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## Skill Gap Analyzer: A Data-Driven Career Development Platform

Raswanth A

M.Sc. Decision and Computing Sciences,  
Coimbatore Institute of Technology, Coimbatore, Tamil Nadu

Dinesh K K V

M.Sc. Decision and Computing Sciences,  
Coimbatore Institute of Technology, Coimbatore, Tamil Nadu

Dr. D. Manju

Associate Professor,  
M.Sc. Decision and Computing Sciences,  
Coimbatore Institute of Technology, Coimbatore, Tamil Nadu

Dr. V. Radhamani

Assistant Professor,  
M.Sc. Decision and Computing Sciences,  
Coimbatore Institute of Technology, Coimbatore, Tamil Nadu

**Abstract:** The modern job market is evolving at an unprecedented pace due to technological advancements, automation, and shifting industry demands. This constant change makes it challenging for students, job seekers, and professionals to keep up with the competencies required to stay relevant in their fields. Traditional methods, such as static training programs or generic career guidance, often lack personalization and fail to address the dynamic nature of skill requirements, leaving individuals uncertain about how to plan their learning and career development effectively. As industries continue to demand more specialized and adaptive skills, the gap between academic preparation and employability is widening. This highlights the urgent need for intelligent tools that can provide customized insights and guide individuals toward targeted skill enhancement.

To overcome this challenge, this paper introduces the Skill Gap Analyzer, a full-stack web application designed to deliver personalized and data-driven insights into an individual's skills. The platform allows users to input their current skill set, which is then benchmarked against a curated database of industry-relevant skills mapped to specific job roles. This comparison enables the system to identify areas where the user excels as well as gaps that need improvement, providing clarity on the precise skills required to meet professional goals. In addition, the platform adapts dynamically to different career paths, ensuring relevance across diverse industries. By providing structured, actionable insights, the system empowers users to make informed decisions about their learning and career development.

One of the core strengths of the Skill Gap Analyzer lies in its visualization capabilities. The system presents the identified "skill gaps" through intuitive, interactive charts that make it easy for users to interpret their strengths and weaknesses at a glance. Beyond gap identification, the application further adds value by generating personalized learning paths. These paths are enriched with targeted, high-quality resources

dynamically fetched from public APIs such as YouTube, ensuring that users gain direct access to relevant tutorials and courses tailored to each missing skill. This combination of analysis and actionable guidance transforms the platform into more than just a diagnostic tool—it becomes a roadmap for growth.

The technical foundation of the project is built on a modern and scalable architecture, featuring a React.js front-end for a responsive interface, a Python FastAPI back-end for efficient processing, and a MongoDB database for flexible and reliable data management. By integrating skill assessment, visualization, and curated resource recommendations into a single platform, the Skill Gap Analyzer

contributes significantly to bridging the gap between education and employability. It has strong potential not only to support individuals in achieving their career aspirations but also to serve as a valuable tool for educational institutions, training providers, and recruiters seeking to align workforce skills with the rapidly changing requirements of the global job market.

**Keywords** - Skill Gap, Career Development, Full-Stack Development, React.js, FastAPI, MongoDB, Data Visualization, REST API, Personalized Learning, Educational Resources, Interactive Charts, Web Application, Scalable Architecture, E-Learning, Workforce Alignment, Industry Skills, Career Pathways, Technology Stack.

## I. INTRODUCTION

The global workforce is undergoing a rapid transformation, driven by advancements in technologies such as AI, data science, cloud computing, and cybersecurity. These innovations are reshaping industries, making traditional career paths, built on static skill sets, obsolete. Reports from organizations like the World Economic Forum and McKinsey indicate that the lifespan of professional skills has shortened dramatically, with many technical skills becoming outdated in just 3-5 years. For both new graduates and experienced professionals, the challenge lies in identifying the skills they lack and addressing these gaps before they impede career progression.

Despite the growing importance of upskilling, individuals often struggle to pinpoint their skill deficiencies. Job descriptions are frequently overloaded with vague or aspirational requirements, and industry standards vary widely across sectors and companies. Furthermore, self-assessments are often inaccurate, with individuals either overestimating or underestimating their abilities. While online learning platforms like Coursera and Udemy provide access to educational content, navigating these resources without a clear understanding of personal gaps can lead to inefficiency and misaligned learning efforts.

To address these challenges, the Skill Gap Analyzer provides a personalized, data-driven solution. By analysing a user's self-reported skills against industry job requirements, it generates a detailed gap analysis, highlighting which skills are missing and how they impact employability. The results are presented in dynamic, interactive visualizations such as bar charts and radar charts, making it easier for users to understand their strengths and weaknesses. This intuitive design ensures users can quickly identify the areas that need attention.

Beyond skill identification, the platform offers a unique learning pathway tailored to each user. By integrating with public APIs like the YouTube Data API, the Skill Gap Analyzer automatically generates a personalized learning path with high-quality, free educational resources. This eliminates the need for manual course searches and ensures that recommended content aligns with current industry standards. Built using React.js, Python Fast API, and MongoDB, the system is scalable and adaptable, providing a modern solution for personalized, role-specific upskilling across various industries.

## II. LITERATURE REVIEW

A comprehensive review of academic and industry literature highlights three converging strands behind data-driven skill gap analysis platforms: (i) competency frameworks and labour market intelligence for defining role requirements, (ii) automated extraction and alignment of skills from user inputs and job postings using NLP and embeddings, and (iii) personalized learning recommendation systems that translate detected gaps into actionable study plans. Despite rapid progress across these areas, most existing solutions are fragmented—either providing static catalogues of competencies, one-off skill assessments without

longitudinal tracking, or generic course recommendations detached from validated gap diagnostics. Our Skill Gap Analyzer is positioned to synthesize these strands into an integrated pipeline that detects gaps, visualizes them clearly, and operationalizes remediation through targeted learning paths.

To better understand the state-of-the-art in skill gap analysis and related domains, a comparative summary of existing works is presented in Table I. The table highlights the methodologies adopted, technologies applied, key findings, and limitations that motivate the development of the Skill Gap Analyzer.

**Table 1**  
**Summary of Literature Review (Table 2.1)**

Authors	Methodology / Technology	Key Findings / Limitations
U.S. Dept. of Labor (O*NET) [1]	Competency frameworks, occupational taxonomy	Standardized role-skill mapping; slow updates for emerging skills
Zhang et al. (2020)	NLP with BERT embeddings for skill extraction	Accurate normalization vs TF-IDF; large labelled datasets required
EMS Analytics (2021)	Embedding-based similarity in job postings	Robust to noisy titles; embeddings drift with evolving terminology
Santos et al. (2019)	Hybrid recommender + prerequisite graphs	Micro-pathways improve completion; scalability remains limited
Gervais (2016)	Competency-Based Education (CBE)	Enables proficiency rubrics; limited to academic settings

In summary, the literature indicates that robust skill-gap systems must: (1) ground requirements in transparent taxonomies, (2) use modern NLP/embeddings for reliable skill extraction and normalization, and (3) translate gaps into concise, explainable learning recommendations with progress feedback. Existing tools typically optimize one of these dimensions in isolation, leading to fragmented or incomplete solutions. The integration of these strands is crucial for a comprehensive system that not only detects gaps but also provides actionable insights in real time.

### III. SYSTEM OBJECTIVES

The development of the *Skill Gap Analyzer* is guided by a set of clear and focused objectives designed to provide comprehensive, end-to-end support to learners and professionals seeking to align their skills with industry demands. Each objective directly addresses a well-documented challenge faced by this user group while leveraging real-time data sources and intelligent algorithms.

#### Enable Role-Specific Skill Profiling and Visualization:

The foundational objective is to provide users with an intuitive interface to input their current skills, select a desired job role, and visualize the alignment between their competencies and role requirements. This functionality serves as the baseline for all subsequent analytical and advisory features, allowing users to understand their readiness for a chosen career path without manually interpreting job postings.

#### Quantify and Communicate Skill Gap Severity:

Beyond simply listing missing skills, the system quantifies the extent of each gap in an easily digestible format. This includes generating visualizations such as bar charts to show the number of missing skills per category, radar charts to compare proficiency across domains, and readiness scores computed from weighted metrics. These insights ensure that users can understand their standing at a glance and make data-driven career decisions.

## Provide Intelligent Learning Resource Recommendations:

A key innovative objective is to directly connect detected skill gaps to targeted, high-quality learning resources. Instead of static course listings, the system integrates dynamic sources such as: i) YouTube Scraping – Automatically retrieves the latest tutorials and lectures. ii) FreeCodeCamp Integration – Provides structured, free learning paths for core technical skills. This ensures learners have instant access to resources that are both current and accessible.

## Personalized Certification and Course Recommendation System:

The tool includes a recommendation engine that suggests certifications and structured courses tailored to the missing skills. Recommendations consider relevance to the target role, credibility of providers (e.g., Coursera, Udemy), and learner demand. The system also factors in the learner's previous experience and learning preferences to ensure a customized approach. These objective transforms certification discovery into a personalized, AI-driven process, making it easier for professionals to find the most relevant and credible resources.

## Deliver Real-Time Industry Insights:

To keep learners aligned with workforce trends, the system integrates external intelligence to provide real-time insights into industry demand. By leveraging Google Trends, the system highlights both rising and declining demand for specific skills, allowing users to track evolving market needs. Additionally, the integration of the JSearch API provides live job posting data, validating which skills are currently most in demand for a target role. This dual approach ensures that users are not only guided by present industry requirements but also by emerging trends and future workforce trajectories, helping them stay ahead in an ever-changing job market.

## IV. SYSTEM ARCHITECTURE

The architecture of the Skill Gap Analyzer is designed to be robust, scalable, and modular, leveraging a modern full-stack technology stack to deliver a seamless, responsive, and secure user experience. It follows a three-tier design comprising the frontend, backend, and database layers, integrated with external APIs for dynamic learning resource recommendations. This layered approach ensures separation of concerns, easier maintenance, and adaptability for future feature enhancements.

### A. Technological Framework and Justification

The system architecture consists of four main entities: Frontend, Backend, Database, and External APIs, arranged in a layered manner for clarity as shown in the figure 4.1.

**Frontend (UI/UX):** The user begins interaction through a React.js web application styled with Tailwind CSS and bundled using Vite for rapid builds and the frontend is deployed on Vercel, ensuring global scalability and continuous integration.

**Backend (Application Logic):** Built with Fast API, the backend manages all processing logic such as skill gap analysis, authentication, and API integration. It provides a set of REST endpoints that communicate seamlessly with both the frontend and external APIs.

**Database (Data Storage):** MongoDB is the primary storage system for user profiles, skills, and mappings. Its NoSQL model supports flexible schema design, enabling easy storage of dynamic skill-role datasets sourced from O\*NET and ESCO standards.

**External APIs (Resource Integration):** The backend connects to public APIs such as YouTube to dynamically fetch learning resources. These external recommendations are personalized based on identified skill gaps and integrated into the learning path.

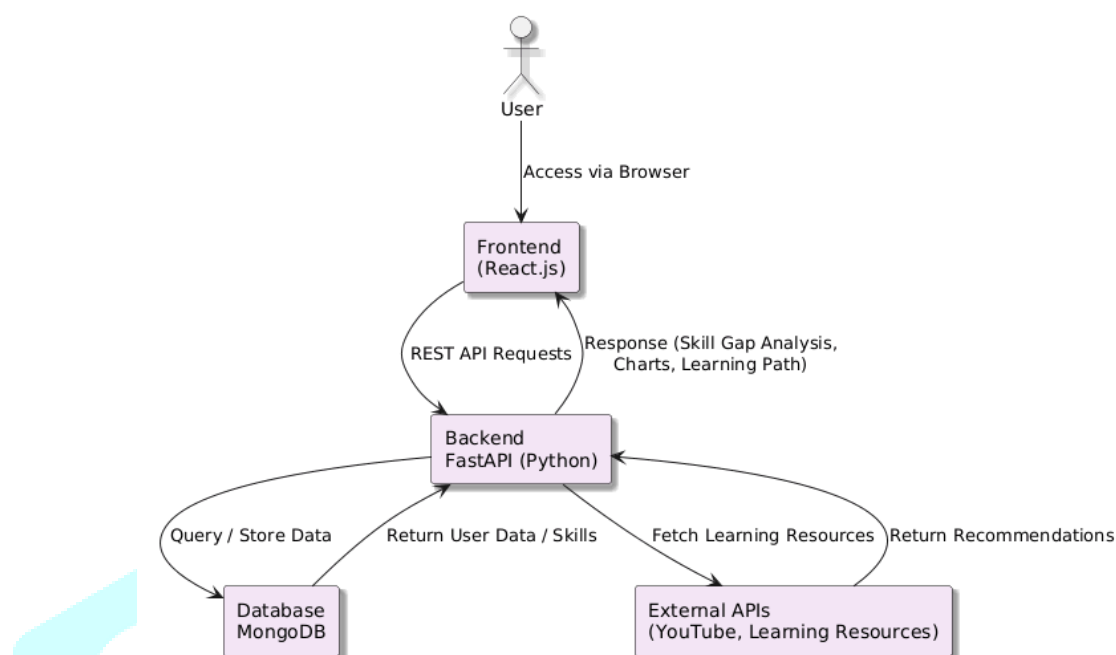


Figure 4.1  
System Architecture Diagram

This architecture ensures that the Skill Gap Analyzer remains user-friendly, responsive, and scalable, while offering actionable insights to bridge the gap between academic preparation and industry expectations.

## B. Functional Modules

The system's functionality is organized into eleven interconnected modules, each handling a distinct aspect of the workflow. This modular approach ensures separation of concerns, maintainability, and scalability while providing a holistic experience to the end user.

**User Profile Module:** This module is the entry point for all users. It manages secure registration, login, and authentication while maintaining persistent profiles that store skills, qualifications, and past analysis results. Users can manually add or update their skills and target roles. The module ensures data consistency and serves as the reference point for all subsequent analyses.

**Role and Skill Data Module:** This Module will automatically update every 24 hours by fetching the latest role and skill data from the JSearch API. This scheduled process ensures the system stays current with industry standards, updating role mappings and skill sets while replacing outdated data. The updates are logged, and error handling ensures smooth operation with minimal manual intervention.

**Skill Gap Analysis Module:** This module forms the analytical core of the system. It compares the user's current skill set with the target role's requirements using weighted set-difference operations and semantic matching to account for skill synonyms. The analysis produces a quantified skill gap score and detailed insights, which are stored for historical tracking and trend analysis.

**Learning Path Recommendation Module:** Based on the skill gap analysis, this module generates personalized learning paths based on the skill gap analysis. It dynamically scrapes YouTube for relevant tutorial videos and integrates with FreeCodeCamp to provide access to structured, free learning paths.



Recommendations are ranked by relevance, recency, and popularity, allowing users to follow a tailored and structured roadmap for skill development. This ensures that learners receive up-to-date and high-quality content to bridge their skill gaps efficiently.

**Certifications Module:** This module suggests professional certifications and training programs aligned with missing skills. Recommendations are prioritized based on industry credibility, relevance, and learner preferences, ensuring that users can access recognized credentials that enhance employability.

**Industry Insights Module:** Leveraging external data sources like Google Trends and JSearch API, this module provides real-time insights into skill demand, emerging technologies, and evolving job roles. Users gain visibility into in-demand skills, helping them make informed career decisions.

**Dashboard and Visualization Module:** Serving as the central hub, this module presents all analyses and recommendations through interactive charts, radar plots, readiness percentages, and learning progress indicators. It provides an intuitive interface for users to interpret results and make actionable decisions.

**Report Generation Module:** It enables users to export their skill gap analyses, learning paths, and recommendations as PDFs or shareable digital reports. These reports consolidate skills, missing competencies, suggested resources, and career insights, ensuring portability and offline access.

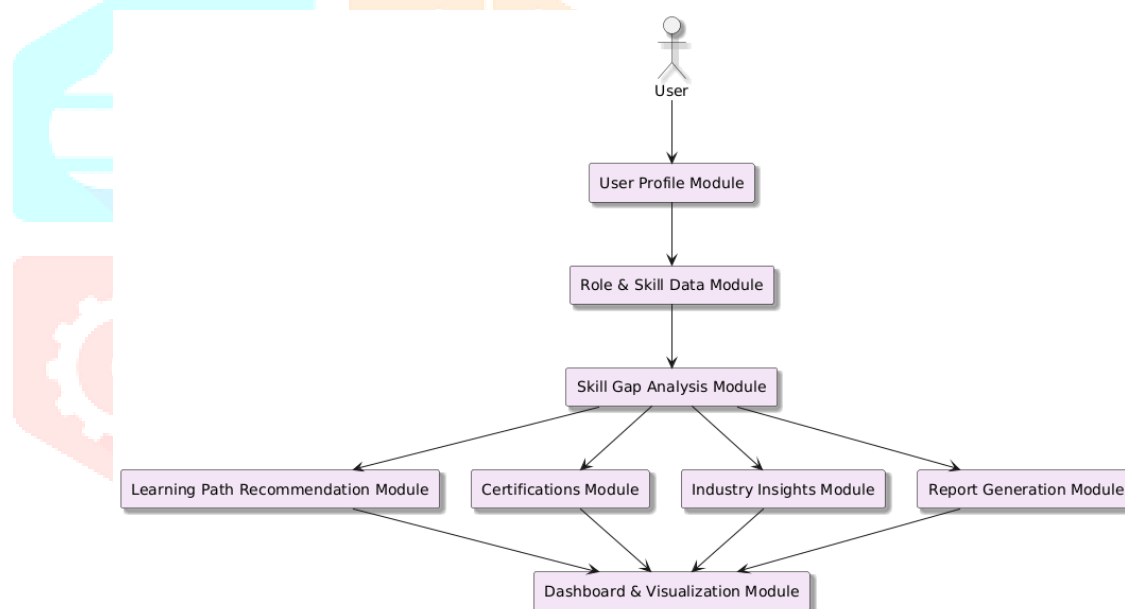


Figure 4.2  
Module Diagram

The workflow begins with the User Profile Module, which interacts with the Role & Skill Data Module and feeds into the Skill Gap Analysis Module. The outputs of the analysis are utilized by support modules (learning path, certifications, progress tracking, industry insights, related roles, and education insights) to provide enriched guidance. Finally, output modules (dashboard and report generation) present results in an accessible and actionable format. This layered and interconnected design ensures that users not only identify their skill gaps but also receive personalized recommendations, monitor progress, and explore industry-aligned career opportunities effectively.

## V. METHODOLOGY AND ALGORITHMS

The methodology of the Skill Gap Analyzer follows a modular pipeline that transforms a user's declared skills and chosen target job role into a personalized gap analysis report. This report integrates advanced algorithms, real-time data sources, and intelligent recommendations to ensure maximum relevance and impact.

**Data Ingestion:** The process starts when the user provides two inputs: Current Skills, selected or entered manually, and Target Job Role, chosen from a curated catalogue. These inputs are processed through a JSearch API, which periodically updates job roles and required skills by fetching data from relevant occupational databases. This ensures the information remains up-to-date, reflecting any changes in industry trends or job requirements, allowing users to align their skills with current market demands.

**Gap Detection Algorithm:** The gap detection stage compares the user's skills with those required for the target role by performing a set-difference operation to identify skills present in the role but missing from the user's list. To refine this comparison, additional algorithms are employed: Decision Trees classify missing skills based on their relevance and importance to the target role, Cosine Similarity calculates the overlap between user skills and required skills to generate a similarity score, and TF-IDF Extraction extracts and prioritizes critical skills from job descriptions and role profiles. The output is a ranked list of missing skills; each associated with a relevance score.

**Learning Resources Recommendation:** Instead of relying on static links, the system dynamically retrieves resources for each missing skill. It uses YouTube Scraping to collect top tutorial videos relevant to the missing skill and integrates FreeCodeCamp to provide direct access to structured, free learning paths. This approach ensures that learners have immediate access to high-quality, accessible material tailored to their needs.

**Course and Certification Recommendation System:** The system employs a machine learning-powered recommendation engine to suggest certifications and structured online courses for each missing skill, based on factors such as the skill's relevance to the target role, historical learner feedback and popularity, and the credibility of the course provider (e.g., Coursera, Udemy), transforming the certification process from static suggestions into a personalized, dynamic recommendation system.

**Industry Insights:** To keep users aligned with real-world trends, the system integrates external labor market intelligence, using tools like Google Trends to analyze the popularity of specific skills over time and highlight industry demand, and the JSearch API to provide real-time job posting data, validating which skills are most in-demand for specific roles. This integration offers users a forward-looking view of the job market, ensuring they stay updated with the latest trends and skill requirements.

**Analysis Report Generation:** Finally, the system compiles the results into an interactive report that includes a summary of current versus missing skills, visualizations like bar charts and radar plots to represent the skill gap, and a personalized roadmap featuring learning resources, certifications, industry insights, and related roles. This ensures that users not only understand their skill gaps but also receive clear, actionable guidance for bridging them.

The Skill Gap Analyzer follows a modular methodology that converts user-declared skills and target job roles into personalized gap analysis reports. It begins with data ingestion, capturing current skills and target roles, and processes them against curated role-skill datasets. The gap detection algorithm identifies missing skills using decision trees, cosine similarity, and TF-IDF extraction. Learning resources and certification recommendations are dynamically generated through API integrations, providing high-quality, role-specific guidance. Industry insights keep users aligned with market trends.

## VI. CONCLUSION AND FUTURE WORK

The Skill Gap Analyzer project aims to provide a user-friendly, interactive web tool that helps individuals identify skill gaps between their current capabilities and the demands of their desired job roles. By utilizing a role-skill database, the system offers personalized, data-driven insights, and targeted recommendations, all designed to enhance career development. Unlike generic platforms, the Skill Gap Analyzer focuses on mapping

identified gaps to relevant learning resources and certifications, offering users a clear, actionable learning path. This approach not only helps individuals pinpoint areas for improvement but also guides them toward effective solutions.

The Skill Gap Analyzer's key contributions are its accurate skill gap identification, personalized recommendations, and visual gap representation. The system uses a precise method of matching user skills with job role requirements, allowing for clear action planning. By presenting results through intuitive visualizations such as bar, pie, and radar charts, users can easily interpret their strengths and weaknesses. This clarity enhances the user experience and provides a solid foundation for making informed upskilling decisions, making the tool a valuable resource for career development.

Several future enhancements could expand the system's scope and further improve its impact. Integrating broader datasets and APIs, such as the JSearch API and YouTube scraping, could provide access to a wider range of learning resources, ensuring that the system remains relevant as new technologies and professions emerge. Additionally, including APIs from learning platforms like Coursera, Udemy, and edX would offer users more flexible learning options and diverse teaching styles to match individual preferences and needs.

The future vision for the Skill Gap Analyzer includes the development of features like progress tracking, AI-powered recommendations, and predictive skill forecasting. These advancements would allow the system to evolve from a one-time diagnostic tool into a continuous learning assistant, supporting users in tracking their growth and adapting to industry trends.

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