Modeling Researchers’ Characteristics For The Formation Of Research Team

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MODELING RESEARCHERS’ CHARACTERISTICS FOR THE FORMATION OF RESEARCH TEAM

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Abstract

Most of research is completed through a research team where team members’ expertise and knowledge complement with each other. In academic contexts, research project generally involve the establishment of multi-disciplinary and competent research teams to simultaneously consider various activities throughout the entire research project. To ensure a successful research team, it is important to understand and model researchers’ characteristics in an appropriate and systematic way. Three fundamental descriptors of researchers are developed in this research. The first is to represent researchers’ expertise level in areas related to project. The second is to consider the team members’ diversity in their expertise. The third is to develop a measurement of team members’ working relationships based on their previous co-authorships and personality characteristics. This research helps construct a team for a research project based on these characteristics.

Keywords: Researcher modelling, Research team formation, Researcher profiling, Researchers’ characteristics
1 INTRODUCTION

As Orbach pointed out, research plays a vital role in economic growth (Orbach 2011). Most of research is completed through a research team where members collaborate and communicate with each other. In academic contexts, research project generally involve the establishment of multi-disciplinary and competent research teams to simultaneously consider various activities throughout the entire process to complete the research project. And the proper composition of the research team is critical to the successful team functioning, and ultimately, in completing the research project (Sauer et al. 2004). The effectiveness of research teams is often a function of who is in the team and the combination of individual-level and collective-level attributes within a team (McClough et al. 2003). In previous research, various factors have been discussed which may influence the performance of a team, e.g., functional expertise, teamwork experience, leadership, communication skills and personality traits (Chen et al. 2004). The importance of these factors may vary with the forms of teams. For example, a marketing team who is responsible for selling a new product may have different requirements of team members comparing with a research team aiming to develop a fraud detection system.

For a successful research team, team members should have enough expertise as required by the projects. Moreover, the diversity of knowledge among members should be considered. And the working relationship can directly affect team performance, and cannot be overlooked. The poor expertise structure and relationships among team members may not function successfully and can lead to the failure of the project.

For small-sized academic organization, an appropriate team can be constructed by person who is responsible for the formation of team, for example, Principle Investigator who has good knowledge of researchers’ research area, capabilities. For medium-sized and large academic organization, especially for online academic community, research team formation is an even more complex issue, where the number of combinations of researchers can be a problem with a large solution space. Furthermore, the variety of research projects makes the research team formation problem even more complex.

In order to ensure a successful research team, it is necessary to carefully choose team members with desired characteristics. However, the existing literature lacks a systematic and quantitative way to integrate researchers’ characteristics into a model. To appropriately forming a research team, a quantitative representation of three characteristics of team members is needed. The objective of this research is to build a team member model to represent the characteristics of researchers, such as their expertise level in related areas of a project, their knowledge diversity and working relationships. Based on the researcher modeling, an efficient team can be formed by selecting members who possess expertise in related areas of the research project, have diversity knowledge structure, and likely to have good working relationship with other team members.

2 LITERATURE REVIEW

Team formation is a result of the deliberate, strategic decisions of individuals who either self-select or assign others to a team with the purpose of satisfying individual and team objectives (Owens et al. 1998). Previous research has proposed various criteria for selecting members to compose a team, for example, their expertise in particular areas (Sharifi et al. 2002; Thamhain 2003), their personal attributes(Zzkarian et al. 1999), their communication skills (Hauptman et al. 1999), their flexibility in job assignment (Sundstrom et al. 1990), etc.

Corgent (2010) investigated how complete information and incomplete information about their partners’ abilities and the self-serving biases influence the formation of team. Taylor (1986) suggested that the optimum team contains members who have the necessary skills to complete the task. Chung and Guinan (1994) noted that the teams the experience of members affect the performance of the team. Chi et al.(2009) employed knowledge-intensive approaches to build team models where ontology and rules are used to represent knowledge. André(2011) proposed a formal model for assigning human resources to teams in software projects. Zhu et al. (2006) considered the roles of team members to construct a team.
Werbel et al. (2001) argued that person-group fit have influence on the performance of the group. And Person-group fit is composed of two parts: supplementary and complementary fit, where supplementary fit focuses on group members have similar characteristics and complementary fit addresses group members have different qualities or characteristics which complement with each other to accomplish a task. Owens et al. (1998) examined how task and relational functions in the group facilitate or hinder task performance in an organizational context. And they believed that a successful team should be composed of members who both have task-performance skills (Functional Alignment) and good personal relationships (Relationship Alignment). Functional alignment refers to select members with required skills and knowledge to perform a particular task. Relationship alignment means to select members with similar values and beliefs to ensure that team members are more likely to communicate and coordinate in the team. Following previous research, we concluded that three important characteristics of team members that contribute to a successful research team: required expertise of team members, diversity in their expertise and their working relationship with each other.

3 TEAM MEMBER RANKING MODEL

3.1 Feature extraction of projects and researcher profiling

A research project may include the purpose, the scope and the requirements of researchers to complete the project. A project can belong to one or multiple disciplines. For one discipline, a project may cover several areas. To ensure the success of a project, team members should have enough expertise in related areas of a project. Based on the extracted information, we can use disciplines and research areas to represent the features of a project as shown in Figure 1.

![Feature extraction of a project](image)

Figure 1. Feature extraction of a project

Researcher profiling refers to the process of obtaining the values associated with different properties that constitutes the researcher model. The information used to construct a researcher’s profile includes his/her name, affiliation, co-authors, personality, disciplines, areas, and expertise level in corresponding areas. The name and affiliation is the basic information to differentiate researchers. The co-authorships and their personality may help to predict researchers’ working relationships. For example, researchers have previous co-authorship with other researchers may tend to be familiar with each other and communicate efficiently. The researchers’ personality may indicate whether the working climate of the research team is good or not. Disciplines, research areas determine the scope or field of a researcher. And the expertise level of a researcher is measured based on their past academic performance, for example, their papers and their projects. Expertise level determines the “depth” of the expertise in related areas. Figure 2 shows the profiling of a researcher.
3.2 Required expertise ranking

A project may require researchers with expertise in different research areas. For example, a project focusing on social network analysis based approach for expertise recommendation may need researchers have expertise in social network analysis and expertise recommendation. By extracting the research areas of a project, then we can select members from these areas to satisfy the requirements of a project.

In exploring a comprehensive measurement of the expertise of a researcher, we use two main source of information: their papers and their projects. To measure the expertise level of researchers through their published papers, following metrics are employed: number and quality of papers, and the period. Generally speaking, more papers have been published means that researchers have higher expertise level in corresponding research areas. Meanwhile, we need to consider the quality of the paper. The quality of a paper can be reflected through the impact factor of a journal. When the researchers published a paper is also an important factor to measure the expertise level of a researcher. If a researcher publishes papers in recent years, it means that he/she is an active researcher and vice versa. Funding agencies prefer to invite active researchers to be reviewers rather than inactive researchers (those who have little or no publications in recent years). Similarly, we can measure the expertise level of a researcher based on their projects. Combining all these factors provide a better measurement of expertise level with regards to a particular research area. Based on the features of a research project and potential researchers’ expertise level measurement in corresponding research areas, we can obtain the expertise ranking matrix as shown in Table 1.

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*Table 1. Expertise ranking of researchers*
3.3 Expertise diversity ranking

It is found that diversity among team members can have a positive impact on creativity, which then leads to superior outcomes (Williams et al. 1998). For research project, diversity in team members’ expertise increases the likelihood that one team member may possess certain knowledge required in the process of completing the project. It is quite likely, as higher levels of expertise are needed to solve complex problems, that researchers with diverse expertise will need to work together to accomplish the project and solve unexpected problems in the project (Horwitz et al. 2007; Shonk 1997). Many theories argue that expertise or knowledge diversity can enhance team performance by improving the team’s creativity problem solving ability through project-related or cognitive conflict (Owens et al. 1998).

To measure the diversity of expertise, we introduce the concept of novelty that one researcher may bring to the research team comparing with other researchers. And a weighted approach is used to aggregate the novelty of every researcher to measure the integrated diversity of a particular research team.

\[ RT_{novelty} = w_1 R_{novelty}(r_1; r_2, ..., r_i) + w_2 R_{novelty}(r_2; r_1, r_3, ..., r_i) + ... + w_i (r_i; r_1, ..., r_{i-1}) \]

Where \( R_{novelty}(r_i; r_1, ..., r_i) \) represents the novelty value that researcher 1 can bring to the team comparing with other researchers in this team, this value can be calculated using vector space model. And the vector is the keywords or terms to represent researchers’ research areas. \( w_i \) is the weight of researcher \( i \)’s novelty contribution to the team. \( RT_{novelty} \) measures the expertise diversity of the whole team.

3.4 Working relationship ranking

The advantage of teams over individuals stems from knowledge or expertise additivity, where overall performance of any teams increase directly with the sum of combined member abilities. However, barriers to coordination of team members exist that degrade team performance due to relational conflict (Safoutin et al. 1993). Therefore, beyond expertise considerations, team formation also needs to involve the relational concerns among team members. Here we consider two aspects which constitute the working relationship of researchers. The first is their previous co-authorship. To the extent that societies and organizations are structured through different social networks, it is possible that most of teams will be formed from people in the same social network. As team expands, new members are recruited from through their social ties with current members. It is reported that in self-selected project, most teams are formed based on their friend ties and acquaintance relationships. The reason lies in that team members from a same or near social network tend to express a preference to dealing with their preexisting relationships and have more knowledge about other members’ expertise, knowledge and personalities. Teams of familiars are more comfortable expressing disagreements, more open to learning from one another, and tend to enjoy working together than teams composed of strangers. In academic context, researchers’ co-authorship is one of the most social relations. Therefore, we use researchers’ previous co-authorship to infer their working relationships.

The second aspect is the personality characteristics, such as introverts and controverts, liberals and conservatives, etc. In this research, we will use a popular personality test, Myers-Briggs type indicator (MBTI) (Brown et al. 2009; Chen et al. 2004) to measure researchers’ personality types and preferences. For Myers-Briggs type indicator, there are four groups with each group consisting of two opposite preferences as shown below:

1) Focus on attention: Extrovert (E) and Introvert (I)
2) Seeking information: Sensing (S) and iNtuitive(N)
3) Decision-Making: Thinking(T) and Feeling (F)
4) Relationship with the World Judging (J) and Perceiving (P)

Individuals are asked to complete a psychometric questionnaire to help measure their psychological preferences. Based on the measurement results, every individual is determined to belong to one preference from the above four groups in any combination that then forms the basis for the 16 personality types. For example, a person may be identified as ESTJ, INFP or other possible types. The effective team should have a good combination of personality types. If the personality of team members can complement with each other, then the team may enjoy a balance to become a successful team. If too much opposition exists in the team, the relation conflict may degrade the performance of the team (Myers 1980). And the score for any two researchers with two personality types can be calculated based on their score for each group. Table 2 shows the personality matching score for two types of people working together (Chen et al. 2004).

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Table 2. Personality score for combination of two types
To measure the working relationship of team members, we try to combine their previous co-authorship and personality characteristics. The working relationship of researcher $i$ and researcher $j$ is calculated using the following formula:

$$R_{ij} = \alpha RC_{ij} + \beta RP_{ij}$$

Where $RC_{ij}$ represents the frequency of co-authorship between researcher $i$ and researcher $j$, and $RP_{ij}$ denotes the personality scaling matching between researcher $i$ and researcher $j$. $\alpha$ and $\beta$ are variables to adjust the contribution of previous co-authorship and personality scaling matching to the working relationship.

By choosing members with good working relationship, the team can gain increased assurance that members are more likely to engage in behaviors that facilitate coordination and communication in the team.

4 TEAM MEMBER RECOMMENDATION MODEL

A mathematical model will be employed to help form the best team composition based on researchers’ expertise level in corresponding areas, their expertise diversity and their working relationship.

$$\text{Max. } \sum_{j=1}^{m} \sum_{i=1}^{n} E_{ij} \cdot x_{ij} \quad (1)$$

$$\text{Max. } RT_{\text{novelty}} \quad (2)$$

$$\text{Max. } \sum_{j=1}^{m} \sum_{i=1}^{n} R_{ij} \times x_{i} \times x_{j} \quad (3)$$

s.t. $RT_{\text{novelty}} = w_{1} R_{\text{novelty}} (r_{1} ; r_{2} , ... , r_{i}) + w_{2} R_{\text{novelty}} (r_{2} ; r_{3} , r_{4} , ... , r_{i}) + ... + w_{i} (r_{i} ; r_{1} , ... , r_{i-1})$

$$R_{ij} = \alpha RC_{ij} + \beta RP_{ij}$$

$$x_{i} = 0 \text{ or } 1 \text{ for any } i$$

Objective function (1) represents that we try to maximize the expertise level in corresponding areas. Objective function (2) denotes that to select optimal members, their diversity of expertise should be maximized. And (3) means that the working relationship of research members is maximized.

5 CONCLUSIONS AND FUTURE RESEARCH

This paper presents an approach based on modelling researchers’ characteristics to solve the team member recommendation problem in academic context. The proposed approach considers three factors which may influence the performance of a research team: the required expertise level, the team members’ expertise diversity and their working relationships. For the expertise level of research team members required by the project, we try to measure researchers’ expertise level by considering their papers and projects. For the expertise diversity, we use a weighted additivity approach to combine all researchers’ novelty that each researcher can bring to the team comparing with other researchers. For future research, we will investigate how the proposed approach can be used to recommend team members for a particular project. And we will evaluate the proposed approach using a case study.

References


