AI-Powered Career Guidance: Personalizing Career Paths with Machine Learning

Shivangini Bihari[1], Md. Irfan Alam[2]

[1]Assistant Professor, Jharkhand Rai University, Ranchi, Jharkhand, India
[2]Associate Professor, Jharkhand Rai University, Ranchi, Jharkhand, India

Abstract - Choosing a career path is a crucial decision with lifelong implications. While traditional methods rely on self-assessment and external guidance, the emergence of AI and Machine learning has opened up a promising avenue for intelligent career guidance. This intelligent career guidance, powered by AI and machine learning models, not only suggests suitable career options but also provides deeply personalized insights by analyzing individual skills, interests, and personalities. This paper aims to inspire optimism about the vast potential of machine learning in intelligent career guidance, discussing various algorithms, data requirements, and the challenges we must overcome.

Keywords: Artificial Intelligence, Machine Learning, Career counseling, Career guidance

1. Introduction

AI, ML, and DL algorithms can enhance traditional career advising services.AI-based career guidance algorithms, in particular, are gaining popularity for their ability to provide individuals with personalized career recommendations. These algorithms use data and machine learning techniques to analyze an individual's skills, interests, and values. They then match these with career options that are a good fit, considering data such as job market trends and salary information to provide users with a comprehensive overview of potential careers. By offering personalized recommendations based on unique skills, interests, and values, AI-based career guidance algorithms make exploring career options more efficient and effective.

The career landscape is evolving rapidly, making it increasingly challenging for individuals to navigate the diverse options available. Traditional career guidance methods often rely on self-assessment tools and consultations with career counselors. However, these methods have significant limitations, including subjective assessments, limited information access, and potential biases. The need for a more practical approach is urgent, and machine learning offers a novel solution to address these challenges and provide personalized career guidance.

Career counseling is not a solitary journey but a collective effort that involves knowing and understanding oneself and one's capabilities and abilities. It is a time when every student receives guidance from various circles (parents, teachers, other educational specialists, etc.) and accordingly decides about which course they want to join.

Career guidance is a crucial process that assists individuals in identifying their career goals and pursuing the right path to achieve them. It plays a pivotal role in helping individuals realize their potential and make informed decisions about their future. Our study focuses on analyzing and understanding the various approaches to career recommendation and guidance systems. The collective approaches were categorized into five broad classes: (i) Machine learning, (ii) Recommendation systems, (iii) Deep learning, (iv) NLP and (v) Chat bot Approach.

2. Literature Review

A. Machine Learning Algorithms for Intelligent Career Guidance

Several machine learning algorithms can be employed for intelligent career guidance; some of the commonly used algorithms include:

Adapa et al. [1] Employed supervised machine-learning techniques and recommended learning styles using VAK (Visual, Auditory, and kinesthetic) techniques. Participants were given 30 Self-assessment questions with multiple answer choices to determine their sensory acuity regarding VAK. There were 900 responses, which were converted to numeric values. Various machine learning algorithms were applied, including linear and logistic regression, Naïve

Bayes, LDA, KNN, SVM, CART, stochastic gradient boosting and Random Forest Classifier (RFC). The highest accuracy is given by Naive Bayes (63.37%), followed by SVM (61.34%).

The research by Casuat and Festijo [2] aims to identify inputs that are most important in predicting the employability signals of students. The dataset comprised nine attributes ranging from identifying inputs that are most important to predicting the general to identifying inputs that are most important to predicting appearance and body language, interview evaluation results, student performance rating, and general percentage average (GPA). SVM, DT, and RF are used for the prediction model, and SVM gives the highest accuracy (91.22%). For feature selection, univariate selection (US), principal component analysis (PCA) and recursive feature elimination (RFE) are employed and compared. PCA with SVM with SMOTE had the % accuracy of any combination, 93%. According to the results of the PCA, mental acuity, speaking style, the ability to express ideas, and self-confidence were the most influential elements affecting employment.

Joshi et al. [3] propose a system that is evaluated using a dataset containing 12 attributes and 700 plus records containing details like marks in SSC, the percentages in physics, maths and chemistry, and their intermediate marks. Three classifiers, namely Support Vector Machines (SVM), Random Forest and Decision Trees, are used, and their accuracies are compared to show that SVM gave the highest accuracy of 90.3%, followed by Random Forest at 88.3% and Decision tree at 86.53%.

Thomas et al. [4] Using eight approaches, predict students' careers in technology, commerce, and the humanities department. While creating the dataset, intellect quotient (IQ) and emotional quotient (EQ) factors are also considered. The paper compares the following algorithms: Naive Bayes, Decision Tree, Logistic Regression, AdaBoost, Multilayer Perceptron, and SVM with the RBF kernel. The algorithm was selected based on accuracy and time to get the result. The author further compares the accuracy of all the algorithms applied to different datasets in science, commerce, and the humanities. The author suggests feeding more real-time data in order to increase accuracy in the future.

Britto et al. [5] Base their research on graduate-level study. The algorithm for recommending courses considers students' GPAs and the subjects they scored well. Feedback from the students was taken in order to assess the system. The paper uses a neural network to recommend courses, which uses the concept of forward and backward propagation with gradient descent.

B. Recommendation Systems for Intelligent Career Guidance

Li et al. [6] focus on designing an AI-based system that provides personalised solutions and long-term companionship in finding "Helping individuals discover a career path they are passionate about and enhancing their vocational skills." The proposed system makes use of a "Content-based recommendation algorithm and incremental learning." Since The proposed framework comprises two main models: user and resource. It uses the cosine similarity algorithm to compare the two models, and then the Naive Bayes algorithm calculates the probability of personalized recommendation suitability.

Dossari et al. [7] Propose a career recommendation system trained on a dataset from a survey of 1707 IT employees in Saudi Arabia. Respondents were asked to rate 20 soft and technical skills as none, low, moderate, or high. The survey also included questions regarding their respondents' job titles, gender, specialization, and programming languages with which they are familiar. The job titles were grouped into three categories. The recommendation model was trained to recommend either of the three categories: analyst, developer and engineer. The model was trained using five machine learning algorithms: K-Nearest Neighbors (KNN), Decision Tree (DT), Gradient Boosting, Bagging meta-estimator, and XGBoost. XGBoost outperformed the other algorithms with an accuracy of 70.47%.

A system was proposed by Rashid et al. [8] that recommends careers for students in Computer Science. Data is extracted by scraping a career information website. The recommendation system is based on a content-based filtering method that takes a career ID (based on the user's preferred career choice) as input and produces results that are available career options based on the user's interests. The system's usability was tested using a system usability scale (SUS) with an average score of 81.25. A score more excellent than 68 indicates high usability.

Gugnani et al. [9] suggested a unique framework that uses text extraction techniques to generate personalised skill graph representations of candidate profiles. The proposed system utilises the concept of skills to generate skill graphs that can serve as the basis for career path suggestions. The authors concluded that such skill graphs, which record both spatial and temporal correlations, facilitate the generation of

accurate career path suggestions. The model takes the candidate's profile to create a skill graph using the skill data retrieved from the candidate's profile. The model also takes feedback and continuously improves using new data, using NLP concepts to understand the feedback.

Dutta et al. [10] aim to create a robust recommendation system connecting students seeking guidance with the most qualified professionals for their questions. The authors use the Career Village Competition Dataset on Kaggle and implement a data pipeline consisting of processes that include gathering data, preprocessing, implementing algorithms and their evaluation, and testing on sample data. The algorithms implemented include a neural network and LightFM Hybrid Recommendation model. The proposed LightFM algorithm achieved an AUC score of 91%.

C. Deep Learning for Intelligent Career Guidance

Kumbhar et al. [11] Built the Smart Career Guidance System with a chatbot that utilizes long- and short-term memory (LSTM) and recurrent neural networks (RNN). to put forth a clever model that uses hybrid deep learning techniques for career guidance. Natural language processing (NLP) and RNN LSTM are the foundations of our suggested hybrid deep learning algorithm.

Harsha et al. [12] implemented various prediction models to the sample data containing information about students' academic, technical, and interpersonal characteristics to obtain the result. They utilised five classification algorithms: ID3, CART (Classification and Regression Tree), Multi-Layer Perceptron (MLP), Random Forest and Neural Networks. CART gave the maximum accuracy of 95.24%.

Rao et al. [13] present the creation of an artificial neural network (ANN) model that uses the Myers-Briggs Type Indicator (MBTI) to predict a person's personality and use that information to guide career decisions, which can be a boon for career counsellors. The ANN model developed in the study could predict personality types based on the MBTI categorization with over 92% accuracy, sensitivity, specificity, and precision.

D. NLP for Intelligent Career Guidance

Khan et al. [14] propose an educational agent system for recommending resources, professional, personalized suggestions and guidance for interviews by building a multilingual virtual assistant with the addition of languages like English, Hindi, Marathi and Gujarati. The authors use

Google APIs to fine-tune data from sites like Reddit and Quora—the end user benefits from FAQ solving and recommendation of technology stacks based on skill sets.

Prabu et al. [15] Using machine learning, natural language processing (NLP), and data analytics, Prabu Approach analyzes extensive job and skill databases to provide tailored advice based on each user's interests and career goals. Our program makes use of these technologies to give users insights into emerging job trends and to help them make well-informed decisions, enabling them to stay ahead in their professional endeavors.

Harrouk *et al.* [16] Using data analytics, machine learning, and natural language processing (NLP), Prabu Approach analyzes extensive job and skill databases to provide customized advice based on the interests and professional goals of each user. Through the provision of insights into emerging job trends and the facilitation of well-informed decision-making, our program leverages these technologies to assist users in staying ahead of the curve in their career paths.

Ouassil et al. [17] Using NLP and machine learning techniques can automatically classify career guidance questions students ask. Based on their abilities and skills, they present a system for categorizing student questions about postsecondary education and career options. Machine learning and natural language processing are employed by the system. They preprocessed the textual content, gathered and labeled a dataset, and then extracted features using the TF-IDF statistical representation. For classification, they put into practice four supervised machine learning algorithms: support vector machines (SVM), logistic regression (LR), decision trees (DT), and K-nearest neighbors (KNN). To make the system better, they also used a feature selection method. With the logistic regression classifier, the highest accuracy of 85.66 percent was attained.

E. Chatbot Approach for Intelligent Career Guidance

Rangnekar et al. [18] Propose a career counselling system that integrates career guidance with artificial intelligence. It comprises a chatbot and a career guidance system that utilises decision trees and Support Vector Machines (SVM) to classify users based on their responses to a questionnaire. The questionnaire was composed of questions regarding the users' skills and interests and was curated separately for different domains.

Nair et al. [18] implement the approach of using chatbots for AI career counselling. The authors mention that the chatbots can receive and remember user inputs, which helps them grow as more and more responses are received. The Rasa framework has been used to implement the chatbot, built on data collected by scraping—TheStudentSuccessapp.com website created by nSmiles. A psychometric engine powers the chatbot, which generates intermittent and final reports containing the list of courses and college recommendations based on the user's interests.

Nguyen et al. [20] built a personalised career counselling chatbot named "ITCareerBot" to address the challenge of quickly changing environments in the IT industry. A chatbot framework is built based on CAK (context-aware knowledge model) and recommendation methodology by collecting data from professional social networking platforms and online education platforms through which the chatbot matches current employee skills and interests.

Sharma et al. [21,22] he suggested system has been designed to accommodate this feature, allowing students to freely express themselves without fear of retribution or bias. In order to answer the student's questions and resolve any doubts or issues, the chatbot will converse with them about both their personal and professional lives and it will remain secured[23]. The student will use text input to submit their query, and the bot will produce an output that best matches their interests. The students may have an option to less stressful in-person mentoring sessions with the help of the suggested system.

3. Conclusion

Compared to traditional systems, AI systems are more efficient, cost-effective and accessible. The purpose of this paper is to present a review of studies that emphasize AI-based career recommendation and guidance systems. Our analysis focuses on the various approaches used by researchers and the algorithms employed in each of those approaches. The broad approaches are machine learning, recommendation systems, deep learning, NLP, and Chatbot. It was noted that most recommendation systems employ machine learning and deep learning algorithms to compute the results.

Reference

1   Adapa, S., Gandi, N., Alekya, V., & Lakshmi Durga, G. (2021). Learning Style Recommender System Using VAK Technique and Machine Learning. In Communication Software and Networks: Proceedings of INDIA 2019 (pp. 187-199). Springer Singapore.

2   Casuat, C. D., & Festijo, E. D. (2020, February). Identifying the most predictive attributes among employability signals of undergraduate students. In 2020 16th IEEE international colloquium on signal processing & its applications (CSPA) (pp. 203-206). IEEE.

3   Joshi, K., Goel, A. K., & Kumar, T. (2020, July). Online career counsellor system based on artificial intelligence: An approach. In 2020 7th International Conference on Smart Structures and Systems (ICSSS) (pp. 1-4). IEEE.

4   Thomas, A., Varghese, A. K., Alex, P. L., Mathews, B. J., & Dhanya, L. K. (2022, March). Analysis of Machine Learning Algorithms for Predicting the Suitable Career After High School. In Proceedings of Third International Conference on Communication, Computing and Electronics Systems: ICCCES 2021 (pp. 89-105). Singapore: Springer Singapore.

5   Britto, J., Prabhu, S., Gawali, A., & Jadhav, Y. (2019, November). A machine learning based approach for recommending courses at graduate level. In 2019 International Conference on Smart Systems and Inventive Technology (ICSSIT) (pp. 117-121). IEEE.

6   Li, X., Zhang, J., Wan, J., Zhang, J., Zhu, C., Guo, N., & Xu, H. (2019, June). Implementation of system for college students' career planning based on user interest model. In Journal of Physics: Conference Series (Vol. 1237, No. 2, p. 022067). IOP Publishing.

7   Al-Dossari, H., Nughaymish, F. A., Al-Qahtani, Z., Alkahlifah, M., & Alqahtani, A. (2020). A machine learning approach to career path choice for information technology graduates. Engineering, technology & applied science research, 10(6), 6589-6596.

8   Rashid, A. H. A., Mohamad, M., Masrom, S., & Selamat, A. (2022, September). Student Career Recommendation System Using Content-Based Filtering Method. In 2022 3rd International Conference on Artificial Intelligence and Data Sciences (AiDAS) (pp. 60-65). IEEE.

9   Gugnani, A., Kasireddy, V. K. R., & Ponnalagu, K. (2018, November). Generating unified candidate skill graph for career path recommendation. In 2018

IEEE International Conference on Data Mining Workshops (ICDMW) (pp. 328-333). IEEE.

10 Dutta, I., Shah, A., Safa, M. M., & Jayavel, K. (2022, January). Building a recommendation system for career advice for students from professionals. In 2022 International Conference on Computer Communication and Informatics (ICCCI) (pp. 1-10). IEEE.

11 Kumbhar, V. R., Maddel, M. M., & Raut, Y. (2023, March). Smart model for career guidance using hybrid deep learning technique. In 2023 1st International Conference on Innovations in High Speed Communication and Signal Processing (IHCSP) (pp. 327-331). IEEE.

12 Harsha, B., Sravanthi, N., Sankeerthana, N., & Suneetha, M. (2022, July). Career Choice Using Machine Learning Algorithms. In 2022 International Conference on Inventive Computation Technologies (ICICT) (pp. 171-176). IEEE.

13 Rao, A. S., Kamath, B. S., Ramya, R., Chowdhury, S., Shreya, A., & Pattan, R. K. K. (2020). Use of artificial neural network in developing a personality prediction model for career guidance: A boon for career counselors. International Journal of Control and Automation, 13(4), 391-400.

14 Khan, A., Masrani, V., Ojha, A., & Hamdare, S. (2021). Personal Assistant for Career Coaching. In Congress on Intelligent Systems: Proceedings of CIS 2020, Volume 1 (pp. 475-485). Springer Singapore.

15 Prabu, P.M., SamyukthasriR., M., & Saranya, R. (2023). Detection of Skin Cancer using Convolutional Neural Network. International Journal of Advanced Research in Science, Communication and Technology.

16 Harrouk, A.I., & Barbar, A. (2018). A Psycholinguistic Approach to Career Selection Using NLP with Deep Neural Network Classifiers. 2018 IEEE International Multidisciplinary Conference on Engineering Technology (IMCET), 1-6.

17 Ouassil, M., Errami, M., Rachidi, R., Hamida, S., Cherradi, B., & Raihani, A. (2023). A Classification System of Career Guidance Questions Based on Natural Language Processing and Supervised Machine Learning Techniques. 2023 3rd International Conference on Innovative Research in Applied Science, Engineering and Technology (IRASET), 01-08.

18 Rangnekar, R. H., Suratwala, K. P., Krishna, S., & Dhage, S. (2018, August). Career prediction model using data mining and linear classification. In 2018 fourth international conference on computing communication control and automation (ICCUBEA) (pp. 1-6). IEEE.

19 Nair, A., Padhy, I., Nikhil, J. K., Sindhura, S., Vandana, M. L., & Vijay Krishna, B. S. (2022). AI-based career counselling with chatbots. In Intelligent Sustainable Systems: Proceedings of ICISS 2022 (pp. 599-612). Singapore: Springer Nature Singapore.

20 Nguyen, D. C., Dinh, N. H. D., Pham-Nguyen, C., Le Dinh, T., & Nguyen Hoai Nam, L. (2022, November). Itcareerbot: A personalized career counselling chatbot. In Asian Conference on Intelligent Information and Database Systems (pp. 423-436). Singapore: Springer Nature Singapore.

21 Sharma, M., Kumari, A., & Jyotsna (2023). AI-Based Deep Learning Chatbot for Career and Personal Mentorship. 2023 IEEE 3rd International Conference on Technology, Engineering, Management for Societal impact using Marketing, Entrepreneurship and Talent (TEMSMET), 1-6.

22 Bihari, S., & Alam, M. I. (2025, July). Leveraging Recommender Systems for Course Selection. In Proceedings of the International Conference on Recent Advances in Artificial Intelligence for Sustainable Development (RAISD 2025) (Vol. 196, p. 333). Springer Nature.

23 Alam, M. I. Securing Cloud Data with DNA and RNA-Based Cryptographic Algorithms: A Python Implementation.