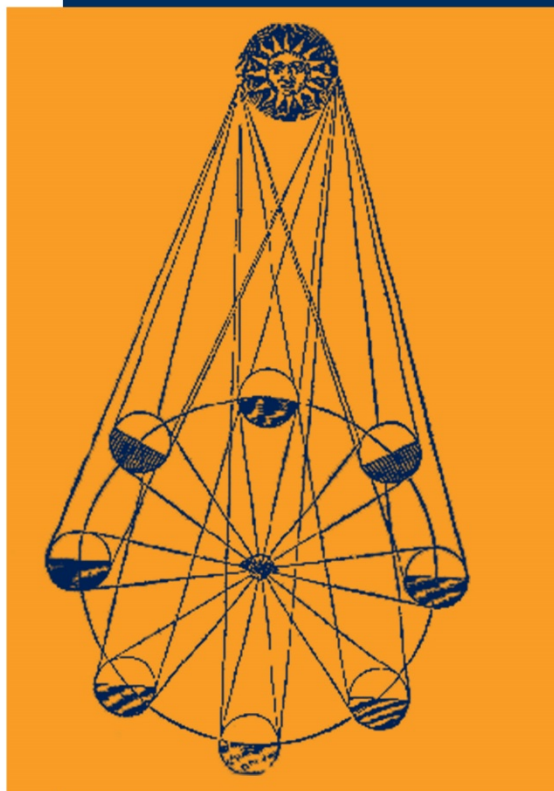


Rapporto Tecnico CNR-IRCrES

Analysis and Application of Generative Transformational Artificial Intelligence

Two case studies on ChatGPT



15/2024

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Rapporto Tecnico CNR-IRCrES, numero 15, 2024



gennaio 2024 by CNR-IRCrES

Analysis and Application of Generative Transformational Artificial Intelligence. Two case studies on ChatGPT

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ABSTRACT

The paper aims at outlining the impact of generative transformational Artificial Intelligence from a profane viewpoint and its potential and current socio-economic impact, with emphasis on the Italian landscape. To that end, it begins with a review of the way the technology was received in Italy by the general public and by linguistic specialists. Then it provides an overview on recent developments of Artificial Intelligence and a compilation of books and sources that discuss artificial intelligence, natural language processing, and the development of generative AI. A survey of potential and current application of the technology is provided and two case studies concerning generation of narrative and of computer codes are discussed. The whole paper is structured in such a way as to give a view of the main expected impacts and risks of this emerging technology to a public of economists.

KEYWORDS: generative AI, socio-economic impact of technology, case studies, creative writing, software coding.

DOI: 10.23760/2421-5562.2024.015

HOW TO CITE

Stefanini, A. (2024). *Analysis and Application of Generative Transformational Artificial Intelligence. Two case studies on ChatGPT*. Rapporto Tecnico 15. CNR-IRCrES. <http://dx.doi.org/10.23760/2421-5562.2024.015>

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1. INTRODUCTION

Although the scope of the present paper encompasses a survey on generative¹ transformational² Artificial Intelligence and of some significant sources worth reading about, its main aim is to outline the impact of the technology from the viewpoint of inexperienced practitioners with a mainly economic background, in view of outlining its potential socio-economic impact in Italy and Europe at large.

The paper begins with an overview of how this revolutionary technology was received in Italy. Then, it provides an historic view of the development of the technology and summarizes three recent significant sources which provide insights on the technology from three different viewpoints, insight, potential socio-economic impact and essay writing. It summarizes the main application areas of the technology, pinpoints some technological issues of general relevance and concern, and provides two case studies instrumented by the author on diverse domains, creative writing and software design and coding. Finally, it provides the author's current conclusions – the technology indeed evolves at such a pace that it is difficult to envisage the benefits and risks it carries with, even on a short-term scale.

2. HOW CHAT GPT WAS RECEIVED IN ITALY

It is worth outlining first which way the innovation was received in our own country. We look at the issue in a twofold way:

- Reception and adoption by the general public
- The uptake by computational linguistics specialists.

The reception of ChatGPT in Italy depended on various factors, including the specific applications, use cases, and the ethical considerations surrounding AI. Here are some general points worth considering:

Interest and Adoption: ChatGPT and similar AI models have generated significant interest globally for their potential in various fields, including customer support, content generation, language translation, and more. In the general public, adoption now looks widespread and enthusiastic. According to HDBlog³, there are:

1,2 milioni di interazioni sui social per OpenAI, 1,4 milioni di visitatori unici in Italia a gennaio per ChatGPT, di cui 905.000 da mobile. Sono però la minoranza dei 523.000 che accedono da desktop a passare più tempo sul sito, 11,1 minuti in media per ciascun visitatore al mese.

According to Fortune Italia⁴:

¹ Generative AI models use neural networks to identify the patterns and structures within existing data to generate new and original content. Generative AI enables users to quickly generate new content based on a variety of inputs, including text, images, sounds and other types of data.

² The use of transformative as an attribute of current generative AI emphasizes its power to bring into a new, qualitatively different future. Possibly the term was mutated by Transformational grammar, a system of language analysis that recognizes the relationship among the various elements of a sentence and among the possible sentences of a language and uses processes or rules (some of which are called transformations) to express these relationships.

³ See: <http://forum.hdblog.it>. HDBlog is a generalist web site and forum with specific focus on technology

⁴ <https://www.fortuneitalia.com/2023/03/12/chat-gpt-in-alcune-aziende-lintelligenza-artificiale-sta-gia-sostituendo-i-lavoratori/>

Business leaders already using Chat Gpt told ResumeBuilders.com that their companies use the software for a variety of reasons: including 66% for writing code, 58% for copywriting and content creation, 57% for customer support and 52% for meeting summaries. In the hiring process, 77% of companies that use Gpt Chat say they use it to help write job descriptions, 66% to draft interview requests and 65% to answer client questions to english.

Many generalist sources, like Panorama and Il Corriere, note that the use of Chat GPT as an oracle of a sort, even for personal uses, like the usage of medicines, is widespread and growing.

Ethical and Regulatory Considerations: Italy, like other European countries, has been actively involved in discussions and regulations related to AI ethics and data privacy. The reception of ChatGPT would also be strongly influenced by how it complies with local and EU regulations. It is significant that the *Garante per la Protezione dei Dati Personali* was the first authority in Europe to ban the use of ChatGPT for its illicit collection of personal data, especially relevant minors on April 2023 and revoke the ban about one month later⁵, after having received ample assurance by Open AI that the praxis was now strongly policed.

Research and Development: Italian researchers and developers may have used ChatGPT for research purposes, such as natural language processing and understanding. Some may be excited about the capabilities it offers, while others may have concerns about job displacement, privacy, and ethical issues. Both reasons certainly have grounds. Geoffrey Hinton, one of the fathers of ChatGPT, warns against chatbot dangers and, more in general, the risks of artificial intelligence⁶.

Use in Different Sectors: ChatGPT could be used in various sectors, including healthcare, finance, education, and media, to assist with tasks like data analysis, content generation, and customer service. It is important to note that the reception and use of AI models have considerably evolved since January 2022, i.e., since its first introduction. Local factors and developments obviously influence how AI models are received and utilized in a specific country, in such a way as to be a moving target for the most current information, which may require to consult recent news, academic research, or industry reports on the use of AI in Italy.

2.1. Uptake by computational linguistics

Computer scientists and computational linguists, as well as other experts in the field, have had varied reactions to advanced language models like GPT-3, such as ChatGPT. Their responses are influenced by a combination of factors, including the capabilities and limitations of these models, ethical considerations, and the potential impact on their field of study. They see these models as significant advancements in natural language understanding and generation. Skepticism: Some experts have raised concerns about the limitations of these models. Puzzlement: The rapid progress in AI language models like GPT-3 has left some experts in the field feeling somewhat puzzled or surprised by the capabilities of these models. The speed of advancements in AI can sometimes outpace expectations and understanding. Ethical Concerns: The use of AI language models has raised important ethical questions related to issues such as bias, misinformation, and privacy. Many experts in the field are concerned about the ethical implications of AI and advocate for responsible AI development and usage. Summarizing, the reactions to these tools are not uniform and can vary from one individual to another. While computer scientists and

⁵ See: [Intelligenza artificiale: il Garante blocca ChatGPT. Raccolta illecita di... - Garante Privacy and ChatGPT è tornato disponibile in Italia | Wired Italia](#)

⁶ See: <https://www.businessinsider.in/tech/news/father-of-ai-warns-of-chatbot-dangers-and-quits-google-geoffrey-hinton-on-the-risks-of-artificial-intelligence/articleshow/99954826.cms>. Personally, while conscious of the dangers of AI, I am rather on the side of the enthusiasts.

computational linguists may have a deep understanding of the technology, they also bring their perspectives and expertise to the table, which lead to a wide range of opinions and attitudes towards these AI language models.

On a personal note, this author was puzzled to receive the first notice of ChatGPT by a generic IT consultant on February 2023, while dedicated research arms such as the CNR ILC and the Fondazione Bruno Kessler, with whom he has a considerable range of common interests, included some ongoing projects, were conspicuously silent on the topic.

3. OVERVIEW ON AI DEVELOPMENT

Over the past 20-30 years, the development of AI systems has witnessed several key turning points that have collectively shaped the field into what it is today. These turning points have been instrumental in advancing AI technologies and driving their adoption in various domains. Here are some of the main turning points in the development of AI systems over the last few decades.

3.1. Machine Learning and Deep Learning Revolution

The resurgence of interest in machine learning, particularly deep learning, has been a pivotal moment. Breakthroughs in neural networks, combined with the availability of large datasets and powerful hardware, have transformed AI systems. This has led to the development of deep neural networks that excel in tasks like image recognition, natural language processing, and speech recognition.

3.2. Big Data and Data-Driven AI

The explosion of digital data has been a driving force. AI systems have become increasingly data-centric, with the ability to process and extract insights from vast datasets. This has been instrumental in areas like recommendation systems, data analytics, and predictive modeling.

3.3. Natural Language Processing (NLP) Advancements

The development of NLP technologies, including the creation of transformer models like GPT-3, has significantly improved the capabilities of AI in understanding and generating human language. This has revolutionized chatbots, virtual assistants, and content generation.

3.4. Computer Vision Progress

AI's ability to interpret and analyze visual data has grown immensely. Computer vision algorithms can now identify objects, people, and scenes with high accuracy, which has been a game-changer in applications like autonomous vehicles, surveillance, and medical imaging.

3.5. Reinforcement Learning Breakthroughs

Progress in reinforcement learning has enabled AI systems to learn through trial and error. This has been essential for applications like game playing (e.g., AlphaGo and OpenAI's Dota 2 AI) and autonomous robotics.

3.6. Autonomous Systems and Robotics

The development of autonomous systems, from self-driving cars to drones and industrial robots, has transformed various industries. AI plays a central role in making these systems safe and efficient.

3.7. Human-AI Collaboration:

The shift from viewing AI as a replacement for humans to a tool for collaboration has been significant. AI technologies are increasingly designed to enhance human capabilities and support decision-making in various fields, including healthcare and finance.

3.8. Ethical and Responsible AI

As AI systems have become more integrated into society, concerns about their ethical use have grown. The development of guidelines and frameworks for responsible AI has gained prominence, emphasizing fairness, transparency, and accountability.

3.9. AI in Healthcare

The healthcare sector has seen substantial AI adoption, from diagnostic tools and drug discovery to personalized medicine. AI's ability to analyze medical data and assist in clinical decision-making has the potential to revolutionize healthcare.

3.10. AI in Finance

In the financial industry, AI systems are used for fraud detection, algorithmic trading, risk assessment, and customer service. These technologies have transformed the way financial institutions operate.

3.11. AI in Education

AI-driven tools have been developed to personalize education, offering adaptive learning and intelligent tutoring systems. These technologies cater to individual student needs and improve learning outcomes.

3.12. AI in Content Creation and Entertainment

AI has impacted content creation, from generating text and music to enhancing visual effects in movies. It has also played a role in personalized content recommendations.

3.13. AI in Natural Resource Management

AI is used for optimizing agriculture, predicting environmental changes, and managing energy resources efficiently. These applications contribute to sustainability and conservation efforts.

These turning points collectively illustrate the evolution of AI systems over the last few decades. The convergence of advancements in machine learning, data availability, and specialized applications has made AI an integral part of our daily lives and industries. The continued development of AI promises to bring about further transformative changes in the years to come, with profound implications for society and the economy.

3.14. Technological issues of relevance

Some important information about the LLM (Large Language Model) technology, including GPT-3, that may be of interest to those who are not familiar with it are the following:

- **Architecture and Training:** GPT-3 stands for "**Generative Pre-trained Transformer 3**," and it is a type of neural network model. It was trained on a massive amount of text data from the internet to learn language patterns and generate human-like text.
- **Computer Network:** GPT-3 and similar models are typically hosted on **powerful computer servers** in data centers. These data centers consist of clusters of high-performance GPUs or TPUs (Tensor Processing Units) that can handle the large-scale computations required for language processing tasks.

- **Computational Power:** GPT-3 is extremely computationally intensive. It has **175 billion parameters** (which are like the ‘knowledge’ it has learned), making it one of the largest language models to date. The model requires a significant amount of computational power to perform tasks, and it can execute trillions of operations per second.
- **Energy Consumption:** The energy consumption of running GPT-3 or similar models can be substantial. These models need large clusters of servers with powerful GPUs, which can consume a significant amount of electricity. This has raised concerns about the environmental impact of AI models like GPT-3.
- **Query Processing:** When you interact with a model like GPT-3, your queries or inputs are sent to the model over a network connection. The model processes these inputs and generates responses, which are then sent back to your device. The actual processing and computations happen on the remote servers, while you interact with a user-friendly front-end or API.
- **APIs:** GPT-3 is often accessed through APIs (**Application Programming Interfaces**), which allow developers to integrate its capabilities into their own applications. This means that you can use GPT-3’s language generation abilities in your own software, such as chatbots, content generation, or text analysis tools.
- **Fine-tuning:** GPT-3 can be fine-tuned for specific tasks or applications. Developers can adapt the model to perform better in particular domains, making it more useful for a wide range of applications.
- **Ethical and Bias Concerns:** Large language models like GPT-3 have faced scrutiny for potential biases in their outputs and concerns about the responsible use of AI. Developers and organizations are working to address these concerns and ensure that the technology is used responsibly.

Understanding these aspects of LLM technology and GPT-3 can provide a broader perspective on how these models work and their implications for various applications and industries. It’s important to stay updated on developments in AI and consider the ethical and environmental aspects of their use.

4. A BRIEF SURVEY ON THE RISE OF GENERATIVE AI

I am reporting in this chapter about three important and rather recent sources of significance on the rise of AI and its impact. All of them are written in simple and understandable terms, so as to maximise impact on the general public.

The Master Algorithm is an anticipatory book written by Pedro Domingos and published in 2015, i.e., when the Chat GPT project still was in the minds of their creators (Domingos, 2015).

The Age of AI: And Our Human Future is a book co-authored by former US Secretary of State Henry Kissinger, former Google CEO Eric Schmidt, and MIT’s Daniel Huttenlocher, one of the former books to explore both the opportunities and risks involved by the rise of AI on a global, geopolitical scale (Kissinger, Huttenlocher, & Schmidt, 2019)⁷.

Impromptu: Amplifying Our Humanity Through AI is a book co-written by Reid Hoffman and GPT-4, which explores how AI, and especially Large Language Models like GPT-4, can be used across key areas like education, business, and creativity (Hoffmann & GPT-4, 2023). The book is basically a conversation with GPT-4: using GPT-4 as his “author’s co-pilot,” Hoffman paints an intriguing, challenging, and often entertaining picture of what’s possible: where trouble may arise, but also crucially, what could possibly go right.

⁷ “A muscular contribution to one of the 21st century’s most pressing debates”, according to *The Economist*.

4.1. The Master Algorithm by Pedro Domingos

The book explores the field of machine learning and the quest to discover a universal algorithm, often referred to as the *Master Algorithm*, that can learn from data and solve any problem. In the book, Domingos introduces the concept of the Master Algorithm, which represents a hypothetical algorithm capable of learning from any type of data and solving any problem.

Further, the book introduces “The Five Tribes of Machine Learning”: Domingos categorizes the field of machine learning into five main approaches or tribes and introduces “The Unification Quest” as a central theme of the book: the idea that combining the strengths of these five tribes could lead to the discovery of the Master Algorithm. The book, commenting on the *Data-Driven Revolution* emphasizes the importance of data in machine learning, discussing the exponential growth of data and its impact on the field.

In the *Quest for Generalization* Domingos explores the concept of generalization in machine learning, where algorithms learn to make predictions or decisions based on data patterns and apply that knowledge to new, unseen data. Then, the book overviews the ethical and societal challenges of machine learning, including privacy concerns, bias in algorithms, and the impact on employment and education.

In the *Future of Machine Learning* Domingos speculates about the future of machine learning, envisioning a world where the Master Algorithm “can be realized and democratized for the benefit of all”.

The Master Algorithm is a thought-provoking book that delves into the history, challenges, and potential of machine learning. It offers insights into the five main tribes of machine learning and their respective approaches while promoting the idea of unification to find a universal learning algorithm. The book is suitable for both those new to the field and experienced machine learning practitioners, as it provides a broad perspective on the subject.

According to Amazon, ‘Pedro Domingos, one of the field’s leading lights, lifts the veil for the first time to give us a peek inside the learning machines that power Google, Amazon, and your smartphone. Step by step, he assembles a blueprint for the future universal learner--the Master Algorithm--and discusses what it means for you, and for the future of business, science, and society’⁸. According to GoodReads, it is

A thought-provoking and wide-ranging exploration of machine learning and the race to build computer intelligences as flexible as our own [...] In The Master Algorithm, Pedro Domingos lifts the veil to give us a peek inside the learning machines that power Google, Amazon, and your smartphone. He assembles a blueprint for the future universal learner--the Master Algorithm--and discusses what it will mean for business, science, and society. If data-ism is today’s philosophy, this book is its Bible.

4.2. Henry Kissinger’s The Age of AI: And Our Human Future

The book explores the implications of artificial intelligence (AI) on the future of humanity. The authors argue that AI is already changing our world and will continue to do so in the future. They predict that AI will affect everything from scientific discoveries to warfare.

The book is divided into three parts. The first part discusses the history of AI and how it has evolved over time. The second part examines the current state of AI and its impact on society. The third part looks at the future of AI and how it will shape our world.

The authors argue that AI has the potential to revolutionize many aspects of our lives, including healthcare, transportation, and education. They also warn that uncontrolled AI poses significant dangers to society, such as producing hyper-realistic fake speeches or videos of events

⁸ See: <https://www.amazon.it/Master-Algorithm-Ultimate-Learning-Machine/dp/0241004543>

that never happened, or a future where the most significant decisions about the fate of the world are not made by humans.

The authors suggest that we need to develop a new framework for thinking about AI and its impact on society. They propose that we need to create national and global committees that should determine AI's uses and limitations across industry, academia, and governments. They also suggest that we need to develop new ethical frameworks for AI development.

Overall, *The Age of AI: And Our Human Future* is a thought-provoking book that raises important questions about the future of humanity in an age dominated by nonhuman intelligence.

4.3. The Impromptu by Reid Hoffmann

As anticipated, Hoffman doesn't just write about GPT-4; he interacts and writes letting readers see the technology's capabilities, its strengths, and limitations alike. *Impromptu* is divided into three parts. In the first part, Hoffman introduces the reader to the concept of "amplifying our humanity" through AI. He explains how AI can be used to enhance our creativity and productivity while also addressing some of the most pressing issues facing humanity today.

In the second part of the book, Hoffman explores how AI can be used to improve education. He argues that AI can help us create more personalized learning experiences that are tailored to each individual student's needs. He also discusses how AI can be used to help students develop critical thinking skills and creativity.

In the final part of the book, Hoffman looks at how AI can be used to improve business practices. He argues that AI can help businesses become more efficient and effective by automating routine tasks and providing insights into customer behavior. He also discusses how AI can be used to create new business models that are more sustainable and socially responsible.

Overall, *Impromptu: Amplifying Our Humanity Through AI* is an insightful and thought-provoking book that explores the potential of AI to enhance our lives in meaningful ways. It is a must-read for anyone interested in the future of technology and its impact on society.

5. APPLICATION REVIEW

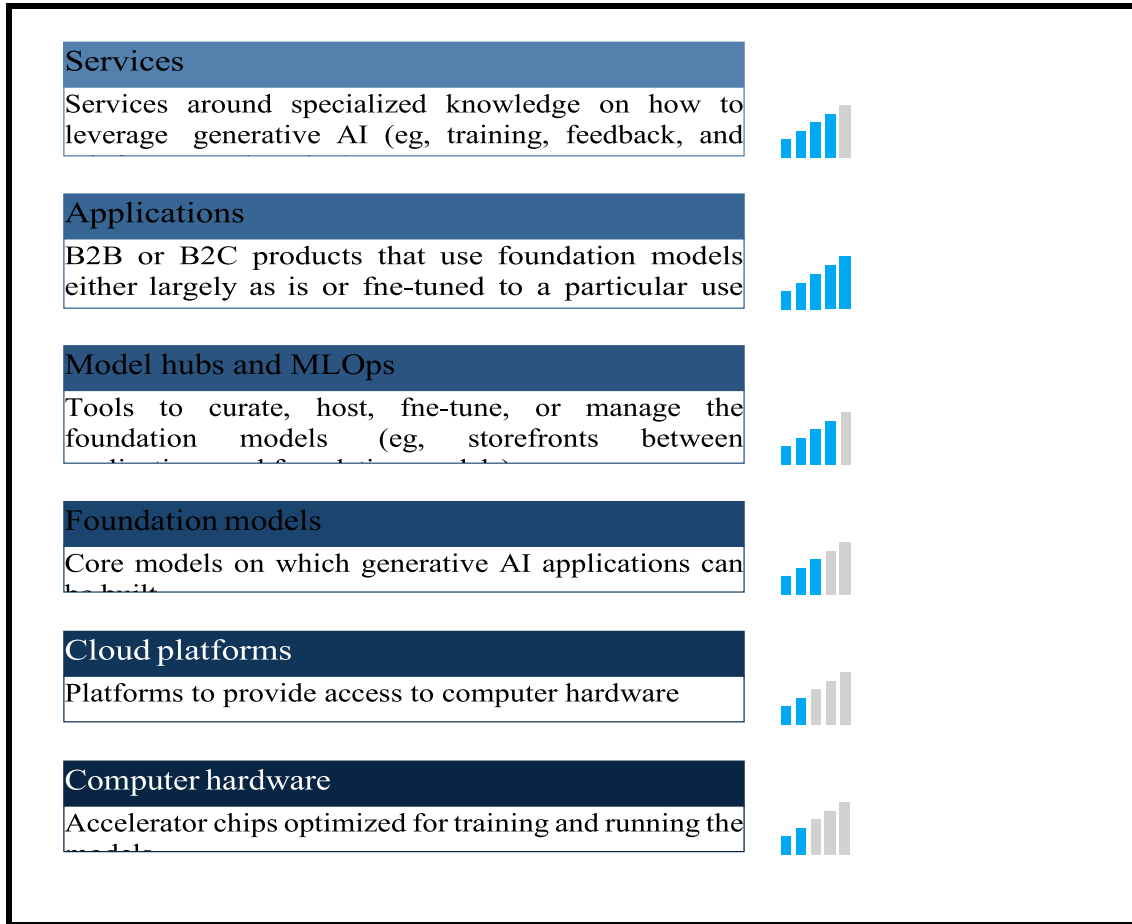
An authoritative view on the application potential of Generative AI, with specific focus on ChatGPT, is provided by a recent McKinsey Report (Mc Kinsey, 2023). This report was among the first being released by an independent source on the subject, and precedes similar reports issued from Gartner⁹ and Price, Waterhouse and Coopers¹⁰. It distinguishes six main value chains:

Figure 1. the Generative AI value chain according to McKinsey, 2023

Exhibit 1
There are opportunities across the generative AI value chain, but the most significant is building end-user applications.
Generative AI value chain
Opportunity size for new entrants in next 3–5 years, scale of 1–5

⁹ See: GARTNER® RESEARCH REPORT, Decoding Generative AI for Customer Service, 24 May 2023, <https://www.freshworks.com/lp/generative-ai-customer-service/>

¹⁰ See: Artificial Intelligence everywhere: AI isn't just a new set of tools. It's the new world. From automation to augmentation and beyond, AI is already starting to change everything., <https://www.pwc.com/gx/en/issues/data-and-analytics/artificial-intelligence.html> PWC choose to provide a site and a forum, continuously updated, which also provides and introduces a set of sector reports.



In view of the aims of this report, we wish to focus especially on the Application range which the McKinsey Report overviews in the following chapter, which is also emphasized on the own native topmost didascaly to the figure above, i.e., **building end-user applications**. In that respect, an overview of application categories is provided by the following figure:

Figure 2 - The end-user application range according to the McKinsey Report, 2023

Modality, Application, Example use cases		
Text	Content writing	<ul style="list-style-type: none"> Marketing: creating personalized emails and posts Talent: drafting interview questions, job descriptions
	Chatbots or assistants	<ul style="list-style-type: none"> Customer service: using chatbots to boost conversion on websites
	Search	<ul style="list-style-type: none"> Making more natural web search Corporate knowledge: enhancing internal search tools
	Analysis and synthesis	<ul style="list-style-type: none"> Sales: analyzing customer interactions to extract insights Risk and legal: summarizing regulatory documents
Code	Code generation	<ul style="list-style-type: none"> IT: accelerating application development and quality with automatic code recommendations
	Application prototype and design	<ul style="list-style-type: none"> IT: quickly generating user interface designs

	Image	Data set generation	<ul style="list-style-type: none"> Generating synthetic data sets to improve AI models quality
		Stock image generator	<ul style="list-style-type: none"> Marketing and sales: generating unique media
	Audio	Image editor	<ul style="list-style-type: none"> Marketing and sales: personalizing content quickly
		Text to voice generation	<ul style="list-style-type: none"> Trainings: creating educational voiceover
		Sound creation	<ul style="list-style-type: none"> Entertainment: making custom sounds without copyright violations
	3-D or other	Audio editing	<ul style="list-style-type: none"> Entertainment: editing podcast in post without having to rerecord
		3-D object generation	<ul style="list-style-type: none"> Video games: writing scenes, characters Digital representation: creating interior-design mockups and virtual staging for architecture design
	Video	Product design and discovery	<ul style="list-style-type: none"> Manufacturing: optimizing material design Drug discovery: accelerating R&D process
		Video creation	<ul style="list-style-type: none"> Entertainment: generating short-form videos for TikTok Training or learning: creating video lessons or corporate presentations using AI avatars
		Video editing	<ul style="list-style-type: none"> Entertainment: shortening videos for social media E-commerce: adding personalization to generic videos Entertainment: removing background images and background noise in post

Note: This list is not exhaustive.

We wish to further focus somewhat on the two topmost categories emphasized in this survey, both because they appear to provide most of the outcome generated using Chatbots, and because to each one of these two categories we will dedicate a case study in the following chapters 7 and 8. The first area, Text, is split into four more specific sub-areas:

- **Content writing** is authorship in the broadest possible sense, and the figure itself in turn emphasizes two key application areas, i.e., marketing and talent scouting. We shall overview later, in Chapter 7, what professional writers deem of ChatGPT as a personal assistant to writing, and epitomize our own view based on a full scope case study.
- **Chatbots or assistants**, indeed another key area of application, both in terms of productivity and overall income, and because of the many ethical issues involved, we will also survey specifically in chapters 7 and 8.

- **Search** applications on the web also appear topmost. Using an AI based chatbot such as ChatGPT is useful in many ways, especially because, based on your own enquiry, it can specify a range of further inquiries you should perform to the benefit of your own survey.
- **Analysis** and **Synthesis** reporting, another sub-domain the authors of the McKinsey report are emphasizing, is the broad domain of professional business analysts. This very report testifies the productivity increases it may guarantee, a 25 pages report which was assembled in less of a couple of weeks of work with the use of ChatGPT 3.5 as a Chatbot assistant.

The other application area which concerns us most is Code, to which we dedicate an extensive case study in Chapter 3. The report distinguishes among:

- **Code generation** proper, the most straightforward and broad application range. ChatGPT is able to generate computer code from a simple inquiry in natural language which may perhaps just refer to a broad application category by a keyword or a set of keywords, then stepwise refine the code itself according to a set of successive user remarks. Experience shows that usually a triple iteration is enough to converge into a satisfactory product. As each code generation step just takes a few seconds, one may estimate that what would take a full person-month of work might be performed now by means of a few hours' inquiry. Our own 2012 study on a sample protection system model (Stefanini, Rossi , & Ceresoli , 2014) was replicated on ChatGPT in just one week work.
- **Application prototype and design.** Indeed, use of Chatbot assistants provides an incredible productivity increase in the generation of credible mock-ups¹¹ of an own application, and again a triple iteration is in most cases enough to converge into a final prototype.
- **Data set generation.** The area concerns synthetic data, i.e., artificially generated data sets, rather than produced by real-world events. Synthetic data can be deployed to validate mathematical models and to train machine learning models, included Generative AI¹². The web of the future is another key application area for data set generation broad range of application.

6. A CASE STUDY ON CREATIVE WRITING

The case study has explored the possible improvement of human productivity as far as narration is concerned, for both work and leisure purposes. The study concerned the creation of a new story under the guidance of an AI Assistant able to suggest valuable alternatives at major focus points of narration, based on all memorized and digested literature. The purpose of the study was twofold:

- To investigate the potential improvements in the productivity of narration. To this purpose, the study int produce a new story starting from a previous one published by one of the investigators.

¹¹ 'A mock-up is a scale or full-size model of a design or device, used for teaching, demonstration, design evaluation, promotion, and other purposes. A mockup may be a prototype if it provides at least part of the functionality of a system and enables testing of a design' (from [Mockup - Wikipedia](#)).

¹² 'Data generated by a computer simulation can be seen as synthetic data. This encompasses most applications of physical modeling, such as music synthesizers or flight simulators. The output of such systems approximates the real thing but is fully algorithmically generated' (from: [Synthetic data - Wikipedia](#)).

- To assess this productivity by comparing two different tools for writing guidance: ChatGPT and Dramatica¹³, a theory of narration and literary presentation. The associated software drives users through the writing process by giving a step-by-step guide that focuses on plot and theme creation as well as story structure.

The investigators experimented with innovative AI quite extensively. AI based assistants may often respond to user inquiries with fake, imprecise, biased and flurry outcomes. This is an issue which cannot be circumvented, and it is let to human evaluators to fix and correct these flaws by making more precise inquiries and correcting the outcome appropriately¹⁴.

6.1. Significant challenges

The case study highlighted the following significant challenges worth mentioning:

1. AI based assistants may often respond to user inquiries with fake, imprecise, biased and flurry outcomes. This is an issue which cannot be circumvented, and it is let to human evaluators to fix and correct these flaws by making more precise inquiries and correcting the outcome appropriately ([AI deep fakes, mistakes, and biases may be unavoidable, but controllable | Computerworld](#))
2. To some extent this also affects creative writing on Sci-fi scenarios, which must be based on solid scientific reckoning and plausible anticipation of future mankind evolution.
3. The measure of efficiency, in particular in terms of time required to compose a story, necessarily requires a term of comparison, similar in length and style, as it is easier and faster to write badly than well, and it is easier to write a simple example rather than a meaningful and interesting story.
While, on the other hand, it is easier to write only for the style without composing a meaningful and interesting story.
4. It is difficult to ascertain to which extent a novel generated with the assistance of an AI may compare to its model, the original it takes inspiration from. Structural analysis, psychology and philology may help, but are still far away from having a proper methodology.

6.2. Comparison with existing or historical efforts

The impact of Generative Intelligence and Open AI on the literary world could not have been broader, not to say heavier. Projects about their exploitation are almost innumerable and encompass all fields of industry and services. In the field of narrative, all major reviews and plenty of newspapers discuss the prospects of humanity with the rise of Generative Intelligence to show both the impressive benefits and the huge risk it may carry on. Literary reviews discuss the impact of this new technology on many facets, economic, political, legal, risks and regulation etc. In that realm, it is almost inevitable that many projects are using generative AI on a myriad of purposes, certainly co-generation of text with a human author among them is a big strand. Among them a

¹³ Dramatica is a whole new theory of Story, although its theoretical base is a derivative of formalism and structuralism. It offers a structuring grid to point out Characters, Plot, and Theme and made tangible the Story Mind, so that an audience can see them and learn.

¹⁴ See: [AI deep fakes, mistakes, and biases may be unavoidable, but controllable | Computerworld](#). The lack of reliability of some GPT-3 responses is often termed 'hallucination', meaning that the generated content is nonsensical or unfaithful to the provided source content. Hallucination was shown to be a statistically inevitable byproduct of any imperfect generative model that is trained to maximize training likelihood, such as GPT-3. To some extent this also affects creative writing on Sci-fi scenarios - such as the subject of the case study is - which must be based on solid scientific reckoning and plausible anticipation of future mankind evolution.

well-known American literary review, the *New Yorker*¹⁵, seems to have a special place: in recent times, their journalists discussed:

- A new wave of artificial-intelligence startups is trying to “scale language” by automating the work of writing (Kyle Chayka, July 11)
- My A.I. Writing Robot (Kyle Chaya, July 11)
- Whether should we and can we put the brakes on artificial intelligence (June 2, 2023)
- An A.I.-Generated Film Depicts Human Loneliness, in “Thank You for Not Answering” (May 26)
- Will AI become the new McKinsey? (Ted Chiang, May 4)
- The Computers Are Getting Better at Writing? (Stephen Marche, April 30)

Both Chayka and Marche touch the relationship by AI and humans, as far as literary arts, creative writing especially, are concerned, sustaining quite opposite views: according to Marche, AI proposed verses rival to those of Coleridge; according to Chayka, aside showing impressive performance, “AI is ... plagued by factual errors and banalities”. One major objective of the study was to measure the time savings it may grant to a human author, but to make this comparison fair it is necessary that the two sources, the literary production of Bruno Riccò (2021), and the one concocted by Bruno Riccò and ChatGPT, cannot be sorted out. But which way two literary productions can be sorted out? Basically, a novel is made of a plot, some characters, their dialogues, and the description of the ambiance they act and speak. According to our experience, upon plot and characters the author either decides or comes to an agreement upon to ChatGPT proposals; thence no more than language may distinguish the original from the AI artifact. And indeed, language has been since a longtime the key field of analysis of Philology, the discipline who studies language in oral and written historical sources, combining textual criticism, literary criticism, history, and linguistics with strong ties to etymology. Philology was instrumental in discovering many fakes, among the most known episodes let us quote:

- The *Donation of Constantine*, a forged Roman imperial decree by which the 4th-century emperor Constantine the Great supposedly transferred authority over Rome and the western part of the Roman Empire to the Pope. Lorenzo Valla, a Renaissance humanist, first attested the forgery with solid philological arguments in 1439–1440¹⁶
- Hermann Dessau, a German XIX century historian and epigrapher uncovered reasons to believe that the *Historia Augusta*, quite our only source on the climateric III century AD, had been written by a single author in the late IV century, instead of the six who allegedly signed it in the early IV century¹⁷. His book opened a controversy which is not yet fully sedated among many believers in Dessau’s arguments and a few unreduced supporters of the originally claimed authorship.

The quantity of fakes discovered by philologists may perhaps overcome the authentic books that make our literary heritage; quite recently, for instance, the historian and philologist Luciano Canfora made a big fuss in Turin and in the whole of Italy, by claiming that the *Papiro d’Artemidoro* bought by the Egyptian Museum in Turin is actually a fake composed in the XIX century by a genial Egyptian forger¹⁸.

¹⁵ See: [The New Yorker November 27, 2023 | The New Yorker](#)

¹⁶ Wikipedia provides an equilibrated view on this famous false ([Donation of Constantine - Wikipedia](#)).

¹⁷ Refer to Wikipedia for a glance on a philological debate that keeps animated after more than a century ([Hermann Dessau - Wikipedia](#)).

¹⁸ Again, one may refer to Wikipedia for a brief report on this debate (https://fr.wikipedia.org/wiki/Papyrus_d%27Artemidore).

6.3. Two sample dialogues with ChatGPT

Here follow two sample dialogues between ourselves and Chat GPT:

Table 1. Structuring Hypotheses

<p>WE: Consider the book Naufragio con vista: a dystopia where two different worlds are put in front. One is regulated by AI, the other left to itself regressed to anarchy and almost belluine life. It's an open book where a naufragus from the second world visits the first then leaves unsatisfied. We are interested in exploring alternative developments or follow ups to this novel and asked me to do a first inquiry</p>
<p>ChatGPT: "Naufragio con vista: un'ipotesi sul future" by Bruno Ricco is indeed a dystopian novel exploring contrasting worlds regulated by AI and one left in a state of anarchy. It's intriguing that the author is interested in exploring alternative developments or follow-ups to this novel. Here are a few suggestions for potential directions or inquiries the author might consider:</p> <ul style="list-style-type: none"> • The aftermath of the protagonist's visit: The author could delve into the consequences of the naufragus' visit to the regulated world. How does their experience and perspective impact their own world? Does it lead to change or resistance against the existing order? • Exploring the origins of the AI-regulated world: The author could delve into the backstory of how the AI-controlled world came into existence. What were the motivations and intentions behind its creation? How did it evolve and gain control? This could provide insights into the larger context and explore the ethical implications of such a system. • Exploring other unregulated worlds: The author could introduce other unregulated or anarchy-stricken worlds and explore their unique characteristics and challenges. This could expand the scope of the narrative and highlight different aspects of the human condition in various dystopian settings. • The role of technology and AI in the anarchy-stricken world: While the AI-regulated world is depicted as orderly, the anarchy-stricken world could showcase the consequences of a lack of control and the struggle for survival. The author could further explore the role of technology, its potential for exploitation, and the complexities of human relationships within this context. • These are just a few starting points to consider for exploring alternative developments or follow-ups to "Naufragio con vista"

Table 2. Ideological Conflicts

<p>WE: Meanwhile also assume that ideological conflicts arose in the mayhem</p>
<p>GPT: Certainly! Building upon the assumption of wars, epidemics, and the socio-political climate in Asia and the Middle East, let's explore how ideological conflicts emerged amidst the mayhem</p> <ul style="list-style-type: none"> • Ideological Divisions: Portray the emergence of ideological conflicts in the wake of the devastation. Different groups and factions could have varying visions for rebuilding society, each advocating for distinct ideologies or principles. • Reconstruction Movements: Introduce ideological movements or factions that seek to shape the post-crisis world. These groups may have conflicting approaches to governance, societal structure, and the role of AI. Some may advocate for decentralized systems, while others may argue for centralization s to prevent future catastrophes. • Ethical Dilemmas: Explore the ethical dilemmas that arise when considering the use of AI in rebuilding society. Delve into the debates surrounding individual liberties, privacy, and the potential for abuse of power. • Political Alliances and Power Struggles: Illustrate how ideological conflicts led to the formation of political alliances and power struggles. Different groups may forge alliances based on shared ideologies or tactical considerations, leading to shifting dynamics and rivalries.

6.4. Main findings of the study

The study tried to evaluate three facets of AI contribution to creative writing:

- Its potential to contribute new developments to a given story.
- Its capability to produce narratives, e.g., description of scenery, dialogues etc.
- Its capability to rewrite stories according to specific styles prescribed by the human authors.

The study was aimed at framing up the impact of the innovation and establish a way to assess it both in a qualitative and quantitative way. As for the quantitative assessment, the study produced the “sequel” of an existing novel (published by one of contributors to the case study, Bruno Riccò (2021). According to Bruno, the novel was written three years ago in a period of ten weeks, while its sequel took approximately four weeks.

The above examples show how productive the generative AI might be in structuring narrative hypotheses and suggesting valuable development alternatives. Concerning the development of the narrative proper, the tool is quite productive as far as scenarios, plot and expansion are concerned. Far less when outlining the main characters of the narrative.

The tool also cannot easily keep consistency in between different chapters of the story and may generate absurd repetition of the same concepts and situations as well as contradictions with previously laid down chapters.

7. A CASE STUDY ON CODE GENERATION

The study addressed the risks and challenges posed by large language models (LLMs) incorporated by generative AI into software production. Focusing on industrial automation, the project tried to evaluate the impact of LLMs on the correctness and security of self-produced code via LLM. Its ambition was to verify the code generated by ChatGPT and analyze its limits, thus creating trust in generative artificial intelligence. While LLMs offer huge productivity benefits, there is no guarantee that the generated code is correct and complies with certain requirements, leading to potentially insecure software. The aim was to establish an approach to code verification, based on an integrated test environment. By testing the correctness and security of the generated code, one can ensure that the application conforms to given user requirements and established standards.

7.1. Reference market & strategic objectives

The study focused on compliance testing of LLM-generated code with correctness and security requirements in the field of industrial automation. This business is presently under pressure, especially in safety-critical sectors, as new security standards are introduced, and systems need be revised if not redesigned anew. This was recognized since the establishment of the Common Criteria for Information Security, formalized as the ISO/IEC 15408. Key standards as the NERC CIP for power systems security, the IEC 62443 for automation security and the IEC 61508 for safety are becoming more and more relevant and compliance of automation and control software is nowadays a critical issue.

The intended target of the study outcome includes automation companies and their customers. The global automation market was estimated to amount to 175 billion US\$ in 2020, expected to grow at 224 billion US\$, 2023. Many resources estimate the security related segment of this market to amount to about 15-20% of the total.

7.2. Operational outline

The problem addressed by the study case is the verification of the code generated by LLM, a focal problem for the acceptance of such tools as code generators, especially in safety-critical sectors such as industrial automation/control, telecommunications, or finance. The verification focuses on the correctness of the code, but also on compliance with specific security requirements. Use cases will address a narrow set of selected problems to solve. In this context, verification of the generated code is performed by developing its natural language description into a formal model based on the NuSMV prover theorem. This software helps to demonstrate whether the model complies with any of the requirements. In most cases the produced code, which is executable, can be implemented directly on the intended platform as such. When direct proof via a theorem prover is not feasible or practical due to performance or resource limitations, an alternative approach is to develop with the same technique code in another programming language intended for operational use. Verification of the latter code against the original requirements can be performed by applying model-based testing techniques that allow to generate a set of test cases and the corresponding software test oracle¹⁹, which verifies various desired functionalities of the program.

Figure 3. A ChatGPT generated model of an overcurrent protection

1. Measure the current flowing through the circuit using a current sensor.
 2. Compare the measured current to the trip settings to determine if an overcurrent condition exists.
 3. If an overcurrent condition exists, initiate a trip signal to interrupt the current flow and prevent damage to the system.
 4. Optionally, initiate an alarm signal to alert operators to the overcurrent condition.
 5. Update the status signal to reflect the current state of the protection system.
 6. Wait for a reset command to reset the protection system.
 7. If a reset command is received, reset the trip signal and update the status signal to indicate that the protection system is ready for normal operation.
- This logical model is a simplified representation of an overcurrent protection system and does not take into account all possible variations and complexities of such systems. However, it outlines the basic steps and inputs/outputs involved in an overcurrent protection system.

Note: This protection is used to protect electrical systems from damage caused by overcurrents or short circuits. It works by detecting when the electrical current flowing through a circuit exceeds a safe level, and then interrupting the flow of current to prevent damage to the system.

¹⁹ It is important to note that the effectiveness of a test oracle depends on its accuracy and completeness. Designing a reliable test oracle is a challenging task and requires application domain expertise and in-depth analysis. Additionally, test oracles must be regularly updated and maintained to align with any changes to the requirements or expected behavior of the code.

Figure 4 - The ChatGPT generated code of a simple control algorithm

```

// AUTHOR'S NOTE: What follows between the symbols /* and */ is the code
// generated by ChatGPT,
// which however is incorrect as not only does it not use fuzzy sets,
// but it does not even produce the expected result.
/* // Calculate the output value using fuzzy logic
   if (diff < 0) {
       // Use NL, NM, and NS linguistic variables
       if (diff <= -2) {
           Out = OutMax;
       } else if (diff > -2 && diff <= -1) {
           Out = ((-1) * (diff + 1) * (OutMax - OutMin) / 2) + OutMax;
       } else if (diff > -1 && diff < 0) {
           Out = ((-1) * (diff - 1) * (OutMax - OutMin) / 2) + OutMin;
       }
   } else {
       // Use PS, PM, and PL linguistic variables
       if (diff >= 2) {
           Out = OutMax;
       } else if (diff < 2 && diff >= 1) {
           Out = ((diff - 1) * (OutMax - OutMin) / 2) + OutMin;
       } else if (diff < 1 && diff >= 0) {
           Out = ((diff + 1) * (OutMax - OutMin) / 2) + OutMax;
       }
   }
*/ // AUTHOR'S

```

Note: The tool was required to generate a C code receiving two input variables ranging from two user defined values, calculating their product, and making the difference of the values obtained in two successive instants.

7.3. Chat GPT as a co-designer

It is often enough to hint or simply mention a control problem at hand to obtain a fully specified model. Although it may create in the first instance a model not fully compliant with the human designer intentions, one should note how much this capability may reduce human workload, as it is usually enough to review once or twice the Chat GPT suggestion to obtain the desired model.

ChatGPT usually provides **critical remarks** on its own models, such as:

- Example 1 (on a finite state model of the overcurrent protection): ‘This absence of a direct transition from Normal to Fault is by design, as the model assumes that the Fault state can only be reached after passing through the Alarm state (...) therefore, based on the defined state transitions, it is indeed impossible to have a direct transition from the Normal state to the Fault state in this FSA model.
- Example 2: On the control algorithm: ‘Fuzzy logic is a complex topic and requires a deep understanding of the domain to create an efficient algorithm. However, I can provide you with a sample code that will give you an idea of how to implement a fuzzy logic-based algorithm in C’.

The AI warns the designer that it is providing a deliberately simplified model, which may not fully comply with his/her initial intentions.

8. CONCLUSION

The rise of Generative AI and Chat GPT, epitomized by models like GPT-3, is a significant technological development that carries implications far beyond the confines of computer science. This essay has explored recurrent themes related to the socio-economic impact, changes in daily life, and shifts in working habits that have been spurred by these advancements.

The socio-economic impact of Generative AI has led to both excitement and concern. While automation can increase efficiency and reduce costs, it also raises the specter of job displacement in certain sectors. Moreover, the creative potential of AI models has the potential to revolutionize industries related to content creation and marketing. In our daily lives, we have witnessed the integration of Chat GPT models into virtual assistants and recommendation systems, transforming the way we interact with technology and experience personalization. However, these advancements also pose challenges related to misinformation and ethical concerns. Working habits have evolved as a result of Generative AI, with remote work and collaboration tools becoming central in the post-pandemic world. Upskilling and adapting to the AI-driven workplace are now essential, and the world economy is expanding due to the entrepreneurial opportunities presented by AI.

In conclusion, the rise of Generative AI and Chat GPT models has not only revolutionized industries and our daily interactions but also reshaped the nature of work itself. The case studies briefly overviewed the considerable impact that this technology may have on human productivity on two very diverse economic sectors, creative writing and software design and production, while outlining the risks the innovation involves. The challenge ahead is to harness these technologies for the betterment of society, ensuring that their potential is maximized while addressing the ethical and social considerations that arise in this transformative era.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to Elenio Dursi and Lorenzo Vandoni for their valuable comments on an early version of this paper. Their insights and feedback contributed to shaping the final content.

Special thanks to Bruno Riccò for both inspiring and significantly contributing to the case study on creative writing, enriching the depth and breadth of the research.

I extend my appreciation to Ugo Finardi, Elena Ragazzi, and the editorial team of CNR-IRCrES for their thorough and comprehensive review of the second draft of the paper. Their meticulous attention and constructive suggestions have been instrumental in restructuring the paper and refining the quality of the content.

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The paper aims at outlining the impact of generative transformational Artificial Intelligence from a profane viewpoint and its potential and current socio-economic impact, with emphasis on the Italian landscape. To that end, it begins with a review of the way the technology was received in Italy by the general public and by linguistic specialists. Then it provides an overview on recent developments of Artificial Intelligence and a compilation of books and sources that discuss artificial intelligence, natural language processing, and the development of generative AI. A survey of potential and current application of the technology is provided and two case studies concerning generation of narrative and of computer codes are discussed. The whole paper is structured in such a way as to give a view of the main expected impacts and risks of this emerging technology to a public of economists.