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Intelligent Resource Scheduling with Neutrosophic Knowledge and Optimized Cache Management Using Cuckoo Search Method in Cloud Computing

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Abstract: The cloud environment comprised of distributed resources in a dynamic fashion, so this necessitates the need for developing optimal scheduling in cloud environment with the satisfaction of Quality of Service necessitated by the cloud consumer with the maximum profit to cloud providers. But the presence of impreciseness while scheduling cloud resources is the challenging issue of traditional scheduling policies. The main objective of this paper is to treat the vagueness in scheduling of cloud resources by designing Neutrosophic inference system for prioritizing incoming tasks and optimizing the resource usage by applying quantum cuckoo search cache management (INIS-QCSCM). This proposed work represents the parameters involved in resource scheduling by the means of Neutrosophic representation with the aim of reducing the response and execution time with maximize throughput which favours the profit of cloud service providers. Once the job is passed to the virtual machine (local schedulers) it is fine grained at the local host level by utilizing cache segmentation with the knowledge of quantum cuckoo search algorithm. The incoming task request is prioritized using neutrosophic inference model by considering impreciseness as the important factor. In local host memory management specifically cache assignment is done by cuckoo search-based model which selects the best cache allocation policy to optimize the resource utilization with quality of service. To prove the performance of this proposed INIS-QCSCM, its make span, degree of imbalance handling, energy consumption, execution time of each task and the hit ratio of the cache management are used as the evaluation metrics. The efficacy of INIS-QCSCM is proved by comparing it with existing classification models support vector machine, Fuzzy inference system and intuitionistic fuzzy inference system. As the outcome of the simulation results proved that INIS-QCSCM model provides potential resource scheduling with optimized resource usage in cloud computing by treating hesitancy, impreciseness and vagueness in adversarial situation of cloud paradigm.

Keywords: Cloud computing, Resource scheduling, Neutrosophic logic, Vagueness, Quantum, Cuckoo search, Adversarial environment.

1. Introduction

A pervasive growth of the internet accesses and usage of big data of its volume, rapidity and different resources accessible through the network, cloud computing paradigm turns into more and more proliferating in academia, industry and to the society [1]. The cloud offers its facility to be accessed by its users worldwide either they are stationary or on move [2]. But these resources are provided in a pay per use fashion on demand [3]. Cloud computing is a hastening technology in distributed computing environment. It can be used in applications that involves in data storing, analytics and applications of IoT [4]. When the cloud users are expected to send the request to the cloud service providers who are responsible for managing the user requests to be fulfilled by allocating the appropriate resources. CSP adapts resource scheduling schemes to schedule the incoming job request and to tackle the resources computation effectively. Both scheduling of jobs and management of cloud resources allows the CSP to maximize the revenue as well as optimized usage of resources. In cloud computing paradigm, the scheduling and allocation of resources are the primary hurdles where performance of the system entirely relies on them. In this regard, the researchers started focusing on the studies about job scheduling in cloud paradigm. The job scheduling is the method of positioning received requests in a certain way so that the accessible resource's will be suitably exploited.

In cloud computing it provides its services to the cloud users through the internet and the users must send their requests online. As each service comprised of many users, a greater number of job request may be made at a time. If the scheme doesn't have the ability to employ appropriate scheduling, then it may result in longer waiting time for tasks. While allotting a job request, constraints such as job size, its nature, execution time, resources availability and resources work load are all has to be considered. Thus, job scheduling is the main issue in cloud computing which directly affects the effectiveness of resource utilization.

During resource scheduling done in local hosts, the problem of cache management is also to be focused for effective memory management and resource computation cost reduction. In cloud computing, web server shares its information to the local hosts within the cluster and performs distributed computing to complete their task quickly. Local servers highly depend on the server to accomplish a particular task. Frequent request from local host to server may increase the computation complex when a task is assigned to a specific host.

The main objective of this paper is to discover the optimal resources for scheduling the appropriate workloads on time in order to minimize the response and completion time to satisfy the QoS of Cloud consumers and maximize the profit of the cloud consumer with the help of multivalued concept of neutrosophic inference system. To accomplish the above four constraints of issue this, work introduced the degree of truthiness, falsity and indeterminacy as the primary factor by designing a neutrosophical classifier in mapping job work load to optimal resource scheduling. Hence, this work highly focuses on effective utilization of cache memory within the local host by formulating cache evicting procedure as a reinforcement learning issue.

The rest of this paper work is organized as follows, in section 2 existing research work related to resource scheduling in cloud paradigm is discussed. Section 3 highlights the statement of problem this paper handles for resource scheduling issues are explained. Section 4 describes about the main contribution of this research work and need for developing a two step process in task prioritization and resource management are clearly explained. In section 5 background study about neutrosophic logic and the cuckoo search model is explained in detail. Section 6 discusses about the overall architecture of the proposed INIS-QCSCM and the process of how it handles both task prioritization and resource utilization are well explained. Section 7 discusses about the simulation result and performance analysis of the proposed model with and comparison with other existing models. Section 8 concludes the finding of the proposed model in resource scheduling and utilization and the future extension is also mentioned.

2. Related work

Some of the existing strategies used for resource scheduling in cloud paradigm is discusses in this section.

Tsai et al. [5] developed a multi-object model which uses enhanced differential evolutionary approach. This method provides time and cost as primary factor in cloud paradigm and they don't take into consideration of tasks variations.

Magukuri et al. [6] introduced a balanced scheduling scheme which deliberates sizes of jobs. The refresh time of the server is measured for fulfilling their needs.

Cheng et al. [7] developed a vacation queuing method for scheduling the tasks. This method doesn't prove the utilization of resources properly.

Lin et al. [8] anticipated a task scheduling scheme which measures bandwidth as a resource. To allocate resources for a specific task, they applied non-linear programming approach.

Zhu et al. [9] in their work developed a rolling horizon scheduling scheme which is used for real time task schedule. The association among scheduling task and conservation of energy is considered as primary factor for allocation of resources.

Lin et al. [10] introduced a parallel workload, which follows the policy of first come first server queuing theory to place the jobs when the resources are presented. This model doesn't concentrate on job starvation and aborting it.

Ghanbari et al. [11] devised a scheduling scheme for assignment of job in cloud computing based on their priority. They deployed multi-criteria decision making with multiple attributes to accomplish this task.

Alejandra et al. [12] in their work used a metaheuristic model known as particle swarm optimization which uses its global best and personal best as the two important influencing factors, position and direction as their constraint for search the best solution for reducing the cost of execution by proposing significant scheduling scheme.

Keshk et al. [13] developed an improved ant colony optimization for balancing the load effectively. This work increases the makespan of a job. But they did not consider the factors of resource availability or tasks weights.

Gougarzi et al. [14] projected an issue in resource allocation of cloud computing paradigm with reduced energy cost. With the assured quality of service to the clients they used a reverse model where penalty is applied if the client does not encounter the specified SLA agreements.

Radojevic et al. [15] developed a centralized load balancing scheme by introducing a decision model in cloud paradigm, this work automates the process of resource scheduling and reduces the interaction of administrators. This model has issue with identifying the nodes capabilities and details of configuration.

Mathew and Moses [16] in their work devised a new fuzzy resource scheduling scheme which considers arrival time, computation and deadline of each scheduling input parameters. The output of the model is used for internal priority queue for assign them to the resources.

Guangshun Li, Yuncui Liu, Junhua Wu, Dandan Lin and Shuaishuai Zhao [22] in their work developed a resource scheduling policy for fog computing, in which they normalized the resource attributes involved in resource scheduling. Fuzzy clustering along with particle swarm optimization is used to segment the resources and volume of resource search in also decreased.

Tahani Aladwani [23] enhanced the static task scheduling process by applying tasks classification and virtual machines categorization depending on the importance of the tasks. Once the task is received by IoT it classifies the tasks as high importance, medium importance and low importance tasks depending on the condition of the patient's health status.

Xuan-Qui Pham, Nguyen Doan Man, Nguyen Dao Tan Tri, Ngo Quang Thai and Eui-Nam Huh [24] developed a cost makespan aware scheduling is a major motive of this work to achieve stability among performance of application execution as well as cloud resources cost are considered. They proved that this work is performs better compared to other scheduling schemes.

Georgios L, Stavrinides, Helen D. Karatza [25] introduced a novel hybrid fog with cloud aware model for dynamic scheduling in IoT using three tier architecture under a real time scenario. Here, main processing in done in fog layer so that computation complexity is reduced with accepted communication cost.

Yongkui Liu, Lihui Wang, Xi Vincent Wang, Xun Xu, Lin Zhang [26] in their articles they did a study on scheduling issues in cloud computing by performing statistical analysis on 158 articles are addressed in detail to reveal the characteristics of scheduling issues.

But these existing models are not more suitable in the situation of uncertainty handling, impreciseness handling and optimizing the scheduling schemes are not considered.

3. Problem definition

This paper work focuses on effective resource scheduling which reducing the cost of execution, time, consumption of energy. To maintain the quality of service the resource providers reject the resource requests in unpredictable or uncertain environment. Most of the cloud-based resource scheduling are not focusing vagueness, impreciseness, ambiguity and inconsistent altogether even fuzzy logic can able to handle vagueness and intuitionistic fuzzy handles vagueness and impreciseness. It is very tough to handle all the four factors together, thus to overcome these constraints the proposed research model is designed elegantly for enriched resource scheduling in heterogeneous cloud environment. This work also incorporates the optimization of cache replacement strategy because these policies plays a vital role in refining Caching algorithms which also improves the resource consumption in cloud computing.

4. Contribution

Thought there are many works in existence for performing resource scheduling in cloud environment, the ultimate goal of scheduling the resources in the uncertain conditions such as vagueness, impreciseness, ambiguity and inconsistent are not greatly focused by any works. While working in Cloud Computing based resource scheduling the presence of impreciseness about the availability of resources are the toughest challenge and the main objective of this research work is to discover the optimal resources for scheduling the appropriate workloads on time in order to minimize the response and completion time to satisfy the QoS of Cloud consumers and maximize the profit of the cloud consumer. To accomplish the above four constraints of issue this, work introduced the degree of truthiness, falsity and indeterminacy as the primary factor by designing a neutrosophical classifier in mapping job work load to optimal resource scheduling. Additionally, the problem is also fine grain to manage the cache allocation in local host by adapting population based behavioural model known as cuckoo search for optimizing this process.

5. Background study

5.1 Knowledge about neutrosophic logic

The multivalued theory which represents real time instance truth value in terms of membership grade of truthiness, falsity and indeterminacy is known as neutrosophic theory. This neutrosophic theory is formulated by Smarandache [17] whose aim is to handle four main factors such as ambiguity, impreciseness, vagueness and inconsistent which are primary problems in many real time applications specifically in cloud paradigm.

The consistency of classical theory and fuzzy theory was well maintained by neutrosophic theory with its varying degree of truthiness (T), falsity (F) and indeterminacy (I) when T+F+I=1. The neutrosophic becomes intuitionistic when the T+F+I < 1 and it can handle the paraconsistency if its three factors T+F+I > 1.

Thus, neutrosophic logic holds the merit of non-standard analysis as its property which distinguishes the relative falsehood denoted by 0 and absolute falsehood is denoted by $^{-}0$. The real truth as 1 and absolute truth as 1^{+}.

5.1.1. Definition

A set B_{nl} is considered to be in universal discourse Y, which is denoted in common as Z, is said to be neutrosophic set if Bnl = {⟨y; [T_{Bnl} (y), I_{Bnl} (y), F_{Bnl} (y)] ⟩: y∈Y}, where T_{Bnl} (y) is referred as confidence because it is the membership grade of truth, I_{Bnl} (y) is referred as uncertainty or inconsistent as it is the membership grade of indeterminacy, F_{Bnl} (y) is known as skepticism as it represents the membership grade of falsity. and their relation between them are signified as

$$^{-}0 \leq T_{Bnl}(y) + I_{Bnl}(y) + F_{Bnl}(y) \leq 3^{+} \quad (1)$$

Eq. (1) denotes that there is no restriction on the sum of TBnl (y), IBnl (y) and FBnl(y). But it is very difficult to apply in real life applications so according to single valued neutrosophical set [27] all three membership grades lie between [0,1].

5.2 Working principle of cuckoo search method

Cuckoo bird is considered to be a most fascinating bird, as it not only of its stunning sounds their aggressive strategy for reproduction. The cuckoos lay their eggs in other communal nests, they could remove the eggs of others in order to increase its own eggs hatching probability. Cuckoo bird follows brood parasitism to lay their eggs in other host bird's nests [20]. There are three common types of brood parasitism namely cooperative breeding, brood parasitism and nest takeover. Sometimes host birds can involve straight struggle with the obtrusive cuckoos, in such case the host bird either throw those alien eggs away or abandon its nest and construct a new nest somewhere. Some of the cuckoo species are specialized in imitation pattern and colour of the eggs of a few selected host birds. This will reduce the probability of abandonment of eggs and thus it raises their reproductively.

In common, the cuckoo eggs will be hatched a litter earlier than their host eggs, when the first cuckoo chick is hatched it instinct action is to evict the host eggs by sightlessly pushing the eggs out of the nest, so that it increases its share of food provided by its host bird. A cuckoo often selects a nest with few eggs based on quantum behaviour. This behaviour is applied to optimized the search of best nest.

6. Methodology of intelligent neutrosophic inference system along with quantum cuckoo search model for Resource scheduling and cache management in cloud paradigm

This proposed work intelligent neutrosophic inference system along with quantum cuckoo search model is developed to handle both the job priority scheduling and cache management in cloud paradigm for optimized quality assured along with resource consumption. The detailed outline of this proposed INIS-QCSCM is depicted in the Fig. 1.

Once the job request is sent by the cloud users, the cloud job load entry management receives it and passes it to the job policy scheduler. The job scheduler passes the job request to the neutrosophic inference system, which receives the input details of each job such as execution time, response time, throughput and turnaround time in the form of crisp values. Before inferring the knowledge about the input job, the values represented in the crisp value is converted to the neutrosophic values and then the neutrosophic inference system infers the pattern of incoming jobs request and assign the relevant priority for each job based on the availability and optimized consumption of resource. The highest priority job is scheduled to the appropriate resources and the efficacy of the local host or virtual machine is increased by significant cache management with the

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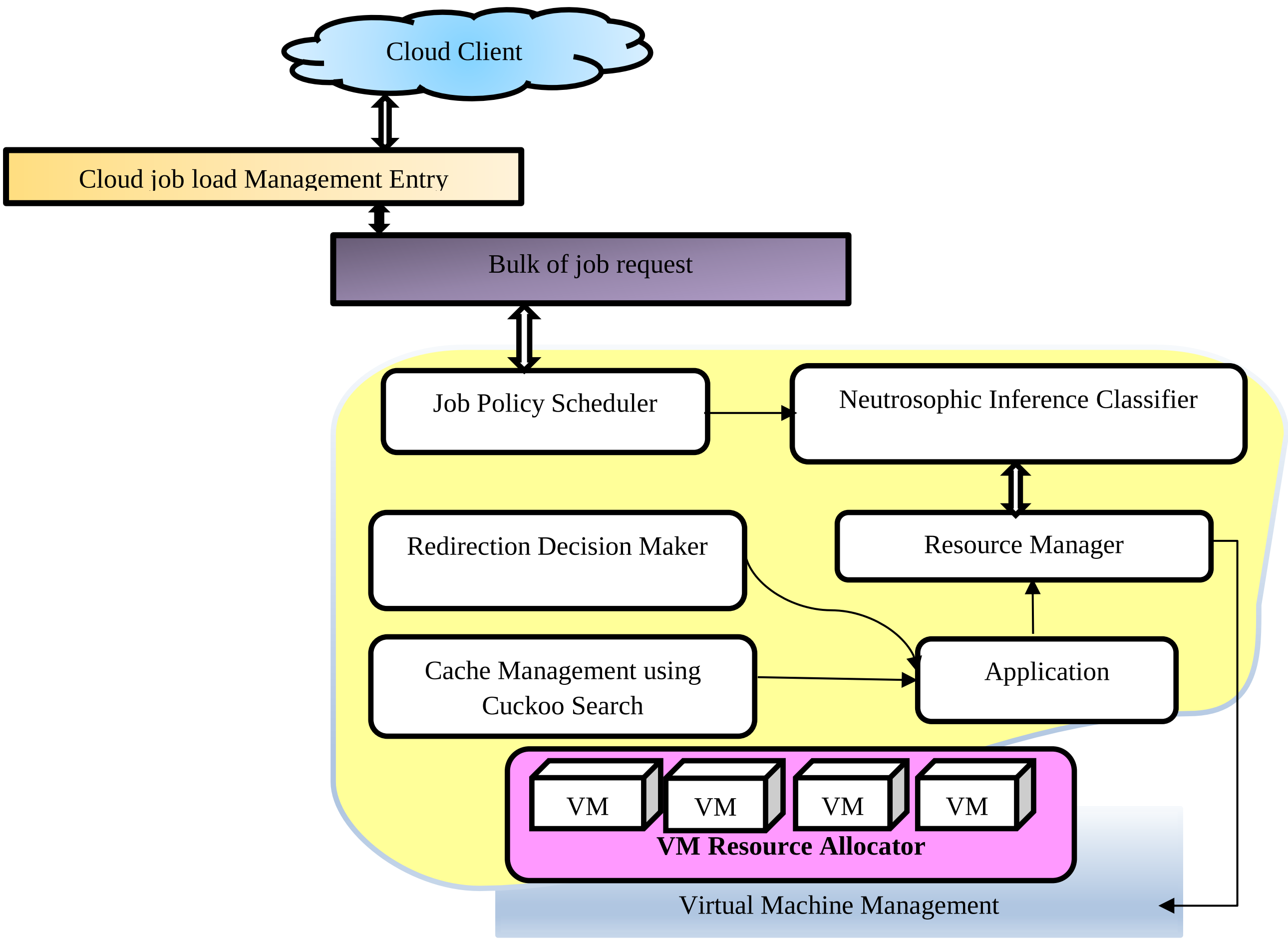

Figure. 1 Intelligent resource scheduling with neutrosophic knowledge and optimized cache management using cuckoo search method in cloud computing

knowledge of quantum cuckoo search method. Thus, the proposed model achieves optimization of both resource scheduling and cache management in cloud paradigm with quality of assurance.

6.1 Intelligent neutrosophic inference system for job scheduling in cloud computing

Once the job request is assigned to the job scheduler, the input details of the concern job requirements such as execution time, response time, throughput and turnaround time are fed as input to the INIFS. intuitionistic fuzzy inference system converts the crisp input values are converted to the neutrosophic domain representation.

- Execution Time (ExT): Amount of time taken by an individual job for executing completely on respective virtual machine. Difference among job completion time and the start time of the job is formulated as

$$ExT\ (i,j) = CmpTt(i,j)\ -\ SttT(i,j) \qquad (2)$$

Where cmpTt is the completion time of a hob and sttT is the starting time of the job

- Turnaround time (Trnt): total amount of time send by a job in a virtual machine is known as turnaround time

$$Trnt(i,j) = CmpTt\ (i,j) - Sbt\ (i,j) \qquad (3)$$

Where sbt refers to submission time of job

- Response Time (RsT): Time gap between job submission and first response received by the task is known as response time

$$RsT\ (i,j) = sbt(i,j) - WtT(i,j) \qquad (4)$$

Where WtT refers to waiting time of the job

- Throughput (Thpt): Total number of jobs executed successful Sucs(N) with respective to the total amount of executing time (T)

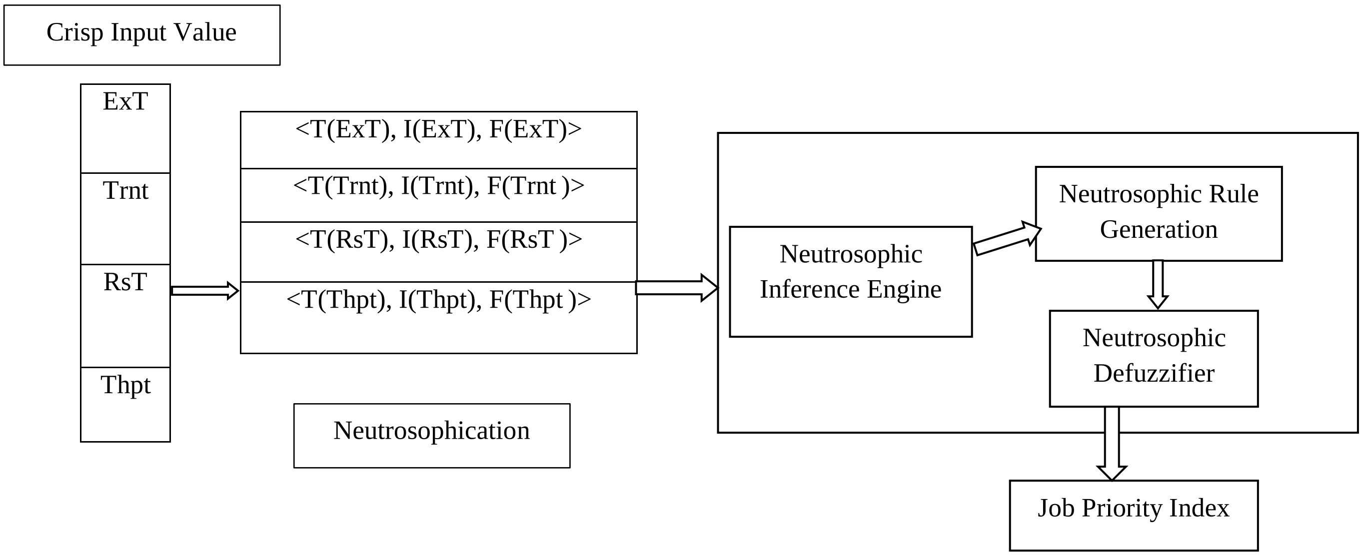

Figure. 2 Work Flow of intelligent neutrosophic inference system for job priority assignment

$$\text{Thpt}(i,j)=\text{S}ucs\ (N)\ /T \tag{5}$$

The step by step process of job priority assignment using neutrosophic inference system is depicted in the Fig. 2

Step 1 **(Neutrosophication)** In this process the given input values are converted to the Neutrosophication value in terms of membership of truthiness, falsity and indeterminacy $<T_{Neu}(x),\ I_{Neu}(x),\ F_{Neu}(x)>$ Conversion of input values of incoming job request details is converted to neutrosophic values as follows

$$\boldsymbol{T_{\check{N}eu}(x)} = \begin{cases} r_{\check{N}\boldsymbol{eu}}(x); & a_1 \le x < a_2 \\ T_{\check{N}\boldsymbol{eu}}(x) \quad ; & a_2 \le x < a_3 \\ s_{\check{N}\boldsymbol{eu}}(x); & a_3 < z \le a_4 \\ 1 \ ; & otherwise \end{cases} \tag{6}$$

$$\boldsymbol{I_{\check{N}eu}(x)} = \begin{cases} m_{\check{N}\boldsymbol{eu}}(x); & b_1 \le x < b_2 \\ I_{\check{N}\boldsymbol{eu}}(x) \quad ; & b_2 \le x < b_3 \\ n_{\check{N}\boldsymbol{eu}}(x); & b_3 < z \le b_4 \\ 1 \ ; & otherwise \end{cases} \tag{7}$$

$$\boldsymbol{F_{\check{N}eu}(x)} = \begin{cases} u_{\check{N}\boldsymbol{eu}}(x); & c_1 \le x < c_2 \\ F_{\check{N}\boldsymbol{eu}}(x) \quad ; & c_2 \le x < c_3 \\ v_{\check{N}\boldsymbol{eu}}(x); & c_3 < z \le c_4 \\ 1 \ ; & otherwise \end{cases} \tag{8}$$

where $T_{\check{N}eu}$, $I_{\check{N}eu}$ and $F_{\check{N}eu} \in [0,1]$ and $T_{\check{N}eu}+ I_{\check{N}eu}+ F_{\check{N}eu} \le 3$, $r_{\check{N}\mathbf{eu}}, s_{\check{N}\mathbf{eu}}, m_{\check{N}\mathbf{eu}}, n_{\check{N}\mathbf{eu}}, u_{\check{N}\mathbf{eu}}, v_{\check{N}\mathbf{eu}}$: $X\to [0,1]$ are termed as side of a fuzzy number. The neutrosophic trapezoidal representation is shown in the Fig. 3.

Step 2 (Neutrosophic Inference Engine) The neutrosophic *Logic* and the knowledge based are applied to generate the neutrosophic rules to get a neutrosophic output. The knowledge base stores available knowledge in the form of *if-then* rules and then it captures semantics of the neutrosophic rules with neutrosophic set [19].

Step 3: Neutrosophic Rule Generation
Each job requests requirements are prioritized with the four different input factors execution time, response time, throughput and turnaround time. The neutrosophic classifier generates the set of rules using its knowledge base. It is in the format of

Rule$_1$: IF condition then class$_1$
Rule$_N$: IF condition then class$_N$

Sample Rules for Job Priority Assignment using neutrosophic rule generation is as follows

- If ExT is high and Trnt is low and RsT is low and Thpt is low then priority is very low
- If ExT is high and Trnt is high and RsT is low and Thpt is low then priority is low [0.6]
- If ExT is medium and Trnt is medium and RsT is medium and Thpt is medium then priority is medium [0.4]
- If ExT is low and Trnt is high and RsT is high and Thpt is high, then priority is very high [0.8]

Step 4 Neutrosophic Defuzzification: In this the neutrosophic representation of the output will be converted to the crisp value.

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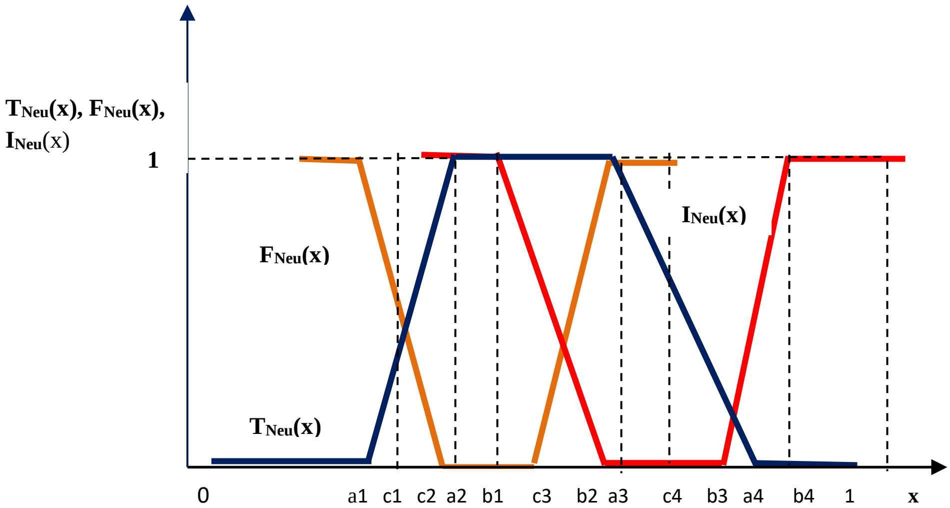

Figure. 3 Trapezoidal representation of neutrosophic domain

6.2 Optimized cache management using quantum cuckoo search model

Once the incoming job requests are prioritized by the neutrosophic inference system, the performance of the virtual machines or proxy servers has to be properly managed, which is accomplished by appropriate management of cache policy. When there is an increase in job request, the computation time for caching policy will also be rapidly high. It leads to high cost when a complete set of request mapping are done through online. This work introduces a quantum cuckoo search model for optimized cache management.

In this cuckoo search caching policy arbitrarily, n number of cuckoos are considered as initial population [21]. Cuckoos are allotted to each job request and their need of memory size is used for identifying appropriate cache space for assigning fittest job requirement. Cuckoo search with high fitness value is considered to have most optimal cache size that suits better for the job request to be completed with minimum requirement of processing cost. Using levy fight function the best cache is selected. If there are n job request s, each of which can be either processed in cache or out of the cache with the possibility of 2n request mappings. The cost of request mapping is formulated as

$$Z = \sum_{k=1}^{p}[pcst_k nr_k hr_k + aplcst_k nr_k(1 - hr_k) + \sum_{l=p+1}^{n} aplcst_l nr_l] \quad (9)$$

Where $pcst_k$ is the processing costs of job request k on cache, $aplcst_k$ is the processing cost on application, nr_k is the number of requests received in a specific Cloud server k, hrk is the hit rate of virtual machine k.

Cuckoo with lower cost than all the cuckoos is measured for caching in and the remaining requests are sent to the applications directly. By repeating this metaheuristic search, a near optimal solution can be obtained for caching policy issue.

Every cached request inhabits one cache block and the size of the block is set to the largest content. Hence, the cache size is identified by the content sizes and the number of requests stored in cache. Based on the request mapping, this proposed method determines the number of requests going to the cache server. The model receives the requested content sizes of different job requests from the load scheduler. Next, the cache size is computed as

$$Size_{ch} = maximum(Size_i) \sum_{j=1}^{p} NRC_j \quad (10)$$

Where NRC_j is the number of requested contents and $Size_i$ is the requested content size in virtual machine i correspondingly. Cache size is determined by contents maximum size.

6.1 Algorithm: Intelligent Neutrosophic Inference System based resource scheduling and Quantum cuckoo search model of optimized cache management.

Input: No. of Job Request: NJR, Each jobs parameters Jb_i (ExT, Rst, Thpt, Trnt) i = 1 … NJR

Stage 1: Job priority Assignment using INIS

1. For i = 1 to NJR

a. Input Jbi (ExT, Rst, Thpt, Trnt) to INIS

b. Jbi (ExT, Rst, Thpt, Trnt) = Jbi(<TŇeu(ExT), IŇeu(ExT), FŇeu(ExT)>, <T(Trnt),(Trnt),F(Trnt)>,<T(RsT), I(RsT),F(RsT)>, <T(Thpt), I(Thpt), F(Thpt)>)

c. IF Jbi(<TŇeu(ExT), IŇeu(ExT), FŇeu(ExT)>, <T(Trnt), I(Trnt), F (Trnt)>, <T(RsT), I(RsT), F (RsT)>, <T(Thpt), I(Thpt), F(Thpt)>) then priority status

d. Jbi (ExT, Rst, Thpt, Trnt) = Jobi(priority)

End for i

2. For i = 0 to NJR-1
   a. Max = i
   b. For j = i+1 to NJR-1
   c. If priority(Jbj) > Max
      Max = priority(Jbj)
   endif
   endfor j
      T = Jbi
      Jbi = Jb(max)
      Jb(max) = T
   End-For i

Stage 2: Quantum Cuckoo Search-based Cache Management Policy

a. Set Pop = 1… maxgen
b. Best-cache=best (cache{1…m})
c. While (j < maxgen)

If rnd() > 0.5, then

XP(t+1) = Pos(individual) - σ|μbst-XP(t)|ln$\frac{1}{p}$

Else

XP(t+1) = Pos(individual) + σ|μbst-XP(t)|ln$\frac{1}{p}$

End if

If fitness(i)> fitness(j) then

Replace j by new solution

- A fraction of worst caches is abandoned and new cache allocations are selected
- Keep the best cache
- Rank the cache sizes with cost request and select the best one and assign the job
- Pass the remaining cache candidates to the next generation

End While

Output: Optimized Scheduling of Job Assignment in Cloud Environment

7. Results and discussions

In this section, the performance of the proposed Intelligent Neutrosophic Inference System with Quantum Cuckoo Search based Cache Management (INIS-QCSCM) in cloud environment is discussed. The proposed model INIS-QCSCM is developed using cloudsim tool executed on Intel Core i5-8250 central processing unit (CPU) with 1.80 GHz frequency, 8 GB random-access memory (RAM), and a Windows 10 Operating System. For this experiment the incoming jobs or cloud work load are varied between range of 10 to 1000 and 100 resources are used. The weights of execution time, response time and throughput are assigned to 1. To validate the performance of the proposed INIS-QCSCM other existing models of resource scheduling namely support vector machine (SVM) [30], Fuzzy Inference System (FIS) [28], Intuitionistic Fuzzy Inference System (IFIS)[18, 29] are used. For cache management Static First, Dynamic First and Least Recently Used (LRU) cache replacement policies are used for comparison.

Testbed configuration of this simulation setup

- Job length varies: 1,000–20,000
- Number of job requests :100–1,000
- Number of Virtual Machines: 50 VM
- Virtual Machine frequency: 500–2,000
- Population size: 10 VM
- memory (RAM): 256–2,048
- VM bandwidth: 500–1,000
- Number of PEs requirements: 1-4
- Number of data centres: 10
- Number of hosts 2-6

7.1 Performance metrics

Make Span: It is defined as the difference between start time and finish time of a sequence of tasks or jobs.

$$MkS = Finish\ time\ (job) - Start\ Time\ (Job) \quad (11)$$

Where Mks refers to make span.

Degree of Imbalance: It is formulated using maximum and minimum execution time (Exe-time) and the average execution time of virtual machines and it is signified as follows:

$$DIB = \frac{Maximum(Exe-time) - Minimun(Exe-time)}{Average\ (Exe-time)} \quad (12)$$

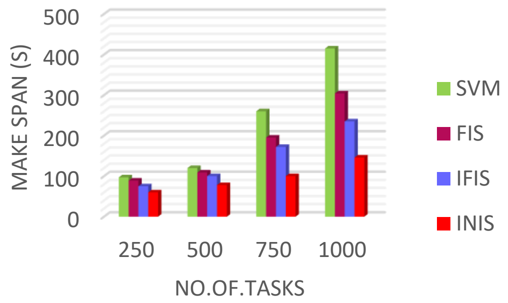

Figure. 4 Comparison based on Makespan

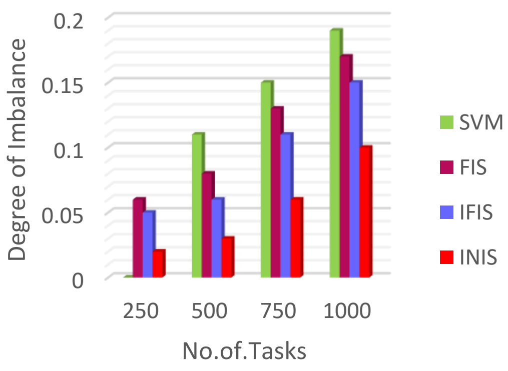

Figure. 5 Comparison based on degree of imbalance

Energy Consumption (Eng-Cnsp): Consumption of energy in cloud system can be represented as

Eng-Cnsp (cloud-system) = Eng-Cnsp (Datacenter) + Eng-Cnsp (Transceivers) + Eng-Cnsp (Memory) + Eng-Cnsp(extra).

Resource Utilization: For a specific resource r_e at any given period of time, the resource utilization is represented as,

$$RU_e = \sum_{d=1}^{f} RU_{e,d} \quad (13)$$

Where f refers to number of cloud workloads running at a specific time and RU_e denotes resource usage of cloud workload W_e. d refers each individual work load varies from 1 to f.

7.2 Analysis of comparison on makespan

As the objective of this research work is to decrease the makespan of the system, the performance of the proposed INIS is compared with the conventional scheduling models such as SVM, FIS and IFIS.

From the Fig. 4 it is proved that the makespan of the jobs scheduled to the cloud resources are effectively controlled by using INIS, while comparing with the other three models. The SVM takes highest makespan to complete the task of resource scheduling and execution. The fuzzy inference and the intuitionistic fuzzy inference systems. The priority of each incoming jobs is examined in terms of membership grade of truthiness, falsity and indeterminacy in INIS, so that the assigned of job priority is done more accurately while comparing with other three models.

7.3 Analysis of performance based on degree of imbalance

The Fig. 5 illustrates, handling the degree of imbalance by four different resource scheduling schemes, which involves in assigned of job priority depending on their principles.

The proposed INIS balances the work load more perceptively by using its ability to handle the indeterminacy of assigning workloads and determining the priority of jobs in an inconsistent situation.

In this adversarial environment, number of job request may vary in a dynamic manner, assigning the priority based on execution time, Turnaround time, throughput and response time are mainly represented in terms of grade of membership of truthiness, indeterminacy and falsity. Based on these values the neutrosophic rules are fired to assign the job priority without any ambiguity and vagueness. SVM can able to handle only small number of jobs, the fuzzy and intuitionistic fuzzy can able the vagueness and uncertainty alone, the failed to overcome the indeterminacy as well defined by neutrosophic theory.

7.4 Analysis of performance based on energy consumption

The Fig. 6 outcome shows that the energy consumption for job scheduling and uniform loading balancing is highly influenced by adapting INIS which has the ability to avoid ambiguity and impreciseness in prioritizing the jobs by considering four different important factors as the primary constraint.

In addition, INIS utilized less energy as it uses low makespan and elected optimal virtual machines, so that the memory is utilized more prominently by this proposed model. The maximum benefits of the cloud service providers with the restricted resource utilization reduced the makespan in an appreciable manner. Thus, IFIS and FIS are considered for certain factors, SVM is applicable for less work load scheduling.

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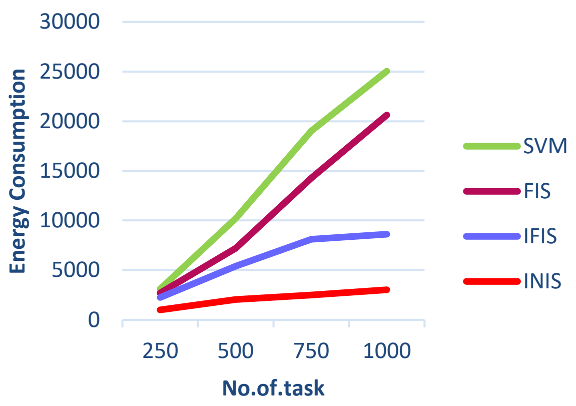

Figure. 6 Comparison based on Energy consumption

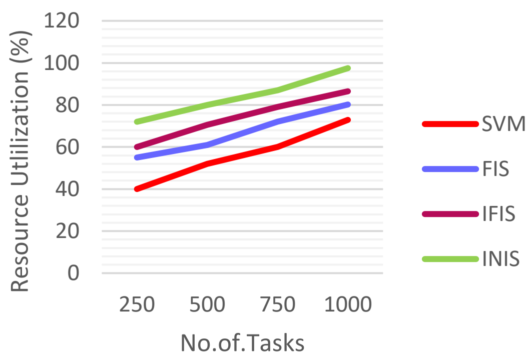

Figure. 7 Comparison based on resource utilization

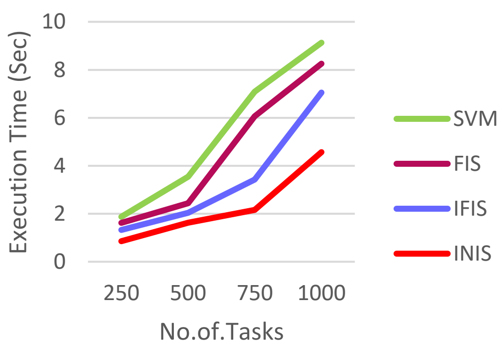

Figure. 8 Comparison based on Execution time

7.5 Analysis of performance based on resource utilization

The outcome of the result depicted in the Fig. 7 portraits the major factor of job scheduling and execution with the effect of resource utilization.

When there is lack of knowledge about assigning heavy loads and arrival of imbalance job request entry makes the situation impreciseness. The choice of selecting optimal number of virtual machines to accomplish a specific job request becomes very tough in such situation. While handling this issue using traditional approaches namely SVM, FIS and IFIS for job priority assignment and scheduling degrades the performance of the cloud system. Thus, using INIS the above-mentioned problems can be easily overcome by using its neutrosophical intelligence in determining the impreciseness and representing them in terms of three membership degrees and based on the rules generated the decision of job priority assignment, with effective resource utilization can be carried out.

7.6 Analysis of performance based on execution time

From the Fig. 8 it is depicted that results of execution time of four different job scheduling models with 10 virtual machines varying size of tasks in cloud environment. The result reveal that the scheduling policy using INIS decreases the execution time of the overall cloud system because the ability to represent each job query in terms of truthiness membership degree, falsity membership degree and indeterminacy membership degree. As the problem of vagueness in assigning the task to resources and prioritizing the jobs in queue are greatly diffused by the proposed INIS scheduling policy. The execution time of the proposed scheduling policy is less compared to the other models because of its efficacy and intelligence of selecting appropriate assignment of job priority more appropriately.

7.7 Comparing hit rate versus cache capacity of INIS with three other approaches

From the Fig. 9 it is examined that the proposed Quantum Cuckoo search cache management (QCSCM) prominently manages the cache replacement policy based on necessitate litter parasitic behaviour along with levy flight searching model and quantum theory-based selection of populations.

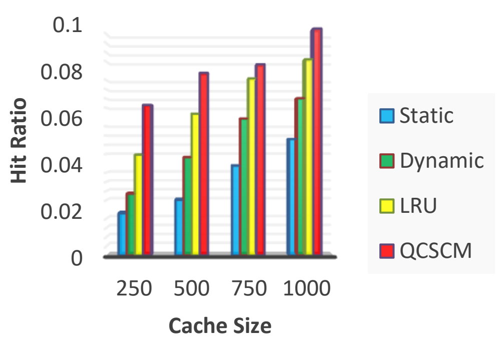

Figure. 9 Comparing hit rate versus cache capacity of INIS with three other approaches

While performing resource allocation based on the priority, the cache management plays a vital role of resource consumption, the main memory has to be effectively used, otherwise it leads to the high computation cost and time complexity. It is also observed that when the cache capacity is increased, the hit rate of each models is also increased, but comparing to the quantum cuckoo search model, the process of static first, dynamic first and LRU doesn't achieve such great accuracy of cache utilization.

7.8 Findings

The experimental setup is done with cloud work load are varied between range of 10 to 1000 and 100 resources are used. As per the setting represented in the parameter settings the dataset for cloud set are configured.

From the performance analysis it is observed that usage of support vector machine in huge volume of task scheduling request is not possible as it is only well suited for small scale dataset.

Fuzzy logic [28] which uses membership degree of each resource attributes to determine the priority of income job requests and Intuitionistic fuzzy logic represents each attributes in terms of membership and non-membership to handle the vagueness in priority assignment of jobs[29] aim to handles only vagueness in scheduling the job requests and in case if they have ambiguity or of there is impreciseness in job prioritization they work based on assumption with the degree of membership and degree of non-membership respective to fuzzy and intuitionistic fuzzy.

While adopting neutrosophic inference system for assigning priority of the jobs, the membership degree of truthiness, falsity and indeterminacy of each attributes the impreciseness and inconsistency will be greatly handled with this multivalued logic more precisely compared to the existing models.

8. Conclusion

This paper work intelligently well handles both the problem of job scheduling and cache management in an effective manner. The problem of vagueness, inconsistency, indeterminacy and impreciseness is perceptively overwhelmed with neutrosophic inference system which optimized the job scheduling using optimization. This proposed work also fine grains the resource scheduling in cloud management with quality of assurance expected by the cloud users and appropriate usage of resources which benefits the cloud source providers by managing cache using quantum cuckoo search model. The simulation results proved the efficacy of the developed INIS – QCSCM has substantially empowers with resource scheduling and cache management in terms of cost computation, resource utilization and highly overcoming the imbalanced job request in adversarial environment of cloud computing paradigm. The work can be extended in future by applying unsupervised learning paradigms, to group the incoming tasks based on the importance of the request and finding the optimized resource allocation using metaheuristic search models.

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