Modelling Of Election Algorithm For Coordinator Selection Using Neuro-Fuzzy Approach In Distributed Computing Environment

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Abstract

Distributed Computing Environment is gaining popularity due to their ability to work on heterogeneous environment and having tremendous advantages over centralized computing environment. Some of major challenging issues involve in the implementation of DOS (Distributed Operating System) are the designing of system architecture, single system image, transparency and coordinator selection. In this paper we have proposed Neuro-Fuzzy based model for selection of coordinator among active processes.

1. Introduction

The evolution of computer applications has led to the design of large, distributed systems for which the requirement for efficiency and availability has increased, as has the need for higher level tools used in their construction, operation, and administration. This evolution has introduced the following requirements for new system structures that are difficult to fulfil merely by assembling networks of cooperating systems [6][10].

The OSF Distributed Computing Environment (DCE) is an industry-standard, vendor-neutral set of distributed computing technologies. DCE is deployed in critical business environments by a large number of enterprises worldwide. It is a mature product with three major releases, and is the only middleware system with a comprehensive security model [5].

DCE provides a complete Distributed Computing Environment infrastructure. It provides security services to protect and control access to data, name services that make it easy to find distributed resources, and a highly scalable model for organizing widely scattered users, services, and data. DCE runs on all major computing platforms and is designed to support distributed applications in heterogeneous hardware and software environments. DCE is a key technology in three of today's most important areas of computing: security, the World Wide Web, and distributed objects [4].

- Separate applications running on different machines, often from different suppliers, using different operating systems, and written in a variety of programming languages, need to be tightly coupled and logically integrated. The loose coupling provided by current computer networking is insufficient. A requirement exists for a higher-level coupling of applications [6][7].
- Applications often evolve by growing in size. Typically, this growth leads to distribution of programs to different machines, to treating several geographically distributed sets of files as a unique logical file, and to upgrading hardware and software to take advantage of the latest technologies. A requirement exists for a gradual on-line evolution [9].
- Applications grow in complexity and become more difficult to understand, specify, debug, and tune. A requirement exists for a straightforward underlying architecture which allows the modularity of the application to be mapped onto the operational system and which conceals unnecessary details of distribution from the application [8].

1.1 Advantages of Distributed Computing Over Centralized Computing Environment

The distributed computing systems are much more complex and difficult to build than traditional centralized systems. The increased complexity is mainly due to the fact that in addition to being capable of effectively using and managing a very large number of distributed resources, the system software of a distributed computing system should also be capable of handling the communication and security problems that are very different from those of centralized systems. Technology Developers are working towards distributed environment to achieve the goal of Grid Computing, Cloud Computing and other Heavy loaded computing environment. Some of the major benefits of DCE are listed below [6]:

•Inherently Distributed Applications
•Information Sharing among Distributed Users
•Resource Sharing
•Better Price-Performance Ratio
•Shorter Response Times and Higher Throughput
•Higher Reliability
•Extensibility and Incremental Growth and Better Flexibility in Meeting User's Needs

1.2 Role of coordinator

The concept of selecting any process as a coordinator is to assign some of the CPU load of currently active process to Coordinator Process and making CPU available for other task. Main idea behind this strategy is to improve the system throughput, performance ratio and reliability of system.

Several distributed algorithms require that there be a coordinator process in the entire system that performs some types of coordination activity needed for the smooth running of other processes in the system. Since all other processes in the system have to interact with the coordinator, they all must unanimously agree on who the coordinator is. Furthermore, if the coordinator process fails due to failure of the site on which it is located, a new coordinator process must be elected to take up the job of failed coordinator [2].

One of the distributed algorithms for coordinator selection is Election algorithm. Election algorithms are meant for electing a coordinator process from among the currently running processes in such a manner that at any instance of time there is a single coordinator for all the processes in the system [6].

Problem associated with coordinator selection is that there are lots of programming techniques used to implement the concept of election algorithm that requires much more resources, effort and skills in the system development and minor variation in distributed environment may affect the whole system so handling such system becomes more difficult. To resolve this issue we are going to present sandwich of Neuro-Fuzzy based model to represent the solution for Coordinator Selection. Artificial neural network will speed up the selection process as well as the task execution and fuzzy technique handle the uncertain preferences passed by the processes during election process efficiently.

4. Related work

Failures with particular features in a distributed system determine the solution to be proposed. A leader election algorithm requires some system features to be satisfied in order to work properly. The bully algorithm proposed by Garcia-Molina assumes that the system has the following properties [1][3].

1. The system is synchronous, and consists of a fixed set of nodes that are connected by a reliable communication network. Nodes communicate with each other by message passing.
2. Nodes in the system never halt temporarily and reply to incoming messages immediately.
3. Integers are used to identify nodes. Every node knows the ids of the others.
4. All nodes use the same leader election algorithm.
5. A node has no prior knowledge that the current leader node has crashed: a timeout policy is used to detect node failure.
6. Crashed nodes may recover and may rejoin the system provided that they agree upon the current election algorithm.

After completion of a successful election according to the bully algorithm-

(a) The node with the highest id of all live nodes is elected as the leader or coordinator: there should be only one leader;

(b) All nodes in the system agree on the newly elected leader. This algorithm uses three types of message:

Election: This message is generated by the node which detects failure, to announce an election.

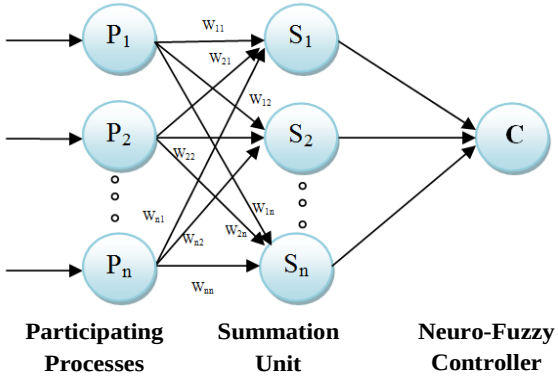
Answer: Recipient nodes send this acknowledgment in response to the election message.

Coordinator: The newly elected leader node announces itself as leader by sending this message to all other nodes.

5. Proposed model

Proposed model is based on Multilayer Feed forward Artificial Neural Network in which Input layer neurons represent set of Participating Processes i.e. P_1, P_2,….P_n. Hidden layer neurons represent Summation Unit (S_i) and Output layer neurons represent Neuro-Fuzzy Controller (C).

For coordinator selection each process will pass fuzzy preferences (Weight w_{ji}) to other processes based on their resources, memory uses, task handling capability or some other factor. Now, the summation unit will individually calculate the sum of the fuzzy preferences for each process. Finally neuro –fuzzy controller will select the maximum of these summed fuzzy preference and announced winning process as a new coordinator.



For the process P_1,

$S_1 = W_{11} + W_{21} + \ldots\ldots\ldots W_{n1}$

Generalized formula for summed fuzzy preference for process P_i,

$S_i = \sum W_{ji}$

Where i=1, 2 ….n and j=1, 2 ….n

Fuzzy rule for Neuro- Fuzzy Controller
CASE 1:

$$\mu_{p_1 Up_{2.....}\ p_n}(w) = \max(\mu_{p_1}(w), \mu_{p_2}(w).....\mu_{p_n}(w))$$

$$C= \mu_{p_1 Up_{2.....}\ p_n}(w)$$

Neuro-Fuzzy Controller use Fuzzy union membership operation to select the maximum summed fuzzy preference value.

There may be two conditions where controller needs to take decision about the selection of coordinator,

Case 1: When all the summed fuzzy preference values are unique in this case controller can easily select maximum fuzzy preference value according to above mention fuzzy operation.

Case 2: When two or more summed fuzzy preference values are equal and maximum in this case controller randomly (or based on the past history of processes that could be resource utilization, memory load any other factor) select any one of process as a coordinator.

6. Conclusion

The proposed model for coordinator selection using combined approach of neural network and fuzzy logic enhance the performance of Distributed Computing Environment and increase the decision making capability of coordinator selection process. We have presented smarter and more applicable model from marrying the learning capability of neural network with the transparency and interpretability of fuzzy system.

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