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SYSTEMATIC LITERATURE REVIEW: APPLICATION OF ARTIFICIAL INTELLIGENCE IN CAREER COUNSELLING

Abstract

This systematic literature review investigates the transformative potential of machine learning (ML) and artificial intelligence (AI) in career guidance, focusing on developing hybrid recommendation systems. The review emphasizes the notable surge in research activity in this field, with the Random Forest and Decision Tree algorithms emerging as the most often utilized because of their resilience and interpretability. The creation of competency-based frameworks, career trajectory prediction, and intelligent career systems are some of the key uses of machine learning that have been recognized. The results highlight the advantages of merging collaborative and content-based filtering techniques to produce more precise and customized career counselling tools. Along with addressing practical and ethical issues including algorithmic bias and data privacy, the paper makes recommendations for future research areas, such as the necessity of interdisciplinary approaches and the creation of transparent machine learning models. This paper contributes to the growing body of knowledge regarding machine learning applications in career counselling, offering scholars, practitioners, and policymakers' insightful information about how cutting-edge ML techniques might enhance career decision-making and boost user happiness.

Keywords: career counselling, recommender systems, machine learning, artificial intelligence, professional competences.

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ЖАСАНДЫ ИНТЕЛЛЕКТТІҢ МАНСАП КЕҢЕС БЕРУ САЛАСЫНДАҒЫ МАҢЫЗЫНА ЖҮЙЕЛІ ӘДЕБИ ШОЛУ

Аңдатпа

Бұл жүйелі әдеби шолу гибридті кеңес беру жүйелерін дамытуға назар аудара отырып, мансаптық бағдар беруде машиналық оқытудың (МО) және жасанды интеллекттің (ЖИ) трансформациялық әлеуетін зерттейді. Шолу осы саладағы ғылыми-зерттеу қызметінің айтарлықтай өсуін көрсетеді, кездейсоқ орман және Шешім ағашы алгоритмдері олардың сенімділігі мен түсіндірмелілігіне байланысты ең жиі қолданылатын алгоритмге айналды. Машиналық оқытудың кейбір негізгі қолдануларына құзыреттілікке негізделген жүйелерді құру, мансап траекториясын болжау және интеллектуалды мансап жүйелері кіреді. Нәтижелер дәлірек және бейімделген мансаптық кеңес беру құралдарын жасау үшін бірлескен және мазмұнды сүзгілеу әдістерін біріктірудің артықшылықтарын көрсетеді. Алгоритмдік бейімділік пен деректердің құпиялылығын қоса алғанда, практикалық және этикалық мәселелерді шешумен қатар, мақала пәнаралық тәсілдер қажеттілігі және машиналық оқытудың мөлдір үлгілерін жасау сияқты болашақ зерттеу бағыттарына ұсыныстар жасайды. Бұл жұмыс мансаптық кеңес беруде машиналық оқытуды қолдану туралы білімнің өсуіне ықпал етеді, ғалымдарға, практиктерге және саясаткерлерге машиналық оқытудың озық әдістері мансаптық шешім қабылдауды қалай жақсарта алатыны және пайдаланушы бақытын арттыратыны туралы пайдалы түсініктер ұсынады.

Түйін сөздер: мансаптық кеңес беру, кеңес беру жүйелері, машиналық оқыту, жасанды интеллект, кәсіби біліктіліктер.

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СИСТЕМАТИЧЕСКИЙ ОБЗОР ЛИТЕРАТУРЫ: ЗНАЧЕНИЕ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В КОНСУЛЬТИРОВАНИИ ПО КАРЬЕРЕ

Аннотация

В данном систематическом обзоре литературы исследуется трансформационный потенциал машинного обучения (МЛО) и искусственного интеллекта (ИИ) в профориентации с упором на разработку гибридных рекомендательных систем. В обзоре подчеркивается заметный всплеск исследовательской активности в этой области, при этом алгоритмы Random Forest и Decision Tree становятся наиболее часто используемыми благодаря своей устойчивости и интерпретируемости. Среди основных направлений использования машинного обучения можно назвать создание систем, основанных на компетенциях, прогнозирование карьерных траекторий и интеллектуальные карьерные системы. Полученные результаты подчеркивают преимущества объединения методов коллаборативной и контентной фильтрации для создания более точных и специализированных инструментов консультирования по вопросам карьеры. Наряду с рассмотрением практических и этических вопросов, включая алгоритмическую предвзятость и конфиденциальность данных, в работе даются рекомендации для будущих областей исследований, такие как необходимость междисциплинарных подходов и создание прозрачных моделей машинного обучения. Данная работа вносит вклад в растущий объем знаний о применении машинного обучения в карьерном консультировании, предлагая ученым, практикам и политикам полезную информацию о том, как передовые методы машинного обучения могут улучшить процесс принятия карьерных решений и повысить уровень счастья пользователей.

Ключевые слова: карьерное консультирование, рекомендательные системы, машинное обучение, искусственный интеллект, профессиональные компетенции.

Introduction. In today's world, where the speed of technological progress, especially in the development of artificial intelligence, and the dynamics of market conditions are becoming increasingly fast, choosing a suitable path for professional development becomes a complex issue that requires deep understanding and careful analysis. Determining career direction and choosing an educational path are key decisions in an individual's life, which largely determine their future well-being and success. However, such decisions are often hindered by a lack of awareness regarding one's abilities, preferences, and the opportunities available in the labor market ([1]).

In this context, the development of an effective career guidance system capable of providing personalized guidance and support in choosing a career path becomes a necessity. Moreover, recommendation systems based on machine learning have proven their effectiveness in areas such as online marketplaces, social networks, streaming platforms, and others. Such a system can facilitate decision-making and help individuals understand their goals and development needs. The literature indicates that ML-based recommendation systems have been highly effective in fields such as e-commerce, streaming platforms, and social networks, helping users make decisions based on their preferences and behaviors ([2]). These systems can similarly be applied to career guidance, offering individuals data-driven suggestions that align with both their personal goals and the rapidly changing needs of the job market ([3]). Various ML techniques are used to develop a recommendation system based on user input or collaboration with other users. This research project aims to create a career guidance system based on a hybrid recommendation method combining content-based filtering and collaboration methods.

The goal of this research is to develop a career guidance system capable of offering personalized recommendations for choosing a career path and educational programs.

Basic provisions. Rapid growth and large investments in AI have led to the development of various tools in various fields. One of the areas is career counseling, where on a scale of thousands of people, a tool is needed that can serve many requests. The systematic literature review examines existing and developed solutions in this area. After a deep analysis, it was found that of the various ML algorithms, the most suitable are Decision Tree and Random Forest, showing the highest average accuracy in comparison.

This systematic literature review explores the significant impact of machine learning (ML) and artificial intelligence (AI) on career guidance, particularly focusing on the development of hybrid recommendation systems. It highlights a marked increase in research activity within this field, with algorithms such as Random Forest and Decision Tree being frequently employed due to their robustness and ease of interpretation. Key applications identified include the creation of competency-based frameworks, predictions of career trajectories, and the implementation of intelligent career systems. The findings underscore the benefits of integrating collaborative and content-based filtering methods to enhance the precision and personalization of career counselling tools. Furthermore, the paper addresses ethical considerations such as algorithmic bias and data privacy while proposing future research directions that emphasize interdisciplinary approaches and the development of transparent ML models, ultimately contributing to a deeper understanding of how advanced ML techniques can facilitate career decision-making and improve user satisfaction.

Study Objectives. The objectives of this study are as follows:

- Reviewing and assessing existing career counselling methods.
- Identifying the factors that influence the choice of career trajectory.
- In connection with the development of ML and AI, understand the demand for recommendation systems in the field of career determination.

This study is also based on the formulation of the hypothesis that the use of hybrid recommendation methods and machine learning will create a more effective career guidance system capable of offering users more accurate and personalized recommendations.

The research will use structured data collection methods and data analysis techniques including machine learning techniques to collect and analyze data. Furthermore, the expected outcomes of the

study include the establishment of a functioning career guidance system and evaluation of its effectiveness based on accuracy and user satisfaction.

Thus, this research has important implications for the scientific community and society at large as it aims to create a career guidance system that can facilitate career decision-making and improve user satisfaction.

Materials and Methods. The SLR was based on conducting a social survey to identify key factors that influence the choice of career trajectory and further development in this area and the PRISMA methodology [4], which helped to identify the relevant literature in career guidance using Machine Learning and Artificial Intelligence approaches. Firstly, these questions are selected for the social survey:

1) 'Your Country of residence?'. This question is needed for grouping by country or by region.

2) Have you started your career in the specialty obtained at the university?'. Since a career can last for quite a long time and an employee can both change direction and develop within the same specialty, it is important to find out how exactly the employee started his/her career.

3) 'Your first IT position or line of study?'. This question is intended for clarification after the second question.

4) What direction in IT have you chosen?'. This question is also needed for grouping by IT direction.

5) 'What factors influenced the choice of your specialty in IT?'. This question is needed to get a sample of the factors that most influence the choice of IT specialty.

6) 'What skills do you think are most important to advance in your career in IT'. Different specialties are responsible for different areas of responsibility for business and product development, so it is important to understand what skills enable different specialists to stay afloat.

7) 'Have you had any professional transitions to other areas within IT? If yes, why?'. In the IT sphere, it often happens that employee from development move to managerial positions, or to lead positions. This question is also intended to group answers.

Furthermore, the SLR was conducted as the synthesis of research papers is transparent and must be documented at each stage. In addition, The SLR is essential when defining the subject area to comprehend its existing state and when context-specific research is needed. The PRISMA method in SLR follows three stages: Identification, Screening, and Inclusion.

1) Identification. This phase begins with defining keywords, these keywords were used to search for publications in popular search engines. The Boolean search strategy used the keywords Career Guidance and Machine Learning as expansion and acronyms and keywords like Career Framework, ICT choice, and Recommender system competencies using the OR functionality between keywords and AND functionality within keywords. The publications included journal articles, conference papers, and books. The language of the publications was limited to English. For the date of publications, the last 5 years were selected, but for those publications that tell why and how people choose a career path, the publications and books earlier than 5 years were taken.

2) Screening. During the screening phase, documents that did not meet the search context were filtered through the title, abstract, and keywords. Screening involved multi-stage filtering using keywords, abstracts, journals, and full-text articles. Out of n = 150 records, this yielded n = 100 records that discussed the application of ML and AI in career guidance and how employers choose a career path. After reviewing the literature, n = 42 records that did not satisfy the search criteria were removed.

3) Inclusion. Finally, n = 58 records were considered. Relevant articles from the database and other articles through snowballing references were considered for the study.

The inclusion-exclusion criteria applied in this study, as outlined in Table 1.1, were pivotal in refining the selection of articles and ensuring the relevance of the material to the research objectives. In particular, the focus was on studies that explored the intersection of career counselling and machine learning, along with frameworks for career guidance and competency-based education

Table 1.1 – Inclusion-Exclusion criteria

S.no.	Criteria	Include	Exclude
1	Topics	Topics related to Career Counselling and Machine Learning; Career counselling framework; Competency-based education;	Topics that are not related to the research context
2	Date	Most of the research on the subjects mentioned above was published in 2019 or later	Studies not conducted on topics based on the search context
3	Main source	The studies are listed in engineering, management, and accounting journals, followed by psychology and social sciences journals	Studies from other journals
4	Geographic location of the study	Not specific to any location	Non-relevant studies from any geography were not considered
5	Language	English language studies were considered	Studies in other languages were not considered

Articles that diverged from these topics were excluded to maintain the research's alignment with the objective. For instance, the date criterion ensured that the majority of studies considered were published after the 2019 year, reflecting the latest advancements in the field, with earlier works included only if they addressed core questions about career choices. The study prioritized engineering, management, psychology, and social sciences journals, while articles from irrelevant disciplines were excluded. The geographical location of studies was not a limiting factor, yet non-relevant regional studies were disregarded. To ensure consistency in analysis, only English-language publications were considered (Table 1.1). These criteria helped to systematically narrow the selection to relevant sources and maintain the study's focus.

Moreover, Table 1.2 presents a detailed review of the authors whose work contributed to the primary areas of focus for this study. These collective studies form the backbone of the literature analyzed in this systematic review, ensuring a comprehensive exploration of the themes central to career development and guidance systems.

Table 1.2 – Inclusion-Exclusion criteria

Area of focus	Authors
Competence-based framework for job-seeking	[1], [5], [6]
Career trajectory	[2], [7], [8], [9], [10], [11], [12]
Career systems	[1], [2], [3], [13], [14], [16], [17]

Furthermore, there is a distinct upward trajectory in the number of publications focused on career guidance and competency-based education employing machine learning in recent years (Figure 1)

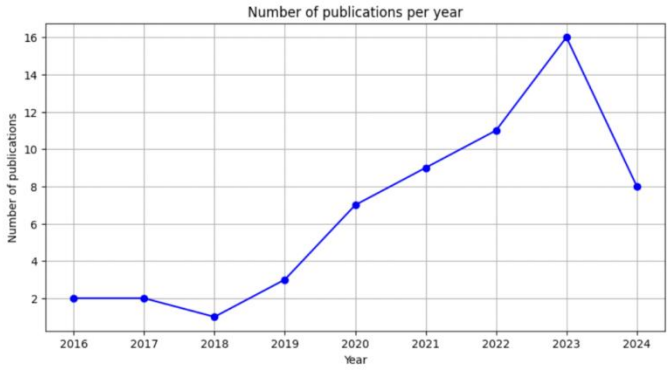

Figure 1 – The number of publications in each year

This pattern indicates growing interest and acknowledgement of the significance and potential of ML in this field. Notably, from 2016 to 2024, there is a steady increase, with a remarkable peak observed in 2023.

Table 1.3 shows that machine learning algorithms employed in different papers offer valuable insights into the current practices and preferences of the research community concerning recommendation and career-guiding systems. The data shows that machine learning techniques are applied in many ways, with Random Forest and Decision Tree algorithms being the most used. This implies that ensemble methods and decision-based procedures are strongly preferred because of their interpretability and resilience. K Means Clustering and KNN also show up frequently, suggesting that career recommendation systems extensively use clustering and instance-based learning techniques.

Table 1.3 – Type of ML algorithms used in the publications

Type of ML Algorithm	Publications
KNN	[7]
K-Means Clustering	[3], [5], [14]
Random Forest	[1], [5], [13], [16]
Decision Tree	[1], [2], [3], [13], [14], [15]
Naïve Bayes	[17]
Reinforcement Learning	[8]

Although less popular, Naive Bayes and Reinforcement Learning are significant niches where probabilistic and sequential decision-making techniques are used. The extensive application of these algorithms in numerous studies highlights the adaptability and effectiveness of machine learning in handling challenging issues in career counselling, demonstrating the approaches' suitability for a range of datasets and goals. This variety also demonstrates the dedication of the research community to investigating and verifying various methods to improve the precision and applicability of career suggestions, ultimately leading to more individualized and successful assistance for people.

Results. The analysis of 59 publications illustrates the profound impact of machine learning (ML) on career guidance, particularly within the realm of competency- based education.

- Competency-Based Framework. These studies demonstrate how ML algorithms can construct detailed competency frameworks tailored for job seekers. By analyzing vast datasets that include job descriptions, required skills, and successful career trajectories, ML models can identify the key competencies necessary for various roles. This targeted approach facilitates a more efficient matching of individuals' existing skillsets with suitable job opportunities, enhancing the precision of career guidance. Studies by [1] and [5] demonstrate how ML can analyze vast datasets, including job descriptions and successful career trajectories, to identify key competencies necessary for various roles. This approach enhances the precision of career guidance by more efficiently matching individuals' skill sets with suitable job opportunities. By leveraging ML, these frameworks offer highly accurate and personalized career advice, adapt quickly to new data, and provide insights that are both current and relevant ([1]; [5]). The integration of ML in constructing competency-based frameworks marks a significant advancement in career guidance. By providing precise, efficient, and adaptable frameworks, ML enhances the ability to align individual competencies with job market demands, ultimately aiding job seekers in navigating their career paths more effectively.

- Career Trajectory Prediction. Research on career trajectory prediction leverages machine learning to forecast potential career paths by analyzing an individual's academic history, work experience, and personal interests. Study by [7], along with ten additional studies, emphasizes the capability of ML models to integrate these diverse data points, thereby predicting careers where individuals are likely to excel and find satisfaction. This predictive power helps individuals make informed decisions about their professional futures by aligning their career choices with their strengths and preferences. ML's ability to process and analyze vast amounts of data means that these predictions are highly personalized and can adapt to new information over time, providing ongoing, relevant career guidance. This approach not

only aids in matching individuals to suitable job opportunities but also enhances the overall efficiency of the career guidance process by ensuring that recommendations are both accurate and tailored to individual needs ([7]).

- Intelligent Career Systems. The development of intelligent career guidance systems are a focal point in the research, with 29 studies, including those by [1], [3], examining their efficacy. These systems utilize advanced machine learning (ML) techniques such as content-based filtering and collaborative filtering. Content-based filtering recommends careers and educational programs by analyzing the attributes of available opportunities and matching them with the user's profile. Conversely, collaborative filtering draws on the preferences and experiences of similar users to make recommendations. These intelligent systems provide personalized and dynamic career advice, significantly improving the user experience by tailoring guidance to individual needs and preferences. This tailored approach ensures that users receive recommendations that are not only relevant but also adaptive to their evolving career paths, thus enhancing the overall effectiveness and user satisfaction of career guidance services ([1]; [3]).

- Focus on Machine Learning. While the bulk of the research emphasizes ML, there are also explorations of non-ML methods for career guidance. However, ML remains the predominant approach due to its ability to handle complex and large datasets, delivering highly personalized and accurate career advice. ML's capacity to bridge the gap between individual competencies and job market requirements underscores its transformative potential in this field. [6] provide a notable example of such research with their study on the essential competencies of software professionals. Instead of using machine learning, their approach creates a cohesive competency framework by identifying critical abilities and competencies using conventional techniques including expert interviews and literature studies. While traditional approaches are still valuable for developing job competencies, using machine learning (ML) offers some clear benefits. ML algorithms are highly effective in handling complex and sizable datasets, which is essential for creating precise and all-encompassing career assistance systems. Machine learning (ML) may produce highly tailored suggestions by examining large amounts of data from job advertisements, educational backgrounds, and career histories. Furthermore, in contrast to conventional approaches, ML may provide personalized advice that considers each person's distinct profile, including their abilities, interests, and experiences. The practicality and usefulness of job recommendations are improved by this degree of customization. Furthermore, ML models can learn and adapt to new data, which guarantees that career counselling is current with both individual development and the most recent developments in the labor market. Compared to static older approaches, this dynamic updating capability is a considerable improvement. Moreover, machine learning (ML) can considerably close the skills gap between workers and employers. ML helps job searchers identify employment that is well-aligned with their talents by precisely mapping a person's competencies to open positions. This leads to an increase in job satisfaction and career success.

Discussion. The primary focus of this systematic literature review (SLR) was to explore how ML can be leveraged to personalize and optimize career guidance systems. The research aimed to develop a hybrid recommendation system combining content-based and collaborative filtering methods to enhance the accuracy and personalization of career and educational trajectory recommendations. The key objectives included examining the limitations of current career counselling methods, identifying gaps in ML-based recommendation techniques, and proposing an effective hybrid system for career guidance.

The SLR included the review of 59 publications, with a notable increase in research activity from 2016 to 2024, peaking in 2023. Several important themes emerged from the evaluated studies, including the fact that Random Forest and Decision Tree algorithms were widely utilized and highly regarded for their robustness and interpretability. Furthermore, it was shown that ML works well for creating comprehensive competency frameworks that match job market demands with individual skill sets. Furthermore, by combining academic, professional, and personal data, ML models showed a great deal of promise in predicting career pathways. Furthermore, sophisticated machine learning methods, like collaborative and content-based filtering, were successfully applied in intelligent career systems to provide dynamic and individualized career guidance.

The future plans include a survey to understand better how employees make career decisions at different stages of their lives, whether during their school years, during university, or after entering the job market. The survey will examine the factors influencing workers' career choices and how they arrived at their decisions. It will also provide insight into the decision-making processes and external influences that shape career paths in IT. By analyzing individual career trajectories and industry demand, the recommendation system will be expanded and refined, ensuring that it offers personalized recommendations and meets current and future market needs.

Many publications did not use a combined recommender system approach, which may be a sign that their system is one-sided and does not consider all factors. An ML model that combines methods to provide suggestions that can consider overall competency requirements, as well as other applicants' current market conditions, is one possible option.

The review's conclusions are consistent with earlier research emphasizing the expanding use of machine learning in customized career counselling. This study, however, emphasizes the advantages of hybrid recommendation systems, which integrate several ML techniques to improve suggestion accuracy and user satisfaction. This contrasts previous evaluations that might have concentrated on discrete ML techniques. A common understanding across studies is reflected in the consistency with which the importance of interpretability in machine learning models, including Random Forest and Decision Trees, is recognized. Reviewing previous research adds to the theoretical understanding of machine learning applications in career counselling by highlighting the potential of hybrid recommendation systems. The development of dynamic and personalized career advising systems has advanced significantly with the combination of content-based and collaborative filtering approaches. This review adds to the larger conversation on morally sound and practical applications of AI by highlighting the significance of interpretability and robustness in ML models.

Based on the empirical evidence about the efficacy of AI-driven career counselling, it is evident that the attainment of counselling objectives and the effectiveness of the AI tools employed are indicative of successful outcomes. The shown achievement provides evidence that AI can be widely used in the field of education across multiple nations.

Conclusion. The review of the 59 publications reveals several important conclusions and highlights key research gaps in the development and implementation of AI and ML systems for career guidance. One of the primaries conclusions are the promising role of AI in revolutionizing career guidance by providing data-driven insights and recommendations tailored to individual career paths. Study by [1] demonstrates the potential of AI to create more adaptive systems that align both with personal interests and market trends. However, despite this potential, significant gaps remain that need to be addressed. A major research gap is the limited extent of personalization in career guidance systems. While many frameworks and systems provide general career recommendations, very few offer deeply personalized pathways based on individual user data, such as evolving skills, real-time interests, or dynamic changes in the labor market [1]. Many systems fail to fully integrate user-specific factors, which limits their effectiveness in delivering individualized career support. This gap indicates the need for future research to focus on developing AI systems that can provide truly customized career recommendations that evolve as users progress in their careers.

Another gap is the lack of longitudinal studies that examine the long-term impact of AI-based career guidance systems. Many current studies, such as [3], present theoretical models or proof-of-concept systems, but do not explore their real-world application over extended periods. As a result, there is little empirical evidence on how effective these systems are in helping individuals achieve long-term career success or satisfaction. Future research should focus on evaluating the effectiveness of AI-driven systems in real-world settings and tracking users' career trajectories over time.

Additionally, the reviewed studies tend to focus on narrow fields or specific geographic locations, limiting the generalizability of their findings. For instance, [8] conducted research in specific industries or high-income countries, leaving out underrepresented sectors or developing economies. This geographic and sectoral bias creates a gap in understanding how AI systems can be tailored to different

industries or economic contexts. There is a need for broader research that expands into diverse fields and regions to make career guidance systems more inclusive and applicable across varying contexts.

Research also highlights gaps in linking competency-based education with the dynamic needs of the job market. While some studies discuss competency frameworks, such as [1] and [5], they often fail to integrate real-time market data to provide timely and relevant recommendations. Career guidance systems should be able to evolve with industry trends, ensuring that individuals continuously develop skills that are in demand. Furthermore, the concept of lifelong learning and how AI can assist individuals in upskilling throughout their careers is underexplored.

This thorough literature analysis highlights how ML and AI may transform job counselling. These tools are changing the way people choose their professional pathways by offering accurate, customized, and dynamic recommendations. To further improve the efficacy of career advising systems, future research should take an interdisciplinary approach, address ethical issues, and investigate novel applications of machine learning. Creating a hybrid recommendation system could lead to better job choices and higher user satisfaction, ultimately resulting in more informed and fulfilling career and educational paths.

The conclusions drawn from this assessment emphasize the necessity of further innovation and study in this area. Flexible career guidance will be more crucial as the workforce changes and new job pathways appear. Career advice systems based on ML and AI cannot only satisfy the needs of job searchers today but also foresee the future workforce's needs by tackling current issues and utilizing the advantages of ML and AI. As a result, people will be more prepared to manage their professional journeys successfully and have more satisfying lives at work.

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