sales can be as well powered by Generative AI through the plethora of applications which have already been created. Contact centers can be optimized through applications like Cresta [15], Forethought AI [139], Grain AI [22] and Replicant [254] which transform the customer experience. Replicant can solve

customer service over the phone, text and chat. Others such as Cresta and Grain provide live help to contact centers. Cresta transforms real-time insights into real-time actions and Grain AI automates note-taking, record-keeping and insight-capture for customer conversations. As for Forethought, it aims to automate the customer experience. For the sales preparation, an application Tennr [295] was created to generate the perfect meeting prep before every sales call. There is even an app, Copy Monkey AI [108], created for optimizing amazon listings and your product's ranking organically.

We can observe how companies are investing resources into AI with EinsteinGPT [261], a platform created by Salesforce that creates personalized content across every Salesforce cloud. It will generate content across every sales, service, marketing, commerce, and IT interaction, transforming customer experience.

Visual content can be powered through Generative AI. Designs can be quickly created through only text prompts as seen with Microsoft Designer [209] which creates invitations, digital postcards, graphics and more. Even logos are able to be created through Generative AI, as it can be observed through Brandmark [79] and Looka AI [201]. Brandmark does too create other business-related content such as business cards. For name ideas you can use Namelix [223], Brandinition [81] and Brandsnap [80] in order to come up with business names.

Generative AI can as well help companies automate repetitive tasks. This can be achieved through many applications like Bardeen AI [12], Magical AI [202] and Notion AI [32]. These applications specifically designed for repetitive tasks are specially useful for companies that want to automate relatively simple processes through Machine Learning.

Generative AI can also be helpful for more strategic, high-level departments of a company. Applications like Rationale AI [176] can help in the creation of several business analysis through GPT. Applications like can help massively in employee management through applications like Albus ChatGPT [272], ChatGPT in Slack [272] and Moveworks [217] through conversation summaries and employee support automation. Product creation can also be optimized through generative AI through an application like Cohere AI [16] that offers LLM in order to retrieve, generate and classify text in order to create the best products. Generative AI can also be useful in order to receive immediate feedback into our businesses ideas through the applications Venturus AI [50] and Mixo AI [213] which analyze business ideas.

The analyst's workflows can also be made easier through Generative AI. This is achieved through helping both in slide generation and in market research. In terms of slide generation, there is several apps that can create presentations through natural language. Some of them are Autoslide AI [9], Canva Docs to Decks [84], ChatBA [91], Decktopus AI [17], Gamma AI [143], Google Workspace AI- Slides [150], Tome AI [45] and Slide AI [38]. Some of them work with just a small text prompt, like Tome AI and other work by introducing long texts like Canva Docs, which converts documents into slide presentations. As well, Decktopus even creates slide notes which can be quite useful.

In terms of research, there are already applications in which you can generate real-world data backed answers through simple natural language queries. These answers come in the form of charts and visualizations to integrate processes and make market search even quicker. Several companies of this type are Alphawatch [60], Dataherald [115], OpenAxis AI [231] and Maya [204].

An application that integrates all processes into one is AI Intern IO [172] which offers AI for most operations around a business: text, reports, code, marketing, HR documents, legal documents, documentation and translations.

Generative AI can massively help the finance industry's tedious process. BloombergGPT [74] is a Large Language Model built from scratch for finance. It can be used for sentiment analysis, named entity recognition, news classification, and question answering, among others. We can see how this could be of massive help for finance professionals. Even for modelling, Quilt Labs AI [245] is an AI-powered tool for the transformation of financial data into financial models. Finance can be seen as a great example of how applying generative AI to an industry can help automate processes.

It can also help tedious processes in scientific research. We can see this through applications such as Agolo AI [11], ArxivGPT [65], ConsensusNLP [106], Elicit AI [21] and Koala [190]. Some capabilities of these applications are finding papers, extracting key claims, spotlighting insights. Specifically ConsensusNLP and Koala are chatbots personalized to scientific research. Fact-checking has also been explored through Generative AI through Golden [149].

Specific industries have been deeply affected by Generative AI. A great example of an industry which has been affected is law. Some applications and companies are Casetext CoCounsel [86], Darrow AI [20], Harvey AI [23] and Spellbook Legal [277]. Harvey AI assists with contract analysis, due diligence, litigation, and regulatory compliance and can help generate insights, recommendations, and predictions based on data. As for Darrow AI, it does Case sourcing and Due Dilligence in order to get law cases for your firm. Regarding Spellbook Legal, it uses GPT-4 to review and suggest the terms of your contract. We can observe how Generative AI is occupying many spaces in law which have the potential to be automated. In this space, there is an application called TaxGPT [292] that takes advantage of GPT to fill out tax documents.

Other industries have also been affected. An example is accounting, with Truewind [300] which applies AI to bookeeping in order to make less errors and empower transparency. Moreover, education has been affected, firstly with the advent of ChatGPT in students work [192] and with companies such as Broadn [82], which uses language models and generative AI to help you create your own private learning course, unique to your learning style. Even modelling could be affected by Generative AI with companies such as LA LA LAND [185] providing an AI-powered digital model studio to show your 3D designs as lifelike models. Lastly, Voice acting can be helped by Generative AI through Sonantic [274], a Text-to-voice acting platform which provides with editing and direction.

Another example of an industry that has had some generative AI applications is architecture with SWAPP AI [44] and Autodesk Spacemaker [66]. SWAPP ap-

plies intelligent, advanced algorithms to deliver accurate, detailed, and complete Architectural construction documents and BIM models. Regarding Autodesk Spacemaker, it is a cloud-based AI software that empowers architects, urban planners and real estate developers to design high-quality site proposals. In fact, Generative AI can as well help in the Real Estate part of the process, which is shown by Zuma [332], AI-powered real estate assistance that automates lead generation.

(<https://www.getzuma.com/>)

Lastly, Generative AI can be used in order to create realistic synthetic data for testing environments. This can be achieved through websites such as Hazy [157], Mostly AI [216], Octopize [227] and Tonic [46].

3.15 Gaming

The gaming industry will be greatly helped by Generative AI technologies, because of being able to use it from image, text and 3d models. 3D models can help with creation and text models with storytelling and characters. We can view gaming as a very clear case study as to how Generative AI can be used through all parts of the value chain in a certain industry.

Generative AI can be used for videogame creation. This can be seen through applications like CSM [114], Illiad AI [24] and Latitude [186]. Explicitly for game assets, Pixelvibe [240] helps in the creation of them through Generative AI. Moreover, for game textures, Armorlab is a software designed for AI-powered texture authoring. There is even now a model called MarioGPT [281] designed for Open-Ended Text-to-Level Generation with LLMs.

Specifically for game characters, we have found Character AI [90], ConvAI [107], InWorld AI [173] and RCT AI Chaos Box [249]. ConvAI and InWorld AI craft characters through natural language. Just by inserting character settings, you are able to obtain full characters. As for RCT AI Chaos Box, this engine uses the Chaos Box algorithm to analyze real-time player inputs and dynamically generate NPC responses and new storylines based on Deep Reinforcement Learning.

3.16 Music

Music creation can also be greatly helped by Generative AI. This can be achieved by basic text prompts or by other music. This helps artists with song creation and can help with basic songs via just text prompts.

In terms of music generation through natural language, there have been many applications to do so. They include Aiva [7], ERNIE-music [330], Harmonai [156], Infinite Album [58], Jukebox [120], Mubert [218], Musico [220], Noise2Music [164], Sonify [275], soundful [276] and Splash AI Beatbot [70]. They have the capability of generating music through simple natural language. Musico even reacts to gesture, movements, code and other sounds. Even dance is starting to be able to be transformed into music through a model called EDGE [301]. Lastly,

musical editing can too be powered by Generative AI with applications such as Moises AI [215] and SingSong [125]

3.17 Biotech

Biotech is helped by Generative AI technologies helping in the process of molecule modelling. This can help with both drug discovery and protein modelling advancing the field. As these technologies advance, biotech could as well see their advancements made much easier. Absci Corporation [1], a listed company in the NASDAQ, already uses generative AI in their drug creation process.

3.18 Drug Discovery

Regarding drug discovery, NVIDIA Bionemo [225] is a cloud service for generative AI in drug discovery researches are provided with generative and predictive biomolecular AI models at scale. There are a plethora of companies that use Generative AI for drug creation including Absci, Atomic AI [8], BigHat AI [72], Exscientia [133], Menten AI [206] and ProteinQure [271]. They combine Machine Learning and biological knowledge in order to create drugs.

In terms of protein modelling, found models include BARTSmiles [98], a generative language model for molecular representation and Alphafold [251], a computer program that predicts protein structures for the whole human genome. As well, two companies have been found that center their business operations around protein design with Generative AI are Cradle [110] and Profluent [244].

3.19 Brain

Brain models can help mute people communicate through Generative AI. Although young technologies, some promising results already can be seen in this field. Regarding models that have been created to transform brain signals into text, we have found Meta AI's Speech From Brain [31] and Non-Invasive Brain Recordings [130]. They both try to decode speech from non-invasive brain recordings. Using Stable Diffusion for Brain Images [288] is a new method based on a diffusion model (DM) called Stable Diffusion to reconstruct images from human brain activity.

4 Others

Category made to fit other models. Firstly, Alphasensor [136] is an AI system for algorithm discovery based on reinforcement learning. The task given to Alphasensor was to improve the efficiency of matrix multiplications, which occur in many fundamental computations. Automating the algorithm discovery procedure is intricate, as the space of possible algorithms is enormous. That is why this model uses AlphaTensor, which is trained to play a single-player game where

the objective is finding tensor decompositions within a finite factor space. AlphaTensor discovered algorithms that outperform the state-of-the-art complexity for many matrix sizes.

Also, AutoGPT [155] has become a very famous model in the Generative AI community. This program, driven by GPT-4, chains together LLM "thoughts", to autonomously achieve whatever goal you set.

4.1 Multimodal

Models can take advantage of many of the listed technologies and combine them into one application. These listed applications take multiple inputs which can greatly help AI advancements. Also, projects of multi-tasking agents, such as GATO, could be the future of Generative AI. Although some models specifically like text-to-slides do take advantage of many generative AI technologies, these models have been selected because of not fitting anywhere else.

Although it has not yet been released to the public, the fourth version of GPT, GPT-4, can accept image and text inputs and produce text output, as the technical report of GPT-4 [229] shows. In the realm of chatbots that can take many forms of data as inputs, ERNIE bot [316] is the chatbot created by Baidu that will include features such as solving math questions, writing marketing copy, answering questions about Chinese literature, and generating multimedia responses. Also, answering in many dialects.

Regarding multimodal language models, Kosmos-1 [165], is a Multimodal Language Model with several capabilities. Some capabilities come in the form of language understanding and generation, perception-language tasks, including multimodal dialogue, image captioning, visual question answering, and vision tasks, such as image recognition with descriptions. Regarding Prismr [200], it is a vision language model with multi-modal experts. Some tasks include image captioning, question answering, object detection and segmentation. This model is competitive with current state-of-the-art vision models, whilst requiring up to two orders of magnitude less training data. As for PALM-E [126], it is an embodied multimodal language model. On the one hand, PaLM-E was primarily developed to be a model for robotics, and it solves a variety of tasks on multiple types of robots and for multiple modalities (images, robot states, and neural scene representations). At the same time, PaLM-E is a generally-capable vision-and-language model. It can perform visual tasks, such as describing images, detecting objects, or classifying scenes, and is also proficient at language tasks, like quoting poetry, solving math equations or generating code.

As for attempts at generalist agents, GATO [250] is a single agent beyond text outputs. It follows a multi-modal, multi-task, multi-embodiment generalist policy. The same network can play games, chat and press buttons at the same time. Regarding Generally Intelligent [171], it is a company in charge of the development of generally capable agents. Their aim is to deploy aligned human-level AI systems that can generalize to a wide range of economically useful tasks and assist with scientific research.

As for multimodal cloud services in generative AI, NVIDIA Picasso [226] is a cloud service for building and deploying generative AI-powered image, video, and 3D applications. It integrates text-to-image, text-to-video and text-to-3d models.

There even is a framework called HuggingGPT [266] that leverages LLMs (e.g., ChatGPT) to connect various AI models in machine learning communities (e.g., Hugging Face) to solve AI tasks. It makes LLMs act as a controller to manage existing AI models to solve complicated AI tasks and language could be a generic interface to empower this. It achieves impressive results in language, vision, speech, and other challenging tasks, which paves a new way towards advanced artificial intelligence.

Concerning Adobe Firefly [5] it is a family of Adobe models that uses text to create images, vectors, videos and 3D models out of text prompts. It is now in Photoshop, where it allows users to add, extend, and remove content from your images with simple text prompts.

5 Conclusions and further work

In conclusion, generative AI has already demonstrated its immense potential in revolutionizing various industries and reshaping our interactions with digital content. As these models continue to advance, they offer businesses and individuals unprecedented capabilities in content creation, problem-solving, and decision-making. Their capacity to generate realistic images, audio, text, and other data modalities unlocks novel opportunities for innovation and growth, while also enabling more personalized and efficient experiences. However, as we embrace this powerful technology, it is crucial to address the ethical implications and potential pitfalls associated with its use. For example, ethical implications applications such as ChatDoctor which can deliver a medical diagnosis. By fostering responsible development and adoption of generative AI, we can harness its transformative potential to shape a more creative, efficient, and prosperous future for businesses and individuals alike.

For future work, this survey is to be updated. From the launch of ChatGPT-3, a big part of these apps have launched. As more technologies are released, this survey will only grow bigger.

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