Best Selection of ASEAN Universities Based on Multi-agent System

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Abstract

Today, multi-agent system is currently popular in computer science communities. Multi-agent system consists of a number of agents which can interact with each other to reach their overall goal. In this paper, we present the best selection of universities for five developed countries from ASEAN countries based on multi-agent system and calculate expected utility to select optimal agent. Firstly, the required parameters for the system are accepted and then the universities information associated with the desired results are obtained. It includes a master agent also act as an interface agent and the other slave agents. The required information is received by master agent and it then suggests the best and the further suitable university information and optimal agent to user. Consequently, the results depended on incoming information are searched by slave agents and reply the result. This system is constructed based on the multi-agent technology and making for the best used of the user who want to know the university information.

Keyword: Multi-agent, expected utility and Optimal agent

1. Introduction

The concept of agents is very popular and the term 'agent' has been applied quite widely in the fields of information systems research and development at the moment. An agent is a computer system that act automatically on behalf of users and capable of interacting with other agents to achieve their design objectives. Agents are capable of flexible (reactive, proactive, social ability) behavior.

A multi-agent system can be defined as a collection of possibly heterogeneous, computational entities, having their own problem solving capabilities and being able to interact among them in order to reach an overall goal. Communication is one of the critical aspects in multi-agent systems because it enables agents to exchange information and coordinate their activities. From the viewpoint of control, Multi-agent System (MAS) architectures can be categorized into centralized, distributed, and hybrid architectures. The centralized multi-agent architectures share many of limitations of master-slave architectures. The distributed architectures are much more complex because of complicated information control. The hybrid architectures combine the advantages of these two types of architectures [7].

Nowadays, there are many people who interested to study abroad in various universities not just because they provide very good education but also the opportunities provided by them to explore a career is notable. Due to the quality of education provided by universities in different countries, many students are trying to study abroad and make the best career in the fields they are interested. There are various international universities that are now providing opportunities for various students belong to different countries to come and study [10].

In this paper, we present the best universities information searching system based on multi-agent technology and the selection of optimal agent based on expected utility.

This paper is organized as follows: section 2 provides some related works. The overview of agent is described in section 3. In section 4, we describe the proposed system architecture. Finally, we conclude the paper in section 5.

2. Related Work

K. Subarmaniam and K. Emaliana [5] proposed a framework of an intelligent multi-agent based information retrieval for education management. This framework is contained with the multi-agent education management system and an ontology model. This system can help school administrators to search for information precisely and rapidly. This system will free education administrators from relatively tedious tasks to focus more on decision-making processes.

At paper [2] described a multi-agent platform for web educational resources retrieval driven by cultural aspects. This proposed architecture helped users to find courses according to their personal and cultural aspects such as preferences and ways of behavior determined by the person's culture.

L. Xin, S. Leen-Kiat [6] proposed the application of decision and utility theory in multi-agent system. This paper explained the applications of decision-related theories such as decision theory, utility theory, probability theory and game theory.

H.Thaung Thaung [4] proposed the multi-agent system for general admin department. This frame work is intended to develop multi-agent information system for General Administration Department effectively. This system contained a number of concurrently executing agents they can communicating with each other through broker agent.

The authors [1] proposed the applications of self-organizing multi-agent systems. This paper presented agents with abilities to automatically devise societies to form coherent emergent groups that coordinate their behavior via social laws. This paper provided several examples of multi-agent systems in which self-organization are used to solve complex problems. Several criteria for comparison of self-organization between the different applications are also provided.

3. Overview of Agent

Agents are computer system with two important capabilities. First, they are at least to some extent capability of autonomous action for deciding themselves what they need to do in order to satisfy their design objectives. Second, they are capable of interacting with other agents. Advantages of using agents are that the agent can work on tedious, repetitive tasks without losing attention and they act and react in situations more quickly than the user. Multi-agent system is a relatively new subfield of computer science. This system is composed of multiple interacting agents. Multi-agent is an outgrowth of distributed artificial intelligence community. It is a large scale system which contains a lot of agents with different goal, concept and structure.

4. System Architecture

The proposed system is the best university information selection based on multi-agent technology. This system involves the access to the databases representing the university data for five developed countries from ASEAN countries. This system includes a master agent also act as an interface agent and five slave agents representing the countries.

The action of the master agent is that it can also act as an interface agent. It receives the user inputs and it can distribute the accepted inputs into other slave agents. Master agent also performs the action such as when the results from the slave agents are received, it can suggest the best and the further university information and the optimal agent to user.

The action of the slave agent is that it can accept the distributed request and then it can search the university information from their related database. After searching the information, this information is responded to the master agent.

At this proposed system, agents can interact with each other to accomplish their desired result in the shortest time. As the enhancement of technology in the field of agent, interacting takes the main part to accomplish the tasks rapidly. In the proposed system, a single master agent also acts as interface agent makes the tasks allocation to the slave agents. The master-slave relationship has two types of interaction. Firstly, a single master agent sends the request to slave agents. Secondly, more complicated relation, a master agent sends the request to the slave agents, and then sends again to the lower level slave agents. The slave agents that send again the request become the master agent [3]. The proposed system used simple master-slave interaction.

4.1. Functionality of Agents of the System

Master agent also act as Interface agent: Master agent also act as interface agent is responsible for interacting with the user for accepting the user request, distribute this request to slave agents and can accept the reply from slave agents. Then, display the best and the other output results and the optimal agent by using the proposed best selection algorithm to user. Figure 1 shows the master agent's operation and communication with other slave agents.

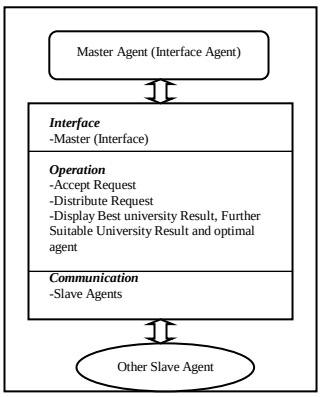

Figure 1. Master Agent

Slave Agent: This system includes five slave agents representing five developed countries. These agents accept the request distributed from master agent and each of the slave agent searches the university information from their associated database according to the requests. After searching the information, each of the slave agents replied the searching results to master agent. Slave agent's operation and the communication to master agent are shown in figure2.

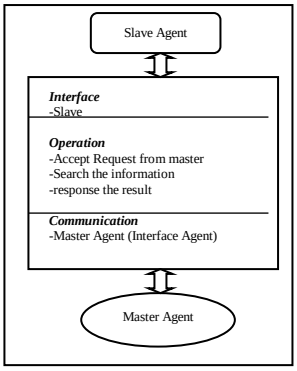

Figure 2. Slave Agent

4.2. Selecting Optimal Agent

The optimal agent is the agent that making things to achieve their wanting by choosing with maximal expected utility. There are different optimal agents exactly when there are actions with equal expected utility. This agent will maximize its expected utility whatever the current state. The optimal agent Ag_{opt} [9] from agents (AG) is chosen with the maximum expected utility (EU) according to the equation (1). By the selection of optimal agent, the system can get the most appropriate universities information. The expected utility (EU) of the agents [8] is calculated with the equation (2). Where, u(r) is the utility function for run (r), P is the probability of run for the agent (Ag) in the environment (Env). The probability of the agent for successive run is described in equation (3). u (r) is the utility function for description of agent ability can be seeing in equation (4).

$$Ag_{opt} = \arg\max_{Ag \subset AG} EU(Ag, Env) \quad (1)$$

$$EU(Ag, Env) = \sum_{r \in R(Ag,Env)} u(r) P(Ag, Env) \quad (2)$$

$$\sum_{r \in R(Ag,Env)} P(r \setminus Ag, Env) = 1 \quad (3)$$

$$u(r) = \frac{\text{no of rows found that satisfied all of the inputs in r}}{\text{no of rows that have to find in r}} \quad (4)$$

Assigning the environment (Env) is described in equation (5). A symbol E is the set of states; e_0 is the starting states of each agent and τ is the state transformer function for the action of each agent α. As this proposed system includes four inputs such as degree, group of subject, subject and scholar, it has sixteen states. The probability can get according to the reach state.

Environment, $Env = < E, e_0, \tau >$ (5)

As an Example,
Let w = degree, x = subject group, y = subject and z = scholar.
w = Master degree, x = Computer Engineering, y = Computer Application, z = scholar yes

The set of states $E = \{e_0, e_1, e_2, e_3, \ldots, e_{16}\}$

e_0 = an initial state of agents
The agents can get any state from E after the actions have been done.

$$\tau(e_0 \xrightarrow{\alpha_4}) = \{e_1, e_2, e_3, \ldots, e_{16}\}$$

$$\tau(e_0 \xrightarrow{\alpha_0}) = \{e_1, e_2, e_3, \ldots$$

$$\tau(e_0 \xrightarrow{\alpha_1}) = \{e_1, e_2, e_3, \ldots$$

$$\vdots$$

The actions of the agents with respect to this environment:

$$\tau(e_0 \xrightarrow{\alpha_4}) = \{e_1\}$$

Ag_1 (e_0) $= \alpha_0$, Ag_2 (e_0) $= \alpha_1$ …

Ag_5 $(e_0) = \alpha_4$

As an example for all of the inputs are satisfied by the agents. So the agents can get to state e_1.

$$\tau(e_0 \xrightarrow{\alpha_0}) = \{e_1\}$$

$$\vdots$$

The probabilities for all of the inputs are satisfied are:

$$P(e_0 \xrightarrow{\alpha_0} e_1 \setminus Ag_1, Env) = 1$$

$$P(e_0 \xrightarrow{\alpha_1} e_1 \setminus Ag_2, Env) = 1$$
$$\vdots$$
$$P(e_0 \xrightarrow{\alpha_4} e_1 \setminus Ag_5, Env) = 1$$

The utility (u) for the agents are calculated by equation (4):

$$u(r \setminus Ag_1, Env) = 0.15$$
$$u(r \setminus Ag_2, Env) = 0.25$$
$$u(r \setminus Ag_3, Env) = 0.2$$
$$u(r \setminus Ag_4, Env) = 0.0$$
$$u(r \setminus Ag_5, Env) = 0.1$$

Expected utility (EU) is calculated by equation (2):

For Agent1, $EU(Ag, Env) = 0.15 * 1 = 0.15$

For Agent2, $EU(Ag, Env) = 0.25 * 1 = 0.25$

For Agent3, $EU(Ag, Env) = 0.2 * 1 = 0.2$

For Agent4, $EU(Ag, Env) = 0.0 * 1 = 0.0$

For Agent5, $EU(Ag, Env) = 0.1 * 1 = 0.1$

After the expected utilities have been calculated, the optimal agent is selected by equation (1).

$$Ag_{opt} = \arg \max_{Ag \in AG} EU(Ag, Env)$$

= max (0.15, 0.25, 0.2, 0.0, 0.1)
= 0.25

So, Agent2 is the optimal agent.

4.3. Algorithm for Master Agent

```
Begin
    Accept degree, subject group, subject and scholar;
    Sent data to Slave Agents;
    Receive result universities information from Slave Agents;
    If (degree, subject group, subject, scholar from Slaves match
       user inputs);
        Store the result universities information to Temp1 table;
        Display the university information from Temp1 table;
     Else If (degree, subject group and subject from Slaves match
           user inputs but not match scholar)
        Store the result universities information to Temp2
        table;
     Else
        Not store to any table;
    End If
    If (user request = "Optimal Agent")
        Calculate the expected utility for the selection of Optimal
        Agent;
        Display the Optimal Agent and the best universities
        information of the Optimal Agent;
    End If
    If (user request = "Further Suitable Result")
        Display the university information from Temp2 table;
        If (user request = "Optimal Agent")
            Calculate the expected utility for Optimal Agent;
            Display the universities information of the Optimal
            Agent;
        End If
        If (user request = "Further Suitable Result")
            Display the universities information from
            Temp1 table;
        End If
    End If
End
```

Figure 3. Algorithm for Master Agent

4.4. Algorithm for Slave Agent

```
Begin
    Accept degree, subject group, subject and scholar from Master
    Agent;
    If (degree or subject group or subject or scholar matches
        Master Agent data);
        Store the university information to Temp table;
        Reply University Information from Temp table to Master
        Agent;
    End If
End
```

Figure 4. Algorithm for Slave Agent

4.5. System Flow of the Proposed System

The system flow diagram in figure 5 shows the step by step working procedure of the system. In this system, the user firstly enters the desire degree, subject group, subject and scholar. Then, the master agent also acts as an interface agent distributes the accepted inputs to slave agents representing each of the countries. All of the slave agents search the result information from their databases and responded the finding results to master agent. Master agent describes the best and further suitable information by using master agent algorithm and calculates the utility and expected utility model. Then, the optimal agent is selected by the optimal agent formulation. By selecting optimal agent can get the more suitable universities that match with the user inputs. Finally, the universities information of the optimal agent is display as the result to user.

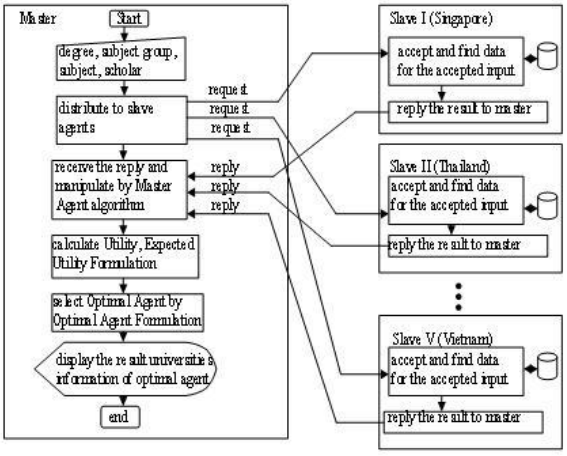

Figure 5. Flow diagram of the system

4.6. Database Table

The proposed system uses five databases such as singapore_db, thailand_db, malaysia_db, indonesia_db and vietnam_db representing five developed countries from ASEAN countries such as Singapore, Thailand, Malaysia, Indonesia and Vietnam.

Each of the databases of the proposed system uses the following tables:

1. Academic Table
2. Control Table
3. Course Level Table
4. Group Table
5. Subject Table
6. Information Table

5. Conclusion

Nowadays, there are many people who interested to study abroad in various universities in different countries to make the best career in the fields they interested into.

By using the proposed system, the user can get the suggested university information in the shortest time. This system is constructed for the universities of five developed countries from ASEAN countries such as Singapore, Thailand, Malaysia, Indonesia, and Vietnam. The proposed system shows the interaction of master and slave agents in the multi-agent system. This system can search the best suitable universities information according to the user preference and based on the selection of optimal agent. This system also provides the concepts of the utility and expected utility model to select the optimal agent.

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