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The Role and Future of Artificial General Intelligence (AGI)

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Abstract: Artificial General Intelligence (AGI) is an area of artificial intelligence research that aspires to create machines that can perform any intellectual task that a human can do. Unlike Artificial Narrow Intelligence (ANI), which is domain-specific, AGI seeks to replicate human-like adaptability, reasoning, and creativity. This paper provides a critical overview of the historical development of AGI, evaluates ongoing projects and initiatives, examines its potential applications across multiple sectors, and discusses associated ethical and governance challenges. The study identifies technological and societal gaps, highlights risks, and proposes a phased roadmap toward the development of AGI. The analysis emphasizes the importance of integrating ethical frameworks, interdisciplinary collaboration, and responsible innovation in shaping the AGI path.

Keywords: *AI, Artificial, Intelligence.*

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I. INTRODUCTION

Artificial General Intelligence (AGI) is the apex of modern-day Artificial Intelligence (AI) that is predicted to represent the ability of a machine to understand and learn any intellectual task that a human can do. AGI differs from a narrow AI that is created to solve a specific task in a narrow domain. The major technological advancements in narrow AI that have been recorded include the development of chatbots, voice recognition systems, image recognition systems, recommendation algorithms, autonomous vehicles, and predictive maintenance. However, the concept of AGI is mostly theoretical and therefore the focus of much research and debate. The goal is to have a machine that can do vast amount of work in different domains like playing chess, cooking meals, understanding a new language, responding to external stimulus in its environment, and solving complex tasks without the need for reprogramming for each new task.

Imagine an autonomous vehicle that can drive a passenger from an airport through a shortage route to a hotel accommodation, and while on transit it provides information on the culture and geography of the area. Additionally, it suggests a best restaurant based on a passenger interest and popularity. Similarly, it can be able to remember the previous conversation with the passenger if any to recommend the experience they enjoyed on a previous trip.

It is no doubt that achieving the above level of intelligence requires great effort that requires integration of sophisticated machines and deep learning algorithms, natural language processing (NPL), and cognitive science.

II. HISTORICAL CONCEPT

The birth of AGI from a broader Artificial Narrow Intelligence (ANI) or simply Artificial Intelligence (AI) is a journey defined by notable breakthroughs, paradigm upheavals, and persistent problems [1]. One of the famous works can be traced around 1950s by inventors like Alan Turing, who created the theoretical framework for machine intelligence. This breakthrough has led to the development of Turing Test as a criterion for testing the machine's ability to exhibit intelligent behavior equivalent to that of a human. This was followed by a notable Dartmouth Conference in 1956, where the term" Artificial Intelligence" was officially adopted [2].

The period that witnessed a remarkable rise in the Expert system development was between 1970s - 1980s. This period witnessed the development of rules-based systems that replicate human expert judgments, especially in the field of medicine and language translation. However, the systems cannot work when deployed to different domain.

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The emergence of data-driven techniques instead of rules- based systems using machine learning approach was a remarkable breakthrough in the late 2000s. Several machine learning techniques such as Logistic Regression, Support Vector Machine, Decision Trees, and Artificial Neural Networks have been the subject of research. Within that period, lots of remarkable achievements in the area of Natural Language Processing (NLP), image recognition, and voice recognition have been recorded. Nevertheless, the path to AGI remains cloudy as the applications only specialize in solving tasks in a specific domain.

The realization of AGI is becoming promising especially with the major breakthrough in the area of Deep learning. The advances in Convolutional neural network models (CNNs) [3] and recurrent neural networks (RNNs) [4] continued to give hopes for the journey that seeks to develop a multi-task and self-control AGI.

The aforementioned technological developments have affirm the possibility of achieving human-level intelligence by a machine, but at the expense of solving numerous technological and algorithmic challenges. These include hardware constraints and algorithmic intricacies, which require innovative solutions and breakthroughs. [1]

III. EXISTING AGI PROJECTS AND INITIATIVES

As AGI continues to evolve, it has the potential to revolutionize various industries and significantly impact human life [5]. In this regard, several projects worldwide are actively pursuing the development of AGI. The 2020 survey by the Global Catastrophic Risk Institute [6] identified 72 active AGI projects spread across 37 countries. This updates the 2017 survey, which identified 45 projects in 30 countries. In 2025, no comprehensive publicly available survey has updated these figures in 2020 survey. Therefore, the number of active AGI projects is expected to grow considering the global interest in AGI systems.

Notable organizations have set different goals on AGI systems for example OpenAI aims to develop AGI that benefits all of humanity, Google DeepMind envisions to solve intelligence and use it to address complex global challenges, and Anthropic focuses on building reliable and steerable AI systems with an emphasis on safety.

➢ *The Core AGI*

AGI is based on some fundamental concepts that mimic human cognitive intelligence. These concepts are the corner-stone for the creation of a self-reasoning and self-controlling autonomous AGI system. The Figure 1 shows the fundamental concepts for the core AGI.

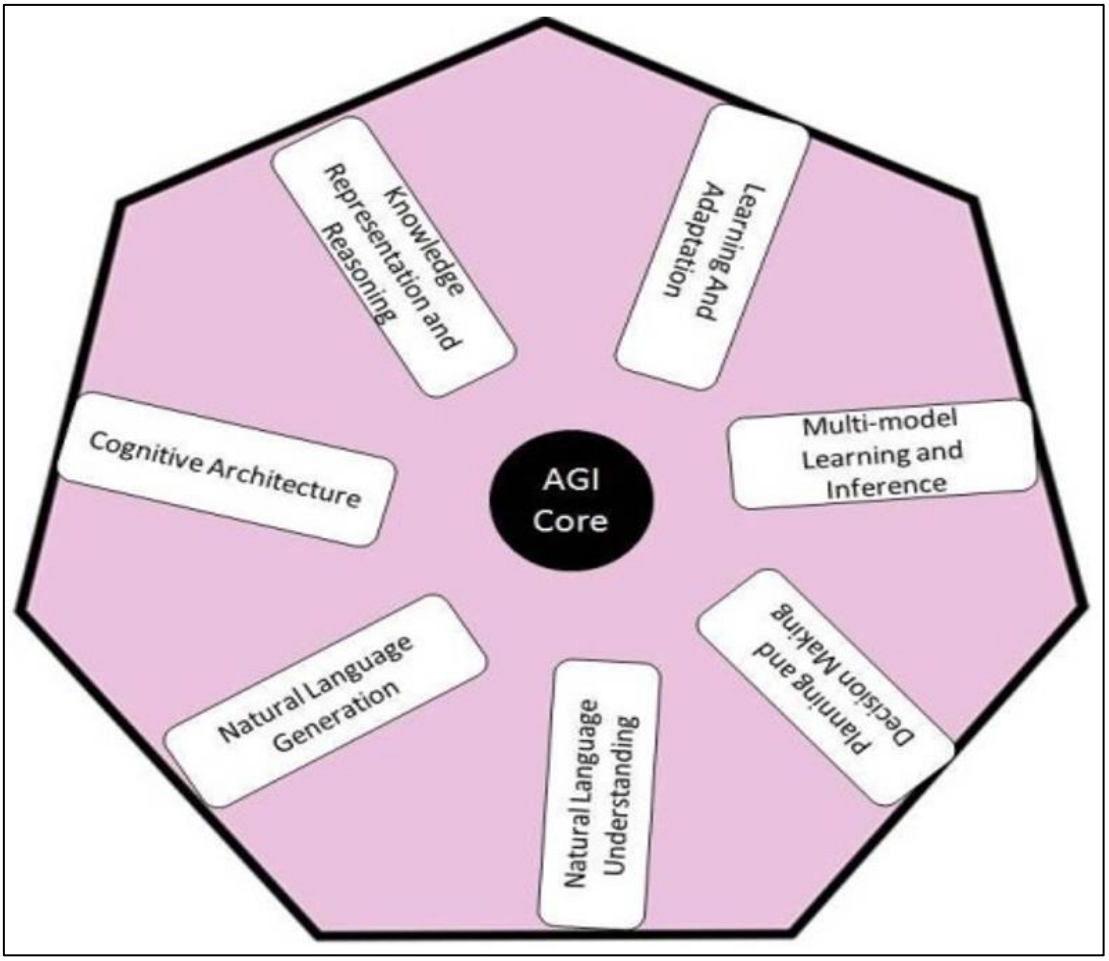

Fig 1 The View of AGI Core.

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AGI system has multifacet roles, but before we delve into these roles, we need to understand what general intelligence meant as agreed by AGI researchers and psychologists, based on a review of AI and literature on psychology [7]. In this regard, general intelligence can be understood by looking at the various *Competencies* that cognitive scientists generally understand humans to display.

- Perception: The sense and understanding of visual, hear-ing, touch information from environment, and the ability of integrating multi-modal information from various senses.
- Actuation: The ability to manipulate physical objects, using tools, and navigation in complex environments.
- Memory: The memory regarding facts or beliefs, the outcome of sequential/parallel combinations of actions, and experience attributed to a particular instance.
- Learning: The ability to learn from teachers, other observed agents, media, experimentation, and positive or negative reinforcement signals in the environment.
- Reasoning: The ability of deduction, induction, and abduction. The ability of reasoning from observed premises, physical rules and spatio-temporal associations.
- Planning: The ability of conducting strategical, physical, and social planning.
- Motivation: The ability of creating sub-goals based on the pre-programmed goals, or driven by curiosity, emotions, empathy, and altruism.
- Emotion: The ability of expressing emotion, as well as perceiving or interpreting emotion.
- Interaction: The ability to initiate communication and organize group activities, with appropriate behavior. The communication could be achieved through verbal, gestural, pictorial or even cross-modal signals.
- Quantitative: The ability to comprehend and articulate mathematical concepts, solve mathematical problems, and apply quantitative reasoning to solve problems that demand mathematical thinking and model-building skills.
- Creation: The ability to build and modify physical objects, assemble and organize social groups, and form novel concepts

➢ *Challenges*

The achievement of human intelligence appears to be promising, but great efforts are needed to address techno-logical and computational challenges. The current state of hardware capabilities limits the rapid development of AGI. There is a need for an advancement in the computational power of the machine by a factor of at least a trillion computations per second [8]. Another challenge to address is to ensure that AGI systems are designed in accordance with human values and ethical principles.

IV. THE ROLES OF AGI

Despite the fact that recent developments in AGI are mostly theoretical, but considering the significant progress in the path to achieve full autonomous AGI systems, AGI systems have the potential to revolutionize various domains [9]. So, we will look at the role of AGI in respect to different field as follows:

➢ *Health*

The health sector is one of the most explored sectors with AGI-like systems. Several achievements have been recorded especially in narrow AI. Moreover, AGI systems have more capabilities to revolutionized health care system and benefit millions of patients globally. Some of the significant contribu- tions of AGI include:

- Smart Hospital Assistant (SHA) [10]: A voice- controlled virtual assistant designed to enhance surgical efficiency and patient safety. It can reduce operating time, optimize surgical staff resources, and decrease the number of major touch-points that can lead to surgical site infections.
- An Artificial Intelligence (AGI) technique in mobile computing for health care: [11]. This is a novel AGI smart hospital plat-form architecture designed for stroke prediction and emergencies. Causal-Associational Network (CASNET) model: A CASNET model consists of three main components: observations of a patient, pathophysiological states, and disease classifications. As observations are recorded, they are associated with the appropriate states. The model maintains a database for collaborators around the world for the diagnosis and treatment of the glaucomas.
- Insilico medicine: A drug development platform to tackle age-related illnesses, including cancer.
- Biofourmis: It creates wearable devices with sensors to enhance patient monitoring and care
- Immunai: An AGI that uses AI to map the human immune system
- Cancer Diagnosis [12]: Several research have been con-ducted using Machine learning algorithm that recognize patterns from large-scale dataset and thus be use for early identification of genomic variants and abnormal protein communications.

➢ *Education*

One of the areas in which AGI systems play a vital role is the educational sector. Educators and researchers continue to explore the possibilities that AGI can offer to transform traditional educational practices and create more personalized, practical learning experiences [13].

- *Large Language Models (LLMs):*

The LLMs has shown an impressive ability in natural language processing, generation, and reasoning. Their ability to learn from a large dataset and generate textual, audio, and video translation, summarization, and question answers has indeed revolutionized teaching and learning practice in education. These class of AI falls under Artificial Generative Intelligence (AgI). They are the class of AI that have shown a promising ability to achieve human intelligence level. Many projects have reached a maturity level and have been deployed by educational and non-educational institution worldwide.

✓ ChatGPT-4 [14]: The emergence of Open AI's chatbots like GPT-4 that can understand and process even images,

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and it accepts both text and image prompts has proved the possibility of realizing a full AGI system in near future. This AGI-like tool will undoubtedly improve teachers in lesson planning, especially regarding content knowledge and assessment strategies.

- ✓ Microsoft Copilot [15]: This is a AgI chatbot developed by Microsoft. Based on the GPT-4 series of large language models. Copilot utilizes the Microsoft Prometheus model, built upon OpenAI's GPT-4 foundational large language model, which in turn has been fine-tuned using both supervised and reinforcement learning techniques. This AGI-like transform education by streamlining processes, automating repetitive tasks, and enhancing the teaching and learning experience.
- ✓ Adobe FireFly [16]. This is a visual AgI that offers an array of creative possibilities, enabling the design of visually engaging educational materials and the illustration of complex concepts.

➢ *Manufacturing Industries*

Unlike the conventional AI, the AGI can monitor the entire assembly line. It can detect and locate point of failures and recommend possible maintenance step. It can analyses historical data, predicts failure, and recommend for necessary maintenance. It can predicts design flow before the physical prototype been develop, there by saving time and funds.

- LeewayHertz industrial solution [17]: This is the leading AI manufacturing company that provides AI- based services for manufacturing solutions. Imagine an AGI that integrate the services provided by Manufacturing Execution Software (MES), CRM Solution, Product Planning and Reporting Solution, ERP & MRP Software solution, and Quality Management Systems. This would provide real-time monitoring and control of production process, customer relationship management, product life-cycle management, resources optimization and waste management, and early defect detection in the production process. The realization of this AGI that can provides the above solutions with the need for programming individual task would no doubt brings a breakthrough to the manufacturing industries.
- Siemens [17]: This company provides different narrow AI-based industry solutions including industrial system automation, equipment failure prediction, and supply chain management tools that improve logistics, inventory control, and demand forecasting.

➢ *Financial Institution*

Wealth creation is one of the main goals of AGIs. AGI's ability to process vast historical data entails its ability to create more accurate financial models for risk management and profitable investment strategies. AGI has been the subject of discussion during the last World Economic Forum meeting in January 2024 [18]. During the meeting, it was argued that AGI has the potential to reshape financial services, especially for underbanked and unbanked populations.

- AI-powered mobile banking apps: The AI-powered mo-bile banking apps have significantly improves banking sector by connecting rural and remote communities with banking solutions remotely. This makes banking process simple and accessible by people in remote areas with limited literacy or tech skills.
- Large Language Models (LLMs): The emergence of AGI-like LLMs has remarkably bring changes in businesses. Customer care services is one of the area impacted by this development. It is estimate that several businesses have reported profits by deploying LLMs like ChatGPT, DeepSeek, Microsoft copilot, and Adobe FireFly into their business.

➢ *Crime Management*

AI has become one of the cornerstones for crime prevention not to mentioned of an improved intelligence system AGI, which has rapidly improved the prevention level of crimes. Looking at the increase crime rate in the world, the AGI can helps to make the world safer.

- Forensic Investigation [19]: AGI can analyze different pieces of crimes related evidences and identify the suspect. AGI system can decide on the number of DNA samples sufficiently enough to detect the individual to whom the DNA sample belongs. AGI can also help in detecting where and how the audio or video evidence have been tempered. Similarly, AGI as a principal actor in forensic medicine can be used to determine the cause and manner of death of a person based on the autopsy report.
- ROSS Intelligence [20]: This is an AGI system with a compilation of a set of all legal data that is more skillful than existing attorney professionals. This tool can help legal practitioners in their field to provide legal justice.

➢ *Agriculture*

The agricultural sector is one of the most promising areas for the application of Artificial General Intelligence (AGI). While narrow AI has already contributed to advancements in precision farming, crop monitoring, and predictive analytics, AGI has the potential to fundamentally transform the way food is produced, distributed, and consumed. Unlike conventional AI systems limited to a single task (e.g., crop disease detection), AGI systems can integrate climate data, soil composition, supply chain information, and market trends to provide holistic, adaptive, and sustainable agricultural solutions. This would ensure food security, optimize resource utilization, and support global sustainability goals. Some of the significant contributions of AGI in agriculture include:

- Precision Crop Monitoring and Management: AGI can analyze multi-modal datasets, including satellite imagery, drone surveillance, and soil sensor outputs, to detect crop stress, nutrient deficiencies, and pest infestations in real time. Unlike narrow AI, which is task-specific, AGI can adaptively recommend dynamic interventions such as irrigation schedules, pesticide application, or soil treatment tailored to specific farm conditions [21], [22]
- Autonomous Farm Machinery: AGI-powered autonomous tractors, harvesters, and drones could not only execute pre-programmed tasks, but also make real-time strategic decisions in the field. For instance, a

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harvester could adjust the speed and technique according to crop density, weather, and terrain variability, ensuring maximum efficiency and minimal waste [23]

- Climate-Smart Agriculture: AGI systems can integrate global climate models with localized farm data to predict the impact of climate variability on crop yields. By doing so, they can recommend adaptive strategies such as crop diversification, optimized planting times, or resilient crop varieties, thus safeguarding farmers against climate-related risks [24]
- Livestock Health and Welfare Management: Through multi-sensory monitoring (visual, auditory, thermal, and movement data), AGI can assess the health and welfare of livestock herds. It can detect diseases early, recommend treatment protocols, and even predict the spread of zoonotic diseases, thereby reducing losses and improving food safety standards [25].

➢ *Climate Change and Environmental Management*

By integrating massive datasets from satellites, sensors, and climate models, AGI could design adaptive strategies to mitigate the effects of climate change, predict natural disasters, and optimize energy distribution globally [26].

The role of Artificial General Intelligence is never limited to the above-mentioned sectors but to every field that requires high intellectual performance with human abilities.

V. THE FUTURE OF AGI

The future of AGI remains the most interesting topic of discussion in computing science and philosophy. Considering the developments recorded in narrow AI, the future is inspiring, but extra care must be taken with regard to ethical and safety considerations to avoid colossal damage to societal values. Although some experts have predicted that AGI could develop in the next 5 years (2030), the exact timeline remains unclear. In this study, we foresee the future of AGI in incremental phases.

➢ *Advancement Phase:*

This phase would witness advancements in narrow AI (e.g. ChatGPT, DeepSeek, autonomous driving technologies, Smart Hospital Assistant, ROSS intelligence, and etc.). These improvements would result in better reasoning and adaptable narrow AIs that mimic some cognitive level of intelligence, yet do not attain the prospect of full AGI. We will witness more government interventions to ensure adherence to ethical and safety frameworks.

➢ *Maturity Phase:*

In this phase, an early AGI system can emerge with the breakthrough in computing power, machine learning, and nanobots that connect our brain to the cloud. We might witness AGI that can learn, reason, and apply knowledge in multiple domains without the need to reprogram for each task. we might witness an expanded intelligence that makes the world healthier, smarter, wealthier, and free from biological limitations and finally achieved singularity.

VI. CONCLUSION

The recent rise in the development of narrow AI systems across different domains, coupled with their ubiquitous nature in solving scientific, educational, and financial problems has given confidence in achieving AGI systems in the near fu- ture. This study has reviewed the historical concept of AGI and elaborated on its fundamental concepts. It follows by reviewing the roles of AGI-like systems in the transformation of different domains and the potential roles of future AGI systems. Finally, we explore the road map for the development of future AGI in phases depending on the breakthroughs made in technology, power generation, computer algorithms, ethical, and safety strategy.

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