Smart Talents Recruiter – Resume Ranking and Recommendation System

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***Abstract*— During the previous decade, the augmentation of automatic e-recruitment has led to the enlargement of web channels that are devoted to candidate dissemination. In an economic and strategic context where cost-effective is basal, the recommendation of the candidates for the given job requirements has become mandatory. The purpose of this work is to acquaint the actual results that we have achieved on a new recommendation system named Smart Applicant Ranker which is a candidate recommendation tool designed to supervise recruiters while they input their job requirements into the system. This system is designed using Ontology where we can compare the resume models with the given job requirements to match the best comparable candidates. Two ranking algorithms are underlined in this system which will be invoked to assign a ranking point to the recommended candidates against the other candidates on the recommendation pool. The Smart Applicant Ranker system will be kept in a Semantic Web approach that provides IT recruitment firms to seek experts in an efficient way.**

Keywords—Ontology, SPARQL, NLP, OWL

I. INTRODUCTION

All organizations today use online stages and services for accepting applicant resumes. Various online resume distribution and search sites have broadly been being used overall today. Smart Applicant Ranker is a web based candidate recommending system which goes along the line of these online platforms, but with additional capabilities. It will ease the workload of a job recruitment company or a company's human resource team who are looking for best matching candidates for IT related vacancies. The main objective of this project would be to locate the perfect matching candidates for a given job requirement with the assistance of an efficient candidate ranking policy. Smart Applicant Ranker (SAR) system will be used by three types of users, Job seekers upload their resumes using the web portal and Job recruiters' look for the perfect candidates for their job requirement. Recruiters are software professionals and job seekers are anyone who is connected with information technology. Admin will handle the users and update the web portal when there are any changes to be made.

Candidate ranking is based on their resume information which include: candidates' educational qualifications, their previous work experiences and their skills. Smart Applicant Ranker will use this information in two different ranking algorithms. These ranking algorithms will rank a candidate profile against all other suggested candidates in order to narrow the search results for the employers which could mean that they have to go through a smaller set of results to find the best candidate that matches their requirement. Smart Applicant Ranker will fill the gap in existing candidate recommending systems and it will have a major influence on the career path of employees while condensing the workload of employers when it comes to recruiting.

Our system is mainly focused on Ontology models. Ontologies have become an important and a trendsetter in structuring knowledge bases and building knowledge-intensive applications and tools [1]. Ontology is used to identify and classify the implicit and explicit relationships between the candidate models and the job requirement model, in order to get the matching candidates result-set as the input for ranking algorithms. Web Ontology Language (OWL) is a standard ontology language from the World Wide Consortium (W3C) that processes and instantiates Ontologies. Smart Applicant Ranker is an Ontology based web application which is implemented using J2EE technologies running with Apache Tomcat server. In order to handle the business logics and the client calls to the server, Model View Controller pattern is been used while MySQL database with JDBC interface is used to process simple user manipulations. For creating and manipulating Ontologies, OWL API is used via Apache Jena.

II. RELATED WORK

For the past few years we have witnessed a marked increment in the number of online job portals committed to providing recruitment services. Job portals like Indeed empower job seekers to create their resume so as to search and apply for desirable jobs, while they also enable employers to find suitable representatives they are searching for. However, these job portals in most cases do not have the rich range of abilities that employers need to locate the best candidate matched to their own preferences, their capacities, and their interests and goals. In order to conquer the disadvantages in these traditional job portals many types of research have been done to develop systems that will lead the employers to persuasively and productively fulfill their requirements while conveniently having access to his or her most interested candidates.

Matching candidate resumes in light of job requirements can turn out to be a vital feature of an online recruitment platform, having the capacity to bring down the expenses for

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employers, facilitate the procedure for candidates and improve the overall recruitment process. There is an assortment of ways to deal with the process of matching candidates based on job requirements. The primary difficulties comprise of giving significant outcomes in a computationally modest way. Keeping in mind the end goal to make this achievable, a wide cluster of methodologies in literature with regard to job requirement matching issue has been taken. There are solutions which depend on machine learning, description logic or semantic, ontology based methodologies. There are other solutions which try to get the most out of both worlds by combining the approaches and creating a hybrid solution, for example, running machine learning algorithms over ontology or utilizing a description logic model with an ontology framework. It is important to take note of that, regardless of the approach utilized, the achievement of the matchmaking procedure is to a great extent subject to how powerful the members' profile is modeled. In this paper, introduce an ontology based hybrid approach that executes a ranking algorithm over the results retrieved through ontology matching, which would output a sorted list of matching candidates where the most suitable candidate for a particular job requirement will sit at top of the suggested list.

Currently, various job portals utilize a combination of distinct algorithms so as to rank applicant profiles. The ranking policies are still inefficient, considering the way that highly impactful and conceivable factors that would describe an individual are not considered. Factors like skills affect employee performance and we can't contemplate these qualities alone to predict the performance. Educational background of the employee with factors such as Grade received in college and previous work experience and the years spent in that field have an extensive impact on the analysis. ResuMatcher, an open source personalized Resume-Job matching system is a perfect example of this. ResuMatcher uses an algorithm that takes only the skill factor to match resumes with job requirements and therefore the similarity percentage a resume can get is the maximum value it can get from the skills in the resume.

Therefore we propose a ranking based system, where different Skills, Educational qualifications and Work experience of a job seeker are considered with a view to providing a ranking among other candidates. Recruiters can utilize this to choose employees for different kind of jobs, one where only knowledge and skills play an essential part and another where all the factors are critical.

III. RESUME ONTOLOGY

Ontology is a term that refers to define and make connections between information. It promises a shared and common understanding of some domain that can be communicated between people and application systems, and this very proposed system is based on Ontology. It has a Resume Ontology (RO) including classes, properties and concepts with relationships which enables to represent parts of a resume in a semantic way. RO has many parts which include: personal information, skills, educational qualifications, certifications and work experience. The creation of resume ontology is done through Protege editor.

Figure 1 shows only the classes of the RO which depicts the main parts of a resume. These classes contain properties as well as sub-properties. A detailed description of all the sections in RO and how resume information is saved and retrieved from the RO is explained in the methodology section

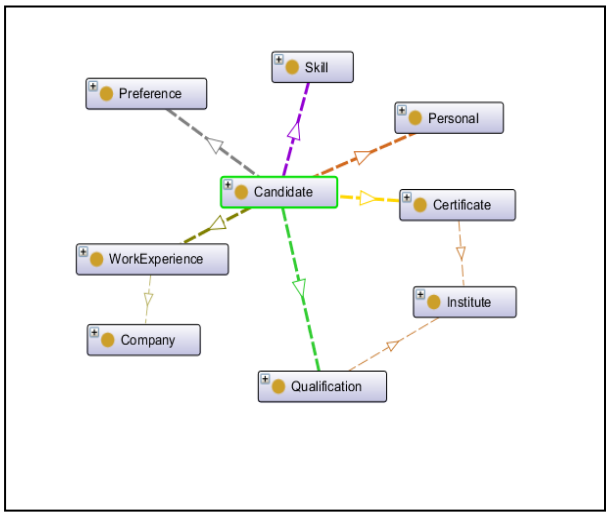

Fig. 1. Part of Resume Ontology (RO)

IV. METHODOLOGY

Smart Applicant Ranker system has 3 main modules: A) Information Extraction B) Candidate search C) Candidate Ranking Algorithms.

A) Information Extraction

The information extraction module consists of major sub tasks which are reading the resume information filled by the job seeker, creating an ontology model for a resume and at last save the information in the database. The proposed system uses a simple approach to extract information from candidates by letting them fill a form containing essential fields of a resume.

Information Extraction module is composed of few sub modules, every one of which plays out the task of extracting a particular section of information. The fundamental sub modules are personal information module, Professional and Educational experience module and Skills extraction module. While the Professional and Educational extraction sub-module extracts details regarding your work places and professional experiences along with other information: graduating university name, degree and the class obtained. The skills extraction module is focused on extracting multiple skills of the candidate. The personal detail extraction module extracts the full name and other information like contact number, date of birth and email address. All these information are validated using a set of Natural Language Processing (NLP) and pattern matching techniques before being saved to the database. Thereafter, an Ontology model of the resume will be created which is required to ascertain the suitability of an applicant with regard to a job requirement of a company.

B) Candidate Search

When recruiters search for resumes by entering their job requirement, the system calculates the similarity value between the selected resume models and the input job requirement, and then returns the resumes ranked by their relative score. The relative score (RS) is the sum of ranking points times their corresponding weights. The relative score between a resume model c and the job requirement j is:

$$RS(c, j) = ((r_i \times w_i) + (r_j \times w_j)) \quad (1)$$

Where, r_i is the value returned by Educational qualification ranking algorithm and r_j is the value returned by Skills and Work experience ranking algorithm. The weightage for skills and work experience is given by w_i and w_j respectively. The maximum relative score that could be assigned to a resume is 1, which states that the resume is perfectly suitable for the given job requirement.

C) Candidate Ranking

a) Educational Qualifications ranking algorithm

In this algorithm, the system will evaluate the recommended candidates' educational qualifications and will assign the rank points according to their University, Degree, CGPA points and Other Qualifications as they mentioned in their resume. There are four kinds of degrees in the SAR system: Diploma, Bachelor, Master and PhD, which are used to compare the degree level of a resume model with the job requirement input in to the system. For example, if a candidate has a lower degree level than the level which is required, that candidate is considered as under-qualified and he or she will receive a 0 similarity value for the degree field. An opposite of this could occur, when the degree level in the resume model is higher than the degree level in the job requirement. But in this scenario, the similarity value for degree will not be 0. Rather a slightly lower value than the maximum similarity value of 1 will be assigned for the resume model. The system maintains a list of local and foreign universities with a specific rank level assigned for each of them. A candidate from a higher ranked university will receive a slightly better rank value for university field, than the candidates from lower ranked universities. The weightage value given for the university field is lower than the other resume fields.

b) Skills and Work Experience ranking algorithm

This algorithm uses two of the important fields in a resume model: skills and work experience field, to assign a similarity value of work experience (SWE) for a resume.

SIMILARITY VALUE OF WORK EXPERIENCE

A resume model records three fields under work experience: job title, number of years and the company name. Each of these fields is given a weight value based on the impact it has for a work experience. The value of SWE is the summation of similarity value of these related fields times their corresponding weights. The equation is given below:

$$SWE(c, j) = \sum_{i=1}^{3} sim_i(c_i, j_i) \times w_i \quad (2)$$

sim_i represents the similarity function of a subfield in work experience, while w_i is the weightage of that field.

When calculating the similarity value of the job title, the system gets the similarity values of all the titles in a resume model and returns the best one that matches the job requirement. A job title consists of subfields: job level, role, skill and platform.

For example, a senior Java web developer has the senior job level, role of a developer and the skill in java web platform. The similarity value of a job title is the mean value of all the subfields' similarity value, which ranges from 0 to 1. If the job level value required is senior level, a resume model with a junior level of experience will not satisfy the job requirement and hence the similarity value would be 0. Maximum similarity value of 1 would be given if the job requirement and the resume model have the same subfield value. In some cases, the subfield value in the resume model will be greater than the value in the job requirement, which means that the relevant candidate might be overqualified; therefore the similarity value of that subfield would be 0.5.

SIMILARITY VALUE OF SKILLS

A job requirement usually has a set of required skills with a predefined priority level. The similarity value of each of these skills is required to calculate the final similarity value of skills (SK). The equation to calculate the similarity value for a single skill in the job requirement is shown below:

$$SimSkill(J_i, R) = \begin{cases} 1, & J_i \in R \\ \max(Skill(J_i, R)), & J_i \notin R \end{cases} \quad (3)$$

In the given equation, J_i represents an individual skill in the job requirement, and R is the set of skills in the resume model. If the skill set R contains the skill value J_i, the similarity value is 1, or else the highest value from all the similarity values between the set of skills in the resume model and the skill J_i is taken. The final similarity value of skills is the mean value of all the similarity values of skills in the job requirement. The system has a skill ontology which represents different classifications of IT related skills in a semantic way. This ontology is used to measure the semantic similarity between the set of skills in the resume model with the skill given in the job requirement.

SEMANTIC SIMILARITY

This section will give a brief description on how to calculate the similarity values of the skills field using a domain specific ontology. The skill ontology shown in Figure 2 is created based on the technical similarity between skills. This would make the skills which require similar technical capabilities share the same parent class, or in other words, similar set of skills would fall under the same category. For example, both MySQL and MS_SQL belong to the same category because they are both relational databases. Therefore, if a candidate is familiar to one of them, he or she can master the other easily. If a candidate has MySQL skill and the required skill is MS_SQL, the similarity value returned will be marginally lower than the maximum value of 1. But if the candidate is skilled in Mongo_DB, the similarity value will be lower than the one returned in the previous scenario, because the candidate has to spend a fair amount of time to learn the other technology.

There are new skills and technologies invented every day, and the SAR system should be able to address this issue. In order to overcome this, SAR use a semi-automatic approach to update the skill ontology. When a job seeker inputs a skill which is not present in the skill ontology, admin will be notified and he or she can save the identified skill into the ontology. Admin has to enter the name of the new skill and then select the sub-classes it belongs when saving a skill.

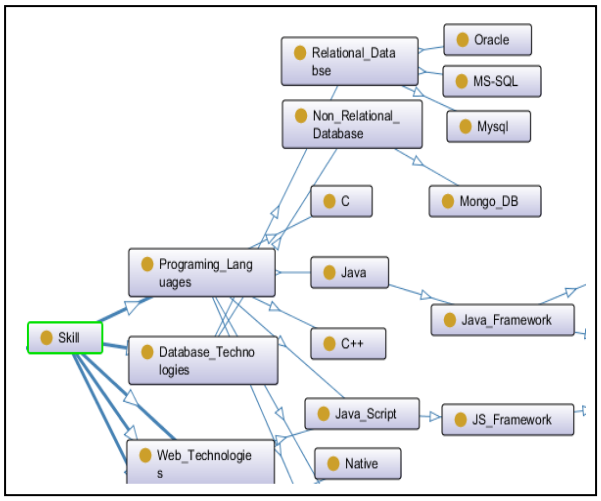

Fig. 2. Part of Skill Ontology

V. RESULTS AND DISCUSSIONS

We mainly assessed the accuracy of the results presented to the user. That is the precision of the recommended candidates ranking with regard to a certain job requirement. The system test was initiated using thirty resumes with varied skills, academic and professional qualifications. All the resume information was saved in the Resume ontology, which were matched against one single job requirement. The job requirement given in Table 1 was input into the system and the following search results were recorded for comparison with actual results.

Table 1: Job Requirement

Job requirement field	Value
Job title	Senior Java Web Developer
Skills	Java 2+ experience, Some experience in MySQL
Education	BSc Degree

In order to verify the reliability of the ranking algorithm, we gave the exact resumes and the job requirement which we tested in our system, for three recruitment professionals, and obtained the ranked list of candidates based on their knowledge and techniques. We analyzed the ranked lists provided by all three recruitment professionals and prepared a final list to compare with the rankings generated by the system.

Table 2: presents the recorded similarity values of top 10 ranked resumes and the Relative Score of each resume with respect to the given job requirement in Table 1. Algorithm I calculates the similarity value of educational qualifications, while Algorithm II calculates the similarity value of skills and professional experience. Relative score is obtained by giving equal weightages to both the algorithms, though it may vary according to the employer's necessity.

The summarized results showed us that SAR ranking algorithm produces a very similar ranking outcome (SAR Ranking in Table 2), when compared with the rankings provided by recruitment professionals (Manual Ranking in Table 2). Table 2 shows that, Resume 3 has the maximum skill similarity value of 1. It is because that resume contains all the skills given in the job requirement. Resumes with zero similarity skill values suggest that those resume models does not have any skill, that is equal to or related to the skills in the job requirement.

The performance of the candidate ranking module of our system can be evaluated by the number of correctly ranked resumes with regard to the total number of resumes used for testing. In order to find out whether a resume is ranked correctly or not, the ranking assigned by the system is compared with the manual ranking given for that particular resume. If the ranking difference is not more than five, either positive or negative, the ranking given by the system is considered as correct. By this way, we can get the percentage of correctly ranked resumes, which will indicate the success rate of the ranking module of the system. For example, if the number of resumes ranked correctly is 25 from a total set of 30 resumes, it would mean that the precision of the rankings given by the system is equal to 83.33.

Table 2: Resume matching compatibility results

Resume No	Algorithm I	Algorithm II			Relative Score (RS)	SAR Ranking	Manual Ranking
		SWE	*SK*	*(SWE+SK)÷2*			
Resume 1	0.245	0.375	0.33	0.3525	0.29875	6	6
Resume 2	0.319	0.25	0.20	0.225	0.272	7	7
Resume 3	0.690	0.875	1.00	0.9375	0.81375	1	1
Resume 4	0.750	0.375	0.50	0.4375	0.59375	5	4
Resume 5	0.293	0.125	0.00	0.0625	0.17775	8	8
Resume 6	0.634	0.625	0.50	0.5625	0.59825	4	5
Resume 7	0.746	0.75	0.90	0.825	0.7855	2	2
Resume 8	0.789	0.75	0.66	0.705	0.747	3	3
Resume 9	0.165	0.125	0.14	0.1325	0.14875	9	9
Resume 10	0.075	0.25	0.00	0.125	0.1	10	10

VI. CONCLUSION

In this paper we presented Smart Applicant Ranker, an ontology based candidate recommendation system that can help recruiters to find suitable candidates more precisely. A new algorithm which uses both logic and semantic based approach to calculate the similarity value between a job requirement and resume models was used to rank candidates. The results showed that the proposed system might be useful in real-world online recruitment and ranking of candidate resumes, and it will have a better recommendation precision and efficiency than currently existing systems. In the future, we attempt to investigate the useful information about job recruiting and extract as much as possible information to implement an enriched candidate recommendation system with better performance and accuracy.

REFERENCES

[1] H. Happel and S. Seedorf, "Applications of Ontologies in Software Engineering," Engineering, pp. 1–14, 2006.

[2] Franca Piazza, Stefan Strohmeier, "Domain-Driven Data Mining in Human Resource Management: A Review", Data Mining Workshops (ICDMW) 2011 IEEE 11th International Conference on, pp. 458-465, 2011. [Accessed 2 Apr. 2018].

[3] Muthyala, Rohit & Wood, Sam & Jin, Yi & Qin, Yixing & Gao, Hua & Rai, Amit. (2017). Data-Driven Job Search Engine Using Skills and Company Attribute Filters. 199-206. 10.1109/ICDMW.2017.33..

[4] Guo, S., Alamudun, F. and Hammond, T. (2016). RésuMatcher: A personalized résumé-job matching system. Expert Systems with Applications, 60, pp.169-182.

[5] Manisha Verma, Nathan Francis, "On Utility of Temporal Embeddings in Skill Matching", Data Mining Workshops (ICDMW) 2017 IEEE International Conference on, pp. 237-241, 2017, ISSN 2375-9259.

[6] Petrican, Teodor & Stan, Ciprian & Antal, Marcel & Salomie, Ioan & Cioara, Tudor & Anghel, Ionut. (2017). Ontology-based skill matching algorithms. 205-211. 10.1109/ICCP.2017.8117005.

[7] Manjula Ramannavar, Nandini S. Sidnal, Advances in Intelligent Systems and Computing, vol. 654, pp. 329, 2018, ISSN 2194-5357, ISBN 978-981-10-6619-1.

[8] Wenxing Hong, Siting Zheng, Huan Wang, "Dynamic user profile-based job recommender system", Computer Science & Education (ICCSE) 2013 8th International Conference on, pp. 1499-1503, 2013.

[9] V. Sarda, P. Sakaria and S. Nair, "Relevance Ranking Algorithm for Job Portals", 4th ed. Mumbai, India: inpressco, 2014, p. 4.

[10] Hong, Wenxing & Li, Lei & Li, Tao & Pan, Wenfu. (2013). iHR: an online recruiting system for Xiamen Talent Service Center. 1177-1185. 10.1145/2487575.2488199.

[11] Thimma Reddy Kalva, "Skill Finder: Automated Job-Resume Matching System," All Graduate Plan B and other Reports. Paper 343, 2014.

[12] Betty Purwandari, Indra Budi, Dana Indra Sensuse, Puji Rahayu, "Indonesian certification of competency profession: A proposed conceptual E-portfolio model", Advanced Computer Science and Information Systems (ICACSIS) 2016 International Conference on, pp. 195-200, 2016.

[13] C. Harris, "Finding the Best Job Applicants for a Job Posting: A Comparison of Human Resources Search Strategies", 2017 IEEE International Conference on Data Mining Workshops (ICDMW), 2017.

[14] Tobias Keim,Prof. Dr. Oliver Wendt,Dr. Tim Weitzel Jochen Malinowski, "Matching People and Jobs: A Bilateral Recommendation Approach," in Proceedings of the 39th Hawaii International Conference on System Sciences, 2006.

[15] Tim Weitzel,Tobias Keim Frank Faerber, "An Automated Recommendation Approach to Selection in Personnel Recruitment," in Americas conference on Information System, December 2003.