

DETERMINING OPTIMIZED LEARNING PATH FOR AN E- LEARNING SYSTEM USING ANT COLONY OPTIMIZATION ALGORITHM

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Abstract— This paper analyzes the optimized learning path based on the behavior of student's pattern by applying ant colony optimization algorithm in e-learning application. The behavior of pattern is analyzed based on the behavior of each particular students and the resource is analyzed through learning management system which can be used to predict the student's motivation for the first time user. The student's motivation is main factor for the successful completion of e-learning course. According to the knowledge of student's motivation it provides the outcomes which to optimize the learning path.

Keywords- Optimized learning path, Behavioral knowledge, Ant colony optimization

I. INTRODUCTION

The Internet plays a major role in our day to day life. The Activities that are unavailable over the Internet are network banking, e-entertainment, online information acquisition, e-business, and distance learning. Because of the Internet's characteristics, an online e-learning system eliminates the major disadvantage in learning perspective: location, time, and age. Lifelong learning is easily satisfied through an e-learning system. Contrast with the traditional learning perspective, e-learning systems are higher up in terms of independence, convenience, adaptation, and interaction.

The Data Mining concepts are applied in the E-Learning application which is commonly referred to the use of networked information and the communications technology in teaching and learning process. The other term also describes the mode of teaching and learning process. Data mining is the process of discovering knowledge from larger database. Data mining has analytical process to derive knowledge and that to be used in data. This knowledge cannot be discovered by normal data, because the relationships are more complex and it present with larger data. These data mining concept are used in process such as online education, virtual education, distributed network education and web based education. These are all referring to educational processes that utilize information and communications technology that mediate to asynchronous as well as synchronous learning and teaching process.

The Data Mining practitioner models have many techniques that include: Genetic Algorithms, Clustering, Fuzzy Logic, and Intelligent agents, Neural Networks and Inductive Reasoning, Visualization techniques. And the information is organized according to the type of Data Mining problem is dealt with the algorithm such as: clustering, classification, prediction, etc.

Our paper uses the Ant Colony Optimization Algorithm by applying Data Mining techniques in E-Learning application to find an Optimized Learning Path based on the students behavior. An Ant Optimization Algorithm is essentially a system based on node that simulates the natural behavior of ants.

II. RELATED WORKS AND MOTIVATION

A. Related Work

Many techniques have been applied in e-learning system in order to obtain the learning path based on the learning knowledge behavior. The Web-based learning portfolios which help teachers to perform the assessments process of individual learners in a Web-based learning environment. The learning can be applied as a guide for teachers and as learning feedback is gets for learners. This feedback mechanism enables learners to understand the process of their current learning status and make suitable learning process [8]. Ant colony optimization (ACO) algorithms are a class of swarm intelligence algorithms in order to solve the discrete (combinatorial) optimization problems, such as traveling salesman problems, network routing problems,

scheduling problems, and circuit design problems. When solving these problems, multiple knapsack problems, pheromones are deposited by ants on links or nodes connecting the nodes [6]. The classification rule discovery problem is a set of training data which comprising one or more attributes and a class attribute, which extracts rules providing the separation of that data into different classes of attribute. And thus it focuses on discovering a new heuristic function and utilizing the framework of Ant Colony Optimization (ACO). This process has the desirable properties of high accuracy and classifier comprehensibility [7]. In a Computer Architecture Laboratory of course classroom session the students are spitted into two groups in order to interact both with a hinting e-learning system and also with human teachers generating hints. The results shows that the high learning gains for both groups, demonstrating the effectiveness of the human teachers as well as of the computer-based hinting technique in e-learning system even without the use of adaptive and personalization capabilities. The worst case, the difference in favor of human teachers would not be significant with respect to the e-learning system, so the computer-based system can replace teachers without a significant loss of effectiveness [1]. The pattern recognition and augmented reality is proposed in interactive e-learning system. The proposed e-learning system was applied to the educational courses in the elementary school, and we obtained satisfactory results for real applications. We expect that the proposed e-learning system is popular when the educational contents and scenarios are sufficiently provided [2]. The adaptation and personalization is applied in e-learning systems. A new metric—QoL (Quality of Learning)—is recommended for e-learning systems to evaluate the learning process. This paper proposes the Adaptive & Personalized E-Learning System (APeLS) that provides dynamic learning content and an adaptive learning process for learners to enhance the quality of learning. According to feedback from the learner, the proposed APeLS is capable of self-adjusting and self-reorganizing the learning components and paths to adapt to each user's learning interests, abilities, and behavior. This adaptation and reconfiguration is produced according to the user's QoL and a dynamic referred ideal learning curve. To ensure QoL, the proposed APeLS revises each user's learning curve to match with the referred ideal learning curve. A prototype system is implemented, and the collected results are excellent []. In this paper, we are focus on learning recourse i.e the subject chosen by the student is considered as a node. By this way, can construct the path using the node i.e subject who visited by the student. Thus the learning paths are identified by applying ant algorithm based on their ability that shows the result as successful completion through an optimized path.

B. Motivation

In this paper, the Ant Optimization algorithm is applied in order to obtain the optimized learning path that has been analyzed based on the searching behavior of ant. By this way applying Ant Optimization algorithm thus it identifies the Optimized learning path based on student's learning and behavior or similar characteristics of searching resources. The optimized learning path thus it identified based on following similar characteristics: feedback about each learning material, more accessible learning and learning behavior. In order to group the student, the similar characteristics are to be followed: the achievement, preference of choosing resources. According to these characteristics, the students are grouped as either lower division students or upper division students based on the path constructed. These paths are constructed by applying ant colony optimization algorithm which retrieves the optimized learning path to the first time students.

III. PROPOSED WORK

In E-learning Scenario, the internal process of learning is implemented based on the learning behavior information. By applying Ant Colony Optimization algorithm to the E-learning scenario which identifies the optimized learning route based on student's learning ability, learning goals and behavior of searching resources that helps to improve the student's with their results.

In our paper, focuses on three stages: i.) Profiling, ii.) Course generation, iii.) Testimonial process. In profiling stage, the personal and the academic data are collected in e-learning system. Based on their profiling information, the learning path and their response are constructed from the optimized learning environment after course generation. In course generation stage, the course is being offered to the students with effective learning style. And, thus the optimized learning path is suggested to the first user student based on the previous set of response feedback and adjustment of learning using testimonial process. This can be done by applying ant colony optimization algorithm. By observing the similar characteristic of students achievements, goal, process, the learning path are analyzed for each particular student. The learning paths are identified by the visitation rate of each node. According to these characteristics, the students are grouped as either lower division students or upper division students based on the path constructed. These paths are constructed by applying ant colony optimization algorithm which retrieves the optimized learning path to the first time students.

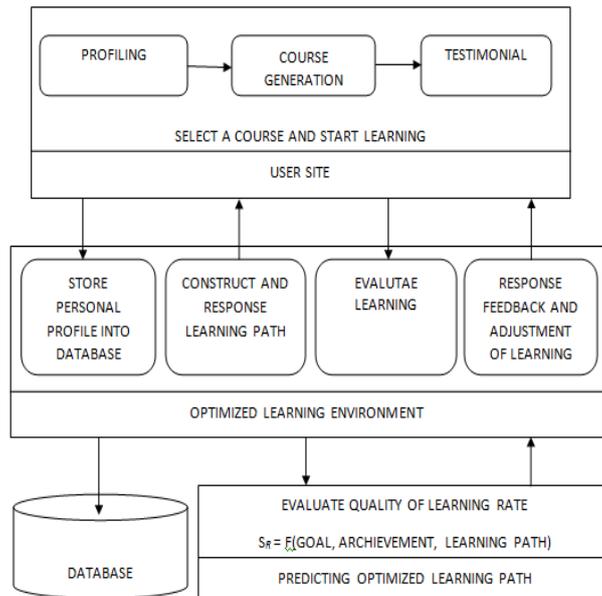


Figure.1 Block diagram of proposed system

A. Ant Optimization Algorithm

The complex social behaviors of ants has been studied by science, and computer scientists are now finds the behavior patterns can provide models for solving the most difficult combinatorial optimization problems. Inspired by one aspect of ant behavior, can have ability to find the shortest paths that has attempt to develop algorithm called Ant Colony Optimization (ACO), the most successful and widely recognized algorithmic technique based on ant behavior.

How it really works:

Ant colony optimization is an awesome algorithm inspired by ant’s natural intelligence. Ants are extremely successful insects surviving for many years. Ants live in their colonies and they have path among them. Physical castes are, like worker ants have some responsibilities divided based on their size. Ants communicate within themselves through path. Their form of communication is efficient enough to help which survive for many years. Apart from that, they use a secreted chemical called pheromone to communicate which provides a path between each ant. Ants go out in search of food and once it finds a food source, on its return back to home ants split pheromone on the trail. If it comes across obstruction during its returns, the group gets separated to find a shortest route. Ants use pheromones to find the shortest path between source i.e home and destination (food source). And the pheromones disappear quickly. Assume that there are two path trails formed by ants between its home and food source. When an ant goes out looking for food, it will choose the path where the pheromone is stronger. Since the shortest path will have strongest pheromone.

Procedure

1. Time t , is a discrete. At $t(0)^{th}$, the algorithm starts. At every $t+1^{th}$ time, the ant will move to a new node
2. Assuming, a fully connected graph with edge that has an *intensity of trail* on it. This trail indicates the pheromone trail laid by the ants
3. Let $T_{i,j}(t)$ represent the intensity of trail edge (i,j) at time t
4. If an ant decides to move from one node to next, it happens with a probability that is based on the distance to that node and the amount of trail intensity on the connecting edge
5. The distance from one node to next node, is represent the *visibility*, n_{ij} , and is defined as $1/d_{ij}$, where, d is the distance between from node i to node j .
6. $Tabu_k$ which holds the node that have been already visited up to the list of k^{th} ant.
7. Then each specific ant search the trail intensity on each edge which is updated through the following formula,

$$T_{ij}(t + n) = p \cdot T_{ij}(t) + \Delta T_{ij}$$

where,

$$\left\{ \begin{array}{l} Q/L_k \quad \text{if the } k^{th} \text{ ant uses edges}(i,j) \text{ in its node between } t \text{ and } t+n \end{array} \right.$$

$$\Delta T_{ij}^k = \begin{cases} 0 & \text{otherwise} \end{cases}$$

Q = a constant
 L_k = the tour length of the k^{th} ant

8. Transition Probability

$$P_{kij}(t) = \begin{cases} \frac{[T_{ij}(t)]^\alpha \cdot [n_{ij}]^\beta}{\sum_{k \in \text{allowed}_k} [T_{ik}(t)] \cdot [n_{ij}]^\beta} & \text{if } j \text{ allowed } k \\ 0 & \text{otherwise} \end{cases}$$

where,

α and β are control parameters that control the relative measures of trail versus visibility

9. At each iteration i.e $t+1^{\text{th}}$ time unit evaporation takes place and the amount of evaporation, p , is a value between 0 and 1

Here, the ant colony optimization algorithm applies to the e-learning application for finding the optimized path. However, time t is discrete one. Since, at every $t+1$, an ant will move from one node to another node. For every visitation of node, a fully connected graph will be constructed for each specific ant. In this graph, each edge has an intensity of trail which represents the pheromone trail laid by the ants. The term $T_{i,j}(t)$ holds the intensity of trail from node i to node j (edge (i,j)) at time t . A transition probability is applied in order to move a node from one to next node, based on the distance to that node and the amount of trail intensity on the connecting edge. And the visibility n_{ij} is calculated by the distance of a next node from i to j is defined by $1/d_{ij}$. The term *Tabuk*, this holds the entire visited node up to the list of k^{th} ant. For every visited node, trials are updated in the data base manifest by getting most visited node, through a node usage behavior. And the pheromones evaporate over time, unless they are reinforced by more ants, then the pheromones will disappear. At each time unit evaporation takes place and the amount of disappears, p , is a value between 0 and 1.

IV. EXPERIMENTAL RESULTS

The node visitation rate can be calculated by the number of visited node made by user on the selecting learning resources i.e subject in a particular course. Thus node visitation rate is determined by this metric and also it helps to analyze the better learning path in the e-learning system. The Visitation Rate of Node is derived by following equation is as,

$$Vr = \frac{Nvt}{Nt}$$

Where,

Vr –Node Visitation Rate

Nvt –Total no.of individual visitation Node

Nt – Total no.of nodes

According to that similar characteristic, the maximum visitation rate i.e. the pheromone trail intensity on each edge is updated by each user and through this, a path which is constructed is predicted based on the parameter value T_{ij} . Such visitation node for every iteration is computed through Node Visitation Rate Vr .

Path Similarity

Similarity measures might be used for performing tasks for checking consistency or coherency if present in the constructed path. Path-based Measures is one of the similarity measures. The main idea of path-based measures is that the similarity between two nodes is a function of the length of the path linking the nodes and the position of the nodes in the graph. The path similarity of path can determined by following equation,

$$\text{learning_path}(n1, n2) = 2 * \text{deep_max}(\text{len}(n1, n2))$$

The measure length value from node $n1$, to $n2$ i.e $\text{len}(n1, n2)$ is to be considerate. It assumes that the $\text{learning_path}(n1, n2)$ depend on how close of the two nodes are in the graph. And also this measure is a variant on the distance method. It is based on two observations. One is that the behavior of conceptual distance resembles that of a Metric. The other is that the conceptual distance between two nodes is proportional to the number of edges separating the two nodes in the graph. Different similarity measures have different characteristic. Path based measures take the path length that linking the nodes and the position of the node into

considerate. They use link or edge as parameter to refer to the relationships between nodes. The measures are effective.

Optimized Path Rate

By observing the similar characteristic of students achievement, goal, process, the learning path are analyzed for each particular student. The learning paths are identified by the visitation rate of each node. The paths are constructed by applying ant colony optimization algorithm and retrieve the optimized learning path to the first time students. The Optimized path rate can be derived by following equation is as,

$$OPr = \frac{\text{Max_vp}}{Vt}$$

Where,

OPr – Optimized Path Rate

Max_vp – Maximum Visited Path by User

Vt – Total no.of Visitors

Obviously, the optimized learning path is obtained based on the similar characteristics of student goal and achievement and by the visited node.

Success Rate

Success rate is a term used in statistics that you can apply to many different areas. The success rate looks at a data sample where you have either successes or failures, such as did a mother give birth or not. The opposite of a success rate is the failure rate. If you add the success rate to the failure rate, then it will equal one because the data is set up to give two responses: success or failure.

$$SR = f(\text{goal}, \text{achievement}, \text{learning_path})$$

Obviously, the learning goal is obtained based on the knowledge of used learning resources by the students. Also the system evaluates the students result based their assessment test. Then the learning process is taken to the first time student based on the previous set of learning path.

The table 4.1 specifies the performance rate of node visited, optimized path, and the rate of success that are achieved by the students who uses the optimized path.

Table.1 Experimental Result

Sl.No	Methods	Node Visitation Rate	Optimized Path Rate	Success Rate
1.	Hinting technique	72.11	55.60	72.33
2.	K-Means	79.90	59.01	77.69
3.	Adoption & Personalization	88.03	63.09	89.23
4.	ACO algorithm	96.38	79.71	95.30

From the above table 4.1, the rate of node visited, the rate of optimized path, and the rate success of the metric values are not efficient when compared to the metric values of proposed system. Hence, by using ant colony optimization algorithm, we can find the optimized learning path. It is also improves the success rate of user in learning system and also improves the visitation rate of each and every node. The proposed learning system provides the future of suggesting optimized path to the first time user to achieve their goal easily as possible.

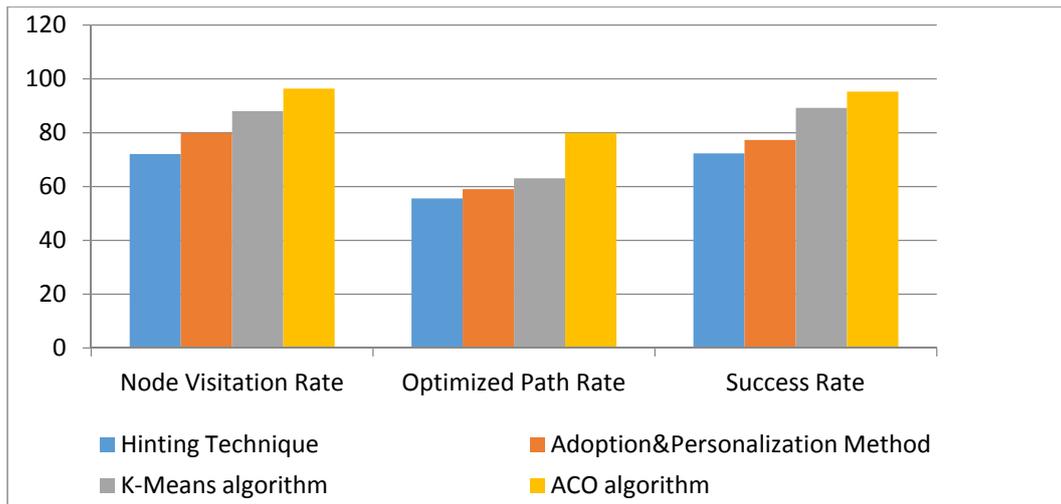


Figure.2 Graphical Representation of Experimental Result

Thus the above graph represents the metric values of existing system and proposed system (Ant colony optimization algorithm) in which it shows the proposed systems is effective and attain a successful completion of course when compared to existing system.

V. CONCLUSION

In this paper, the Ant Optimization algorithm is applied in order to obtain the optimized learning path that has been analyzed based on the searching behavior of ant. By this way applying Ant Optimization algorithm thus it identifies the Optimized learning path based on student's learning and behavior or similar characteristics of searching resources. The optimized learning path thus it identified based on following similar characteristics: feedback about each learning material, more accessible learning and learning behavior. We analyzed the results for the pathways retrieved from the database, and we analyzed all the pathways containing nodes and compared our results. The results of our proposed measure were quite impressive and competitive. We chose these pathways with various numbers of nodes as examples to discuss our experiments and evaluation. They concluded that their measure performs the similar or better pathways.

REFERENCES

- [1] Huey-Ing Liu, Member, Min-Num Yang, "QoL Guaranteed Adaptation and Personalization in E-Learning Systems", IEEE Transactions On Education, Vol. 48, No. 4, November 2005.
- [2] Chih-Ming Chen, Yi-Yun Chen, Chao-Yu Liu, "Learning Performance Assessment Approach Using Web-Based Learning Portfolios for E-learning Systems ",IEEE Transactions On Systems, Man, And Cybernetics—Part C: Applications And Reviews, Vol. 37, No. 6, November 2007.
- [3] Pedro J. Muñoz-Merino, Carlos Delgado Kloos, Mario Muñoz-Organero," Enhancement of Student Learning Through the Use of a Hinting Computer e-Learning System and Comparison With Human Teachers " IEEE Transactions On Education, Vol. 54, No. 1, February 2011.
- [4] Sang Hwa Lee, Junyeong Choi, Jong-II Park,"Interactive E-Learning System Using Pattern Recognition and Augmented Reality", IEEE Transactions on Consumer Electronics, Vol. 55, No. 2, May 2009.
- [5] Antonio Garrido and Lluvia Morales, "E-Learning and Intelligent Planning: Improving Content Personalization", IEEE Revista Iberoamericana De Tecnologias Del Aprendizaje, Vol. 9, No. 1, February 2014
- [6] Rafael S. Parpinelli, Heitor S. Lopes, "Data Mining with an Ant Colony Optimization Algorithm ", IEEE Transactions on Evolutionary Computing, Vol. 6, No. 4, August 2002.
- [7] Chia-Feng Juang, Senior Member, IEEE, Chi-Wei Hung, and Chia-Hung Hsu "Rule-Based Cooperative Continuous Ant Colony Optimization to Improve the Accuracy of Fuzzy System Design", IEEE Transactions On Fuzzy Systems, Vol. 22, No. 4, August 2014
- [8] Abdul Rauf Baig, Member, Waseem Shahzad, and Salabat Khan,"Correlation as a Heuristic for Accurate and Comprehensible Ant Colony Optimization Based Classifiers", IEEE Transactions On Evolutionary Computation, Vol. 17, No. 5, October 2013
- [9] David Martens, Manu De Backer, Raf Haesen, Student Member, IEEE, Jan Vanthienen, Monique Snoeck, and Bart Baesens, "Classification With Ant Colony Optimization", IEEE Transactions On Evolutionary Computation, Vol. 11, No. 5, October, 2007.
- [10] Chia-Feng Juang, Senior Member, IEEE, Chi-Wei Hung, and Chia-Hung Hsu "Rule-Based Cooperative Continuous Ant Colony Optimization to Improve the Accuracy of Fuzzy System Design", IEEE Transactions On Fuzzy Systems, Vol. 22, No. 4, August 2014