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Improving Content Personalization through Ant Optimization in E-Learning

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ABSTRACT

E-learning standard covers all the aspects of online education, virtual education, learning platforms, web-based training, and flexible teach that architect the learning management and educational applications. Intelligent tutoring system provides with the high quality education to each and every student, thus it reforms the entire education system. In this paper, we proposed with an algorithm called Ant Optimization Algorithm for finding intelligent learning route, thus identify the specific necessities of each student based on content personalization. Content personalization which retrieves the content that best matches with his or her interest based on some constraints. An Ant Optimization approach extracts the information from the e-learning metadata stored at database manifest, and identifies Optimized learning route by including many features like identifying the most accessed learning objects and collecting student's feedback in order to provide best learning objects based on their preferences, learning goals and searching behavior.

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INTRODUCTION

Data mining is the process of discovering actionable information from larger database. Data mining has mathematical process to derive patterns and trends that used in data. These patterns cannot be discovered by normal data exploration because the relationships are too complex and it present with larger data. The Data Mining concepts are applied in the E-Learning application which is commonly referred to the intentional use of networked information and the communications technology in teaching and learning. The other term also describes the mode of teaching and learning. They also include online education, virtual education, distributed network education and web based education. These are all referring to educational processes that utilize information and communications technology to mediate asynchronous as well as synchronous learning and teaching process. In this paper, the main objective becomes finding the patterns of system usage by teachers and students and, discovering the students' learning behavior knowledge.

The Data Mining practitioner models many techniques which include: Genetic Algorithms, Clustering, Fuzzy Logic, and Intelligent agents, Neural Networks and Inductive Reasoning, Visualization Methods. And the information which is organized according to the type of Data Mining problem is dealt with the algorithm: clustering, classification, prediction, etc. The e-learning practitioner, provide a taxonomy of e-learning problems in which the Data Mining techniques have been applied, including, for instance: Students' classification based on their learning performance; detection of irregular learning behaviors; getting feedback about learning material; e-learning system navigation and interaction optimization; optimized learning; clustering according to similar e-learning system usage; and systems' adaptability to students' requirements and capability.

Our paper uses the Ant Optimization Algorithm by applying Data Mining techniques in E-Learning application to find an Optimized Learning Route. An Ant Optimization Algorithm is essentially a system based on node that simulates the natural behavior of ants, including the mechanisms of cooperation and adaptation of node that it behaves.

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Related works and motivation:

A. Related works:

Many techniques have been applied in e-learning application in order to predict the learning route based on the learning knowledge behavior. The case-based technique reuses the plans which are previously learned and stored in a database manifest, to provide solutions more efficiently. Two reasons make this process very appealing in an e-learning application. First, we can learn from previous plans and adapt them to the e-learning scenario given by the current students. After, similar students make similar errors and the way to solve that error is usually similar as well. Second, adapting a previous plan to a new scenario that reuse the original plan if possible, this is proved to be as expensive one as generating a new process from scratches however that it tends to be more efficient on average (Antonio Garrido, 2010). AI (Artificial Intelligent) planning is the task to find a solution within a search environment specified in the application of legal actions. Each action has the preconditions and their effects. Preconditions are needed to be satisfied before the action is applied on learning system, whereas the effects leads the results based on the changes after the action is executed (Chih-Ming Chen, 2007). The Web-based learning portfolios which help teachers to perform the assessments process of individual learners in a Web-based learning environment. The learning performance 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 (Antonio Garrido, 2012). 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 (David Martens, 2007). AP is an Automatic Programming technique that uses with the genetic algorithms as for the searching technique, and it serves Ant Colony Optimization (ACO) to search for programs. This approach was used to solve the problem of symbolic regression and a multiplexor problem with the relative success. Swarm intelligence techniques are applied to e-learning application which is able to provide the learning outcome process of each specific student by the combination of simple local interactions among them (Chia-Feng Juang, *2014*).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 (Abdul Rauf Baig, 2013). Thus the learning route for the user based on their ability is identified in an optimized and effective manner.

Motivation:

In this paper, the Ant Optimization algorithm is applied in order to predict the learning route that has been analyzed based on the searching behavior of ant. By this way applying Ant Optimization algorithm which identifies the Optimized learning route based on student's learning ability and behavior of searching resources. The best learning route is identified based on following criteria: feedback of each learning material, most accessible learning and learning behavior. The optimized learning routes are predicted based on the following process: i) learning goal and students preferences, ii) learning outcomes, iii) student's profile adoptability with These personalization processes are integrated in Learning Management System (LMS). The LMSs are widely used to promote and as a support in learning, either face-to-face learning, distance-learning or blended learning. They also technically include the process such as: i) extraction of information and data mining, ii) learning route generation, iii) outcomes of the learning route, and iv) analyzing the right execution of every route.

The proposed e-learning scenario:

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 performance with their results (Juan Luis Olmo, 2011). The personalized e-learning system helps teacher to save a lot of time for learning. Also the learning result which helps teacher to examine the learning progress for students.

If a new user creates an account, can sign in to the website after registration. A profile will be created for each and every students and provide with the courses. A students can search their resources randomly and use and vote on them.

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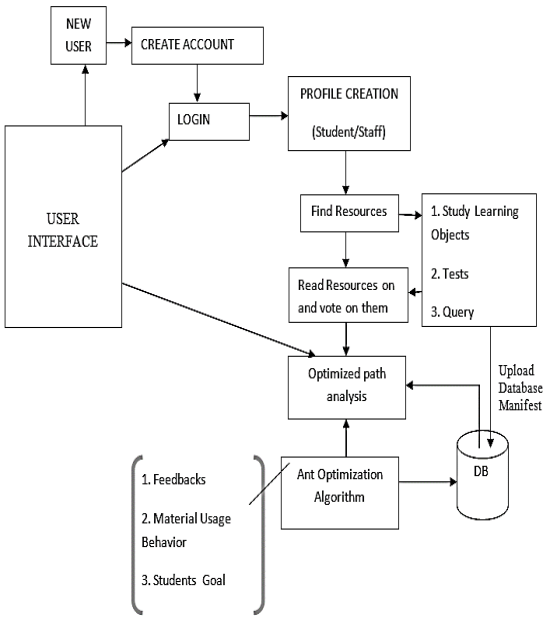

Fig. 1: System diagram.

For every visited resource, trials are updated in the database manifest through an applying Ant Optimization Algorithm by getting most visited resources through feedback, resource usage behavior and students goal.

Personalized E-learning:

The personalized e-learning is attempted to adopt with the e-learning course. Each courses, can compliant to e-learning standards with various forms of e-learning content which adhering to same learning object, that serves the individual needs and preferences of learners. Personalized learning systems support learners to set own learning goals of the students and manage their learning process, also managing both content and process, communicate with in process of learning, and by achieving learning goals (Antonio Garrido 2014).

The 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

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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,

$$\Delta T_{ij}^{k} = \begin{cases} \frac{Q}{L_k} & if the k th ant uses edge (i, j) in its tour \\ & (between time t and t+n) \\ 0 & otherwise \end{cases}$$

Q = a constant

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

8. Transition Probability

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

where,

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

9. At each iteration i.e $t+1^{th}$ 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 T*abuk*, this holds the entire visited node up to the list of kth 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**.**

Experimental result:

The Ant Optimization algorithm predicts the behavior of searching resources of each specific student and stores the behavioral data in the database manifest. According to that behavioral data, the maximum visitation rate i.e. the pheromone trail intensity on each edge is updated, the parameter d*ij* to calculate the distance in order to move from one node to another through transition probability $p^{k}_{j}(t)$ and the path traced through all visitation node, hence these data are analyzed and store in the database manifest. Here, we are focus on the metric evolution such as predictive accuracy by calculating the no of rules converged per iteration, the success rate is calculated by the no of pass and fail category each specific students and the visitation rate is calculated by the number of visited node made by user on the choosing node in a particular trail.

Predictive Accuracy:

$$\boldsymbol{Z = \frac{X}{Y}\ x\ A} \quad (1)$$

Where,

X= Max $_{\text{uncovered cases}}$

Y=Min $_{\text{cases per rule}}$

A= No. of ants

Z = No. of rule converge

The *No. of ants* is calculated by the maximum number of completed candidate rules constructed for each iteration, and each ant is associated with a single rule. The larger No_of_ants, the more candidate rules are evaluated per iteration. Each rule must cover at least Min $_{cases\ per\ rule}$ cases. It avoids an over fitting of the training data. If the current ant has constructed a rule that is exactly the same as the rule constructed by the previous ants, then the system concludes that the ants have converged to a single rule.

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Table 1: Evaluating Predictive Accuracy.

Data Set	Max. Ants	Ant-Miner Predictive Accuracy	CN2's Predictive Accuracy	Ant Optimization Predictive Accuracy
WDBC	1 0 0 0	91.61 ± 0.65	95.30 ± 0.25	97.05 ± 0.25
Tic-tac-toe	1 0 0 0	98.22 ± 0.58	101.23 ± 0.43	108.02 ± 0.55
Hepatits	1 0 0 0	88.01 ± 0.33	91.22 ± 0.55	92.22 ± 0.55
Student learning system	1 0 0 0	99.22 ± 0.45	107.25±0.55	109.22 ± 0.45

Success Rate:

$$SR = \frac{Ps}{Fs}\ x\ Ts \quad (2)$$

Where,

SR = Success Rate

P*s* = No. of passes students

F*s* = No. of failed students

T*s* =Total no. of students

The Success rate can calculated through the No. of passed students to the No. of failed students by multiplying total no. of students. Measuring the number of students completed a particular course and finding rate a pass/fail category is measured through this formulae.

Visited Rate:

It calculates the number of visited node made by user on the choosing resources in a particular course. Thus user visitation rate is determined by this metric and also it helps to analyze the better learning route in the learning system.

For a given user u,

$$Visited\ Rate_{at\ every\ iteration} = I\ (n) \quad (3)$$

Where,

n -The total number of node visited by user u.

I(n) - An indicator function which equals to 1 if n has clicks and otherwise 0.

And, according to that behavioral data, 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 I(n).

Table 2: Evaluating Success Rate.

Data Set	Max. Candidate	Success Rate
WDBC	1000	Low
Tic-tac-toe	1000	Medium
Hepatitis	1000	High
Student learning system	1000	Very high

Conclusion:

In this paper, an Ant Optimization algorithm is applied to identify the 'best learning route' based on student's learning ability and behavior of searching material. The best learning route is identified based on following criteria: optimized learning, most accessible learning. The learning objects are stored based on the searching behavior of material in background database manifest. The learning objects are selected from the database manifest. PDLL (Problem Domain Definition Language) model extracts the learning object by matching metadata with e-learning content by applying Ant algorithm. For every visited resource, trials are updated in the database manifest through an applying Ant Optimization Algorithm by getting most visited resources, feedback, and resource usage behavior and students goal. It extracts the learning objects through a knowledge extraction process from the database manifest which results with the optimized subject, learning time, profile adoption, and learning result. The predictive value of accuracy is high by applying this approach. The Success Rate will also increase by using this optimized algorithm by finding an optimized path for learning. For future enhancement, an Ant Optimization algorithm is to be applied for finding optimized learning route. The personalization of user profile is maintained for user. Based on the weight value of resources, the suggestion for next node will be identified by applying transition probability method. The accuracy of optimized route is improved by number of visitation rate of user on particular learning objects. The feedback from every user will collect and analyze for providing suggestion to the new user.

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