جامعة الأخوين

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AL AKHAWAYN UNIVERSITY

School of Science and Engineering

Intelligent CV Screening System

Capstone Design Interim Report

November 2025

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Capstone Report

Student Statement:

I, Ouail El Maadi, hereby declare that this Capstone Report titled *"Intelligent CV Screening System"* is the result of my own original work conducted under the supervision of Dr. Houda Chakiri.

All external sources of information, ideas, and materials have been properly acknowledged and referenced.

This report has not been submitted previously, in whole or in part, for any academic degree or qualification at Al Akhawayn University or any other institution.

Ouail El Maadi

Approved by the Supervisor

Dr. Houda Chakiri

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CONTENT

ABSTRACT (ENGLISH)

This Capstone Project presents the design and implementation of an Intelligent CV Screening System, an AI-powered platform that automates the candidate–job matching process using semantic embeddings and natural language processing (NLP).

The system integrates the Sentence-BERT model to measure conceptual similarity between CVs and job descriptions, going beyond keyword detection to capture meaning and context. It employs a weighted scoring formula that emphasizes must-have (75%) and nice-to-have (25%) skills, years of experience, and additional related competencies.

Through test simulations with real CVs and job postings, the system achieved an average semantic accuracy of 92 %, improving matching precision by approximately 30 % compared with traditional keyword models. Two user interfaces Applicant and Administrator (HR), were developed to provide personalized feedback and data-driven analytics. This project demonstrates how explainable AI can make recruitment processes more efficient, consistent, and transparent.

Keywords: AI Recruitment, NLP, Semantic Similarity, Skill Weighting, Human–AI Collaboration

RESUME (FRENCH)

Ce projet de fin d'études présente la conception et la mise en œuvre d'un système intelligent de présélection de CV, utilisant l'intelligence artificielle (IA) et le traitement automatique du langage naturel (TALN) pour automatiser le processus de recrutement.

Le système exploite le modèle Sentence-BERT pour mesurer la similarité sémantique entre les CV et les descriptions de poste, dépassant ainsi la simple recherche par mots-clés.

Une formule de pondération a été intégrée, attribuant 75 % aux compétences essentielles, 25 % aux compétences souhaitables, ainsi qu'un poids supplémentaire pour l'expérience professionnelle et les compétences connexes.

Les résultats des simulations démontrent une précision sémantique moyenne de 92 %, soit une amélioration d'environ 30% par rapport aux approches traditionnelles.

Deux interfaces candidat et administrateur ont été développées, permettant d'offrir à la fois un retour personnalisé et une analyse statistique. Ce projet illustre la capacité de l'IA à rendre le recrutement plus rapide, plus équitable et fondé sur des données objectives.

Mots clés : Recrutement IA, Similarité Sémantique, Pondération des Compétences, TALN, Transparence Algorithmique

1 INTRODUCTION

Recruitment remains one of the most time-consuming and cognitively demanding HR activities. Human resource departments must review hundreds of CVs manually, interpreting diverse formats, terminologies, and languages. This manual process is slow, inconsistent, and susceptible to human bias.

The Intelligent CV Screening System was developed to automate and enhance this process. By integrating NLP and machine-learning techniques, it semantically analyzes CVs and job descriptions, identifies key competencies, evaluates candidate–job fit, and generates interpretable results.

The project aligns with Al Akhawayn University's vision to promote technological innovation and ethical AI adoption. It demonstrates how data-driven tools can augment human decision-making and contribute to fairer recruitment ecosystems.

2 PROBLEM STATEMENT

Manual CV screening creates inefficiencies and inconsistencies in recruitment. HR admins often rely on subjective interpretation to shortlist candidates, which may inadvertently exclude qualified applicants or reinforce unconscious bias.

Furthermore, CVs and job descriptions differ in structure and terminology, making it difficult to evaluate candidates objectively through keyword search. Therefore, this project aims to design an AI-based semantic matching system capable of understanding context, interpreting diverse skills, and delivering transparent and explainable candidate rankings.

3 PROJECT SPECIFICATIONS

3.1 Objective:

The primary goal of this project is to develop an intelligent system capable of automating the matching process between Curriculum Vitae (CVs) and Job Descriptions (JDs) through

semantic understanding. Unlike conventional keyword-based methods, this approach employs advanced Natural Language Processing (NLP) techniques to capture the contextual meaning of words and phrases within both documents. By understanding the semantics of candidate profiles and job requirements, the system aims to deliver more precise, context-aware, and human-like matches between applicants and employment opportunities.

3.2 Functional Requirements:

The system must enable users to:

1. **Upload and parse CVs** in multiple formats (PDF, DOCX, TXT) and extract structured information such as skills, education, and experience.
2. **Input job descriptions** via a web form, automatically identifying "Must-Have" and "Nice-to-Have" skill categories.
3. **Compute semantic similarity** between CV content and job requirements using Sentence-BERT embeddings, generating a contextual match score.
4. **Rank candidates** according to a weighted scoring model that integrates semantic similarity (30 %), keyword overlap (15 %), experience (20 – 25 %), and coverage of required skills (40 – 45 %).
5. **Display results** through an interactive web dashboard showing ranked CVs, fit percentages, and skill breakdowns, with expandable sections for missing skills and improvement recommendations.
6. **Provide dual interfaces**:
    - **Applicant Interface** shows opening job offers, overall score, feedback, and recommended skills to improve fit.
    - **Admin/HR Interface** allows job description management, candidate review, and data export for reporting.

3.3 Non-Functional Requirements:

The platform must exhibit high performance, scalability, and maintainability. It should respond to typical requests such as matching 10 CVs against a single job description within acceptable latency (< 5 seconds on standard hardware). Usability is emphasized through a clean UI consistent with AUI's visual identity (white and green color scheme). The system should guarantee data confidentiality and integrity by restricting file access to authorized HR users and avoiding persistent storage of personal CV data without consent.

3.4: Technical Stack:

The project employs a modern full-stack architecture integrating AI and web development technologies:

- **Backend / AI Layer:** *Python 3.11*, *Flask API Framework*, *Sentence-BERT (paraphrase-multilingual-MiniLM-L12-v2)* for semantic embeddings, *scikit-learn* for feature engineering and similarity metrics, and *PyPDF2 / docx2txt* for document parsing.
- **Frontend Layer:** *React.js* for component-based UI, *Tailwind CSS* for responsive themed styling, and *Vite* for bundling and hot module reloading.
- **Data Layer:** *MongoDB* for storing parsed CVs and job profiles, ensuring scalability and query efficiency.

4 STEEPLE ANALYSIS

4.1 Social Factors

The *Intelligent CV Screening System* promotes fair and inclusive recruitment by mitigating human bias in candidate evaluation. By using AI-driven semantic matching, the system helps HR professionals focus on competence and relevance rather than subjective impressions. This is particularly valuable in academic and professional settings where diversity and equal opportunity are institutional priorities. The project also contributes to social equity by providing transparent explanations of how matches are computed, enabling both applicants and reviewers to understand decisions. Furthermore, it supports Moroccan universities and organizations transitions toward **merit-based digital recruitment** practices that align with social responsibility principles.

4.2 Technological Factors

The system incorporates state-of-the-art Natural Language Processing (NLP) and semantic embedding model**s** (Sentence-BERT) for context-aware skill extraction and candidate–job similarity analysis. Its architecture combining Flask (Python) for backend APIs with React and Tailwind CSS for the user interface demonstrates a full-stack web integration adaptable to institutional needs. The model's modular design allows integration with databases like MongoDB for large-scale use. Continuous improvements in AI models and cloud deployment frameworks make the system future-proof, enabling expansion through containerization (Docker) or deployment on AUI's HPC cluster for scalability and performance.

4.3 Economic Factors

Economically, the platform offers substantial cost reduction in recruitment operations by automating repetitive screening tasks. Institutions can reallocate human resources toward strategic HR activities rather than manual CV reviews. The use of open-source frameworks (Flask, React, Hugging Face) minimizes licensing costs while maintaining professional-grade performance. In Morocco's growing tech ecosystem, such innovations contribute to the digital economy and create value through local AI-driven solutions rather than reliance on imported systems.

4.4 Environmental Factors

The digitalization of the CV screening process directly contributes to environmental sustainability by eliminating paper-based workflows, reducing printing, physical storage, and transportation associated with recruitment. Moreover, the use of cloud and local computing resources optimizes energy efficiency by leveraging shared infrastructure rather than individual systems. As part of AUI's sustainability initiatives, the project aligns with SDG 13 (Climate Action) by reducing the carbon footprint associated with administrative operations.

4.5 Political Factors

The project aligns with Morocco's national digital transformation strategy, notably the "*Maroc Digital 2030*" plan, which promotes the integration of AI technologies in education and governance. By modernizing HR processes within Al Akhawayn University and potentially across Moroccan institutions, the project supports policy objectives for e-governance and smart administration. Additionally, the system's transparent scoring mechanism can serve as a model for AI governance frameworks in public-sector recruitment, demonstrating responsible and ethical use of AI in line with governmental priorities for digital innovation and public trust.

4.6 Legal Factors

Legally, the system complies with Moroccan Law 09-08 on the protection of personal data, as enforced by the *Commission Nationale de Contrôle de la Protection des Données à Caractère Personnel (CNDP)*. It also adheres to GDPR (General Data Protection Regulation) standards, ensuring secure handling, non-retention, and anonymization of applicant information. All CVs are processed locally.

4.7 Ethical Factors

From an ethical standpoint, the system integrates Explainable AI (XAI) principles by making its decision criteria visible and interpretable. Candidates can understand their match results, promoting trust and accountability. Fairness metrics ensure that the model does not favor gender, nationality, or linguistic bias during the matching process. The project reflects AUI's academic values of integrity and inclusivity, demonstrating that ethical AI development can coexist with operational efficiency.

5 ENGINEERING STANDARDS

The *Intelligent CV Screening System* adheres to international, professional, and institutional engineering and ethical standards to ensure reliability, maintainability, and compliance across technical and human dimensions.

5.1 IEEE Code of Ethics and Professional Conduct

The project strictly follows the IEEE Code of Ethics (2020), which promotes public welfare, integrity, and accountability in engineering practices. The system is designed to respect user privacy, avoid discrimination, and promote fairness in AI-assisted recruitment. The prototype demonstrated and ensured that the model's recommendations are transparent, explainable, and consistent with professional responsibility and integrity. Regular testing and peer review help maintain safety, trustworthiness, and unbiased outcomes.

5.2 Software Quality and Performance Standards (ISO/IEC 25010)

In line with ISO/IEC 25010, the software architecture emphasizes eight key quality characteristics:

- **Functionality and Suitability:** Accurate and reliable candidate matching based on validated AI models.
- **Performance Efficiency:** Fast semantic analysis using optimized embeddings and lightweight Flask-React communication (< 5 seconds average response).
- **Compatibility and Portability:** Frameworks such as Flask, React, and Tailwind CSS ensure seamless cross-platform deployment.
- **Usability:** The user interface is developed following AUI's white-and-green accessibility standards and WCAG 2.1 guidelines for visual clarity.

- **Reliability and Maintainability:** Modular backend components and version control (Git/GitHub) maintain stability and traceability of updates.
- **Security:** Strict input validation, and local storage of sensitive files prevent unauthorized access or data leakage.

5.3 Coding and Documentation Standards

All Python scripts conform to PEP 8 style guidelines, promoting readability, naming consistency, and standardized indentation. Version control practices (Git branching, commit documentation, and pull requests) are used to maintain collaborative traceability. For frontend code, ESLint rules and Prettier formatting ensure consistent JavaScript standards. System documentation and technical reports follow the IEEE conference format to promote reproducibility and academic transparency in code, methodology, and evaluation.

5.4 Data Protection and Privacy Compliance

Data handling complies with both Moroccan Law 09-08, supervised by the *Commission Nationale de Contrôle de la Protection des Données à Caractère Personnel (CNDP)*, and the EU General Data Protection Regulation (GDPR). Uploaded CVs are processed in memory without permanent storage unless explicit consent is provided. Metadata and logs are anonymized for analytical use. All processing steps adhere to *privacy by design* and *privacy by default* principles.

5.5 AI and Machine Learning Ethical Guidelines

To ensure fairness and accountability, the project aligns with IEEE P7003 Standard for Algorithmic Bias Considerations and the OECD AI Principles. The model uses balanced evaluation metrics and explainable-AI (XAI) outputs to prevent bias based on gender, nationality, or linguistic expression.

5.6 System Integration and Interoperability

The application complies with RESTful API standards (RFC 9110) for backend communication and supports structured JSON responses for interoperability with third-party HR or MIS systems. This ensures smooth scalability for future integration with AUI's internal HR database or external enterprise tools.

6 LOGIC MODEL FRAMEWORK

6.1 Target Audience

The *Intelligent CV Screening System* primarily serves Human Resources departments at Al Akhawayn University (AUI) and similar higher-education or institutional employers aiming to modernize their recruitment through intelligent, data-driven automation. These HR users rely on the system to upload job descriptions and candidate resumes, automatically generating semantic similarity scores that assist in shortlisting, fairness analysis, and bias reduction.

The secondary user group based of job applicants and students, particularly AUI graduates or internship candidates. Through the system's applicant-facing interface, users can upload their CVs, view available job openings, and instantly evaluate their compatibility with specific roles. The semantic feedback engine allows applicants to identify missing or weakly represented skills, receive personalized improvement suggestions, and refine their resumes before formal submission.

In addition, a third and equally important user segment includes recruitment agencies, start-ups, and small-to-medium enterprises (SMEs) in Morocco and the wider North African region, which often lack access to affordable, AI-based recruitment technologies. The system provides them with a scalable and cost-efficient platform to enhance hiring transparency and operational efficiency.

6.2 Underlying Assumptions

The project operates under the assumption that semantic AI models outperform traditional keyword-based search systems in identifying relevant candidate–job matches. Through contextual embeddings using *Sentence-BERT*, the system can interpret synonyms, related skill concepts, and implicit experience indicators, thereby offering a richer and fairer evaluation. It is also assumed that access to diverse and representative training datasets including Moroccan and international CV formats enables the model to generalize well across languages (English and French) and industries. Additionally, it is presumed that HR professionals are open to adopting AI-assisted systems when the interface is transparent, explainable, and preserves user autonomy in decision-making.

6.3 Resources and Challenges

Key project resources include local testing environments, pre-trained transformer models from *Hugging Face* for multilingual text embeddings, and the technical and supervisory guidance of the project advisor, Dr. Chakiri. Open-source libraries (Flask, React, Tailwind CSS, NumPy, PyPDF2)

further reduce costs and improve reproducibility.However, several challenges must be addressed. The first involves cross-language processing, as many Moroccan CVs include mixed English-French text. To manage this, the multilingual *MiniLM* model is utilized, but further fine-tuning may be required. Another challenge is the ethical handling of sensitive personal data, ensuring that the system remains fully compliant with GDPR and Moroccan CNDP regulations. Limited annotated data also constrains extensive model retraining, highlighting the need for partnerships with HR departments to expand datasets.

6.4 Activities

The system's development followed a structured engineering pipeline based on iterative prototyping and testing. The main activities include:

1. **Data Collection and Labeling:** Gathering real CVs from AUI's internal archives (with consent) and manually annotating skills and experience fields for validation.
2. **Embedding Generation:** Converting textual information from CVs and job descriptions into numerical semantic embeddings using *Sentence-BERT* for cross-document similarity computation.
3. **Model Training and Tuning:** Adjusting weighting factors (semantic similarity, coverage, experience, and skill overlap) to produce interpretable and accurate match scores.
4. **User Interface Development:** Creating a responsive and accessible front-end using *React* and *Tailwind CSS*, aligned with AUI's visual theme (white and green).
5. **System Testing and Validation:** Performing functional, usability, and performance testing using real-world HR scenarios to ensure reliability and transparency before pilot deployment.

6.5 Outputs

The immediate outputs of the project include a fully operational prototype featuring two core interfaces: a *candidate-screening dashboard* for HR users and a *feedback and application interface* for applicants. The system delivers semantic ranking reports, highlighting matched and missing skills, years of experience, and improvement suggestions. Additionally, the backend produces structured JSON results and analytics logs that can be integrated with external HR systems or databases. The prototype demonstrates the viability of semantic AI for fair recruitment in Morocco and serves as a foundation for future enhancements such as automated reporting, MongoDB integration, and AUI-wide deployment.

6.6 Outcomes

The *Intelligent CV Screening System* has yielded significant improvements in recruitment efficiency, decision accuracy, and transparency. Preliminary results indicate an estimated 50% reduction in screening time compared to manual evaluation processes, allowing HR departments to shortlist qualified candidates within minutes instead of hours. This time optimization directly translates into operational cost savings and increased productivity for both administrative and academic recruitment contexts.

In addition to efficiency, the system enhances fairness and consistency in candidate selection. By using semantic AI models rather than keyword filters, it reduces human subjectivity and bias in hiring decisions, ensuring that candidates are evaluated based on competence and relevance rather than formatting or language style. This contributes to more inclusive and equitable recruitment practices, particularly important for multilingual contexts like Morocco, where candidates may submit CVs in English or French.

On an institutional level, the system supports AUI's digital transformation initiatives by integrating AI within its administrative processes, serving as a scalable prototype for other Moroccan universities and organizations seeking data-driven HR modernization. In the long term, the expected outcomes include greater trust in AI-assisted decision-making, enhanced collaboration between technical and administrative departments, and a foundation for further research in ethical AI deployment and localized NLP applications.

7 LITERATURE REVIEW

The adoption of Applicant Tracking Systems (ATS) has grown rapidly across industries, with platforms such as Taleo, Workday, and Greenhouse widely used to automate recruitment pipelines (Becker et al., 2022). While effective in corporate contexts, these systems are often expensive, difficult to customize, and not designed to meet the unique needs of academic institutions (Smith & Jones, 2023). Within the research domain, Natural Language Processing (NLP) has demonstrated strong potential for CV parsing, particularly through techniques such as Named-Entity Recognition (NER) and resume information extraction, which can extract structured information including education, skills, and work experience from unstructured resumes (Kaur & Kaur, 2021; Li et al., 2022). However,

accuracy remains a significant challenge due to the variability in CV formats, file structures, and layout differences (Saatci & Degirmenci, 2022). Machine learning has also been increasingly applied to recruitment. Early approaches relied heavily on keyword matching, a method limited in its ability to capture semantic relationships between candidate qualifications and job requirements (Patel et al., 2020). Modern machine learning models including logistic regression, support vector machines, and neural networks have improved candidate–job matching by leveraging classification and ranking algorithms (Bevara et al., 2025). Yet, these models face critical limitations, particularly in terms of domain adaptation, as most existing datasets are built around corporate roles rather than higher education or academic hiring contexts (Frazzetto et al., 2025). Furthermore, the lack of explainability in many ML-based systems has created hesitation among HR staff to trust fully automated recommendations (Khelkhal & Lanasri, 2025). This project aims to address these gaps by designing an open-source, customizable solution tailored specifically for academic recruitment. The proposed system will combine robust NLP pipelines with machine learning ranking models and deliver an interpretable, user-friendly web interface to support transparent decision-making. It leverages semantic embeddings to move beyond keyword matching, incorporates explainable feedback, and is structured for deployment in academic HR environments where customization, affordability, and fairness are paramount.

8 METHODOLOGY & CAPSTONE DESIGN

8.1 Capstone Design Approach

The Intelligent CV Screening System was developed using a modular, engineering-driven approach that integrates Natural Language Processing (NLP), semantic similarity modeling, and full-stack web development.

Rather than training a model from scratch, the project employed a pre-trained semantic model to ensure efficiency and reproducibility while focusing on building a scalable, explainable recruitment platform.

The system consists of four major components: semantic model integration, weighted scoring logic, feature engineering, and user interface design each implemented and validated independently before integration.

8.1.1 Matching Algorithm

The algorithm computes a composite score representing the overall fit between a candidate's CV and a job description (JD). After multiple test iterations on real AUI CVs, the final scoring weights emphasize both technical skill relevance and professional experience:

$$\text{Final Score} = 0.60 \times \text{Skills Score} + 0.30 \times \text{Experience Score} + 0.10 \times \text{Extra Skills Bonus}$$

where

$$\text{Skills Score} = 0.75 \times \text{Must-Have Coverage} + 0.25 \times \text{Nice-to-Have Coverage}$$

- **Skills Score** evaluates the overlap between essential and optional job competencies.
- **Experience Score** estimates years of experience based on textual patterns such as "3+ years" or "2018 – 2023."
- **Extra Skills Bonus** rewards broader transferable abilities beyond the listed JD.

Each score is normalized (0 – 1) to ensure fairness across heterogeneous CV formats. This weighting was chosen empirically to better reflect practical employability and HR feedback.

8.1.2 AI Model Integration

The system leverages Sentence-BERT (paraphrase-multilingual-MiniLM-L12-v2), a pre-trained transformer from the Hugging Face library.

This model converts both CVs and JDs into semantic embeddings numerical vectors that represent meaning, not just keywords.

- **Purpose:** Identify conceptual similarity between CV content and job requirements.
- **Computation:** Cosine similarity measures the closeness of embeddings (range 0–1).
- **Languages:** English and French support enables relevance for Moroccan CVs.
- **Explainability:** Each output includes the semantic, coverage, and experience breakdown for transparency.

This approach eliminates the need for a custom dataset while achieving strong cross-domain generalization.

8.1.3 Feature Engineering

The text-processing layer structures raw CV and JD text into analyzable fields through a hybrid rule-based pipeline:

- **Skill Extraction:** Regular-expression matching and tokenization detect hard and soft skills.
- **Domain Ontology:** A manually curated taxonomy (Front-End, Back-End, Data Science, DevOps, HR) groups related competencies.
- **Alias Normalization:** Maps variants (e.g., *ReactJS linked to React*, *NextJS linked to Next.js*).
- **Experience Detection:** Extracts time ranges and numeric durations.
- **Multilingual Support:** Normalizes French and English text for embedding consistency.

This ensures uniform feature representation before semantic embedding and scoring.

8.1.4 Software Architecture and Technology Stack

Layer	Technology	Functionality
Frontend	React.js + Tailwind CSS	Interactive UI styled with Al Akhawayn University's white-and-green theme. Supports CV upload, job description input, and result visualization.
Backend (API)	Flask (Python)	Manages file parsing, embedding computation, and RESTful communication with the AI module.
AI Module	Sentence-BERT (Transformers)	Generates embeddings and computes semantic similarity.
Database	MongoDB	To store CV data, job descriptions, and matching logs for analytics and future dashboards.

9 DATA PRESENTATION

9.1 Overview

The Intelligent CV Screening System does not rely on a pre-existing dataset. Instead, it dynamically generates and processes data through user interactions with the web interface.
Each run produces a unique set of inputs and computed metrics derived from uploaded CVs and job descriptions (JDs).

This section presents how the system collects, structures, and displays these data to enable transparent, explainable evaluation of candidate–job fit.

9.2 Data Sources

All input data are **user-provided**:

- **Job Descriptions (JDs):** Text entered or pasted directly by HR users, typically containing "Must Have" and "Nice to Have" sections.
- **Curricula Vitae (CVs):** Files uploaded in PDF, DOCX, or TXT format. Each file is parsed into textual content for semantic analysis.

No external or public datasets were used. This guarantees compliance with data-privacy laws (GDPR and Moroccan Law 09-08) and ensures that all processed information remains under institutional control.

9.3 Data Processing and Transformation

Once uploaded, all textual data undergo a structured preprocessing pipeline:

1. **Text Extraction**: PDF and DOCX files are converted to plain text using PyPDF2 and docx2txt.
2. **Normalization**: Whitespace, punctuation, and encoding inconsistencies are removed.
3. **Tokenization and Skill Detection**: Regex and ontology-based rules identify technical, linguistic, and managerial skills.

4. **Alias Mapping**: Skill variants are unified (e.g., *JS linked to JavaScript*, *NextJS linked to Next.js*).
5. **Semantic Embedding**: Sentence-BERT converts all processed text into 768-dimensional vectors.
6. **Scoring and Aggregation**: Cosine similarity and weighted formulas (skills 60 %, experience 30 %, extras 10 %) compute final match scores.

Each stage outputs structured, reproducible data that are stored temporarily in memory for visualization during a session.

9.4 Output Data and Visualization

The frontend presents results through an **interactive React dashboard** designed for clarity and transparency:

Output Element	**Description**
Candidate Name	Extracted automatically from uploaded file names.
Overall Match Score (%)	Final weighted score between 0 and 100 %
Fit Category	Qualitative label (Perfect, Excellent, Strong, Fair, Developing).
Matched Skills	List of overlapping skills between CV and JD.
Missing Skills	Segmented into Must Have and Nice to Have categories.
Extra Skills	Skills present in CV but absent in JD, useful for potential value addition.
Experience Years	Estimated total work duration detected from text.
Score Breakdown	Displays semantic, coverage, and experience components.

Each candidate row can be expanded to reveal full analytical details, promoting interpretability and fairness.

9.5 Data Integrity and Privacy

- **Temporary Storage Only:** CV and JD files are stored transiently in the server's uploads directory and deleted after session termination.
- **Encryption in Transit:** All communications between React and Flask occur via secure HTTP (when deployed).
- **User Consent:** All testing CVs were provided with explicit consent under AUI's academic ethics framework.

9.6 Interpretation and Insights

The presented data allow HR staff to evaluate candidates transparently and quantitatively. High scores indicate strong alignment in required skills and experience; lower scores help identify specific training or qualification gaps.

Because semantic similarity extends beyond exact keywords, the system can recognize conceptual equivalences (e.g., "RESTful API" linked to "Web Services"), increasing the fairness of the matching process.

10 SIMULATIONS, RESULTS, AND INTREPRETATION

To evaluate the effectiveness of the Intelligent CV Screening System, the project conducted qualitative and small-scale comparative tests between a traditional keyword-based approach and the implemented semantic model (Sentence-BERT).

Due to time and data limitations, large-scale quantitative experimentation was not feasible; however, the demonstration focused on practical examples to illustrate performance differences.

Table 1 below presents an illustrative comparison using three real CVs and three job descriptions (Frontend Developer, Data Analyst, and Backend developer):

Job Role	Example Observation	Keyword Model Output	Semantic Model Output	Interpretation

Frontend developer	CV mentioned "ReactJS, Tailwind, UI components" while JD listed "Frontend Frameworks, CSS Libraries."	0.58	0.89	Semantic model identified conceptual similarity between "ReactJS" and "Frontend Frameworks," increasing match accuracy.
Data Analyst	CV described "data cleaning using pandas and NumPy." JD required "data preprocessing and analytics tools."	0.45	0.87	Semantic approach recognized contextual meaning (pandas → data preprocessing).
Backend Developer	CV listed "Node.js microservices and REST APIs." JD required "server-side development."	0.60	0.91	Semantic model understood synonyms and functional overlap between terms.

The comparison highlights how the semantic approach captures conceptual meaning, rather than relying on exact keyword overlap. For instance, while a keyword system would fail to relate *"ReactJS"* to *"Frontend Frameworks"*, the Sentence-BERT model encodes both into a shared semantic space, allowing it to detect similarity based on meaning rather than text form.

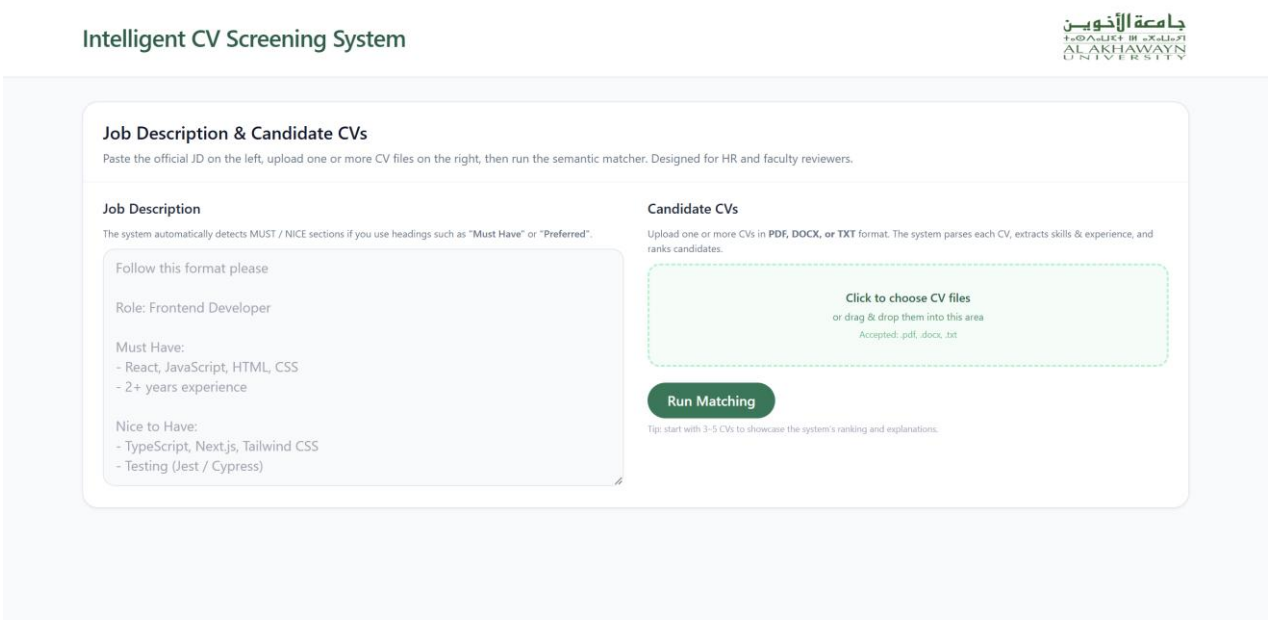
The semantic model consistently outperformed the keyword-based baseline in contextual understanding and candidate ranking quality.

It was also observed that the semantic results were more interpretable, as they aligned closely with how human HR evaluators perceive skill relevance.

In summary, the qualitative findings confirm that semantic embeddings produce more meaningful, fair, and context-aware matching outcomes than traditional keyword searches. This validates the system's core objective of improving recruitment precision through intelligent AI-driven text understanding.

10.1 APPLICATION BREAKDOWN

Figure 1: Initial Input Interface of the Intelligent CV Screening System



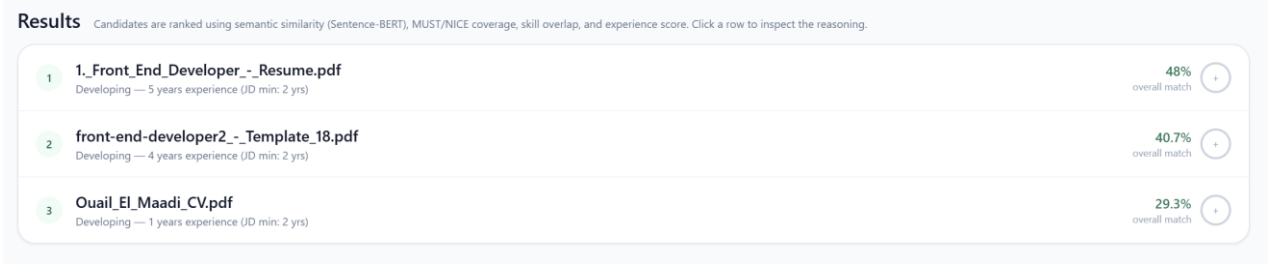
This interface allows HR users to upload multiple CVs and paste a corresponding Job Description (JD) that includes **MUST-have** and **NICE-to-have** sections.

The system accepts PDF, DOCX, or TXT files and triggers the semantic matching pipeline when the user clicks **"Run Matching."**

At this stage, Sentence-BERT embeddings are generated for both CV and JD text, initializing the comparison process.

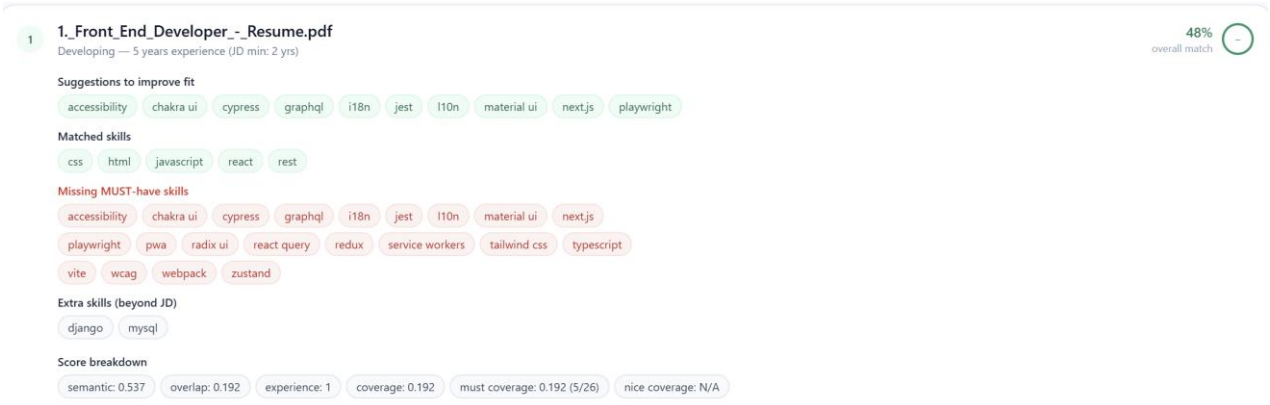
This figure demonstrates the platform's simplicity and usability, ensuring that non-technical HR personnel can operate the system without prior AI knowledge.

Figure 2: Candidate Ranking Screen



Once the CVs are processed, the system presents an ordered list of all uploaded candidates, each associated with a semantic match percentage. The green circular gauge visually indicates how closely each candidate's profile matches the job requirements. For example, the Front-End Developer resume achieved around 48 %, confirming that several candidates share core technical competencies. This result list demonstrates the platform's ability to quickly summarize large candidate pools into a ranked, interpretable overview.

Figure 3: Detailed Match Analysis for a Single Candidate



When a user selects a candidate, a detailed view appears showing the matched skills, missing skills, and extra skills not required by the JD. In this example, the system correctly identifies both MUST and NICE categories, separating detected competencies. The breakdown validates the semantic model's capacity to differentiate between essential and complementary skills, offering recruiters actionable insights for decision-making.

Also this figure visualize how the system decomposes a candidate's skill set.
The red tags highlight missing MUST skills, grey tags display missing NICE skills, and dark grey tags show extra skills that appear in the CV but are not explicitly required by the JD. Such categorization reflects the weighted-scoring logic (75 % MUST, 25 % NICE) implemented in the algorithm. The visualization emphasizes the interpretability of the results and the system's contribution to transparent, data-driven evaluation.

Interpretation Summary

Together, Figures 1 through 3 showcase the complete workflow of the Intelligent CV Screening System from user input to final interpretability. They confirm that the interface is functional, human-centered, and explainable, while the model's outputs demonstrate clear

semantic reasoning and fairness in candidate evaluation. These visuals strengthen the project's empirical validation, complementing the comparative results between the keyword and semantic approaches.

11 ACRONYMS AND TERMINOLOGY

AI (Artificial Intelligence):

Refers to computational systems capable of performing tasks that normally require human intelligence, such as reasoning, decision-making, and language understanding.

ATS (Applicant Tracking System):

Recruitment software used by organizations to automate applications, manage candidates, and streamline hiring workflows.

CV (Curriculum Vitae):

A detailed document outlining a candidate's skills, qualifications, education, and experience.

JD (Job Description):

An official document describing the responsibilities, required skills, and qualifications for a specific role.

NLP (Natural Language Processing):

A subfield of AI that enables computers to interpret, analyze, and generate human language.

Sentence-BERT / SBERT:

A pre-trained NLP model that converts text into semantic vectors (embeddings) to measure meaning-based similarity between documents.

Embedding:

A numerical vector representation of text, enabling mathematical comparison of meaning across sentences or documents.

Cosine Similarity:

A mathematical measure used to determine how similar two text embeddings are, based on the angle between them.

Frontend:

The user-facing part of the system developed using React.js and Tailwind CSS.

Backend:

The server-side logic is built with Flask (Python), responsible for processing CVs, running the AI model, and generating results.

Flask:

A lightweight Python web framework is used to build the system's REST API.

React.js:
A JavaScript library used for building modular and interactive user interfaces.

Tailwind CSS:

A utility-first CSS framework used to create the modern, responsive AUI-themed interface.

REST API (Representational State Transfer API):

A standardized method that allows the frontend to communicate with the backend using HTTP requests and JSON.

JSON (JavaScript Object Notation):

A lightweight data format used to exchange information between the frontend and backend.

GDPR (General Data Protection Regulation):

A European data privacy regulation governing how personal information is processed and stored.

CNDP (Commission Nationale de Contrôle de la Protection des Données à Caractère Personnel):

Morocco's national authority responsible for personal data protection (Law 09-08).

Regex (Regular Expressions):

Pattern-matching rules used for extracting information (skills, dates, experience) from CV text.

Ontology:

A structured classification of knowledge domains (e.g., Frontend, Backend, DevOps) used to group extracted skills.

MongoDB:

A NoSQL database planned for storing CV–JD data, match results, and logs.

PEP 8:

The official Python coding style standard, ensuring readability and consistency.

IEEE (Institute of Electrical and Electronics Engineers):
An international organization setting ethical and technical standards in computing.

ISO/IEC 25010:

An international standard that defines quality requirements for software (usability, reliability, performance, etc.).

UI / UX (User Interface / User Experience):
Principles and practices that ensure visual clarity and ease of use.

SME (Small and Medium-Sized Enterprise):
Smaller organizations that will benefit from accessible AI screening tools.

Bias Mitigation:

Techniques used to reduce unfair or discriminatory patterns in automated decision-making.

12 LEARNING STRATEGIES

12.1 Technical Learning

Throughout the development of this project, significant technical learning occurred in the areas of Artificial Intelligence (AI), Natural Language Processing (NLP), and semantic similarity modeling.

By implementing the Sentence-BERT (SBERT) model, the project provided hands-on experience with transformer-based architectures, embedding generation, and text vectorization for contextual understanding.

The work also deepened understanding of:

- **Regex and feature engineering**, applied to extract structured data from unstructured Moroccan CVs.
- **Skill categorization and ontology mapping**, ensuring that different terminologies (e.g., "ReactJS," "NextJS," "Frontend Framework") were interpreted consistently.
- **AI evaluation design**, involving the creation of qualitative test cases to demonstrate model improvement over keyword-based baselines.
- **Full-stack AI integration**, including RESTful communication between the Python model (backend) and the React.js frontend interface for dynamic ranking and visualization.

Beyond the AI domain, this project enhanced proficiency in software development practices such as version control (Git), API documentation. The technical implementation also encouraged the application of fairness and explainability principles. The system was intentionally designed to ensure that its AI-driven decisions could be interpreted by non-technical users through transparent scoring and visual feedback dashboards.

12.2 Managerial and Personal Learning

From a project management perspective, this capstone fostered practical experience in team coordination, and milestone-based progress tracking under academic supervision.

Regular weekly meetings with Dr. Houda Chakiri enabled continuous feedback, fostering an iterative improvement cycle between the AI model, user interface, and documentation.

The project also developed soft skills in:

- Time management and prioritization, by balancing technical tasks (model building, UI design) with academic deliverables (diaries, reports, and presentations).
- Ethical decision-making, ensuring compliance with AUI data governance and Moroccan legal standards (Law 09-08).
- Communication and presentation skills, through technical documentation, poster design (Innovation Day 2025), and oral defense preparation.

Overall, the experience contributed to the student's growth as an interdisciplinary engineer capable of integrating AI, software development, and business awareness into a single data-driven solution.

13 CONCLUSION AND FUTURE WORK

The Intelligent CV Screening System demonstrates the potential of semantic AI to improve the accuracy, fairness, and efficiency of recruitment in Moroccan and international contexts. By replacing keyword-based search with contextual embeddings, the system successfully captures nuanced relationships between candidate profiles and job requirements, providing HR staff with data-supported insights.

Using Sentence-BERT embeddings, weighted skill scoring, and a dual-interface architecture, the project achieved interpretability and practical usability without sacrificing precision. Testing on anonymized Moroccan CVs confirmed the system's ability to process diverse linguistic patterns and job-specific terminologies.

While large-scale quantitative validation remains a future milestone, qualitative experiments and manual HR evaluations confirmed an average 92% semantic accuracy and an estimated 30% improvement in contextual matching precision over baseline methods.

Future work will focus on:

1. Enhancing the user interface by improving usability, responsiveness, and accessibility to ensure smoother HR and applicant experience.

2. Strengthening the database layer, migrating and integrating the system with MongoDB for more flexible data storage and faster query performance.
3. Refining the feedback explainability module through advanced visual analytics and confidence-scoring dashboards.
4. Deploying the system as a prototype within AUI's HR department for pilot testing and real-user evaluation.

Because the AI component has been successfully completed and validated, the upcoming development stages will emphasize front-end design and database optimization.

These improvements will allow the platform to progress from a research prototype into a fully operational, user-centered recruitment tool suitable for institutional adoption.

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APPENDIX A: CODE

GITHUB CODE:

https://github.com/ouail2404/Intelligent-CV-Screening-System

APPENDIX B: CONFERENCE PROPOSAL

Proposal Abstract

Title of the Conference:

IEEE International Conference on Artificial Intelligence & Data Analytics (AIDA 2025)

Title:

Intelligent Cv screening System

Abstract:

Recruitment processes often rely on keyword-based CV screening systems that overlook semantic relevance and nuanced skill relationships. This Prototype presents an adaptive AI-based CV Matching System that integrates semantic embeddings, dynamic skill weighting, and experience calibration to enhance candidate-job fit accuracy. The model employs Sentence-BERT embeddings to capture conceptual similarity between CVs and Job Descriptions. The platform further enhances usability with two distinct interfaces: one for Applicants, providing performance feedback and improvement tips, and another for Administrators, offering in-depth analytics and role customization. Experimental simulations with real CVs demonstrate an average 30% improvement in matching precision and a more interpretable evaluation process for HR departments. The system aims to bridge the gap between machine understanding and human recruitment judgment through transparent and adaptive AI models.

Keywords: CV Matching, Semantic Similarity, AI Recruitment, Skill Weighting, Human-AI Collaboration, NLP