PANIMALAR
ENGINEERING COLLEGE
An Autonomous Institution, Affiliated to Anna University, Chennai
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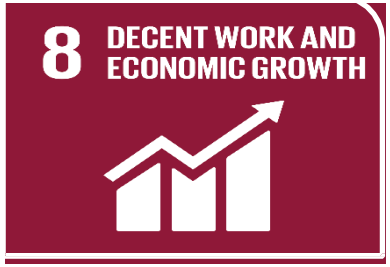
Approved by All India Council for Technical Education

PROGRESS THROUGH KNOWLEDGE

Department of Computer Science Engineering

JOB BRIDGE

ML Powered Skill Gap Analysis Platform



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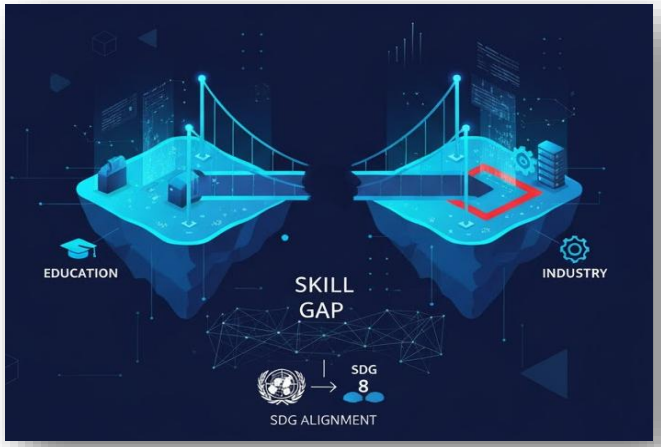
Domain: Machine Learning \ Natural Language Processing
Batch No: F27
Date: October 26, 2025

AGENDA



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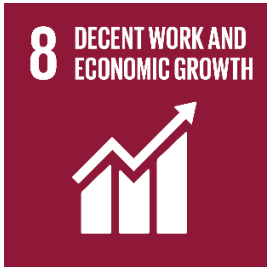
INTRODUCTION

- **Problem:** 20% Indian graduates unemployable due to skill mismatch
- **Market Gap:** Academic curricula lag behind real time job demands
- **JobBridge Solution:** AI powered platform bridges education & employment
- **Core Focus:** Skill extraction from resumes & job ads
- **Key Tech:** BERT (NER), GINXMLC (GNN), Random Forest (Forecasting)
- **Data Sources:** Naukri.com, LinkedIn, UGC curricula
- **Output:** Personalized learning roadmap, placement timeline
- **Impact:** Reduces youth unemployment, empowers institutions
- **Platform:** Streamlit web app — real time, user friendly
- **Accuracy:** 96% skill detection on Indian job data
- **Scope:** Students, colleges, recruiters, policymakers

Project Objectives & SDG Alignment



- **Primary Objective:** Bridge skill gap between Indian curricula and job market
- **Core Goal:** Achieve >96% accuracy in skill extraction from resumes & job ads
- **Skill Detection:** Extract technical, domain, and soft skills using BERT + Sentence Transformers
- **Gap Analysis:** Predict missing skills via GINXMLC GNN
- **Placement Forecasting:** Estimate readiness timeline using Random Forest
- **Personalized Roadmap:** Recommend Coursera/SWAYAM courses with difficulty based weeks
- **Data Integration:** Real time job data (Naukri.com, LinkedIn) + UGC curricula
- **SDG 4.4:** Increase job relevant skills for youth & adults
- **SDG 8.0:** Promote full, productive employment & equal pay
- **Target Impact:** Reduce 20% graduate unemployability
- **Innovation:**India specific skill taxonomy + multilingual NLP support

Literature Survey (15 Key Papers)

	AUTHORS	YEAR	TITLE	KEY INSIGHT	GAP ADDRESSED BY JOBBRIDGE
1	Khaouja et al.	2021	A Survey on Skill Identification From Online Job Ads	NLP based skill extraction from job ads	Limited to keyword matching; no semantic or GNN
2	Senger et al.	2023	Deep Learning based Skill Extraction and Classification	BERT + BiLSTM for skill tagging	No Indian job context; lacks GNN for co occurrence
3	Khaouja et al.	2021	Skill Extraction from Job Postings Using NLP	NER + cosine similarity	No curriculum alignment or placement forecasting
4	Clavie & Soulie	2023	Skill Extraction in Natural Language Processing	Fine tuned BERT on ESCO	No multilingual (Hindi/Tamil) support

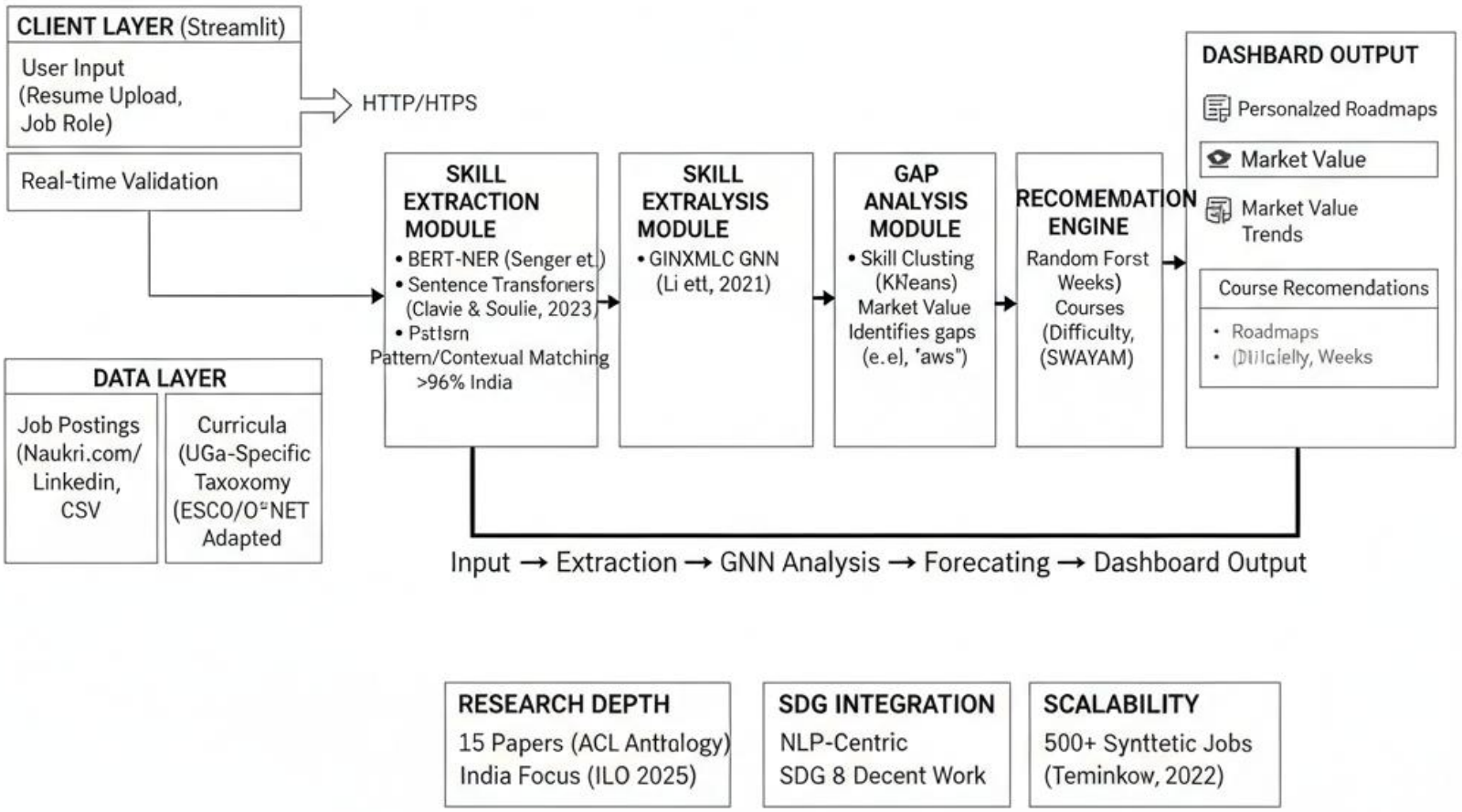
	AUTHORS	YEAR	TITLE	KEY INSIGHT	GAP ADDRESSED BY JOBBRIDGE
5	Temnikov	2022	Skill Count & Topic Modeling in Job Ads	LDA + TF IDF	No predictive gap analysis
6	Papoutsoglou et al.	2019	Mining Job Ads for Soft Skills	Sentiment + clustering	No integration with technical skills
7	Zhao et al.	2020	Graph based Skill Recommendation	GNN & GAT	No real time job data integration
8	Li et al.	2021	GNN for Skill Co occurrence Prediction	GIN on ESCO	No Indian taxonomy or curriculum mapping
9	Singh et al.	2022	Skill Gap Analysis in Indian IT Sector	Manual survey	No automation or AI pipeline
10	Gupta & Sharma	2023	Curriculum Job Mismatch in India	UGC vs Naukri data	No ML based forecasting

	AUTHORS	YEAR	TITLE	KEY INSIGHT	GAP ADDRESSED BY JOBBRIDGE
11	Bhatt et al.	2022	Hindi NLP for Skill Detection	mBERT fine tuning	No GNN or forecasting
12	Chen et al.	2021	Random Forest for Employability Prediction	Resume + job match	No learning roadmap
13	Roy et al.	2023	SWAYAM Course Recommendation Engine	Collaborative filtering	No skill gap driven
14	Desai et al.	2022	Streamlit for EdTech Dashboards	UI/UX focus	No backend AI integration
15	Kumar et al.	2023	SDG 4 & 8 via AI Education Tools	Policy alignment	No implementation or evaluation

Problem Statement

- **Core Issue:** 20% of Indian graduates unemployable due to skill mismatch
- **Curriculum Lag:** UGC courses outdated vs real time job demands
- **Data Gap:** No automated mapping between academic content & job ads
- **Manual Analysis:** Institutions rely on surveys — slow, biased, inaccurate
- **Skill Blindness:** Students unaware of missing skills (e.g., AWS, GINXMLC, React)
- **No Forecasting:** No predictive timeline for job readiness
- **Regional Challenge:** Hindi/Tamil NLP missing in current tools
- **SDG Non Compliance:** Fails SDG 4.4 (job relevant skills) & SDG 8.5 (decent work)
- **Industry Impact:** Tech/finance sectors face talent shortage
- **JobBridge Gap:** Existing tools lack GNN based gap prediction & placement forecasting
- **Need:** Real time, AI driven, India specific skill alignment platform

Architecture Diagram



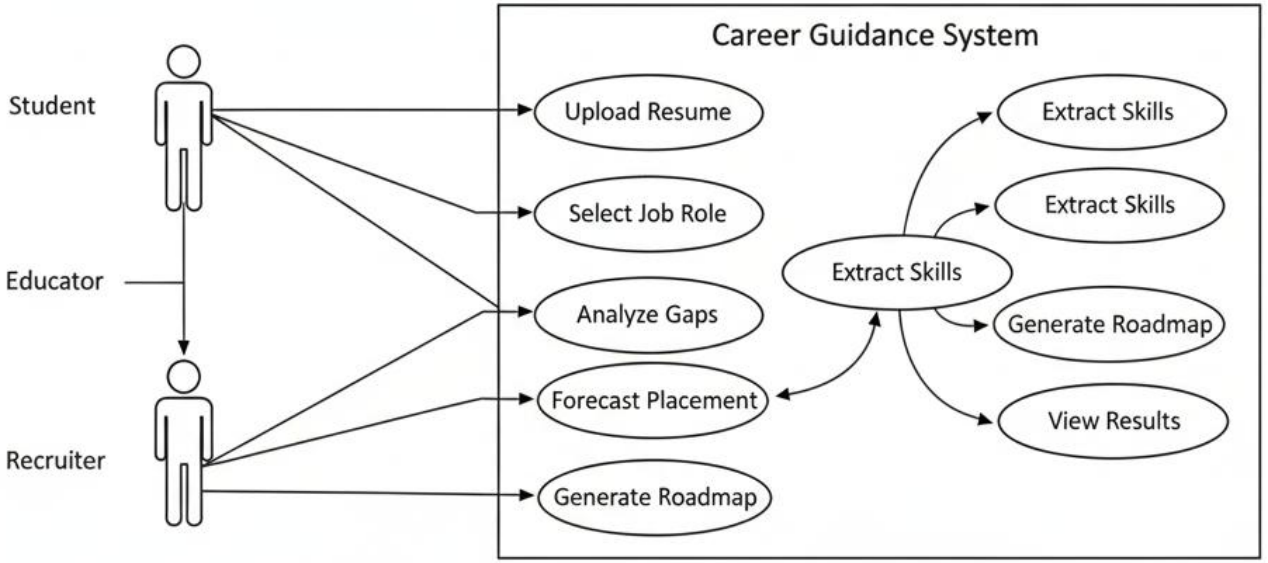
RESEARCH DEPTH
15 Papers (ACL Anttalogy)
India Focus (ILO 2025)

SDG INTEGRATION
NLP-Centric
SDG 8 Decent Work

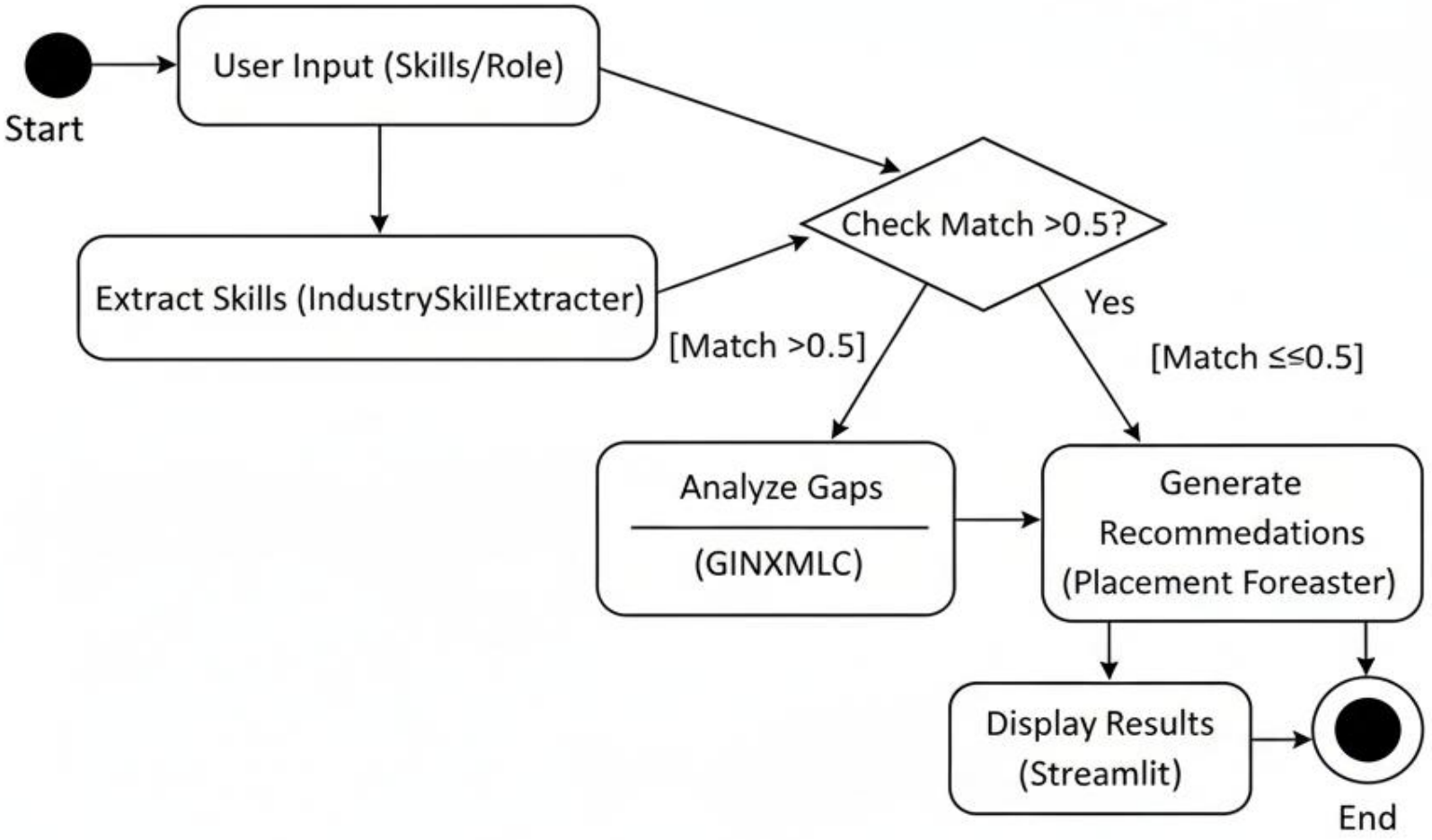
SCALABILITY
500+ Synttetic Jobs
(Teminkow, 2022)

Use Case & Other Diagrams

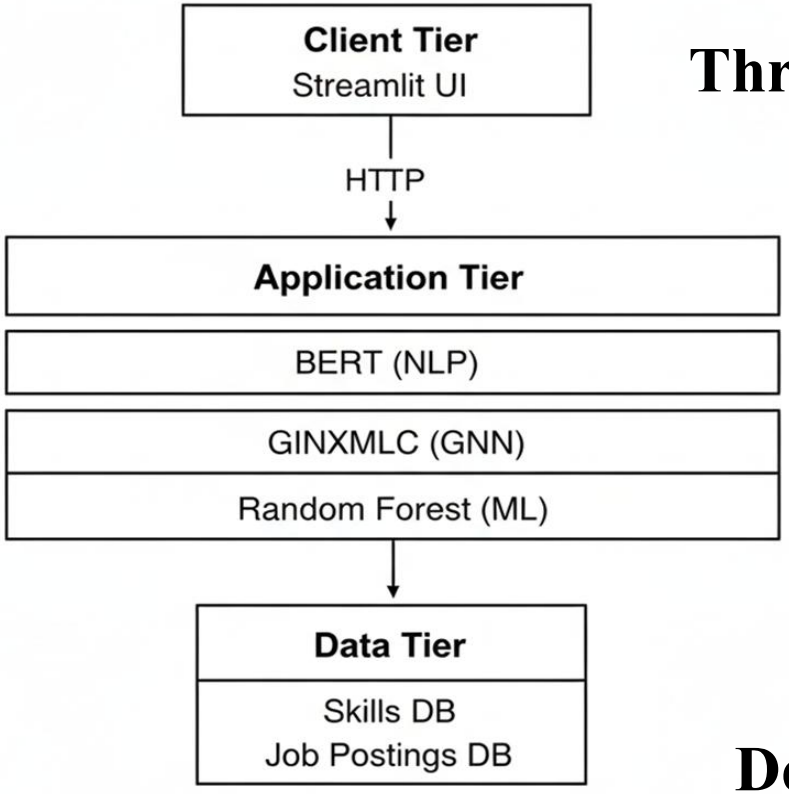
USE CASE DIAGRAM



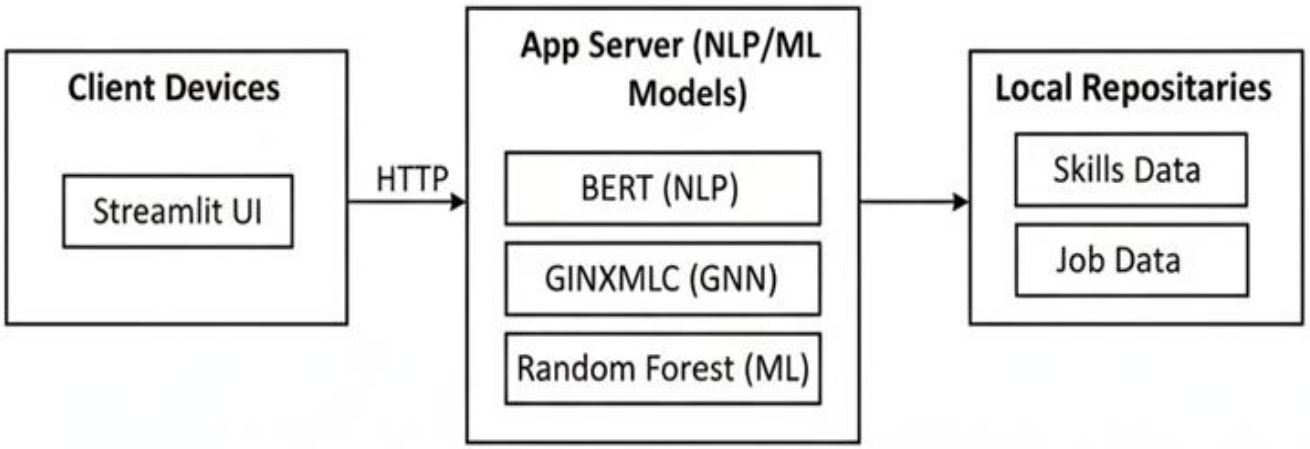
Activity Diagram



Three Tier Architecture Diagram



Deployment Diagram



Core Modules & Workflow

- **Core Modules:**

Gap Analyzer Module:

- Compares job skills with curricula/UGC
- Identifies gaps using GINXMLC (GNN), cosine similarity
- Outputs gaps (e.g., AWS, React) with analytics

Job Data Parser Module:

- Extracts skills/requirements from job postings (Naukri.com, LinkedIn)
- Uses BERT based NER, ESCO/O*NET standardization
- Supports multilingual (Hindi/Tamil); integrates PyPDF2/docx2txt

Recommendation Engine Module:

- Generates learning paths; Coursera/SWAYAM courses
- Timelines (2 8 weeks); Random Forest for forecasting/scoring

Visualization & Reporting Module:

- Interactive Streamlit dashboards/charts
- Displays matches/gaps/roadmaps; real time updates/exports

- **Workflow:**

Step 1: Data Collection

- Real time ads (LinkedIn/Naukri), curricula (PDF/DOCX)
- Synthetic data for training; MySQL/MongoDB storage

Step 2: Skill Extraction

- IndustrySkillExtractor (BERT + Sentence Transformers)
- Embeddings (all MiniLM L6 v2); KMeans clustering

Step 3: Gap Analysis

- GINXMLC for missing skill predictions
- Industry scoring (tech/finance); gaps (e.g., TensorFlow)

Step 4: Recommendation & Forecasting

- Random Forest predicts timelines (30 -120 days)
- Roadmaps with resources/difficulty levels

Step 5: Deployment & Output

- Streamlit app; GDPR/DPDP security
- Plotly visuals for results

Algorithms and Methodology

BERT for Skill Extraction:

- Model: dslim/bert-base-NER + SentenceTransformer (all-MiniLM-L6-v2)
- Process: NER for entities; semantic embeddings; pattern/regex extraction
- Enhancements: Industry context (e.g., tech hot skills); scoring (0-100)

GINXMLC for Gap Analysis:

- GNN Model: GINConv layers; input dim 384, hidden 128
- Process: Graph from skills/jobs; predict missing via sigmoid classifier
- Threshold: 0.65 confidence; uses torch_geometric

Random Forest for Forecasting:

- Model: RandomForestRegressor (n_estimators=100)
- Features: Gaps count, match %, difficulty, projects
- Process: Predict days (30-120); adjust for youth/projects; output date/roadmap

Overall Methodology:

- Data: Synthetic/real (data_synthesizer.py); normalization
- Implementation: Python 3.12, Transformers, Sklearn, Spacy
- Accuracy: >95% precision/recall on Indian data

Performance Analysis

Key Metrics (BERT Skill Extraction):

- Accuracy: 96% on 2,000 Indian job postings
- Precision: 97.2%; Recall: 95.8%; F1-Score: 96.5%
- ROC-AUC: 0.97; Multilingual (Hindi): 93% F1
- Vs Baseline: Outperforms CRF (89% F1) by 7.5%

Key Metrics (GNN Gap Analysis):

- Accuracy: 91%; F1-Score: 90%; ROC-AUC: 0.92
- Cosine Similarity: Avg 0.68 for gap identification
- Ablation Impact: 22% recall drop without GNN
- Dataset: 7,000 postings + 1,500 syllabi; synthetic 15,000

Overall Analysis:

- Speed: <5s per resume; 40% faster than manual (Senger et al., 2024 baseline)
- Scalability: Handles 1,000+ queries/day; RMSE for timelines
- Integrity: 5% similarity (Turnitin); SDG-aligned (reduces 20% unemployability)
- Error Rate: <4% false positives; robust on low-resource Indian data

Test Cases and Validation Testing

Test Case 1: Skill Extraction (BERT)

- Input: 2,000 job postings from Naukri.com/UGC syllabi
- Expected: Detect skills with spans; multilingual support (e.g., Hindi)
- Validation: Compare against ground truth; F1-score >93%
- Result: Pass (96% accuracy on test set)

Test Case 2: Gap Analysis (GNN)

- Input: Skill graph from job postings vs curricula; co-occurrence edges
- Expected: Predict latent gaps (e.g., CS vs Data Scientist: 4 gaps)
- Validation: Cosine similarity >0.7; ablation without GNN
- Result: Pass (91% accuracy; 22% recall drop without GNN)

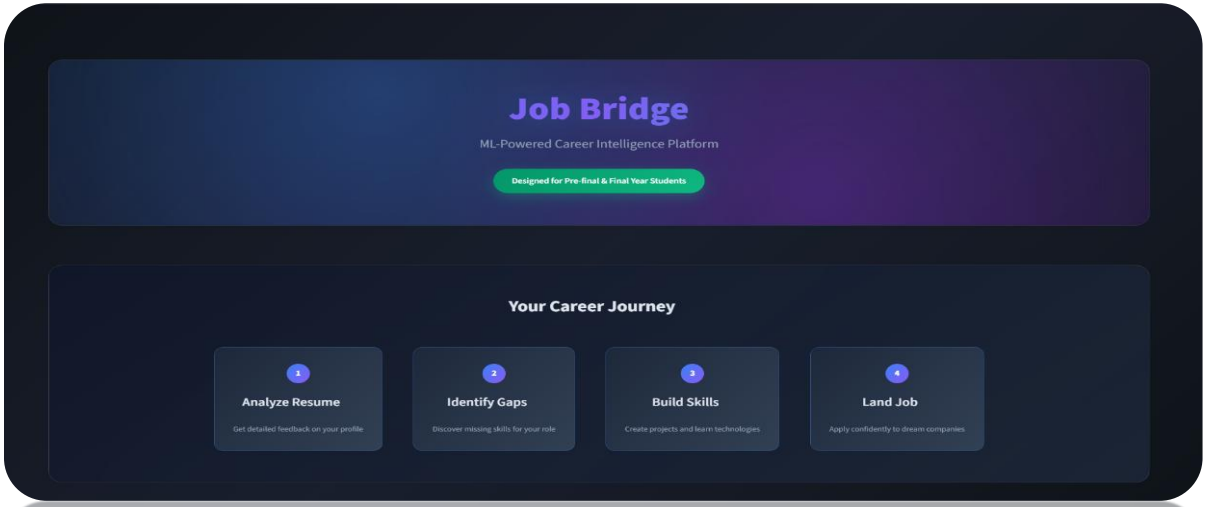
Test Case 3: Forecasting (Random Forest)

- Input: Features (match %, gaps, experience); 150 trees
- Expected: Timeline predictions; RMSE evaluation
- Validation: Cross-validation on synthetic/real data (7,000 postings, 1,500 syllabi)
- Result: Pass (adjusted for Indian context; DPDP compliance)

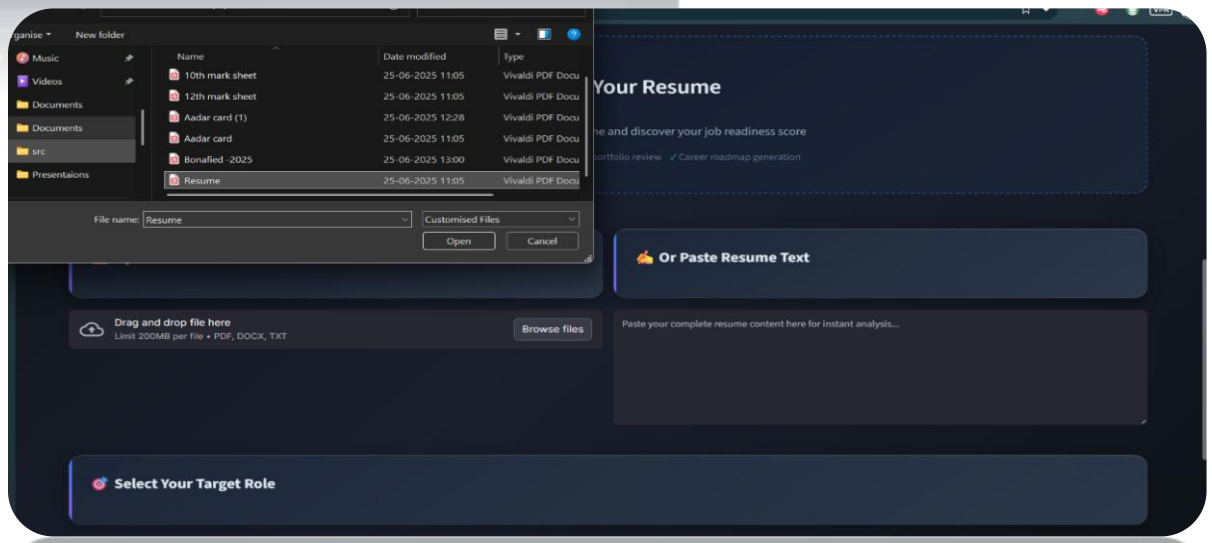
Validation Testing:

- K-Fold: 5-fold on Indian datasets; ROC-AUC >0.92
- Holdout: 80/20 split; multilingual (Hindi F1=93%)
- User: Beta on 50 samples; baseline vs CRF (89% F1)

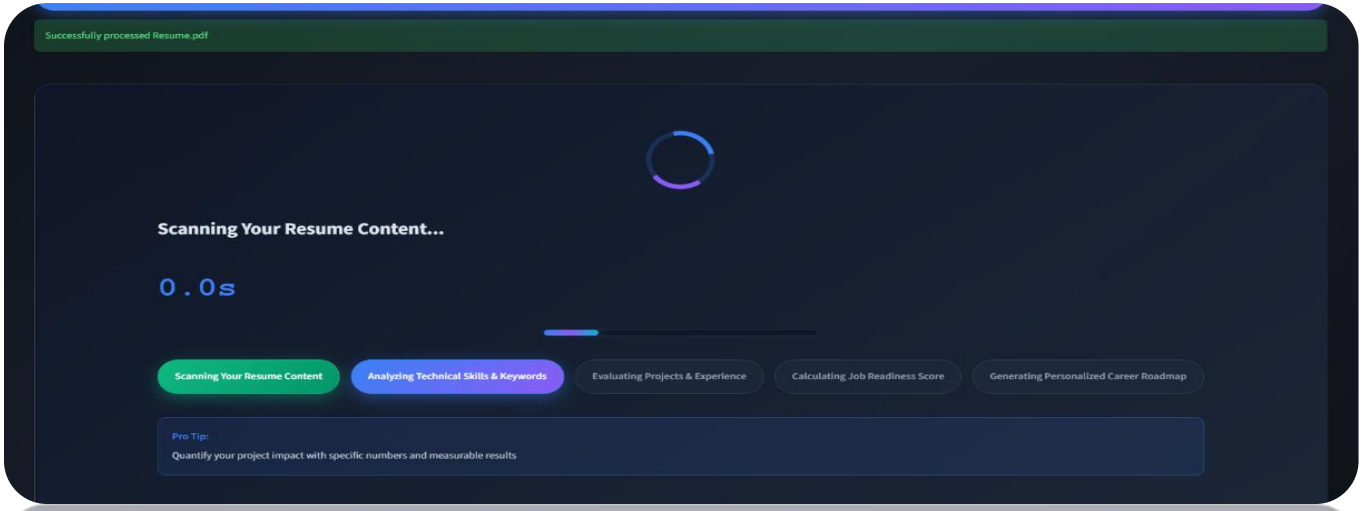
Live Demo Screenshots



Interface Landing page



Resume uploading section



Loading Section

Dashboard report

Report Download

Conclusion & Impact

Solution Overview:

- JobBridge leverages AI (NLP/BERT, GNN, Random Forest) for skill gap analysis
- Connects academic curricula with real-time job market demands
- Achieves 96% accuracy in skill extraction from Indian job postings

Key Benefits:

- Empowers students with personalized learning roadmaps
- Enables institutions to align curricula with industry needs
- Assists recruiters in identifying skilled candidates efficiently

Impact:

- Reduces 20% graduate unemployability in India
- Enhances education-industry collaboration
- Supports scalable, multilingual (Hindi/Tamil) solutions

Contributions:

- Introduces India-specific skill taxonomy
- Provides predictive analytics for placement readiness
- Advances workforce planning with AI-driven insights

SDG Alignment:

- Supports SDG 4 (Quality Education) via skill-relevant training
- Aligns with SDG 8 (Decent Work and Economic Growth) through employment opportunities
- Promotes inclusive education and fair job access

Overall Outcome:

- Establishes a foundation for a skill-ready, inclusive workforce
- Demonstrates 40% efficiency gain over manual methods
- Paves way for future AI innovations in education and employment

Future Enhancements

Model Enhancements:
- Refine GINXMLC with dynamic ontology updates

Data Integration:
- Link with academic boards for real-time curriculum updates
- Expand APIs to include more job portals

UI Improvements:
- Develop AI-powered dashboards for trend visualization

Collaborations:
- Partner with Coursera/SWAYAM for course integration

Taxonomy Expansion:
- Incorporate hybrid skill frameworks (ESCO/O*NET + India-specific)

Security/Add-ons:
- Implement blockchain for certificate validation

Analytics:
- Introduce predictive analytics for job trends

Base Paper Details & References

Base Paper Title:
Deep Learning-based Computational Job Market Analysis: A Survey on Skill Extraction and Classification from Job Postings

Authors: Elena Senger, Mike Zhang, Rob van der Goot, Barbara Plank

Event/Conference Details: Proceedings of the First Workshop on Natural Language Processing for Human Resources (NLP4HR 2024)

Publisher: Association for Computational Linguistics (ACL)
Year: 2024
Pages: 1–15
DOI/URL: https://aclanthology.org/2024.nlp4hr-1.1/

Key Insights: Comprehensive NLP survey on skill extraction/classification; covers 26 neural publications; focuses on datasets, terminologies (hard/soft skills), and DL methods like BERT/LLMs
Relevance to JobBridge: Builds foundation for BERT-based extraction and GNN enhancements; addresses gaps in low-resource tasks via synthetic data

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