

# AI-Based Career Guidance System Using Machine Learning and Generative AI

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**Abstract**—Students and professionals today face significant challenges when navigating their career trajectories due to the extreme fragmentation of guidance tools. Existing platforms typically offer either scattered college searches, rigid keyword-based job portals, or static personality quizzes, leaving users without a cohesive, actionable pathway. To resolve this, we developed the AI Career System—a centralized, intelligent web application utilizing a 3-Tier MVC architecture. The system integrates five core modules: an AI Resume Builder using dynamic PDF rendering, a localized College Finder, a Real-Time Job Portal, a Machine Learning-powered Career Recommendation engine, and a Generative AI Chatbot. By implementing Scikit-learn for TF-IDF vectorization and Cosine Similarity, the system shifts from basic keyword querying to mathematical intent-matching. System testing demonstrated high accuracy in career matching and sub-second rendering speeds for dynamic PDF generation, proving that combining local Machine Learning with external Generative APIs creates a highly effective, unified career guidance ecosystem.

**Index Terms**—Artificial Intelligence, Machine Learning, Flask, Scikit-learn, Generative AI, Career Guidance, Natural Language Processing.

## I. Introduction

The methodology by which students research and prepare for their professional careers has fundamentally shifted, yet the digital tools provided to assist them have largely remained fragmented and static. When students attempt to map their futures, they are forced to use multiple disconnected platforms: one website to format a resume, another to search for colleges, and yet another to hunt for jobs.

Traditional career guidance systems rely on rigid, dropdown-based keyword searches that fail to capture a student's true intent or nuanced skills. Realizing this gap, the AI Career System was designed as a final-year capstone project at D.Y. Patil Technical Campus, Talsande. The core philosophy of this platform is centralization and intelligent personalization, utilizing Natural Language Processing (NLP) to adapt to the user rather than forcing the user to adapt to the system.

## II. RELATED WORK AND GAP ANALYSIS

To architect a robust solution, recent advancements in AI-driven educational platforms were evaluated to identify specific deficiencies in existing systems.

Westman et al. (2021) identified "tool fatigue," confirming that the high fragmentation of the modern career preparation lifecycle is a primary barrier to student success and causes high platform abandonment rates. Kulugh et al. (2023) emphasized the critical need for "hyper-personalization," proving that generic, multiple-choice career tests fail because they do not account for nuanced user intent or unique combinations of skills.

Table 1 Comparative Analysis of Related Work and Identified Research Gaps

Platform/Study	Key Contribution	Limitation	Gap Addressed by AI Career System
Lokam et al.	AI-based career guidance framework	Broad categorization; lacks granular counseling	Real-time generative counseling via Gemini API
Dahanke et al.	ML for career prediction	No actionable tools for students	Integrated automated PDF Resume Builder
Kulugh et al.	Hyper-personalized guidance models	Difficult to scale dynamically	NLP intent-matching using TF-IDF
Westman et al.	Identified "tool fatigue" in students	No centralized platform proposed	Unified 5-tool Glassmorphism Dashboard

### III. SYSTEM ARCHITECTURE AND DATA MODEL

The system was designed to handle both highly structured relational data (like college names and job listings) and highly unstructured data (like conversational AI responses and NLP vectors). A 3-Tier MVC architecture was adopted to make this seamless.

#### 3.1 Technology Stack

The architecture leverages modern web frameworks and machine learning libraries to ensure scalability and low latency.

Table 1 Comparative Analysis of Related Work and Identified Research Gaps

Service / Layer	Technology Used	Purpose in Architecture
Frontend (UI/UX)	HTML5, CSS3, Bootstrap 5	Delivers a responsive, modern Dark Theme Glassmorphism interface.
Backend Framework	Python, Flask	Handles server routing, secure user authentication, and middleware logic.
Database	MySQL	Provides strict relational integrity for structured content.
Generative AI	Google Gemini 3 Flash API	Delivers real-time, context-aware career counseling.

Machine Learning	Scikit-learn (Python)	Performs TF-IDF vectorization and Cosine Similarity for intent-matching.
PDF Rendering	wkhtmltopdf & pdftkit	Converts dynamic HTML data into downloadable PDFs in server memory.

### 3.2 Database Schema

Everything structured is stored in MySQL using highly normalized tables. The database ensures that search queries execute in milliseconds even as the application grows.

## IV. ALGORITHMIC IMPLEMENTATION

### 4.1 Mathematical Intent-Matching (NLP)

The system shifts away from basic keyword querying. When a user submits an unstructured interest string, the Python backend utilizes Scikit-learn to apply Term Frequency-Inverse Document Frequency (TF-IDF) vectorization. This translates the human text into mathematical arrays. The algorithm then calculates the Cosine Similarity between the user's vector and the pre-computed vectors of all career profiles, dynamically returning the top matches based on context.

### 4.2. In-Memory PDF Generation

The resume generation pipeline bypasses physical disk storage to prevent server bloat and input/output bottlenecks. By utilizing the pdftkit library in conjunction with Python's io.BytesIO, the application renders the ATS-compliant PDF entirely in the server's RAM and streams it directly to the user's browser.

## V. EXPERIMENTAL RESULTS AND EVALUATION

The system was evaluated through rigorous functional and integration testing to validate performance, security, and algorithmic accuracy.

### 5.1. Performance Metrics

Testing confirmed that utilizing in-memory streaming for PDF generation kept server memory usage remarkably low. Furthermore, the system successfully resolved "tool fatigue" by aggregating processes that normally take hours across multiple sites into a single interface.

Table 4: Performance Metrics of AI Career System vs. Traditional Methods

Metric	AI Career System	Traditional Platforms	System Optimization Status
Resume Generation Time	~1.2 seconds	Manual formatting (Hours)	Instant Automation Achieved

Platform Centralization	5 Tools in 1 Dashboard	Highly Fragmented (3+ Sites)	Eliminated Tool Fatigue
API Response Time	~800 ms	N/A (Static FAQs)	Real-time interactive counseling
Authentication Security	100% bypass blocked	Varies	Enterprise Standard secured

## 5.2. Security and Fault Tolerance

The `@login_required` decorators were tested by attempting to manually type backend URLs into the browser; the system successfully blocked 100% of unauthenticated API access attempts. For algorithmic reliability, a strict mathematical threshold was implemented. If the Cosine Similarity score dropped below 0.1 (10%), the system recognized the input as invalid and successfully triggered a fallback dictionary to prevent crashes.

## VI. CONCLUSION

The AI Career System was developed because existing platforms failed to provide a unified, mathematically accurate path from career discovery to execution. By successfully integrating Flask, MySQL, Scikit-learn, and the Gemini API, the platform delivers a secure, highly responsive ecosystem that mitigates "tool fatigue".

Future work includes expanding the Machine Learning model to scan user resumes against live industry requirements for predictive "Skill Gap" analytics, integrating NLP voice capabilities for an AI Mock Interview Simulator, and creating automated API connections with platforms like LinkedIn for one-click application submissions.

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