LEARNET
A Location-based Social Networking Methodology for Learner Group Forming

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Abstract: The benefits of collaboration in learning have widely been discussed in the literature. Our position is that location-based social networks can facilitate location-based group formation for learners and support face-to-face collaboration. In this paper, we present a methodology (LearNet) that is focused on the learner's past and current location(s) as a key criterion for recommending peers for collaboration. LearNet is a component of OnLocEd, a location-based social networking model for online learners that can help learners discover content, events, and people in proximity to their current location. LearNet utilizes OnLocEd's location-based features to recommend learner group forming in the social navigation network system (SoNavNet).

1 INTRODUCTION

The importance of collaboration in learning is stressed in literature (e.g., Moreno et al., 2007). Collaboration takes place when learners work with a group of their cohorts to achieve some learning outcomes. Thus, group formation is viewed as an important process of collaboration (Burton et al., 1997; Barros et al., 2001). In this work, we focus on location-based group formation to enable learners to meet each other in-person. This requires consideration of a learner's past and current context. The term context is used in this paper to refer to the learner's frequently visited lcoation, the date and time of the group formation request, and the learner's availability for the requested date and time. Our position is that location-based social networks (LBSN) can be leveraged to facilitate location-based group formation.

In this paper, we propose a location-based social networking methodology for collaboration, called LearNet, based on the OnLocEd methodology offered in Anwar et al. (2011) and supported by a social navigation network platform, SoNavNet (Karimi et al., 2009). LearNet can facilitate face-to-face collaboration among learners by recommending course-centered or interest-centered groups based on each other's locations. The contribution of the paper is LearNet, a methodology for collaboration designed to leverage OnLocEd's R3 methodology and operate within SoNavNet, an LBSN focused on navigation.

We provide background to our position in Section 2, introduce the key parameters of the LearNet methodology in Section 3, and illustrate the process of group formation using LearNet parameters through an algorithm and scenarios in Section 4. Section 5 summarizes the paper.

2 BACKGROUND

As computers miniaturize and the use of mobile phones increases worldwide, advances in mobile technology are enabling the application of these technologies to learning (Gupta and Koo, 2010). Gentile et al. (2007) observe that mobile devices can "support students in positioning themselves both in the physical space and in the community space." An emerging learning environment with a focus on community is the 'Learning Network', a specific kind of online social network to facilitate communication, participation, and collaboration among learners (Fetter et al., 2010). This new environment shows promise for social learning and collaboration; however, these environments do not consider any aspect of current or past locations of the learner as the context for collaboration.

One study of a Mobile Virtual Campus (MVC)

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offers a rule-based clustering approach to location-based grouping for learning (Tan et al. 2009; Tan et al. 2010). The work presented on MVC focuses on the current location of a learner and learning interest and style. The novelty of our work is the use of the L-factor paired with knowledge of the learner's interests for group formation or clustering. Clustering is an exploratory process of organizing objects into groups based on two or more variables (Finch 2005). In LearNet, we cluster based on a learner's location patterns and their learning interests.

Karimi et al. (2009) developed a special purpose location-based social network (LBSN) for navigation experience sharing, called SoNavNet (i.e., social navigation network). The focus of SoNavNet is on personalized navigation information sharing. SoNavNet can support location-based collaboration among learners. Building on the initial description of SoNavNet, Karimi et al. (2011) provide a model for sharing navigation experiences using a concept called 'L-factor'. The users of SoNavNet are assigned an L-factor for each of their visited locations, and their familiarity with each location decays as the distance from a visited location increases. The more a user visits a location, the larger the L-factor for that location will be and the strength of their knowledge extends further out from the location. The L-factor can assist in location-based grouping and pairing of learners for collaborative learning activities because it can group learners based on their location patterns.

Anwar et al. (2011) present a methodology, designed for SoNavNet, for supporting collaboration. This methodology, called OnLocEd (Online Location-based Education), facilitates recommendations of resources and peers to learners. The authors emphasize two learning situations, location-based learning and location-aware learning, both are supported by the combination of online social networks, location-based services (LBS), and mobile technologies, which can result in experiential and authentic learning activities. The authors demonstrate that OnLocEd can be used for sharing learning resources. LearNet serves as a core model for the OnLocEd methodology utilized in SoNavNets.

3 LearNet

LearNet is a methodology for location-based collaboration within a network of learners and resources. LearNet uses this network to support the R3 methodology of OnLocEd. This section provides a description of LearNet parameters.

We describe the LearNet graph G as:

$$G = (M, E) \tag{1}$$

where *M* and *E* are two finite sets of nodes and links. In LearNet, nodes and links represent learners and resources; a node represents an entity such as a learner *p* or a location-dependent resource *r* (e.g., learning artefact or event). Each node is either a learner or a resource:

$$M = \{M_p, M_r\} \tag{2}$$

where M_p is the set of all learners and M_r, is the set of all resources. In LearNet, a link can connect a learner to another learner *pp*, or a learner to a resource *pr*. The links are of two types: learner-to-learner and learner-to-resource:

$$E = \{E_{pp}, E_{pr}\} \tag{3}$$

where E_{pp} is the set of all learner-to-learner links and E_{pr} is the set of all learner-to-resource links. The attributes of a learner node are referred henceforth as a portfolio:

$$U = (\Omega, Z, Lf\ , \mathrm{X}, \mathrm{C}, I) \tag{4}$$

where *U* is the learner portfolio containing Ω, the user profile from SoNavNet, *Z,* the academic information shared by the learner, *Lf,* a set of L-factors for the learner, *X,* the context information, C, the completed and active courses, *I,* and the learner interests. The profile, Ω, includes a user's name, unique ID, home address, contact information, and account credentials. The academic information shared by the user includes highest level of education and degree/program information. The L-factor in SoNavNet measures the location knowledge of a user based on their interaction with the system and is viewed as a learner's past context. The set of L-factors in a learner's profile is:

$$Lf_p = \{Lf_{xy_1}, Lf_{xy_2}, \ldots Lf_{xy_n}\} \tag{5}$$

where Lf_{xy_i} is the L-factor of a single location and is:

$$Lf_{xy_i} = (L_{name}, L_{xy}, \mathrm{r}, A, \mathrm{n}) \tag{6}$$

where L_{name} is the name of the location; L_{xy} is the coordinate pair for the location; r is a range from the location; *A* is the strength of knowledge about the location; and n is the magnitude of the L-factor (see Karimi et al. 2011). Current context information is:

$$X = (v_p, d_p, t_p, L_{xy}) \tag{7}$$

where v_p is the learner's availability (available, busy, etc.), d_p is the current date, t_p is the current time, and L_{xy} is the coordinate pair of a learner's current location. The set of courses a learner has completed or is enrolled in can be viewed as C, a set of $\dot{c}$, or:

$$\dot{c} = (d, c_{num}, Þ) \quad (8)$$

where $\dot{c}$ is a single course, d is a term number, c_{num} is a unique university class number, Þ is a set of unique IDs for all learners who have previously taken the course and $Þ_i$ is a single peer ID. Learner interests are topic areas that the user finds interesting, and the set of learner interests is defined as:

$$I = \{I_1, I_2, \ldots I_n\} \quad (9)$$

where I_i is a single keyword of interest for a learner. Finally, attributes for each resource node (these are location-dependent, not online, resources) include resource content, location, availability, date and time.

4 LearNet SCENARIOS AND GROUPING ALGORITHM

LearNet graph construction is a dynamic process that occurs as learners interact with SoNavNet. LearNet starts as a null graph and evolves over time as learners initiate learner nodes by creating profiles and resource nodes by searching for resources. Table 1 displays conditions for the construction of nodes and links in a LearNet.

Table 1: Node and link construction.

Node Type	Initialization
Learner	Learner submits a profile
Resource	Resource is found during a search
Link Type	Generation
Learner to Resource	Learner requests navigation/routing to a resource, recommends a resource, or sets a reminder for a resource.
Learner to Learner	A Learner connects to, communicates with, or recommends another learner ('friends'), or requests navigation/routing information from another learner.

Relationships (learner-to-learner and learner-to-resource links) are created through the actions of the users. For example, if a learner befriends another learner a link between their respective learner nodes is added to the database. Now we will provide an example scenario to illustrate how nodes and links are created. A learner submits a profile to SoNavNet, sharing their academic information, course list, and interests, and is currently using SoNavNet to request a reference book for their upcoming class. Given this scenario, we know that their portfolio, U, is initialized and a learner node has been constructed. A book request populates the resource containers for the resulting resources. Let's say the result list includes 10 books. The learner selects the book they want from the list and requests a route to its location. At this point, the LearNet instance includes one learner node and one learner-to-resource link between the learner and the desired resource. As the learner continues to interact with the system making friends and finding resources the LearNet instance will evolve and grow. Now that we have briefly shown how a LearNet instance is created and grows, we will explore LearNet's method for collaboration support.

LearNet supports collaboration by helping learners create location-based groups. The grouping process is shown in Figure 1.

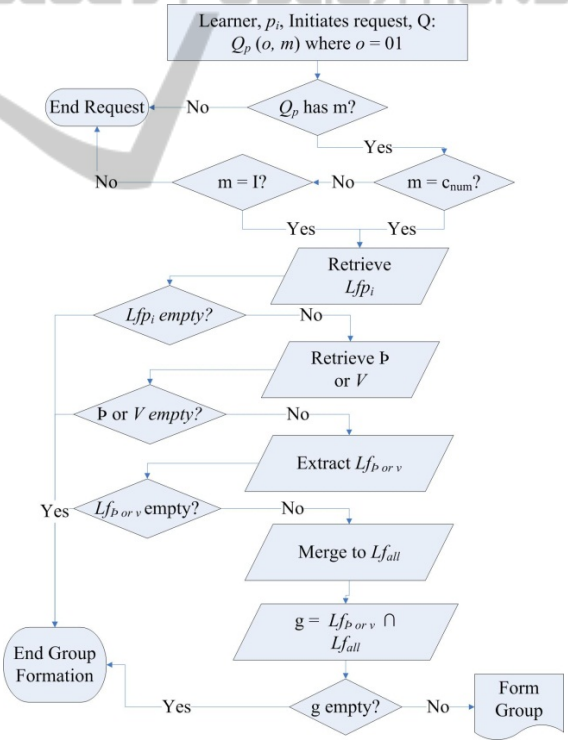

Figure 1: Dynamic Grouping Process.

A search request, Q, includes a search object and a match constraint for either a learner or resource, that is:

$$Q = (Q_p, Q_r) \quad (10)$$

one set must be non-empty

$$Q_p = (o, m) \quad \text{both sets must be non-empty} \tag{11}$$

$$Q_r = (o, k) \quad \text{both sets must be non-empty} \tag{12}$$

$$o = \{01, 02, \ldots n\} \tag{13}$$

$$m = (\, c_{num_i},\, I_i) \quad \text{one set must be non-empty} \tag{14}$$

where Q_p is the learner request, Q_r is the resource request, o is an objective for the search, m is a match constraint of either c_{num}, a unique course number, or I_i, a learner interest for a learner request, and $k_i \in k$ is a keyword for a resource request. Example objective (o) codes are as follows: form a group (01), find an event (02), find a book (03), and so on.

One example of the recommendation feature in LearNet is a recommendation requested by a learner. Recommendations requested by a learner are requests using the attributes assigned to known items and retrieving items that match the search criteria. To illustrate this kind of recommendation, we will show a technique to create a dynamic study group. The process for a dynamic grouping request is shown in Figure 1. The following assumptions are made: all students attend the same university online and all students have a SoNavNet account.

The grouping recommendation process is initiated by a learner, p_i, who submits a learner request, Q_p, with the objective of forming a group (o=01) and either a course number or an interest topic (see Equation 11). Once the algorithm has verified that the objective is group formation, the process of grouping begins. The algorithm verifies the provided course number or interest topic and retrieves the set of L-factors from the requestor's portfolio, Lf_{p_i} (see Equation 5). The L-factor is critical for grouping due to the knowledge of a user's location patterns. This allows for a more thorough match than using only a learner's current context.

Next, the algorithm uses the course number to retrieve peers Þ (list of students with same course) or the interest topic to retrieve, V (a set of learners who have the same interest), such that:

$$V = \{\mathrm{pI}_1, \mathrm{pI}_2, \ldots \mathrm{pI}_n\} \tag{15}$$

where pI_i is a learner with the same interest. Then, a set of L-factors are retrieved for all learners in Þ or V, such that:

$$Lf_{\text{Þ } or\ v} = \{Lf_{p_1}, Lf_{p_2}, \ldots\ Lf_{p_n}\} \tag{16}$$

where $Lf_{p_i}$is the set of L-factors for one matched learner. Finally, these L-factors are merged into one set, such that:

$$Lf_{all} = Lf_{p_1} \cup\ Lf_{p_2} \ldots \cup\ Lf_{p_n} \tag{17}$$

Where

$$Lf_{all} = \{Lf_{xy_{1_{p_1}}}, Lf_{xy_{2_{p_1}}}, Lf_{xy_{1_{p_2}}}, \ldots Lf_{xy_{n_{p_n}}}\} \tag{18}$$

where $Lf_{xy_{i_{p_i}}}$ is a single L-factor for a single location-learner pair in the set. The result set of the intersection of requestor, H, and candidate, V's L-factors:

$$g = Lf_p\ \cap Lf_{all} \tag{19}$$

where Lf_p is the requestor's L-factors and Lf_{all} is the merged set of L-factors for all candidate group mates in the result set. If g is not empty, the system will initiate group formation and push the candidate list to OnLocEd to suggest a physical meeting using the recommendation model described in Anwar et al. (2011). Let's look at a scenario.

Betty is an online learner who needs to form a group for a course. She could use email but Betty uses SoNavNet to initiate a grouping request because she wants to be able to meet her group in-person. The algorithm gets Betty's L-factors and compares them to L-factors for all students in the course. Once the candidate set is retrieved, it is passed to OnLocEd which can help the students coordinate the meeting and navigate to the location. Betty is very happy to be able to meet in person a few times during the semester and feels that this will make it easier to work on a large project for an online class.

5 SUMMARY

Our position in this paper is that, location-based social networks (LBSN) can be leveraged to facilitate location-based group formation for collaboration in the learning context. We introduce a location-based social networking methodology for collaboration, called LearNet, and present a location-based grouping algorithm.

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