International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 03 Issue: 03 March 2025
Page No: 865-868
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2025.0123

Analyzing Results using Machine Learning Techniques

R. Chinchwadkar[1], Piyush Wagh[2], Roshan Suryawanshi[3], Amanpreet Ruppyal[4]

[1]Assistant Professor, Computer Engineering, Guru Gobind Singh College of Engineering and Research Centre, Nashik, Maharashtra, India.

[2,3,4]UG Scholar, Computer Engineering, Guru Gobind Singh College of Engineering and Research Centre, Nashik, Maharashtra, India.

Emails: *riya.chinchawdkar@ggsf.edu.in[1], piyushwagh5656@gmail.com[2], suryawanshiroshan02@gmail.com[3], aman9156293929@gmail.com[4]*

Abstract

"Analyzing results using machine Learning techniques" is an innovative, web-based platform designed to transform the management and analysis of academic results in engineering institutions through advanced machine learning algorithms. This project integrates modern front-end technologies with a robust Flask back-end and a PostgreSQL database, ensuring a secure, scalable, and user-friendly system.

At its core, the platform features dual access portals tailored for both students and staff. Students can easily retrieve their examination results by entering their unique PRN number, while staff members benefit from secure, role-based access via Google OAuth authentication. A key component of the system is its sophisticated PDF processing module, which automates the extraction, analysis, and categorization of exam data. Leveraging machine learning models, the system not only generates detailed CSV reports—covering class distinctions, top performers, and subject-specific performance—but also provides predictive analytics to offer deeper insights into student achievements. The system further enhances user experience through dynamic batch and year selection interfaces and a minimalist, responsive design that ensures intuitive navigation. Additionally, the platform supports robust staff management capabilities, enabling real-time editing and deletion of user credentials, thereby reinforcing its production-ready architecture and deployment readiness.

Keywords: *Result Analysis, Machine Learning, Web-Based System, PDF Processing, Academic Results, Flask, PostgreSQL, Google OAuth, CSV Generation, Staff Management.*

1. Introduction

1.1. Background and motivation

Academic result processing plays a crucial role in educational institutions, serving as the foundation for evaluating student performance, identifying trends, and making informed decisions regarding academic planning. However, most institutions still rely on traditional result processing methods, which involve manual data entry, spreadsheet-based calculations, and basic statistical summaries. With advancements in machine learning and automation, educational institutions now have the opportunity to improve efficiency, accuracy, and data-driven decision-making. The proposed system leverages machine learning algorithms to analyze academic results, detect trends, and generate structured insights, ultimately enhancing student evaluation processes and institutional decision-making.

1.2. Objectives

- Automate the extraction and processing of academic results from PDFs to eliminate manual errors.
- Generate structured reports that provide insights such as class distinctions, top performers, and subject-specific analysis.
- Utilize machine learning algorithms to analyze student performance trends and uncover hidden patterns.[2]
- Develop a secure, scalable, and user-friendly web application for students and staff, ensuring ease of access and management.

1.3. Research Contributions

- **Automated PDF result processing:**

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Converts unstructured result data into structured CSV files. [1]

- **Machine learning-based performance analysis**: Applies ML algorithms to identify trends and patterns in student performance.
- **Secure, scalable web-based system:** Provides role-based access control and a user-friendly interface for both students and staff.

2. Related Work

2.1 Existing Systems

Most academic institutions use traditional database management systems or manual data entry methods to handle student results. Some research has explored educational data mining, but few approaches fully integrate machine learning with automated PDF extraction and analysis. [3]

2.2 Limitations of Previous Approaches

- **Manual effort:** Conventional methods require significant manual input for data entry and analysis.
- **Limited analytics:** Existing systems focus on basic statistical summaries without advanced trend analysis.
- **Security concerns:** Many result management systems lack robust authentication and role-based access control.

2.3 How This Work is Different?

- End-to-end automation of result extraction, analysis, and visualization.
- Integration of machine learning algorithms to analyze performance trends and insights.[8]
- Role-based access management to ensure secure and scalable deployment across institutions.

3. Methodology

3.1 System Architecture

The system is built as an easy-to-use website that focuses on keeping data safe and presenting information clearly for both students and staff. It offers a simple interface where users can quickly access important details without needing to know the complex background of how everything works. Different parts of the system work together to turn raw information into clear and helpful reports. The design makes sure that all user information is kept secure through trusted login methods, and it is built to easily grow and handle more data if needed. Each component is designed to work well with the others, creating a smooth and hassle-free experience. Overall, the platform is reliable, secure, and straightforward, making it accessible to everyone without any unnecessary complications. Figure 1 shows System Architecture.

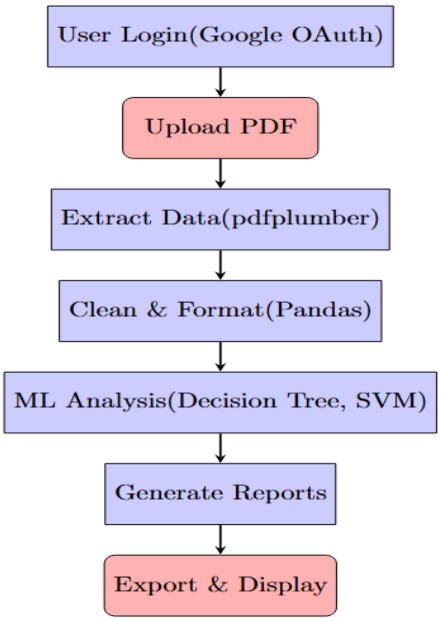

Figure 1 System Architecture

3.2 Data Processing

- Extracts student result data from PDFs using **pdfplumber** and **Pandas.**[5]
- Cleans and formats the extracted data into structured CSV files for further analysis
- Stores the processed data in a PostgreSQL database for secure and scalable retrieval.

3.3 Machine Learning Algorithms

The system employs various machine learning algorithms for analysis:

- **Decision Trees & Random Forest:** To identify factors affecting student performance.
- **Support Vector Machines (SVM):** To classify students based on performance trends.[3]
- **Clustering techniques:** To group students with similar academic progress patterns.

3.4 Web Application Development

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- **Student Portal:** Students can retrieve their results by entering their unique PRN number.
- **Staff Portal:** Staff members access result analytics and manage student records via Google OAuth authentication.
- **Batch and Year Selection:** Enables users to dynamically filter data based on academic year and batch.

3.5 Role-Based Access Management

- Staff can edit, delete, and manage user credentials securely.
- Authentication ensures unauthorized users cannot access sensitive academic data.

4. Experimental Results & Analysis

4.1 Dataset Description

- **Size:** Dataset comprises results from over 5,000 students across multiple academic years.
- **Structure:** Includes subjects, marks, CGPA, attendance records, and backlog status.

4.2 Comparison with Existing Methods

Table 1 Comparison with Existing Methods

Feature	Traditional Systems	Proposed System
Manual Data Entry	Yes	No
Automation	No	Yes
Data Analysis Using ML	No	Yes
Secure Role-Based Access	Limited	Yes
Scalability	Low	High

4.3 Statistical Analysis Insights

- Identifies high-performing and low-performing students based on semester-wise trends. Table 1 shows Comparison with Existing Methods.
- Tracks progression patterns and subject-wise performance insights to assist educators in decision-making.
- Grade Distribution Analysis to Computes the percentage of students in different grade categories (Distinction, First Class, Second Class, Pass, Fail) across multiple semesters. Figure 2 shows statistical Analysis Insights.
- Top 5 Student Ranking Identifies the top 5 students in each academic year based on CGPA, subject-wise performance, and overall consistency. This ranking helps in recognizing outstanding students and awarding academic excellence.

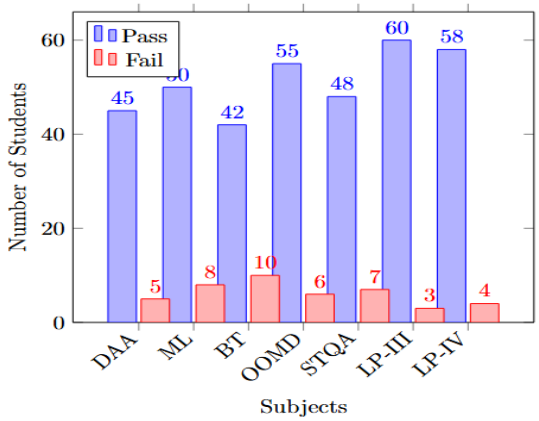

Figure 2 statistical Analysis Insights

5. Challenges & Limitations

- **Variability in PDF formats:** Different universities use diverse result templates, requiring adaptable extraction techniques.
- **Data quality issues:** Incomplete or inconsistent student records may affect analysis accuracy.[4]
- **Integration hurdles:** Connecting the system with existing university databases poses technical challenges.

Conclusion

This research introduces a novel approach to academic result processing through automation and machine learning. The system efficiently extracts structured data from PDFs, applies ML models for performance insights, and offers a secure, web-based interface for users. Future improvements include:

- **Enhancing machine learning models** for deeper statistical analysis and insights.
- **Integrating with university ERP systems** for seamless academic data management.
- **Implementing AI-driven recommendations** for personalized student

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improvement strategies.

Acknowledgment

We express our sincere gratitude Guru Gobind Singh College of Engineering and Research Centre, Nashik, Maharashtra, India and the Department of Computer Engineering for their continuous support and resources throughout this research. We extend our special thanks to our project guide, R. Chinchwadkar, for their invaluable guidance, insightful feedback, and encouragement at every stage of this project.

We also acknowledge the contributions of our peers and faculty members, whose constructive discussions and suggestions helped improve the research. Finally, we appreciate the support of our families and friends for their unwavering encouragement during this work.

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