An Effective Mentoring System based on Automated Matching Process

Hyeyoung Cho, Sul-Ah Ahn
Korea Institute of Science and Technology Information, Daejeon 305-806, Korea,
chohy@kisti.re.kr, snowy@kisti.re.kr

Abstract
Nowadays, in order to establish a professional relationship in which a mentee develops specific skills and increase knowledge for personal growth, mentoring programs become more and more important. Female researchers in KISTI have been participating in the WISET Fellow Mentoring program since 2009.

In this paper, we present a new architecture design for mentoring system. For building a successful mentoring program, matching process is one of the key factors for satisfaction of mentoring participants. So matching between mentors and mentees needs to be best fitted considering specific characteristics of mentors and mentees. So we focus on designing automated matching process, which effectively utilizes profile and requirement data of candidate mentors and mentees. We apply a weighted matching algorithm on our matching process.

Keywords: Automated Matching, Mentoring System, Weighted Matching Algorithm, Matching Process

1. Introduction
Nowadays, in view of coaching and mentoring professional career path and pursuing successful career of the seniors, mentoring programs enabling mentors and mentees to give and get career advice are more and more important among professionals and students[1]. Various kinds of mentoring programs are conducted these days domestically and internationally, including specially focused mentoring programs exclusively designed with regard to participants’ jobs, stage of education, genders, etc. Through mentoring programs students can get career information, advice and tips for their development and success.

Mentoring programs for female students that encourage themselves to enter science and other high-level fields of engineering and technology have been operated by the Korea Advanced Institute of Women in Science and Engineering (WISET) and funded by Korean government from 2001[2]. Among the multiple mentoring programs offered by WISET, the WISET Fellow Mentoring program aims at supporting female university students, majoring in science and engineering, by mentoring from careered women scientists and engineers in Korea. Women Scientists and engineers in KISTI have participated in the WISET Fellow Mentoring program from 2009 [2,3].

After we have taken part in mentoring activities for five years, we got experiences about successful mentoring activities. Some mentoring program operates during short term, such as several months or a year. If a matched mentor and mentee wants to continue mentoring or mentor-mentee relationship much longer, the mentoring relationship can be continued for several years and the more. For the case that the mentoring relationship continues over several years, and the short-term mentoring results in successful outcome and satisfaction of mentoring participants, the matching between mentor and mentee would be very successful [4]. Therefore, if once matching between mentor and mentee is done successfully in the beginning stage of the mentoring relationship, the chance for successful mentoring program will increase.

In this paper, we design the overall architecture of mentoring system based on our automated matching process proposed recently[5], with our automated matching process. The overall architecture of mentoring system has three steps: data gathering, matching process, mentoring. For satisfaction of mentoring participants, mentor-mentee matching process is one of the key factors. So we introduce a new design for an automated matching process between mentors and mentees. Matching between mentors and mentees needs to be best fitted considering specific characteristics of mentors and mentees. For best fit matching, our automated matching process effectively utilizes data of candidate mentors and mentees.
The remainder of the paper is organized as follows. First, Section II introduces the overview of the WISET Fellow Mentoring program and describes the current structure and activities of the WISET Fellow Mentoring program from KISTI. Section III describes our mentor-mentee matching process and algorithms. Finally, we present our conclusions in Section IV.

2. WISET Fellow Mentoring Program

The WISET Fellow Mentoring program from KISTI started in 2009[3]. The WISET Fellow Mentoring program aims at supporting female university students, majoring in science and engineering, by mentoring from careered women scientists and engineers in Korea. Mentees participating in the WISET mentoring program can get help from mentors about how to become successful professional scientists and engineers as women after graduation. The WISET mentoring program is operated by Ewha women’s university and funded by Korean government from 2001.

The WISET Fellow Mentoring program starts in spring every year by connecting female professional scientists or engineers in the fellow institute (mentors) with female undergraduate students or graduate students (mentees) studying science or technology in Korean universities. The WISET Fellow Mentoring Program is operated using both on-line and off-line system. Online system comprises exchanging e-mails, writing letters in web board, sending text messages via cell-phones (SMS), etc. Offline system comprises face-to-face meeting of mentors and mentees, mentees’ visit to mentor’s lab, mentees’ participating with their mentor in an academic conference or a technical seminar, etc. Online system and offline system are effectively joined together through mentoring portal of WISET. Figure 1 shows the structure of WISET fellow mentoring system.

![Figure 1. The Structure of WISET Fellow Mentoring System][3]

3. An Effective Design of Mentoring Program

For making successful mentoring program, the matching process has a primary importance in the beginning of the mentoring program. To build a successful matching process, we design the structure of mentoring system using automated mentor-mentee matching process. Figure 2 shows the overall architecture of mentoring system. The mentoring system process can be divided into following three steps: data gathering, matching process, mentoring. Generally, various mentor volunteers and mentee volunteers from various universities, industry and research institutes register on the mentoring program. At this process, we can gather data from the mentor and mentee volunteers. We classified the data by two kinds: the profile and requirement data(See Table 1 and Table 2). Also, the weight can be granted to each profile and requirement by mentees. This is the data gathering step.
At the matching process step, best matching score is calculated using data and weight which are input by mentees. A mentor who get maximum of best matching score is matched to each mentee. We describe the matching process in detail at Section III. At the mentoring step, matched a mentor and a mentee from matching process make a professional relationship in which the mentor assists the mentee in developing specific skills and knowledge that will enhance the mentee’s professional and personal growth.

At the mentoring step, mentoring is conducted according to the result of matching process. However, in some case the result can be modified. For example, according to the favorability from the first meeting between a mentor and a mentee, the result can get feedback on the matching process and be modified. Finally, at the end of mentoring step, mentors and mentee can evaluate the mentoring program. If the evaluation data and matching process data are collected for many years, we could analysis the data and give feedback to the matching process and the data gathering step. The collected data could be a valuable data base for best matching algorithm on mentoring area.

4. Design of Automated Matching Process for Mentoring Program

In order to match mentors and mentees appropriately, there have been introduced automated matching processes between mentors and mentees [6,7]. As a method for finding the best fit matching between mentors and mentees, we suggest a newly designed automated matching process which comprises an input process for entering profiles and requirement of mentors and mentees, an analysis process using weighted matching algorithm to find best fit matching between mentors and mentees based on the data. The data is divided two kinds of data: Profile data and Requirement data. The profile data is data which describes the mentee and mentor in their subjective viewpoints. Table 1 shows profile data. The profiles of mentors and mentees include their areas of expertise, hobbies, characteristics including gender, age, region of residence, religion, etc. The requirement data is data which describes what the mentee is looking for in the mentoring program. Table 2 describes profile data. The requirement data include interesting area, desired area of development, major, gender, etc.
Candidate mentors and mentees can input their profiles and requirements in detail online. And then, the analysis process using matching algorithm automatically deals with profiles and requirements of mentors and mentees. Finally, the best-fit matching between mentors and mentees is resulted from weighted matching algorithm using profiles and requirement of mentors and mentees.

In the input process for entering profiles and requirements, the data is ranked in order of importance. Mentors and mentees can rank the profiles by their own preferences. For example, region of residence, area of expertise, hobby, gender, age, religion, is ordered as stated. Also, the weight can be granted to each profile and requirement. If no preference or weight is given to the data, the statistical values of ranks and weights obtained from successful mentoring results can be given to the profiles as default values. The analysis process using weighted matching algorithm and the scheme of best-fit matching between mentors and mentees are described in Figure 3.

**Table 1. Considering Factors (Profile Data)**

<table>
<thead>
<tr>
<th>Considering Factors (Profile Data)</th>
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<tbody>
<tr>
<td>$F_1$ region of residence</td>
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<tr>
<td>$F_2$ area of expertise</td>
</tr>
<tr>
<td>$F_3$ hobby</td>
</tr>
<tr>
<td>$F_4$ gender</td>
</tr>
<tr>
<td>$F_5$ age</td>
</tr>
<tr>
<td>$F_6$ stage of education</td>
</tr>
<tr>
<td>$F_7$ religion</td>
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</tbody>
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**Table 2. Considering Factors (Requirement Data)**

<table>
<thead>
<tr>
<th>Considering Factors (Requirement Data)</th>
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<tbody>
<tr>
<td>$R_1$ interesting area</td>
</tr>
<tr>
<td>$R_2$ desired area of development</td>
</tr>
<tr>
<td>$R_3$ major</td>
</tr>
<tr>
<td>$R_4$ gender</td>
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</tbody>
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**Figure 3. Weighted Matching Algorithm**
A basic formula for matching between mentors and mentees using factor analysis:

\[ S = \sum_{i=1}^{n} (W_i F_i) + \sum_{k=1}^{m} (W_k F_k) \]

- \( S \) = best matching score
- \( W_i \) = weight of \( F_i \)
- \( F_i \) = profile factors
- \( W_k \) = weight of \( F_k \)
- \( F_k \) = requirement factors

4.1 Matching Process for Online Mentoring

With recent development of Internet and mobile devices, mentoring methods has diversified\[8,9,10\]. For mentoring, people use not only offline meetings but also Internet website, internet cafe, and SMS, etc. The benefit of online mentoring is to meet mentors and mentees and share mentor’s experiences and knowledge, regardless of distance, time and space. Online mentoring is powerful, because it can occur all the time and the accessibility is good. On the other hand, because online mentoring is achieved through system without meeting, a mentor’s and a mentee’s attitude is important. The more active mentee participate in the mentoring program, the more counsel and information mentee can get from mentors. In the case of mentoring, the requirement data could be more important than profile data. Because it is easy for online mentoring to make mentees and mentors accomplish mentoring goal and object regardless of time and place, requirement data which describes what the mentee is looking for in the mentoring program may be more important rather than profile data which describes mentee’s and mentor’s profiles.

4.2 Matching Process for Offline Mentoring

Offline system comprises face-to-face meeting of mentors and mentees, mentees’ visit to mentor’s lab, mentees’ participating with their mentor in an academic conference or a technical seminar, etc. The advantage of offline mentoring is more impact to a mentee because it achieved direct personal connects between individuals. Through the direct relationship between mentors and mentees, individuals encourage higher order thinking and substantive conversations. The disadvantage of offline mentoring is to have the limitation of time and spatial distance. It takes a lot of effort to have face-to-face meeting of mentors and mentees in terms of time and budget. In the case of offline mentoring, both profile data and requirement data are important. In some case, profile data could be more important than requirement data. Because offline mentoring is progressed by face-to-face meeting, profile data including individual regions and personal characteristics can give a lot of influence, comparing with offline mentoring.

4.3 Discussion

In this design of matching process, each weight of personal profile is also given by the mentee him or herself. In case that mentee decides to skip the process to give weights to profiles, weights of personal profiles are given from the system as default values. Only mentee’s preference in favor of online mentoring or offline mentoring, is required because default default values for weights of profile data and those of requirement data are differentiated each other according to preference of the mentee.

Not only the 1st matching of mentor and mentee, the 2nd matching is possible on request of mentee (or mentor). After the 1st matching or the 1st online/offline meeting of mentor and mentee, mentee or mentor may express opinion or satisfaction of the matching. This is a feedback point of the matching process. Matched mentor and mentee are required to have sufficient communications in their 1st meeting to understand each other and estimate the partner is appropriate for the purpose of the mentoring. These personal opinions are given to the matching system as feedback data. Through the feedback point of the matching process, best-fit matching is more possible for the successful mentoring.
5. Summary

In this paper we suggest a new structure of mentoring system using automated matching process. After we have participated and experienced mentoring activities for five years, we find mentor-mentee matching is one of the key factors to get successful mentoring results. As a result, we designed an automated mentor-mentee matching process supposed to find the best fit matching between mentors and mentees. For best matching we utilize profile and requirement data of mentors and mentees. After gathering profile and requirement data, best-fit matching by use of weighted matching algorithm is resulted based on primary data gathered from mentors and mentees. In the mentoring process, the 2nd matching can be done if feedback data, such as opinions from mentor or mentee, are given as an evidence for the change of the 1st matching. If our automated matching process is used for online or offline mentoring program, the matching between mentor and mentee can be more efficient and fit much better. Also, we design overall architecture of mentoring system based on our matching process. We anticipate that mentoring system is a useful system for constructing more successful mentoring relationship between mentors and mentees.

6. Acknowledgement

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7. References