The Use of Artificial Intelligence in Job Seeking and Competence Development

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ABSTRACT

Artificial Intelligence (AI), in the public and private sectors, creates new opportunities worldwide. One of such domains where the elements of AI play a critical role are recommendation systems related to finding a new job and offering training suggestions. Based on current literature, only a few attempts are made to implement intelligent recommendation systems in public sector environments such as employment agencies. In this regard, the existing state-of-the-art models should be explored for creating AI-enabled e-services helping unemployed citizens to find suitable jobs or to receive training suggestions based on their profiles. While job recommendation and training suggestion is still a constantly evolving area of research, the task of the current study is to support this research domain by firstly mapping the state-of-the-art AI techniques used in the current job and training recommendation system research literature. Secondly, in collaboration with multiple stakeholders in the Estonian public sector and universities from Latvia and Finland to conceptualize citizen-centered public service architecture that uses AI and is accessible to every European citizen.

Keywords: AI, Recommendation system, Virtual competency assistant, Labour market

INTRODUCTION

With the recent pandemic, many people have lost their jobs and are forced to find new career opportunities. In 2021 the global shortfall of jobs caused by the crisis was projected to stand at 75 million (International Labour Organization, 2021), which creates the need for better support by government institutions such as employment agencies. Their support to date has been built on human interaction between the citizen and career counselor and electronic tools such as portals to register for state support and search for a job. As we are increasingly moving towards proactive and automated services in building better e-governance related solutions, the complexity related to how governments can satisfy the needs of their citizens in challenging times needs addressing. As one of the pioneers in e-governance, Estonia has only recently started implementing AI technologies into public e-services using modern technological concepts such as Chatbots (Government CIO Office of Estonia, 2019). Such concepts can be implemented parallel to the already existing citizen's portals. To date, such portals' functionality is incrementally being enhanced to meet the required functionality following local legislation. However, they are currently not exploiting the benefits of

the technological revolution of artificial intelligence. This research aims to establish a conceptualized view of citizen-centered service for people over 50 years old and integrate it into the already existing Virtual Collaborative platform (Silver Hub).

Based on current literature, only a few attempts are made to implement an intelligent recommendation system in a public sector agency such as employment agencies (Rodriguez, et al., 2019). In this regard, the existing state-of-the-art models should be explored for creating new AI-enabled e-services to help unemployed citizens easily find suitable jobs or get training suggestions based on their profiles. The term recommendation system in information technology literature first emerged in 1997 (Resnick & Varian, 1997) and is widely used for various purposes. However, based on (Dhameliya & Desai, 2019), a recommendation system and a job recommendation system have the following key differences: (1) increased difficulty in providing ratings to jobs, (2) the importance of timeliness as seeking jobs is time-critical and (3) compared to recommendation systems job recommendation systems need to consider the characteristics of both the candidate and job needs. Although mainly in the current literature, job and training suggestions are often handled in separate research providing models. Still, some authors, especially in the recent literature, combine job recommendation research with human skills (Dave, et al., 2018) (Giabelli, et al., 2021). However, little is researched focusing on the aspect of the AI field specifically. For example, a systematic literature review done in 2020 categorized the existing e-recruitment recommendation systems into four well-known traditional categories: Content-Based Recommendation (CBR), Collaborative Filtering Recommendation (CF), Hybrid, Knowledge-Based Recommendation (KBR), and added the fifth category called Other Techniques (OT) where all state-of-the-art AI-based recommendation system models were added, including Machine Learning (ML), Artificial Neural Networks (ANN) and Deep Neural Networks (DNN).

This paper focusses on literature where AI is used. In addition to focusing only on AI in job recommendations, the work includes the latest developments in training suggestion systems. To tackle these topics mentioned above, two research questions are formed:

RQ1. What data and models have been used in studies concerning the use of AI in job and training recommendation systems?

RQ2. How to design a new set of AI-enabled proactive solutions for supporting EU citizens with job recommendations and competence development?

METHODOLOGY

Our broader research aims to build AI-enabled public career services, such as Virtual Competency Assistants for the European labor market. Therefore, the overall research methodology is chosen as Action Research, where we aim to develop a technological artifact and intervention for the Estonian Unemployment Insurance Fund. For this research, we have been conducting a literature

survey, semi-structured interviews, and workshops building upon previously validated problems and gathered data for this research.

A literature survey is conducted to answer the first research question exploring current state-of-the-art recommendation systems. For finding the most significant articles, the query was limited to: (1) Title contains "recommendation system," (2) Optional keywords in title: "job, training, artificial intelligence," (3) Time range: All. In addition, the search sources were limited to Scopus (40 matches in total) and Google Scholar (141 matches in total). Finally, we excluded all studies which did not specify the AI methods, such as ML, ANN, or DNN, used in their research and analyzed if the remaining articles had their data sets explicitly characterized. The total amount of articles left in the study after elimination was 34.

The interviews were conducted with open-ended questions to get insight into current concerns and open ends to answer the second research question. The interviewees were the representatives of Nordic Institute for Interoperability Solutions, the Estonian Unemployment Insurance Fund, Tallinn University of Technology, the Estonian Qualifications Authority, and universities from Latvia (Riga Technical University) and Finland (Häme University of Applied Sciences and South-Eastern Finland University of Applied Sciences). In addition to the interviews, in total, three workshops were conducted. The next step in broader research aims to build an AI-enabled Virtual Competency Assistant for the European labor market.

RESULTS

What Data and Models Have Been Used in Studies Concerning the use of AI in Job and Training Recommendation Systems?

The collection of data sources used in the research involved can be primarily categorized into career-related social networks such as XING (Mishra & Reddy, 2016) (Zhang & Cheng, 2016) (Polato & Aiolli, 2016) (Pacuk, et al., 2016) (Xiao, et al., 2016), LinkedIn (Diaby, et al., 2014) (Heap, et al., 2014) (Patel & Vishwakarma, 2020) and Facebook (Benabderrahmane, et al., 2018). Another major category is job portals such as CareerBuilder (Shalaby, et al., 2017) (Dave, et al., 2018) (Zhao, et al., 2021), Work4 (Diaby, et al., 2013), (Diaby, et al., 2014), (Dong, et al., 2017) (Benabderrahmane, et al., 2018), beBee (González-Briones, et al., 2019) and JobStreet (Bakar & Ting, 2011). Some researchers used historical job transitioning data to predict the next jobs. However, others included different historical activities such as user clicks (Xiao, et al., 2016) (Benabderrahmane, et al., 2018) (Shalaby, et al., 2017) (Jiang, et al., 2019), passed training records (Benabderrahmane, et al., 2018) and history of former applications (Nigam, et al., 2019). Based on the results of data sources, one singular, remarkable event stands out from another research. In the year 2016, a particular topic of Job Recommendation was co-organized by the social network XING in a yearly challenge called RecSys'16[1], held in the US, contributing six papers to improve job

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[1]10th ACM Conference on Recommender Systems, Boston, MA, USA, 15th-19th September 2016. https://recsys.acm.org/recsys16/.

recommendation with modern AI tools (Mishra & Reddy, 2016) (Zhang & Cheng, 2016) (Polato & Aiolli, 2016) (Liu, et al., 2016) (Pacuk, et al., 2016) (Xiao, et al., 2016).

Several investigated studies combine traditional recommendation system approaches (CF, CBR, KBR, and Hybrid) with new AI techniques. (Paparrizos, et al., 2011) trained a machine learning algorithm using linear Support Vector Machines (SVM) to improve the performance and results of the CBR recommendation system. Another study created a multi-agent system capable of learning through the CBR model using ML with argumentation network (González-Briones, et al., 2019). Five distinct studies improve the CF model with AI techniques:

- (Mishra & Reddy, 2016) created gradient boosting algorithm by applying linear regression and gradient boosting methods while using Random Forests for missing values.
- (Shalaby, et al., 2017) used content-based similarity measure, which is learned by the DL approach to computing the similarity scores from multiple data sources that capture users' behavior and resumes and jobs content while proposing a homogeneous graph-based recommendation architecture.
- (Hossain & Arefin, 2019) applied association rule mining to find positive frequent skill sets and train collaborative filtering model with logistic regression and linear SVM model to classify the posted jobs to positive and negative.
- (Patel & Vishwakarma, 2020) showed a concise review of CF rating prediction-based job recommendation system and their execution utilizing a tool called RapidMiner.
- (Appadoo, et al., {2020) made use of NLP and correlation between mapping user skills with the job requirements and accounts for related skills.

Three different studies used AI techniques with Hybrid models (traditional CF and CBR), combining them with: (1) Word2Vec, Latent Semantic model (LSI) (Zhang & Cheng, 2016), (2) statistical relational learning (SRL) models (Yang, et al., 2017) and (3) clustering together with text mining techniques (Tondji, 2018).

Bayesian Network Model is involved in two separate studies for (1) proposing the optimal soft skills (Bakar & Ting, 2011) and (2) for improved performance evaluation (Qin, 2017). The latter included an additional fuzzy neural network model with mathematical optimization and SVM, which is similarly used in (Diaby, et al., 2014). Model training using Cosine Similarity is explored in (Heap, et al., 2014) and (Polato & Aiolli, 2016). NLP is used in three separate studies focusing on: (1) extracting meaningful data from job postings using text-clustering methods (Mhamdi, et al., 2020), (2) in combination with correlation mapping user skills with the job requirements while considering related skills (Appadoo, et al., {2020) and (3) assigning "interaction points" with different values to the various elements in a CV (Hernández, 2016). Neural Networks are used as follows:

- RNN is used by (Liu, et al., 2016) to explore the RNNs approach to capture job-vacancy behavior patterns and by (Feng, et al., 2021) to map a student questionnaire to a weight d in combination with K-means clustering of vacancies to help students find optimal jobs collection.
- ANN is used: in combination with Logistic Regression to predict the suitable workout for each beginner in fitness using the Fitness Assistance system (Tran, et al., 2018) and for processing data from tested questionnaires to provide accurate recommendations for an internship place (Permana, 2019).

The first study using DL emerged in the field, proposing instead of the probabilistic models a DNN to predict future values of the clicks on job boards (Benabderrahmane, et al., 2018) (Benabderrahmane, et al., 2018). (Zhao, et al., 2021) construct a DL embedding model with domain-specific vocabulary to process information from CV-s and vacancies. (Nigam, et al., 2019) address an internal company-related solution and highly volatile job market while introducing a new machine learning model called Bidirectional Long Short Term Memory Networks (Bi-LSTM), which used candidate-job preference to propose future recommendations. (Shalaby, et al., 2017) use DL to compute the similarity scores from multiple data sources that capture users' behavior and CV and vacancy content.

How to Design a New Set of AI-Enabled Proactive Solutions for Supporting EU Citizens With Job Recommendations and Competence Development?

In Estonia and many other countries in the EU, a standardized occupational classification ISCO-08 is being used for multiple purposes such as its widespread acceptance, statistical simplification across organizations, etc. However, from mid-2021, another classification called ESCO[2] is strongly recommended and, to some extent, mandatory classification for EU member states. The key difference between ISCO-08 and ESCO is that there are also skills and qualifications included in addition to occupational titles. As today's employment agencies have only used ISCO codes and occupational titles, there is a lack of matching citizens' skills to specific vacancies or training for improved recommendations. According to NIIS, another EU-wide component that could assist in building EU-wide citizen-centered services is eDelivery. This set of specifications, standards, and software can enable secure data exchange between public registers, AI-enabled services, and citizen-centered platforms. Surprisingly eDelivery is already used for data exchange between employment agencies to determine the social security rights of persons in a cross-border situation. However, this solution is integrated into national social security systems and not directly related to citizen-centered services.

Interestingly, in some EU countries, including Estonia, the EU citizens can log in to the employment service with their national authentication solution, which must comply with IDentification, Authentication, and Trust Services

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[2]ESCO is a European Commission project classifying skills, competences and occupations while covering 27 languages in the EU.
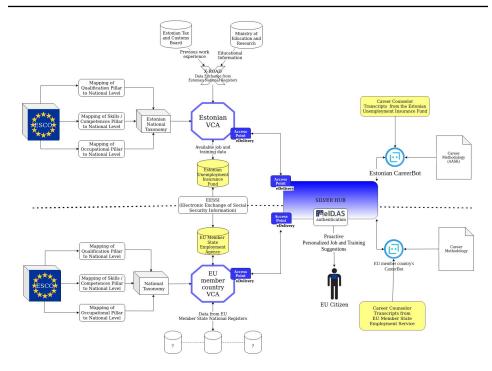
Figure 1: Conceptualized view on AI-enabled services accessible through Silver Hub.

(eIDAS) regulation and be certified by Certificate Authority. Combining such EU-wide components create the opportunity for AI-enabled service provisions and could be integrated into modern platforms. In one of the workshops with the Estonian Unemployment Insurance Fund representatives, we achieved a crucial necessity to targeting the labor market's less capable target group – the 50+ years old. After investigating this idea in a workshop with colleagues from local and international universities, we achieved the standpoint to establish a pilot version of AI-enabled competency services, integrating them to a Virtual Collaborative platform (Silver Hub). During the Interreg Baltic-Sea Region project, Tallinn University of Technology developed the platform- "OSIRIS: Supporting the Smart Specialization Approach in the Silver Economy to Increase Regional Innovation Capacity and Sustainable Growth."

DISCUSSION

In our previous research, we analyzed the current situation in the Estonian Unemployment Insurance Fund and proposed an initial model for a national VCA (Liutkevicius & Erlenheim, 2021). The main difference between Estonia and other countries in the EU is the usage of Estonian data exchange layer X-Road that is in use in Estonia for receiving citizen's data from different registers (i.e., occupational data from the Tax and Customs Board and educational data from the Ministry of Education and Research). This makes receiving the data for building AI models for VCA easier because the data already exists in a structured form. In this research, we gained initial feedback from other EU member state countries (Finland and Latvia), the Nordic

Institute of Interoperability Solutions (NIIS). Therefore, we can expand our concept to the international level (Figure 1).

CONCLUSIONS

This paper analyzed the existing research on job and training recommendation systems and conceptualized views on AI-enabled services supporting citizen-centered career services. The work is a step closer to bringing the services of employment agencies to the next level. Our objective is to target the 50+-year-old EU citizen by integrating the AI-enabled services to the already existing platform Silver Hub using the benefits of eIDAS authentication, eDelivery data exchange security, and ESCO. Besides having occupations and other essential background information about citizens, using ESCO, we additionally include skills and qualifications for improved recommendations using the new virtual assistant – Virtual Competence Assistant (VCA). In that way, if an EU citizen logs into the portal and presumes that her national employment agency has been successfully implemented, she can select the relevant skills based on the suggestions received from her background (former occupations and education from state registry) and start receiving recommendations for the next career choice. The VCA-s will proactively make personalized training and job recommendations using the citizens' personal background information. In addition, we see the opportunity to develop a national career chatbot called CareerBot for more efficient career counseling performing standardized career suitability tests, and suggesting sources of information that can help find a new career. As many employment agencies have recorded the phone calls of career counselors, they can be transcribed and used for AI model training. For that, a separate state of the art research is required, which was not in the scope of this paper. Nevertheless, such a solution can be added with similar means as VCAs. Consequently, we are creating a new set of AI-enabled solutions, which will enhance data exchange and public service provision for European citizens.

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