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Research Article

HYBRID MULTI AGENT SYSTEM FOR EVALUATING QUALITY OF SERVICE IN ONLINE SHOPPING APPLICATIONS

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Abstract

Metrics are essential building blocks for any evaluation process. They set specific goals for improvement. The multi-agent system (MAS) is complex in nature, due to the increasing complexity of developing a multi-agent system, the existing metrics are less than adequate to evaluate the quality of the MAS. This is due to the fact that the agent reacts unexpectedly. The metrics that exist to measure MAS quality fail to address potential communication, initiative behaviour, and learning ability. In this paper the proposed additional metrics to measure the software agent. Shopping Software agent for online shopping system is developed and matrix values are derived from it and quality of multi agent system is analysed.

Keywords: Hybrid Multi agent system, Quality of Service, Agent Interaction, Quality Metrics, E-Commerce Application

1. Introduction

Agents are the science and engineering of developing intelligent computer applications and systems, with an emphasis on intelligent computer applications [1]. It is the same work that is similar to using human intelligence and computers to learn and display characters. Intelligent agents do not need to limit it to biologically similar methods and techniques. Intelligence is a quantitative way to achieve goals in the world. People and some machines come in a variety of forms and genius applications. Artificial intelligence, which specializes in agents, helps machines find solutions to problems in a more human-like fashion [2].

The solutions that are available are based on procedural and object-oriented examples. There are a few evaluation procedures for the software agent. Software agent pro activity is the most important in directing and targeting initiatives. The agent must take the initiative rather than perform a simple task in an unfamiliar environment. There are many studies related to pro activity but those studies are not related to the evaluation process. The steps that are all used are to reach the result.

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Studies There are several studies for software agents and these studies are based on quantitative methods, procedural and object-oriented examples [3]

A software agent evaluates the quality of its features using a set of steps for those features. This set of steps for testing agent-oriented software has not yet been developed, so due to the common features between them, a few software step-by-step examples of software-oriented steps have been adopted. The ability of a software agent to communicate with other agents to achieve a goal is classified as a property of social competence [4].

This paper offers a set of solutions for assessing the social competence of software agents. Measures are divided into three types: Syntax code semantic based, Execution code execution based, Objective data objective based. The measures used in this work apply the concepts of execution-based or dynamic-based agents. In order to validate the output in the quality of a multi-agent system, the evaluation process must take place in a stable controlled environment known as a threshold. Measures are told through an experimental formula that expresses the measurement of parameters as a function of one or more parameters. The result of each step is normalized at intervals [5].

2. Agent Processing and Related metrics

This feature is measured using the following metrics,
Message Response (RFM): It measures the number of messages sent in response to a message received by an agent, as the agent communicates more.
Average Message Size (AMS): It measures the data size of a message sent or received by an agent during a communication. If the message size is too large it leads to bad communication.
Sea Incoming Messages (FIM): It measures the number of messages received by an agent during its lifetime, high values show that the agent depends on the agents required for its services.
Outgoing Messages (FOM): It measures the number of outgoing messages of an agent during its lifetime, if its value ID is high it shows that the agent is a dependent agent [6].

2.2.1 Agent's Cooperation in timely execution of jobs

Feature is measured using the following metrics
Request denied by the Service Request Agent (SRRA): It measures the percentage of rejection agent services under the cooperation. Criteria are considered optimal when the percentage of denied services is low.
Agent Services Advertising (ASA): Measures the total number of services it advertises on the yellow page directory of agents. A lower value indicates that the agent is less cooperative [7].

2.2.2 Negotiation of parameters

Attribute is measured using the following metrics
An Agent Goals Achievement (AGA): It measures the agent's negotiations to achieve his goals.
Messages via Requested Service (MRS): Measures the number of messages sent and received by another agent during its negotiation process with the request for its creation by the agent.
(Messenger Service) Messages sent to make a request: It measures the number of messages sent or received by an agent during the negotiation process with another agent when the agent makes a request to another agent.

Various metrics are designed for the characteristics of the agent-oriented intelligent system, they are determined and developed that measure the quality of the characteristic of the software agent. Even more accurate metrics must be obtained to measure the quality of software

agent characteristics. A quality evaluation model that evaluates models in various software application applications taking into account the various properties and characteristics of the agent must be designed and developed [8].

3. Reactivity property of a software agent

Agent tools use complex development algorithms in distribution applications. Software agents are the building blocks of a multi-agent system (MAS). Software agents are different so they have different properties like proclivity, reactivity, social ability, autonomy and efficiency. Agent behaviour can vary with different inputs and therefore evaluating the quality of a software agent is a difficult process. Character superiority and agent behaviour are not fully provided. This function works with the reactivity property where the quality of the software agent is measured [9] [10].

Software agents are defined as the generalization of a computer program that acts on behalf of another human being. The testing method for the software agent based system is lacking. The reactive property is defined as how it responds and acts according to changes in the environment. Then other properties include autonomous which means that some self control is exercised over states and actions. In this work the quality of the software agent that is developed is tested. The reactive property also describes how the agent perceives the sensors by the environment and uses actuators in a timely manner to make changes.

Measures are not appropriate for reactive properties. Features included
[1] level of interaction of agents
[2] level of communication of agents
[3] Perception level of agents
The interaction level of the agents is included in the matrix
Class Methods per Class (MC) - Specifies the number of methods contained in a particular class
Message Number of Message Types (NMT) - Shows the type of messages and their mode of communication.
Agents are included in the communication level metrics
Message Message for Response (RFM) - Reply to the message.
Incoming Message (IM) - Number and contents of incoming messages.
Going Outgoing Message (OM) - Number and contents of outgoing messages.
Agents are included in the level metrics of vision
Ledge Knowledge Consumption (KUG) - Knowledge is considered the computational value of knowledge.
Ledge Knowledge Update (KUP) - Additional information for the agent to perform additional tasks.
They are implemented in Jade. Case study shopping is done for online shopping system where buyer and seller agents are developed

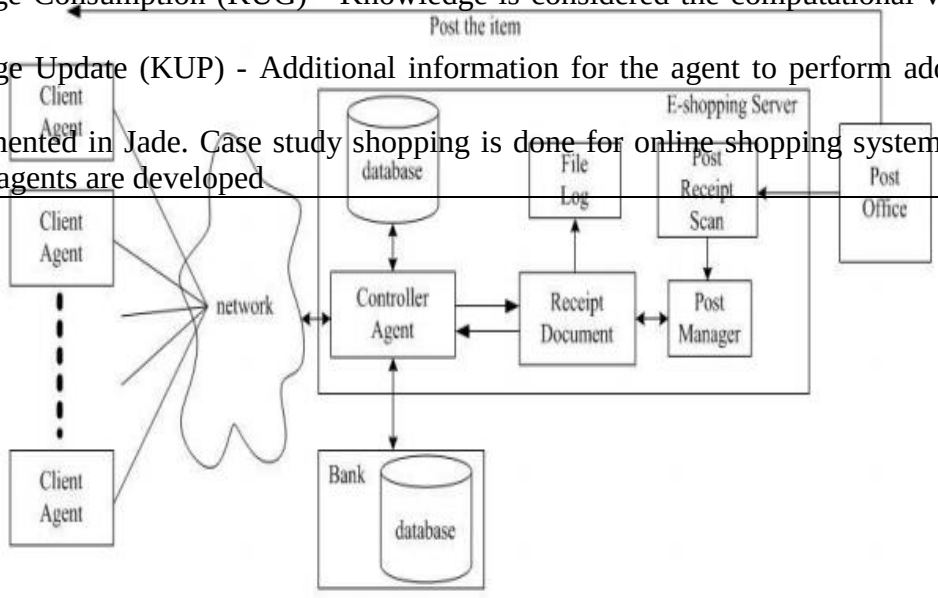


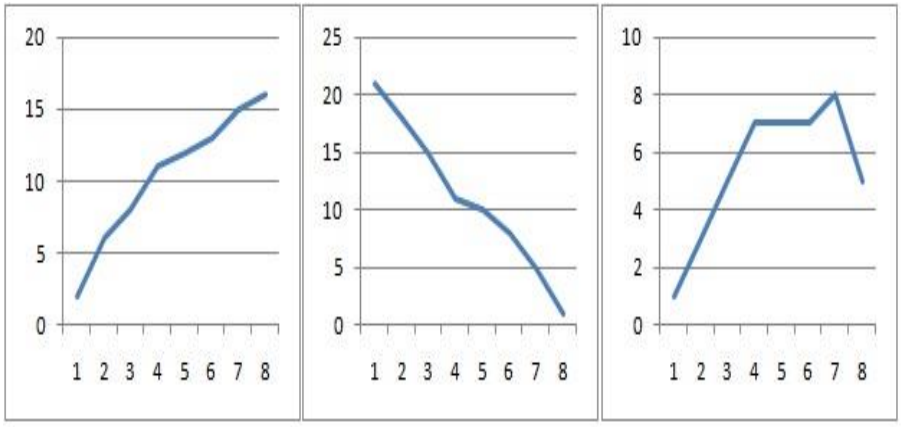
Figure 1. Architecture diagram for online shopping agent

The software quality of the shopping system is measured for its responsiveness properties. They are so simple that they can be based on the designed metrics. Attributes are measured and some more metrics can be added for each attribute so that attributes and properties are measured more accurately. Pro-activity is the property of the software agent that is related to the agent target or output directed behaviour measured using pro-activity. The agent's ability to communicate particularly effectively with other agents is known as social-ability. The agent is able to perform any process without the need for any human intervention known as autonomy.

Must be able to balance the environment and the agent is known as adaptability. The agent is able to move manually into any environment and must interact with the new environment in order to gather information. The agent is able to respond to the explained action known as the agent's reaction. The agent has to take the initiative to suit his goal. Various attributes are used to evaluate the agent target directed characteristics. Pro-activity is the most important factor in the efficiency of a software agent, as there must be a goal for every task.

4. Experimental Setup and Evaluation

The software agent evaluates the quality of the features it has. Agents have different properties and the value of each property is determined using specific metrics. Although there are many metrics with which agents are evaluated, the metrics that exist for the properties are of low quality to evaluate the software agent. In general we have considered three properties of an agent and that is reactivity, social ability and activism. The metrics that exist to measure MAS quality fail to address potential communication, initiative behavior, and learning ability. We have therefore proposed metrics of potential communication, initiative behavior and learning ability for effective evaluation.



$$log k_{k+1}\ (x+1)\ 0 \le x \le k \qquad \begin{cases} 0 \le x \le k & \frac{e^{-(x-k/2)}}{k}\ 0 \le x \le k \\ e-(x-k)^2\ x > k \end{cases}$$

Figure 2. Formula type used in the measures

a) *Time Duration Between Goals* (TDG): TDG measures the influence of percentage of time taken to accept a goal after finishing a task. Higher values indicate that the agent is not ready to accept tasks .Let is define that TD measures the time duration between the end of first task and the start of the next task .The. If ET is the end time of first goal and ST is the starting time of the next goal then TD gives the time taken to start the next task (equation 1).

$$TD = (ST-ET)*100 \qquad (1)$$

The TDG measure (equation 2) depends on the value of TD and describes curve (a) in figure. This measure is considered to be optimum if the percentage of time taken is low (TDG=1).The value of K depends on the environment in which it operates.

$$TDG=\begin{cases} 1 & 0 \le TD < K \\ e^{-\frac{(TD-k)^2}{K^2}} & TD > K \end{cases} \qquad (2)$$

b) *Environment changes* (EG): The agent must be ready to accept the environmental changes and start working to achieve the goal. The amount of how the agent is interactive depends on the agent's readiness to accept changes. If the agent is not able to adapt to the new environment it affects in achieving the goal and also the quality of the software agent

c) *Rejection of Goals* (ROG): ROG measures the influence of percentage of rejection of goals on reaction. Let us define AG as the total number of accepted goals and RG as the total number of goals rejected by the agent .We then define the value of REG (equation 3) as the percentage of goals rejected by the agent when RG+AG>0.

$$REG=\frac{RG}{RG+AG} * 100 \qquad (3)$$

The value for ROG (equation 4) describes curve (a) in figure. This measure is optimum if the percentage of rejected goals is low (ROG=1).The value of parameter K depends on the type of activity performed by the agent and the environment in which it operates.

$$\text{ROG}=\begin{cases} 1 & 0 \le REG < K \\ e^{\frac{-(REG-k)^2}{K^2}} & REG > K \end{cases} \quad (4)$$

d) *Response for Each Received Message* (RERM): RERM measures that whether each received message is give a response or not. If RM is the total number of received messages and SM is the total number of messages sent in response from the agent to the requested agent and n is the total number of messages received and sent by the agent during one execution of benchmark. Then the value of RR is (equation 5)

$$\text{RR} = \frac{RM-n}{RM} \quad (5)$$

The RERM measure (equation 6) depends on the value of RR and describes the curve (b).Its value increases as the agent gets more communicative until RR reaches a particular value k_1.At this point it reaches maximum value and remains unchanged until the value of RR is k_2.

$$\text{RERM}= \begin{cases} \left(\frac{2RR}{K_1}\right) - \left(\frac{RR}{K_1}\right)^2 & 0 \le RR < K_1 \\ 1 & K_1 \le RR \le K_2 \\ e^{\frac{(RR-K_2)^2}{K_2^2}} & RR > K_2 \end{cases} \quad (6)$$

e) *Language Capability* (LC): LC measures the human language capability of a software agent. We define L as the total number of languages that the agent is familiar. It follows the curve (c) in the figure.

$$\text{LC}=\log_{K+1}(L+1) \quad (7)$$

As the agent gains experience its language capability also increases.

f) *Is Message to Requested Agent* (IMRA): IMRA measures whether the message is sent to the requested agent or not. If R defines the total number of messages received by the requested agent and S denotes the total number of messages sent by the requesting agent to another agent. RA gives the percentage of the messages sent to the appropriate requested agent.

$$\text{RA}=\frac{R}{S} * 100 \quad (8)$$

The IMRA measure (equation 9) depends on the value of RA and describes the curve (b).IMRA is optimum when the value of RA lies between k_1 and k_2. The value of k_1 and k_2 depends on the environment in which the agent is operated.

$$\text{IMRA}=\begin{cases}\left(\frac{2RA}{K_1}\right)-\left(\frac{RA}{K_1}\right)^2 & 0\le RA<K_1\\ 1 & K_1\le RA\le K_2\\ e^{\frac{(RA-K_2)^2}{K_2^2}} & RA>K_2\end{cases} \quad (9)$$

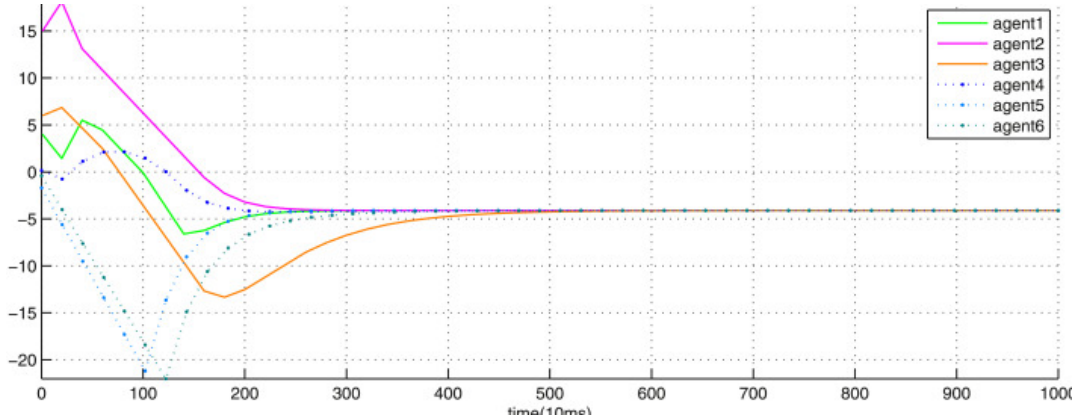


Figure 2. Multi agent input processing with respect to execution time

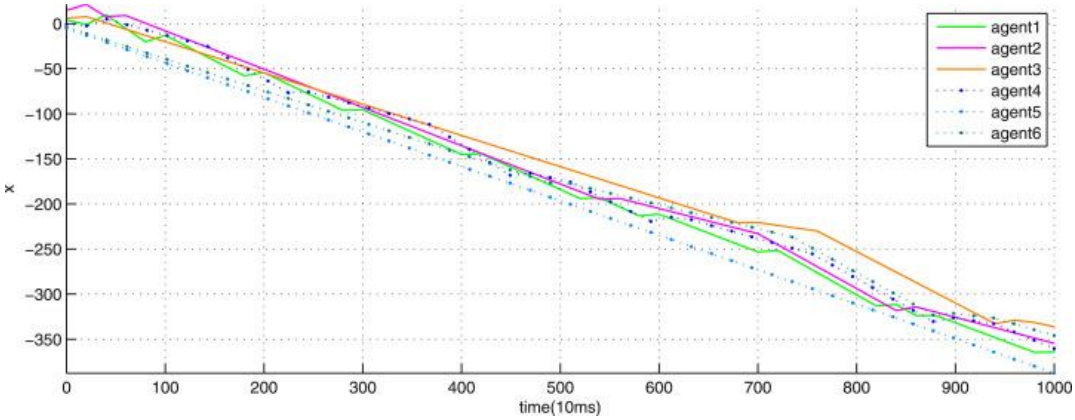
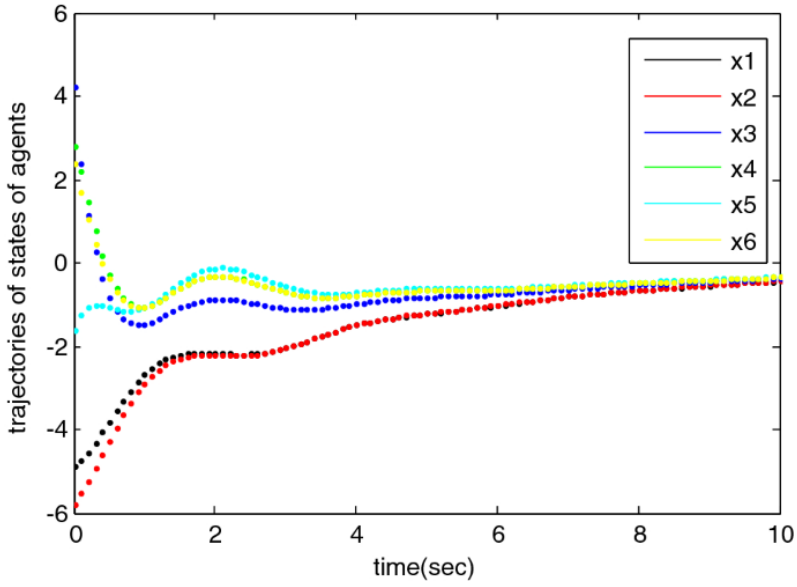


Figure 3. Multi agent triggering based on requests



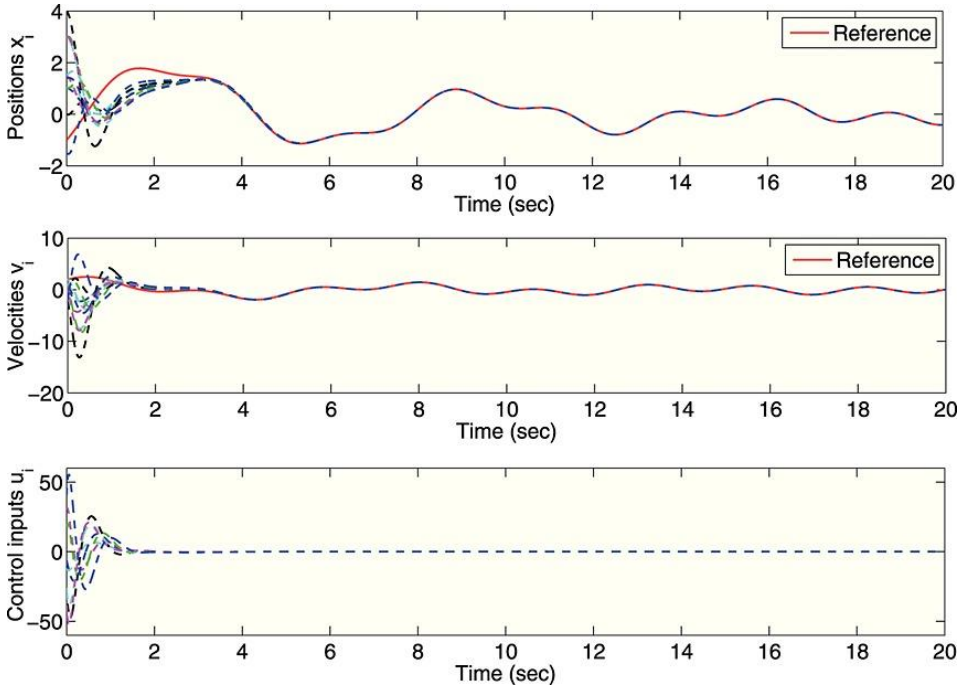


Figure 4: Exponential Calulation of each reques QoS using TensforFlow

The metrics for the Interaction and communication are described in the previous properties so in Reactivity property the Perception level attribute is discussed below. Knowledge Sharing measures the average value of how the knowledge is shared with an agent requesting for knowledge. A higher value of KS shows that it is more reactive and co-operative with the agents in the environment.

5. Conclusion

Evaluating a software agent is not an easy task. The quality of the software agent is evaluated using appropriate metrics. From the survey it is understood that the available metrics are insufficient to evaluate the Multi Agent System (MAS). Properties such as pro-activity, reactivity and social competence have already been proposed but the metrics used in them are not up to the level of any MAS evaluation method. Therefore metrics like RERM, EG, LC, IMRA, KS, TDG, ROG are added to those features.

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