Publisher
Vandana Publications
www.vandanapublications.com

International Journal of Engineering and Management Research

2025 Volume 15 Number 2 April

E-ISSN:2250-0758
P-ISSN:2394-6962

Research Article

Fuzzy System

A Detailed Study on Introduction of Computational Intelligence

Saklani N[1*], Bade K[2]

DOI:10.5281/zenodo.15309780

[1*] Nikita Saklani, Visiting Faculty, Department of Applied Electronics & Software Technology, L.A.D. and Smt. R.P. College for Women, Nagpur, Maharashtra, India.

[2] Kanchan Bade, Associate Professor, Department of Applied Electronics & Software Technology, L.A.D. and Smt. R.P. College for Women, Nagpur, Maharashtra, India.

This article demonstrates an analysis of Computational Intelligence (CI) through its crucial concepts together with principles and implementation examples in the field of artificial intelligence. The core computational models in CI help replicate human reasoning and solve complex problems through neural networks as well as fuzzy systems alongside evolutionary algorithms while hybrid systems interpolate their benefits. The paper demonstrates CI development from inception to present day while focusing on eminent milestones alongside CI adoption across data mining and robotic control and optimal decision making applications. The chapter explores both theoretical perspectives of CI and provides an evaluation of its strengths and limitations. This paper uses different examples to validate the importance and usage of CI in modern technology before establishing directions for future research in this developing field. The obtained outcomes demonstrate that CI methods can reach practical use after implementing improvements. This paper delivers an extensive overview of CI principles to support researchers and practitioners so they can boost innovation alongside cross-disciplinary work in this developing field.

Keywords: Computational Intelligence, Symbolic Reasoning, Artificial Neural Network, Fuzzy System

Corresponding Author

Nikita Saklani, Visiting Faculty, Department of Applied Electronics & Software Technology, L.A.D. and Smt. R.P. College for Women, Nagpur, Maharashtra, India.
Email: nikitasaklani13@rediffmail.com

How to Cite this Article

Saklani N, Bade K, A Detailed Study on Introduction of Computational Intelligence. Int J Engg Mgmt Res. 2025;15(2):35-39.
Available From
https://ijemr.vandanapublications.com/index.php/j/article/view/1728

To Browse

Manuscript Received	Review Round 1	Review Round 2	Review Round 3	Accepted
2025-03-03	2025-03-22			2025-04-17

Conflict of Interest	Funding	Ethical Approval	Plagiarism X-checker	Note
None	Nil	Yes	3.82	

1. Introduction

Over three millennia have passed since the beginning of the study of (human) intelligence.

The development of computers in the 20th century made it possible to create and research systems that display traits or actions typically associated with intelligence but are not natural in the sense that they are created by humans. The field of artificial intelligence (AI) is typically used to refer to the growing science or engineering discipline. Even though the phrase itself is broad enough to encompass all approaches to intelligent systems created by humans, the AI research community's norms limit its definition, at least in its most widely accepted under-standing.

Computational intelligence refers to the capability of computers and their systems to perform tasks that typically require human-level intelligence. Computers and computer systems demonstrate human-like intelligence through abilities such as problem-solving, decision-making, learning, natural language comprehension, pattern recognition, and other skills. The success of computational intelligence is achieved via data processing and the application of algorithms, in conjunction with machine learning techniques. Utilizing these methods, computers analyze vast amounts of data to identify patterns and subsequently generate predictions based on the analyzed information. Computational intelligence encompasses widely-used applications such as Machine Learning, where statistical models and algorithms enable computers to enhance their performance based on experience. Robotics creates intelligent machines through an integration of hardware and software, allowing for autonomous operation or minimal oversight from human operators. Expert Systems act as digital platforms that replicate expert decision-making abilities within specific professional fields. Artificial Intelligence is the broader field that includes the entire process of developing intelligent machines, alongside its computational intelligence aspect. Natural Language Processing enables computers to interpret, analyze, and produce human language. Computers can extract valuable insights from images and videos that exist in the real world. Computational intelligence offers numerous applications across various sectors, including healthcare, finance, manufacturing, transportation, and entertainment.

Future advancements in technology will empower computers to tackle more intricate issues while managing increasingly complex.

2. Evolution

The Progression of Computational Intelligence:

Revealing the Path

1. Initial Computers and Symbolic Reasoning:
Computing machines, which initially served as basic tools for mathematical computations, have experienced a significant metamorphosis over the years, transforming into intelligent entities capable of per-forming complex tasks. The progression of computational intelligence is an intriguing journey that extends from the mid-20th century to today, characterized by key developments in artificial intelligence (AI) and machine learning. This discussion seeks to clarify this progression for newcomers, following the path from early computing systems to the modern era of intelligent technologies. The origins of computational intelligence can be traced back to the mid-20th century, when early computers were mainly created for numerical computation. However, the innovators of that era began to envision machines that could replicate human cognitive abilities. Symbolic reasoning, a method based on rules, was the primary focus of early AI research. Influential figures such as Alan Turing and John McCarthy laid the foundation for what would evolve into the field of artificial intelligence. The emergence of artificial intelligence (AI) is closely linked to the creation of the Lisp programming language. An acronym for "List Processing," Lisp is more than just a programming language; it is a key concept that has greatly impacted the AI field. In this piece, we explore the origins and features of Lisp, the first programming language specifically designed for artificial intelligence.

2. Emergence of Machine Learning:
The discovery that machines could learn from data instead of only using explicit programming gave the evolution a boost. The arrival of ma-chine learning, a branch of artificial intelligence, presented algorithms that can get better with practice. This transition marked a revolutionary advance in computational intelligence from rule-based systems to learning algorithms. With origins in mathematics, computer science, and artificial intelligence,

machine learning emerged around the middle of the 20th century.

Paradigms used in Computational Intelligence

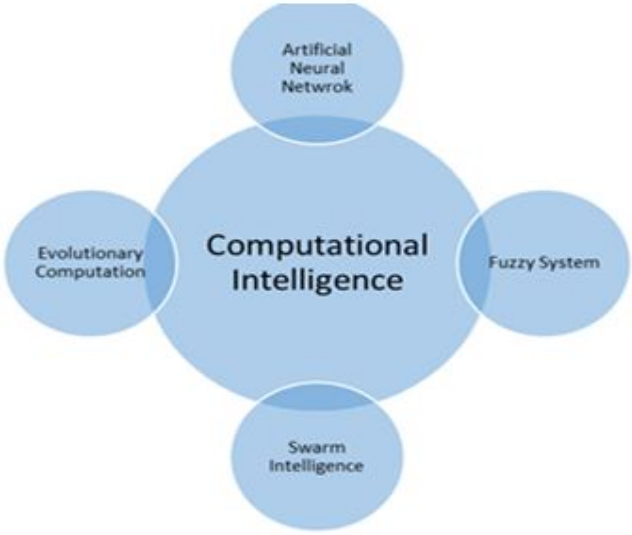

Figure1: Diagram for Terms involved with Computational Intelligence.

Artificial Neural Network

The computer architecture referred to as an Artificial Neural Network (ANN) is inspired by the biological neural networks found in animal brains. This type of machine learning algorithm analyzes data by utilizing layered structures composed of interconnected nodes or neurons.

The basic building blocks of an ANN are neurons, which resemble real neurons. After processing information, they send the results to other neurons.

The layers into which ANNs are arranged are:
Initial data is received by the input layer.
Hidden Layers: Apply intricate calculations to the data.
Output Layer: Generates the end product.
Weights and Biases: The strength of each neuronal connection is determined by its corresponding weight. To modify the neuron's activity, biases are introduced to its output.
Activation Function: Controls a neuron's output.

Evolutionary Computation

Evolutionary computation has the main aim of sampling of natural evolution where main idea is the survival of the fittest. In this survival is made through reproduction. Basically evolutionary computation draws its ideas from natural selection and genetics to solve large complex problems.

Evolutionary computation methods are distinguished by their repetitive process, utilizing a population-oriented strategy to create and enhance possible solutions. These methods typically incorporate actions like selection, recombination, and mutation, mimicking the natural evolutionary mechanisms found in nature.

In evolutionary computing, we simulate a population of organisms, each known as a chromo-some. A chromosome represents the traits of individuals within this population. Each trait is identified as a gene, while the specific value of a gene is called an allele. During each generation, individuals compete to produce offspring, with those possessing superior survival abilities being more likely to reproduce. Offspring are created by merging sections of the parents' chromosomes, a process known as crossover. Additionally, each individual in the population may experience mutation, which changes some of the alleles on the chromosome. The survival capability of an individual is evaluated using a fitness function that reflects the goals and constraints of the problem at hand.

Swarm Intelligence

Assets in Swarm Intelligence operate as cooperative independent units that work with the environment and their fellow members. Groups of agents that come from a single class connect within their nearby area to reach outcomes without needing direct connections are called swarms. The introduction of the "swarm intelligence" concept emerged in 1989 through G. Beni and two of his collaborators Hackwood and J. Wang. Robotic systems have experienced intensive growth as the main part of this examination. The sector examines social human behaviors within public interactions and environmental contacts.

Intelligent machines based on advanced research are active in robotic fields and computer science and software applications technology development. The basic behavior of SI produces global intelligence from local parts. The concept of SI describes complex management systems which maintain organizational interoperational behaviors. These administrative frameworks can achieve higher operational effectiveness and operational efficiency as well as operational agility.

Swarm algorithms offer fast responsive and robust operations through their new artificial intelligence field,

that analyzes swarm behaviors in nature among ant colonies birds flocks and confined-behavioral honey bee colonies using fundamental behavioral rules. The social interactions among swarms occur through direct and indirect methods.

Fuzzy System

Fuzzy Systems represent a potent computational paradigm. They manage uncertainty and im-precision effectively. They differ from traditional computing. Traditional computing relies on strict binary logic. This logic is either true or false. Fuzzy logic permits degrees of truth. These are represented through values ranging from 0 to 1.

Fuzzy Sets: These sets lack sharply defined boundaries of distinction. A membership function determines membership in a fuzzy set. This function assigns a degree of membership. Membership ranges from 0 to 1. As an example "tall" can be a fuzzy set. It is not a case of people being either tall or not tall. There are shades of tallness present.

Fuzzy Rules: These rules articulate relationships. The relationships are between input and out-put variables. They use linguistic terms. A classic example is "If temperature is high and humidity is high, then fan speed is high."

Fuzzy Inference: This process involves the application of fuzzy rules. The rules are applied to input data to determine the output. This process typically includes a few steps. There is fuzzyfication which converts crisp inputs to fuzzy sets. This is followed by rule evaluation. It establishes the truth values of rules. Lastly there's defuzzification. It converts fuzzy outputs to crisp values.

3. Applications

1. Recommendation systems: CI enhances recommendation systems in online shopping.
2. Autonomous vehicles: CI facilitates the operation of autonomous vehicles.
3. Medical diagnosis: CI supports medical diagnosis efforts.
4. Supply chain management: CI improves the efficiency of supply chain management.

4. Conclusion

This paper offers a concise overview of Computational Intelligence, discussing its definition and different facets. It also explores various applications to enhance understanding.

References

1. D. Saxena, S.N. Singh, & K.S. Verma. (2010). Application of computational intelligence in emerging power systems. *International Journal of Engineering, Science and Technology, 2*(3), 1-7.

2. Kevin E. Voges, & Nigel Pope. (2006). *Business applications and computational intelligence*. https://books.google.co.in/books?isbn=1591407044.

3. Esteva, A., Kuprel, B., Novoa, R. A., Ko, J., Swetter, S. M., Blau, H. M., & Thrun, S. (2019). Dermatologist-level classification of skin cancer with deep neural networks. *Nature, 542*(7639), 115–118.

4. Korach, Z. T., Yang, S., Rosset, S., & Topol, E. (2020). Leveraging machine learning to individualize treatment for patients with multiple chronic conditions. *Nature Communications, 11*(1), 619.

5. Vankipuram, M., Kahol, K., & Cohen, T. (2018). A predictive analytics approach to reducing 30-day avoidable heart failure readmissions. *JMIR Medical Informatics, 6*(4), e10104.

6. Mishra, R., Jha, R., & Mishra, A. (2018). AI-based decision support system: A proposed paradigm for remote areas. *Health Information Science and Systems, 6*(1), 4.

7. Sarker, A., Chandrashekar, P., Magge, A., Cai, H., Klein, A., Gonzalez, G., & Scotch, M. (2019). Discovering cohorts of pregnant women from social media for safety surveillance and analysis. *Journal of Medical Internet Research, 21*(4), e13044.

8. Aliper, A., Plis, S., Artemov, A., Ulloa, A., Mamoshina, P., & Zhavoronkov, A. (2016). Deep learning applications for predicting pharmacological properties of drugs and drug repurposing using transcriptomic data. *Molecular Pharmaceutics, 13*(7), 2524–2530.

9. Olivecrona, M., Blaschke, T., Engkvist, O., & Chen, H. (2017). Molecular de-novo design through deep reinforcement learning. *Journal of Chemical Information and Modeling, 57*(11), 2657–2666.