ANT COLONY OPTIMIZATION FOR ADAPTIVE LEARNING

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Abstract: This paper aims to produce the best Learning Object (LO) for the learners in e-learning based on the learner characteristics. Delivery of optimal learning objects is a challenging task because the learning object (e.g., learning content, materials) should be suitable for learner’s knowledge. To forecast the best learning objects, the Ant Colony Optimization (ACO) with learner characteristics has been proposed. ACO is an important probabilistic technique used to find the good solutions for hard problems in a reasonable amount of computation time. For adaptive learning, ACO observed the most recurrent trails followed by the previous learner. Therefore, in this paper an advanced e-learning is proposed, which provides flexibility for the learners based on learner characteristics as some e-learning abandon to consider learner characteristics and desires.

Keywords: E-learning, ACO, Learning Objects, Adaptive learning

I. INTRODUCTION

The Internet is revolutionizing the society, economy and technological systems. One of the interesting usages of Internet is e-learning. E-learning is the use of technology to enable people to learn anytime and anywhere. E-learning can include training, the delivery of just-in-time information and guidance from experts.

The growth of searching technology has facilitated rapid access to amount of information on the Internet, thus assist to develop traditional learning to a global perspective. Two problems arise here: the “one size fits all” (1) offer the same learning materials to each learner, and the immense amount of information leads to information overload (2). To overcome these problems the population-based heuristic ACO algorithm and learner characteristics for the adaptive learning is proposed. ACO aim at exploring an optimal learning object and the system must be focused on learner characteristics. Each learner has different characteristics such as learning style and knowledge level (e.g., apprentice, beginner, intermediate and expert); each LO has its own characteristics also, such as different types (e.g., text, video etc.) and different levels (e.g., initial, introductory etc.). Kolb’s (1984) learning style is utilized. Style differs from one learner to another, some learn by Diverging (feeling and watching), Assimilating (watching and thinking), Converging (doing and thinking), and Accommodating (doing and feeling). Establishing the best Learning Objects for the learners is confidently not a new approach but based on the paths followed by the earlier learners and the learner characteristics have resulted in the expansion of adaptive learning.

2. LITERATURE SURVEY

This literature survey classifies the different approaches to adapt the best learning object in an e-learning system. Evolutionary computation is the field of study devoted to the design, development, and analysis for problem solvers based on natural selection (simulated evolution) (3). Evolution has proven to be a powerful search process. Evolutionary computing techniques mostly involve metaheuristic optimization algorithms which include Swarm Intelligence (SI). SI is an Artificial Intelligence (AI) technique based on the collective behavior in decentralized, self-organized systems. It contains agents which interact with each other and the environment. With no centralized control structures. It is based on group behavior found in nature (4,6,7). The two technique used in SI are Ant Colony Optimization (ACO) and Particle Swarm Optimization (PSO). PSO is a computational method as it makes few or no assumptions about the problem being optimized and can search very large spaces of candidate solutions. PSO can therefore be used on optimization problems that are partially irregular, noisy, change over time, etc. ACO is a probabilistic technique for solving computational problems which can be reduced to finding good paths through graphs (5,15). ACO provides more adaptive and strong solution. The various advance of the ACO for adaptive learning is discussed in the following segment.

Learning Profile of Previous Users

This approach generates adaptive learning path by taking the previous user’s learning profile by using an extensive ant colony system approach (8).
Adaptive learning based on style

Style based is an extensive ant colony system for adaptive learning. The learning rule was developed to identify how learner of different styles may associate those contents which have higher probability of being useful to form an optimal learning path (9). They used VARK (Visual, Aural, Read and Kinesthetic) model.

Adaptable Learning Pathway Generation

The learner’s performance logs are thus gradually built up. When the next new learner logs on, the system will select up to a specific number of previous learners who have similar profiles (10). The paths they have taken and their performance are analyzed by ACO to induce a path for the new learner.

Adaptive learning based on pattern graph model

For adaptive learning, they have taken the data mining based frequent pattern graph model to define the association and sequencing between the words and then adopted ACO to derive a searching technique to obtain learning path (11).

Adaptive learning based on attribute

Attributes of the learner and learning objects are considered for providing the learning object. Kolb’s learning style was modeled (12). The learner activities of each learner in e-learning recorded into learner object repository. Based on the learner attributes it provides the learning object.

Adaptive learning based on hypermedia

Adaptive hypermedia systems are used here. It offer free exploration learning however they adapt to the user’s knowledge level and learning goals, offer help and the user can full control over it (13). Kolb’s learning style is used.

Adaptive learning based of hyperlinks

The online materials can be organized in a graph by means of hyperlinks of education topics (14). The learner move on the graph leaves pheromones in the arc. The process is referred as man-hill. Successive represent in positive pheromones and failure by negative pheromone.

3. PROPOSED APPROACH

As ACO for Adaptive Learning provide the best learning object in an e-learning system (18) for adaptive learning, the algorithm makes use of the learner characteristics and ACO. The following description of the proposed approach, will improve the recital of the system by providing most suitable learning object for learners.

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ACO is normally used to solve minimum cost problems. ACO is a metaheuristic in which a colony of artificial ants cooperates in finding the shortest path between a food source and the nest. The ants lay pheromones to mark trails (16,17). Pheromone trails can be measured. When there are more pheromones on the path, there is larger probability that other ants will use that path, and therefore the pheromones trails on such a path will grow faster and attract more ants to follow. Similarly the learners also follow the most visited learning object. This help the learners advance their E-Learning.

In this section, we present ACO with its characteristics as a method of finding the learning paths and then provide adaptive LO for learners. ACO updates the trail pheromones from different knowledge levels and different style to create dynamic learning object. To achieve this three basics principles are applied. They are (a) E-learning system knows the learner’s characteristics which include the learner’s knowledge level and learning style (Kolb). (b) Adaptive matching rule is generated to match the relationship between learner and learning object. (c) Providing the best learning object for the learner based on ACO. (a) The e-learning system should have complete knowledge about the learner characteristics and desires. Advanced e-learning provide more suitable LO to the learners. The following table created for differentiating the learner’s and LO’s characteristics.

<table>
<thead>
<tr>
<th>Learner Characteristics</th>
<th>Learning Style</th>
<th>Diverging</th>
<th>Assimilating</th>
<th>Converging</th>
<th>Accommodating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Level</td>
<td>Apprentice</td>
<td>Beginner</td>
<td>Intermediate</td>
<td>Expert</td>
<td></td>
</tr>
<tr>
<td>Learning Object</td>
<td>LG Type</td>
<td>Graphic</td>
<td>Video</td>
<td>Text</td>
<td>Coding</td>
</tr>
</tbody>
</table>
(b) Adaptive matching rule is generated to match the relationship between learner and LO’s.

![Matching circumstances diagram](image)

Adaptive matching rule is illustrated using an example. As show in Fig.1, The learner has the characteristics of learning style as converging and knowledge level as Intermediate, the adaptive matching rule provide the best LO to the learners. Converging style learner use the LO in the format of text (doc, ppt etc.) and the Intermediate level use the LO as advance level. Final alone is the complete contest to learner characteristics.

(c) Providing the best learning object for the learner set on characteristics based ACO. The proposed algorithm has six main steps for resolving the problem of adaptive paths, and pseudo-code of the characteristics based ant colony system is shown as the following.

![Algorithm of Ant Colony Optimization for adaptive learning](image)

**Initialize characteristics**

The procedure which initializes the learning style, knowledge level, LO type and LO level. Learner characteristics are the inputs from the learner and learning objects are the output provided by the system.

**Construct solution**

The procedure which construct the solution, the learner visit the learning object based on the paths of previous learner and put into optimal solution list.

**Update pheromone trails**

The procedure which updates the most visited paths of the learner. Considering learning characteristics of the learner, dynamically it adds the learning object has the same characteristic each time.

**Compute heuristic match rule**

The procedures which compute the Match Ratio (MR) for learning style and learning object level along with the pheromone values.

**Listing the learning object**

The procedure which obtains the adaptive learning objects from the optimal solution list. The following section will give details about the implemented system.

4. THE IMPLEMENTED SYSTEM

This section introduces the system architecture which is based on the algorithm in the Fig.2. The framework of the system is shown in Fig.3. The system includes Learner, E-learning system, Learner database, Learning Object database, Author and Algorithm of ACO based adaptive learning. Initially the learner enters into the e-learning system. The learner details will automatically updated in the learners database. Learner details consist of learning styles and knowledge level and keyword to search. This will be analyzed by the algorithm of ACO based adaptive learning. This provides heuristic match rule, match rule is responsible for ranking learning objects and matching
ratio is calculated. The author uploads the new learning object into the LO database in a commonly accessible format, so that the learner can efficiently search and retrieve the suitable learning object.

Fig. 3. The framework of the e-learning system based on ACO

The following section describes briefly how the algorithm works for SQL course. Fig. 4 shows the match ratio efficiency with pheromone updation. Fig. 5 shows the entire layout of the e-learning system, in that learners can register with the system. He/she enters the details in the registration form. The learner should mention his/her style of learning. The learner has to mention the knowledge level and keyword to search SQL learning objects. Based on the learner characteristics the adaptive learning objects are generated. Fig. 6 shows the generated learning object which are represented by paths.

Fig. 4 Heuristic match ratio

Fig. 5 The User Interface of e-learning system for registration
5. CONCLUSION
The early e-learning system did not include the characteristics of learner and ended up with rigid e-learning systems. At present, customized LO’s which adapts to learner’s perspective is a powerful constraint of any e-learning system.

In this paper three basics (a) E-learning system knows the learner’s characteristics which include the learner’s knowledge level and learning style (Kolb). (b) Adaptive matching rule is generated to match the relationship between learner and learning object. (c) Providing the best learning object for the learner based on ACO is defined.

The learning object can be generated using Ant Colony Optimization. This is because the various learner’s characteristics are measured for adaptive learning. The heuristic matching ratio values deviation learner’s from knowledge level and style are calculated. ACO are best suitable for handling multiple constraint satisfaction problems which have many alternative solutions.

6. ACKNOWLEDGEMENTS
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REFERENCES

Fig.6. The best learning objects are retrieved