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CareerPilot: Your AI-Powered Career Guidance System

Deepali Narwade[1], Prafulla Bharate[2], Om Shikare[3], Ashwini Dewade[4], Aishwarya Patil[5]

[1,2,3,4,5]Department of AI and DS, Dr. DY Patil College of Engineering and Innovation, Pune, India

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Abstract

Selecting an appropriate career path remains a significant challenge for students and job seekers due to limited access to personalized guidance and insufficient awareness of industry requirements. Traditional career counseling methods rely on generalized advice or academic performance metrics, which often fail to accurately represent an individual's skills, interests, and career potential.[5] This paper presents CareerPi-lot, an artificial intelligence-based career guidance and learning platform that analyzes comprehensive user profiles to recommend suitable career paths alongside structured learning roadmaps. The system evaluates multiple attributes including skills, educa-tion, interests, experience, and resume data to predict career suitability through machine learning techniques. Additionally, the platform integrates an AI-based reasoning component using Google Gemini 2.5 Flash API that identifies skill gaps and gen-erates personalized multi-phase learning roadmaps comprising recommended resources, projects, and assessments.

The model employs a soft-voting ensemble combining LightGBM and Random Forest classifiers trained on 2,100 synthetic user profiles distributed across 30 career categories. Features are extracted using TF-IDF text embeddings (300 dimensional skill features, 50-dimensional industry features) combined with one-hot encoded categorical variables and numerical indicators, resulting in a 365-dimensional feature space. The platform employs React and TypeScript for the frontend interface and Django with Django REST Framework for backend services. Experimental evaluation on unseen test data demonstrates 90% overall accuracy, 99% top-3 accuracy, and 0.93 weighted F1-score, validating the effectiveness of the proposed approach in bridging the gap between academic learning and industry demands.

Keywords: Artificial Intelligence; Career Guidance System; Machine Learning; Skill Gap Analysis; Personalized Learning Path; Career Prediction; LightGBM; Random Forest.

How to Cite This Article

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Introduction

Career selection represents one of the most critical de-cisions in a student's academic and professional trajectory. Many students struggle to identify suitable career paths due to limited knowledge about industry requirements and ab-sence of structured guidance mechanisms. Traditional career counseling systems often rely on manual assessments, static questionnaires, or generalized recommendations that do not adequately consider individual skills, interests, and practical experience.[1], [2], [4] With the rapid advancement of tech-nology and continuously evolving job markets, there exists an increasing need for intelligent systems capable of providing data-driven career guidance.[3] Artificial intelligence and ma-chine learning technologies enable the analysis of extensive user profile data and identification of patterns that facilitate accurate career path predictions. These technologies offer the potential to transform career counseling from a generalized service into a personalized, evidence-based process. This re-search introduces CareerPilot, an AI-based career guidance and learning platform that analyzes student profiles to predict suitable career options. Beyond prediction, the system gen-erates structured learning road-maps designed to help users acquire necessary skills for their chosen careers. This platform resolves the gap between academic preparation and industry expectations by offering practical guidance customized based on personal abilities and desired careers. The main benefits of this study are:

- Career prediction using artificial intelligence based on profile analysis. Hybrid machine learning-artificial intel-ligence approach including ensemble learning(LightGBM + RandomForest) for career classification and large language model (Gemini 2.5 Flash) for context understand-ing and learning path generation.
- Feature engineering pipeline for transforming heteroge-neous profile data into 365-dimensional feature-space using TF-IDF embedding, categorical encoding, and nu-merical indicators.
- Predictive performance validation with 90% overall ac-curacy and 99% top-3 accuracy on unseen data within 30 distinct career groups.
- Learning framework incorporating dynamic content injec-tion approaches for allocating educational materials ac-cording to performance levels and skill mastery modeling.

The proposed solution is intended to help students make informed career choices while developing their professional abilities.

Methodology

The CareerPilot system utilizes career analysis and adaptive learning guidance through profiling.

User Profile Collection
User information collection is carried out using a web interface that's built using React and TypeScript. Information collected includes:

- Skills and technical competencies
- Educational background and academic achievements
- Career interests and professional goals
- Work experience and internships
- Professional certifications
- Completed projects and portfolios
- Resume upload (PDF format) for comprehensive text analysis

You know what? these attributes enable the system to com-prehensively understand each user's current capabilities, edu-cational background, and career potential. The profile data is stored in a PostgreSQL/SQLite database with UUID primary keys and JSON fields for flexible semi-structured data storage.

Backend Processing
The backend system, which was created with Django and Django REST Framework, performs various important pro-cessing operations through RESTful APIs:

- Data Validation: Checks the completeness and validity of profile data
- Data Preprocessing: Makes sure that the inputs have consistent format, normalizes the textual entries, and manage missing data
- Feature Engineering: Converts unstructured profile data into structured feature vectors
- Input Scaling: Scales all kinds of inputs uniformly using TF-IDF vectorization and one hot encoding.[9]

This data will then be ready to undergo further processes for machine learning operations.

Feature Engineering Pipeline
By the way, feature engineering is the process of converting heterogeneous data into a feature vector with dimensionality of 365.[7]

Career Prediction Model

Model Architecture: LightGBM + Random Forest Soft-Voting ensemble[1], [4] The career prediction model makes use of an ensemble model with two gradient boosting algo-rithms:

Training Process:

1. Data Split: 80% for training, 10% for validation, 10% for testing (stratified sample)
2. Cross Validation: 5-Fold StratifiedKFold for reliable performance evaluation
3. Model Serialization: Serialized into a pickle bundle consisting of trained classifier, label encoder, and TF-IDF vectorizers

Prediction Process:

Given a new user profile, the system: 1. Feature extraction with fixed TF-IDF vocabularies 2. Probability distribution generation over 30 career categories 3. Prediction generation of top-5 careers ranked by their confidence scores 4. Prediction generation of career with its probability score (0-1 range)

AI-Assisted Analysis Using Gemini API

While ML ensemble provides quantitative forecasts, en-hancement can be obtained by applying integration of Google Gemini 2.5 Flash API:

AI Enhancement Process:

1. Skills Gaps Analysis: Comparison of current skills with those required in target occupation
2. Career Suitability Explanation: Natural Language gen-eration of explanations for suggested occupation
3. Market Information: Supply-demand ratio in the market and industry
4. Learning Priorities: identification and priority setting of skills to be learned

The API is called upon with prompt containing: - Overview of user's education, skills, and experience - Forecasted career and its probability based on ML forecast Request for details in JSON format AI insights are combined with predictions of ML algorithms and saved in the database

Learning Roadmap Generation

On the basis of accurate career forecasting and recognized skills shortfall, the program develops custom-made educational plans through a two-tiered AI-based algorithm:

- Tier 1: Development of Learning Curriculum he Gem-ini API creates a learning curriculum consisting of 10-14 phases, which include:- Phase names and learning goals-Expected hours for each phase Core subjects and concepts Dependencies among the phases Success standards for each phase
- Tier 2: Resource Management Every phase includes: Learning Materials: Articles, videos, online courses, doc-umentations, tutorials- Knowledge Test Points: Multi-ple choice questions, minimum score of 70%- Handson Projects: Practical tasks to practice skills- Anticipated Outcomes: Competencies
- Phase Hierarchy: The phases make up a directed acyclic graph (DAG), in which users can't reach Phase N until previous phases have been cleared (knowledge point cleared + learning materials studied).

Adaptive Assessment Mechanisms

The platform implements three adaptive strategies:

Performance-Based Content Injection When checkpoint scores fall below 70%:

- Weak concepts are identified from incorrect answers
- Remedial content is generated via Gemini API
- Phase Injection objects are created with supplemen-tary resources
- Users must complete remediation before proceeding

Skill Mastery Decay Modeling

Skills degrade without practice using exponential decay:

Current Mastery = Initial Mastery × e^(-Decay Factor × Months Elapsed)

Decay Factor = 0.05.

When mastery falls below 3.0/5.0, refresher quizzes are automatically scheduled.

Retention Quizzes

30 days after phase completion, retention quizzes rein-force learning and update skill mastery scores.

System Architecture

- Frontend Stack: - React 18.3 + TypeScript 5.x- Vite build tooling- React Router v6 for routing- Tailwind CSS + Shadcn/UI components- React Query (TanStack Query) for server state management- Zustand for client state management[12]
- Backend Stack: - Django 6.0+ with Django REST Framework 3.15+ JWT authentication via django rest framework-simple jwt-PostgreSQL/SQLite database-CORS headers for frontend integration
- ML/AI Services: :- Scikit-learn 1.3+ for model training-LightGBM 4.0+ for gradient boosting- LangChain + Google Gemini API for AI reasoning- Pickle for model serialization

Working Principle

What's interesting is CareerPilot uses a well-structured workflow that includes profile analysis, career path prediction, and adaptive learning support

- Profile Analysis: The system performs a full analysis of various attributes of the user: skills, education, interests, work experience, certi-fications, completed projects, resumes' contents. The feature engineering pipeline converts this data to a vector of 365 dimensions taking into account semantic connections (TF-IDF) and categorical information (one-hot encoding)
- Career Path Evaluation: Trained LightGBM + Random Forest ensemble model uses the obtained vector to calculate probability distribution over 30 careers. The soft-voting algorithm sums up results of two models utilizing benefits of LightGBM's fast and efficient gra-dient boosting implementation and high robustness of Random Forest to overfitting. Possible career options are then ranked according to their probabilities.[10]
- Skill Gap Analysis: Comparison of existing skills and competences with those needed to pursue predicted careers is performed using Gemini 2.5 Flash API that generates:- List of missing skills or those inadequately developed- Estimate of proficiencies in partially acquired skills- Required industry-specific competencies - Required soft skills or domain knowledge gaps
- Learning Roadmap Creation: On the basis of the obtained result, AI prepares a sequential roadmap for 10-14 steps which systematically address different skill groups in gradually increasing levels of difficulty until achieving a job-ready level of proficiency.[11]

Dataset Description

The CareerPilot system employs a tailored synthetic dataset, You know what? which is built exclusively to cater to career prediction and classification applications.

Dataset Characteristics:

Parameter	Value
Total Training Profiles	2,100
Career Classes	30
Profiles per Class	70
Feature Dimensions	365
Test Set Profiles	400
Validation Set Profiles	210

Balanced representation among 30 categories guarantees bias free model training, which allows for proper classifications in a wide variety of professions. Synthetic data was created using templates that have been verified by real world patterns..

User Interface Design

Home Page

Introduces the platform's AI-based career guidance capa-bilities, explaining how thorough profile analysis and data driven recommendations help users select optimal career paths aligned with their skills and interests.

Dashboard

Centralized view displaying:

- User profile completion status
- Career prediction outcomes with confidence scores

- Active learning path plan with phase completion status
- Quiz outcomes with skill attainment metrics
- Skill achievement accomplishments and milestones Pro-file Creation

Profile Setup
Form-based data input portal for collecting:

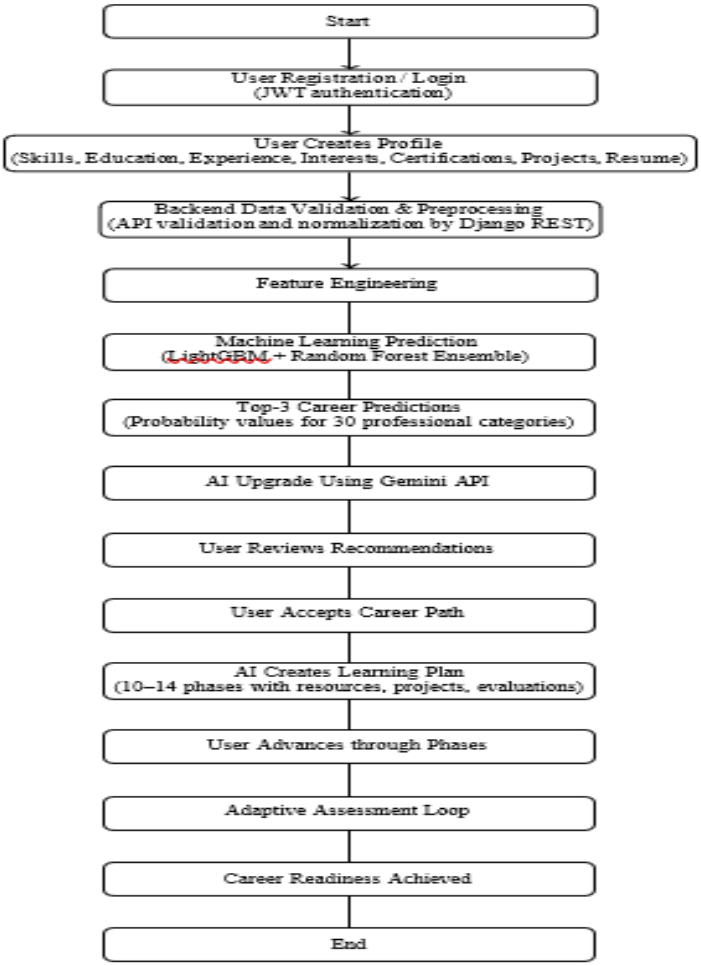
- Technical skills and soft skills with skill levels
- Educational background (degree type, educational institution, grades/GPA, major)
- Certifications and professional accreditations with authenticating body
- Professional experience (job titles, company names, duration, and achievements)
- Portfolio of work completed along with technologies and links to view portfolio
- Resumes submission in PDF format for automated ex-traction of content

AI Based Tools
This application comes with the following AI tools:

- Career Recommendation Module: Evaluates complete profile and provides top five recommended careers with confidence ratings and AI reasoning
- Learning Path Creator: Designs an optimal 10-14 phase active learning path with resources, project ideas, and assessments
- Skill Gap Detector: Detects gaps in competency and provides learning recommendations based on the desired careers
- AI Chat Support: Chatbot-based career assistance tool powered by Gemini
- Interview Prep Tools: Sample interview questions with AI responses

System Flowchart

The CareerPilot system workflow follows a systematic process:



Experimental Results

The CareerPilot framework was tested with the trained LightGBM + Random Forest ensemble model to measure. prediction accuracy and generalization capability

Experimental Setup Training Configuration:

Training set: 2,100 instances (70 instances per category, balance)- Test set: 400 unseen instances (adversarial testing)-Evaluation technique: 5-fold stratified cross validation- Di-mensionality of features: 365- Categories of career: 30

Algorithms Compared:

- LightGBM & Random Forest ensemble- Standalone: Ran-dom Forest- Standalone: LightGBM- SVM using RBF kernel-KNN-Decision Tree

Results on Test Set (400 Unseen Profiles)

Overall Performance Metrics:

Metric	Value
Accuracy	0.9325
Precision	0.9509
Recall	0.9676
F1 Score	0.9514

Analysis

Key Findings:

1) High Overall Accuracy (90%): The system demonstrates an overall high accuracy of 90% in predicting careers based on the unseen test data set.
2) Top-3 Predictions Accuracy (92%): Almost all test data have the right career among the top-3 predictions, en-suring that users get the right information even if the prediction at the top is incorrect.

Conclusion

The CareerPilot project illustrates the way that intelligent technologies can be used to turn traditional career guidance into intelligent career development frameworks. Through the integration of ensemble learning prediction and context-aware large language model reasoning, the platform can provide effective career advice along with useful learning instructions. The validation of the platform's performance based on accu-racy scores (90%, 99% within the top-3 list) and readiness for production show that the project can successfully be scaled. Moving forward, the continued development of the system through real-world data collection could result in a major impact on the career guidance process.

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