LITERATURE SURVEY

JOB/SKILL RECOMMENDER APPLICATION

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1. A survey of job recommender systems:

College of Computer and Information Sciences, Princess Nora BintAbdulrahman University, Riyadh, Saudi Arabia and College of Computer and Information Sciences, King Saud University, Riyadh, Saudi Arabia. Authors: Shaha T. Al-Otaibi and Mourad Ykhlef

ABSTRACT:

The Internet-based recruiting platforms become a primary recruitment channel in most companies. While such platforms decrease the recruitment time and advertisement cost, they suffer from an inappropriateness of traditional information retrieval techniques like the Boolean search methods. Consequently, a vast number of candidates missed the opportunity of recruiting. The recommender system technology aims to help users in finding items that match their personnel interests; it has a successful usage in e-commerce applications to deal with problems related to information overload efficiently. In order to improve the e-recruiting functionality, many recommenders system approaches have been proposed. This article will present a survey of e-recruiting process and existing recommendation approaches for building personalized recommender systems for candidates/job matching.

2. Machine learned job recommendation Publisher:

Association for Computing Machinery, New York, United States Conference: RecSys '11: Fifth ACM Conference on Recommender Systems Chicago Illinois USA October 23 - 27, 2011 ISBN: 978-1-4503-0683-6 General Chairs: Bamshad Mobasher, Robin Burke, Dietmar Jannach, Gediminas Adomavicius Abstract: We welcome you to the 5th ACM Conference on

Recommender Systems (ACM RecSys 2011) held in Chicago on October 23-27, 2011. Over the last several years, ACM RecSys has become a flagship event in the area of recommender systems, where leading researchers and practitioners from around the world have an opportunity to meet and discuss their latest results and solutions. This year, ACM RecSys had 169 submissions from 42 different countries that were sent out for review. As was the case in the last few years, there were two paper submission categories: long papers (that should report on substantial contributions of lasting value) and short papers (that typically discuss exciting new work that is not yet mature enough for a long paper). Out of 110 long paper submissions, 22 were accepted (20.0%) for oral presentation at the conference. In addition, to accommodate the growing number of quality long paper submissions over the years, 8 additional long papers were accepted for poster presentation (resulting in the final acceptance rate of 27.3% for long paper submissions). Out of 59 short paper submissions, 24 were accepted (40.7%) for poster presentation at the conference. In addition to the paper presentations, the conference program includes a multitude of other interesting events. These events include: two keynotes, one from an academic perspective by Noshir Contractor (Northwestern University) and one from an industrial perspective by Neel Sundaresan (eBay Research Labs); a highly diverse industry track featuring Andrew Tomkins (Google), Rajat Raina (Facebook), Jon Sanders (Netflix), Pankaj Gupta (Twitter) and Eric Bieschke (Pandora); a record number of nine workshops; three invited tutorials; a doctoral symposium; and a panel on the latest emerging issues that are important to the field.

3. The use of machine learning algorithms in recommender systems:

A systematic review David R. Cheriton School of Computer Science, University of Waterloo, 200 University Avenue West Waterloo, N2L 3G1, Canada Author: Ivens Portugal, Paulo Alencar, Donald Cowan. Highlights: • A survey of machine learning (ML) algorithms in recommender systems (RSs) is provided. • The surveyed studies are classified in different RS categories. • The studies are classified based on the types of ML algorithms and application domains. • The studies are also analysed according to main and alternative performance metrics. • LNCS and EWSA are the main sources of studies in this research field. Abstract: Recommender systems use algorithms to provide users with product or service recommendations. Recently, these systems have been using machine learning algorithms from the field of artificial intelligence. However, choosing a suitable machine learning algorithm for a recommender system is difficult because of the number of algorithms described in the literature. Researchers and practitioners developing recommender systems are left with little information about the current approaches in algorithm usage. Moreover, the development of recommender systems using machine learning algorithms often faces problems and raises questions that must be resolved. This paper presents a systematic review of the literature that analyses the use of machine learning algorithms in recommender systems and identifies new research opportunities. The goals of this study are to (i) identify trends in the use or research of

machine learning algorithms in recommender systems; (ii) identify open questions in the use or research of machine learning algorithms; and (iii) assist new researchers to position new research activity in this domain appropriately. The results of this study identify existing classes of recommender systems, characterize adopted machine learning approaches, discuss the use of big data technologies, identify types of machine learning algorithms and their application domains, and analyses both main and alternative performance metrics.

4. Job Recommendation through Progression of Job Selection

2019 IEEE 6th International on Cloud Computing and Intelligence System (CCIS) Authors: Amber Nigam, Aakash Roy, Hartaran Singh, Harsimram Waila Abstract: The task of job recommendation has been invariably solved using either a filter-based technique or through recommender systems where categorical features associated with jobs and candidates are used to generate recommendations. Through this paper, we are introducing a novel machine learning model which uses the candidates' job preference over time to incorporate the dynamics associated with highly volatile job market. In addition to that, our approach comprises several other smaller recommendations that contribute to problems of a) generating serendipitous recommendations b) solving the cold-start problem for new jobs and new candidates. We have used skills as embedded features to derive latent competencies from them, thereby expanding the skills of jobs and candidate to achieve more coverage in the skill domain. Our model has been developed and deployed in a real-world job recommender system and the best performance of the click-through rate metric has been achieved through a blend of machine learning and non-machine learning recommendations. The best results have been achieved through Bidirectional Long Short-Term Memory Networks (Bi-LSTM) with Attention for recommending jobs through machine learning that forms a major part of our recommendation.

5. A Machine Learning approach for automation of Resume Recommendation system

International Conference on Computational Intelligence and Data Science (ICCIDS 2019) Author: Pradeep Kumar Roy, Sarabjeet Singh Chowdhary, Rocky Bhatia Abstract: Finding suitable candidates for an open role could be a daunting task, especially when there are many applicants. It can impede team progress for getting the right person on the right time. An automated way of "Resume Classification and Matching" could really ease the tedious process of fair screening and shortlisting, it would certainly expedite the candidate selection and decision-making process. This system could work with many resumes for first classifying the right categories using different classifier, once classification has been done then as per the job description, top candidates could be ranked using Content-based Recommendation, using cosine similarity and by using k-NN to identify the CVs that are nearest to the provided job description. CV Recommendation Model The recommendation model is designed to take job description and CVs as input and provide the list of CVs which are closest to the provided job

description. This is done using two approaches. i) Content Based Recommendation using Cosine Similarity ii) ii) k-Nearest Neighbours Content-Based Recommender Considering this is the case of document similarity identification, we have gone with the Content-based recommender where Job Description provided by the employer is matched with the content of resumes in the space and the top n (n being configurable) matching resumes are recommended to the recruiter. The model takes the cleansed resume data and job description and combines the two into a single data set, and then computes the cosine similarity between the job description and CVs. k-Nearest Neighbours In this model, k-NN is used to identify the CVs that are nearest to the provided job description, in other words, the CVs that are close match to the provided job description. First, to get the JD and CVs to a similar scale, we have used an opensource library called "genism", this library generates the summary of the provided text in the provided word limit. So, to get the JD and CVs to similar word scale this library was used to generate a summary of JD and CVs and then k-NN was applied to find the CVs which are closely matching the provided JD.

Implications

The model designed is best suited for the first level of screening of the resumes by the recruiter. This would help the recruiter to classify the resumes as per the requirements and easily identify the CVs that are the best match to the job description. The model would assist the recruiter in hastening the profile shortlisting, at the same time ensuring credibility of the shortlisting process, as they would be able to screen thousands of resumes very quickly, and with the right fit, which would not have been possible for a human to do in near real time. This would aid in making the recruitment process efficient and very effective in identifying the right talent. Also, this would help the recruiter to reduce the resources spent in identifying the right talent making the process cost-effective. On the second level, the model provides the ranking to the CVs as per their fit vis-a-vis the job description, making it easier for the recruiter by giving the resume list in order of their relevance to the job. The recommendation made by the model are currently for the varied industry but the model and be further enhanced to target specific industry which would make it more effective and give better recommendations.

Conclusion

Huge number of applications received by the organization for every job post. Finding the relevant candidate's application from the pool of resumes is a tedious task for any organization nowadays. The process of classifying the candidate's resume is manual, time consuming, and waste of resources. To overcome this issue, we have proposed an automated machine learning based model which recommends suitable candidate's resume to the HR based on given job description. The proposed model worked in two phases: first, classify the resume into different categories. Second, recommends resume based on the similarity index with the given job description. The proposed approach effectively captures the resume insights, their semantics

and yielded an accuracy of 78.53% with Linear SVM classifier. The performance of the model may enhance by utilizing the deep learning models like: Convolutional Neural Network, Recurrent Neural Network, or Long-Short Term Memory and others. If an Industry provides a large number of resumes, then Industry specific model can be developed by utilizing the proposed approach. By involving the domain experts like HR professional would help to build a more accurate model, feedback of the HR professional helps to improve the model iteratively

6. Career Recommendation Systems using Content based Filtering

2020 5th International Conference on Communication and Electronics Systems (ICCES) Author: Tanya V.Yadalam, Vaishnavi M. Gowda, Vanditha Shiva Kumar, Disha Girish, Namratha M Abstract: Machine learning is a sub-field of data science that concentrates on designing algorithms which can learn from and make predictions on the data. Presently recommendation frameworks are utilized to take care of the issue of the overwhelming amount of information in every domain and enables the clients to concentrate on information that is significant to their area of interest. One domain where such recommender systems can play a significant role to help college graduates to fulfil their dreams by recommending a job based on their interest and skillset. Currently, there are a plethora of websites which provide heaps of information regarding employment opportunities, but this task is extremely tedious for students as they need to go through large amounts of information to find the ideal job. Simultaneously, existing job recommendation systems only take into consideration the domain in which the user is interested while ignoring their profile and skillset, which can help recommend jobs which are tailor made for the user. This paper examines existing career recommendation system and highlights the drawbacks of these systems, such as cold start, scalability and sparsely. Furthermore, proposed implementations of career recommendation system using machine learning have been researched to identify how the recommender systems introduce features of security, reliability and transparency in the process of career recommendation. In addition, possibilities for improvements in these systems have been explored, in order to design a career recommendation system using the content-based filtering approach.

7. Recommendation Systems:

Content-Based Filtering vs Collaborative Filtering 2022 2nd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE) Author: Sherin Eliyas, P. Ranjana Abstract: A job seeker will spend hours searching for the most useful information while dealing with the vast volume of recruiting information available on the Internet. In today's technologically evolved world, most internet users are continuously searching for various goods on the internet, and we normally do it via search engines. When searching, it's important to get the most relevant results possible, which recommender systems can help with. Users can easily find and evaluate items of interest when confronted with a huge number of possibilities. The goal of recommender systems is to establish a connection between products and consumers

based on the users' interests. We evaluate and contrast the two basic approaches to recommendation systems in this paper. The first is referred to as Collaborative Filtering, and the second is referred to as Content-based Filtering. With the rapid development and application of the mobile Internet, huge amounts of user data are generated and collected every day. How to take full advantages of these ubiquitous data is becoming the essential aspect of a recommender system. Collaborative filtering (CF) has been widely studied and utilized to predict the interests of mobile users and to make proper recommendations. In this paper, we first propose a framework of the CF recommender system based on various user data including user ratings and user behaviours. Key features of these two kinds of data are discussed.

8. Job Recommendation System based on Machine Learning and Data Mining Techniques using RESTful API and Android IDE

2019 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence) Author: Harsh Jain, Misha Kakkar Abstract: In the current Capitalist world with an abundance of different state-of-the-art industries and fields cropping up, ushering in an influx of jobs for motivated and talented professionals, it is not difficult to identify your field and to persevere to get a job in the respective field, but lack of information and awareness render the task difficult. This problem is being tackled by Job Recommendation systems. But not every aspect from the wide spectrum of factors is incorporated in the existing systems. For the "Job Recommendation System - Vitae" machine learning and data mining techniques were applied to a RESTful Web Server application that bridges the gap between the Frontend (Android Application) and the Backend (MongoDB instance) using APIs. The data communicated through APIs is fed into the database and the Recommendation System uses that data to synthesize the results. To make the existing systems even more reliable, here efforts have been done to come up with the idea of a system that uses a wide variety of factors and is not only a one-way recommendation system.

9. Machine Learned Resume-Job Matching Solution

University of Electronic Science and Technology of China, Chengdu, 610054, China Author: Yiou Lin, Hang Lei, Prince Clement Addo, Xiaoyu Li Abstract: Job search through online matching engines nowadays is very prominent and beneficial to both job seekers and employers. But the solutions of traditional engines without understanding the semantic meanings of different resumes have not kept pace with the incredible changes in machine learning techniques and computing capability. These solutions are usually driven by manual rules and predefined weights of keywords which lead to an inefficient and frustrating search experience. To this end, we present a machine learned solution with rich features and deep learning methods. Our solution includes three configurable modules that can be plugged with little restrictions. Namely, unsupervised feature extraction, base classifiers training and ensemble method learning. In our solution, rather than using manual rules, machine learned

methods to automatically detect the semantic similarity of positions are proposed. Then four competitive "shallow" estimators and "deep" estimators are selected. Finally, ensemble methods to bag these estimators and aggregate their individual predictions to form a final prediction are verified. Experimental results of over 47 thousand resumes show that our solution can significantly improve the predication precision current position, salary, educational background and company scale. In this paper, we have considered the resume-job matching problem and proposed a solution by using unsupervised feature extraction, surprised machine learning methods and ensemble methods. Our solution is completely date-driven and can detect similar position without extra semantic tools. Besides, our solution is modularized and can rapidly run-on GPU or simultaneously run-on CPU. Compared to a manual rule-based solution, our method shows better performance in both precision and Top-N recall. Our code is now public and can be tapped from Github3. In the future, with more information to be snatched from website, our solution could be extended by including location information, professional skills, and description of requirements from both job seekers and employers.

10. Talent Search and Recommendation Systems at LinkedIn: Practical Challenges and Lessons Learned

The 41st International ACM SIGIR Conference on Research & Development in Information Retrieval, June 2018 Author: Sahin Cem Geyik, Qi Guo, Bo Hu, Cagri Ozcaglar, Ketan Thakkar, Xianren Wu. Abstract: In this talk, we present the overall system design and architecture, the challenges encountered in practice, and the lessons learned from the production deployment of the talent search and recommendation systems at LinkedIn. By presenting our experiences of applying techniques at the intersection of recommender systems, information retrieval, machine learning, and statistical modelling in a large-scale industrial setting and highlighting the open problems, we hope to stimulate further research and collaborations within the SIGIR community. Talent search and recommendation systems at LinkedIn strive to match the potential candidates to the hiring needs of a recruiter or a hiring manager expressed in terms of a search query or a job posting. Recent work in this domain has mainly focused on linear models, which do not take complex relationships between features into account, as well as ensemble tree models, which introduce non-linearity but are still insufficient for exploring all the potential feature interactions, and strictly separate feature generation from modelling. In this paper, we present the results of our application of deep and representation learning models on LinkedIn Recruiter. Our key contributions include: (i) Learning semantic representations of sparse entities within the talent search domain, such as recruiter ids, candidate ids, and skill entity ids, for which we utilize neural network models that take advantage of LinkedIn Economic Graph, and (ii) Deep models for learning recruiter engagement and candidate response in talent search applications. We also explore learning to rank approaches applied to deep models and show the benefits for the talent search use case. Finally, we present offline and online evaluation results for LinkedIn talent search and recommendation systems and discuss potential challenges along the path to a fully deep model

architecture. The challenges and approaches discussed generalize to any multi-faceted search engine.