Trail Map – a New Way to Organize Web Contents Based on Ant Colony Model

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Abstract

A new concept called *trail map* (*T-map*) is proposed. It helps an Internet user reusing the *knowledge* of others in the Internet world. T-map is built based upon the concept of the ant colony model. An Internet user plays the same role as an ant in an ant colony such that it is able to follow and spread pheromones on the routes to the food sources. As many ants collaborating with each other through pheromone spreading in the area for a while, some routes will finally become useful trails to the food sources and others may just disappear. The existing trails with strong pheromone can be treated as an associated network of the related web contents under some special subject. In fact, the set of these trails can be treated as the knowledge of the corresponding subject. Unlike searching technology, T-map tries to record how the Internet users find and think of the web contents they have encountered.

Keywords: ant colony, knowledge reuse, pheromone, search, trail map

1. Introduction

Recently, by utilizing web contents and services, such as Wikipedia [1, 7], Google [2, 4], etc, to help doing research work is indeed an efficient and useful way. In fact, Internet can be considered as the largest knowledge base that has ever existed. However, either using searching service repeatedly to acquire the articles they need or following the hyperlinks one-by-one to identify the required contents gradually, sometimes is not a pleasant experience. For those research issues with clean keywords or exact topics, the above two mechanisms are quite good enough. However, when the research studies are still in brainstorming stage, "*how to think for the next step*" and "*how to know what keywords are useful*" are the two important problems required to be solved.

From "human" point of view, one of the best ways to tackle the above two issues is to *reuse* someone's *experience*. Of course, this "someone" should be a knowledgeable guy or a group of knowledgeable ones in the corresponding field. Experience, in fact, is a kind of implicit knowledge which is difficult to be expressed explicitly. So, this raises a new issue:

"Can we provide a mechanism such that it can let those knowledgeable guys collaboratively organize their experiences of using a set of related web contents and other users can reuse these experiences later?"

In order to solve this issue, we propose a new solution called *trail map* (*T-map*). In fact, T-map treats the Internet world as an *ant colony* [3]. In this model, an Internet user is treated as an ant in an ant colony such that it is able to follow and spread *pheromones* on the routes which are the searching

steps to the food sources, i.e. the target contents. As many ants searching the food sources for a while, they can collaborate with each other through pheromone spreading in the area. Some routes will finally become useful *trails* leading to the food sources and others may just disappear. The existing trails with strong pheromone can be treated as an associated network of the related web contents under some special subject. T-map organizes these trails in a way that Internet users can easily visit and set pheromone on the article nodes of the trails. Unlike searching technology, T-map tries to record how the Internet users find and think of the web contents they have encountered.

This paper is organized as follows. First, we introduce how T-map is modeled as an ant colony. Next, we introduce T-map structure and mechanism designs. Later, we use a scenario to illustrate why T-map can help recording and reusing the knowledge about "*how to think for the next step*" and "*how to know what keywords are useful*". The final section is the conclusion remark of this paper.

2. Modeling as an Ant Colony

As shown in Figure 1, web articles are considered as food sources in an ant colony. Internet user, on the other hand, is treated as an ant. It's known that in a real ant colony ants are able to find routes from food sources to the nest by exploiting their pheromone along the trails [5, 6]. This means that while an ant is searching, it may decide to place pheromone or not on its searching steps and construct a trail which may probably be followed by other ants. Nevertheless ants in the same colony may deny following the existing pheromone trails and create a new search direction instead. By this way, many trails leaded to a same food source may be constructed by different ants and can be referenced by other ants

later.

An ant in the colony can do two things. The first one is that it can reuse an existing T-map related to some interested topic. If the ant chooses a trail, the pheromone *evaporation rates* for the articles on the trail is reduced. In other words, the more the trails are used, the longer the pheromone on the article node of the trail will stay.
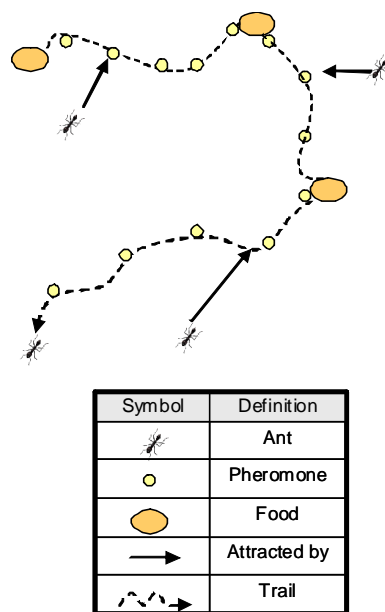

Symbol	Definition
🐜	Ant
○	Pheromone
⬭	Food
→	Attracted by
⌇→	Trail

Figure 1. Modeling as ant colony

The second thing an ant can do is that it can spread pheromone on the article node of the trail that it believes the article will lead to the food sources, i.e., the articles related to the ant's interested topic. By doing this, the pheromone level of the article will be increased.

Consider the linking association of the articles among web articles as a directed graph. When a user surfing on the Internet, a set of trails of associated articles are recommended. The trails are generated by calculating the pheromone levels of the nodes in a spanning tree of the graph rooted at the page.

The pheromone level on an article node of a trail is finally reduced to zero if no ants travel through it. The pheromone level of nodes or even

trails become zero, they are removed from T-map automatically.

3. T-map Structure and Mechanism

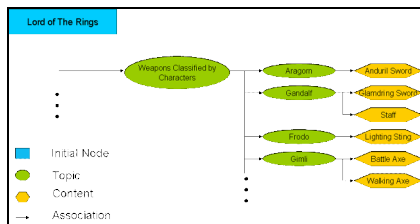To show the idea, we use the following example to explain the structure of a T-map.

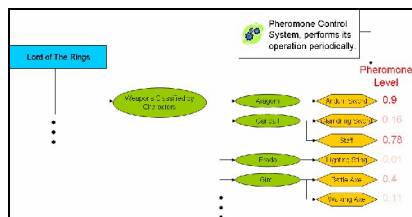**Figure 2. Example of T-map's structure**

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Figure 3. Example of pheromone level in T-map.

In Figure 2, the initial node of the trail is "Lord of the Rings". It is also the title and main topic of the T-map. The T-map is composed by a set of associations between nodes and contents related to the main topic. The contents are physical articles, while the topics are used to classify the contents. The contents of the T-map can vary dynamically according to users' behaviors. Each article has a pheromone level, and there is a vaporization system checking and changing these values. For instance, in Figure 3, the pheromone level of an article decreases when the article gets fewer accesses. When the pheromone level of an article is decreased to 0, it is

removed from the T-map. The same happens to the topics. When all the contents have been removed, the topic is removed too. The evaporating rate of an article is decreased when a user visits it. The user may also choose to increase or decrease the pheromone of this article if he believes that it is appropriated.

4. Scenario

In this section, a scenario is given to show how the T-map works.

1) A user *A* navigates in a website researching for the weapons used by the different characters in the epic fantasy novel "Lord of the Rings." The user *A* finds an interesting article about the "Anduril Sword", the weapon used by Aragorn, then *A* decides to add this article under an existing T-map related to Lord of the rings. *A* performs searching operation and the search results are popped up as shown in Figure 4.
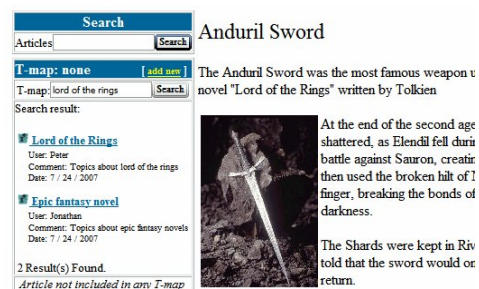

Figure 4. Scenario for T-map

2) *A* picks up the T-map named "Lord of the Rings" and views all existing topics available in that T-map as Shown in Figure 5. *A* then clicks on "Characters" and finds "Aragorn" in the character list; then the topic "Weapons" is added as a new association. It appends the food source "Anduril Sword" to be associated with the just

added topic "Weapons" as shown in Figure 6. For the process of adding topic or content, *A* can specify her (his) name, metadata or a comment explaining why this topic or content is required.

3) User *A* keeps adding information about the weapons used by different characters to the T-map.

4) Assume another user *B* visits this article. *B* finds the T-map named "Lord of the Rings" and *B* may decide to use this T-map or not. If user *B* does, then she (he) can reuse the searching experience built by other users, of course, it including user *A*. For each visiting by B in the T-map, the pheromone level is varied accordingly..
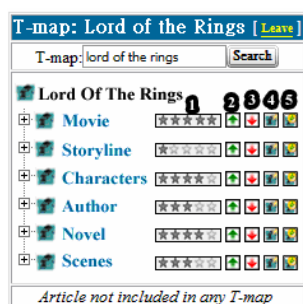

Figure 5. List of associated topics in Lord of the Rings

(1) Pheromone Level

(2) Manual increasing

(3) Manual decreasing

(4) Add new topic

(5) Add new article

Figure 6. Form to submit a new article.

5) Any user viewing a topic or an article would see a list of T-maps available which have association with the topic/article the user is viewing as shown in Figure 7. This could help another user *C* to reach to this T-map when it is viewing any topic or article this T-map is associated with, and find what she (he) needs.

6) The user *C*, while using this T-map, may find it incomplete. This T-map is allowed to add more topics and contents if *C* wants to do that.
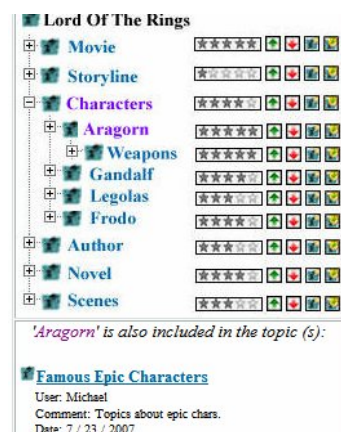

Figure 7. List of available T-map associated with the topic "Aragorn"

7) All users are allowed to increase or decrease an article's pheromone level manually. For example, user *B* may choose to decrease the pheromone level of an article: "Watermelon" in the T-map "Lord of the Rings", an association which had been added accidentally by user *A*. The manual increasing and decreasing of the pheromone level affects much more than what the system does.

8) When no one visiting the topic about the weapons classified by characters for a long period; then the pheromone level is evaporated to 0 and it causes the T-map removed.

Conclusion

A new concept called trail map (T-map) is proposed in this research. T-maps help Internet users

reusing the searching experience built by other Internet users. We borrow the idea of ant colony model to define the mechanism supporting T-map. The current solution is still not mature enough. We need more user experiences to refine our algorithms and services.

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