

Applications Of Fuzzy Logic in Cloud Computing: A Review

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Abstract

The objective of this paper is the analysis of various applications of Fuzzy Logic in Cloud Computing. This paper reviews the already available application areas of Fuzzy Logic in Cloud Computing. Methods/ Statistical analysis: Various studies on application areas of Fuzzy Logic in cloud computing systems have been considered. Relative analysis has been made to categorize these application areas. Findings: Cloud computing is web based technology that has brought a lot of improvement in the field of Information Technology. It is a pay-as-you-go service model that delivers services on the basis of demand of users. Because of its capability to deal with uncertainties, Fuzzy Logic has given a good response in cloud computing. Various Fuzzy Logic based application areas in cloud computing are prevalent in the existing literature like Load balancing, Job Scheduling, QOS optimization etc. Results have shown that Fuzzy Logic helps in improvement in various areas in Cloud Computing. Application/ Improvements: This research work is very useful for researchers working in the field of cloud computing with Fuzzy Logic.

Keywords: *Cloud Computing, Fuzzy Logic, Job Scheduling, QOS, Reliability.*

1. INTRODUCTION TO CLOUD COMPUTING

Cloud Computing is an emerging web based technology where the information can be accessed by anyone anywhere.

Cloud Computing attracts users by minimizing infrastructure investments and resource management costs while presenting a flexible and elastic service[1].

Cloud Computing makes possible the efficient utilization of resources by allocating and deallocating the hardware and software resources to the customers on demand. So the customers need not to worry about the arrangement of computing resources. They can use these resources

without making any costly investment by purchasing them . The customers use these resources on demand and when these are not needed, the customers can give these resources back to the resource providers. Customers will be charged only on the basis of usage. Unlimited services are offered by Cloud Computing. Basically, on the basis of types of services, Cloud Computing is divided into three types:

SAAS: Software resources are offered by SAAS providers on request. The customers need not to bother about software purchasing cost and other maintenance tasks and related costs

IAAS: Hardware resources are provided to the customers on request.

PAAS: The operating platform for developing the application is provided on request to customers.

On the basis of deployment models, Cloud is of four types:

Public Cloud: Anywhere on the internet can access public cloud infrastructure.

Private Cloud: Whole and sole owned and managed by the organization in which it is run and accessed.

Hybrid Cloud: Combination of two or more clouds

Community Cloud: Where two or more organizations with common interest jointly share a common cloud.

2. FUZZY LOGIC INTRODUCTION

Fuzzy Logic provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy or missing input information. It is a type of logic that recognizes more than simple true and false values [2]

Fuzzy Logic was proposed by zadeh in 1965 and now it has been widely used because it deals with imprecise and incorrect information. It is very close to human mind. In Fuzzy Logic, the human expertise is embedded into the system. Fuzzy Logic applies in various fields like Air Conditioners, Washing Machine, Microprocessor, Microcontrollers, Image processing and many other real world applications. In general, Fuzzy Logic consists of four components:

- Fuzzifier
- Rule Base
- Inference Engine
- Defuzzifier

Fuzzifier determines the input and output variables and maps them into linguistic variables with the help of membership functions[3].

The inference engine uses If-Then rules defined in the rule base and on the basis of that it arrive at the fuzzy output. This fuzzy output is converted into a single crisp value with the help of defuzzifier.

Because of its wonderful response in various applications and its capability to deal with uncertainty, Fuzzy Logic is also used in Cloud Computing[4] In Cloud Computing, it is widely used in various areas which we will explain in the next section.

3. Applications of Fuzzy Logic in Cloud Computing

On the basis of existing literature, we have identified various fields in Cloud Computing where Fuzzy Logic applies:

3.1 LOAD BALANCING

Load balancing is a technique of dividing the traffic between the servers so that data can be sent and received with minimum response time[5],simultaneously removing a condition in which some nodes are overloaded while some others are under loaded[6]

A Load Balancing model has been proposed for the public cloud by using Cloud partitioning concept that simplifies the concept of load balancing and also improves the performance and maintains stability[7]

A Fuzzy Logic based Firefly algorithm for efficient load balancing in Cloud Computing also has been proposed. Firstly the cloud is partitioned into heavy and least loaded nodes. With this algorithm, the best suited partition for the cloud is selected and the firefly algorithm helps the load to get attract towards that partition. Fuzzy Logic is employed for handling uncertainties in time. The proposed algorithm is compared with genetic algorithm. The result shows that the algorithm consumes less execution time, incurs less execution cost, can handle much heavier load, and balances a good amount of arrived load then genetic algorithm [8]

Another Fuzzy Logic based algorithm for efficient Load Balancing also has been proposed .The researcher has taken two input variables for fuzzification i.e. assigned load and processors speed. Rules have been defined to measure the balanced load as output. The proposed algorithm is compared with round robin load balancer and the results have shown that the proposed technique helps in balancing the load by minimizing response time, minimizing processing time and maximizing resource utilization and in real life applications it can be used more efficiently[9]

3.2 JOB SCHEDULING

Scheduling is a method by which thread or process are granted access to computer resources[10]

A fuzzy neural network based job scheduling algorithm has been proposed where the Fuzzy Logic is used to convert the classified inputs into linguistic variables. The genetic algorithm in neural network is used for mapping the system resources with the tasks. Defuzzification process is used to convert the linguistic variables to the crisp values. The proposed algorithm is implemented on CLOUD SIM and compared with the traditional Berger model. The result shows that the proposed technique results in reduction in bandwidth utilization and completion time thereby enhancing performance[11].

A Job Scheduling Algorithm is also proposed which allocates the resources on the basis of job length. Genetic Algorithm along with the Fuzzy Logic is used. Fuzzy Logic is used to modify the standard genetic algorithm. The proposed approach is compared with ACO and MACO algorithms in terms of make span and

degree of imbalance. The results have shown that the system performance is improved by minimizing execution cost and execution time[12]

A Fuzzy Logic based multi queue job scheduling has been proposed for cloud computing and this technique helps in reduction of waiting time and response time as compared to existing technique[13].

3.3 IMPROVING RELIABILITY

An algorithm is proposed by using Fuzzy Logic for scheduling resources to improve the reliability of cloud computing. Three linguistic variables i.e. cost, length and trust are taken and fuzzified. The output of the system is the priority which will be assigned to the task that needs to be scheduled. The proposed system is compared with other algorithms like FIFO and MAX-MIN. The results have shown that there is also an improvement in waiting time, turn-around time, accuracy and reliability[14]

A conceptual model is proposed for assessment and prioritization of risk that may occur if the company is thinking to rent out resources from resource providers in Cloud Computing. Risk assessment and prioritization in Cloud Computing is very much essential to reduce and manage the risk and to enjoy the unlimited services of Cloud Computing. Here Fuzzy Logic is used to deal with uncertainties and estimate the risk rate with probability and impact of risk. The results is discussed by using various entities and show that decision taken using Fuzzy Logic is more beneficial in risk assessment and management process[15]

3.4 QOS OPTIMIZATION

A Fuzzy Logic technique is also proposed in the behavior, load and performance prediction model by taking imprecise information. The data is fuzzified and the defuzzified value is generated for scale control module that scales up and down the use of VMs. The proposed approach is compared with conventional rule set and the results showed that with this approach, the scaling process of VMs can be improved thereby minimizing SLA violation and thus improving QOS parameters[16]

Another researcher has taken the concept of different service providers providing different levels of qualities in

services offered. Also there is difference in requirements of users. So it is very difficult for customer to select best service from the best service provider that fit into their quality of cloud service(QOCS)requirement i.e. high availability, timeliness, reliability etc. So in this paper, the researcher has proposed an evaluation approach for measuring QOCS in Cloud Computing..Firstly, the cloud service providers are evaluated as per user requirements on the basis of the level of services provided with the help of Fuzzy Logic model. Secondly, the researcher has taken a cloud model to calculate the uncertainties in the services provided by them on the basis of QOCS data. Finally, the output of personalized evaluation module and uncertainty evaluation module are used to calculate QOCS evaluation value. Comparisons have been made with “QOSC” and “SLC” which are existing techniques. Results have shown that proposed approach is better than existing approach in terms of accuracy and time cost[17]

3.5 TRUST EVALUATION

An evidence based trust evaluation model is proposed for relying on the cloud based services. The Fuzzy Logic model is used to obtain the trust value. Various attributes like CPU utilization, Data in, Data out, Disk Read Throughput and Disk Write throughput are taken. At every request these attributes of services are measured and stored in database at various time slots and then they are normalized. These normalized values are fuzzified and defuzzified value represents the trust value for the time slot. Using IOWA (Induced Weighted Aggregating Operator),the global trust value is calculated. Also weights are assigned to the time slots to tackle the instable performance of cloud service. The calculated trust value is used to ascertain the trust-worthiness on service and fuzzy logic is used to handle the uncertain nature of attributes in dynamic cloud based services[18].

3.6 Power Monitoring System

A researcher has designed and implemented power monitoring and control system using Fuzzy Logic and Cloud Computing. This system is responsible for automatically adjusting the working time of electrical appliances which we use in our day to day life. The Fuzzy Logic part helps in calculating the working time of appliances as output by taking humidity and temperature of the environment as inputs. With the help

of Cloud Computing, various computers and handheld devices can be used to access the information about power consumption of electrical appliances through internet. The results of experiment have shown that the proposed system helps in efficient utilization of energy, thereby helps in power saving [19].

4. CONCLUSION

We have identified various research papers of applications of Fuzzy Logic in Cloud Computing. This paper gives a review of various applications areas of Fuzzy Logic in Cloud computing. We hope that this research work will be prove useful for the researchers doing research in the field of Cloud Computing with Fuzzy Logic

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