Fuzzy Logic Foundation of Soft Computing

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***Abstract*—The foundation of computing laid by FUZZY LOGIC which is a form of multi-valued logic that led with reasoning that approximation rather than precis fuzzy allowed for partial membership in set character by degree of truth between 0 and 1. It used to handle uncertainty and imprecision in various system making it value tool in the Boolean field of soft computing. the concept of soft computing this encompass technique like fuzzy logic artificial intelligence and genetic algorithms which work efficiently and effectively in partial situation where conventional computation methods are not feasible in soft computing a fuzzy relation is the fuzzy set defined on the certain product of two or more crisp set where each tuples has a membership value in the range (0, 1) representing the strength of relationship, unlike crisp relation (which are binary :related or not)fuzzy relation capture degree of association between the element making them ideal for modeling uncertainty and vagueness.**

***Index Terms*—crips, fuzzy, IoT, Artificial Intelligence**

I. INTRODUCTION

Fuzzy logic is a computational approach designed to handle uncertainty and impression allowing for reasoning that mimic human making traditional Boolean logic which operate strict with binary values (true or false,0 or 1) fuzzy logic permit value between 0 and 1 representing degree o truth in flexibility make it ideal for real-world scenario where information often vague or incomplete. in Boolean logic is rigid, dealing only with absolute truth or falsehood. in contrast fuzzy logic accommodate partial truth enabling systems to interpret and act on data that is not black-and-white while Boolean logic might classify a temperature as either “HOT” or “COLD” fuzzy logic can describe it as “partial hot” (eg 0.7) and “partial cold” (eg 0.3) simultaneously because it has four main component that is 1. Fuzzification, 2.rules based, 3. inference engine, 4. defuzzification. if you consider an air condition system that was fuzzy logic instead simply turning the cool “on” or “off”. It in values the room temperature and adjusts the cooling level dynamically. This approach ensures the smoother and more computable temperature regulation closely resembling human-reasoning. fuzzy logic ability to handle imprecise data and mimic human thought process make it a powerful tool for solving complex real-word processing however it does not come with challenges such as ambiguities in rule design and potential compromises in accuracy.

II. SOFT COMPUTING MEANS

The soft computing is a computational approach design to solve complex, real-world problems that in values uncertainty, imprecision and approximation unlike traditional hard computing which relies on precise and deterministic model soft computing emphasis flexibility and approximation to handle the problem that one difficult or impossible to solve exactly. Soft computing technique are inspired by biological process and huma-reasoning making them adaptive and tolerance of imprecise data it was first introduced by Dr Lotfi Zadeh who also developed fuzzy logic of its components. Soft computing does not require strict mathematical model and can adapt to change it the environment it is stochastics in nature meaning it in corporate randomness and probabilistic reasoning it often uses parallel computing to process ambiguity or noisy data efficiently the solution provided by soft computing are approximate but effective for real-world application.

III. TECHNIC IN SOFT COMPUTING

Soft computing employees several methodologies including

1. artificial neural network (ANN)
2. fuzzy logic
3. genetic algorithms.

Artificial neural networks: mimic the human brain neural structure to solve problems like pattern recognition and classification
fuzzy logic: handle impress and vague data using degree of truth rather than binary logic.
Genetic algorithms: solve the optimization problems by simulating natural selection and evaluation.

Application of soft computing;
Soft computing widely used in field such as image processing, bio medical diagnosis, intelligent control system and smart instrumentation.

For examples;
It can optimize motor control in power plants or enhanced image quality in video processing. Soft computing often high efficiency adaptability and applicability in real-time scenario however it provides approximation result and may require significance effort to correct errors in the system despite this limitation it is ability to handle the complex uncertain problems make it invaluable in modern computing.

IV. HARD COMPUTING

Hard computing is a traditional computing it requires a precisely stated analytical model and usually a lot of computation time it strict follows known step to solve the task as opposed to soft computing which is heuristics. The term hard computing was coined Dr Lotfi zedah here “hard” has nothing to hardware. the principles of hard computing are precises, certainty and rigor. The hard computing is achieved using sequential program that use binary logic it deterministic in nature. the input data should be exact and output will be precises and variables.

Computing means in software:
Software computing refers to the use of computer program and instructs to the performance task, managing data and control hardware operation. software is the collection pf instruction program or data that direct the computer performance specific task and operation, distinguish it from hard ware which is the physical components of computer systems it acts as a bridge between human command and machine instruction, enabling computer to the process information run application and perform complex computation.

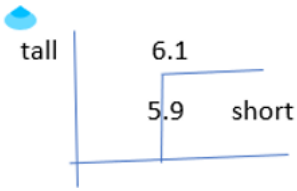
Hard computing and soft computing (CRISP and FUZZY)
Hard computing based on binary logic (0 or 1) require exact input and produced deterministic output it is not talent to uncertainty and imprecision and uses the conventional algorithms and Boolean logic

Example calculator and traditional control systems.
In contrast soft computing based on fuzzy logic mimic human- decision making with tolerance and imprecision and uncertainty. it capable of learning and adaptive and uses algorithm that are more flexible adaptive.

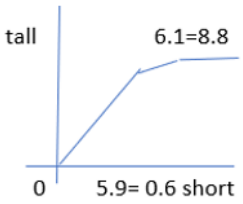
Examples;
Include air condition with fuzzy control, washing machines and AI system.

V. DIFFERENCE

A. Crisp Set
1. Crisp set define the values either 0 or 1.
2. It is called classical set
3. It shows full membership
4. Crisp application digital design
5. It is bi-value function.
6. Full membership means totally true or false /yes or no/ o or 1.

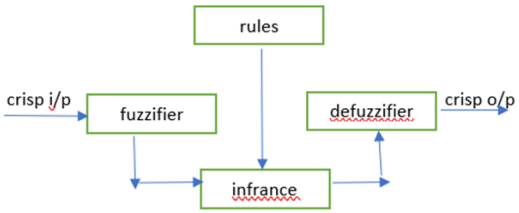


B. Fuzzy set:
1. 1.fuzzy define the value between 0 or 1 including both 0 and 1
2. 2.it specify the degree to which some time true.
3. 3 it shows partial membership
4. 4 fuzzy set used in the fuzzy controller
5. 5.it is infinite valued function logic
6. partial membership means true to false /yes to no / 0 to 1.



C. Crisp set:
Ideal for scenario requiring defective categorization and clear- cut data they are used in application where precise definition and distinct categories are essential such as classical mathematic computer science crisp set follow classical logic mathematics and computer science the crisp se t follow classical logic in their operation making them suitable for scenario that required definitive categories

D. FUUZ set:
Suitable for ambiguous an uncertainty data they allow for more nuanced and flexible reasoning compared to crisp set. Fuzzy set are widely applied field like artificial intelligence, control system and decision-making when ambiguity and subjective interpretation are common, they provide a frame work for dealing with uncertainty and vogues in various real-world application. The choice between using fuzzy set or crisp set depends on the nature of problems and required precision in handling data and information crisp set are more prevalent in classical mathematics and computer science application while fuzzy set are used in domain were incomplete or imprecision information prevalent.



Soft computing development history

E. From fuzzy logic:
Soft computing= evolutionary computing + neural network + fuzzy logic
Dr zadeh(1981)= rechanberk(1960) +(1943)+ Dr zadeh(1965)
Evolutionary computing= GP + ES + EP + GA
(1960) = (1992) + (1965) + (1962) + (1970)

VI. SOFT COMPUTING

The soft computing is new multi dispensary field to construct a new generation of artificial intelligence known as computational intelligence. The main goal of soft computing is to development intelligence mechanism to provide solution to real- world problems which are not modelled or too difficult to model mathematically. Aim to exploit the tolerance for approximation, uncertainty, imprecision and partial truth in order to achieve close resembles with human-like decision making.

- Approximation: here the model feature is similar to the real once but not same.
- Uncertainty: here we not sure that the feature of the model are the same as that of entities (belief).
- Imprecision: here the model feature (quantities) is not same as that of real one but close them.

A. Application of Soft Computing
It proved two mains advantageous:
First: in solving non-linear problems where mathematical model is not available or nt possible.
Second: introducing the human knowledge such as cognition, recognition, understanding, learning and others in to the field of computing this resulted is possibility if constructing intelligence system such as autonomous self-turning system and automated designed system. The relevant of soft computing for pattern recognition and image processing is already established during last few years. The subject was recently gained important because of its potential application of problems skills.

- Remote sensor data analyzing
- Datamining -web mining
- Global positioning system
- Medical images
- Forensic sciences
- Optical character recognition
- Signature verification
- Multimedia
- Target recognition
- Face recognition
- Man, machine communication.

B. Feature of soft computing:
It like hybrid, adaptive system that blend fuzzy logic, neural network and swam intelligence to manage

uncertainty and complexity heavily integrated with AI, IoT, and big data it is shifting from traditional, rigid computing to human like, autonomous decision making in autonomous vehicle smart cities and industrial application,

C. Key Trends

Hybrid intelligence system combines multiple methods (fuzzy neural network) create high flexible adoptive solution that handle imprecision data better then single-technique approach.

D. Edge cloud-synergy:

Soft computing techniques are moving to low cost fast micro controller in IoT devices, enabling real- time analytics and reducing latency in industrial environment.

VII. CONCLUSION

Fuzzy logic serve as foundation pillar of soft computing by providing a mathematical frame work to model imprecision, uncertainty and vagueness inherent in real- world problems unlike traditional binary (0 or 1) fuzzy logic allows for intermediate truth value between 0 and 1 facilitating human-like decision making and approximation fuzzy logic is essential for managing vague, noisy or imprecision information allowing soft computing system to operate effectively in environment when data is not exact also by utilizing linguistic variable (e.g. “WARM”, “FAST”)and IF-THEN rules fuzzy system translate human expectation and natural language in to the computer understandable compute control mechanism it is vital non-computational component of shift computing along side natural and genetic algorithm their hybrid use such as neuro- fuzzy system combine the learning ability of neural network with the interpretability of fuzzy rules to create high robust intelligent system, it is primary strength like in single, interpretable and non-linear model for control system, pattern recognition, and decision making-system. The fundamental principle of graduation (matter of degree) and granulation (grouping of similar values) make fuzzy logic and robust method dealing with complexity aiming for low solution cost and high transability fuzzy logic pioneered by lotfi zadeh act as the primary tool is soft computing for tackling complex real-world complex system where crisp, Boolean modeling fails.

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