TEACHING "REALISM" WITH COMPUTATIONAL INTELLIGENCE

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ПРЕПОДАВАНЕ НА „РЕАЛИЗЪМ" С ИЗЧИСЛИТЕЛНА ИНТЕЛЕКТУАЛНОСТ

Abstract

Computational Intelligence refers to concepts, paradigms, algorithms and implementations of systems that are designed to show "intelligent" behavior in complex and challenging environments. Categorization, Abstraction and Algebra are by far the most used triad for the mathematical representation of Realism. Teaching "Realism" along with manipulating the same to adapt the solutions within a given context has now become universal. With Algorithm replacing Algebra in this triad, grounding claim has become a challenge. This report shares some experiences in bridging the obvious gap intelligently using computational models and methods.

Keywords: *Computing; Mathematics; Algorithm; Intelligence; Realism.*

INTRODUCTION

"Realism" in computing is to create digital representations or experiences that closely mimic reality. The digital representations are usually generated using complex algorithms, advanced computing hardware, sensors that reflect the understanding of human perception. The outputs are at their best indistinguishable from the actual world through a combination of photorealistic graphics, physical accuracy, functional equivalence and perceptual immersion. The key aspects of these outputs are the fidelity and utility of synthetics data, the quality of associated computer graphics, simulations based on the choice of parameters that reflect reality, the functionality made of well specified tasks and the quality of the virtual environment to produce the effect of immersion that matches the human perception.

Computational realism or Digital humanities has emerged as a discipline that takes the actual technical function and limitations of software, hardware and sensors to understand the socio-cultural phenomena in a more advanced manner than metaphors, similes and analogies.

Artificial Intelligence offers powerful tools not only for believable creation but also for potent deception. These highly advanced tools blur the line between real and fake, challenging truth perception and necessitating formal teaching to comprehend the capabilities and risks rather than "accept or reject" mode of usage. Artificial Intelligence has evolved way beyond the specific tasks to a human grade of accomplishing them and holding the promise to better than the human. Currently, there are seven types of Artificial Intelligence as in Figure 1. Narrow AI is also called Weak AI and is specific task oriented.

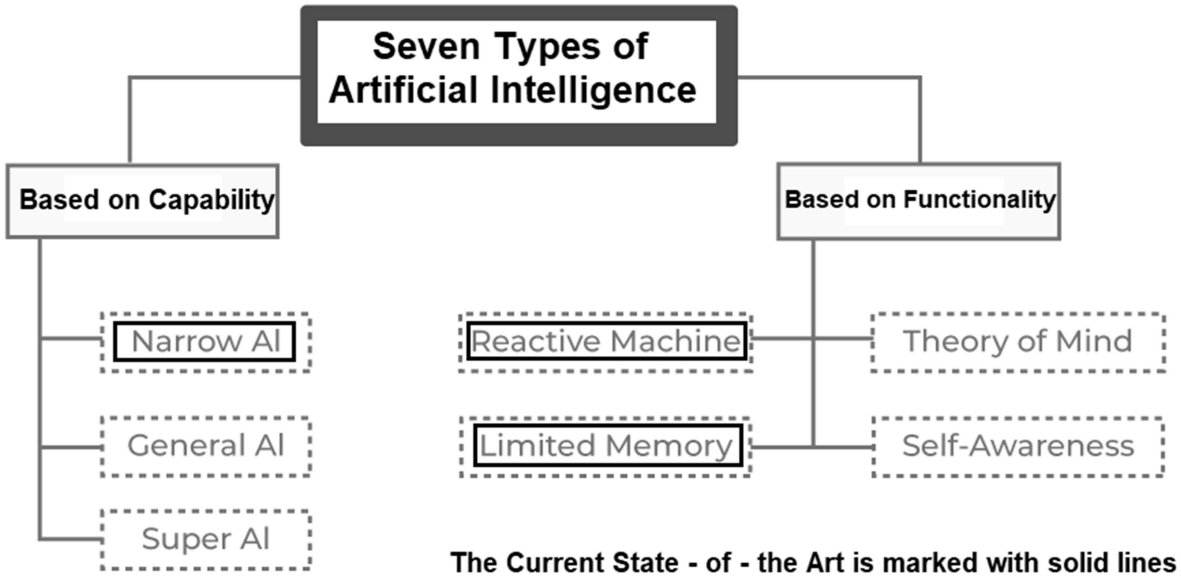

Figure 1: Seven Types of Artificial Intelligence (AI)

The full potential of Artificial Intelligence is a few more decades away. The current state – of – the art has already blurred the fundamental distinction between the synthetic and authentic. It has achieved a "hyper-realistic" baseline significantly exceeding the human sensory detection. A new aesthetic known as "deep reals" has emerged. The reality adopts the "grammar of fakeness". Realism is now fragmented on the lines of pragmatics, responsible and scientific that demand global, legal and ethical frameworks. The current impact of Artificial Intelligence on realism is outlined in Table 1.

Table 1: The Current of Artificial Intelligence (AI)

Feature	Narrow [Weak] AI	General AI
Current Status	Exists today and is used in applications like virtual assistants, recommendation engines, and navigation.	Hypothetical and does not exist. The field of AI is still pursuing this as a long-term goal.
Capability	Performs specific, predetermined tasks with high proficiency but without genuine consciousness or independent learning.	Possesses human-level cognitive abilities across a wide range of tasks, including learning, reasoning, and applying knowledge to new situations.
Implications for Realism	Can simulate realism by executing narrow tasks in a lifelike way. Its performance can seem realistic, but it lacks a deeper, holistic understanding.	Would achieve true realism, as it would have the cognitive abilities to understand the world and adapt to it as a human does.

"The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages" – **Core Definition of Artificial Intelligence (AI), Oxford English Dictionary**

Computational intelligence (CI), a subset of Artificial Intelligence (AI) encompassing machine learning and deep learning. Currently, CI uses algorithms inspired by biological processes, such as neural networks, fuzzy systems, and evolutionary computation, to achieve limited forms of realism. Advanced generative models based on CI can create photorealistic images, videos, and lifelike synthetic voices that are often indistinguishable from the real. These models are highly adaptive to dynamic environments and their performance metrics are

many times unexpectedly high due to massively parallel architectures [1], [2], [3], [4], [5], [6], [7], [8], [9], [10].

The concept of realism in this context can be evaluated on a spectrum, from narrow, task-specific capabilities to the theoretical goal of human-level general intelligence. CI works best in adapting to the complex dynamic environments rather than aiming at emulating the natural intelligence of human beings.

OVERVIEW OF COMPUTATIONAL INTELLIGENCE (CI)

The prominent characteristics of CI are:

- **Adaptation and Learning:** CI systems are designed to learn from data, adapt to new situations, and generalize information to new problems.
- **Nature-Inspired:** Many CI methods are inspired by biological systems, such as the human nervous system [neural networks] and evolutionary processes.
- **Complex and Uncertain Environments:** CI excels at solving problems that are too complex for traditional, "hard" computing methods, especially when dealing with incomplete information, stochastic processes, or unforeseen changes.
- **Flexible Information Processing:** CI aims to create systems that can sense, understand, and process information in a flexible, human-like manner

The core techniques for CI are:

- **Artificial Neural Networks:** Systems inspired by the human brain's structure that learn by processing information and identifying patterns.
- **Fuzzy Logic:** An approach that allows systems to use imprecise or fuzzy concepts, rather than just precise binary logic (0s and 1s), to make decisions.
- **Evolutionary Computation:** Algorithms that mimic biological evolution, using concepts like natural selection to find optimal solutions.
- **Swarm Intelligence:** Techniques inspired by the collective behavior of social animals, allowing for decentralized decision-making and problem-solving.
- **Support Vector Machines [SVMs]:** A machine learning technique used for classification and pattern recognition.
- **Hybrid Systems:** Combining two or more CI techniques [e.g., neural networks, fuzzy logic, and evolutionary algorithms] to create more powerful and robust solutions.

EXPOSITION

CI has a dual relationship with fake news: it is used to both generate sophisticated misinformation (like deepfakes) and to develop powerful detection and mitigation tools. The Generative AI tools that use many aspects of CI generate "Deepfakes" with advanced face-swapping and voice-cloning technologies. They can produce highly realistic fake audio and video content, which can be used to spread hate speech, manipulate political discourse, and harm reputations. 78 Billion Dollars is the damage caused by Misinformation according to a study conducted by the University of Baltimore and CHEQ in 2019. This epidemic of misinformation has only grown exponentially from the start of this decade and is now threatening the human mind's grasp on reality itself. The automatic text generation using Large Language Models [LLMs] and tools for rapid dissemination are making "Deepfakes" a challenging proposition.

CI techniques used for the detection of "Deepfakes" include:

- Machine Learning (ML) and Deep Learning (DL): Support Vector Machines (SVM), Convolutional Neural Networks (CNNs), and Recurrent Neural Networks (RNNs) used to analyze content and identify patterns indicative of fake news.
- Natural Language Processing (NLP): NLP engines are used to analyze news headlines and body text to ascertain semantic meaning and weigh facts based on the authenticity of the source
- Multimodal Data Integration: Data types—text, images, video, and social context are integrated to improve detection accuracy
- Explainable AI (XAI): Methods help make the "black box" decision-making process of AI models more transparent, allowing human experts to understand an provide a rationale to build public trust and provide accountability
- Source Verification and Network Analysis: CI techniques can predict the reputation of a source based on specific parameters. These techniques and tools can analyze the information flows and mitigation the propagation of deepfakes.

Anna University, Chennai collaborated with the Prime Point Foundation, Chennai to nudge the young minds in the direction of creating a shield of defense against this infodemic of misinformation created from synthetic media production and its dissemination. "Deepfakes" has been the focus. Please see Figure 2.

Figure 2: Hackathon [June – July 2024] - Misinformation due to "Deepfakes"

The following are the objectives of the Hackathon

1. **Develop Innovative Tools / Process:** Encourage student teams to develop innovative technological solutions such as AI-powered algorithms, browser extensions, or mobile applications that can efficiently identify and flag misinformation across various digital platforms.

2. **Enhance Collaboration among fellow students:** Foster collaboration among diverse teams of developers, data scientists, journalists, and domain experts to leverage their collective expertise in designing comprehensive solutions that address the multifaceted nature of misinformation.
3. **Promote Data Literacy on Misinformation:** Organize workshops and training sessions to enhance participants' understanding of data literacy and critical thinking skills, empowering them to effectively analyze and verify information sources to combat misinformation.
4. **Facilitate Information Sharing to enable Open Source Approach:** Create platforms or frameworks that facilitate the seamless sharing of credible information sources, fact-checking resources, and methodologies among different stakeholders, including journalists, researchers, and the general public.
5. **Ensure Ethical Implementation of the Tools:** Emphasize the importance of ethical considerations in the development and deployment of misinformation detection tools, including issues related to privacy, bias, and unintended consequences, to ensure responsible innovation in this domain.

The hackathon has the working definition of "Reality" as referring to the actual state of things as they exist and "Realism" as a philosophy, artistic movement, or perspective that aims to portray or understand this objective reality faithfully, without idealization or embellishment. **In essence, reality is the "what is," while realism is a "way of being" or "way of showing" what is.**

Though it is still a long way ahead, the Hackathon highlighted that CI techniques achieve impressive, though limited, forms of realism.

15 entries were received for the Hackathon when the Jury decided to begin the evaluation. After weeks of intensive work, the final assessments were conducted online via Zoom, allowing the jury to interact directly with the participating teams. Only four entries were chosen by the Jury for the final assessment and demonstration. Despite their innovative efforts, no team was able to secure the top prizes. However, all finalist teams were awarded 'Participation Certificates' on December 26, 2024 at Anna University. The author has served on the three member Jury.

Teams of students illustrated that the state – of – the art CI techniques such as:

- **Generate realistic media**
- **Adapt to dynamic environments**
- **Achieve superior performance in specific tasks.**
- **Display "intelligent" behavior**

The Hackathon also brought into sharp focus the limitations of the CI techniques and the presentations scoped the need for the human interventions in using common sense, ethics and creativity.

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