Semantic Modeling for Group Formation

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Abstract. Group formation has always been a subject of interest in collaborative learning research. As it is concerned with assigning learners to the groups that maximize their benefits, computer-supported group formation can be viewed in this context as an active personalization for the individual as an entity within the group. While applying this personalization to all students in the class can cause conflicts due to the differences of needs and interests between the individuals, negotiating the allocations to groups to reach consensus can be a very challenging task. The automated process of grouping students while preserving the individual's personalization needs to be supported by an appropriate learner model. In this paper, we propose a semantic learner model based on the Friend of Friend (FOAF) ontology, a vocabulary for mapping social networks. We discuss the model as we analyse the different types of groups and the learners' features that need to be modeled for each of these types.
Keywords: Learner modeling, personalization, semantics, ontology, social networks, communities of practice, teams, group formation, FOAF.

1 Introduction

For decades, group formation has been a subject of study in many domains including psychology, sociology, philosophy, and education. In learning, teachers form groups of students for different types of collaborative activities. For the formation to be efficient, teachers need take into account any parameters that can influence the performance of the group as a whole and that of the individuals within the group. For example, a teacher aiming at forming students' groups for software engineering collaborative projects might be concerned with the even distribution of the students across the groups in terms of their previous experience in the subject of study to ensure all groups will have an equal opportunity in performing well in the task.

In addition to that, the teacher has to be aware that the students are allocated to the groups that maximize their benefits from the collaborative work. For example if a female student qualifies best to be a leader in group work, then she should not be allocated in a group with other leaders as this might create a negative conflict. At the same time, she should not be allocated in an all-male group as she might be left out by the other members within the group [1]. Thus, group formation here is viewed as a personalization of the individual's allocation to a group. As individuals tend to be different, the problem of satisfying all the students' needs is complex; and negotiating the allocations to reach consensus is a challenging task. As the number of parameters such as experience, roles (e.g. leadership), and gender grow larger, the group formation becomes more complicated.

In computer-supported group formation, in addition to providing a learner model by describing the learners' features, these parameters can be used as a set of constraints to identify the formation requirements (this the example above: experience, gender, and group role).

In [2] we proposed the use of Semantic Web concepts [3] to model the learners for the automatic generation of students' social networks. In particular, we discussed the potential of using the Friend of a Friend (FOAF) ontology, a vocabulary that provides a set of properties and classes to describe people for building communities and social groupings [4]. In this paper, we introduce an ontology that extends FOAF by modeling the parameters a teacher may consider in the formation of different types of groups in addition to communities and social groupings.

2 Taxonomy of Groups

There are several types of groups and different taxonomies that describe these types. In general, the types of groups vary based on the group duration, its cohesion, and the degree of focus on the task the group is formed to fulfill [5]. The major types of groups are:

1 Teams: The most used type of groups in learning is teams, a planned group of people that collaborate together on a well-defined task or set of tasks. Teams can be as small as a *pair* of students discussing some aspects of the course; to as large as 15 to 20 members *task-oriented teams* working together to solve a complex problem. The structure of teams usually depends on the aim of the task. In learning this is the purpose of the collaboration the teacher has asked the students to perform [6].

2 Communities: According to Wenger [7], Communities of Practice (CoP) are groups of people who have a common interest in some subject, and collaborate to share ideas or find solutions. In learning, the teacher often guides the students to form communities based on their interests or preferences to encourage discussion on different topics within the community.

3 Networks: There are two common sorts of networks:

- *Intensional Networks (IN)*: This is an informal collection of collaborators who are selected to accomplish a specific task [5]. The members in this group do not need to be familiar with each other as long as they can collaborate to deliver the task.
- *Social Networks (SN)*: This grouping is usually described as a social structure of nodes that represent individuals and the relationship between them within a certain domain. Social networks of learners can be to support social learning within distance learning [2].

3 Modeling Group Formation

In learning, the type of grouping used to facilitate the collaboration is determined based on the objectives of the collaborative activity the teacher is introducing to the students. After specifying the type of groups to be used, the teacher is faced with the task of allocating students to groups and deciding who should work with whom in each group. The formation of the groups can aim to create: *diverse groups,* where the students' population is evenly distributed over the groups in terms of grades, gender, nationality, and so on; *complementary groups,* where the group members complement each other to perform a specific task (e.g. non like-minded students); or *similarity-based groups* where the students share a common feature or interest.

However, regardless of whether the teachers aim to form homogeneous or heterogeneous groups, there are a number of variables they have to consider in the formation of the groups. These variables are used to model the students; and combinations of these variables are used to model the group formation (i.e. constraints of the group allocation). This enables the teachers to initiate different formations with different combinations of the modeled constraints. In this context, we categorize the variables into three types:

- *Task-related:* these parameters model the students in relation to the course or the task of the group work such as experience, education level, knowledge, skills, abilities (cognitive and physical), grades, interests, and preferences of topics and experts the student want to work with [8, 9]
- *Relation-oriented:* these parameters are independent from the topic of the collaboration as they involve personal information on the student such as gender, age, culture (race, ethnicity, national origin), social status, personality and behavioral style, social ties, trust between members [9].
- *Context-related:* these parameters hold information on the context features of the students and their environment such as geographical location, availability schedules, and communication tools [10]. These variables are usually useful for part time and distance learners.

For each of the group types introduced in the previous section, there are some specific parameters that need to be modeled for the formation of that type. Table 1 illustrates the mapping between the range of these attributes and the different types of groups. In particular, except for teams that can be formed for different reasons (complementary, similarity, and so on), and thus can use any range of constraints; the table shows the variables that are crucial to the formation of each type of grouping.

In [2] we argued that FOAF can form a good learner model for building students' social networks if it is extended with the right variables. In the next section, we introduce an ontology that extends FOAF for the formation of all types of groups. We refer to the ontology as Semantic Learner Profile (SLP).

4 The Semantic Learner Profile Ontology (SLP)

So far, the SLP ontology (http://www.ecs.soton.ac.uk/~ao05r/research/LearnerProfile/slp.owl) models most of the attributes discussed in the previous section:

- *Task related:* for this category, we model:
  - Degree: the current degree of study, e.g. Bachelor of computer Science.
  - Grade: can be the student mark for the overall year of study or for a particular module (unit).
  - Skills: any skills or abilities the student has, e.g. programming java.
  - Interests: can either be academic or non-academic, e.g. artificial intelligence, bass guitar.
  - Preferences: can be a preference of an academic topic, or preference of working with an expert such as a supervisor, tutor, or an experienced peer.
  - Experience: level of experience on a specific topic. For different topics, this can either be ranked by a teacher, a peer, or self-rating.
  - Learning style: whether the students is a theorist, reflector, pragmatic, or an activist.
- *Relation-oriented:* for this category, we model:
  - Gender: is already modeled in the FOAF ontology.
  - Age: used to monitor mature students within the course.
  - First spoken language: used to model the students' culture instead of ethnicity or national origin. This is mainly because students tend to communicate with people speaking their first language within the group.
  - Personality and behavioral style: in group work, behaviors are usually modeled using Belbin team roles (www.belbin.com), or the Myers Briggs personality types (MBTI) (http://www.myersbriggs.org/). An existing foaf property presents the MBTI as literals. However, since the latter has to be monitored by an expert in psychology [11], we only consider the Belbin roles in this ontology, which represent the students' behavior in team work and thus their possible functional contribution to the team. In task-oriented teams such as software engineering project teams, forming groups with consideration to Belbin roles have proven to make a positive difference in the team performance. [5] [11].
  - Social ties: are already modeled using the "*knows*" attribute of FOAF. In order to enrich the ties with other types of relations, we added more vocabulary such as *classmateOf, tutorOf, teacherOf, studentOf* to describe the academic relations within the university.
  - Trust: the FOAF ontology has already been extended with trust vocabulary [12]. Thus, we directly use this vocabulary in our models.
- *Context related:* So far the ontology does not model any of the attributes in this category. Figure 1 shows an example of using the SLP ontology to model some features of a student.

5 Conclusion

In this paper we discussed modeling students' features for the semantic formation of different types of groups using an ontology that extends the FOAF vocabulary. The ontology will be used as a part of a Semantic Web-based system that aims at automating group formation while preserving the personalization at the individual level. Further work will involve analyzing different algorithms for forming teams, communities, and networks, and implementing these algorithms to generate semantic group formations. To allow different degrees of freedom in group formation, the system will be supported by an interface that enables the teachers to choose a set of parameters from the ontology that they think is important to achieve the goal of the collaboration, as well as an option to rank the

priorities and importance of each parameter of the group formation. Depending on these parameters and the modeled data provided by the students (also using the ontology), the system will apply an appropriate algorithm to recommend a group formation and output a list of groups to the teacher.

Table 1 The different variables needed to be modeled for the formation of different groups

Group Type	Task-related	Relation-oriented	Context-related
Teams	All variables	All variables	All variables
Communities	Interests, topic preferences, experience, expert preferences	Expertise relationships, trust	None
Intensional Networks	Skills, abilities, experience	None	All variables
Social Networks	Interests, topic preferences	Social ties, trust	None

```
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    xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
    xmlns:foaf="http://xmlns.com/foaf/0.1/"
    xmlns:slp="http://www.ecs.soton.ac.uk/~ao05r/LearnerProfile/slp.owl">

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 </foaf:Person></rdf:RDF>
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Figure 1 An example FOAF file extended with the SLP schema

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