AN INTEGRATED E-RECRUITMENT SYSTEM FOR CV RANKING BASED ON AHP

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Keywords: e-Recruitment, Knowledge management systems, Recommendation systems, Analytic hierarchy process.

Abstract: In the last decades the explosion of Information and Communication Technologies has led to a whole new scenario concerning peoples' accessibility to new job opportunities and companies' options for employing the right person for the right job. But, is there a way to exploit today's technological advances as well as people's web presence in order to achieve this goal? In this work we present a set of techniques that makes the whole recruitment process more effective. We have implemented a system that models the candidate's CVs in HR-XML, and ranks the candidates based on AHP (Analytic Hierarchy Process). Finally, it presents the results to the recruiter who evaluates the top candidates and takes the final decision.

1 INTRODUCTION

The rapid development of modern Information and Communication technologies (ICTs) in the past few years and their introduction into people's daily lives has led to new circumstances at all levels of their social environment (work, interpersonal relations, entertainment, etc). People have been steadily turning to the web for job seeking and career development, using web 2.0 services like LinkedIn and job search sites (Bizer, 2005). On the other hand, a lot of companies use online knowledge management systems to hire employees, exploiting the advantages of the World Wide Web. These are termed e-recruitment systems and automate the process of publishing positions and receiving CVs.

The online recruitment problem is two-sided: It can be seeker-oriented or company-oriented. In the first case, the system recommends to the candidate a list of job positions that better fit his profile. In the second case recruiters publish the specifications of available job positions, and the candidates can apply, submitting their CVs.

Many approaches can be applied to automate the e-recruitment process combining techniques from classical IR (Kessler, 2009). These include collaborative filtering techniques (Rafter, 2000), relevance feedback (Kessler, 2009), semantic matching (Mochol, 2007), multi-agent systems (De Meo, 2007) etc. Their main drawback comes from the fact that the CVs in these works are either submitted by the user in an arbitrary format or are mined automatically from the Web or other sources (i.e. from server logs).

In this work we have implemented an integrated company oriented e-recruitment system that automates the candidate evaluation. Our approach differs from conventional e-recruitment systems in that we don't accept CVs in a document format, but rather mandate that applicants fill-in predefined web forms. Additionally, it models the candidates' CVs in HR-XML representation and subsequently provides a ranking of the applicants, scoring their

Faliagka E., Ramantas K., Tsakalidis A., Viennas M., Kafeza E. and Tzimas G..
AN INTEGRATED E-RECRUITMENT SYSTEM FOR CV RANKING BASED ON AHP.
DOI: 10.5220/0003379014701501
In *Proceedings of the 7th International Conference on Web Information Systems and Technologies* (WEBIST-2011), pages 147-150
ISBN: 978-989-8425-51-5

qualifications for the given position requirements. The scoring and ranking process is based on Analytic Hierarchy Process, or AHP (Saaty, 1990).

2 CV SUBMISSION AND MODELING

In on-line recruitment systems, candidates typically upload their CVs in the form of a document with a loose structure, which must be considered by an expert recruiter. This incorporates a great asymmetry of resources required from candidates and recruiters, resulting in candidates uploading the same CV in numerous HR agencies that become overwhelmed with thousands of CVs. In this work, we follow a different approach in the CV submission process, which is detailed in this section, along with the CV modelling in HR-XML format.

2.1 CV Submission

In the proposed system, we mandate that applicants submit their CVs in a structured way, filling-in predefined web forms. These web forms include many closed-form questions that examine the candidate's professional qualifications and his personality and aptitudes. There are also open-type questions to be considered by human recruiters. The forms designed are divided in the 4 sections.

In the first section, which is the education and qualification section, the candidate fills in his academic degrees (BSc, MSc, PhD) and professional qualifications. The candidate is expected to be able to prove all entered information in this section.

In the second section, the experience section, there are questions about the applicant's professional history. These include his years of experience, the candidate's loyalty, his former position titles and the organizational culture of his previous jobs.

In the personality section, the candidate is asked to perform a self-assessment of his personality. The personality traits are divided in four broad categories, as shown in Figure 1. From these answers an average score is calculated for each category. We plan to enrich our system with online psychometric tests that will give us a more accurate picture of the candidate's personality.

In the last section we give the opportunity to the candidate to write about his competencies. The candidate could report being good in numbers, having writing skills, social skills, or scientific / analytical thinking. In this way, we can give an opportunity to "unproven" juniors with talents and potential to build their careers.

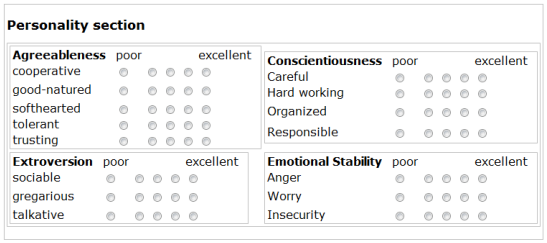

Figure 1: Self-assessment of candidate's personality.

2.2 CV Model

In the proposed system the CVs entered by the applicants, following the CV submission process, are represented in HR-XML format. HR-XML is a library of XML schemas that supports a variety of business processes related to human resource management and was developed by the HR-XML Consortium. It includes schemas to represent all the necessary information about a candidate. Representing the CVs in HR-XML allows HR agencies and companies to exchange CVs in a machine readable, standardized format which is easy to process, automating part of the recruitment process. Our system allows the candidate to download the XML representation of his submitted CV, which he can then re-submit to another compatible system avoiding manual re-entry.

3 RECRUITMENT PROCESS

In this section, we will present the recruitment process followed in the proposed system. As seen in Figure 2, the process starts with the candidates submitting their CVs in the system's web interface. These are formatted in HR-XML representation, and stored in the system's XML-enabled database. This allows preserving the structure of the CV as an XML document.

When a position opens, the recruiter follows a 3-stage online recruitment process. These stages include a pre-screening of unqualified candidates, an automatic online background search and finally the ranking of candidates. In what follows, we present in detail the implementation of the system modules.

3.1 Filtering Module

The filtering module performs an automatic pre-screening of candidates, to identify those that meet

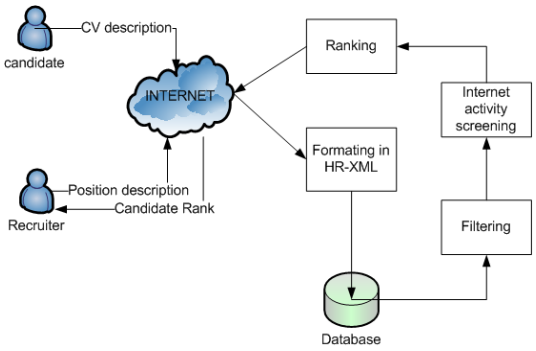

Figure 2: The stages of online recruitment.

the minimum requirements of the offered position. The filtering process is implemented as a series of XQueries (Boag, 2002). Using XQueries the recruiter is able to make iterative queries tightening the minimum requirements. For example, he can query the system for "candidates with a BSc on computer science and job experience over 3 years". It must be noted that the applicants rejected by the filtering module are no further considered for recruitment.

3.2 Internet Activity Screening

An applicant's internet activity can be relevant for some positions, as it can testify some skills regarded critical for a position. Informal activities, like being contributor to an open source free-time project might be considered more important than some official qualifications. It is widely acclaimed that recruiters perform web searches and take advantage of applicant's online activity. We performed Google searches with the user's full name, location and affiliation using the Google AJAX Search API. We also asked the candidate to voluntarily provide his personal web site, his blog, the url of an open source project he contributes, etc. To evaluate the significance of the submitted information we used the Google toolbar API and extracted the PageRank value of each of these pages (Wu 2008).

3.3 Ranking Module

In the ranking stage, the system derives and ranks the candidates that have passed the filtering stage, based on classic IR techniques. Each candidate's rank acts as a score of how well his profile fits the recruiter's specifications. Ranking is based on the analytic hierarchy process, or AHP.

The first step in the analytic hierarchy process is to define the ranking criteria and the criteria's grades. The grades may take numeric values or take the form: excellent, very good, average, poor and very poor and may differ for each criterion. The criteria we used in our system are:

- Personality traits: the average scores from the 4 personality categories shown in Figure 1.
- Education: The number of years of full-time formal (academic) learning..
- Work Experience (Years in a related position)
- Loyalty (years the candidate spent per job).
- Internet activity: Rated as described in 3.2
- Skills: The optional skills the candidate fulfils.

The second step is the elicitation of pair wise comparison judgments. Specifically, the recruiter has to compare the importance of the abovementioned criteria, entering weights. These weights rank the relative significance of each pair of criteria. For example, the recruiter has to decide how much more important is work experience from education. For this procedure a web form was implemented shown in Figure 3.

From these comparisons a matrix A with dimensions $n \times n$ is derived, where n is the number of the criteria. The matrix A is in the form:

$$A=\begin{pmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \vdots & \vdots & & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{pmatrix} \quad (1)$$

Then we sum each column of the reciprocal matrix and divide each element with the sum of its column, normalizing the matrix. The *global priority vector*, that stores the weights of the ranking criteria is obtained by averaging across the rows.

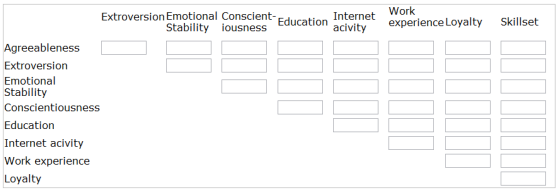

Figure 3:Form with the pair comparisons.

Then we move to the pair wise comparisons of the candidates with respect to each ranking criterion forming 9 matrices. The elements of these matrices are automatically calculated from the candidates' grades to each criterion, creating 9 vectors that are the *local priority vectors*. Then we compute the overall *composite weight*, that acts as the candidate rank, which is the linear combination of the priority vector computed by the recruiter's judgments and the local priority vectors computed automatically.

4 PILOT SCENARIO

In order to demonstrate the system's functionality a testing scenario was defined that uses all the subsystems detailed above. We used as an input the CVs from 30 graduate students from University of Patras in Greece.

Two job positions were selected from the liaison office of the University of Patras. These jobs required a different set of skills, so that the selection and ranking of candidates would become apparent. The first one was for a junior java developer and the second one for a junior researcher. For the first job position the prerequisites were java knowledge and one year of experience, while for the second position the required qualification was the possession of an MSc degree. We firstly used the filtering module to exclude the candidates who didn't meet the positions' prerequisites

At the ranking phase the priority vectors were calculated as shown in Table 1, where the global and local priority vectors for the first job position are shown. We only display the calculations for the first 6 criteria due to space constraints. The second row is the global priority vector, while the columns represent the local priority vectors. It is obvious from the Table 1 that the criterion 6 (the job experience), has the highest priority with 27% of the influence.

Table 1: Local and global priorities for the first job position.

	1	2	3	4	5	6
	0,08	0,14	0,02	0,05	0,13	0,27
C18	0,09	0,11	0,09	0,08	0,07	0,15
C23	0,06	0,10	0,07	0,09	0,05	0,12
C6	0,09	0,09	0,12	0,07	0,07	0,13
C12	0,08	0,07	0,05	0,06	0,06	0,10
C14	0,07	0,08	0,11	0,05	0,07	0,09

The results of the pilot scenario were very promising. The top-5 ranked candidates for the two job positions were different, which is justified by their different requirements. After evaluating the skills of the top-5 candidates of the first job position we verified that they outweighed the others in technical skills and the experience section, having participated in open-source projects. At the second job position the ranking was based mainly on personality criteria while the experience and the technical skills were not as important and had smaller weights.

5 CONCLUSIONS AND FUTURE WORK

In this work we have proposed and implemented a company oriented e-recruitment system that assists the recruiter in his decision-making process. The applicants submit their CVs in a structured way, which are represented in HR-XML format. Our system automatically filters the candidates that don't meet the minimum requirements of the offered position. Finally, the candidates are ranked based on the Analytic Hierarchy Process. A number of tests were performed for evaluating the developed system. We found that the system is able to effectively match candidates to offered positions based on their qualifications and competencies.

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