

A Social Referral Mechanism for Job Reference Recommendation

Full Papers

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Abstract

Recently, with the popularity of various social media, this new trend of information technologies has impacted our lives, redefined the way we interact with each other, and facilitated the communication and influence cross different social groups, such as enhancing the power of social search and appraisal. In this research, we mainly focus on this mystery process of information exchanges existing long ago on the base of sociology and apply this power in the field of job seeking. Considering the factors of both willingness and influence, we generate the list of proper reference candidates to desired job for job seekers to provide more job-related information or to be referrals. Integrating the knowledge of human resources management, we implement this social referral application with the support of information technologies and strive to enrich the service of social media, turning the passively searching for job seeking to actively consulting for exclusively job information.

Keywords

Social Search, Business Social Platform, Job-seeking, Social Referral, Social Appraisal

Introduction

Internet now has become irreplaceable in our daily lives and widely applied in many ways. For many business companies, the internet has replaced the classified advertisement section in the newspapers and turns out to be an important channel for recruitment. For 72 % of job seekers who have just graduated from college and are eager to find their jobs, job websites are also their first choice for job-hunting (Wang 2000).

While many jobs are filled through online recruitment, human resource departments have also noticed that there is another effective channel, which has existed for thousands of years; that is by personal relationship, or what we now call social networks. A survey conducted by the Society for Human Resource Management and Wall Street Journal in 2001 showed that 95% of human resources managers or job-seekers find employees and job-seeks find ideal jobs through their personal relationships.

Because contacting as many people as possible is a highly effective way to find a job, social scientists analyze the relationships and interactions between the job-finders and the job information providers. Those people who belong to distant social circles and meet occasionally would bring us novel information, which includes new job offerings and opportunities. This acquaintance relationship, which is labeled as a weak tie, becomes crucial and remarkable while considering mobility opportunities. While considering the strength of weak ties, the popularity and prevalence of social media sites can offer a perfect opportunity to practice the social theory. Social search, defined as a search for people via social networks or as a human intermediary search, utilizes web search techniques based on huge amounts of data and has been extended to the situations involving collaboration and support. It can help people to obtain information or connect to people who might provide help through various social circles. Much convenience has been brought by various job websites and social platforms, however, users have to spend a lot of time to gather

more information about the job itself, such as the working hours, real workload, and the target company's culture on the Internet. It is a big challenge and a time-consuming task for job-seekers to gather more true information about that position and even harder to actually connect to someone working in the company or relevant industry. On the other hand, job seekers can use the business social platform, LinkedIn, to gather information about companies as well as about some workers in these companies. However, since LinkedIn is only for the purpose of social networking, it lacks the ability to support real, frequent, and timely interactions among people compared to other social platforms, such as Facebook.

As social media is widely used among people, it is sensible to use this platform to start a social search. The challenge we have to take on is how to distribute the user's social search query across the network and how to find out the best people based on the query given all potential candidates in the social network. As well, we seek to determine the best kind of information to index and thus categorize people in order to calculate a score for ranking the candidate list according to their willingness to provide help. To resolve the problem, we need to integrate and analyze the database of both job websites and social platforms. In this paper, we aim to exploit the power of social networks in improving job search. Specifically, we develop a social referral mechanism applied in the online job search and improve the job-matching process by exploiting the power of social ties. Unlike the existing social recruiting services, which mainly focus on the benefits for the recruiters as well as companies, we will construct a mechanism including social search and appraisal engines striving for the convenience of job seekers.

Literature Review

Online Recruitment

Generally speaking, there are two channels for a company to identify and attract a potential employee: formal and informal (Kirnan et. al 1989). Formal channels refer to those organizations and agencies involved in the process of connecting the employees and job-seekers, such as job fairs, ads in the newspapers, education institutes, and online human resources agencies. The informal channels indicate that personal recommendations from internal employers, friends, or relatives can facilitate the process for recruiters and potential employers. While a company can enjoy the convenience and cost-effectiveness brought by the internet recruitment sites, 33% of European companies indicates that the employers recruited through online websites are more liable to leave their jobs and 44% think that it not easy to find out the very good-fit employers with the internet tools (Kuhlen 2014). On the other hand, the employers who enter a company with personal referral would significantly work longer and also tend to accept the job offer. In this study, we try to improve the effectiveness of online recruitment by integrating the idea of informal referral into the online web sites.

Social Ties Analysis

Social network analysis has played a key role in modern research of sociological, which illustrates the connection between two individuals as "tie". Regarding the measurement of relationships, the intuitive notion of the "strength" of those ties would appear and thus can be calculated by different elements. Granovetter (1973) indicates there are two different kinds of social ties, which vary on the strength scores. One is the "Strong Tie", which usually occurs between trusted friends and families. The other is the "Weak Tie", which often happens among acquaintances. Those ties impacts people's daily lives in different ways. Reliable friends and close families can affect emotional health, help people suffering from stress, and often join together to lead the groups while facing the crisis. Weak tie friends can help a friend inspire new ideas (Cui and Zhou 2012), launch the diffusion of information, or find a job through reference (Burt and Silverman 2008). In this study, we utilize the function and properties of weak ties as a perfect tool to locate a social referral for job-seekers.

Social Search

Since the social acts and social interactions could benefit the search process, this type of search can even be applied in a decentralized search. In this search model, how to route the queries over a social network becomes the main issues to resolve (Trias and Mansilla 2013), considering factors, such as whether a specific node will respond or not, or whether this node is relevant to the target we are searching for (Banerjee and Basu 2008). Recently, besides the elaboration of application on the expert-finding area,

social search has been extended to various fields, such as resource discovering, new web services finding, people search (Li et. al 2011), etc. In this study, we further use the approach of social search to find the reference candidates for our desired jobs.

Social Support and Appraisal

Social appraisal can be regarded as one of the important features for social support evaluation, which is the combination of psychological and behavior functions. S. Wasserman and K. Faust (1994) have proved that with more connections, whether in link of friendship or interaction, it is more likely for people to influence to each other. Actually, this kind of influence play an important role when talking about social support, which is defined as a mediating construct providing help from other people in the social network (Syme 1985). With the help or support, the information from others in the social network could be offered as the source of social appraisal to help the decision making process (Li and Lai 2014). Recently, social appraisal has been widely used due to the popularity of social network analysis. For example, a lot of research has been conducted in the field of electronic commerce, focusing as information filtering and spreading. Besides, the social appraisal is also used in knowledge management, such as expert-finding (Trias and Mansilla 2012). In this research, we use the social network relationship as the sources of social support to provide social appraisal for evaluating how people are willing to help you and also how people could affect others.

The System Framework

The process of job searching is divided into five steps: locating a job, researching employees, networking, applying, and interviewing. In this paper, we mainly pay the attention on the first three steps and design the mechanism to increase the possibility to attain the interview for job seekers. Especially, for the first step to locate the job openings, we emphasize the enhancement of current job websites, which have been the main channels for job searching. Following job locating and researching, the third step mentioned above would be decisive and also be a challenge for most of job seekers; that is networking. How to discover the right reference that can affect the opportunities by considering the willingness of all the candidates within one’s social network is important for the job seekers. To meet the objective of searching for the proper candidates for reference from the social network and rank these referral candidates, several techniques are required. An illustration of this mechanism is depicted in Figure 1.

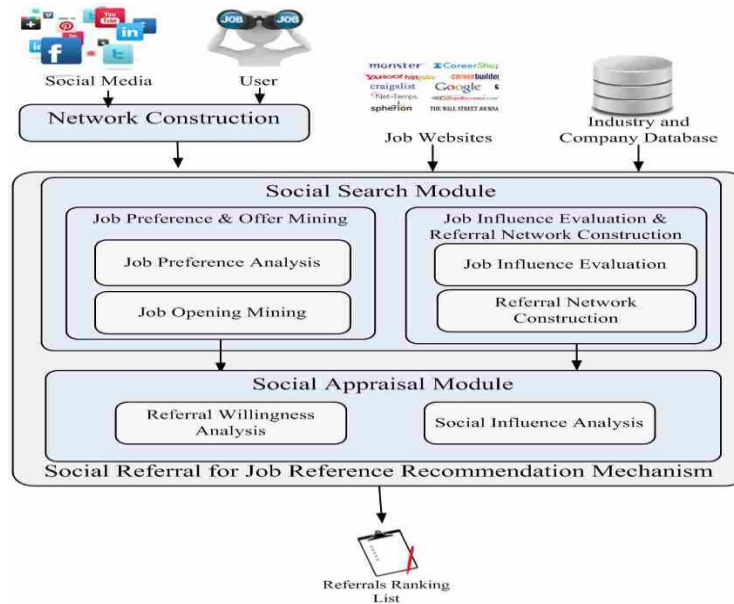


Figure 1. Architecture of Social Referral Mechanism

Social Search Module

The objective of social search module is to identify the set of job referral candidates with high relevance. The social search module includes the following processes (1) analyzing the job searched, (2) discovering the jobs offer (3) measuring the job relevance of each user in the social network, identifying the job referral candidate with high job influence to help the job seeker, and (4) constructing a referral network for the job seeker.

Job Preference Analysis & Offer Mining

This analysis is to search all possible job offerings in the desired industries, companies or functions that users may be interested in. Before the search phase, we have to describe our query condition. In this research, we refer the common job description shown on the job websites and use four properties to describe a job. They are industry categories, company name, function name and job grade, and each of those variables belongs to their individual set. A job j could be denoted as:

$$Job_j = \{I_j, C_j, F_j, G_j\}, \text{ where } I_j \in I, C_j \in C, F_j \in F, G_j \in G, \quad (1)$$

I : the set of industry category, C : the set company category.

F : the set of function category, G : the set of job grade.

Job Preference Analysis. Job seekers choose their desired job by describing the input of the four job property variables. The job referral invited has also been asked to describe property variables of the jobs they are familiar with. In this study, the options of those variables are designed by the reference of job websites.

Job Opening Mining. After analyzing the job seeker's preference, the job search will be executed through the online web sites and relevant information is stored in the database used to mine the available job offerings by the tools of web crawlers. The system will store the list of job openings in the job set for the job seekers. For example, the job offerings which are suitable for job seeker u are described as:

$$Openings(u) = \{Job_{u1}, Job_{u2}, \dots, Job_{um}\}. \quad (2)$$

Job Influence Evaluation & Referral Network Construction

The goal of the processes is to search job referral candidates for the job offerings mined and construct the referral network expanded from the job seeker.

Job Influence Evaluation. A referral candidate with influence should be familiar with the job offer. We calculate the job referral influence score by comparing the four indexes describing the job offering and the information of working experiences. In other word, the job influence is measured as the similarity between the job to referral and job to search. We consider one suitable job offer to referral at a time, denoted as the J_v . The similarity between the job offer to referral J_v and the job to search J_u can be estimated as:

$$Sim_{industry}(J_v, J_u) = \begin{cases} 1, & \text{if } Industry(J_v) = Industry(J_u) \\ 0, & \text{otherwise} \end{cases}. \quad (3)$$

$$Sim_{Company}(J_v, J_u) = \begin{cases} 1, & \text{if } Company(J_v) = Company(J_u) \\ 0, & \text{otherwise} \end{cases}. \quad (4)$$

$$Sim_{Function}(J_v, J_u) = \begin{cases} 1, & \text{if } Function(J_v) = Function(J_u) \\ 0, & \text{otherwise} \end{cases}. \quad (5)$$

$$Sim_{JobGrade}(J_v) = \begin{cases} 0.2, & \text{if } J_v \text{ is associate} \\ 0.5, & \text{if } J_v \text{ is staff} \\ 0.7, & \text{if } J_v \text{ is middle-level manager} \\ 1, & \text{if } J_v \text{ is high-level manager} \end{cases}. \quad (6)$$

If the person works in the same industry, the same company or the same function that is the same as the job user u is searching for, we mark 1. Otherwise it is zero. Since we only consider how the user v influences the job offer, we only use the job grade of user v . The job influence of user v to job seeker u is formulated as:

$$JI(J_v, J_u) = \alpha \times Sim_{Industry(J_v, J_u)} + \beta \times Sim_{Company(J_v, J_u)} + \gamma \times Sim_{Function(J_v, J_u)} + \delta \times Score_{JobGrade(J_v)}, \quad (7)$$

where $\alpha + \beta + \gamma + \delta = 1$.

Referral Network Construction. After measuring the job influence of each user in the social network, the network of referral candidates will be expanded continuously from the job seeker. Specially, we denote $\Theta_{SN}(l)$ as the set of users in the social network which is constructed by nodes expanding for l layers and $Friends(u)$ the function to express the friend set of a certain user u . For example, for a job seeker u , $\Theta_{SN}(0) = u$, $\Theta_{SN}(1) = Friends(u)$ and $\Theta_{SN}(2) = Friends(Friends(u))$. Along by the $\Theta_{SN}(l)$ definition, we also use $\Theta_R(l)$ as the set of users included in the referral candidate network for layers expanding. The network expanding process in this stage can be described as:

$$\Theta_R(l+1) = \Theta_R(l) \cup \{v \mid v \in \Theta_{SN}(l+1), JI(J_u, J_v) > \varepsilon_R\}. \quad (8)$$

where $\Theta_R(0) = \phi$, J_u is the job user v is familiar with and J_u is the job user u is searching. ε_R is the threshold of job influence level. We construct the network of referral candidate network after expanding three layers ($l=3$). To record the link from job seeker u to certain candidate v in the expended social network, we record all the social paths from user u to job seeker v :

$$SocialPaths(u, v) = \{SocialPath_1(u, v), SocialPath_2(u, v), \dots, SocialPath_n(u, v)\}. \quad (9)$$

where $SocialPath_i(u, v)$ stores all the nodes along a path i and described as:

$$SocialPath_i(u, v) = \{sp_{i1}, sp_{i2}, \dots, sp_{ik}\} \text{ where } p_{i1} = u, p_{ik} = v. \quad (10)$$

Social Appraisal Module

The objective of the social appraisal module is to further evaluate and rank out the best referral candidates which are identified through the social search module. This module consists of two major components: (1) referral willingness analysis and (2) influence analysis.

Referral Willingness Analysis

Two components used for evaluating the referral willingness score are: social tie strength and the similarity of experience. The factors considered in evaluating social tie strength include mutual friends, interaction duration (day since the last communication), and status comment (the frequency of like or comment in the status wall), which represents three different dimensions concerning the referral willingness - the structure, the intimacy, and the intensity respectively.

Social Tie Strength Analysis. From the structure view, the more mutual friends two people have, the higher possibility there would be a certain social link between two people and the more chances to help each other. From the intimacy view, as the research focuses on soliciting the help of taking real referral action, private messages exchanging will be a perfect index to reflect the actual interaction of intimacy. Last, as for the intensity, we use the status update rate of comment and like to evaluate how intensely friends interact with each other.

(1) **Mutual Friends:** The number of mutual friends between two people intuitively indicates how close these people are in the social circle. Deduction from the theory of social tie triangle, the stronger tie exists between two people, the more possible they would be friends and get quite familiar with each other. Here we use the function $MF(u, v)$ to record the number of mutual friends of user u and user v and use it to compare the closeness between two people.

$$MF(u, v) = \frac{|Friends(u) \cap Friends(v)|}{|Friends(u) \cup Friends(v)|}, \quad (11)$$

(2) **Interaction duration:** The social tie strength differs significantly for the people who talked once and for those who never talk (Gilbert and Karahalios 2009). In this research, we record the days of the first communication and the last communication to evaluate the index of duration. The function $FirstDay(u, v)$ is defined as the function which returns the time intervals from the first conversation to now between

users u and v . The function $LastDay(u,v)$ means from the last conversation to now. If the conversation just happened today, the value will be zero. If the conversation never happens, both the function return the infinite value.

$$Duration(u,v) = \alpha \times \frac{1}{FirstDay(u,v)} + (1-\alpha) \times \frac{1}{LastDay(u,v)}. \quad (12)$$

(3) *Status comment*: The emotional effect is another crucial element affecting the decision whether we would like to assist other people or not. If we have good feelings about the other person, we are liable to give him/her a hand. In this research, we accumulate the number of “like” or comments a user v has made on the status of person u during the past two months to figure out how user v thinks about person u compared with his or her other friends. We use $Friend_{Like}$ and $Friend_{Comment}$ functions to summarize the number of times the user v has clicked a “like” on the post of user u and the number of times user v has left a comment on the post of user u .

$$Friend_{Comment}(u,v) = \sum_{p \in Post(u)} Post_{Comment}(v,p), \quad Friend_{Like}(u,v) = \sum_{p \in Post(u)} Post_{Like}(v,p). \quad (13)$$

Note the set $Post(u)$ is used to record all the status post of user u . $Post_{Like}(v,p) = 1$ if user v clicks a “like” for the post p or $Post_{Like}(v,p) = 0$ otherwise. The rule works the same on the $Post_{Comment}$ function. If user v left a comment on post p , then $Post_{Comment}(v,p) = 1$, otherwise $Post_{Comment}(v,p) = 0$. We conduct the linear normalization as below:

$$Like_{given}(u,v) = \frac{Friend_{Like}(u,v) - \min_{f \in Friends(u)} Friend_{Like}(u,f)}{\max_{f \in Friends(u)} Friend_{Like}(u,v) - \min_{f \in Friends(u)} Friend_{Like}(u,f)}, \quad (14)$$

$$Comment_{given}(u,v) = \frac{Friend_{comment}(u,v) - \min_{f \in Friends(u)} Friend_{comment}(u,f)}{\max_{f \in Friends(u)} Friend_{comment}(u,v) - \min_{f \in Friends(u)} Friend_{comment}(u,f)}, \quad (15)$$

$$Status(u,v) = \alpha * Like_{given}(u,v) + (1-\alpha) * Comment_{given}(u,v). \quad (16)$$

As the values in $MF(u,v)$, $Duration(u,v)$ and $Status(u,v)$ are not located during $[0,1]$, we apply the min-max normalization to normalize those values.

Finally the social tie strength of user u and v is computed as:

$$ST(u,v) = \alpha \times MF(u,v) + \beta \times Duration(u,v) + \gamma \times Status(u,v), \quad \text{where } \alpha + \beta + \gamma = 1. \quad (17)$$

Experience Similarity Evaluation. While the social tie quantifies the private, personal and subjective side of referral willingness, the experience similarity reflects the objective side of referral willingness. It is common to see a job reference comes from alumni although the senior managers may not directly interact with the younger students. Two elements are considered for experience evaluation: living location and education background. The experience similarity between job seeker u and user v is computed as:

$$ES(u,v) = \alpha \times Sim_{Education}(u,v) + (1-\alpha) \times Sim_{Location}(u,v) \quad (18)$$

(1) *Living location*: People tend to take care of those who come from the same living areas in most referral cases. So in this case, we take this factor into consideration.

$$Sim_{Location}(u,v) = \begin{cases} 1, & \text{if } Location(u) = Location(v) \\ 0 & \text{otherwise} \end{cases}. \quad (19)$$

(2) *Education background*: The seniors who are graduated are commonly willing to share their own working experiences and even want to recruit some talented juniors to join their companies. People with the same education background influence the strength of their referring referral willingness. For the job reference case, the college, the graduated school, and the major are three major information sources for describing the education experience.

$$Sim_U(u,v) = \begin{cases} 1, & \text{if } University(u) = University(v) \\ 0, & \text{otherwise} \end{cases} \quad (20)$$

$$Sim_G(u,v) = \begin{cases} 1, & \text{if } Graduate(u) = Graduate(v) \\ 0, & \text{otherwise} \end{cases} \quad (21)$$

$$Sim_M(u,v) = \begin{cases} 1, & \text{if } Major(u) = Major(v) \\ 0, & \text{otherwise} \end{cases} \quad (22)$$

Consolidating the three factors, the similarity of experience is computed as:

$$Sim_{Education}(u, v) = \alpha \times Sim_U(u, v) + \beta \times Sim_G(u, v) + \gamma \times Sim_M(u, v), \text{ where } \alpha + \beta + \gamma = 1 \quad (23)$$

After going through all the processes of social tie strength and experience similarity evaluations, we can get the score of referral willingness of user v to job seeker u as:

$$W(u, v) = \alpha \times ST(u, v) + (1 - \alpha) \times ES(u, v). \quad (24)$$

Referral Willingness Calculation. After computing the willingness score among each social link, we find the referral willingness along the social path from job seeker u to certain candidate v . The calculation process is depicted as:

$$W(u, v) = \underset{SocialPath_i(u, v) \in SocialPaths(u, v)}{Max} W(sp_1, sp_n) = \underset{SocialPath_i(u, v) \in SocialPaths(u, v)}{Max} \prod_{i=1}^{n-1} W(sp_i, sp_{i+1}) \quad (25)$$

Besides locating the possible candidates, we also find the best referral routing path - the closest path to each possible candidate which achieves the goal of maximizing willingness and increase the possibility for those candidates to help the job seekers. The example of calculating process is illustrated in Figure 2. In the social search stage, after finding the candidate Amy, the system will also identify the two social paths between from job seeker John and Amy. In the social appraisal stage, the system will further do referral willingness score computing

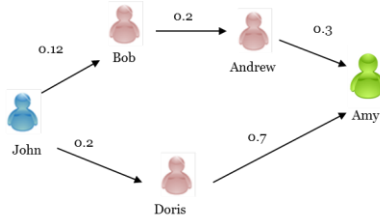


Figure 2. The example of calculating willingness

The referral willingness score between John and Amy will be computed as:

$$w(John, Amy) = w(John, Bob) * w(Bob, Andrew) * w(Andrew, Amy) = 0.12 * 0.2 * 0.3 = 0.0072.$$

$$w(John, Amy) = w(John, Doris) * w(Doris, Amy) = 0.2 * 0.7 = 0.14.$$

After comparing the two social paths from John to Amy, the system will automatically select the social path with the highest score as the path to obtain the referral willingness score for $w(John, Amy)$.

Social Influence Analysis

We use three elements, total friends, social popularity, and social engagement to evaluate the status of certain user in the social circle. The first element is to measure the possible social circle a person can impact on. The second one is to measure the actual attention a person can gain, or how popular he or she is in the social network. The last one is to measure how this person becomes involved in the communities of social network.

- (1) **Total Friends:** The total number of friends is measured by the number of friends a user has on the social network platform and used to evaluate the scope he/she may influence and the number of people that user can help distribute the job query. We use the $tf(u)$ function to get the number of friends of a certain user u . Considering the diversity of different social circle, the normalization formula is described as:

$$TF(v) = \frac{tf(v) - \underset{f \in Friend(v)}{Min} tf(f)}{\underset{f \in Friend(v)}{Max} tf(x) - \underset{f \in Friend(v)}{Min} tf(f)}. \quad (26)$$

- (2) **Social Popularity:** We express this kind of social power in the way of gaining attention. Some person may not be directly relevant with your desired job, neither the company nor the industry. However, this person is popular in publishing your job hunting news in his/her own social network and directs you to his/her friends. In this evaluation, the average number of “like” and comments from friends per status update are used to measure how much attention a user would get through their personal social network. The two indexes of popularities are measured as:

$$Like_{received}(v) = \frac{\sum_{p \in Post(u), f \in Friends(v)} Post_{Like}(f, p)}{n(Post(v))}, \quad Comment_{received}(v) = \frac{\sum_{p \in Post(v), f \in Friends(v)} Post_{Comment}(f, p)}{n(Post(v))}. \quad (27)$$

The score of social popularity is generated as:

$$SP(v) = \alpha \times Like_{received}(v) + (1 - \alpha) \times Comment_{received}(v). \quad (28)$$

(3) *Social Engagement*: The popularity of low-cost and often-asynchronous social network on the Internet, social involvements turned from the local and group-based to the Internet-based. In this research, we consider the status in the way of participating group. We use the function $group(v)$ to denote the number of group user v joins and compare this involvement degree with a user's friends.

$$SE(v) = \frac{group(v) - \underset{f \in Friend(v)}{Min} group(f)}{\underset{x \in Friend(v)}{Max} group(f) - \underset{f \in Friend(v)}{Min} group(f)}. \quad (29)$$

Finally, the score of social influence will be defined as:

$$SI(v) = \alpha \times TF(v) + \beta \times SP(v) + \gamma \times SE(v), \text{ where } \alpha + \beta + \gamma = 1. \quad (30)$$

Note that the social influence only considers personal power and only the candidate user v will be involved. The final influence is formulated as the following formula:

$$I(u, v) = JI(u, v) \times SI(v). \quad (31)$$

Experiments

We choose the most popular job website in Taiwan, 104 human resources bank and the most popular social services websites, Facebook, as our experimental platforms to execute job-seeking process and observe the interaction process among people. Job openings information is collected from the 104 human resources bank and the social interaction data is collected from Facebook. We use a web crawler to analyze the job openings published in the 104 websites and index some properties in advance in order to optimize the request process later happened in the social search on Facebook. We use Facebook API to gather the real interactions among specific relationship to estimate the intimacy between friends or the popularity of certain people in his/her own social network.

Data Collection

We start data collection by asking what kinds of jobs users prefer and index the job with predefined variable, such as industry, company, and function. Here user can either enter the job query by his/her own preference or by the current available job openings listed on the job websites. We refer the categories of 104 job banking websites as our variable. Users also have to input their personal information, such as living location and education background. After figuring out the description about their ideal jobs, or we could call the "query condition" of social search, we collect the data by passing the webpage link we designed to gather all information we need for further calculation. We use this web form to get both personal information concerning job (industry, company, function, and job grade) and education and the records of social interaction happening in the Facebook. There are 35 users participating as initiators. For each initiator, we ask him/her to pick up three kinds of different types of jobs and spend approximately one week long to distribute and gather information from their social network. At the end of our experiment, we have 4,445 participants involved and collect 1,877,995 social links. On average, there are 127 participants in each social network and 53657 social links among per social network.

Weight Generation

In this paper, we adapt ANP model to solve the weighting problem among all kinds of combination. We use our app to analyze the relationship of weighting between different factors from our participants. In order to do the survey more conveniently, we use the example questions to figure out the correlation between each pair of variables and convert it to the original calculation in Table 1. After carefully analyzing, we get the results from the collaborative opinions imputed from all participants and thus use this to further recommend people of possible candidate lists.

Left side is important						Right side is important										
Important						Degree										
Extremely	Very	Slightly	Generally	Equal	Generally	Slightly	Very	Extremely								
9:1	8:1	7:1	6:1	5:1	4:1	3:1	2:1	1:1	1:2	1:3	1:4	1:5	1:6	1:7	1:8	1:9
A																B

Table 1. ANP table for weighting

Results and Evaluation

To evaluate the accuracy of our proposed mechanism about recommendation referral candidate, we use our web-based app to execute the candidate processing and inform our users the candidate list. Furthermore, we ask them to rate the result of candidate and to see what's their opinion about it as the feedback to enhance the mechanism.

Accuracy of Social Referral Information

In this experiment, top ten candidates are selected from the ANP result and ranked in the candidate list by their scores. The reason we choose top ten people is it's the reasonable number for a job seeker to actually contact in person for a specific job position. After the recommendation, we ask the job seeker to review that list and pick up those people he/she thinks are actually helpful. In this evaluation, we measure the accuracy of the referral recommendation mechanism by the equation (32), where $\Phi_{recommended\ referrals}$ is the set of referrals on the recommendation list and $\Phi_{recommended\ referrals} \cap helpful\ referrals$ is the set of referrals whom job seeker thinks are truly useful in our recommended list.

$$Accuracy = \frac{|\Phi_{recommended\ referrals} \cap helpful\ referrals|}{|\Phi_{recommended\ referrals}|} \quad (32)$$

Components Weighting Determination

In order to determine the weighting approach to provide better recommendation result, we perform three different combinations of weighting to see the evaluation of each method from users: (1) equally weighting, (2) group weighing approach and (3) personal weighting approach. We use those different approaches to output the ranking result and ask users to evaluate the accuracy. Figure 3 shows that the users are satisfied with the recommendation result the most from the group weight approach, surprisingly. This may because the weighting approaches of group and personal weight are quite similar. We also conduct the t-test to confirm the result. According to Table 2, the results shows that all the pair tests are significant under 0.05 at 95% significant level which provided that group weight is statistically better than the other two weighting approaches.

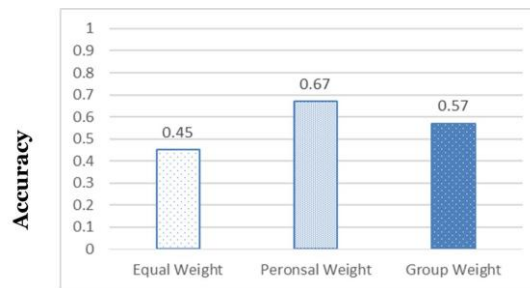


Figure 3. Weighting Approach

Paired Group		Mean	Std. Deviation	Std. Error Mean	t	Sig. (2-tailed)
Group Weight	Equal Weight	1.06780	1.40030	0.18230	5.857	0.000
	Personal Weight	0.49153	1.20877	0.15737	3.123	0.003

Table 2. Statistical verification results of weighting

Recommendation List

We further analyze the performance in referral candidate network construction by comparing different types of social tie strength ranking list. There are three different types of social tie ranking list: (1) ranked from the strongest to the weakest, (2) ranked from the weakest to the strongest, and (3) randomly ranked. Align with the concept defined by Granovetter (1983): for those people who directly contact at least twice a week, we define their relationship as strong tie and others are weak tie. The random ranking approach is a randomly selected person from the friend list of user without considering the social tie between them. The size of referral candidate network is the measurement of those three methods. Figure 4 shows the results.

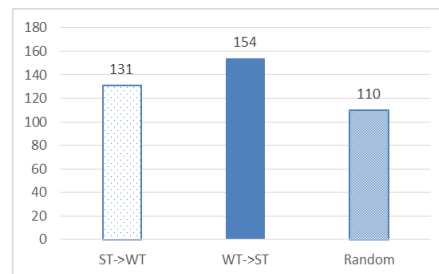


Figure 4. The average number of participant network

We can observe that the results match the sociological theory. Social search for job referrals based on the rule of weak-tie first approach (WT->ST) can construct a larger pool of referral candidates. Though strong-tie friends are definitely willing to help the job seeker more, there would be more possible to have people overlapped in the scope of social network. On the other hand, weak-tie friends might have less direct interacts, though, somehow they are still happy to give a hand in the context such as job hunting.

Conclusion

This study makes several significant contributions as follows. First, from the methodological aspect, our mechanism exploiting the power of social search to find out referral candidates, who provides more job information more than the official description in the job websites. With this key element, a searching mechanism ground on social networks is proposed to locate the possible candidates with high referral willingness and influence. Second, from the empirical aspect, we discover that not all the factors are equally important in improving the effectiveness of social referral. Actually, the social tie strength, experience similarity, and job relevance are the three factors that truly matters. Among those three factors, job relevance is the most important, which is surprisingly against what users think. Lastly, from the practical aspect, people can gain more information other than the job information itself and interact with the real referral people. Furthermore, they can easily search and access those targeted people by the “social path” which is connected by the friend social network. By considering the real-time and daily interaction occurred on Facebook, the proposed social path is more helpful for those users, which is different from the function that LinkedIn provided.

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