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Personalized Abroad University Recommender System: A Survey

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ABSTRACT: This paper reviews on sophisticated recommendation system leveraging machine learning and deep learning techniques to assist prospective students in selecting suitable universities for pursuing higher education abroad mostly in US. The system incorporates critical admission criteria such as IELTS score, GRE score, TOEFL score and UG scores to provide personalized recommendations. This model utilizes a combination of neural networks and advanced algorithms and also machine learning techniques to analyse and weigh the significance of each input factor, offering effortless and data-driven approach to university suggestions. Through extensive training on diverse datasets, the system aims to enhance accuracy and relevance, ensuring that recommendations align closely with individual academic profiles. This recommendation system holds promise for optimizing the decision-making process for students, contributing to informed choices and successful academic pursuits.

KEYWORDS: University Recommendation System; Deep Learning Techniques; Machine Learning; Higher Education Abroad; Admission Criteria, Personalized Recommendations.

I.INTRODUCTION

In the dynamic landscape of higher education, the selection of an academic institution has evolved into a pivotal decision for students aspiring to pursue education abroad. This paper introduces a state-of-the-art recommendation system crafted to aid international students in their quest for the ideal university. This system aims to revolutionize the traditional approach to university selection by providing tailored and nuanced recommendations [1]. Figure1. shows the work flow of Machine Learning and Deep Learning.

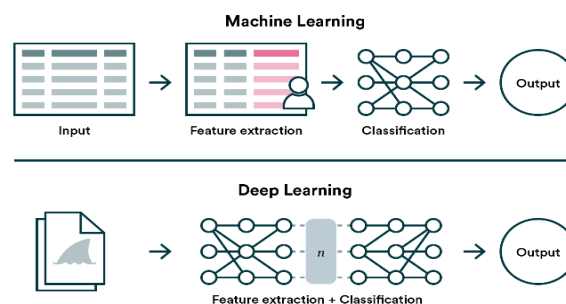


Fig. 1. Work flow of Machine Learning and Deep Learning

Amidst the increasing demand for global education, the necessity for a robust decision-support system becomes crucial. The recommendation system outlined here integrates key admission criteria, such as IELTS score, GRE score, TOEFL score, and UG scores, offering a comprehensive evaluation of prospective students' academic profiles [2]. Its utilization of a sophisticated deep learning model, seamlessly integrating neural networks and advanced algorithms. This intricate fusion enables a meticulous analysis and weighting of each input factor, presenting a data-driven methodology for suggesting universities.

A notable feature of this system is its rigorous training on diverse datasets, enhancing its capability to provide recommendations with heightened accuracy and relevance. The system endeavours to address the unique needs and preferences of each aspiring student. In essence, this recommendation system holds the promise of optimizing the decision-making process for international students, empowering them to make well-informed choices that set the stage for successful academic pursuit.

II.LITERATURE SURVEY

Yun Wu [1] proposed the introduction of personalized recommendation technology based on deep learning algorithms into online learning platforms to address data representation and mining needs. Introduced a feature-weighted optimization recommendation model that considers dynamic changes and adjusts factors affecting their needs accordingly. Solved multi-objective functions to obtain personalized learning resource recommendation sequences.

Ramkishore Swaminathan, Jeo Manley, Swetha Krishnakumar [2] explored the effectiveness of K-Nearest Neighbor, Support Vector for recommending the top 10 universities for aspiring graduate students. Conducted model performance analysis and summarized accuracy results and selected the Support Vector Machine as the most effective model for university recommendations.

Sakshi Shetty, Prishita Shrivastava, Aditi Bhonsle, Prof. Ragini Mishra [3] highlighted that the Featured Weighted and KNN algorithms aim to provide the most appealing graduate or undergraduate colleges for each input. Implemented the K-Nearest Neighbor algorithm for recommending graduate universities and a feature-weighted algorithm for undergraduate universities.

Xiangnan He, Liqiang Nie, Lizi Liao, Hanwang Zhang [4] explored neural network architectures for collaborative filtering. Developed a general framework called NCF (Neural Collaborative Filtering). Proposed three instantiations within the NCF framework: GMF (Generalized Matrix Factorization), MLP (Multi-Layer Perceptron), and NeuMF. Designed the framework to be simple and generic, providing a guideline for developing deep learning methods for recommendation.

Chuhan Wu, Fangzhao Wu, Yongfeng Huang [5] aimed to contribute rich insights for extending the frontier of the personalized news recommendation field. Explored different core modules of personalized news recommenders, including the technologies involved.

Dongjin Hou [6] proposed a recommendation model based on DAE (Denoising Autoencoder) and LSTM (Long Short-Term Memory) for personalized book recommendations in university libraries. Implemented LSTM to enhance DAE by allowing the model to extract temporal characteristics from the data. Utilized Softmax for the direct recommendation of books to users.

Yezi Zhang [7] conducted analysis to identify data and classification errors in content delivery related to music features. Advised the model on optimization strategies based on the identified errors. Evaluated the content-based convolutional neural network recommendation algorithm and highlighted its advantages.

Qing Wan and Lin Ye [8] proposed a hybrid convolutional neural network model for employment recommendation of college students. Improved the activation function, pooling strategy, and loss function in the algorithm to enhance the model prediction quality. Demonstrated a nearly 15% higher recall rate than the DNN model. Established the algorithm's effectiveness in improving the quality of human resources recommendation.

Yunxia Zhou and Lei Li [9] has proposed method that utilized different types of teaching materials to guide and inspire students, aiming to enhance the teaching effect and increase students' interest in classes. The results indicated that the proposed method had a longest recommendation time of 4.5 minutes, an average recall rate of 95.18%, an average precision rate of 97.2% thus signifying its positive impact on college mental health education.

Jingdong Liu, Won-Ho Choi and Jun Liu [10] identified the issue of information overload in accessing movie content and emphasized the importance of recommendation systems in addressing this problem. Highlighted the widespread use and commercial value of recommendation systems in well-known movie and video websites globally.

Author And Reference	Method	Dataset	Contribution	Findings
Aishwarya Nalawade, Bhavana Tiple [11] Paper Title (use style: paper title) (ijrte.org)	SVM (Support Vector Machine), KNN (K Nearest Neighbor)	Student's data, University Data Collection	Proposed a recommendation system for helping students select suitable graduate universities; Applied machine learning algorithms SVM and KNN for classification and similarity calculation.	Successfully recommended universities based on criteria such as GRE, TOFEL score, and other parameters; Acknowledged the importance of past records in decision-making for prospective graduate students.
Prof. Pooja Bhatt, Miss. Manali Shah, Miss. Priyanshee Soni [12] Paper217.pdf (ijarsct.co.in)	Decision Tree Regressor, Random Forest Regressor, Linear Regression, KNeighbors Regressor, Multinomial NB, Support Vector Classifier.	AdmissionPredict	Developed a comprehensive recommender system for higher studies abroad using various machine learning algorithms; Considered multiple factors for decision-making and user interaction.	Highlighted the importance of features like GRE and TOEFL scores; Random Forest algorithm provided the best results in predicting admission chances.
Inssaf El Guabassi, Zakaria Bousalem, Rim Marah, Aimad Qazdar [13] https://doi.org/10.3991/ijoe.v17i02.20049	Supervised Machine Learning algorithms (Linear Regression, Support Vector Regression, Decision Tree Regression)	Graduate Admission 2	1. Application of multiple Supervised Machine Learning algorithms. 2. Comparison and evaluation of algorithms using various metrics. 3. Determination of the most important parameter (CGPA) influencing admission.	1. Random Forest Regression identified as the most suitable algorithm. 2. CGPA found to be the most important parameter affecting admission.
Young-Jun Ko, Lucas Maystre, Matthias Grossglauser [14] ko101.pdf (mlr.press)	Recurrent Neural Networks (RNNs)	Brightkite7 (BK) and LastFM8 (LFM)	Proposes a collaborative sequence model based on RNNs to capture temporal and contextual aspects of user behavior in dynamic recommender systems.	Demonstrates the model's versatility and outperformance in music recommendation and mobility prediction tasks compared to static and non-collaborative methods.

<p>Huma Samin and Tayyaba Azim [15] Knowledge Based Recommender System for Academia Using Machine Learning: A Case Study on Higher Education Landscape of Pakistan IEEE Journals & Magazine IEEE Xplore</p>	<p>Probabilistic Topic Models (LDA and ATM)</p>	<p>PakScholarScan</p>	<p>Development of the ScholarLite recommender system for academia.</p>	<p>Identified research themes in Computer Science faculty resumes using LDA and ATM.</p>
<p>Alcina Judy, Kesha D'cruz, Janhavi Kathe, Kirti Motwani [16] IRJET-V7I41243.pdf</p>	<p>Collaborative Filtering, Content-Based Filtering, K-Means, Naïve Bayes.</p>	<p>Own Dataset</p>	<p>Proposed a recommendation system for higher studies using machine learning, integrating various algorithms for university recommendations.</p>	<p>KNN achieved the highest accuracy (91%) among KNN, SVM, and Linear Regression. The elbow method determined 3 clusters for K-Means. Naïve Bayes resulted in 124 correct predictions out of 195 total predictions. Content-based filtering displayed top 20 universities.</p>
<p>Haojie Zhang and Zhidong Shen [17] Information Free Full-Text News Recommendation Based on User Topic and Entity Preferences in Historical Behavior (mdpi.com)</p>	<p>NRTEH (News Recommendation based on Topic and Entity Preferences in Historical Behavior)</p>	<p>Bing News server logs from 16 May 2017 to 11 January 2018</p>	<p>Introduced NRTEH framework for CTR prediction.</p>	<p>Significant improvements over baselines (AUC: 2.6% to 11.4%, ACC: 3.3% to 12.4%) in news recommendation. Used contextual knowledge and latent topic classification for additional improvements.</p>

<p>Mahamudul Hasan, Shibbir Ahmed, Deen Md. Abdullah3 and Md. Shamimur Rahman [18] (PDF) Graduate school recommender system: Assisting admission seekers to apply for graduate studies in appropriate graduate schools (researchgate.net)</p>	<p>Recommender System using K-nearest Neighbor algorithm.</p>	<p>Academic records of successful graduate applicants from Bangladesh.</p>	<p>Developed a technique for grad school recommender system using data mining and machine learning techniques.</p>	<p>Recommender system calculates similarity based on weighted scores, aiding in choosing appropriate higher educational institutes for graduate studies abroad.</p>
<p>Devendra G. Ingale, Dr. R.R. Keole, Dr. A.P. Jadhao [19] fin_ijrmets1665483029.pdf</p>	<p>Collaborative Filtering, Deep Learning (Neutral Collaborative Filtering Algorithm)</p>	<p>Own Dataset</p>	<p>Proposed a user-based system for product recommendation using Python, PIL, pandas, and tkinter. Utilized Collaborative Filtering and Deep Learning.</p>	<p>Improved purchase rates by 70%, higher basket rates, more product views per visit, and 5x higher per-visit spend. Improved sales, revenues, and user satisfaction.</p>
<p>Yash Kadam, Yash Kadulkar, Vishwas Moolya, Shruti Agrawal [20] university-recommendation-system-for-abroad-studies-using-machine-learning (ijraset.com)</p>	<p>Recommender System, Random Forests, Decision Trees, XGBoost.</p>	<p>Yocket (web scraped)</p>	<p>Developed a recommendation system for graduate admission applicants using historical data of enrolled students. Factors considered: academic records, standardized test scores, university characteristics.</p>	<p>Provided personalized recommendations to help applicants choose the best-suited university. Achieved an accuracy of 81% using XGBoost.</p>

TABLE 1. Analysis of Techniques Discussed in Literature Survey

III.METHODOLOGY

Data Preprocessing:

In preparing the dataset for analysis, extensive data preprocessing techniques were employed to address anomalies and enhance the overall quality of the data. Firstly, irrelevant columns were removed to streamline the dataset. Null values were handled through either appropriate filling or deletion of corresponding rows to ensure data completeness. Additionally, whitespace removal and size reduction were implemented to improve computational efficiency. Specific attention was dedicated to standardizing admission criteria, such as GRE scores and GPA, where normalization techniques were applied to foster consistency. The cleansing process extended to the graduate dataset, addressing variations in GRE and GPA scores originating from different examination versions and point systems. Furthermore, the selection of input attributes for the learning model was carefully determined based on pre-experimental results and previous analyses. The presented data preprocessing framework lays a solid foundation for subsequent analyses, ensuring the dataset's accuracy, relevance, and uniformity.

Feature Extraction:

In the feature extraction phase, the dataset is loaded, and a model is created based on a predefined threshold for the column. The features selected for the model are 'IELTS', 'GRE', and 'TOEFL', which are crucial indicators for university admission mostly concentrating on US based universities. Fig. [2] shows flowchart of the recommendation system.

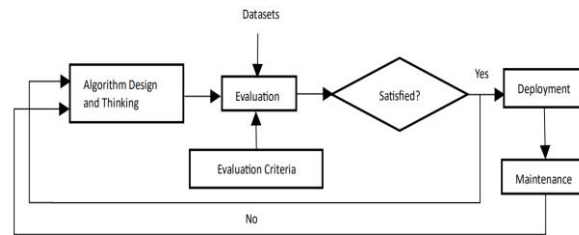


Fig. 2. Flowchart

Recommendation System Framework:

In the landscape of recommendation systems for abroad university selection, various classification techniques have been employed, with a significant emphasis on both traditional machine learning (ML) methods and deep learning (DL) architectures. The K-Nearest Neighbors (KNN) algorithm has stood out as a prevalent ML technique, particularly in collaborative filtering scenarios. By classifying items based on the preferences of users with similar profiles, KNN offers a straightforward yet effective approach to recommendation. It is worth noting, however, that KNN may be sensitive to outliers and may encounter challenges with new items or users, commonly known as the "cold start" problem. Fig. 3. Shows the machine learning system architecture.

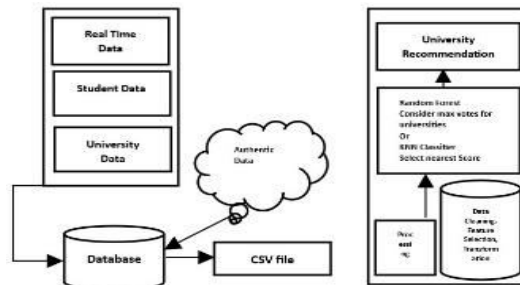


Fig. 3. Machine Learning System Architecture

On the deep learning front, Multi-Layer Perceptron (MLP) architectures have gained prominence in recommendation systems. Comprising multiple layers of neurons, MLPs demonstrate an ability to capture intricate non-linear relationships within the data. Despite their power, MLPs necessitate careful hyperparameter tuning and may be prone to overfitting, making their implementation contingent on dataset characteristics and experimental considerations. Fig. 4. Shows the deep learning system architecture.

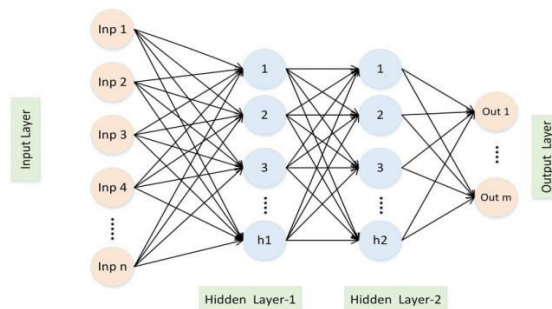


Fig. 4. Deep Learning System Architecture

Additionally, Convolutional Neural Networks (CNNs), traditionally associated with image-related tasks, have found adaptation in recommendation systems. By applying convolutional layers to capture spatial patterns in user-item interactions, CNNs excel in identifying local dependencies within sequential data. While effective, the application of CNNs requires careful consideration of model design to handle the inherent sequential nature of user-item interactions, and access to substantial datasets to unveil their full potential.

Moving on to activation functions, KNN, being non-parametric, does not involve the use of activation functions. However, in the realm of deep learning, activation functions play a pivotal role. For MLPs, Rectified Linear Unit (ReLU) functions are commonly employed in hidden layers, owing to their simplicity and effectiveness in capturing non-linearities. In the output layer, Sigmoid or Tanh activation functions are prevalent, depending on the nature of the recommendation task.

Optimizers are integral to the training process, ensuring convergence and efficiency. While KNN does not undergo iterative optimization, MLPs and CNNs rely on optimization algorithms. Adam, with its adaptive learning rate capabilities, and Stochastic Gradient Descent (SGD), a classic optimization algorithm, are frequently used for MLPs. In the case of CNNs, Adam and RMSprop (Root Mean Square Propagation) have proven effective in handling non-stationary distributions.

The amalgamation of traditional ML techniques like KNN and sophisticated DL architectures such as MLPs and CNNs presents a nuanced and comprehensive approach to recommendation systems for abroad university selection. Each technique brings its own strengths and considerations, offering a diverse toolkit for researchers and practitioners in the pursuit of personalized and accurate university recommendations.

IV.CONCLUSION AND FUTURE WORK

The current trend in university recommendation systems predominantly favours the application of traditional machine learning (ML) techniques, with K-Nearest Neighbors (KNN) being a prominent choice. In contrast, deep learning (DL) approaches, such as Multi-Layer Perceptrons (MLPs) and Convolutional Neural Networks (CNNs), are less frequently employed. This observation suggests that researchers and practitioners lean towards simpler and interpretable ML models like KNN for providing university recommendations.

A notable aspect worth highlighting is the reliance on datasets primarily sourced from the United States for training these recommendation models. This practice raises concerns about potential biases in the systems, as the recommendations might be skewed towards preferences and patterns specific to the U.S. educational landscape. Recognizing this limitation, it becomes imperative for future research endeavours to focus on acquiring more diverse and representative datasets. A more comprehensive dataset would better capture the nuances of various cultural and educational contexts, enhancing the generalizability of recommendation models worldwide.

In conclusion, the synergy between ML and DL methodologies offers an exciting avenue for further exploration and refinement in the field of university recommendation systems. By addressing the current reliance on U.S.-centric datasets and promoting inclusivity in data collection, researchers can contribute to more robust and unbiased models. This, in turn, will play a vital role in advancing the accuracy and reliability of recommendations, thereby facilitating well-informed decision-making for prospective international students seeking higher education opportunities.

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