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Employment Recommendation System: A Review

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Abstract: Enormous amounts of jobs are posted on the job websites on daily basis and large numbers of new resumes are also added to job websites daily. In such scenario it's a very tough job to suggest matching jobs to the job applicants. A recommendation system can solve this problem to the great extent. A recommendation system has already been proved to be very effective in the area of Online shopping websites and Movie recommendation. Given a user, the goal of an employment recommendation system is to predict those job positions that are likely to be relevant to the user. An Employment recommendation system would suggest matching jobs to the users using matching, collaborative filtering and content based recommendation based on ranking.

Keywords: recommendation system, collaborative filtering, content based filtering, matching

1. INTRODUCTION

The recommender system technology plays an important role in various e-commerce applications by helping individuals to find right items in a large option space, which match their interests. Recommender systems are software tools and techniques providing suggestions for items to be of interest to a user such as videos, songs, or news articles. Driven by this success, more application domains have adopted recommender systems to reduce the information overload by generating personalized suggestions. Also for recruitment scenarios, in which applicants search for suitable job offers, recommender systems are a useful tool for job candidates, recruiters, as well as platforms that connect both [12]. The mainstream approaches to recommender systems are classified into four categories:

Collaborative Filtering (CF), Content-Based Filtering (CBF), knowledge-based and hybrid approaches [1]. Besides, utility-based and demographic approaches also exist. The main advantage of CF approaches is that they can find the patterns among user ratings data and work well for complex objects.[2] The problem of recommending jobs to users is fundamentally different from traditional recommendation system problems such as recommending books, products, or movies to users. While all of the above have a common objective to maximize the engagement rate of the users, one key difference is that a job posting is typically meant to hire one or a few employees only, whereas the same book, product, or movie could be potentially recommended to hundreds of thousands of users for consumption.[13] Ideal job recommendation system would need to achieve three goals simultaneously: (1) Recommend the most relevant jobs to users. (2) Ensure that each job posting receives sufficient number of applications from qualified candidates.

2. Related Work

Job Recommendation work resides in the domain of online recommender systems, which are widely adopted across many web applications, e.g., movie recommendations [14], e-commerce item recommendations [15], job recommendations [16] and so forth, where authors mainly concentrate on the relevance retrieval and ranking aspects of the recommendation system. There is insightful research and modeling of the hiring processes within job marketplaces. Such research includes work related to estimation of employee reputation for optimal hiring decisions [17], as well as work related to ranking and relevance aspects of job matching in labor market places [18, 19, 20]. There has been work related to the theory of optimal hiring process, e.g., on the problem of finding the right hire for a job (the hiring problem), as well as on the classical secretary problem, where a growing company continuously interviews and decides whether to hire applicants [21, 22].Authors of [23] investigated job marketplace as a two-sided matching market using locally stable matching algorithms for solving the problem of finding a new job using social contacts.

3. Types of Recommender Systems:

Distinction of four basic algorithm types has been proposed in RS [6]:

3.1 Collaborative Filtering (CF) Recommenders: They utilize social knowledge (typically ratings of items by a community of users) to generate recommendations.

A new user is matched against a database to discover neighbors, i.e. other users who, historically, had similar interests with him. Thus, the items that his/her neighbors liked are recommended to the user because he/she will probably like them too [7]. Fig. 1 illustrates the CF Recommendation concept. [11]

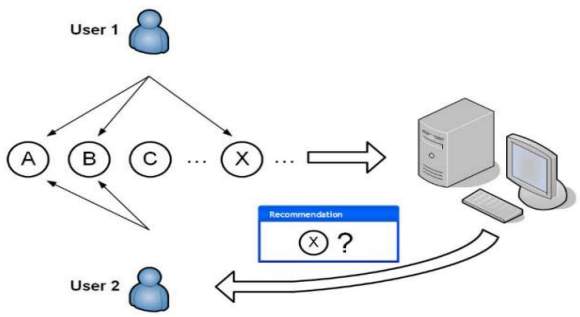

Fig. 1. User 1 selected A, B and X items, User 2 selected A and B, the CF system will suggest X item to User 2

Collaborative filtering can be categorized into basic types namely Item based collaborative filtering and user based collaborative filtering. In the item based collaborative filtering similar items are find out to recommend it to users and in Content based recommendation users past activities are analyzed to suggest new recommendations.

3.2 Content Based (CB) Recommenders: They utilize item features to recommend items similar to those a user has liked in the past. A CB system analyzes a set of characteristics of items that are rated by a user and build the profile of the user interests based on the features of the items that are rated by her [7]. The recommendation process matches up the attributes of the user profile against the set of properties of a content item [8], [9],[10].

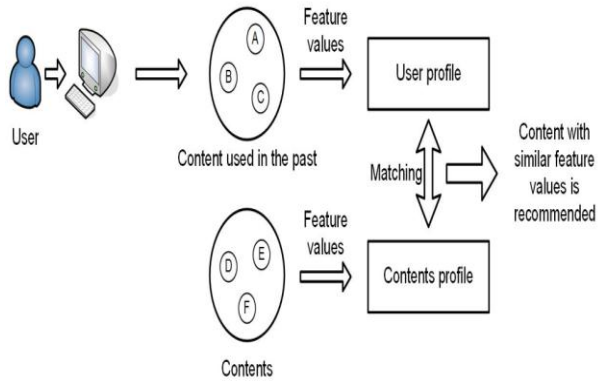

Fig.2. The CB recommender utilizes item features to recommend items similar to those a user has liked in the past Collaborative filtering can work

3.3 Knowledge-based (KB) Recommenders: Knowledge-based (KB) Recommenders use domain knowledge to generate recommendations.

3.4 Hybrid Recommender systems:

Hybrid Recommender systems combine two or more techniques to gain better results with fewer drawbacks.

4. Employment recommendation system challenges

The job matching process normally takes into consideration of the data available in the resume and match against the data listed in the list of open vacancies. One of the most challenging tasks of this type of job matching is that there are usually too many data to match against. Furthermore, these data usually submitted in free form, as each individual has their own preference to prepare the data. For example, Person A claimed that he has a total of 8 years 'experience in Oracle product. A Database Administrator will interpret that this person has 8 years of experience in Oracle Database. A Platform Leader will make assumption that it's 8 years of experience in Oracle Commerce Platform, while a Lead Programmer will think that is a 8 years of experience in Java programming. Therefore, an intelligent job matching engine is required to overcome this issue.

Recommending a job is different than recommending a product or movies as it involves large number of parameters and filtering based on different criteria.

A same job cannot be recommended to all the people all over the world as demographic area also needs to be considered for recommendation of a particular job to particular user.

5. Employment recommendation using Collaborative Filtering

The traditional Item-based CF processes as follow: First, for each job which current user (*useri*) applied in the past (we regard user-applied jobs as user-liked jobs), find out other users who applied this job (*userj*) (we regard these users as co-applied users), and then find out other jobs these co-applied users also applied, except for the current job (user-liked jobs), uses these jobs as candidate set. The procedure is presented below:

for each job_i $user_i$ *applied*
{
for each co-applied $user_j$ *who applied* job_i
{
find out jobs(job_j*) that* $user_j$ *applied;*
add these jobs to candidate set;
}
delete job_i *from candidate set;*
}

Second, for every job $Item_j$ in the candidate set {Item1…$Item_p$}, compute the predict preference grade for it using The Jaccard similarity index. Jaccard similarity is calculated using formula:
Number of user common for job_i *and* job_j (intersection) divided by number of users either for job_i or job_j (union)
At last, sort all the grades and choose top N jobs as the result set. The procedure is presented below:

for each $item_j$ *in candidate set*
{
compute pref (U_i*,*$Item_j$*);*
}
sort these pref (U_i*,Item);*

6. Employment recommendation using Content based Filtering

One of the most popular recommender approaches is content-based filtering, which exploits the relations between (historically) applied jobs and similar features among new job opportunities for consideration. Generally speaking, the goal of content based filtering is to define recommendations based upon feature similarities between the items being considered and items which a user has previously rated as interesting. for the target user-item rating f(ˆ u ,ˆ i) , content-based filtering would predict the optimal recommendation based on the utility functions of f(ˆ u , I h) which is the historical rating information of user ˆ u on items (I h) similar with ˆ i . [23] Given their origins out of the fields of information retrieval and information filtering, most content-based filtering systems are applied to items that are rich in textual information.

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A Proposed Study with the "DARPA Model" Network Issue Classifier

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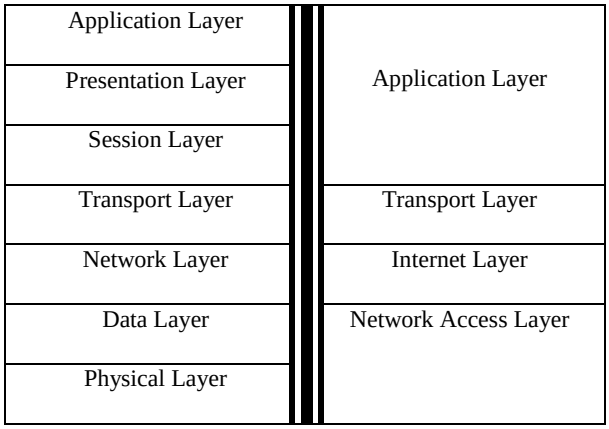
Abstract: DARPA model named after the U.S. government agency "Defense Advanced Research Projects Agency" that initially developed TCP/IP. Moreover, network issues are expressed by taking the DARPA 4 Layer model into account. Possible issues on such layer of these four categorized as efficacious network administration so they standardized in a way that would be more eligible. Network issue shooting policy developed by considering the mentioned earlier model.

Keywords: DARPA model, Network issues

1. INTRODUCTION

TCP/IP protocols compressed from 7 to 4 layers calling it "*DARPA model"*, named after the American government agency that initially dealt with the so called TCP/IP [1]. The layers of DARPA model are: Application, Transport, Internet, and Network Interface. Each layer in the DARPA model compared to single or several layers of the old layers in Open Systems Interconnection (OSI) model [2, 3, and 4].



7 - Layer OSI Model *4 - Layer DARPA Model*

I. Application Layer

The *Application layer* provides the access ability to such services of other layers and characterizes the protocols that applications use to exchange data. Widely application used in application layer such as (Telnet, SMTP, spreadsheet, word processor, FTP, TFTP, DNS, http and etc.) it consists the old three layers in the *OSI Model* (Application, Presentation & Session).

II. Transport Layer

The *Transport layer* (also known as the Host-to-Host Transport layer) responsible for providing the Application layer with session and datagram communication services, two core protocols of the Transport layer are TCP and UDP.

III. Internet Layer

Responsible for addressing, packaging, and routing functions. The core protocols of the Internet layer are IP, ARP, ICMP, and IGMP.

IV. Network Access Layer

Responsible for placing TCP/IP packets on the network medium and receiving TCP/IP packets off the network medium. TCP/IP was designed to be independent of the network access method [5], frame format, and medium. In this way, TCP/IP can be used to connect differing network types. These include LAN technologies such as Ethernet and Token Ring and WAN technologies [6, 7].

2. PROPOSED NETWORK TROUBLE IDENTIFIER MODELS

I. Issue Classification on Application Layer

As it is known, Application layer is a layer which includes all network software but it is irrelevant to hardware. Here, it is possible to split or divide them to two categories: ***i)*** **Off-line software** (word-processor, spread-sheet and etc.), ***ii)*** **On-line software** (TFP, FTP, http, DNS and etc.). In this case, issues on Application layer are divided into two: **"Off-line Issues"** and **"On-line Issues"**. In network administration, off-line issues are problems inside the host, and on-line issues are software which affects sharing between computers. As for presentation there will be issues such as Text, audio, video–graphic. Such Problems might be categorized as: **"Text Issues"**, **"Audio Issues"** and **"Video-Graphic Issues"**. Therefore, text issues such format malfunctions of text only files in MS (Word, Excel and etc.) Problems in peer-to-peer model with two PCs just are assembled under one category and problems in connection-multi are grouped under another.

In this way, problems of session are split down into pair: These are **"Peer-to-Peer Issues"** and **"Multi-Connection Issues**" [8].

II. Issue Classification on Transport Layer

The *Transport layer* (Known as the Host-to-Host) is in charge of giving the Application layer session and datagram communication services. The Transport layer core protocols is *Transmission Control Protocol* (**TCP**) and the *User Datagram Protocol* (**UDP**). Network Problems are divided into tri-categories: **"UDP Based Issues", "TCP Based Issues"** and **"Buffer Issues"**. In this way, troubles on this layer are at a micro level for network administration identification and troubleshooting become faster.

A) **TCP:** Gives a balanced, connection-oriented, dependable communications service. TCP is in charge for establishment of a TCP connection, the sequencing and acknowledgment of packets sent, and the recuperation of packets lost amid transmission.
B) **UDP:** Gives a balanced or one-to-many, connectionless, inconsistent communications service. UDP is utilized when the amount of data to be small when transferred (for example data that would fit into a solitary packet), when the overhead of setting up a TCP connection isn't wanted or when the applications or upper layer protocols give dependable conveyance.

3. ISSUE CLASSIFICATION ON INTERNET LAYER

The *Internet layer* is addressing, packaging, and routing functions which the internet layer responsible for. The core protocols of the Internet layer are **IP, ARP, ICMP, and IGMP**.

- **The *Internet Protocol* (IP)** is a routable protocol in charge of IP addressing, packet routing, and packet fragmenting and reassembly.
- **The *Address Resolution Protocol* (ARP)** Is in charge of Internet layer address's resolution to the Network Interface layer address such as a hardware address.
- **The *Internet Control Message Protocol* (ICMP)** Is in charge for giving symptomatic functions and errors reports due to the delivery failure of IP packets.
- **The *Internet Group Management Protocol* (IGMP)** is responsible for the management of IP multicast groups. In internet layer issues are classified as: "**Hardware Issues"** for standard router hardware problems, **"Echo Message Issues** may categorized as Non-reach problems like echo messages such as ping to the next terminal and tracerout. Problems caused by telecommunication systems in general might be categorized as "**Telecommunication Issues"**. Problems on internet layer caused by wrong structuring of routed protocols are standardized as "**Routed Configuration Issues"** problems on internet layer in network administration cannot be handled under one category and the fact that problem on one layer may vary should be taken into account. Thus, standardization the problem by categorization is predestined [9].

4. PROBLEM CLASSIFICATION ON NETWORK ACCESS LAYER

There are active devices such as switch and bridge used in LAN administration, and protocols such as PPP (Point-to-Point Protocol), HDLC (High Data Link Control), and Frame Relay which are Wide Area Network's protocols. As a result, Problems on this layer might belong to both LAN and WAN. There is NIC (Network Interface Card), an indispensable part for LAN for communication. As it is easy to recall, there are two sub-layers on MAC (Media Access Control) and LLC (Logic Link Control). MAC totally refers to framing on LAN based on NIC. Standardization or so to be called classifying of Problems *network access layer* will be realized according to the above mentioned information. Problems on WAN might be Classified as **"WANs Protocols Issues"**. Problems on NIC, an determined part for communication in LAN administration, are called **"NIC Issues"** and problems in MAC address, which has virtually been changed recently, are called **"MAC Issues"**. Therefore, Classification is ensured. Problems on LLC, which provides transfer from Data Link Layer to Network Layer within the Network Access Layer, might be standardized as **"LLC Issues"**. In this sense, it is possible for a network administrator to identify Problems on Network Access Layer immediately. This layer in charge of setting TCP/IP packets on the medium of the network and receiving TCP/IP packets off that medium. TCP/IP was intended to the network access method and being independent, frame format, and medium. Along these lines, TCP/IP can be what we can call "interface utilization" by connecting different network types. These comprise LAN technologies for example like Ethernet, Token Ring and WAN technologies such as X.25 and Frame Relay [10]. Unrestrained from any specific network technology TCP/IP the ability to be adapted to new technologies such as Asynchronous Transfer Mode (ATM). Network Access layer encompasses the Data Link and Physical layers of the OSI model. Note that the Internet layer does not take advantage of sequencing and acknowledgment services that might be present in the Data-Link layer. An untrusted Network Interface layer is assumed, and trusted communications through session establishment and the sequencing and acknowledgment of packets is the obligation of the Transport layer. It is known that all data on communication networks are changed into electrical signals (0-1). Data to be transferred in network settings are varies to be into electrical signals on physical layer and this layer is the last phase where data splits. In this unique circumstance, on physical layer, there are active-passive components such as electrical signals, cables, modems and hubs. Troubles on this layer are generally electrical problems. Troubles on cables such as UPT, STP, Coaxial and RS-232, V.35, especially used in LAN and WAN, are handled on Physical Layer. Cable based troubles on mentioned layer above might be categorized as **"Cables Troubles"** and excessive voltage loadings might be called **"Overload Voltage Troubles"**. In addition, troubles in hub devices used on LAN might be standardized as **"Hub Troubles"** and troubles in modems used on WAN might be

standardized as **"Modem Troubles".** Moreover, broadcast troubles in wireless settings should be handled on PL. **"Wireless Wave Signal Troubles"** standard may be eligible for such troubles. In this way, possible troubles on Physical Layer are standardized and troubleshooting in network administration could be faster [11].

Layers	Troubles
Application Layer	Off-line Troubles, On-line Troubles, Text Troubles, Audio Troubles, Video-Graphic Troubles, Peer-to-Peer Troubles, Multi-connection Troubles
Transport Layer	UDP Based Troubles, TCP Based Troubles, Buffer Troubles
Internet Layer	Hardware Troubles ,Echo Message Troubles ,Telecommunication Troubles, Routed Configuration Troubles, Routing Configuration Troubles
Network Access Layer	WANs Protocols Problems on, Network Access Layer , NIC **Issues** ,MAC **Issues**, LLC **Issues** ,Cables **Issues**, Overload Voltage Troubles, Hub Troubles, Modem Troubles, Wireless Signal Wave Troubles

5. CONCLUSION:

In this research, network troubles were identified and standardized for network administration. In this way, network troubleshooting could be identified faster. In the traditional approach, network troubles are expressed by names of layers. However, as it was shown in this research, troubles might vary on each layer. Therefore, troubleshooting will be faster. Such a standardization approach was OSI based and the proposed model was structured in this way. The model is thought to contribute to make network troubleshooting faster and easier.

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