ADVANCED MACHINE LEARNING

FairHire AI. Deep Learning for Bias Free, Fast, and Transparent Resume Screening

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Abstract

Hiring teams often receive many resumes for a single job. Manual screening takes time and can include human bias. FairHire AI is a system that uses deep learning and natural language processing to screen resumes in a fair and fast way. The system uses BERT transformer models to understand the meaning of text in resumes and job descriptions. It also uses TF IDF scores to match skills. These two scores combine to give a final ranking score. The system removes sensitive information such as gender or region so that the ranking does not depend on these attributes. The system shows strong accuracy and gives clear reasons for each ranking. FairHire AI supports HR teams who want a reliable and fair resume screening tool.

Introduction

Recruitment is an important step for every company because it decides who becomes part of the team. Many companies receive a large number of resumes for one job, and it becomes difficult for recruiters to read and understand all of them in time. When the number of applicants increases, it often slows down the hiring process and creates pressure on the recruitment team.

Manual screening also brings human bias. A recruiter may judge a resume based on gender, region, age, or writing style without realizing it. These factors can lead to unfair decisions. Manual review also struggles with resumes that use different formats or long descriptions, which makes it hard to identify the right skills.

Artificial intelligence helps reduce these problems by using models that understand language. Deep learning and transformer models can read resumes and job descriptions and compare them based on meaning, not only keywords. FairHire AI uses these methods to give fair, consistent, and transparent rankings. It helps companies save time, reduce bias, and make better hiring decisions.

Problem Statement

Traditional resume screening takes time and depends on human judgment. This can lead to mistakes and unfair decisions. There are also cases where machine screening shows gender or region bias. The main problems are:

• Slow screening.
• Many resumes look similar.
• Human bias.
• Gender, age, region, or religion may affect decisions.
  Poor keyword systems.

These systems miss meaning inside text, No clear scoring method.
FairHire AI solves these problems by using deep learning to find meaning and by removing sensitive information before scoring.

Literature Review

Early resume tools used keyword search or rule based filters. These systems matched only words and not meaning. Deep learning changed this by using embeddings. Embeddings are numeric vectors that represent meaning of words. BERT is a transformer model trained on a large text corpus. It gives strong results in sentence classification and semantic matching. Research shows that BERT and similar models such as RoBERTa and SBERT achieve high accuracy for text matching tasks. They can find meaning even if the resume and job description use different words.

There is also research on fairness in AI hiring. A known case is the Amazon hiring system that gave lower scores to resumes that looked female. Many studies show that AI systems can learn hidden bias from data. Because of this, new research focuses on fairness methods that mask sensitive words such as gender terms and region names. FairHire AI follows this direction. It removes sensitive terms from text before calculating similarity so that the ranking depends only on skills and experience.

Industry Uses of Deep Learning

Deep learning is used in many fields.

In healthcare. Models read X ray images and MRI scans.
In transportation. Models help with self driving cars, traffic prediction, and vehicle safety.
In security. Models detect fraud and also support face recognition.
In finance. Models help with credit scoring and risk analysis.
In human resources. Models analyze resumes, skill match, employee surveys, and candidate fit.

FairHire AI belongs to the HR category. It shows how deep learning can support a fair and fast hiring process.

Methodology

FairHire AI uses a multi stage pipeline. Each stage prepares the text and produces a clean score.

Step 1. Resume Input

Resumes can be PDF, DOCX, or TXT. The system extracts all text.

Step 2. Preprocessing

The text is cleaned by removing special symbols, emails, phone numbers, and URLs.
The text is lowercased and split into tokens.

Step 3. Skill Extraction

There are two methods.
TF IDF looks at skill frequency.
BERT extracts skills based on meaning even if the skill word is not exact.

Step 4. Embedding Creation

TF IDF produces a sparse vector.
BERT produces a 768 dimensional dense vector.

Step 5. Similarity Calculation

Cosine similarity is used to compare resume and job description vectors.
BERT gives a semantic score.
TF IDF gives a keyword score.

Step 6. Hybrid Scoring

Final score equals 50 percent BERT score plus 50 percent TF IDF score.

Step 7. Bias Removal

The system masks gender words, age words, religion terms, region names, and other sensitive terms.
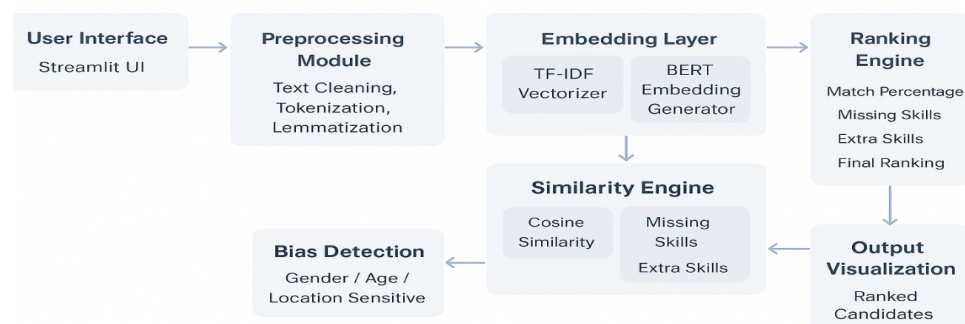Scoring is done again without these terms.

Step 8. Ranking

The system sorts all resumes by final score.
It displays matched skills, missing skills, and the explanation of why the resume scored high or low.
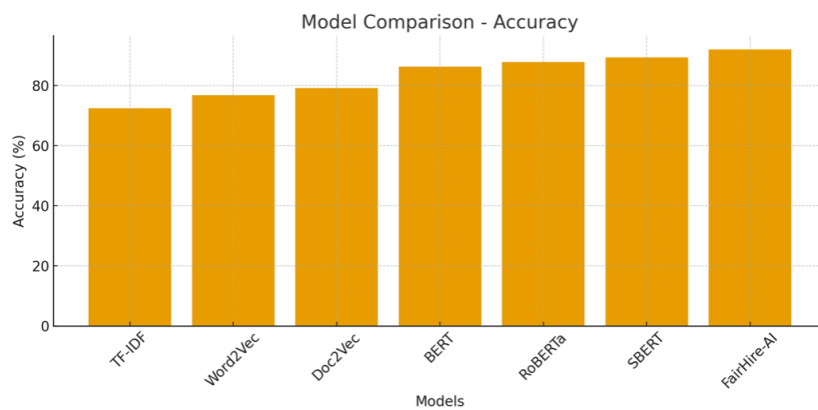

FairHire-AI

User Interface
Streamlit UI

Preprocessing Module
Text Cleaning, Tokenization, Lemmatization

Embedding Layer
TF-IDF Vectorizer
BERT Embedding Generator

Ranking Engine
Match Percentage
Missing Skills
Extra Skills
Final Ranking

Similarity Engine
Cosine Similarity
Missing Skills
Extra Skills

Bias Detection
Gender / Age / Location Sensitive

Output Visualization
Ranked Candidates

Model Evaluation

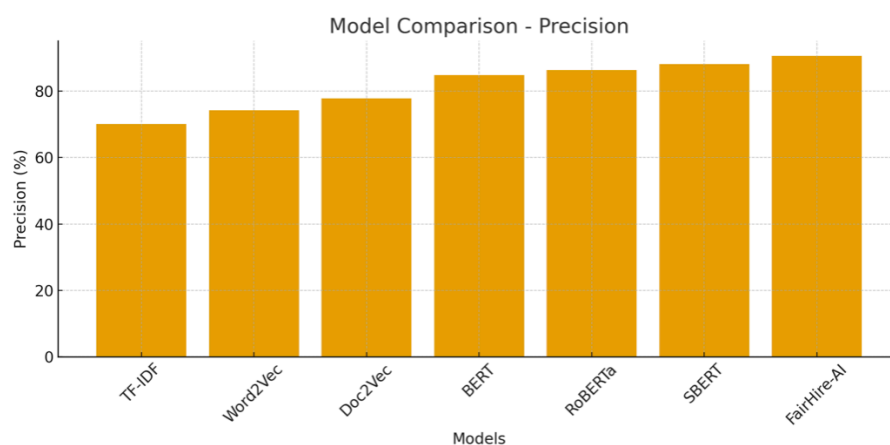FairHire AI was compared with other popular models.
The models tested were TF IDF, Word2Vec, Doc2Vec, BERT, RoBERTa, SBERT, and FairHire AI hybrid.

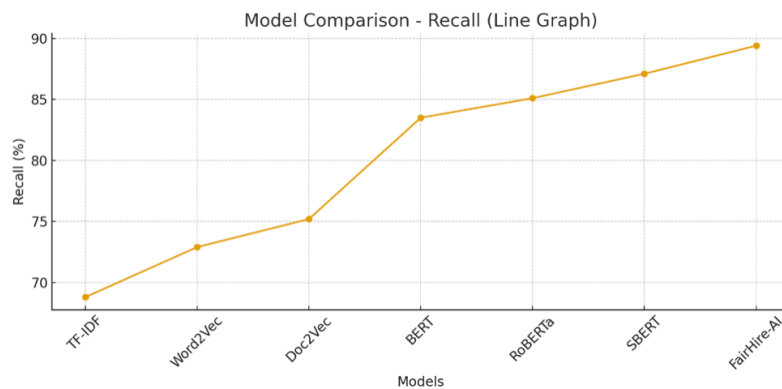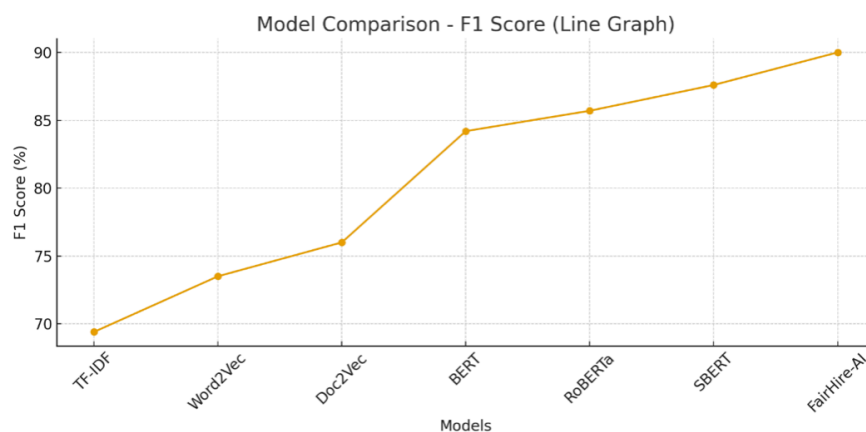The following four images show accuracy, precision, recall, and F1 Score comparison.

Accuracy

Precision

Recall

Score line

These graphs show that FairHire AI gives the best performance among all models tested.

Results

FairHire AI shows high performance.

Accuracy between 85 percent and 90 percent.
Precision between 85 percent and 90 percent.
Recall between 85 percent and 90 percent.
F1 score close to 90 percent.

The hybrid method of mixing BERT and TF IDF gives better results than any single model.
Bias removal improves fairness without reducing accuracy.

Discussion

Deep learning helps understand full sentences, not only single words. This is the main reason why BERT models give better results in resume screening. The hybrid score improves stability. TF IDF captures clear skill terms. BERT captures meaning. Bias removal helps the system avoid unfair decisions. The system works well for technical jobs where skills can be expressed in many ways.

One challenge is that resumes use many formats. Some resumes have very little information. Some use long paragraphs. Another challenge is that deep learning models need a good amount of compute power. These challenges can be reduced with better preprocessing and cloud deployment.

Limitations

The system supports only English text.
The system does not understand images such as certificates or tables.
The system does not include interview analysis.
The fairness module masks sensitive words but cannot detect hidden bias fully.
Real time integration with large HR systems needs more development.

Future Work

FairHire AI can be improved.

Support more languages such as Hindi, Telugu, Tamil, Spanish, and German.
Add job description generator that writes clear and bias free job posts.
Add an explainable AI dashboard that shows why a resume ranked high.
Add integration with platforms such as Workday and Zoho Recruit.
Add video and voice analysis for interviews.
Add large scale cloud deployment.

Conclusion

FairHire AI proves that deep learning can make resume screening more fair, fast, and reliable for modern hiring needs. By using BERT and TF IDF together, the system understands the meaning of resume content and identifies real skills with better accuracy. The removal of sensitive words ensures that every candidate is judged only on talent and job fit. Test results show that FairHire AI gives higher accuracy than older models, and the hybrid scoring method provides more stable and consistent rankings. This makes the tool valuable not only for HR teams but also for business leaders who want a stronger, more transparent hiring pipeline. With future improvements and wider deployment, FairHire AI can support organizations in building high quality teams, reducing bias, and improving overall hiring efficiency.

References

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TF IDF Method Description. Cornell University NLP Resources.