# Evaluate the International Talents in Professional Social Networks using the Entropy Weight Method

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Abstract—Social network, especially international professional social network, not only gives users a chance to promote their own profiles, but also gives companies a platform to locate international talents. However, the social network has a great number of users across the countries, who generate huge amount of information everyday, which makes it very difficult for the hiring companies to find excellent international talents. In this context, this article bases on LinkedIn as the international professional social network and proposes a research model to effectively find international talents. Firstly, we establish an evaluation model using a group of evaluation indices based on the online professional profile; Secondly, we use the model to evaluate users' LinkedIn profile on each index and the weights of each index through entropy weight method; Thirdly, it integrates these values and weights into one comprehensive score for the user's profile, which can be used to rank the international talents and help the company recruiting; Finally, a group of LinkedIn users' profiles are randomly selected and we have conducted experiments on these profiles to validate the research model.

Keywords—professional social networks; international talent; evaluation model; entropy weight method.

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# I. INTRODUCTION

In order to adapt to the development of economic globalization, actively respond to the increasingly fierce international competition, there is a great demand of enterprises for international talents who have an international perspective and well understand international rules. International talents should have comprehensive knowledge structure, outstanding capabilities and world-wide networks to compete for international opportunities and handle global challenges [1-4]. A company that has more excellent international talents can have higher productivity, better performance, and more revenue. To recruit real international talents, organizations need to correctly and accurately understand the skills and experiences of the job applicants for more effective and informed hiring decision. Wrong decision in talents recruiting will incur significant loss of value and high turnover of human resources [5].

Traditionally, companies tend to publish recruitment information through websites, newspapers and other media to attract candidates to send their resume, and then review and screen applicants based on their resumes. This approach can help companies to find some suitable talents, who have a Jianxia Wang SHU-UTS SILC Business School Shanghai University Shanghai, P.R. China wjx.630604@163.com

certain ability to work, but the cycle is often longer and the efficiency is low, meanwhile, it cannot help companies to find those high levels of international talent hidden in other enterprises.

In order to reduce these drawbacks in the traditional recruiting process, we consider the professional social network web site LinkedIn as a platform to help hiring companies to effectively and accurately find talents. LinkedIn is currently the most widely used web site by business professionals, and so many companies use it to get candidates' effective and trustworthy information, including their biography information, education background, work history and recommendation, etc. Since all this information is visible online and under the scrutiny of the public audience, it is considered relatively creditable to the hiring companies. Through information integration and comprehensive assessment, the companies have a better chance to find suitable talents. Section 2 reviews the literatures that are related to this work. Section 3 presents a model to evaluate international talent based on the information on the professional social network. Section 4 conducts a comprehensive evaluation of users randomly selected on LinkedIn and Section 5 concludes this paper and outlines the future work that should be extended to from this research.

## II. LITERATURE REVIEW

# A. Professional Social Network

A social network in our research work refers to the computer network that connects people or organizations [6]. It can be seen as a group of people and connections between them [7]. More specifically, it is defined as "a category of Web sites with profiles, semi-persistent public commentary on the profile, and a traversable publicly articulated social network displayed in relation to the profile." [8]. Social networks have gained the attention of the research community that tries to understand users profile and their interconnection [9,10] as well as interactions among users [11].

Within various kinds of social networking web sites, the sites that aim at professionals, such as LinkedIn, enable individuals to share their educational background, career paths and skill-sets, and request for recommendations and endorsements. In specifics, a business professional's LinkedIn profile has the following sections: basic personal information, work experience, language proficiency, skills and endorsements, education background and recommendations.



# 1) Basic personal information

In the personal basic information section, we can get user's name, company and work position, location, friends and professional summary.

## 2) Work experience

In the work experience section, we can find the companies that the users worked in, their work positions and employment period.

# 3) Language proficiency

The language proficiency section shows the languages that the user speaks and his proficiency, including five levels: Elementary, Limited Working, Professional Working, Full Professional Working and Native or Bilingual.

#### 4) Skills and endorsements

On LinkedIn the user can freely claim the skills that he owns, such as computer programming or financial accounting. After that, he needs to rely on his friends to endorse these skills of his. In this section, we can obtain the types of skills and the number of endorsement the user gets on LinkedIn.

#### 5) Education background

In the education background section, users can publish the names of the institutions they attended, the time period of their study and the degrees they have earned.

#### 6) Recommendations

In this section on LinkedIn, users can get recommendation from, or make recommendations for, other users electronically. The number of the recommendations the user has received and given will be used in our approach to evaluate the international talents.

In this article, we will discuss how to use all the above information to improve the recruiting process and reduce the existing drawbacks. In particular, we will define a set of evaluation factors based on the information that the hiring companies can obtain online, and then we will propose calculation methods to evaluate the professional capability of the job seekers.

#### B. Entropy weight method

An evaluation model is composed of various indices. To make such a model effective, we need to define the weight of each index. In order to reduce the influences of subjective factors in determining these weights, we apply the entropy weight coefficient method, in which the index weight is systematically calculated based on the level of the difference between the evaluation values of original objects using each index. Simply put, if the value difference between the objects, when evaluated using an index, is higher than the difference using other indices, that index has more weight than other indices [12-14]. The rest of this section explains the details of this method.

Suppose that there are m evaluation indices, n objects to be evaluated, considering the value of each object on each index, we can get a matrix X, where  $x_{ij}$  represents the j<sup>th</sup> index value of the i<sup>th</sup> object. Then we use the following procedure to calculate the index weight:

# 1) Normalize the data matrix

We will normalize the data matrix using the following formula:

$$r_{ij} = \begin{cases} \frac{x_{ij} - \min_{i} \{x_{ij}\}}{\max_{i} \{x_{ij}\} - \min_{i} \{x_{ij}\}}, & \text{if } x_{ij} \text{ is a benefit index} \\ \frac{\max_{i} \{x_{ij}\} - x_{ij}}{\max_{i} \{x_{ij}\} - \min_{i} \{x_{ij}\}}, & \text{if } x_{ij} \text{ is a cost index} \end{cases}$$
(1)

## 2) Calculate the entropy value of the evaluation index

We will calculate an entropy value of each evaluation index, based on value difference in the index column. The entropy value of the j<sup>th</sup> index can be calculated as follows:

$$H_{j} = -k \sum_{i=1}^{n} f_{ij} \ln f_{ij}, 1 \le i \le n, 1 \le j \le m, 0 \ln 0 = 0.$$
(2)  
Where  $f_{ij} = r_{ij} / \sum_{i=1}^{n} r_{ij}$  and  $k = 1/\ln n$ .

3) Calculate the index entropy weight

The entropy weight of the  $j^{th}$  index can be calculated as follows:

$$w_{j} = \frac{1 - H_{j}}{m - \sum_{j=1}^{m} H_{j}}, 1 \le j \le m.$$
 (3)

Where  $w_j$  is the weight of the j<sup>th</sup> index,

and 
$$\sum_{j=1}^{j} w_j = 1, 0 \le w_j \le 1$$

# III. EVALUATION MODEL FOR INTERNATIONAL TALENTS

User information on LinkedIn are various and not fully structured, so when using this information to evaluate the international talents, we should proposed a model that include the necessary and sufficient information that can be extracted from LinkedIn and used to evaluate international talents.

International talents should have comprehensive knowledge structure, outstanding capabilities and world-wide networks to compete for international opportunities and handle global challenges. Based on this understanding, our research model to evaluate the internationalization level of LinkedIn users will at least include the following components: work history, education background, language proficiency, international connections, and recommendations and endorsements. The rest of this section will discuss the details of each component.

## A. Work history

In this section, we consider two factors: the internationalization level of work and work experience.

1) Internationalization level of user's work

In our model, we consider the internationalization level of a user's work is related to the number of companies that the user ever worked at and the number of regions that company staff are from.

$$IW(u) = \frac{\sum_{i=1}^{N_w} \left(\frac{R(i)-1}{k}\right)}{N_w} \tag{4}$$

Where IW(u) is the internationalization level of user u's work;  $N_w$  is the total number of companies that user u worked at; R(i) is the number of the regions the company staff are from, and k is 4 (considering most of the Linkedin users are from America, Asia and Pacific, Europe and Africa).

## 2) Work experience

Work experience is related to the number of positions and the working period of each position. It is calculated as follows:

$$AJV(u) = \sum_{i=1}^{N_w} Tit(i)Dur(i)$$
<sup>(5)</sup>

Where AJV(u) is the score of the work experience of user u;  $N_w$  means the number of jobs user u have had; Tit(i) is the weight of the user u's job title, which we define based on the levels of the job title. On LinkedIn we identify the following six levels of titles which are commonly found: President, Vice President, Assistant President, Department Manager, Group Leader, and Staff, Table 1 shows their corresponding values based on the time frame that the users spent before reached that position; DUR(i) is the working period in months.

TABLE 1. TABLE POSITION DEGREE AND CORRESPONDING SCORE

Title	Score
President	1
Vice President	0.9
Assistant President	0.7
Department Manager	0.6
Group Leader	0.4
Staff	0.2

## B. Education background

In this section, we consider two factors: internationalization level of the universities that user attended and the degree that user obtained.

#### 1) Internationalization level of the user's universities

The following formula calculated the internationalization level of the universities that the user attended:

$$IE(u) = \frac{\sum_{i=1}^{N_e} UIS(i)}{N_e}$$
(6)

Where IE(u) is the international level of user's universities;  $N_e$  means the number of universities user u studied at; UIS(i) is

the international level of university i, which can be obtained from the QS World University Rankings 2015 Report [15].

#### 2) Education level

The level of education is related to the number of university the user has studied at and the degrees that the user has got.

$$ES(u) = \sum_{i=1}^{N_e} Deg(i) UOS(i)$$
(7)

Where ES(u) means the level of education of user u; Ne is the number of university user u has studied at; Deg(i) is the degree that user u got from university i, Degree has three levels: Bachelor, Master and Ph.D. Each level corresponds to a score as shown in Table 2; UOS(i) is the overall level of university i, which can be obtained from the QS World University Rankings 2015 Report [15].

TABLE 2. DEGREE AND CORRESPONDING SCORE

Degree	Score
Ph.D.	1
Master's Degree	0.9
Bachelor's Degree	0.8

# C. Language proficiency

Language proficiency of user u can be calculated as follows:

$$LP(u) = \sum_{i=1}^{N_i} L(i) \times Pro(i)$$
(8)

Where LP(u) is the language proficiency of user u;  $N_1$  is the total number of language that user u can speak; L(i) is the score of a language, we select the world's ten largest language based on the survey about world major language conducted by the United Nations, and assign score to them according to the rankings, as shown in Table 3[16]; Pro(i) is the proficiency of language, and according to LinkedIn, language proficiency has five levels: Elementary, Limited Working, Professional Working, Full Professional Working, and Native or Bilingual. As our research is to find the talents and help company recruiting, we only use Professional Working, Full Professional Working and Native or Bilingual and their corresponding value are shown in table 4 based on the popularity.

TABLE 3. LANGUAGE AND CORRESPONDING SCORE

Language	Score
English	10
Chinese	9
German	8
French	7
Russian	6
Spanish	5
Japanese	4
Arabic	3

Korean	2
Portuguese	1
Other	1

TABLE 4. LANGUAGE PROFICIENCY AND CORRESPONDING SCORE

Language Proficiency <b>Pro</b> (4)	Score
Professional Working	0.6
Full Professional Working	0.8
Native or Bilingual	1

# D. International connections

International connections can indicate the internationalization level of a user's friend circle, which is related to the number of regions that the user's friends are from.

$$IC(u) = \frac{p(u) - 1}{k} \tag{9}$$

Where IC(u) is the internationalization level of friend circle of user u; p(u) is the number of regions that the user's friends are from and k is 4.

#### E. Recommendations and endorsements

# 1) Recommendation

Recommendation is related to the total number of recommendation that user gets from others.

$$Rcm(u) = N_{rec} \tag{10}$$

Where Rcm(u) is the recommendation Score of user u;  $N_{rec}$  is the total number of recommendation that user u gets.

## 2) Endorsements

Endorsement is related to the number of skills the user lists, and the number of other users who endorse the skill and the number of the user's connections:

$$Edm(u) = \frac{\sum_{i=1}^{N_s} N_{end}(i)}{N_s N_f}$$
(11)

Where Edm(u) is the endorsement scores of user u;  $N_s$  is the total number of specific skills that user u lists;  $N_{end}(i)$  is the total number of endorsements that user u gets for skill i;  $N_f$  is the total number of the user's connections.

In this section, we have established the evaluation model for international talents, based on five components, and explained the details of each component. The next section explains the experiments that were conducted based on this evaluation model.

# IV. COMPREHENSIVE EVALUATION OF INTERNAIONAL TALENT

In this paper, we establish a talents evaluation model using a group of evaluation indices. By calculating the value of user's LinkedIn profile on each index, as well as the entropy weights of each index, we can integrate these values into one evaluation score, which will be used to rank the talents and help company recruiting teams to make more effective decisions.

In order to test this model, we randomly selected 50 user profiles on LinkedIn. The index values of these profiles have been calculated and listed in Table 5 and the entropy weight of these indices are shown in Table 6. Table 7 shows the evaluation scores that are calculated by integrating these index values and corresponding weights.

	Internationaliza	International	Language	Internationali	Education	Work Experience	Endorsement	Recom
	Work	University	Tonciency	Friend Circle	Level	Experience		on
	WORK	enversity						011
1	0.65	53.35	16.4	1	129.84	168.9	0.252	2
2	0.25	33.6	1	0.5	175.2	80.6	0.256	2
3	0.625	65.467	26.4	0.25	165.6	38.1	0.275	3
4	0.5	79.033	5.6	0.25	173.19	45.8	0.330	9
5	0.5	57.067	6.4	0.5	145.95	156.7	0.225	9
6	0.833	42.3	7.8	1	77.8	44.9	0.297	2
7	0.5	65.6	7.2	0	169.29	98.8	0.333	9
8	0.417	48.6	6.2	0.75	104.05	173.6	0.266	2
9	0.375	100	26.2	0.75	65.34	100.4	0.370	11
10	0.3	48.7	14.8	0.25	136.99	122.8	0.326	2
11	0.5	86.6	1	0.5	152.62	58.6	0.304	2
12	0.625	58.967	5	0.25	166.32	73.2	0.287	8
13	0.625	48.85	23.8	1	94.5	121.4	0.312	6
14	0.667	83	11.6	0.5	115.77	80.7	0.262	5
15	0.375	57.7	14.4	0.75	87.22	74.2	0.164	5
16	0.292	71.9	8.8	0.25	108	144.5	0.398	3
17	0.45	13.4	14.6	0.75	60.75	161.2	0.355	7
18	0.542	18.067	9.4	0.75	190.4	117.1	0.370	9
19	0.375	63.3	4	0	135.12	201.8	0.304	10
20	0.5	65.333	17.8	0	133.76	43.6	0.225	1
21	0.5	32.7	3	0.5	85.33	46.6	0.256	8
22	0.5	16.833	9.6	0	118.58	34.4	0.364	10

TABLE 5. EVALUATION INDEX VALUES OF USER PROFILES

23	0.313	20.633	21.6	1	139.45	77.8	0.384	10
24	0.333	59.2	24.6	0.75	83.04	177.2	0.382	4
25	0.313	63.5	16.2	0.5	142.6	84.9	0.265	5
26	0.55	88.167	6.6	0.5	227.58	108.4	0.410	7
27	0.313	61.9	15.6	0.25	40.41	92.4	0.293	1
28	0.75	57.9	3.6	0.75	71.82	31.8	0.371	6
29	0.375	88.8	9.2	0.25	108.32	23.2	0.219	4
30	0.625	11.9	8.2	0	33.93	98.7	0.303	7
31	0.65	38.7	14	1	84.19	94.9	0.354	15
32	0.25	57.833	6.2	0.5	156.74	16.8	0.294	1
33	0.75	13	17	0.5	37.52	16.2	0.404	16
34	0.438	41.7	7.4	0.5	34.65	56.9	0.292	5
35	0.75	43.1	0.8	1	136.49	9.8	0.431	12
36	0.458	45.05	11.4	0	92.03	93.2	0.313	9
37	0.45	68.4	1	0.25	53.6	188.1	0.373	8
38	0.7	33.3	23.2	0	49.52	136.6	0.311	4
39	0.292	56.4	4.8	0.25	138.57	93.7	0.363	4
40	0	65.4	2	0.5	71.1	39.8	0.306	5
41	0.25	27.4	3	0.5	40.88	125.5	0.366	10
42	0.5	55.4	16	0	87.5	121.4	0.330	5
43	0.625	90.933	7.8	0.25	194.97	44.6	0.387	5
44	0.625	30.8	10	0.75	35.28	127.1	0.302	6
45	0.417	17.3	2.2	0.75	68.3	71.3	0.321	2
46	0.313	65.4	13.6	0.75	98.22	81	0.357	10
47	0.5	34.25	12.2	0	111.2	76.6	0.373	1
48	0.083	18.133	11	1	162.64	94.6	0.263	6
49	0.625	91.9	21.8	0	144.54	34.4	0.288	5
50	0.5	50.51	10.2	0.5	100.89	70.46	0.296	2

TABLE 6. ENTROPY WEIGHTS OF EVALUATION INDICES

Internationalization	Internationalization	Language	Internationalization	Education	Work	Endorsement	Recommendation
Level of Work	Level of University	Proficiency	Level of Friend	Level	Experience		
			Circle				
0.047910504	0.119842855	0.1632667	0.197522362	0.13854257	0.118688186	0.047	0.167423844

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TABLE 7	EVALUATION	SCORES AND	LISER RANKINGS
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user	score	ranking	user	score	ranking
26	57.3553	1	23	36.45773012	26
19	52.61668069	2	46	35.13360812	27
5	48.34274916	3	20	34.6440497	28
1	47.68127857	4	17	32.8968521	29
7	45.76383414	5	36	32.61541671	30
18	45.67500624	6	31	32.60763942	31
43	45.41089805	7	32	31.94422601	32
24	44.49886518	8	38	31.56977431	33
16	42.7507377	9	15	31.16722083	34
8	42.37165067	10	47	30.80273995	35
10	42.22043031	11	29	30.65190551	36
4	41.41159903	12	50	30.53038792	37
25	41.05101398	13	35	27.63135795	38
12	41.04560898	14	27	26.77601031	39
3	40.21507864	15	44	26.49363781	40
49	39.56114058	16	41	26.13460899	41
37	39.53943733	17	22	25.81119017	42
9	39.25564078	18	40	23.68862475	43
11	39.11292733	19	21	23.2354354	44
48	38.94792327	20	6	23.03672395	45
39	38.61177146	21	28	22.45705116	46
13	38.48768803	22	45	20.87535297	47
2	38.48646579	23	30	20.39626116	48
14	38.43813611	24	34	18.72996677	49
42	36.65930604	25	33	14.28672828	50

Table 6 shows the internationalization level of a user's friend circle has the highest entropy weight, meaning the profiles of our randomly selected users have biggest difference on this index. It is followed by the recommendation, language proficiency, education level, internationalization level of university and work experience. The weights of the other two indices: "internationalization level of work" and "endorsement", are the lowest, showing the sample users have relatively small difference in the two indices.

From table 7 we can see that user 26 has the highest ranking. She has the highest working experience score and relatively high score in other indices as well. User 33 is at the bottom of the list: she has particularly low scores in the "internationalization level of university", "education level" and "work experience" indices which have very high entropy weights.

Overall, a hiring company should consider all possible factors, not only language proficiency, work history and education background, but also the "internationalization level of friend circle" and "recommendation", which have relatively higher weight, judged from our data analysis results. For a job seeker, when working on her professional ability, she should also improve his communication skills. In particular, she should improve her international connections, and request for more people's recommendation.

## V. CONCLUSIONS

This paper proposed a comprehensive model for evaluating international talents based on their user profile on a professional social networking web site. This model is composed of a group of evaluation indexes, each of which is a part of the user's professional profile, and then employs mathematical methods to calculate the value of the user's profile on each index, and also considers the entropy weight of these indices. Finally, this model integrates these values and weights into one comprehensive score for the user's profile, which can be used to rank the users' talents for a more effective recruiting.

It is a difficult problem to quantitatively evaluate the international talent. This paper makes such an attempt in combining entropy weight method and professional social networks to measure international talents. To some extent, entropy weight method can reduce the influences of subjective factors in determining the weights of evaluation indices. However, this model can still be much improved by considering the following factors: choice of evaluation indices, accuracy of index weights, and a more scrutinous definition of international talents.

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