Designing an RFID-Based Solution for Accurate Attendance Tracking and Cashless Transactions in Educational Institutions

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INTRODUCTION

Educational institutions face challenges with traditional systems for tracking attendance and handling cash transactions

Our proposal introduces an RFID-based system that automates attendance tracking and facilitates secure, cashless transactions on campus.

Background


What is RFID Technology?

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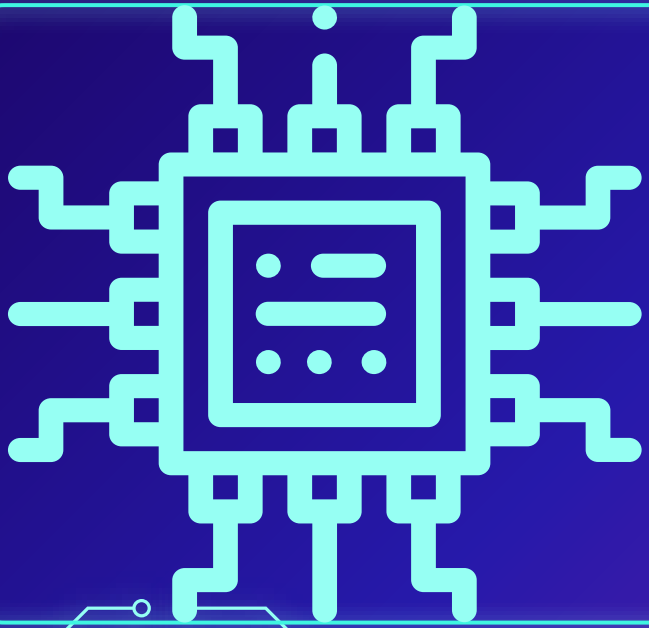


Radio Frequency Identification (RFID) uses electromagnetic fields to identify and track tags attached to objects automatically. These tags contain electronically stored information that can be read by RFID readers.

Project Motivation

Educational institutions are increasingly adopting automated systems to enhance operational efficiency, data accuracy, and student experience. In large university environments, traditional attendance tracking, and cash-based payment systems are not only time-consuming but also prone to errors, security risks, and scalability issues.

Problem Statement

Limited Parental Oversight

Parents lack real-time access to attendance and spending.

High Administrative Costs

Manual processes increase operational expenses.

Lack of Financial Guidance

Students lack budgeting and spending guidance.

Cash-Based Transactions

Security risks and limited data insights.

Manual Attendance Tracking

Prone to errors and lacks real-time updates

Inadequate Data for Service Optimization

Limited insights into student preferences.

Project Objectives 1/2

Parental Oversight

Parents will be able to real-time access to attendance and spending data.

Provide Personalized Budget Management

Offer tools that help students manage their funds, receive budget advice, and track spending tailored to their individual needs.

Enable Financial Oversight and Analysis

Provide administrators and parents with categorized insights into student expenses, aiding in better financial decision-making and tracking.

Project Objectives 2/2

Implement a Scalable Attendance Tracking System Using RFID

Design an RFID-based system that accurately tracks attendance and can be expanded to accommodate more students and courses as needed.

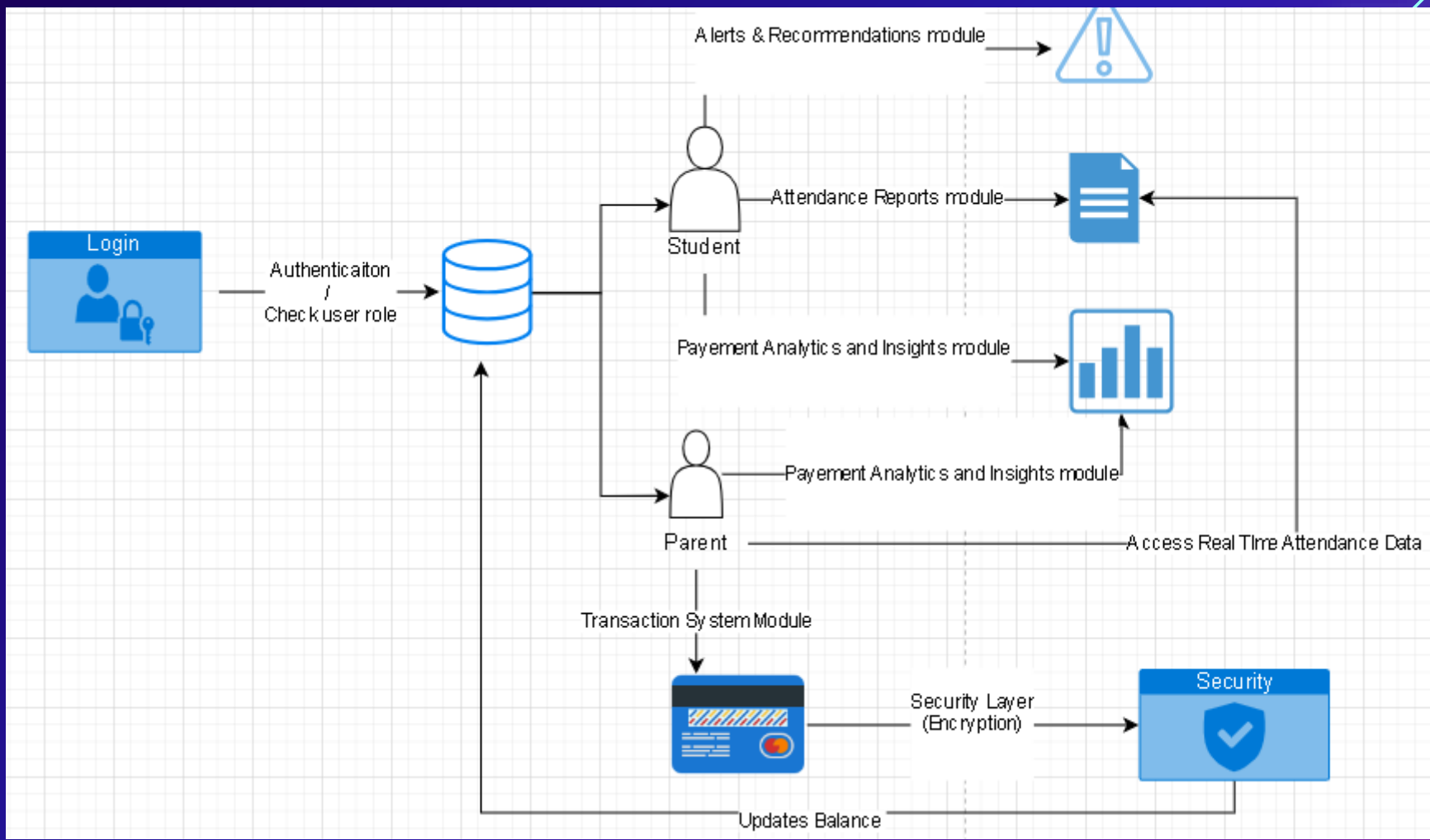
Facilitate Secure, Cashless Transactions

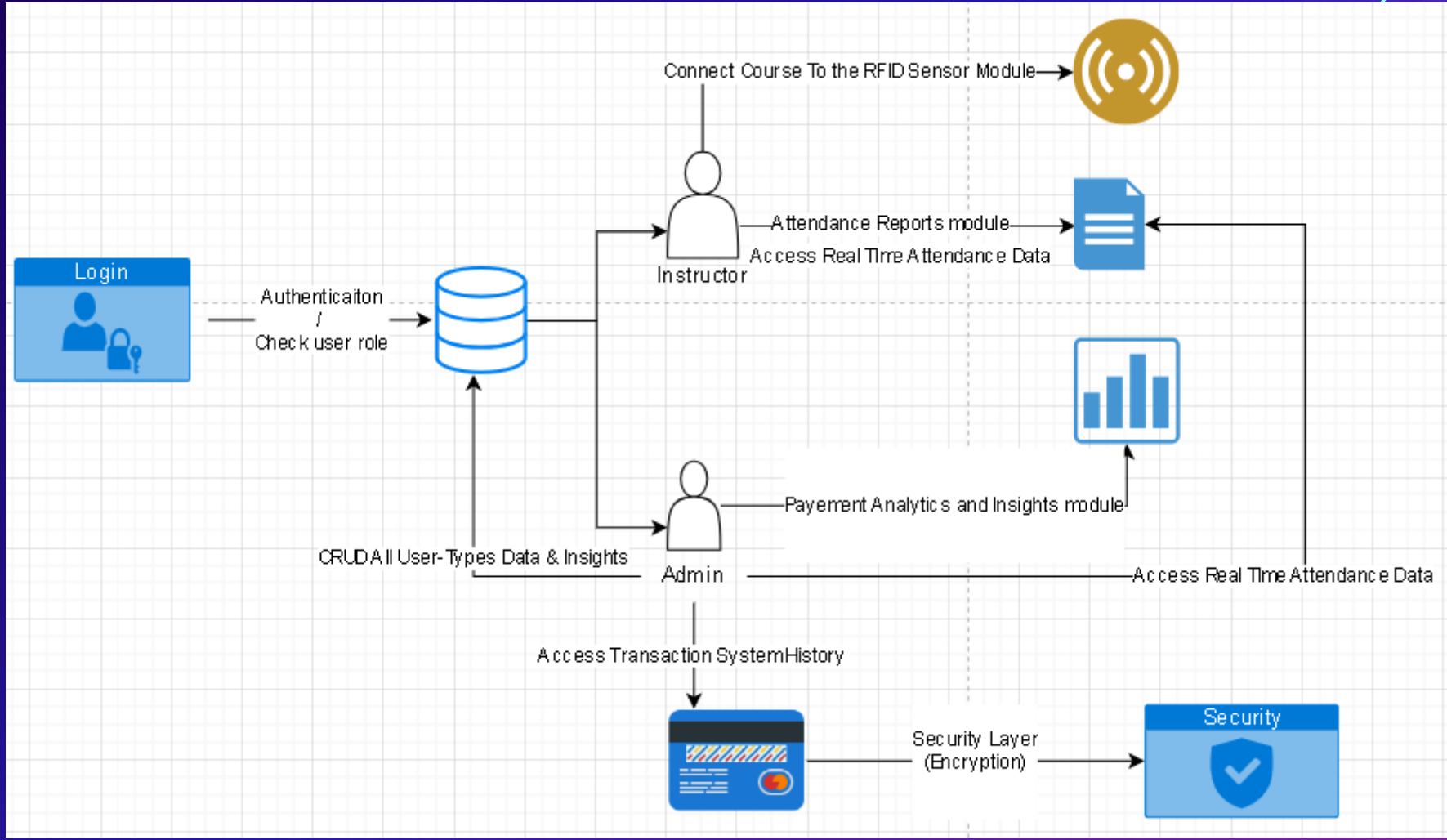
Enable cashless payments within campus premises, ensuring safety and reducing cash-handling risks.

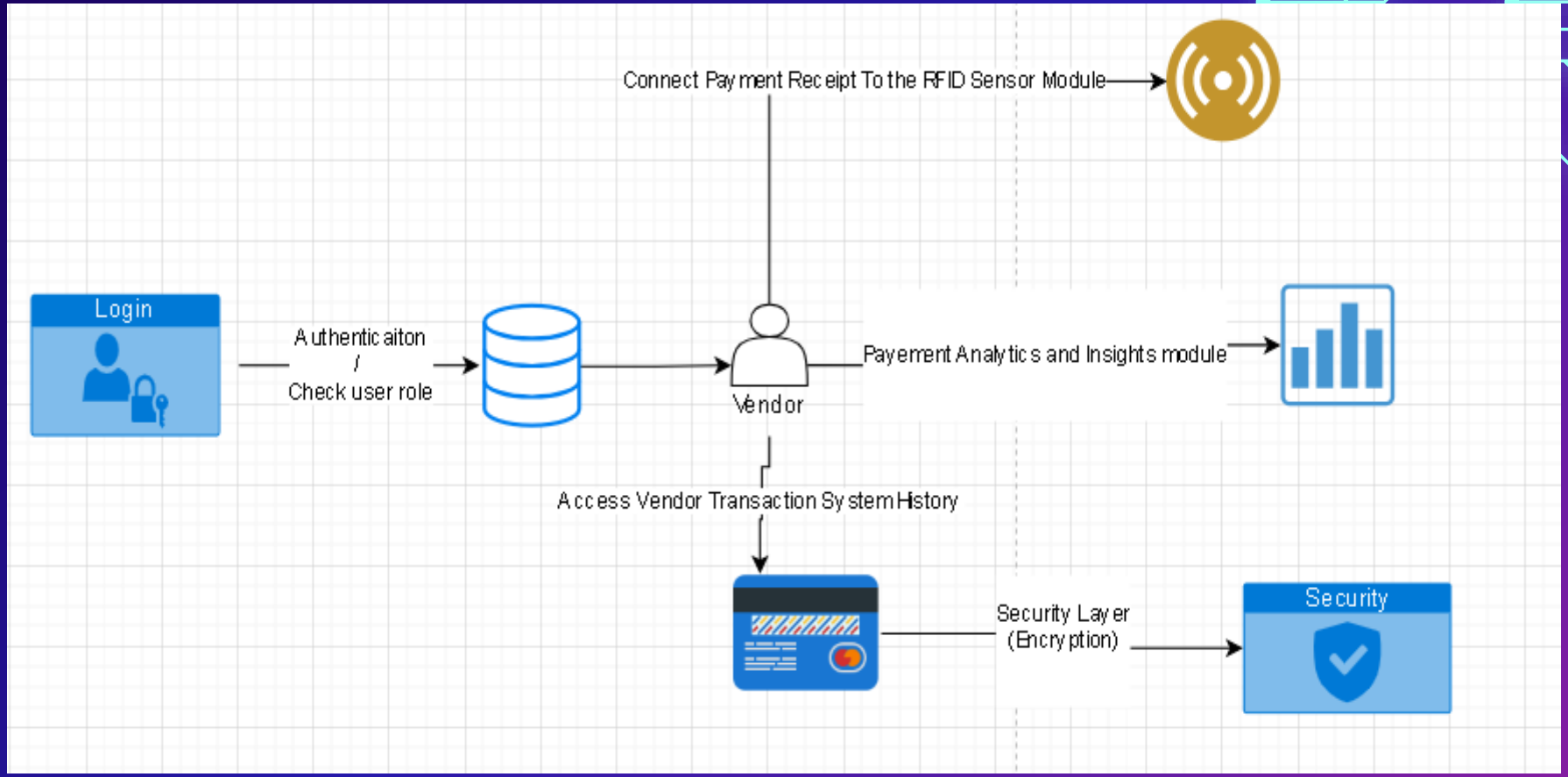
Ensure Data Integrity and Security

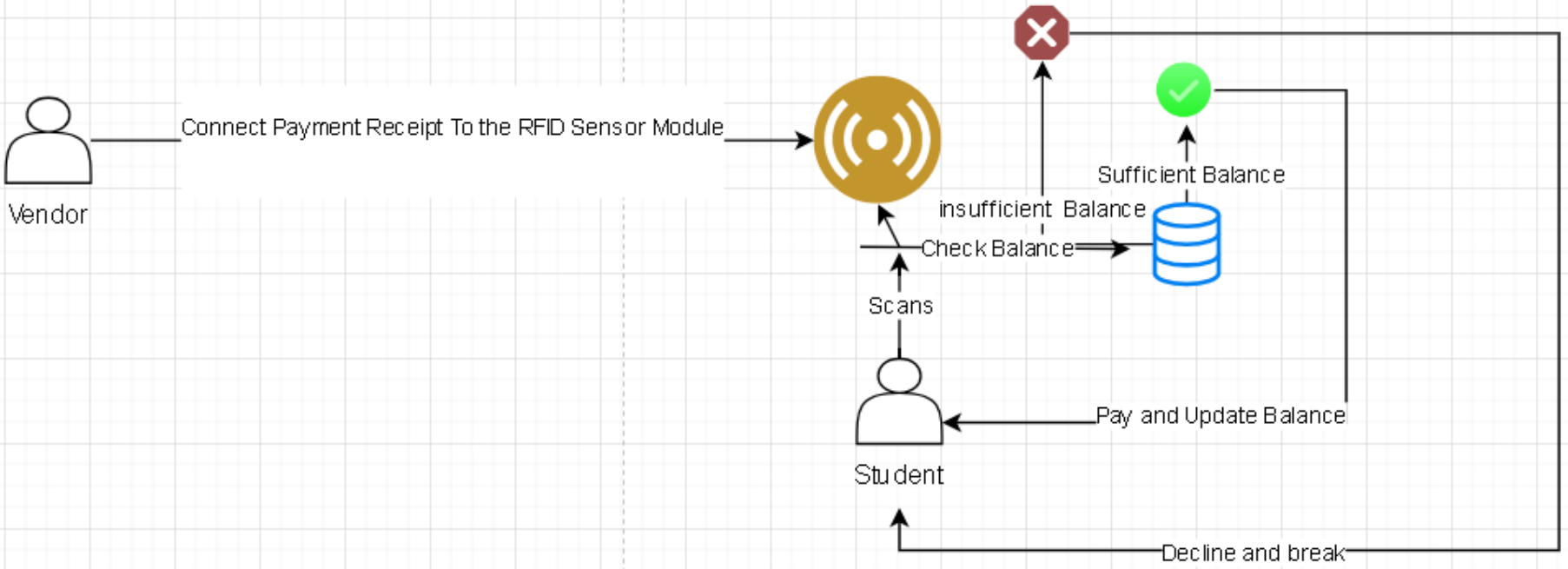
Maintain accurate, real-time logs of student attendance and transactions while protecting sensitive data from unauthorized access or breaches.

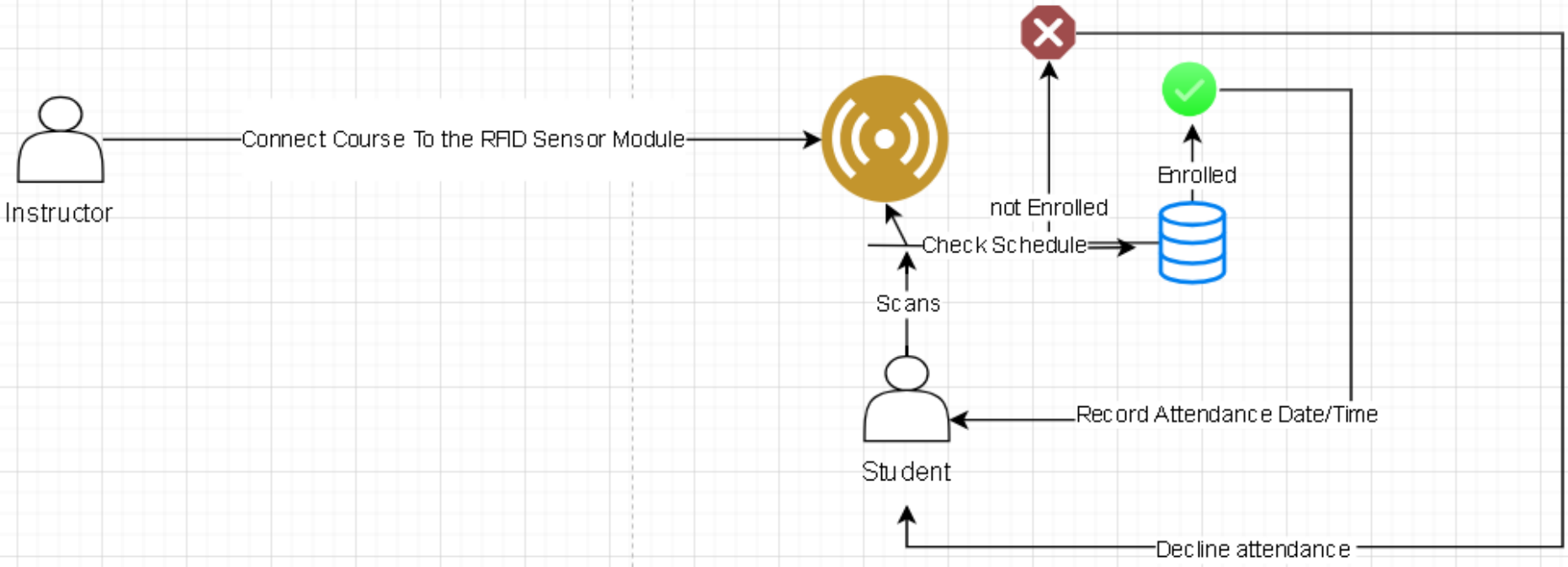
System Architecture


Alerts & Recommendations module
Attendance Reports module
Student
Login
Authenticaiton
/
Check user role
Payement Analytics and Insights module
Payement Analytics and Insights module
Parent
Access Real Time Attendance Data
Transaction System Module
Security
Security Layer
(Encryption)
Updates Balance


Connect Course To the RFID Sensor Module
Instructor
Attendance Reports module
Access Real Time Attendance Data
Login
Authenticaiton
/
Check user role
Payement Analytics and Insights module
CRUD All User-Types Data & Insights
Admin
Access Real Time Attendance Data
Access Transaction SystemHistory
Security Layer
(Encryption)
Security


Connect Payment Receipt To the RFID Sensor Module
Login
Authentic aiton
/
Check user role
Vendor
Payement Analytics and Insights module
Access Vendor Transaction System History
Security Layer
(Encryption)
Security


Vendor
Connect Payment Receipt To the RFID Sensor Module
insufficient Balance
Sufficient Balance
Check Balance
Scans
Pay and Update Balance
Student
Decline and break


Instructor
Connect Course To the RFID Sensor Module
not Enrolled
Enrolled
Check Schedule
Scans
Record Attendance Date/Time
Student
Decline attendance


Dataset

Attendance Dataset

- The Dataset contains ~500k records related to attendance tracking.

- Key Features include Time columns (sign-in, sign-out, lecture-start, lecture-end)
- Status : [‘present’, ’late’, ’absent’]

- Additional computed feature : [‘Sign-in delay’ , ‘Attended in minutes’]

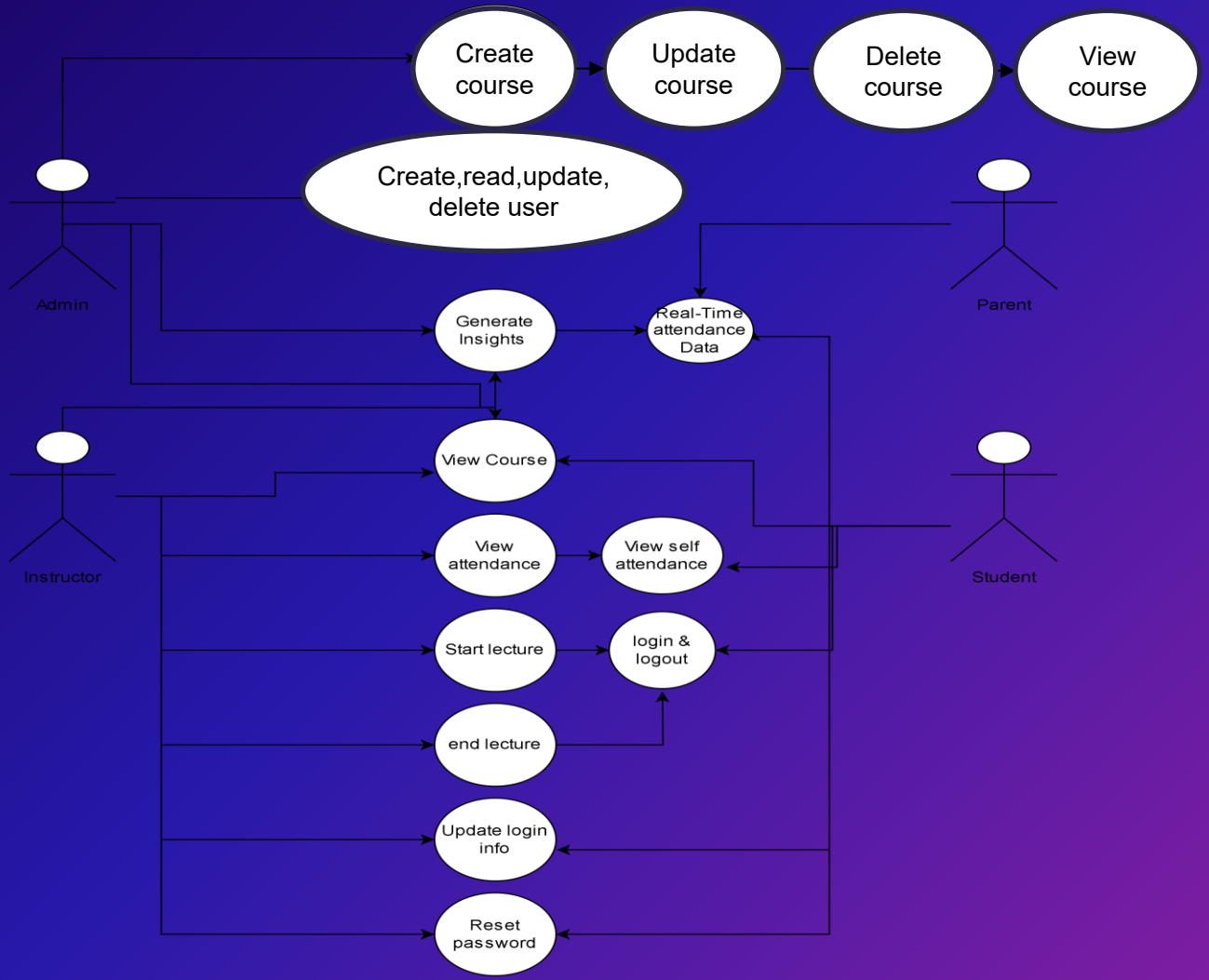
- Challenges: Handling missing values in time columns, Balancing the dataset due to class imbalances

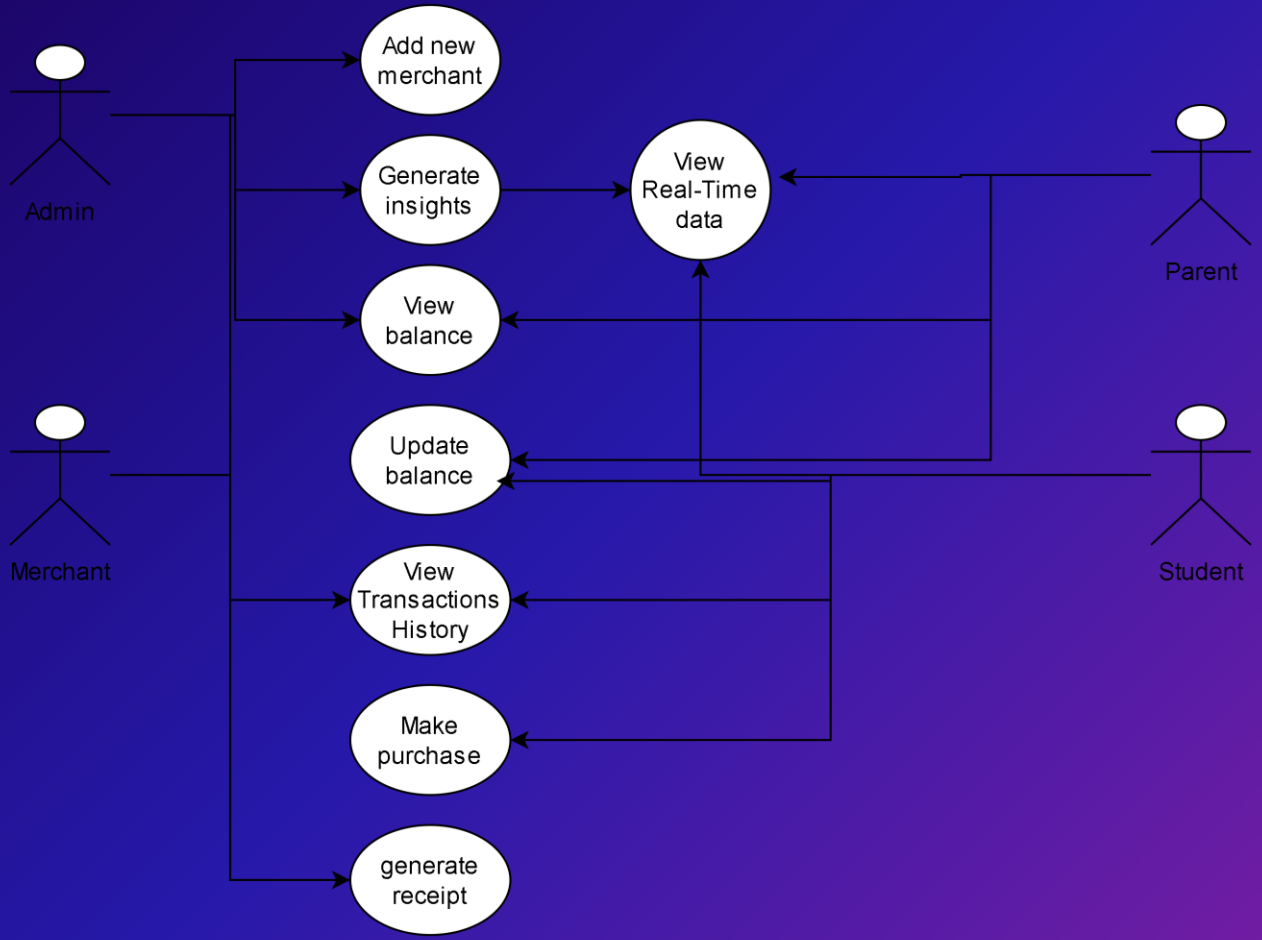
Student ID	Date	Day	CourseCode	CourseName	Time Lecture Started	Time Lecture Ended	Lecture Duration	Student Sign-in to Lecture	Student Sign-out from Lecture	Status
S001325	12/31/2024	Tuesday	CHEM505	Physics Fundamentals	8:10	9:19	69	8:16	9:09	late
S004829	12/31/2024	Tuesday	CHEM505	Physics Fundamentals	9:50	10:52	62			absent
S003046	12/31/2024	Tuesday	CS202	Data Structures	8:06	9:28	82	8:08	9:32	present
S001865	12/31/2024	Tuesday	PHY303	Advanced Mathematics	9:35	10:58	83	9:42	10:53	late
S009011	12/31/2024	Tuesday	CS202	Physics Fundamentals	8:27	9:35	68			absent
S009011	12/31/2024	Tuesday	CS202	Advanced Mathematics	9:40	11:07	87	9:53	10:58	late
S004347	12/31/2024	Tuesday	PHY303	Physics Fundamentals	15:46	16:50	64	16:02	16:42	late
S004435	12/31/2024	Tuesday	PHY303	Advanced Mathematics	15:48	16:54	66			absent
S004829	12/31/2024	Tuesday	CHEM505	Data Structures	12:47	13:57	70	12:55	13:51	late
S005835	12/31/2024	Tuesday	CHEM505	Intro to Biology	9:31	10:52	81	9:33	10:56	present
S003828	12/31/2024	Tuesday	PHY303	Intro to Biology	8:16	9:18	62			absent
S009406	12/31/2024	Tuesday	CS202	Advanced Mathematics	8:04	9:20	76	8:04	9:21	present
S009406	12/31/2024	Tuesday	BIO101	Data Structures	11:29	12:30	61			absent

Algorithm Overview

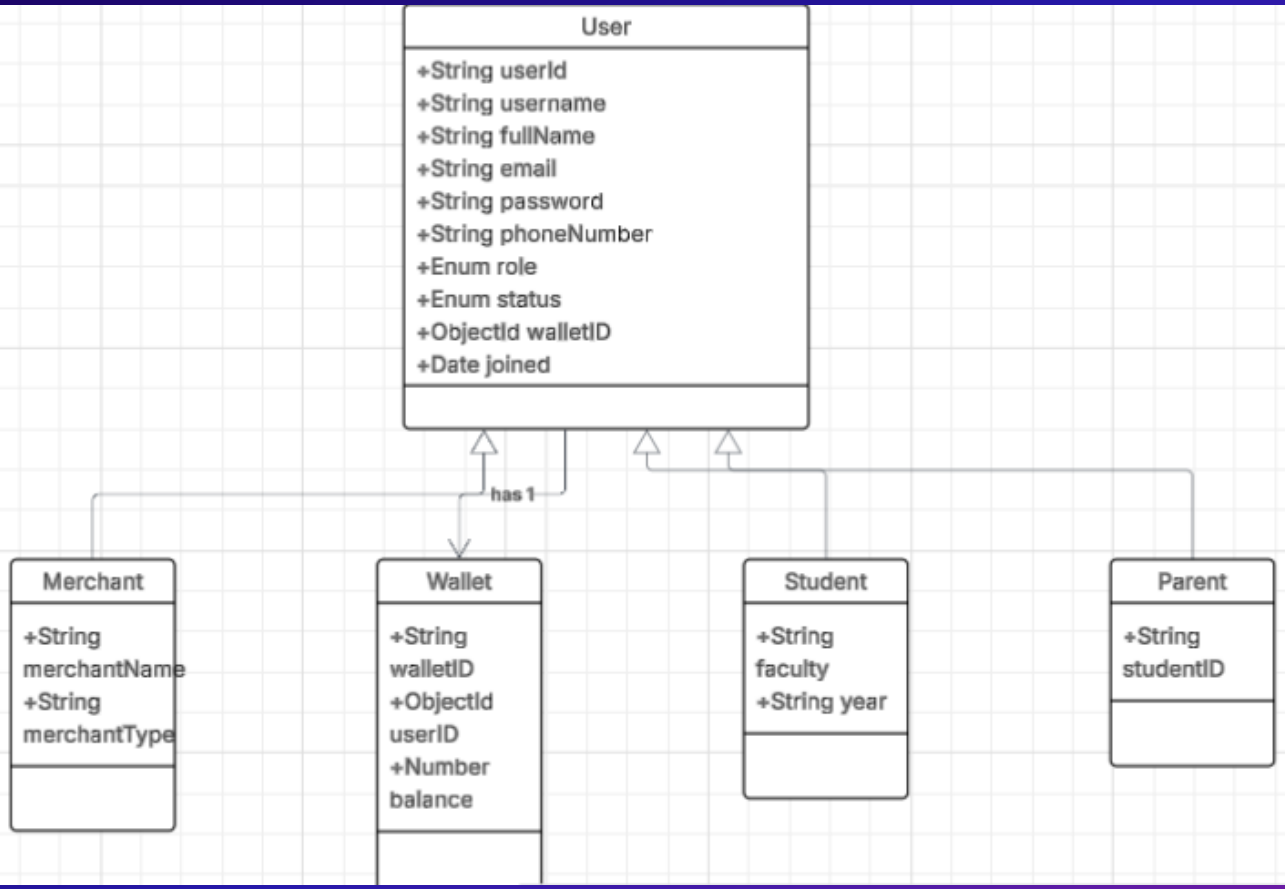
- Preprocessing Steps:
- Missing values in time columns replaced with '00:00'.
- Categorical encoding for 'Status' using LabelEncoder.
- Feature scaling using StandardScaler.
- Models Used:
- Artificial Neural Network (ANN):
- Trained to predict attendance status with dropout layers to mitigate overfitting.
- Decision Tree:
- Used with hyperparameter tuning to identify best configurations.
- Key Metrics:
- ANN Accuracy: ~66.54%.
- Decision Tree Overfitting: Addressed with pruning and Random Forest.

Use Case Diagram


Create course
Update course
Delete course
View course
Create,read,update, delete user
Admin
Parent
Generate Insights
Real-Time attendance Data
View Course
Instructor
Student
View attendance
View self attendance
Start lecture
login & logout
end lecture
Update login info
Reset password


Admin
Merchant
Parent
Student
Add new merchant
Generate insights
View balance
Update balance
View Transactions History
Make purchase
generate receipt
View Real-Time data

Class Diagram


User
+String userId
+String username
+String fullName
+String email
+String password
+String phoneNumber
+Enum role
+Enum status
+ObjectId walletID
+Date joined
has 1
Merchant
+String merchantName
+String merchantType
Wallet
+String walletID
+ObjectId userID
+Number balance
Student
+String faculty
+String year
Parent
+String studentID

CONCLUSION

- Scalable and Secure Solution
- Enhanced Transaction Speed
- Improved Financial Accuracy
- Real-Time Parental Access
- Comprehensive Data Insights
- Increased User Convenience
- Streamlined Campus Operations
- Future Expansion Opportunities
- Alignment with Smart Campus Initiatives

Q&A

REFRENCES

1. Ishaq, Kashif, and Samra Bibi. "IoT Based Smart Attendance System Using RFID: A Systematic Literature Review." 2023. Available at: https://arxiv.org/abs/2308.02591v1

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3. Srindhi and Ramil. *Research on RFID and Biometric Technology for Student Attendance*. Journal of Emerging Trends in Engineering and Applied Sciences, 13(5), 202.

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THANK YOU!

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