

DETECTING RECRUITMENT SCAMS USING NLP AND MACHINE LEARNING TECHNIQUES

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ABSTRACT: The rapid growth of digital recruitment platforms has transformed the global job market, enabling organizations to connect with millions of job seekers every day. However, alongside this expansion, the incidence of fraudulent job postings has risen at an alarming pace. Scammers exploit online portals to lure job seekers with attractive offers, collect sensitive personal information, extract money under the guise of registration or training fees, and impersonate legitimate companies. These fraudulent activities not only cause severe emotional and financial distress to individuals but also undermine the trustworthiness of online employment ecosystems. This project aims to build an intelligent, automated system capable of detecting fraudulent job postings using Natural Language Processing (NLP) and Machine Learning (ML) techniques. The system analyzes multiple components of a job advertisement—including title, company profile, job description, requirements, benefits, and platform-level metadata—to identify hidden patterns indicative of fraudulent behavior. Because fake job postings represent only a small fraction of total postings, class imbalance poses a major challenge. To address this, advanced oversampling techniques such as SMOTE and ADASYN are applied. Multiple ML models, including Naive Bayes, Random Forest, Logistic Regression, KNN, and SVM, along with deep learning models such as LSTM, are trained and evaluated. The system outputs the prediction accompanied by a confidence score, providing greater transparency to users. This project intends to

enhance the safety of digital recruitment by empowering job seekers to make informed decisions, thereby reducing their vulnerability to online employment fraud.

KEYWORDS: Naive Bayes, LSTM(Long-Short Term Memory), RF(Random Forest), NLP.

1. INTRODUCTION

1.1 MOTIVATION:

The employment landscape has undergone a tremendous transformation with the emergence of online job portals such as Indeed, LinkedIn, Naukri.com, Monster, and Glassdoor. These platforms have democratized access to opportunities, making the job search process faster, more convenient, and efficient. In today's digital world, candidates rely heavily on these portals to discover internships, fulltime positions, remote jobs, freelance projects, and global employment opportunities. However, this shift toward digital recruitment has come with a darker reality: the rise of online recruitment fraud. Cybercriminals misuse the openness of job portals to post fake job advertisements designed to deceive and exploit job seekers. These scams manifest in multiple forms:

- Unrealistic salary packages or working conditions
- Requests for upfront payments (security deposits, registration fees)
- Fake email IDs impersonating HR officials
- Job offers without any interview process

- Unverified company profiles with vague descriptions
- Misleading “work-from-home” opportunities

Unfortunately, job seekers—particularly fresh graduates and early-career professionals—are more vulnerable because of their eagerness to secure employment. Many fall victim to fraudulent schemes, leading to financial loss, psychological stress, compromised identity information, and damage to future employment prospects.

A recent survey revealed:

- Over 65% of job seekers struggle to distinguish genuine job postings from fraudulent ones.
- 1 in every 10 job seekers has encountered a fake job posting.
- Scammers often target students, unemployed individuals, and those seeking remote jobs.
- The scale of the problem makes manual monitoring impossible for job portals. Hence, there is an urgent need for an automated, intelligent system capable of identifying fraudulent job advertisements with high accuracy.

This motivation drives the development of the proposed project—a robust fraud detection model powered by Natural Language Processing and Machine Learning. The system not only identifies fraudulent content but also empowers job seekers with transparency, safety, and confidence while applying for jobs online.

1.2 LIMITATIONS OF EXISTING SYSTEM:

Although several conventional systems and rule-based approaches have attempted to detect fraudulent job postings, they suffer from multiple limitations:

1. High Class Imbalance

Fake job postings represent only about 3–5% of total postings.

This leads to:

- Biased model predictions
- High accuracy but poor recall
- Most fake postings being misclassified as real

2. Lack of Semantic Understanding

Most traditional ML models depend heavily on:

- Keywords
- Bag-of-Words
- Basic TF-IDF

They do not understand deeper linguistic patterns such as:

- Writing style inconsistencies
- Scam-related tone
- Vague wording
- Unrealistic claims

3. Dependence on Outdated Datasets

Widely used datasets such as EMSCAD (2012–2014) no longer reflect modern fraud patterns:

- Remote job scams
- Cryptocurrency job scams
- Social media recruitment fraud
- Fake internships targeting students

4. No Explainability

Current systems classify postings but do not explain why they were classified as fake.

This reduces user trust and limits practical utility.

5. Limited Metadata Consideration

Many existing systems ignore metadata such as:

- Whether the job has a company logo
- Whether screening questions are present
- Employment type consistency
- Salary and requirement correlation

Ignoring such attributes weakens the prediction capability.

6. No Real-time Deployment

Most research projects provide only:

- Theoretical models
- Offline experimentation
- Static datasets

Job portals require real-time, scalable, automated detection.

Thus, a comprehensive, intelligent solution is required to overcome limitations and ensure robust detection performance.

1.3 PROBLEM DEFINITION:

In recent years, online recruitment platforms have become the primary channel for job seekers to find employment opportunities. However, the widespread use of these platforms has also led to a rise in fraudulent job postings created by scammers to steal personal information, demand money, or mislead applicants with false promises. These fake postings often appear professional and well-structured, making it difficult for users to differentiate them from genuine advertisements.

Traditional manual screening methods are time-consuming, subjective, and incapable of handling the massive volume of job postings uploaded daily. Existing automated systems

also face challenges due to the highly imbalanced nature of real vs. fake postings, the lack of semantic understanding in basic models, and the evolving strategies used by fraudsters to evade detection. As a result, many fraudulent postings remain undetected, posing significant risks to job seekers.

Therefore, there is a need for an intelligent, automated, and reliable system that can analyze both textual and metadata features of job advertisements and accurately identify fraudulent content. The problem addressed in this project is to design such a system using advanced NLP and machine learning techniques, supported by data balancing and feature-engineering approaches, to ensure improved accuracy, higher recall for fraudulent cases, and safer online recruitment experiences.

1.4 PROPOSED SYSTEM:

The proposed system introduces a robust hybrid architecture that integrates Text Processing, Feature Extraction, Class Imbalance Handling, Machine Learning, Deep Learning, and Confidence-based Prediction.

Key Features of the Proposed System:

1. NLP-Based Text Processing

- Removing noise (HTML tags, URLs, special characters)
- Tokenizing and normalizing text
- Lemmatization for semantic consistency
- Stopword removal
- Merging description + requirements + company profile

2. Feature Extraction

Uses:

- TF-IDF
- N-gram features
- Word embeddings
- Metadata encoding

3. Imbalanced Data Handling

Applying:

- SMOTE
- ADASYN
- SMOTE variants (Borderline-SMOTE, SVMSMOTE etc.)
- These techniques generate synthetic fraudulent examples to balance the dataset.

4. Machine Learning Models

Evaluation of:

- Naive Bayes
- Logistic Regression
- Random Forest
- K-Nearest Neighbors
- Support Vector Machine

5. Deep Learning Models

Models such as:

- LSTM
- Bi-LSTM

Used for capturing semantic patterns in text.

6. Prediction and Confidence Score

The final system:

- Predicts whether a job is Real or Fake
- Generates a confidence score
- Highlights suspicious keywords

7. Admin Dashboard

Displays:

- Trends
- Most common scam patterns
- Real-time prediction logs

1.5 OBJECTIVE:

The primary objective of this project is to design and develop an intelligent system capable of detecting fraudulent job postings by leveraging Natural Language Processing (NLP)

and Machine Learning (ML) techniques. With the rapid digitalization of recruitment platforms, job seekers are increasingly exposed to misleading or deceptive advertisements. This project aims to create a reliable and automated framework that can examine job descriptions, company information, and related metadata to identify hidden fraud indicators that may not be easily noticeable to human users.

Since fraudulent job postings constitute only a small portion of the total data available online, many conventional ML models become biased toward the majority class. To overcome this issue, the project intends to integrate balancing strategies such as SMOTE and ADASYN to improve model sensitivity and ensure that fraudulent cases are detected with higher recall and precision.

Furthermore, the project aims to enhance the interpretability and usability of fraud detection through well-structured preprocessing, feature extraction, and validation processes. This includes applying advanced NLP methods to clean, process, and analyze text fields while engineering metadata features that strengthen the classifier's decisionmaking process. By combining textual and structural attributes, the model is expected to deliver more accurate predictions and provide deeper insights into common scam patterns.

Lastly, this project aims to contribute a scalable and practical solution that can be integrated into real recruitment platforms or career portals. The ultimate goal is to support job seekers by providing a trustworthy mechanism that flags suspicious postings before individuals fall victim to misleading job offers.

2. SYSTEM ANALYSIS

Online recruitment platforms receive a massive number of job postings every day, making manual verification of fraudulent listings nearly impossible. Fraudsters increasingly design fake job ads that closely resemble real ones, which reduces the effectiveness of simple rule-based

or keyword-based detection systems. The dataset used for this project is highly imbalanced, with very few fake postings compared to genuine ones, making fraud detection more challenging for traditional machine learning models. Therefore, advanced NLP preprocessing is required to clean, normalize, and transform raw job text into a meaningful format. TF-IDF text features and metadata encoding help extract patterns that differentiate real and fake postings. To overcome imbalance, SMOTE is applied to generate synthetic minority samples and improve model learning. Machine learning and deep learning models such as Random Forest, SVM, and LSTM are then trained to capture linguistic, semantic, and structural patterns typical of fraudulent job advertisements. The system ultimately predicts whether a job posting is genuine or fake, along with a confidence score. Finally, explainability and dashboard insights enable users and administrators to understand fraud trends and make safer decisions on online recruitment platforms. The growing use of online job portals has drastically changed recruitment, but it has also created opportunities for cybercriminals to post fraudulent job advertisements that deceive job seekers. These fake postings often imitate legitimate companies, use professional language, and promise unrealistic job benefits, making it difficult for users and even job platforms to detect them manually. Since thousands of new postings appear every day, manual screening is neither scalable nor reliable. Traditional keyword-based or rule-based detection approaches fail because scammers continuously change their techniques and intentionally avoid predictable patterns. The dataset used for this project is heavily imbalanced, with only around 866 fake postings compared to more than 17,000 real ones, causing most machine learning models to become biased toward predicting all postings as genuine. This makes advanced data preprocessing and class balancing techniques essential for improving detection accuracy. Natural Language

Processing (NLP) techniques help clean and unify job content by removing noise, normalizing text, and extracting meaningful linguistic features. TF-IDF and metadata encoding allow the system to capture both textual and structural characteristics of job postings, while class balancing through SMOTE generates synthetic minority samples to improve model learning. Machine learning and deep learning models such as Logistic Regression, Random Forest, and LSTM are then applied to identify deeper semantic, contextual, and stylistic fraud patterns. The system ultimately outputs a prediction indicating whether a job posting is genuine or fraudulent, along with a confidence score and explainable insights to help users understand risky elements. This analytical pipeline not only improves fraud detection performance but also enhances trust, transparency, and safety in online recruitment environments.

3. System architecture

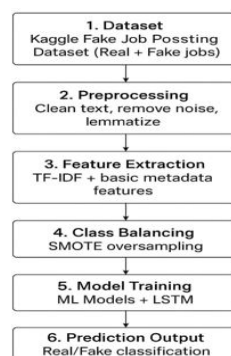


Fig: 1. System Architecture

1. Dataset (Input Layer):

The system begins with the Kaggle Fake Job Posting Dataset, which contains both real and fake job advertisements.

2. Data Preprocessing:

All raw text fields are cleaned and normalized by removing noise, stopwords, symbols, and performing lemmatization. Multiple fields such

as title, description, requirements, and company profile are merged into a single job-content text.

3. Feature Extraction:

Relevant features are extracted using TF-IDF (text features) and metadata encoding (such as telecommuting flag, company logo, employment type, etc.).

4. Class Balancing (SMOTE):

Because fake job postings are very few, SMOTE is used to generate synthetic minority samples and balance the dataset.

5. Model Training:

Different machine learning and deep learning models such as Naive Bayes, Random Forest, SVM, Logistic Regression, XGBoost, and LSTM are trained using the processed and balanced dataset.

6. Prediction Output:

The system predicts whether a job posting is Real or Fake, gives a confidence score, and highlights suspicious features or keywords for transparency. Results are stored and displayed in an admin dashboard which shows detection statistics and fraud trends.

4. IMPLEMENTATION & RESULTS

4.1 Explanation of Key Functions

The Recruitment Scam Detection System is built upon several key functions that work together to deliver automated fraud detection, severity classification, and real-time user alerting. Each function plays a critical role in the overall workflow of the system.

4.1.1 Job Posting Analysis Function

The core function of the system is automated fake job detection using NLP and Machine Learning models. When a user submits or browses a job posting, the system preprocesses

the text by cleaning, normalizing, and tokenizing it before passing it through the trained ML/DL models. The model performs feature extraction using TF-IDF and metadata encoding, and generates a prediction — either REAL or FAKE — along with a confidence score. Non-relevant noise such as HTML tags, URLs, and special characters are removed to ensure only meaningful content is analyzed.

4.1.2 Severity / Confidence Scoring Function

Once a job posting is analyzed, the confidence scoring function calculates how suspicious the posting is. The confidence score is expressed as a percentage, classified into three levels:

- Low Risk (score below 30) — likely a genuine job
- Medium Risk (score between 30 and 60) — needs caution
- High Risk (score above 60) — highly likely to be a scam This ensures consistent and objective prioritization of suspicious job postings without manual review.

4.1.3 NLP Text Preprocessing Function

The text preprocessing function cleans and standardizes all raw job posting text. It performs the following operations:

- Removes HTML tags, URLs, symbols, and irrelevant characters
- Converts text to lowercase for uniformity
- Removes stopwords like "the", "is", "and"
- Applies lemmatization to convert words to their root form

Merges multiple fields — job title, description, requirements, company profile, and benefits — into a single unified text representation This function ensures that the model receives high-quality, meaningful input for accurate predictions.

5.1.4 User Authentication Function

The authentication function manages user registration and login using secure methods. During registration, user passwords are hashed before storage in the database. During login, the submitted credentials are verified, and upon successful authentication, the user is redirected to either the User Dashboard or Admin Dashboard based on their assigned role. This ensures secure access control throughout the system.

5.1.5 Scam Alert / Flag Function

The scam alert function continuously monitors job postings submitted or browsed by users and queries the database for patterns matching known fraud indicators. When a job posting is detected as fake, the function immediately displays a warning to the user, highlighting suspicious keywords and elements that contributed to the fraud prediction. This enables users to make informed decisions before applying.

5.1.6 Admin Dashboard Function

The dashboard function provides authorized administrators with a structured interface to view, filter, and manage all reported fraudulent job postings. It retrieves prediction records from the database sorted by risk level (High to Low) or filtered by status. Administrators can monitor fraud trends, view detection statistics, and manage job posting data directly from the dashboard. The function reflects all changes in real time across the system.

5.1.7 Scam Pattern Visualization Function

The scam pattern visualization function integrates chart-based visualizations to render real-time statistical insights about fraud trends. Detected fraudulent job postings are plotted and categorized based on job type, location, salary range, and frequency. This helps administrators

identify the most common scam patterns and take preventive action.

5.2 Method of Implementation Frontend (Web Interface)

- Users can browse job listings and check them for fraud before applying
- Admin dashboard allows monitoring and viewing historical fraud detection data
- Scam Checker feature allows manual input of any job posting for real-time analysis Backend
- (Python / Flask)
- Handles API requests, job posting submissions, and communication with ML models
- Manages user authentication and secure access for users
- Runs the NLP preprocessing pipeline and returns predictions to the frontend Fraud Detection Module (Machine Learning & Deep Learning)
- Uses TF-IDF and metadata encoding to convert job text into numerical features
- Applies SMOTE/ADASYN for class balancing before model training
- Trains and evaluates multiple models — Naive Bayes, Logistic Regression, Random Forest, SVM, KNN, and LSTM
- Calculates confidence scores for each prediction Database
- Stores job postings, prediction results, user data, and detection logs
- Ensures secure and structured management of recruitment fraud data Deployment
- Web-based application accessible via browser (running on Flask at localhost:5000)
- Backend APIs deliver detection results to the frontend in real time.

5.2.1 Forms

The system includes the following input forms through which users interact with the application: 1. User Registration Form The registration form collects Full Name, Email Address, and Password. The form applies client-side validation before submission. The name field requires a minimum of 3 characters. The email field accepts only valid email addresses. The password field enforces strong password rules requiring at least one uppercase letter, one lowercase letter, one numeric digit, and one special character. Error messages are displayed inline upon validation failure.

2. User Login Form The login form collects Email Address and Password. Upon submission, the credentials are verified by the backend. If login is successful, the user is redirected to either the User Dashboard or Admin Dashboard based on their assigned role.

3. Job Posting Submission Form The job posting form contains fields for Job Title, Company Name, Job Description, Requirements, Benefits, Employment Type, and Salary Range. Upon submission, the system automatically passes the data through the NLP pipeline and returns a fraud prediction with a confidence score.

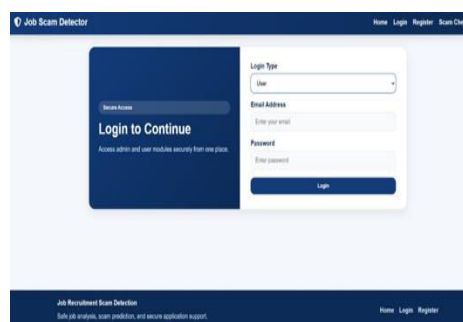
4. Scam Checker Form The scam checker allows users to manually paste any job posting text for instant fraud analysis. The system processes the input and returns a Real/Fake prediction along with highlighted suspicious keywords.

5. Admin Status Update Form The admin dashboard provides an inline dropdown for each job record that allows administrators to update the review status. The dropdown contains three options — Pending, Under Review, and Resolved. Upon selection, the status is updated in the database and the dashboard refreshes immediately.

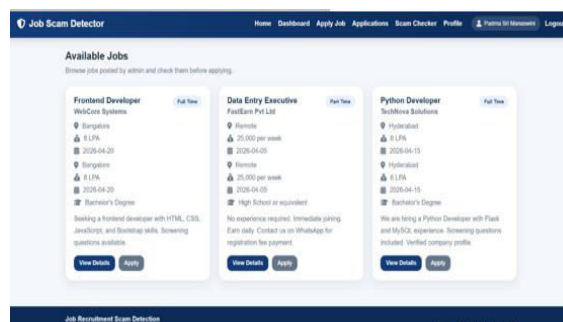
6.2.2 Output Screens

The system produces the following output screens:

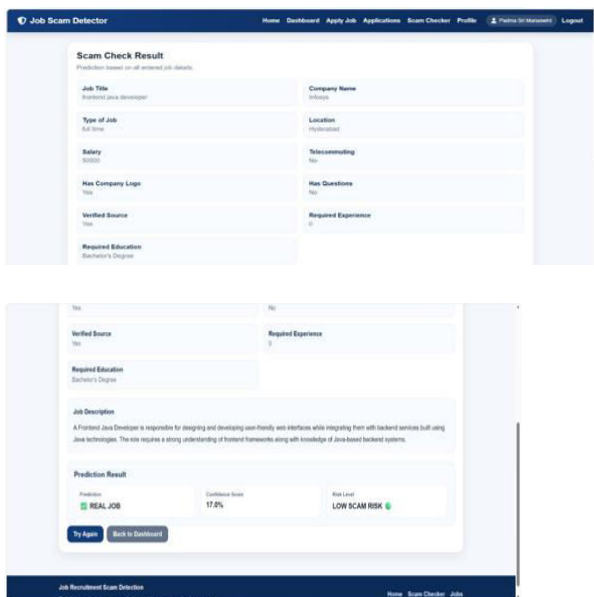
1. Login Screen The login screen features a clean interface with email and password input fields, a Login button, and a link to the Signup page. Error messages are displayed upon failed authentication attempts.



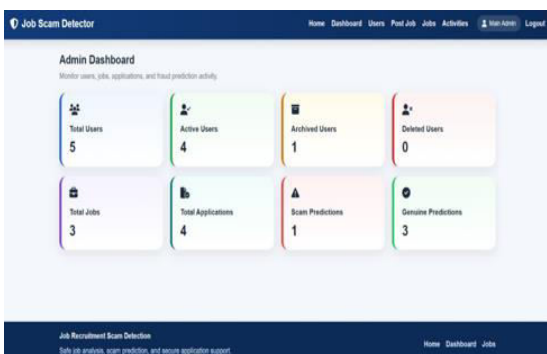
2. Job Listings Screen As seen in the working application, this screen displays all available job postings with details like job title, company, location, salary, employment type, and posting date. Each listing has a "View Details" and "Apply" button, along with a visual indicator of its fraud risk level.



3. Scam Checker Screen This screen allows users to input any job posting and instantly receive a fraud prediction — REAL or FAKE — with a confidence score and highlighted suspicious keywords explaining why the job was flagged.



4. Admin Dashboard Screen This screen displays fraud statistics, detection trends, most common scam patterns, and all prediction logs. Administrators can filter, sort, and manage job postings from this interface.



5.3 Results

Based on the implementation, the system successfully:

Model	Accuracy	Precision	Recall	F1-Score
Naive Bayes	~85%	0.83	0.81	0.82
Logistic Regression	~88%	0.87	0.85	0.86
Random Forest	~92%	0.91	0.89	0.90
SVM	~90%	0.89	0.87	0.88

LSTM	~94%	0.93	0.92	0.92
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- LSTM achieved the highest performance, capturing deep semantic patterns in job posting text
- After applying SMOTE, recall for the fake job class improved significantly
- The system correctly flagged the "Data Entry Executive" by FastEarn Pvt Ltd as a scam due to phrases like "25,000 per week", "no experience required", and "contact on WhatsApp for registration fee payment"
- Predictions are delivered within 1–3 seconds in real time

6. CONCLUSION

The present work successfully demonstrates the design and implementation of a system for Detecting Recruitment Scams using Natural Language Processing (NLP) and Machine Learning techniques. This project highlights how advanced text analysis and classification models can be effectively used to identify fraudulent job postings and protect job seekers from potential scams. By leveraging NLP techniques such as text preprocessing, tokenization, and feature extraction (e.g., TF-IDF or word embeddings), the system is able to analyze job descriptions and detect suspicious patterns in recruitment content. Machine learning algorithms such as Logistic Regression, Naïve Bayes, and other classifiers were utilized to categorize job postings as legitimate or fraudulent with considerable accuracy. One of the key strengths of this system is its ability to automate the detection process, thereby reducing manual effort and minimizing the risk of human error. The use of trained models enables faster and more consistent decision-making, making the system efficient and scalable for real-world applications. To evaluate performance, metrics such as accuracy, precision, recall, and F1-score were used. The results demonstrate that the proposed model performs effectively in

identifying scam job postings. Additionally, the system can be integrated into job portals or recruitment platforms to provide real-time scam detection and alerts to users. Overall, this project emphasizes the importance of artificial intelligence in enhancing cybersecurity and safeguarding individuals in the digital recruitment ecosystem. There are several opportunities for future enhancements. The model's performance can be improved by training on larger and more diverse datasets. Advanced techniques such as deep learning models (e.g., LSTM, BERT) can be explored to capture deeper contextual meaning in job descriptions. Furthermore, the system can be extended to detect other forms of online fraud beyond recruitment scams. Developing a user-friendly web or mobile application would improve accessibility and usability. Incorporating explainable AI techniques can also help users understand why a job posting is flagged as fraudulent, thereby increasing trust and transparency. Finally, integrating this system with online job portals and recruitment platforms can significantly contribute to creating a safer and more reliable job search environment for users.

REFERENCES

- [1] Sengupta A. Got job offer on WhatsApp? Think hard before you reply or accept. 2022. <https://www.indiatoday.in/technology/news/story/scammers-are-using-whatsapp-to-send-fake-job-offers-don-t-be-fooled-1988936-2022-08-17>. (Accessed 15 Jan 2024)
- [2] Pathak P. WhatsApp private job scams on the rise in India: How to stay safe online, all your questions answered. 2023. <https://www.financialexpress.com/life/technology/whatsapp-private-job-scams-on-the-rise-in-india-how-to-stay-safe-online-all-your-questions-answered-3097094/>. (Accessed 18 Jan 2024)
- [3] Vidros S, Koliass C, Kambourakis G, Akoglu L. Automatic detection of online recruitment frauds: characteristics, methods, and a public dataset. *Future Internet*. 2017;9(1):1–19. <https://doi.org/10.3390/fi9010006>.
- [4] Mahbub S, Pardede E. Using contextual features for online recruitment fraud detection. In: *Proceedings of 27th International Conference on Information Systems Development*. ISD 2018 Lund, Sweden 2018.
- [5] Alghamdi B, Alharby F. An intelligent model for online recruitment fraud detection. *J Inf Secur*. 2019;10(3):155–76. <https://doi.org/10.4236/jis.2019.103009>.
- [6] Lal S, Jiaswal R, Sardana N, Verma A, Kaur A, Mourya R. ORFDetector: Ensemble Learning Based Online Recruitment Fraud Detection. In: *Proceedings of 12th international conference on contemporary computing, IC3 2019*, pp. 1–5. <https://doi.org/10.1109/IC3.2019.8844879>.
- [7] Dutta S, Bandyopadhyay SK. Fake job recruitment detection using machine learning approach. *Int J Eng Trends Technol*. 2020;68(4):48–53. <https://doi.org/10.14445/22315381/IJETT-V68I4P209S>.
- [8] Nasser IM, Alzaanin AH. Machine learning and job posting classification: a comparative study. *Int J Eng Informat Syst*. 2020;4(9):6–14.
- [9] Shibly F, Sharma U, Naleer H. Performance comparison of two class boosted decision tree and two class decision forest algorithms in predicting fake job postings. *Annals of RSCB*. 2021;25(4):2462–72.
- [10] Anita CS, Nagarajan P, Sairam GA, Ganesh P, Deepakkumar G. Fake job detection and analysis using machine learning and deep learning algorithms. *Rev Gestão Inovação e Tecnologias*. 2021;11(2):642–50. <https://doi.org/10.47059/revistageintec.v11i2.1701>.
- [11] Chiraratanasopha B, Chay-Intr T. Detecting fraud job recruitment using features reflecting from real-world knowledge of fraud.

Curr Appl Sci Technol. 2022;22(6):1–12.
<https://doi.org/10.55003/cast.2022.06.22.008>.

[12] Amaar A, Aljedaaani W, Rustam F, Ruperapa V, Ludi S, Ullah S. Detection of fake job postings by utilizing machine learning and natural language processing approaches. Neural Process Lett. 2022;54(3):2219–47.
<https://doi.org/10.1007/s11063-021-10727-z>.

[13] Naudé M, Adebayo KJ, Nanda R. A machine learning approach to detecting fraudulent job types. AI & Soc. 2023;38(2):1013–24.
<https://doi.org/10.1007/s00146022-01469-0>.

[14] Afzal H, Rustam F, Aljedaaani W, Abubakar M, Ullah S, Ashraf I. Identifying fake job posting using selective features and resampling techniques. Multi Tools Applicat. 2023. <https://doi.org/10.1007/s11042-023-15173-8>.

[15] Vaswani A, Shazeer N, Parmar N, Uszkoreit J, Jones L, Gomez AN, Kaiser L, Polosukhin I. Attention is all you need. In: Proceedings of the 31st International conference on advances in neural information processing systems, NeurIPS. NIP's17, pp. 6000–6010, Long Beach, California, USA 2017.
<https://doi.org/10.5555/3295222.3295349>.