Smart Students Attendance System

Using QR CODE

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Computer Engineering Department

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ABSTRACT

Recording attendance is something repetitive and time-consuming. The process of attendance-taking is the same and repeats every day. Smart Student Attendance System (SSAS) is a student attendance management system for universities applied by using Quick-Response Code (QR Code), which is the trademark for a type of matrix barcode (or two-dimensional barcode). The system is able to manage the student's daily attendance. The system is also able to check every student's identity using the face recognition technique. However, most of the lectures in colleges and universities used manual sheet paper for class attendance. This way has many drawbacks. The manual record system is not efficient and requires more time. Moreover, by having the manual sheet of paper for attendance, students that skipped the class tends to cheat by asking their peers to sign or cover their attendance. Thus, the attendance system based on Quick-Response Code is meant to improve the manual attendance system. This project implements a Quick-Response Code for the students to scan via a specific Smartphone application, which is being displayed to students during or at the beginning of each lecture. The students will need to scan the code to confirm their attendance. The attendance system comes with a mobile application, which all the students have to install. Once the student scans the QR Code, the data of the students will automatically transfer into the database and the attendance should be recorded. In conclusion, the project had achieved its objectives, which ultimately save lecturers' time in managing attendance, the student will come to know how much he/she had got the attendance presentence in one month, and the instructors will check the attendance of their students at any time and calculate monthly attendance, prevent cheating on attendance where the student can't write a name of another student.

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ABBREVIATIONS

ML	Machine Learning
DL	Deep Learning
AI	Artificial Intelligence
ANN	Artificial Neural Network
ReLU	Rectified Linear Unit Function
CNN/ConvNet	Convolutional Neural Networks
SVM	Support Vector Machine

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CHAPTER 1: INTRODUCTION

1.1. Introduction

Regular attendance in all organizations, whether educational or at the corporate level, is necessary to improve the efficiency of the organization, and in light of the conditions that the world is suffering from due to Covid-19, in addition to the traditional means used by institutions at present, such as fingerprint devices and paper, which were causing congestion when completing attendance processes. This process takes a long time, especially when the numbers are large, and in light of the current circumstances and with the spread of Covid-19 and the need to achieve social distancing, it was necessary to have an easy solution that ensures the accuracy and speed of the processes of the attendance of students while maintaining their safety and saving time and effort to complete this process. That is why we thought of developing an easy-to-use application to record the attendance process for all students.

This project proposed Attendance system is a system that uses Face recognition & QR code to record the attendance of all students using smart phones, moreover, analyzing attendance on a weekly and monthly basis and the main objective of the automated attendance system is to reduce or eliminate the need for the traditional system, providing an efficient and secure method for tracking attendance.

1.2. Problem statement

The process of Taking and tracking students' attendance manually may cause a loss of attendance sheets, dishonesty, wasted time, and high error scales.

And these are the problems facing the lecturers using the existing attendance process. It is a hard process, takes time, and causes a lot of paper-based work. As a result, in order to solve these problems, save lecture time, and avoid errors we suggest computerizing this process by providing a system that records and manages students' attendance automatically without needing lecturers' interference.

1.3. Motivation

In order to maintain the records of students' attendance with accuracy, we will design a better attendance management system for the faculty of engineering at Helwan university. And it is considered to be an important key behind motivating this project.

i. Overcoming the problem of time-consuming by using QR code technology.

ii. Overcoming the problem of cheating in the attendance process using face recognition technology.

iii. Storing record attendance in sheets in a database to overcome missing & distortion of attendance sheets.

1.4. Objectives

“Smart Students Attendance System” is developed mainly to provide an efficient and automated method to track attendance in institutions and universities rather than the traditional way of calling the name of each student or by using papers. So, this application saves lecture time. It is very useful for the students to check their attendance; the student will come to know how much

he/she had got the attendance presentence in one month. Also, the instructors will check the attendance of their students at any time and calculate monthly attendance. This system provides good security and prevents cheating on attendance where the student can't write the name of another student.

1.5. Literature Review

In most universities in developing countries, students' attendance is usually taken by the old file system approach by calling students' names and using paper sheets. This approach has been used for a long time [1][2]. According to [3] P. Taxila, it becomes difficult for the administration at universities to regularly update the attendance record and manually calculate the percentage of absence and attendance for the purpose of subsequent results processing and examinations.

According to Hsarena (2017), University Malaysia Sarawak (UNIMAS) was the first in Malaysia to use the QR Code method to record attendance in October 2017 followed by University Technology Petronas (UTP) in January 2018.

Faizan Shaikh [4] proposes to use a QR code, an open-source confirmation of-idea verification framework that uses a two-figure

authentication by joining a secret key and a camera prepared cell phone, going about as a confirmation token. The code is scan with the QR code scanner of cell phone. Examining result produce one string which is the mix of IMEI number of a telephone which is enlist by the client and the arbitrary number, where irregular number is created by the arbitrary number capacity.

Fadi Masalha (2014) [5] proposes a system that is based on QR code, which is being displayed for students during or at the beginning of each lecture. The students will need to scan the code in order to confirm their attendance. The paper explains the high-level implementation details of the proposed system. It also discusses how the system verifies students' location to eliminate false registrations by using GPS.

O. Sanli (2018) [6] proposes the utilization and plan of face detection and recognition framework to consequently recognize students. This proposed facial biometric framework will contain an enrollment procedure in which the remarkable features of people's faces will be put away in a database and after that the procedures of distinguishing, proof, and verification of the person.

Saraswat (2010) [7] proposes using a fingerprint scanner to record attendance. The fingerprint is a unique characteristic that we all have and is accessible all the time. Using a fingerprint scanner,

will prevent cheating on attendance and provide a convenient and secure way to record attendance.

Sumit Saha (2018) [8] proposes an algorithm for efficient attendance management. With face recognition, the effort of recording attendance is reduced to minimum. The process is done behind the scenes. The algorithm able to identify multiple faces from a single image. This will ultimately prevent cheating on attendance.

CHAPTER 2: ANALYSIS AND REQUIREMENT

2.1 Analysis

In order to arrive at the specific requirements of our system, we wrote below, we did some steps to collect ideas and data about the proposed project, which are:

- We did research about some systems serving the same goal As we mentioned in the literature review.
- We did a small survey with couple of groups consisting of both developers and testers through social media.
- We compared between different ways to take attendance and choose the easiest and fastest way.
- We did a lot discussions with our supervisor professor about the topic.

2.2 System Requirements

Requirements can be divided into functional requirements and non-functional requirements.

2.2.1 Functional Requirements

1- Register /Login:

- All users are directed to this page when using the system whether the web application or the mobile application.
- From this page users can login or register as a new user (first the user is an anonymous).

2- Role Management:

- Role management means specify the role of every user in the system.
- Student affairs change the role of students from anonymous users to student users by generating a unique QR identity for every student according to the student's national id (or setting number) or by using a function to read csv file contains students' info to generate automatic QR identity cards equals the number of students in the csv file and printing these cards. and then they can scan these QR codes to access their respective interface.
- Admin users have access to an interface for managing anonymous users' roles, add them to roles or archive them. These roles are : Administrator, Affairs and Doctor. And that done also by generating QR identity for then to scan it.

3- Add/Archive subject

- The Administrator can add or archive subjects to the system and distribute different subjects to each doctor in different departments.

4- Generate QR for attendance

- The instructor can generate a QR code containing lecture information (id, date, subject name). then display it by the projector to students can scan it to record its attendance.

5- View the attendance/prepare attendance sheet

- The instructor will need to view all the attendance of his subjects, so he can view the attendance from its web application to evaluate the students' grades and prepare the attendance sheet as he wants.

6- Manage Attendance

- The instructor can manage attendance or edit it in case there is an excuse for any student not to use his phone.

7- Scan QR for attendance /validation of student’s face

Students scan the QR code of the lecture and then open the camera to recognize their faces to make sure the user ID matches the account login ID to take the attendance process.

8- View the attendance /percentage of absence

Students can view their attendance in each subject only not all attendance and can view percentage of absence in each subject by this feature in the android application.

9- Storing the attendance

Storing the attendance can be done without errors by storing it in the database using firebase storage.

2.2.2 Non-functional Requirements

The categories of non-functional requirements given are security, availability, maintainability, usability, and flexibility.

Security:

- The system will prevent cheating attendance by verifying the request.
- The system will prevent unauthorized login on users' accounts and by using QR identities every user is anonymous and can’t use the system functions until the admin/ affairs identify them by these identities.
- The student can view his attendance only in each subject
- The student can’t ensure his attendance without validating itself by face recognition after scanning the QR code of lecture.

Availability:

- It ensures that the site runs constantly in all browsers.
- It ensures that the responsiveness works on every screen resolution like mobiles, tablets, and desktop PCs.
- The system mobile application or web application could be running at every time. And the mobile needed actually available for all users today also laptops these all are available to all users.

Maintainability:

The maintainability requirements are concerned with the maintenance issues of the system. The report time of the Attendance Tracking System shall be under a half hour. System downtime for maintenance should be less than 6 hours per quarter of a year.

Usability:

- Queries upon the database shall be performed in less than 5 seconds.
- The system shall be fast and responsive.
- people with no training and no understanding of English shall be able to use the product.
- The system shall be able to be reused for each new semester.

Flexibility:

- A user shall be able to log into the system at any instance of time.
- The program shall support taking attendance for class sizes of up to 300 students. With a maximum class size, performance must still conform to all performance requirements.

2.3 Functional Requirements Specification

2.3.1 System Stakeholders

- Students
- Instructors
- College committee
- College

2.3.2 Actors and goals

1. Administrator

- The administrator will have overall control over the system
- He has the privilege to access the entire system and distribute the permissions to a group of users.
- Add all subjects from different departments in the system.
- Distribute different subjects to each doctor in different departments.
- Generate and print QR identity codes for users to confirm their login into the system.
- Manage database, access, and modify on it.

2. **Student affairs**
   - Responsible for modifying the role of users or archiving these users (anonymous, student).
   - Generate and print QR identity codes for users to confirm their login into the system.

3. **Doctor**
   - Generate QR code containing lecture information (id, date, subject name) then display it by the projector then students can scan it to record its attendance.
   - Manage attendance and generate the report by students' attendance in his subjects to evaluate the students' grades.
   - View the attendance according to the date and view attendance percentage for each student

4. **Student**
   - Submit their photos in a different profile for face recognition procedures.
   - Scan the QR code of lecture for attendance.
   - Can open the camera to recognize their face to make sure the user ID matches the account login ID to take the attendance process.
   - View his attendance percentage in each subject.
   - Can edit their profile in the application.

2.3.3 Use cases Description

- **Registration**

Actor: student affairs/admin/student/doctor.

Brief Description:

This use case describes how new users register to the System.

Basic Flow:

This use case starts when a new actor wishes to register to the System.

1. The user, if new, requests to register himself with the system
2. The system asks for the personal details of the user(name, email, password).
3. User enters the personal details and submits the registration form.

- **Login**

Actor: student affairs/admin/student/doctor

Brief Description:

This use case describes how a user logs into the System.

Basic Flow:

This use case starts when an actor wishes to log into the System.

1. The system requests that the actor enter his/her email and password.
2. The actor enters his/her email and password.
3. The system validates the entered email and password and logs the actor into the system.

Alternative Flows:

Invalid email / Password

If in the Basic Flow the actor enters an invalid password and/or password, the system displays an error message. The actor can choose to either return to the beginning of the Basic Flow or cancel the login, at which point the use case ends.

- **Generate QR identity**

Actor: student affairs/admin.

Brief Description:

This use case describes how to authenticate each user in the system. So, you give a unique QR Code to each user.

Basic Flow:

1. An actor chooses a new identity
2. System request to enter the national id of the user and select the role of him/her.
3. Then an actor press saves.
4. These QR Codes show guest details that are matched with details in the database to authenticate their entry.

- **Generate QR code**

Actor: doctor

Brief Description:

This use case describes how the doctor generates a QR code for taking attendance.

Basic Flow:

1. An actor logs into the system.
2. Select subject.
3. Then choose a new lecture.
4. System creates QR code containing lecture information(lecture id, subject name, date, time).

- **Scan QR code**

Actor: student

Brief Description:

This use case describes how students scan the QR code by system.

Basic Flow:

1. An actor logs into the system.
2. select scan QR code.

- **Take a photo for authentication**

Actor: student

Brief Description:

This use case describes how the system takes student photos to verify that the prediction ID matches the ID of the current login user.

Basic Flow:

- The system request from actor to open his/her camera to take his/her photo.
- An actor selects open camera and takes a photo of his/her face.
- System displays a confirm message “attendance is recorded successfully”.

Alternative Flows:

Can't authenticate

If in the Basic Flow the system finds face ID doesn’t match the ID of the current login user, the system displays an error message “Attendance record incomplete”. The actor can choose to either return to the beginning of the Basic Flow or cancel, at which point the use case ends.

● Change user role

Actor: admin/student affairs

Brief Description:

This use case describes how an actor changes the user role in the system.

Basic Flow:

- Actor logs into the system.
- Choose users.
- System views list of users then actor select edit.
- System views dialog message then actor chooses the new role of the user.

● View attendance

Actor: doctor

Brief Description:

This use case describes how the doctor views attendance.

Basic Flow:

- Actor logs into the system.
- Choose view attendance.
- The system view list of students' names, subject name, date of the lecture, and departments.

- **Manage subject**

Actor: Admin

Brief Description:

This use case describes how the admin manages subjects.

Basic Flow:

- Actor logs into the system.
- Select manage subject.
- Select add subject.
- System request enters information about it.
- Actor enters the subject name, discerption about the subject.
- Press Save.

CHAPTER 3: SOFTWARE DESIGN

3.1 Use case Diagram

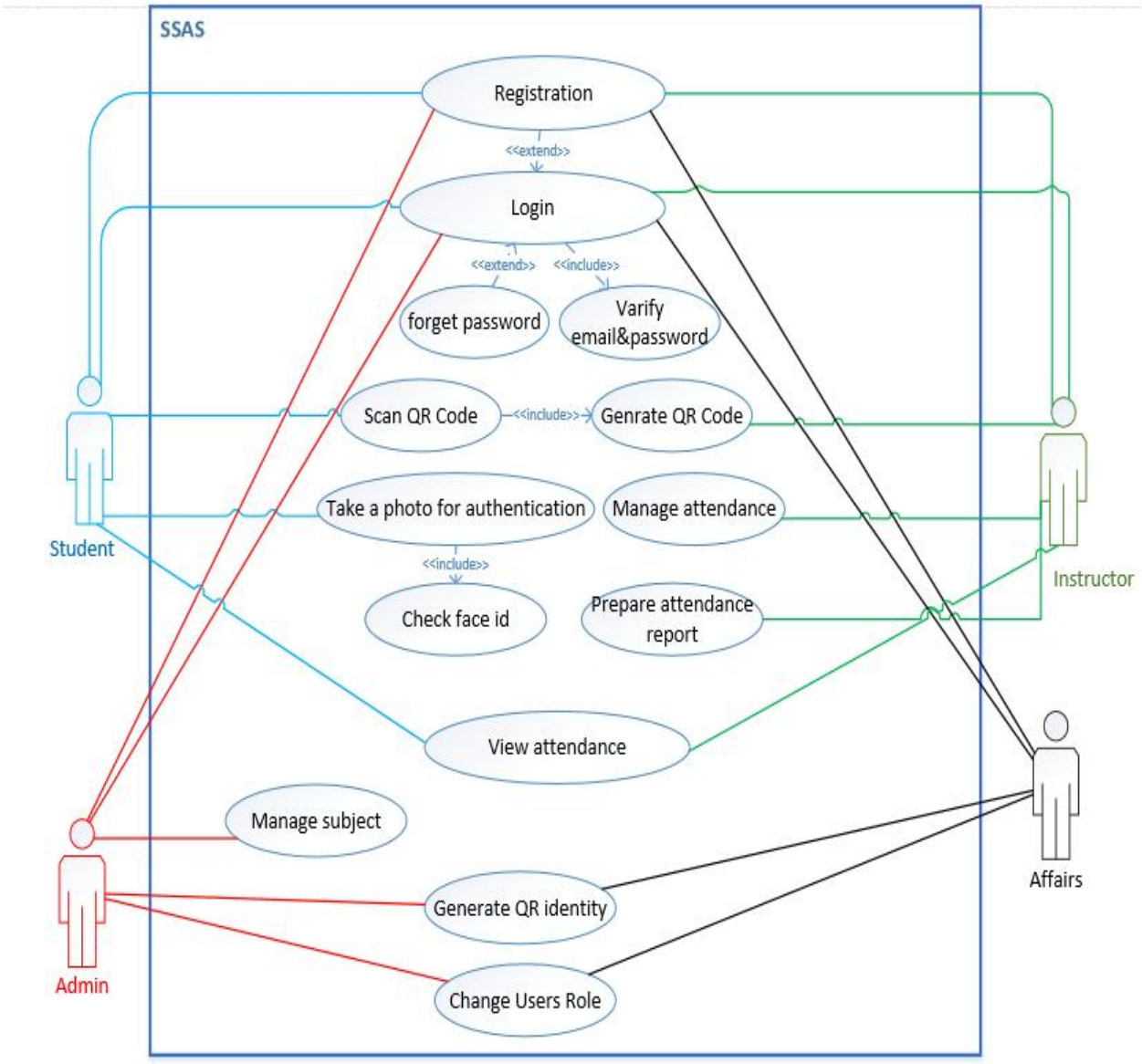


Figure 1: Use case Diagram

3.2 System Sequence Diagram

<> User sequence to determine the role

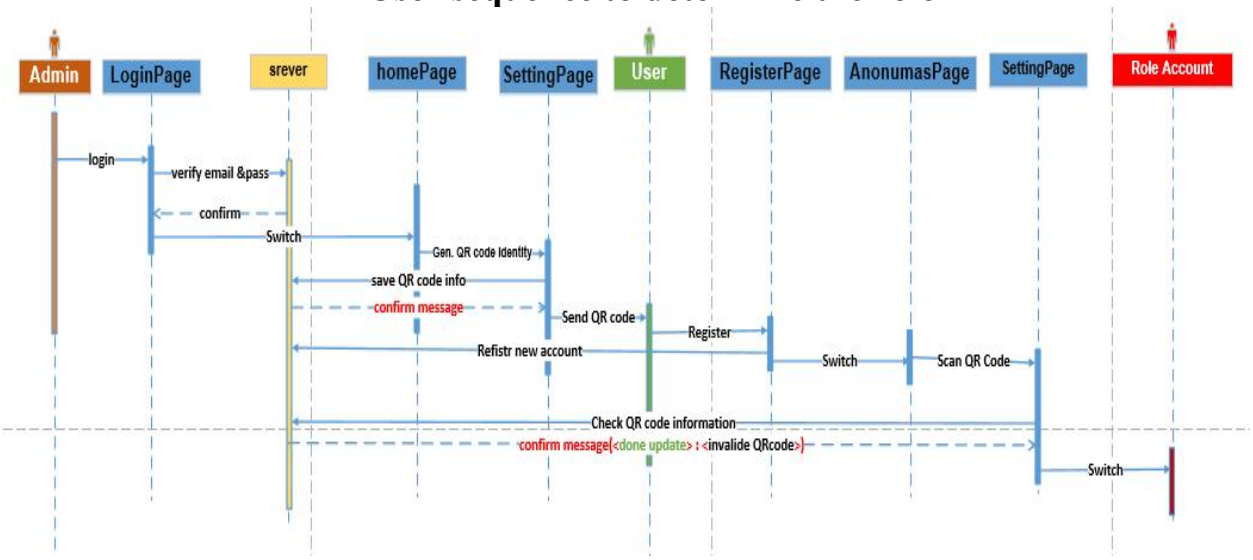


Figure 2: System Sequence Diagram1

<> Student and Instructor sequence to record attendance.

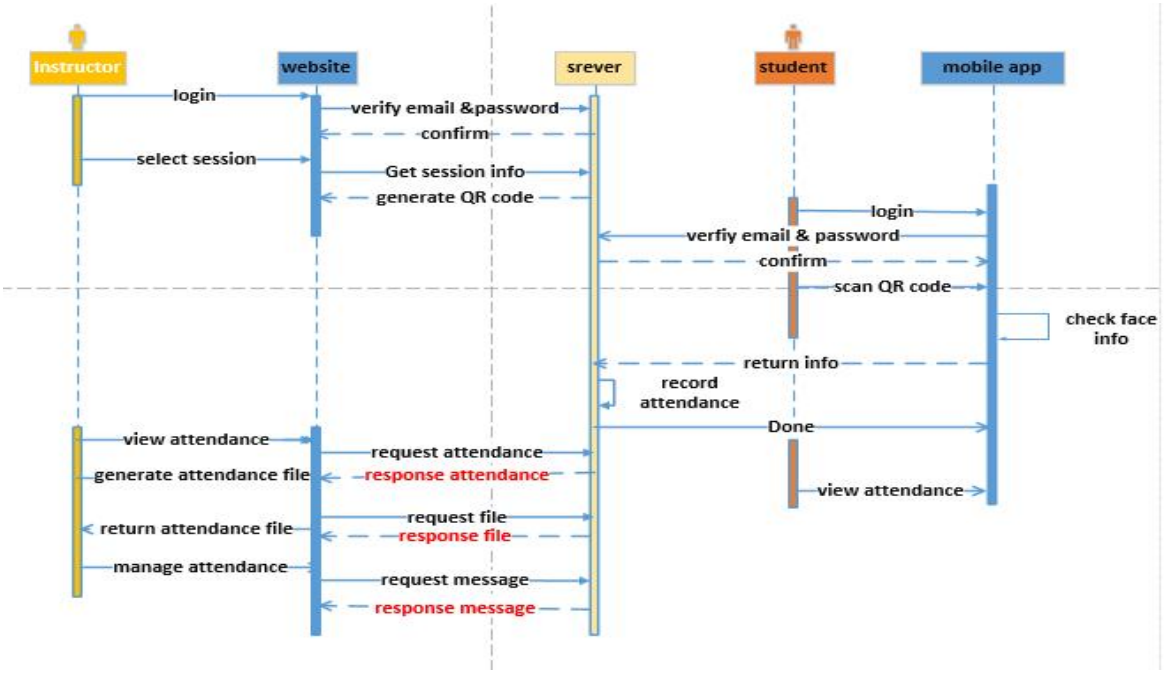


Figure 3: System Sequence Diagram2

3.3 Class diagram

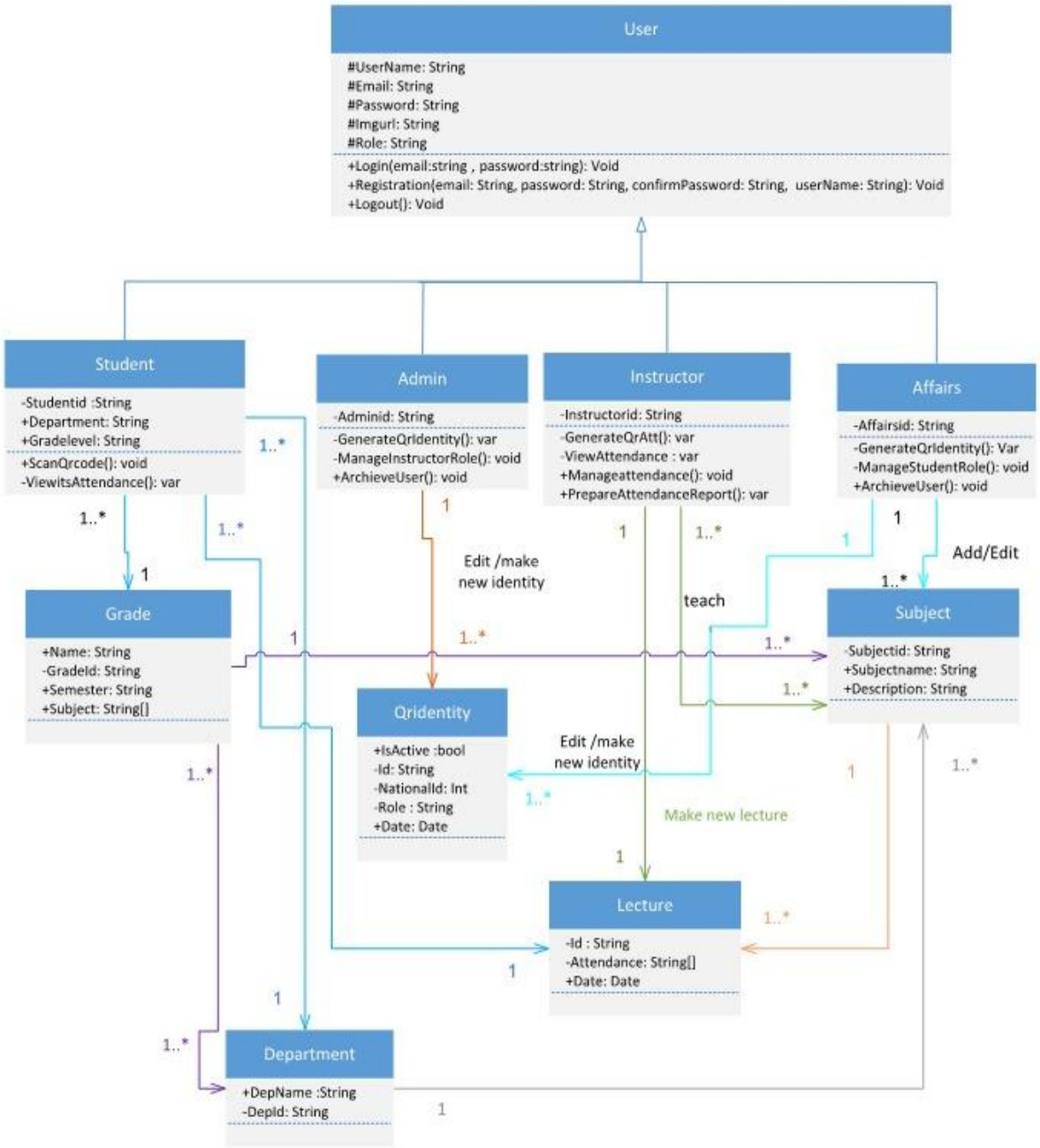


Figure 4: Class Diagram

3.3.1 Class diagram specification

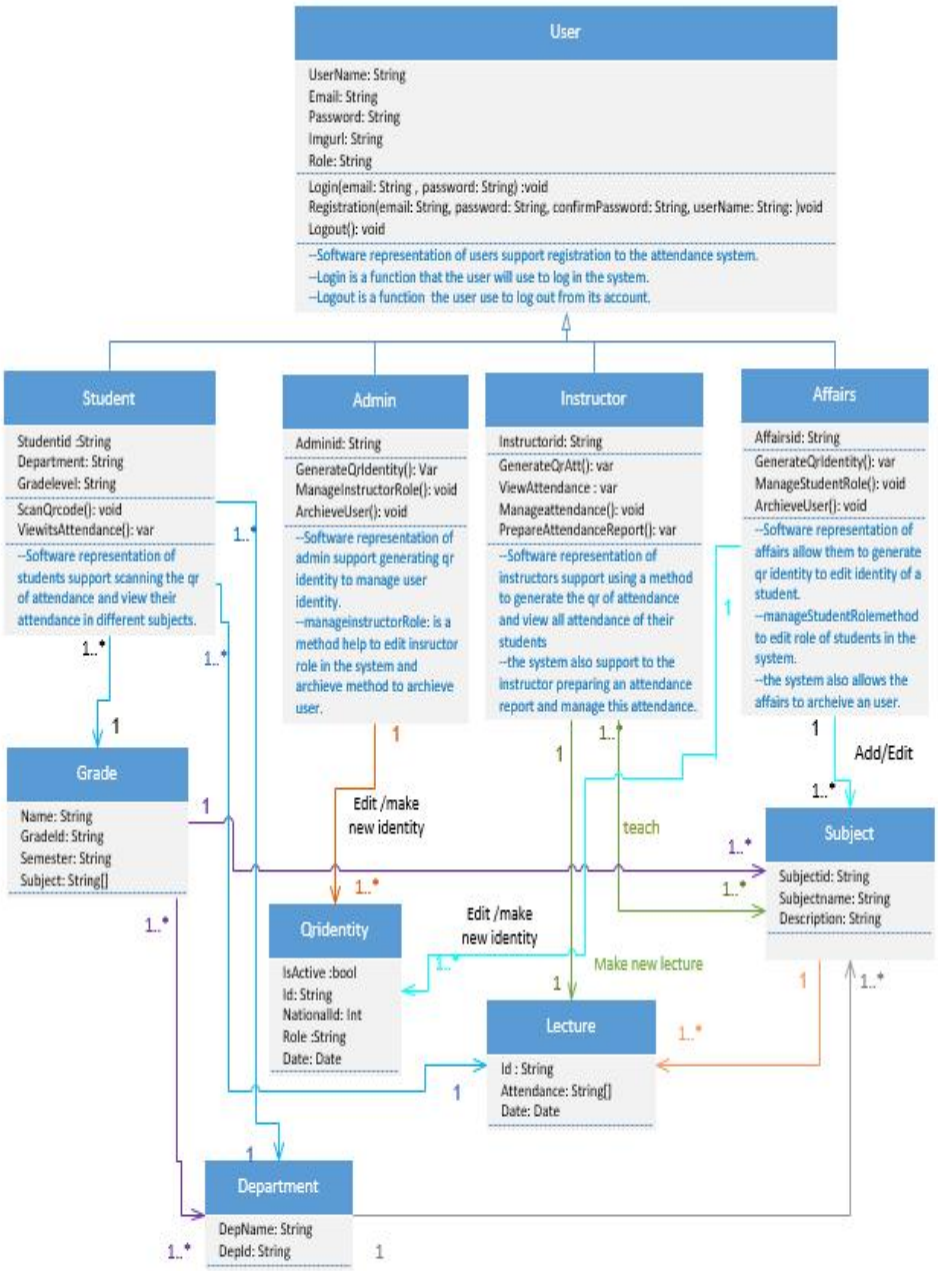


Figure 5: Class Diagram Specification

3.4 Data modeling Diagram

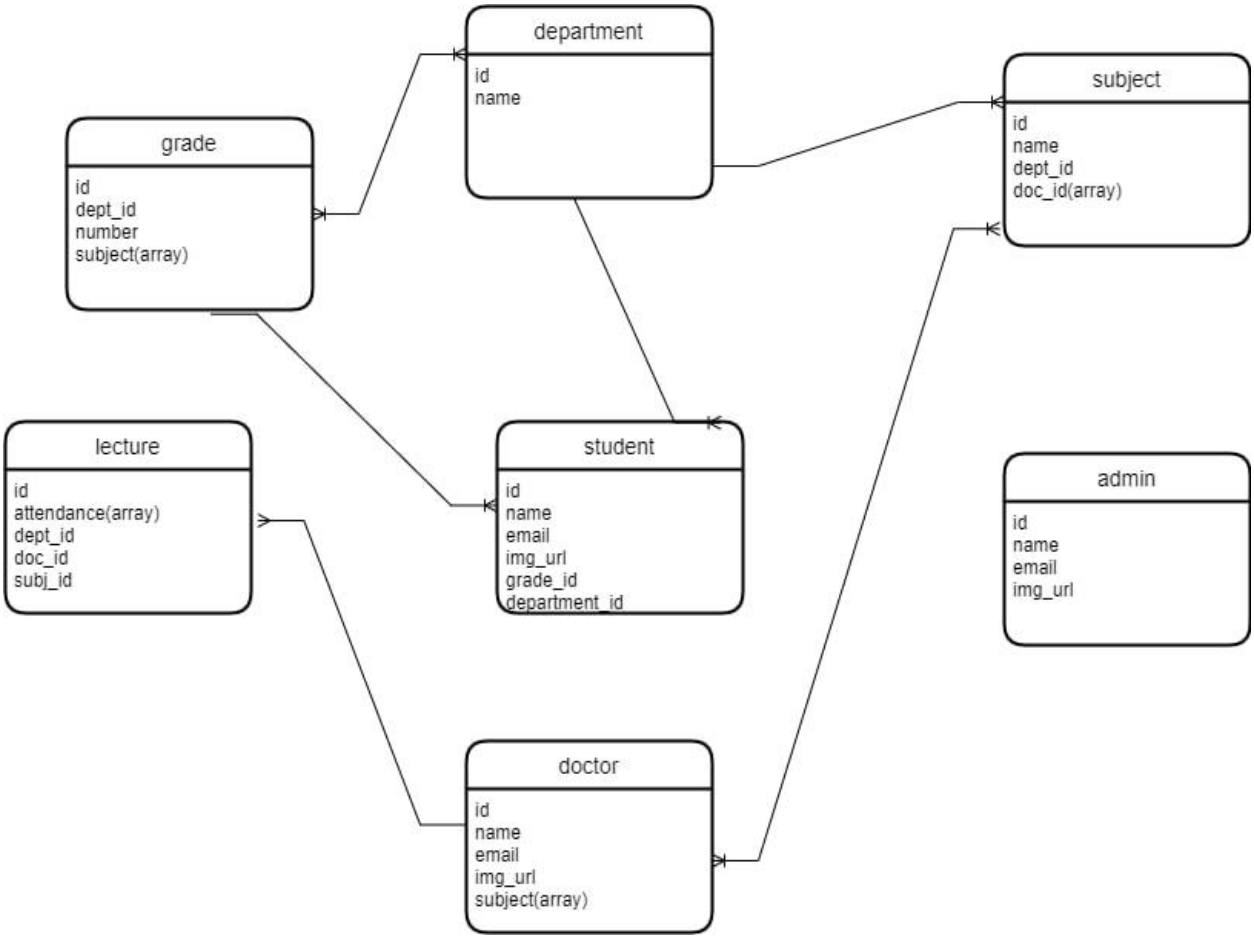


Figure 6: Data Modeling Diagram

3.5 System Block Diagram

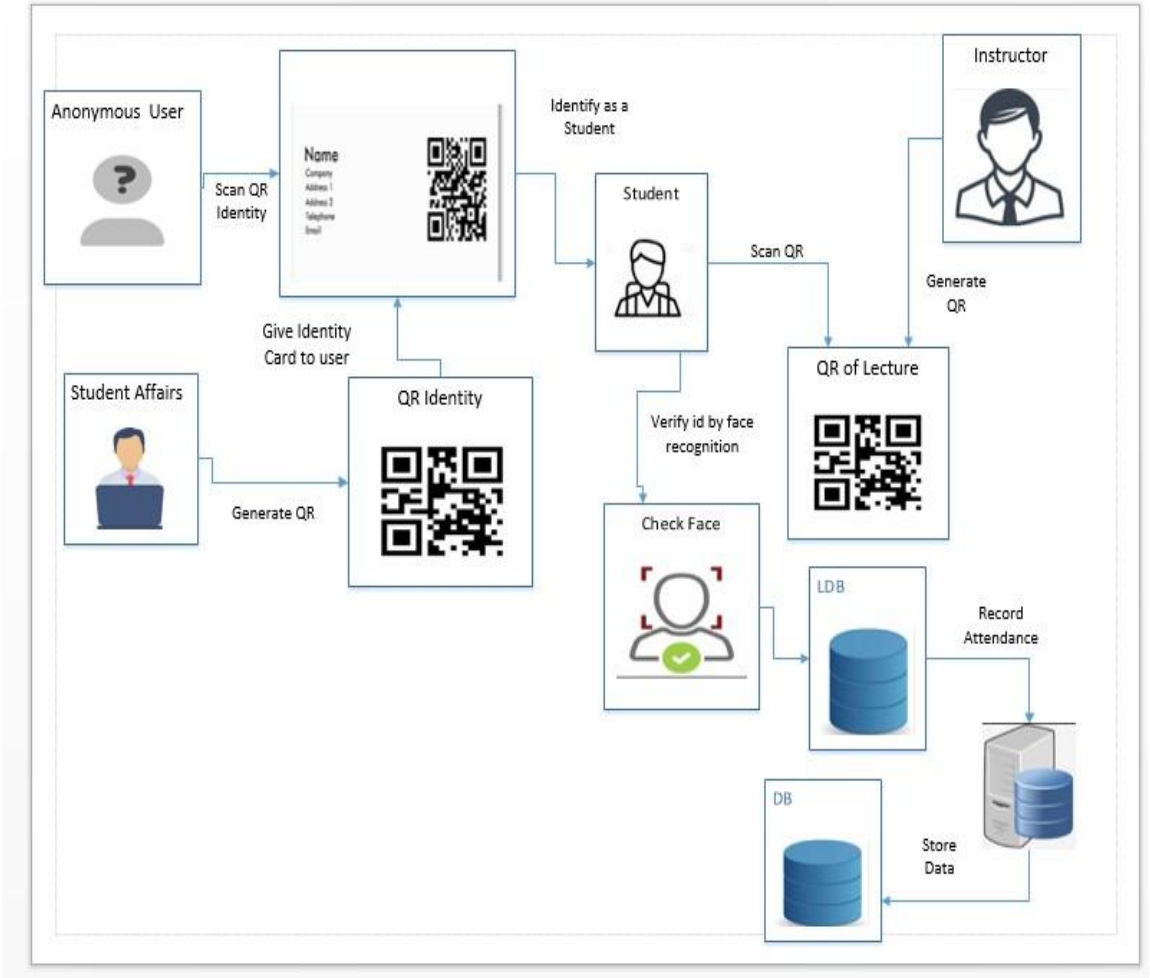


Figure 7: System Block Diagram

CHAPTER 4:
DEEP LEARNING

4.1 Deep learning Definition

Deep learning is a subset of machine learning, which is a subset of artificial intelligence. Artificial intelligence is a general term that refers to techniques that enable computers to mimic human behavior. Machine learning represents a set of algorithms trained on data that make all of this possible. Deep learning is just a type of machine learning, inspired by the structure of the human brain. [11]

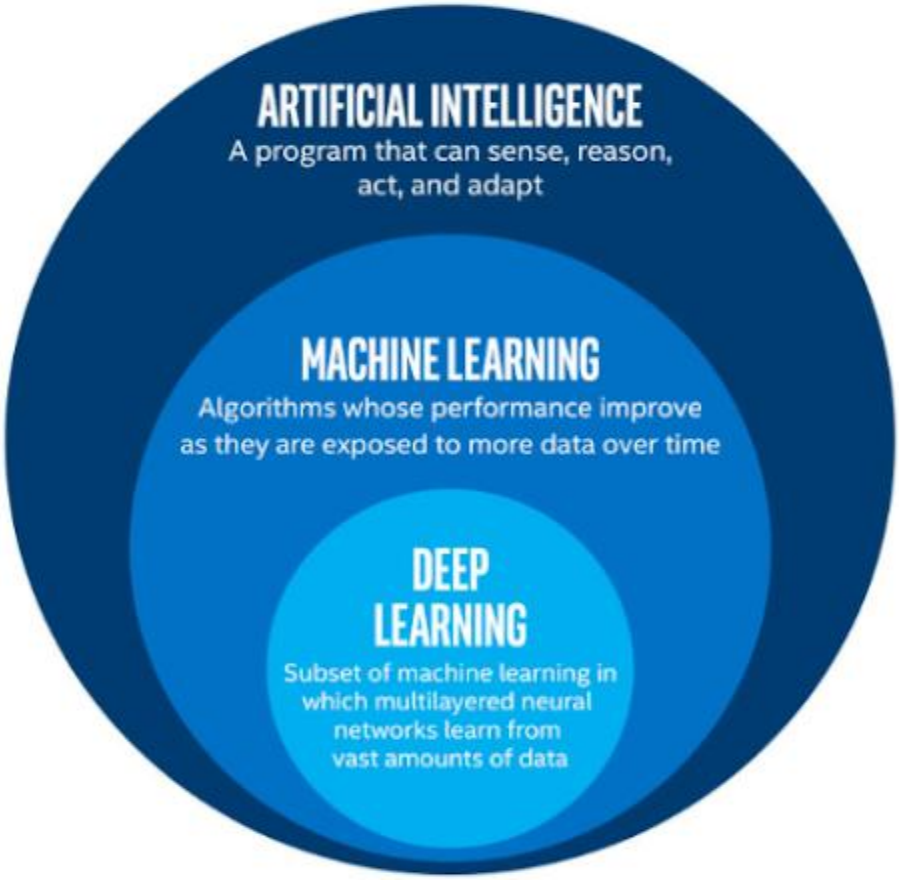


Figure 8: Difference between AI, ML and DL

4.2 ML vs DL

1) No feature extraction

- The first advantage of deep learning over machine learning is the redundancy of the so-called feature extraction.
- Long before we began using deep learning, we relied on traditional machine learning methods including decision trees, SVM, naïve Bayes classifier and logistic regression. These algorithms are also called flat algorithms. “Flat” here refers to the fact these algorithms cannot normally be applied directly to the raw data (such as .csv, images, text, etc.). We need a preprocessing step called feature extraction.
- The result of feature extraction is a representation of the given raw data that these classic machine learning algorithms can use to perform a task. For example, we can now classify the data into several categories or classes. Feature extraction is usually quite complex and requires detailed knowledge of the problem domain. This preprocessing layer must be adapted, tested and refined over several iterations for optimal results.

- Deep learning’s artificial neural networks don’t need the feature extraction step. The layers are able to learn an implicit representation of the raw data directly and on their own.[12]

Here's how it works: A more and more abstract and compressed representation of the raw data is produced over several layers of an artificial neural net. We then use this compressed representation of the input data to produce the result. The result can be, for example, the classification of the input data into different classes. [12]

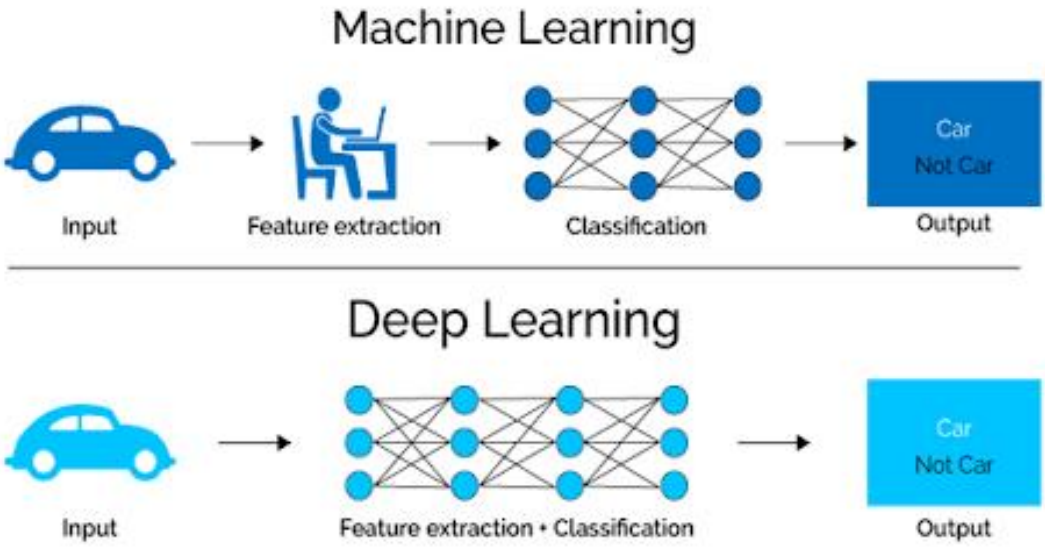


Figure 9: Machine Learning and Deep Learning

Feature extraction is only required for ML algorithms

- In other words, we can say that the feature extraction step is already part of the process that takes place in an artificial neural network.

- During the training process, this neural network optimizes this step to obtain the best possible abstract representation of the input data. This means that deep learning models require little to no manual effort to perform and optimize the feature extraction process.

- Let's look at a concrete example. If you want to use a machine learning model to determine if a particular image is showing a car or not, we humans first need to identify the unique features of a car (shape, size, windows, wheels, etc.), then extract the feature and give it to the algorithm as input data. In this way, the algorithm would perform a classification of the images. That is, in machine learning, a programmer must intervene directly in the action for the model to come to a conclusion. [12]
- In fact, refraining from extracting the characteristics of data applies to every other task you'll ever do with neural networks. Simply give the raw data to the neural network and the model will do the rest.

2) The era of data

- The second huge advantage of deep learning, and a key part of understanding why it's becoming so popular, is that it's powered by massive amounts of data. The era of big data will provide huge opportunities for new innovations in deep learning.

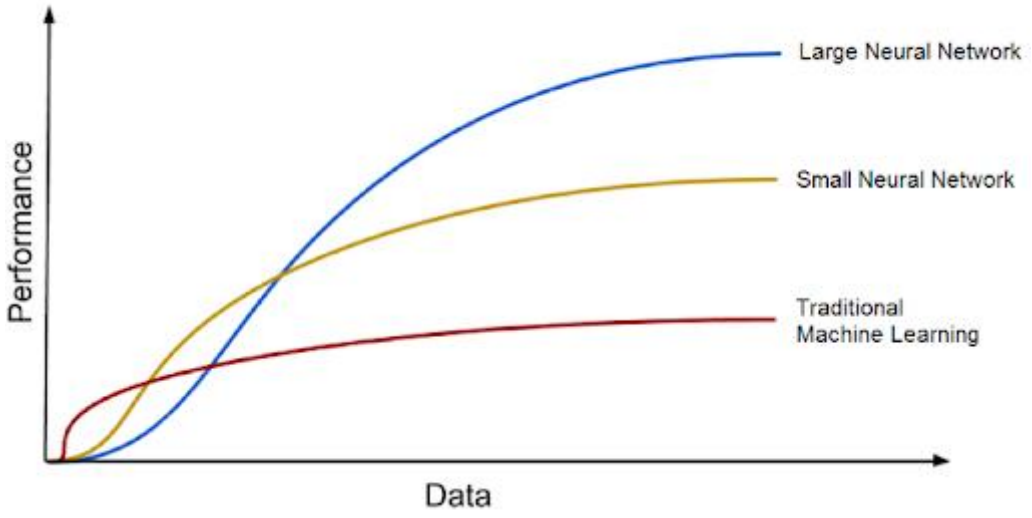


Figure 10: Difference between Deep Learning algorithms

Deep learning algorithms improve with increasing amounts of data.

- Deep learning models tend to increase their accuracy with the increasing amount of training data, whereas traditional machine learning models such as SVM and naive Bayes classifier stop improving after a saturation point.[12]

3) Execution time

- A deep learning algorithm takes a long time to train, this is because there are so many parameters in a deep learning algorithm that training them takes longer than usual whereas machine learning comparatively takes much less time to train, ranging from a few seconds to a few hours.

- This in turn is completely reversed on testing time. At test time, deep learning algorithms take much less time to run. Whereas, if you compare it with k-nearest neighbors (a type of machine learning algorithm), test time increases on increasing the size of data. Although this is not applicable on all machine learning algorithms, as some of them have small testing times too.[13]

4.2.1 Neural Network

- The inspiration for deep learning is the way that the human brain filters information. Its main motive is to simulate human-like decision-making. Neurons in the brain pass the signals to perform the actions.
- Artificial neurons connect in a neural network to perform tasks clustering, classification, or regression. [14]

4.2.2 Layers

Neurons are grouped into three different types of layers :

- **Input layer**

  It receives the input data from the observation.

- **Hidden layer**

It performs mathematical computations on input data.

- **Output layer**

It gives the desired result.

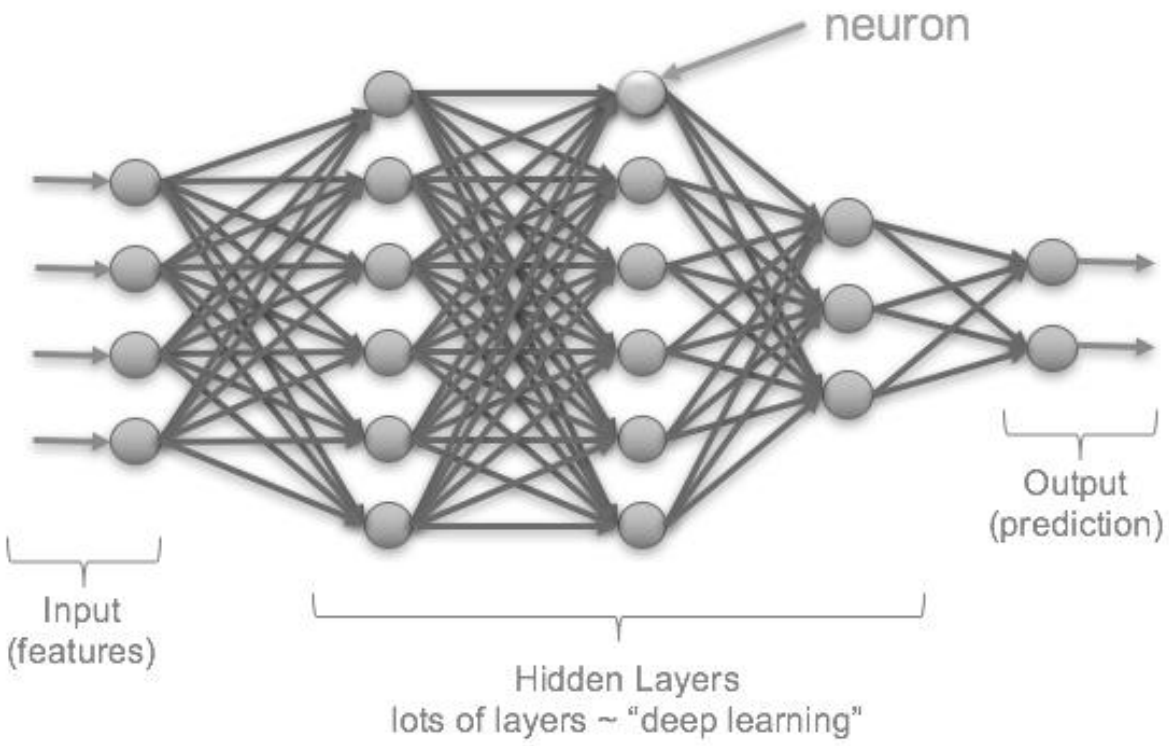


Figure 11: Types of Neurons Layers

4.2.3 Weight

The connection between neurons is called weight, which is the numerical value. the weight between neurons determines the learning ability of the neural network.[14]

4.2.4 Activation Function

It is used for standardizing the output from the neuron , Activation functions are the mathematical equations that calculate the output of the neural network. It also helps to normalize the output in a range between 0 to 1 or -1 to 1. [14]

Types of Activation Functions:

- **Linear Function:[15]**

Equation:

$$f(x) = ax + c$$

Explanation: The value of f(x) increases proportionally with the value of x .

Range: The input value is the weighted sum of the weighted and bias of the neurons in a layer .

Usage: solves the issue of a binary step function where it reports only a value of 0 and 1.

Issue: this function is not fit to handle complexes.

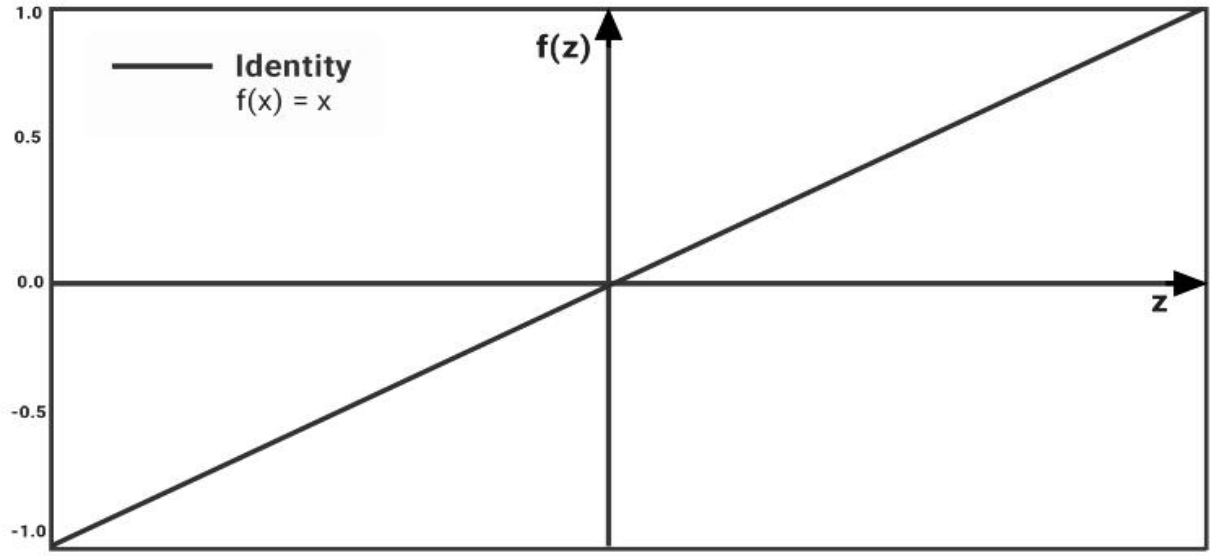


Figure 12: Linear Function

- **Sigmoid Function [15]**

Equation:

$$\frac{1}{1+e^{-x}}$$

Explanation: The Sigmoid function takes a value as input and outputs another value between 0 and 1 , It is non-linear and easy to work with when constructing a neural network model , The good part about this function is that continuously differentiable over different values of *z* and has a fixed output range.

Range: from 0 to 1 .

Usage: especially in binary classification models as part of the output layer to capture the probability ranging from 0 to 1.

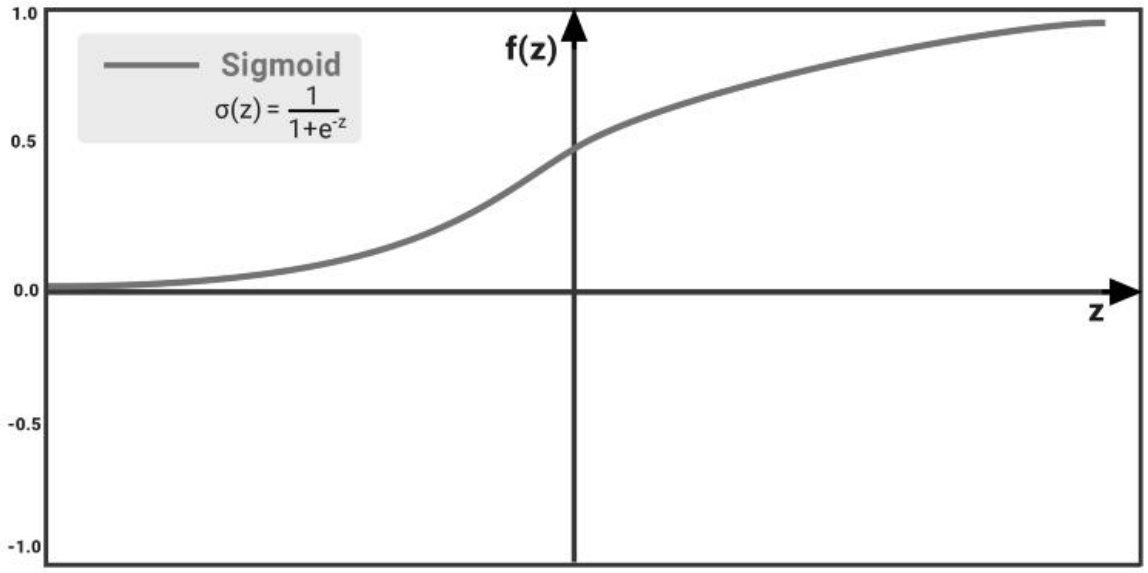


Figure 13: Sigmoid Function

- **Tanh Function[15]**

Equation:

$$\frac{e^{2x} - 1}{e^{2x} + 1}$$

Explanation : The Tanh function is a modified or scaled up version of the sigmoid function.

Range : from -1 to 1

Usage : helps us in establishing which scores to consider in the next layer and which to ignore.

Issue: this function still has the vanishing gradient problem.

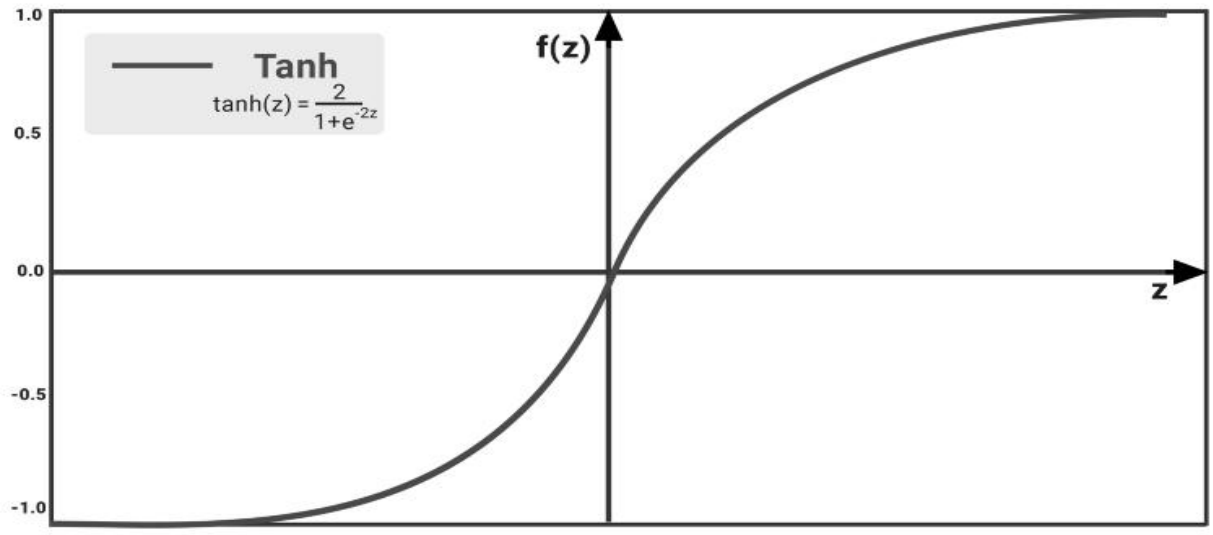


Figure 14: Tanh Function

- **Rectified Linear Unit Function (ReLU)**

Equation:

$$f(x) = max(x, 0)$$

Explanation: the Rectified Linear Unit or ReLU for short would be considered the most commonly used activation function in deep learning models .

The function simply outputs the value of 0 if it receives any negative input, but for any positive value *z,* it returns that value back like a linear function.

Range : from 0 to ∞ .

Usage : backpropagate the errors and have multiple layers of neurons being activated by the ReLU function.

Issues : The function suffers from the dying ReLU problem For activations corresponding to values of z< 0, the gradient will be 0 because of which the weights will not get adjusted during the gradient descent in backpropagation.

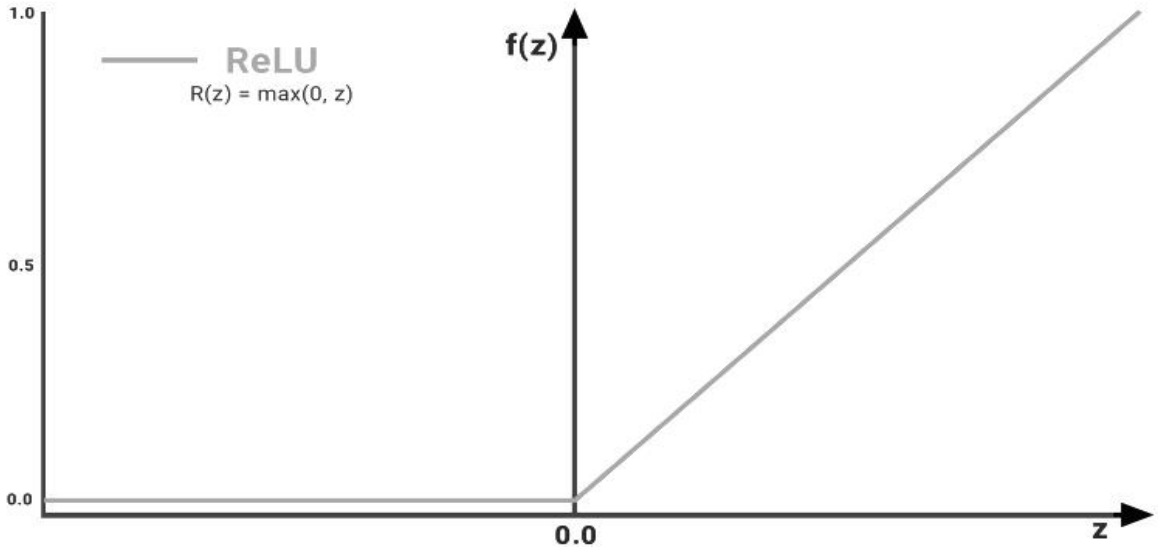


Figure 15: ReLU Function

● **Softmax Activation Function**

Equation:

$$\sigma(\vec{z})_i = \frac{e^{z_i}}{\sum_{j=1}^{K} e^{z_j}}$$

Explanation : softmax function and the sigmoid function are similar. The softmax operates on a vector while the sigmoid takes a scalar.

Range : it used in classification problem which output either 0 or 1.

Usage :it converts a vector of numbers into a vector of probabilities ,where the probabilities of each value are proportional to the relative scale of each value in the vector softmax function is used to normalize the outputs.

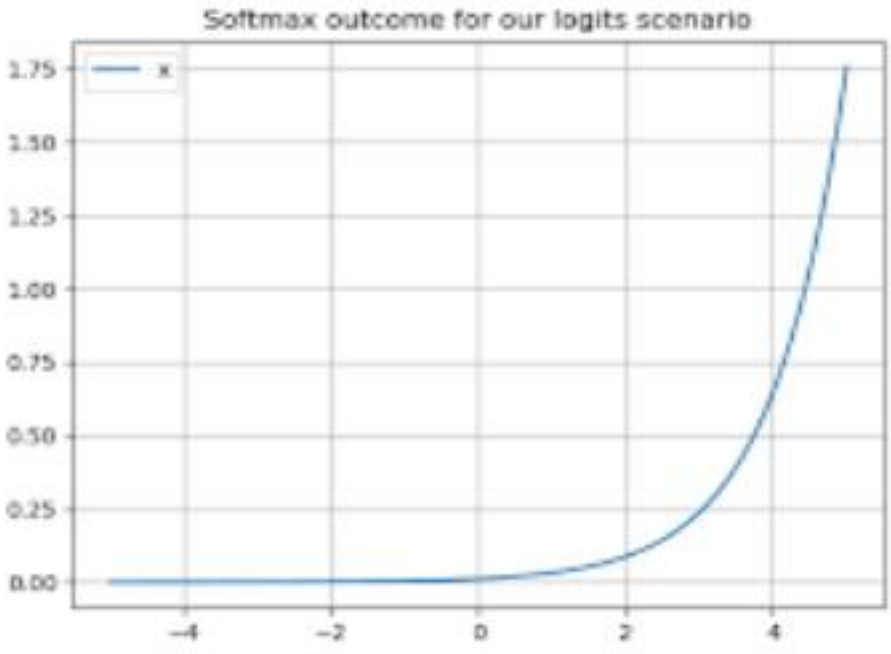


Figure 16: Softmax Function

In an ANN, the sigmoid function is a non-linear AF used primarily in feedforward neural networks. It is a differentiable real function, defined for real input values, and containing positive derivatives everywhere with a specific degree of smoothness. The sigmoid function appears in the output layer of the deep learning models and is used for predicting probability-based outputs.

4.3 DL Algorithms

4.3.1 Convolutional Neural Network

- A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other.[16]

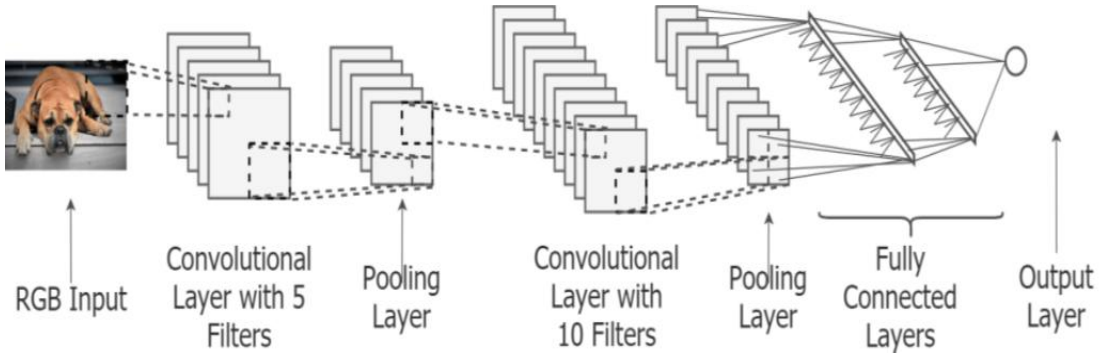


Figure 17: CNN Architecture

Convolutional neural network (CNN), a class of artificial neural networks that has become dominant in various computer vision tasks, is attracting interest across a variety of domains, including radiology. CNN is designed to automatically and adaptively learn spatial hierarchies of features through backpropagation by using multiple building blocks, such as convolution layers, pooling layers, and fully connected layers.

CNN Layers:

1) Convolution Layer : Convolution is the first layer to extract features from an input image. Convolution preserves the relationship between pixels by learning image features using small squares of input data. It is a mathematical operation that takes two inputs such as image matrix and a filter or kernel.

Convolution is a mathematical operation on two objects to produce an outcome that expresses how the shape of one is modified by the other.

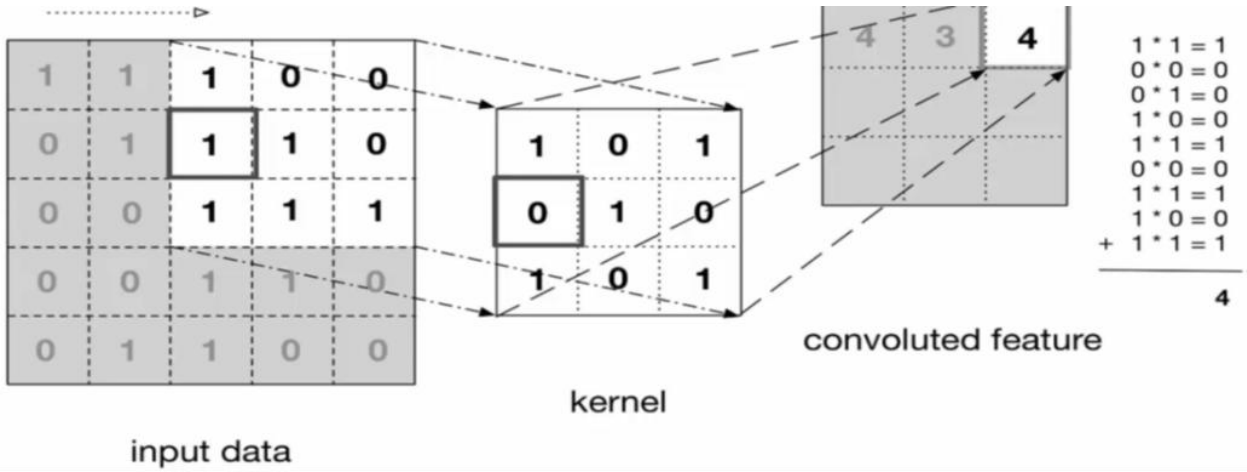


Figure 18: Convolution Layer

CNN uses filters (Kernels) to detect specific features in an image in order to get useful features .

Filter (Kernel) is a set of weights in a matrix applied on an image or a matrix to obtain the required features.

We can obtain different output using different filters and here are some types of filters

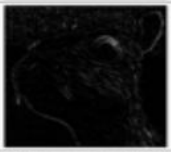
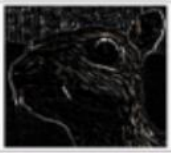
Operation	Filter	Convolved Image
Identity	$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	
Edge detection	$\begin{bmatrix} 1 & 0 & -1 \\ 0 & 0 & 0 \\ -1 & 0 & 1 \end{bmatrix}$	
	$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$	
	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$	
Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
Box blur (normalized)	$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	
Gaussian blur (approximation)	$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$	

Figure 19: Types of filters

Strides:

Stride is the number of pixels shifted over the input matrix. When the stride is 1 then we move the filters to 1 pixel at a time. When the stride is 2 then we move the filters to 2 pixels at a time and so on.[17]

Padding:

Sometimes the filter does not fit the input image. We have two options:

- Pad the picture with zeros (zero-padding) so that it fits
- Drop the part of the image where the filter did not fit. This is called valid padding which keeps only valid part of the image.[17]

2) Pooling Layer: Pooling layers section would reduce the number of parameters when the images are too large. Spatial pooling is also called subsampling or downsampling which reduces the dimensionality of each map but retains important information. Spatial pooling can be of different types:

- Max Pooling
- Average Pooling
- Sum Pooling

Max pooling takes the largest element from the rectified feature map. Taking the largest element could also take the average pooling. Sum of all elements in the feature map call as sum pooling.[17]

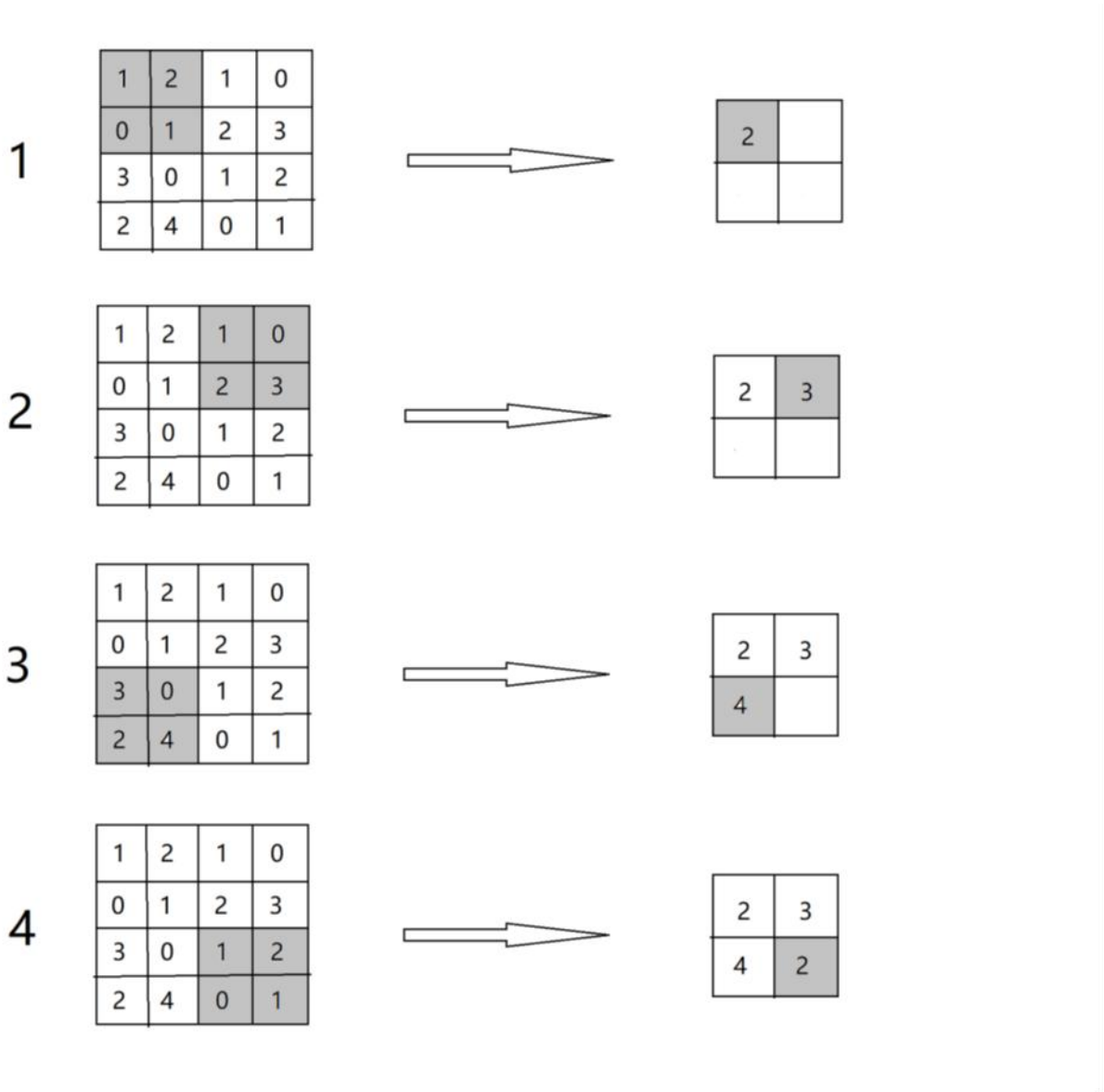


Figure 20: Example of Pooling (Max pooling)

3) Flatten layer: Flattening is converting the data into a 1-dimensional array for inputting it to the next layer. We flatten the output of the convolutional layers to create a single long feature vector.[18]

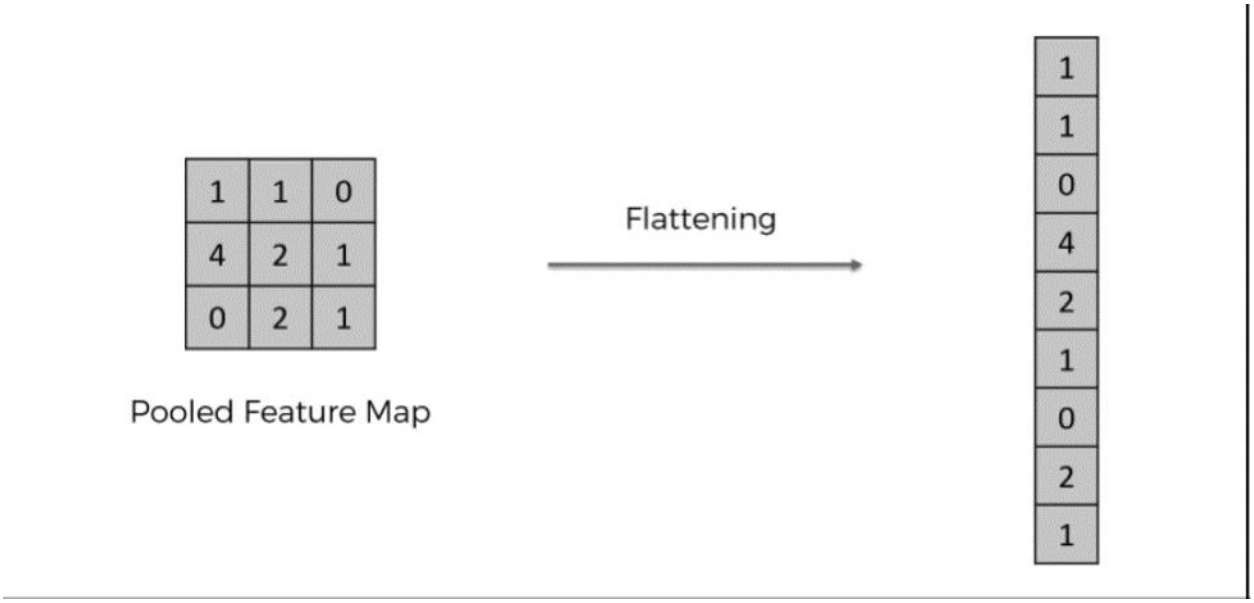


Figure 21: Flatten Layer

4) Fully Connected Layer: which is feedforward neural networks , neurons in a fully connected layer have full connections to all activations in the previous layer, as it is in regular ANN, and their activation can be computed via a matrix multiplication followed by a bias offset.

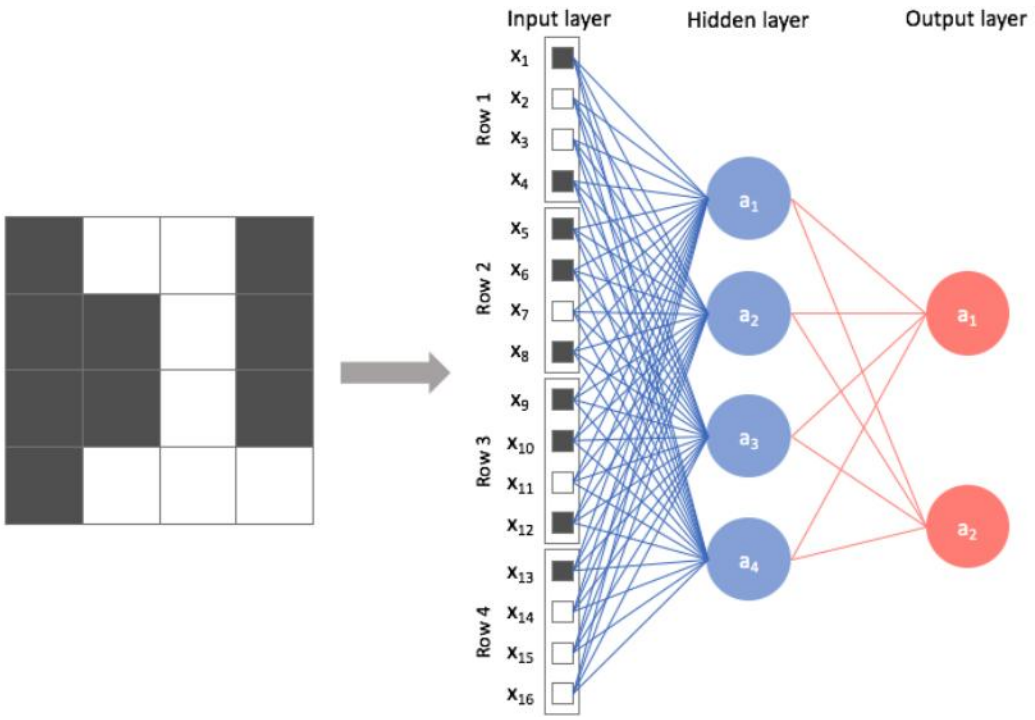


Figure 22: Fully Connected Layer

CHAPTER 5: SYSTEM IMPLEMENTATION

5.1 Software Architecture

- **Splash Screen**

Figure 23: Splash screen view

- **Start Page**

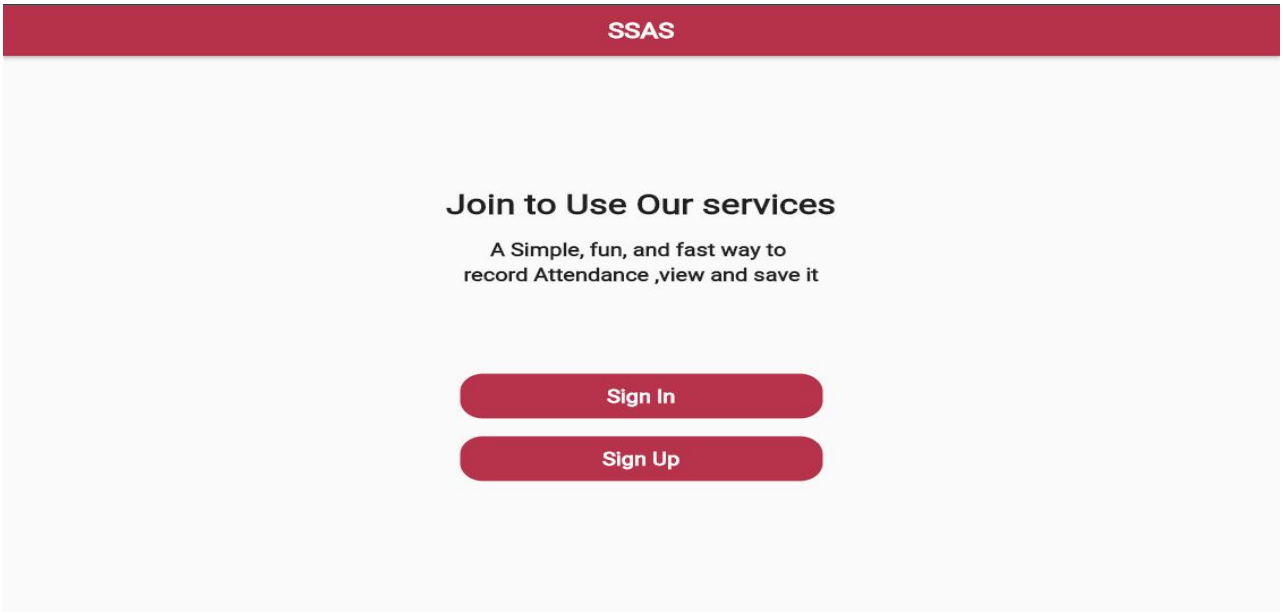


Figure 24: Start page view

- **Login Page**

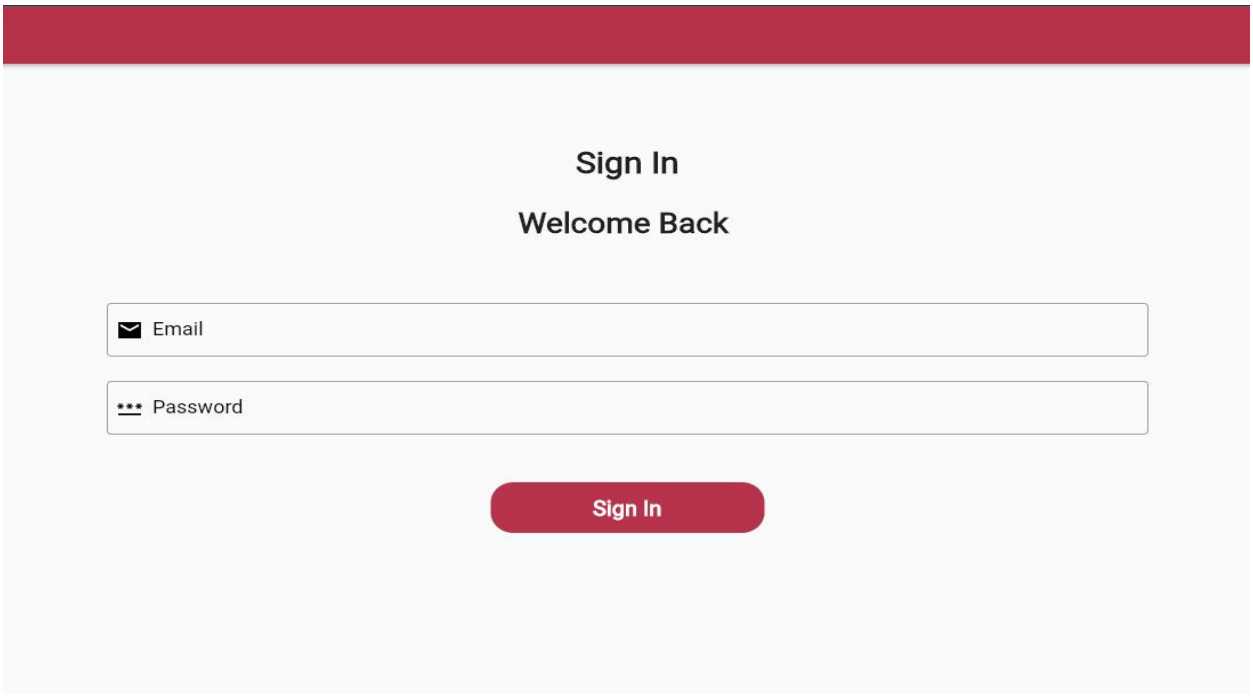


Figure 25: Login page view

- **Register Page**

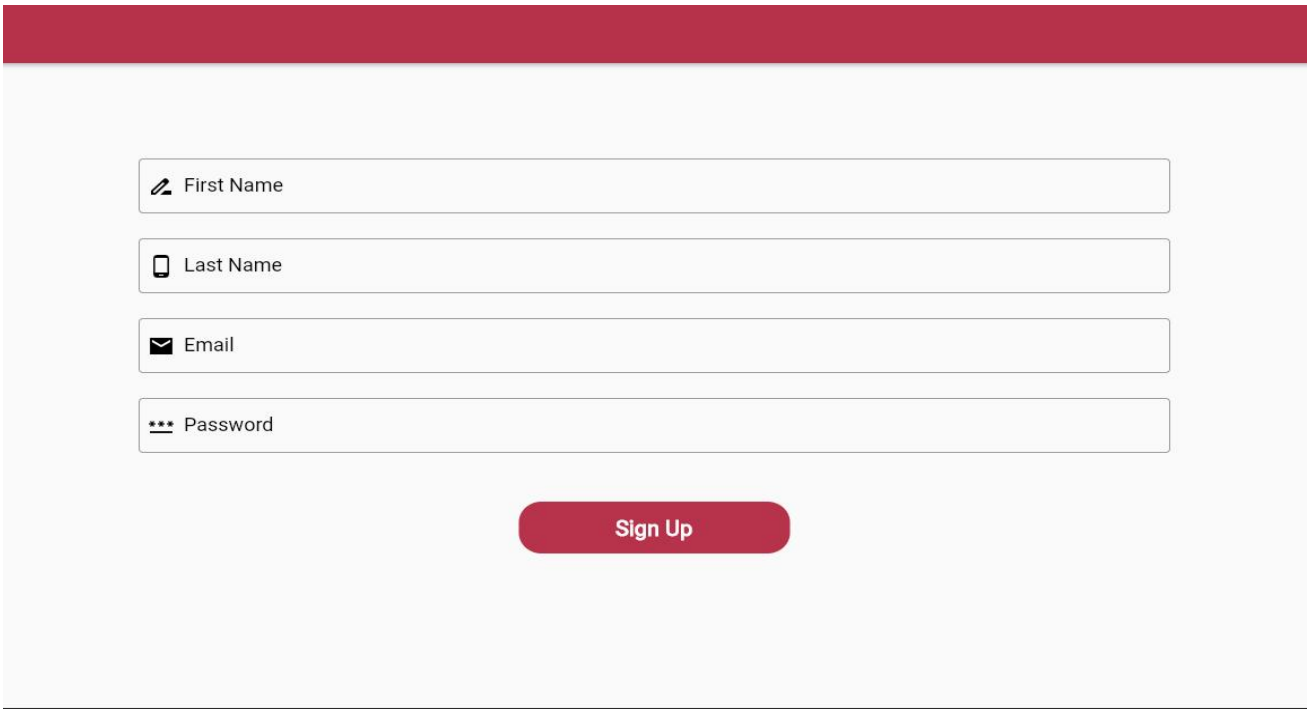


Figure 26: Register page view

Admin View:

- **Users Page**

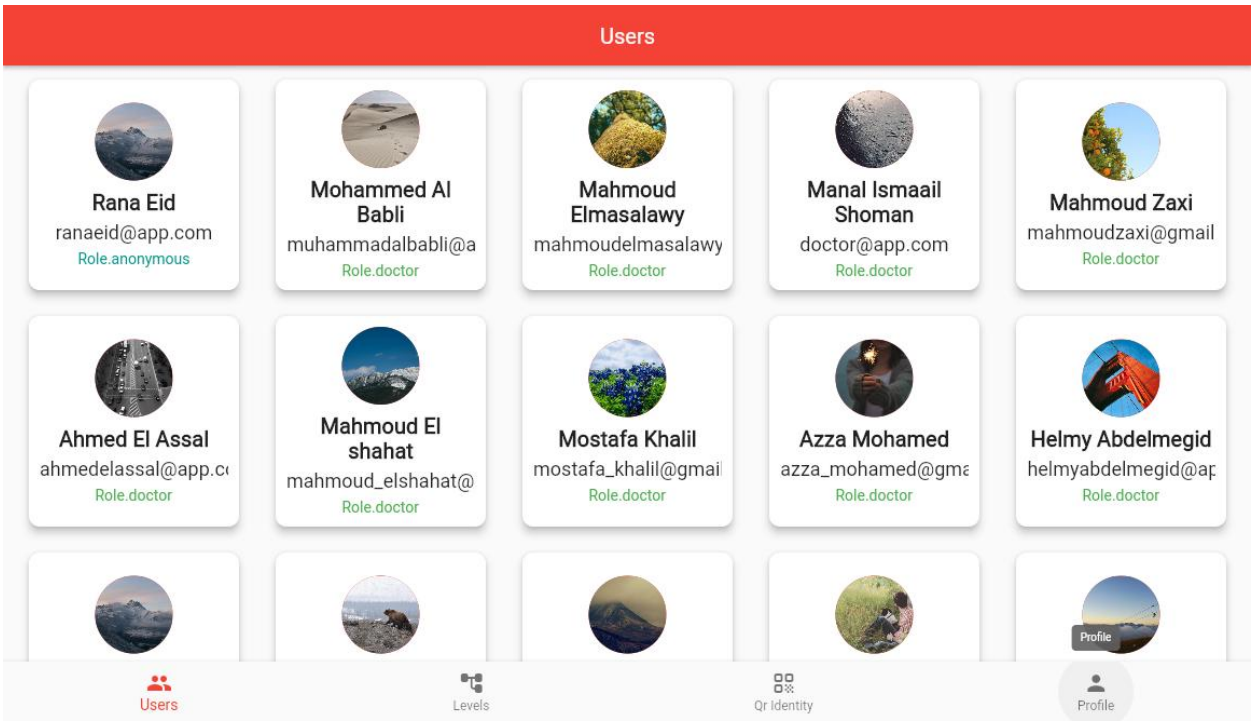


Figure 27: Users page view

- **Edit User Role**

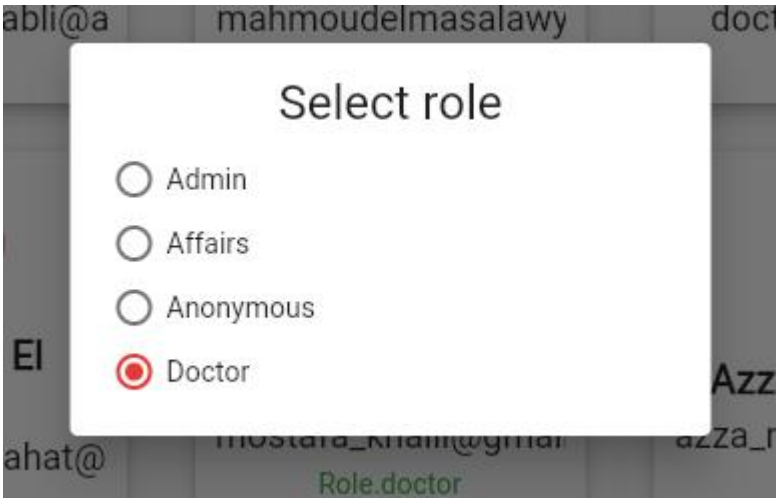


Figure 28: Edit user role view

- **Academic Years**

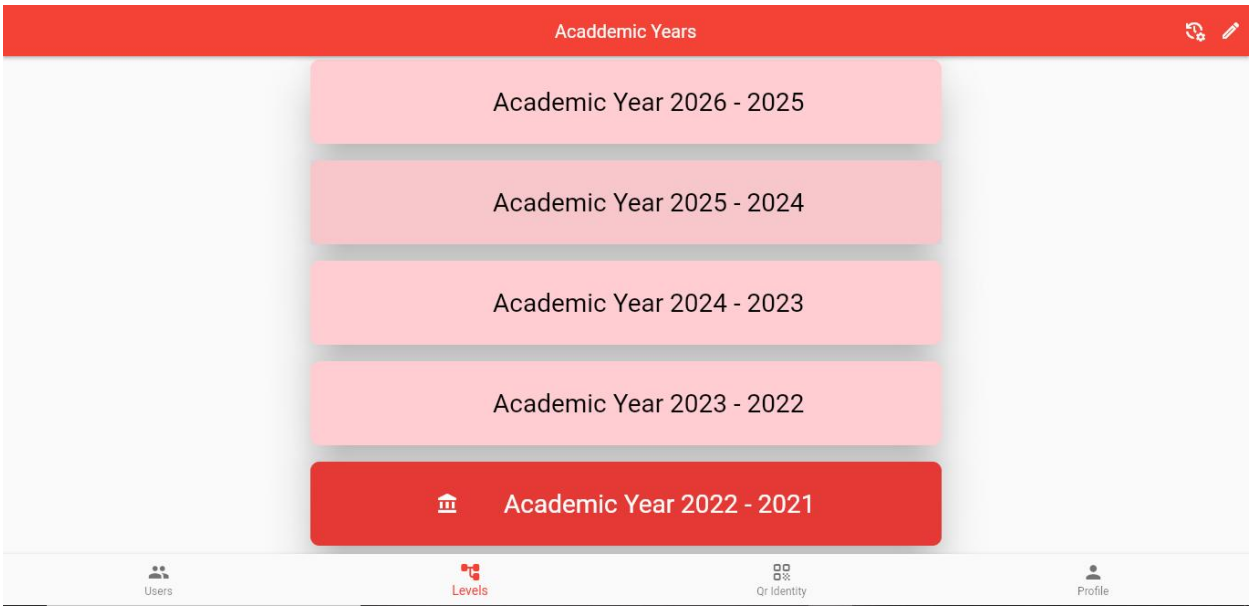


Figure 29: Academic year view

- **Select Active Academic Year**

Figure 30 Select Active Academic Year

- **Edit Academic Years**

Figure 31 Edit Academic Years

- **Academic Levels**

Figure 32: Academic levels view

- **Departments**

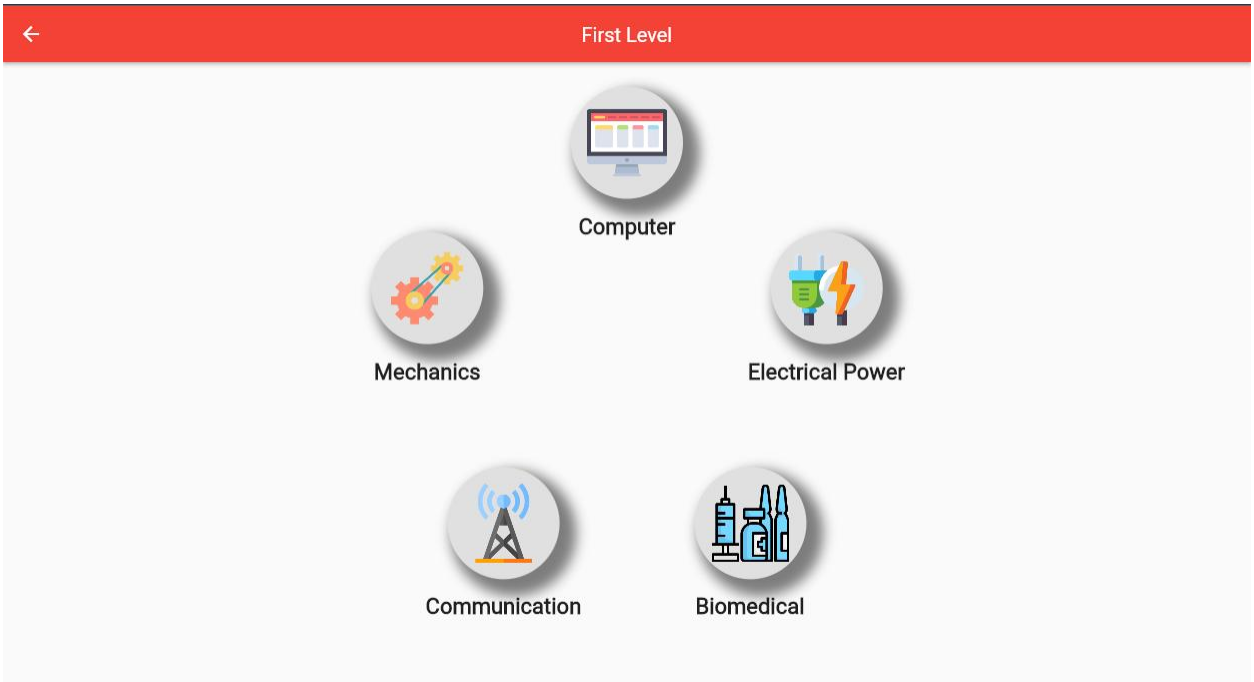


Figure 33: Departments view

- **Division**

Figure 34: Departments view

- **Subject Screen**

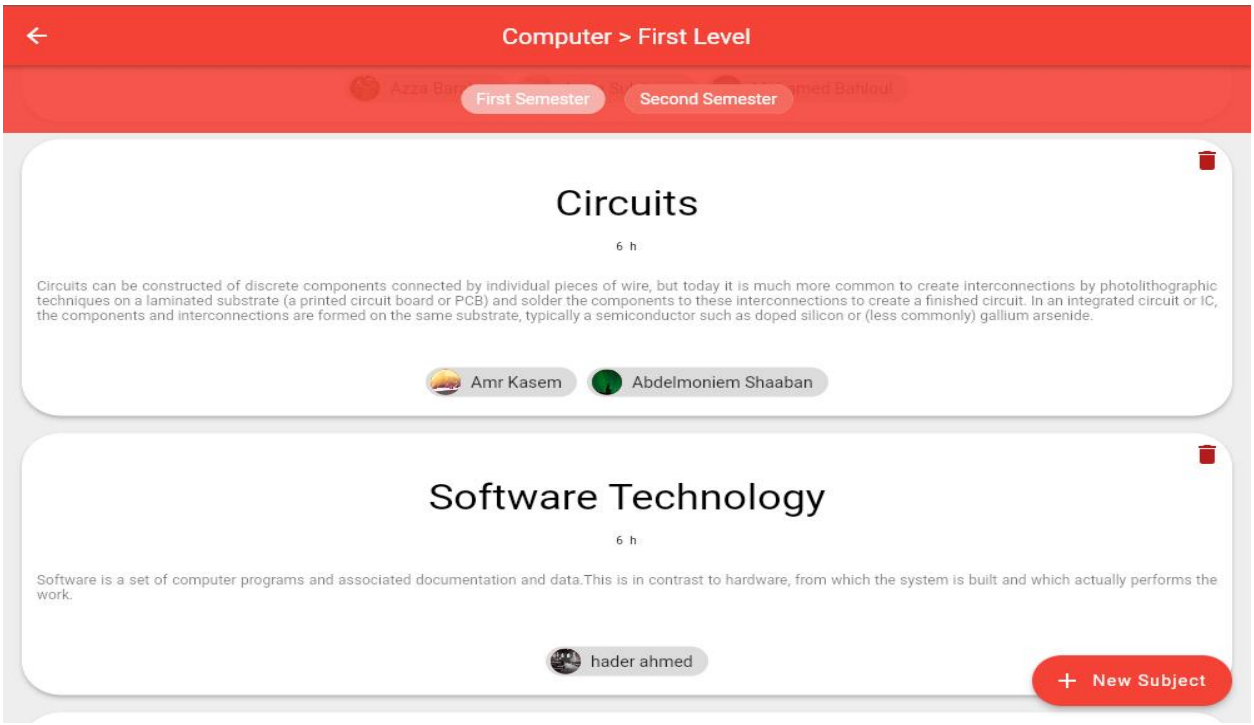


Figure 35: Subject screen view

- **Add a New Subject**

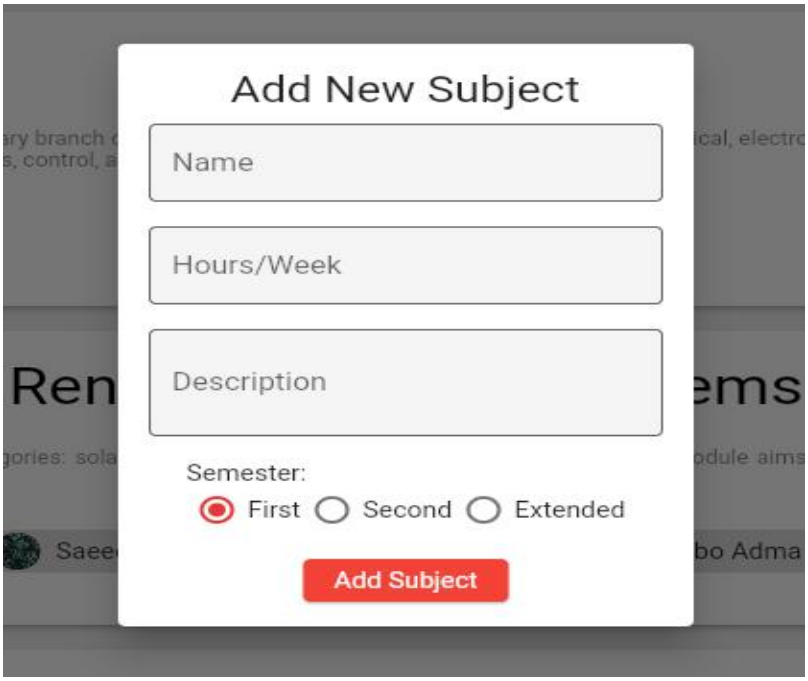


Figure 36: Add new subject view

- **Subject Details**

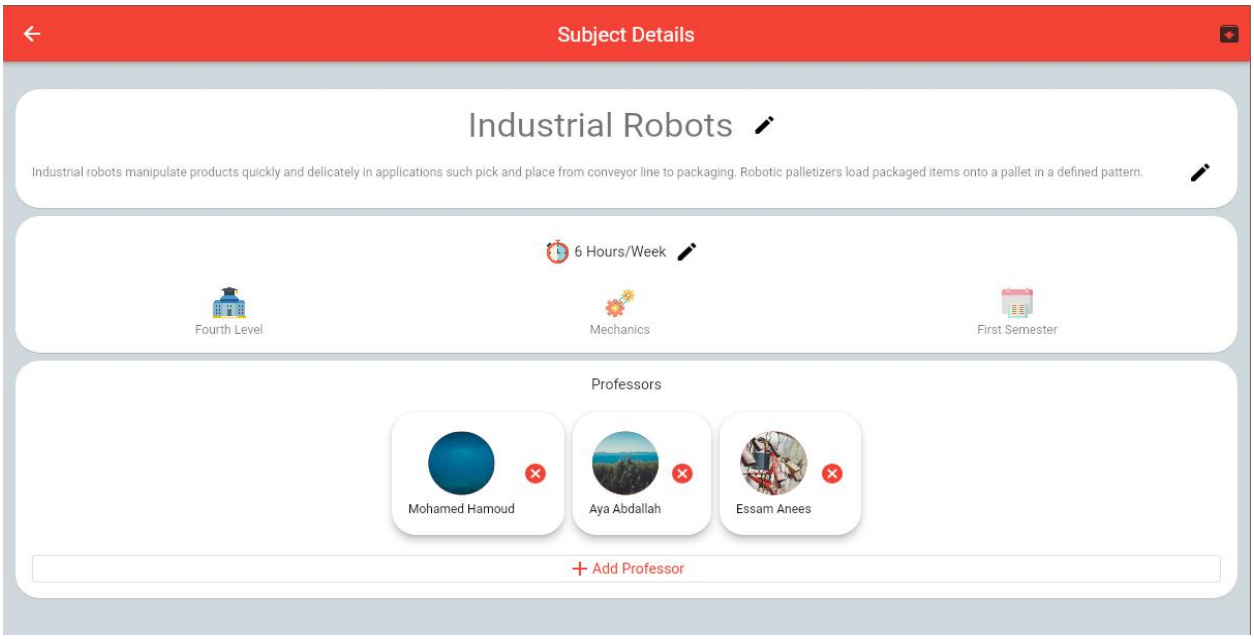


Figure 37: Subject details view

- **Professors List**

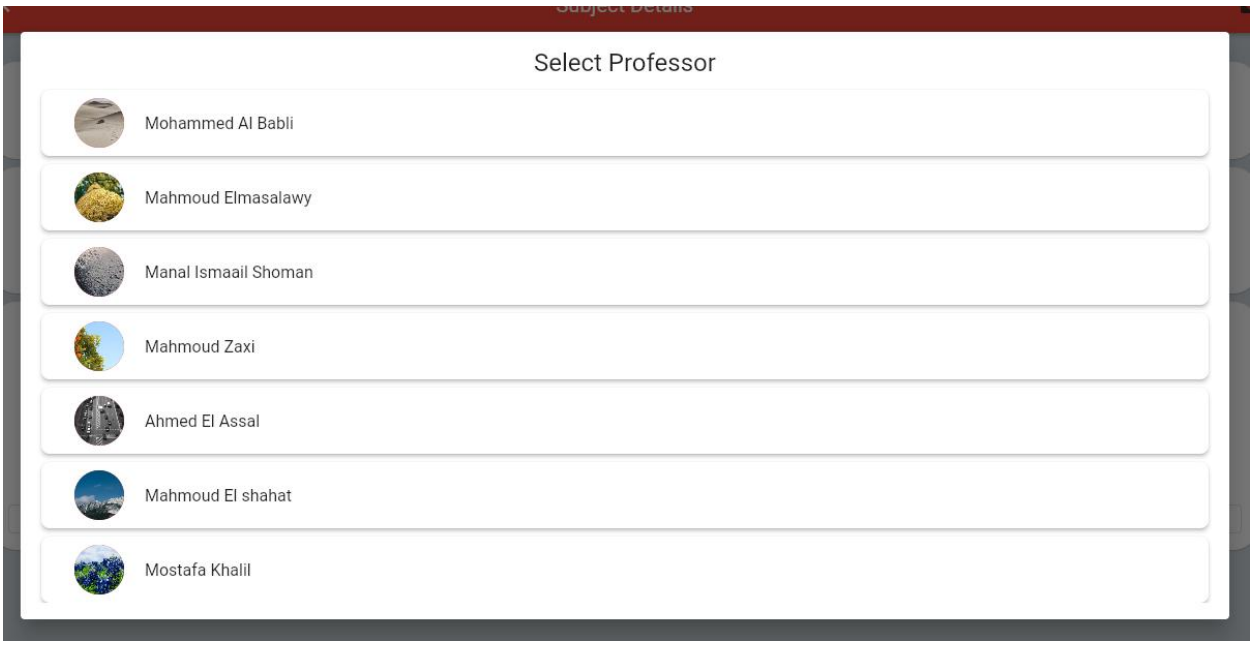


Figure 38: Professor list view

- **Identity QR Code Screen**

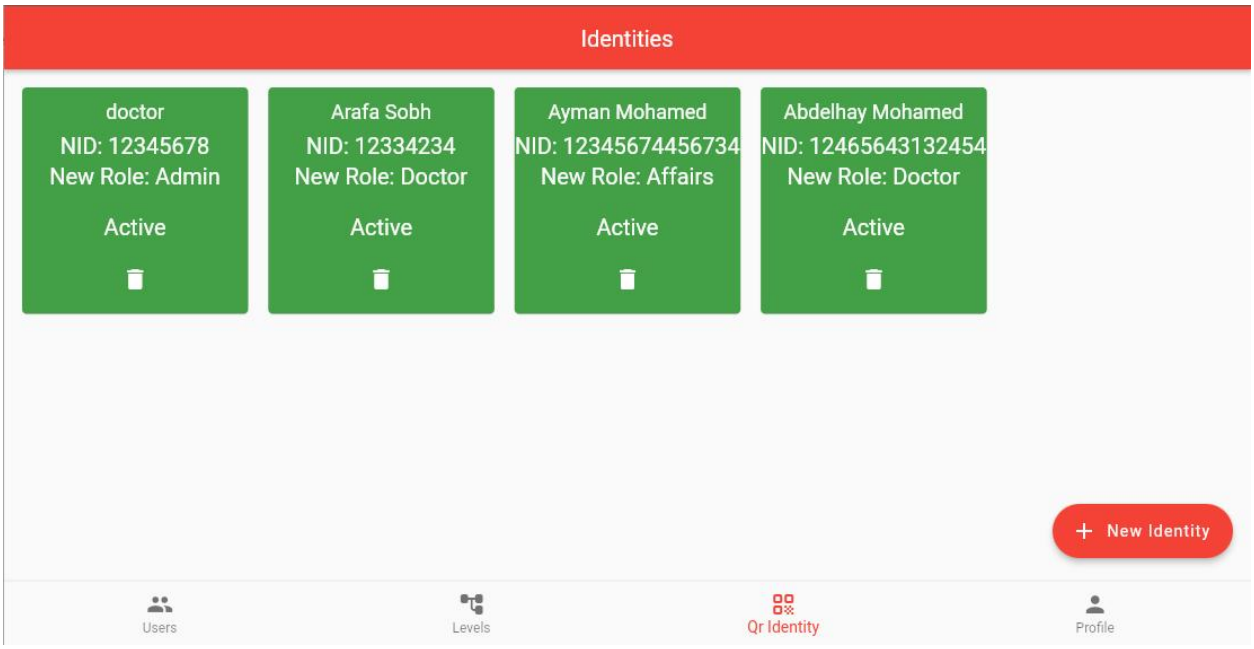


Figure 39: Identity QR code screen view

- **Add a New Identity**

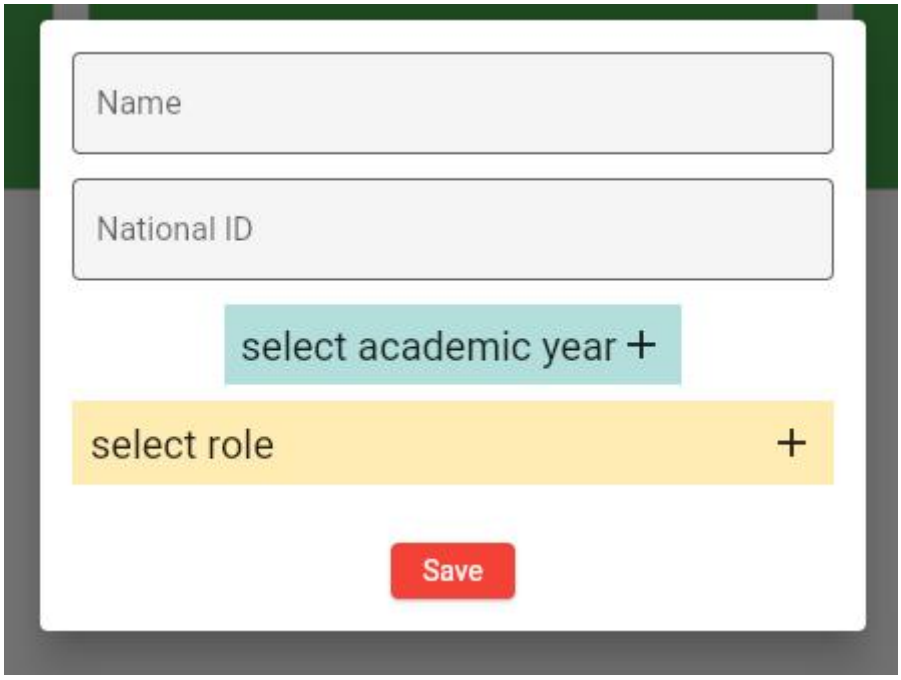


Figure 40: Add new identity view

- **Select Role**

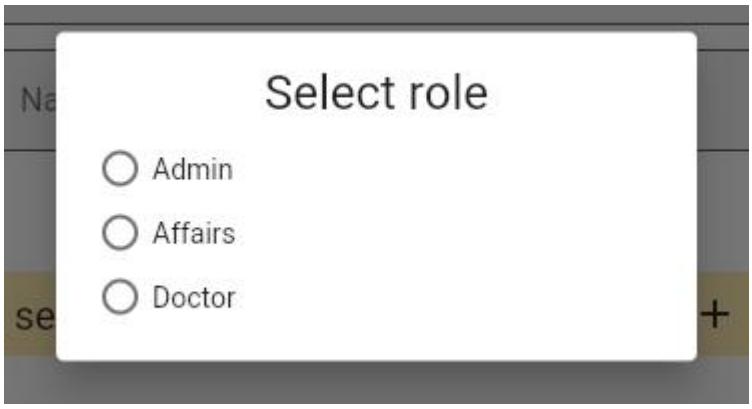


Figure 41: Select role view

- **Profile**

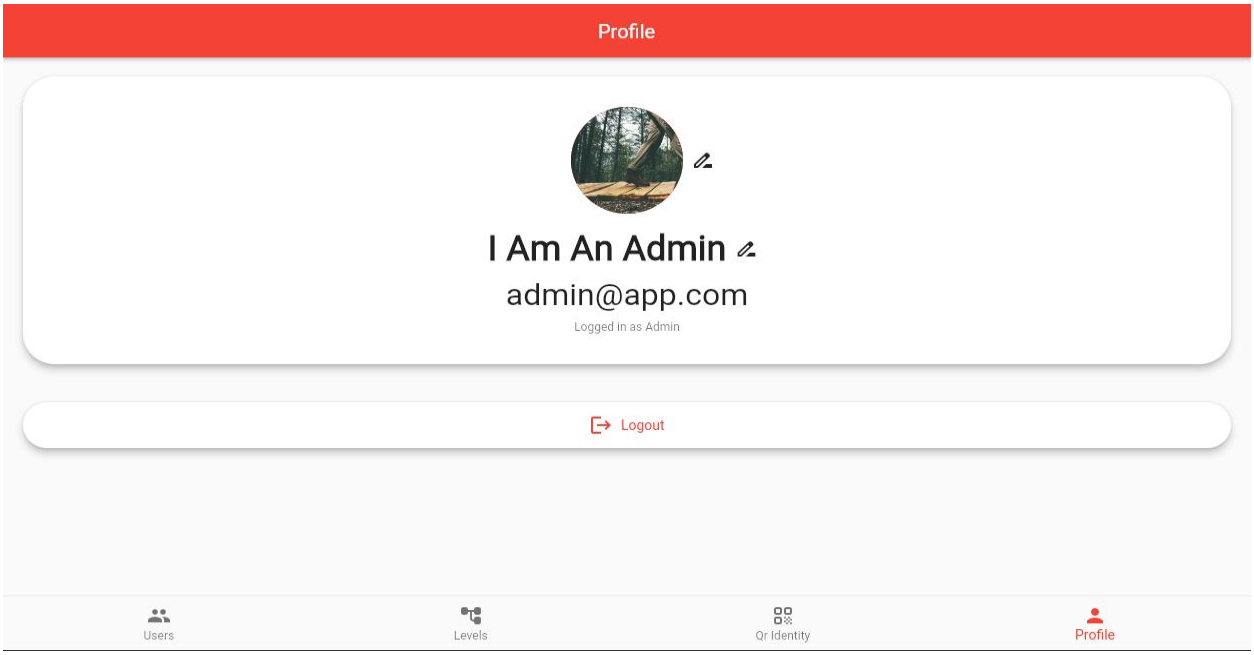


Figure 42: Profile view

Student Affairs View:

- **Users Page**

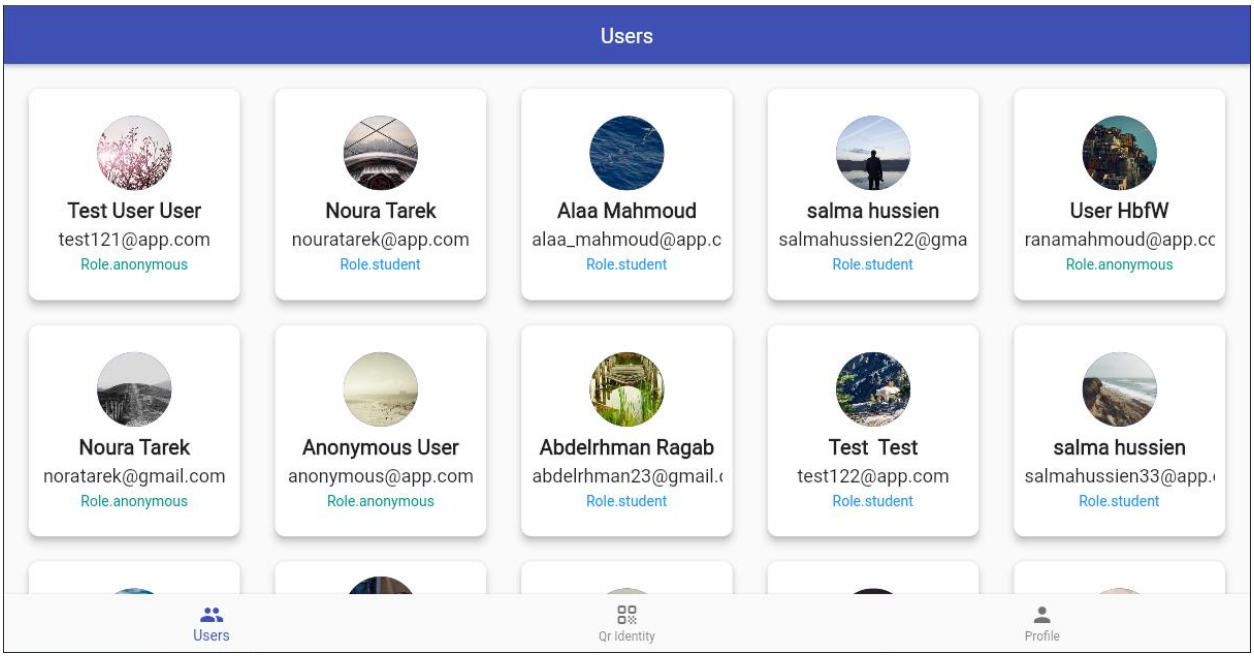


Figure 43: Users page view

- **Identity QR Code Screen**

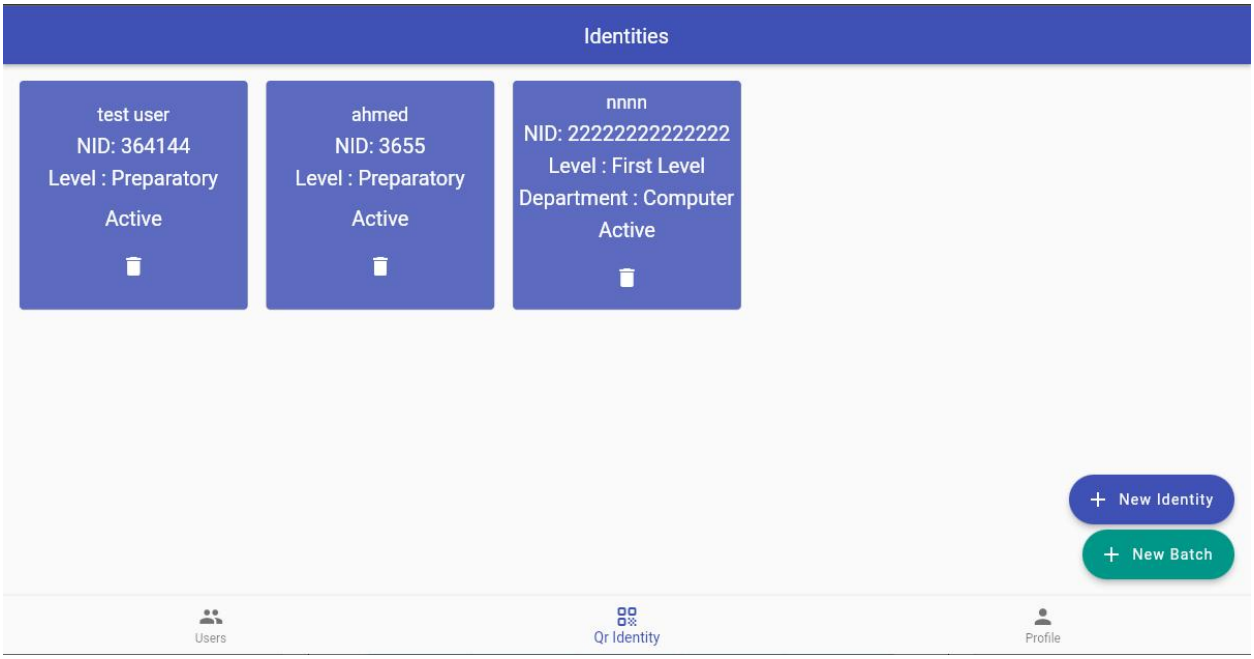


Figure 44: Identity QR code screen view

- **Add a New Student Identity**

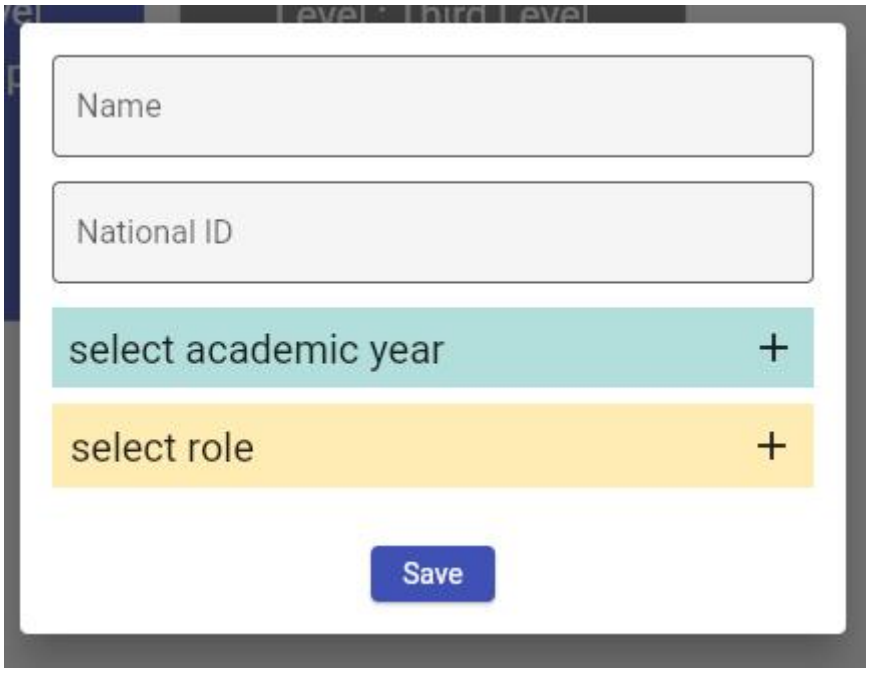


Figure 45: Add new student identity view

- **Select Grade**

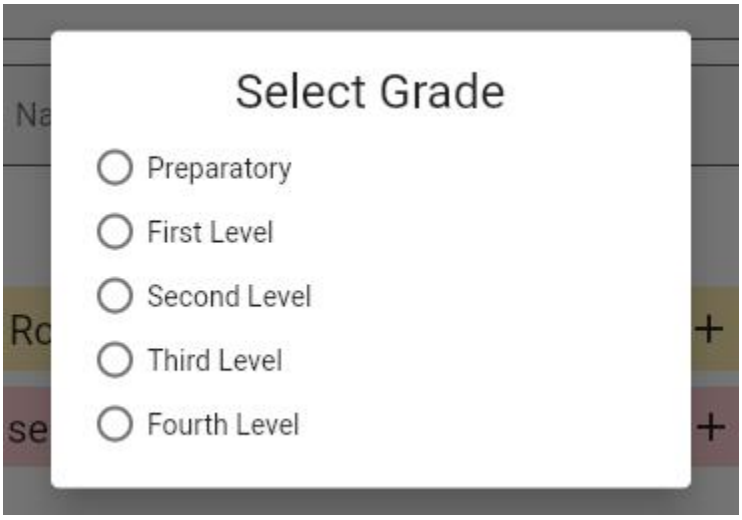


Figure 46: Select grade view

- **Select Department**

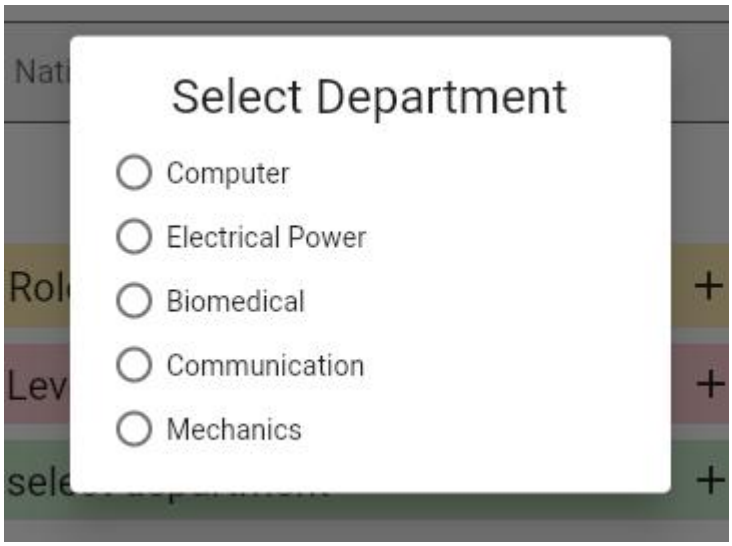


Figure 47: Select department view

- **Select Academic Year**

Figure 48: Select academic year view

- **Select Division**

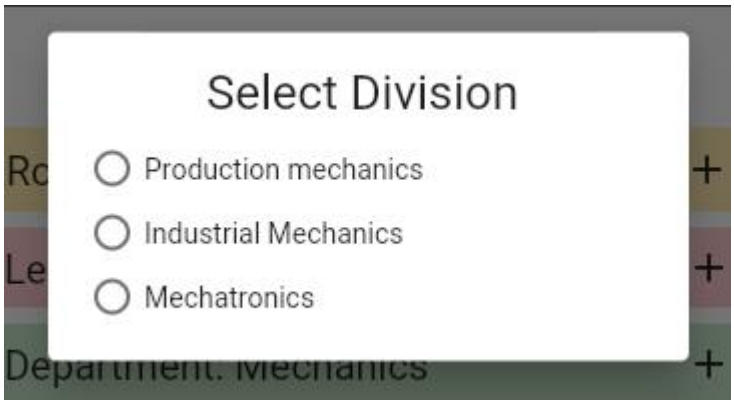


Figure 49 Select Division view

- **Student Identity QR Code Structure**

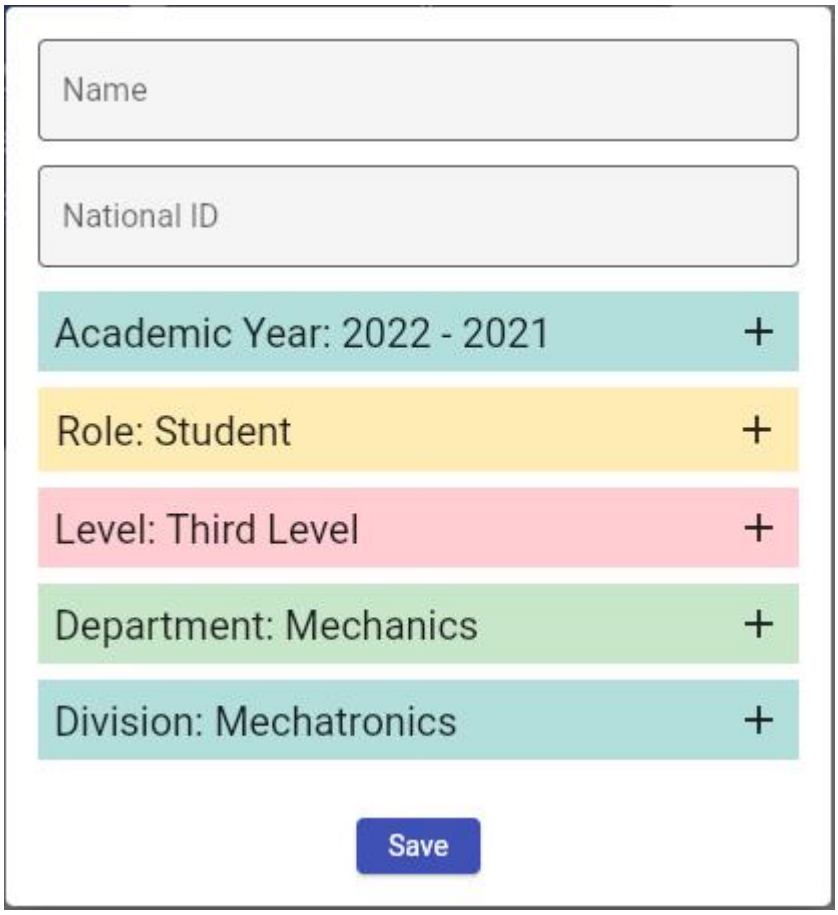


Figure 50 Student Identity QR Code Structure

Professor View:

- **Professor Home Page**

Figure 51: Professor home page view

- **Associated Subjects Screen**

Figure 52: Associated subject view

- **Lectures Screen**

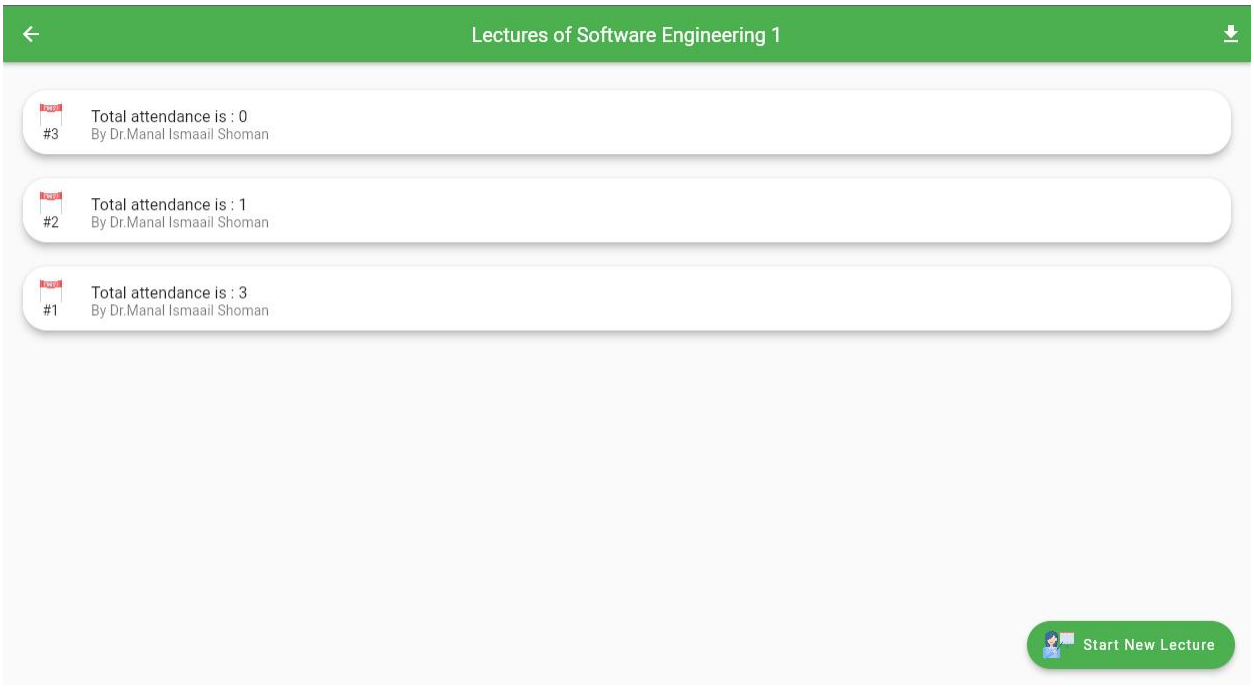


Figure 53: Lecture screen view

- **Attendance List**

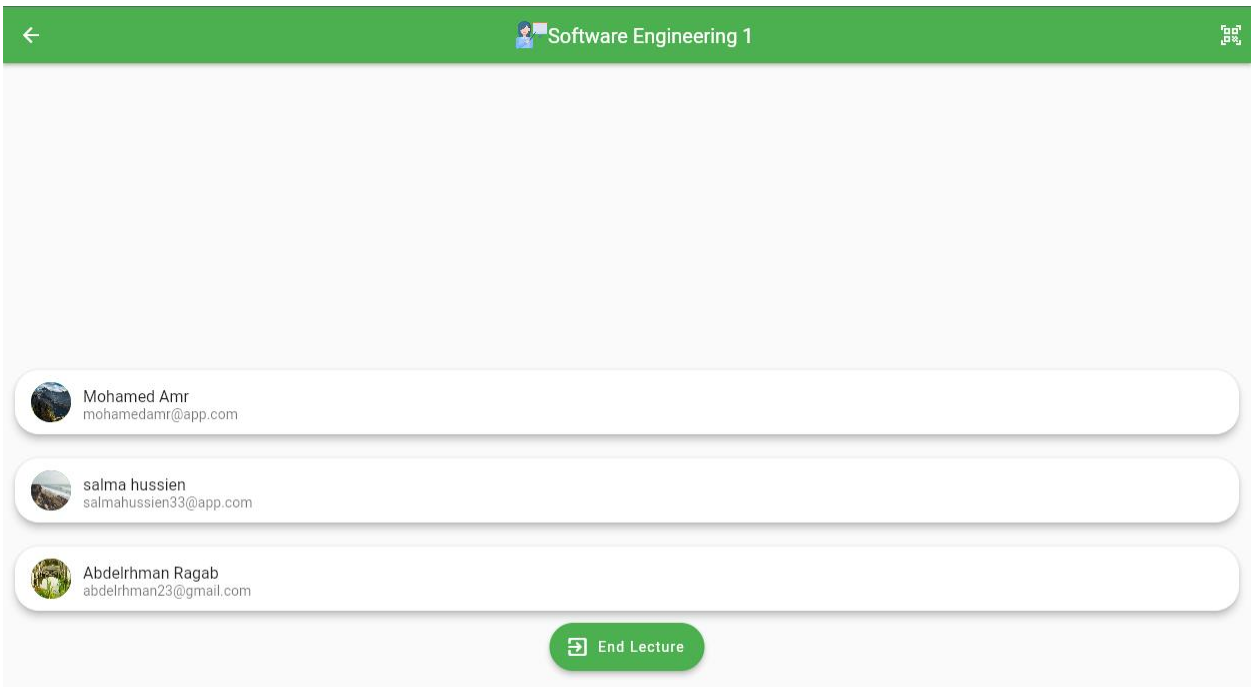


Figure 54: Attendance list view

- **Generate Attendance Report**

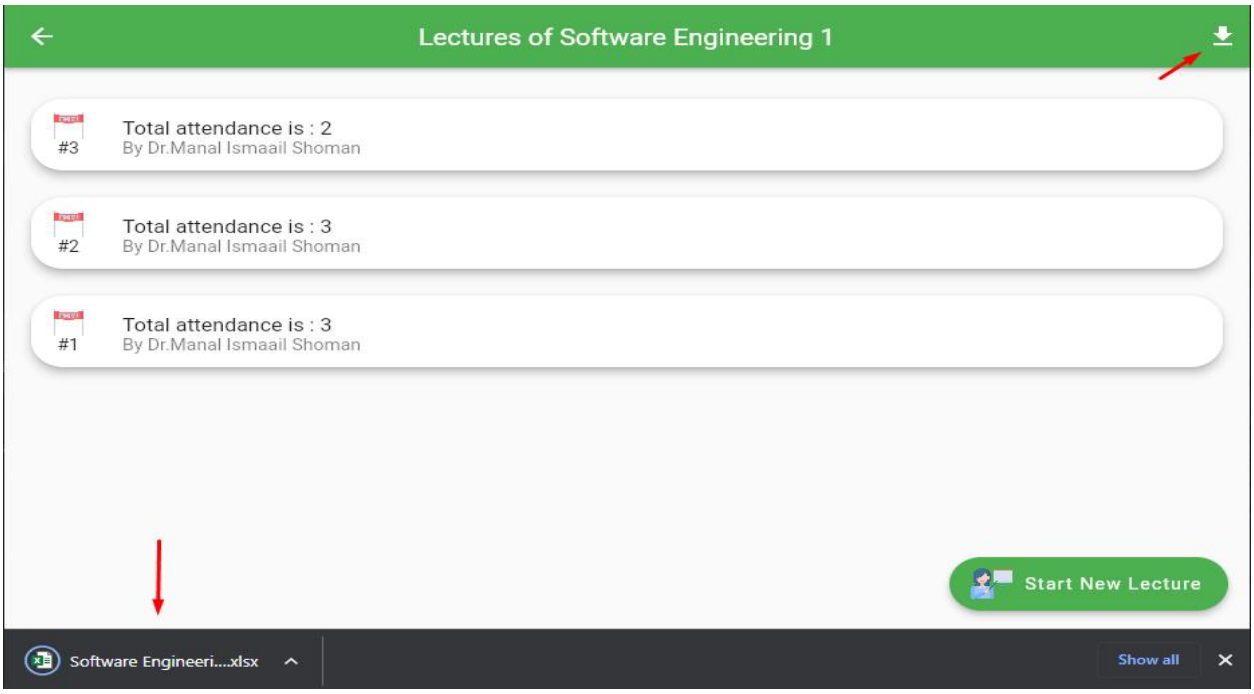
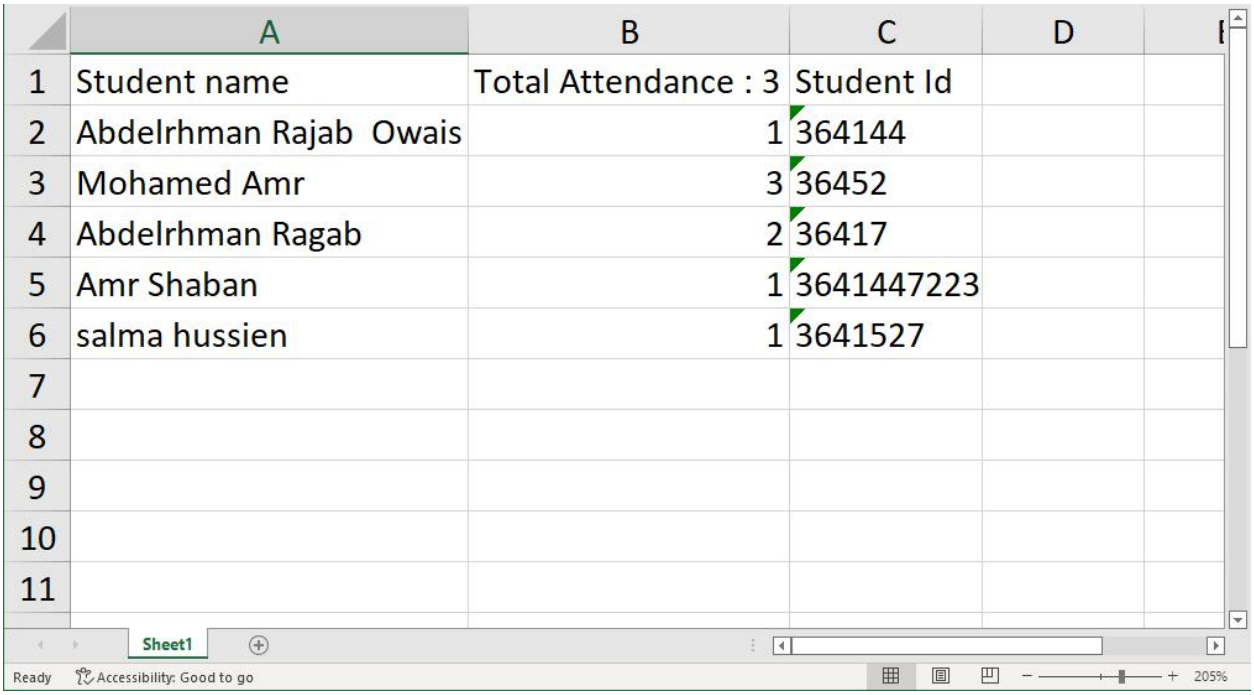


Figure 55 Generate Attendance Report

Attendance Report:



	A	B	C	D
1	Student name	Total Attendance : 3	Student Id	
2	Abdelrhman Rajab Owais	1	364144	
3	Mohamed Amr	3	36452	
4	Abdelrhman Ragab	2	36417	
5	Amr Shaban	1	3641447223	
6	salma hussien	1	3641527	
7				
8				
9				
10				
11				

Figure 56 Attendance Report

- **Lecture QR Code**

Figure 57: lecture QR code view

- **Student Home Page on Web**

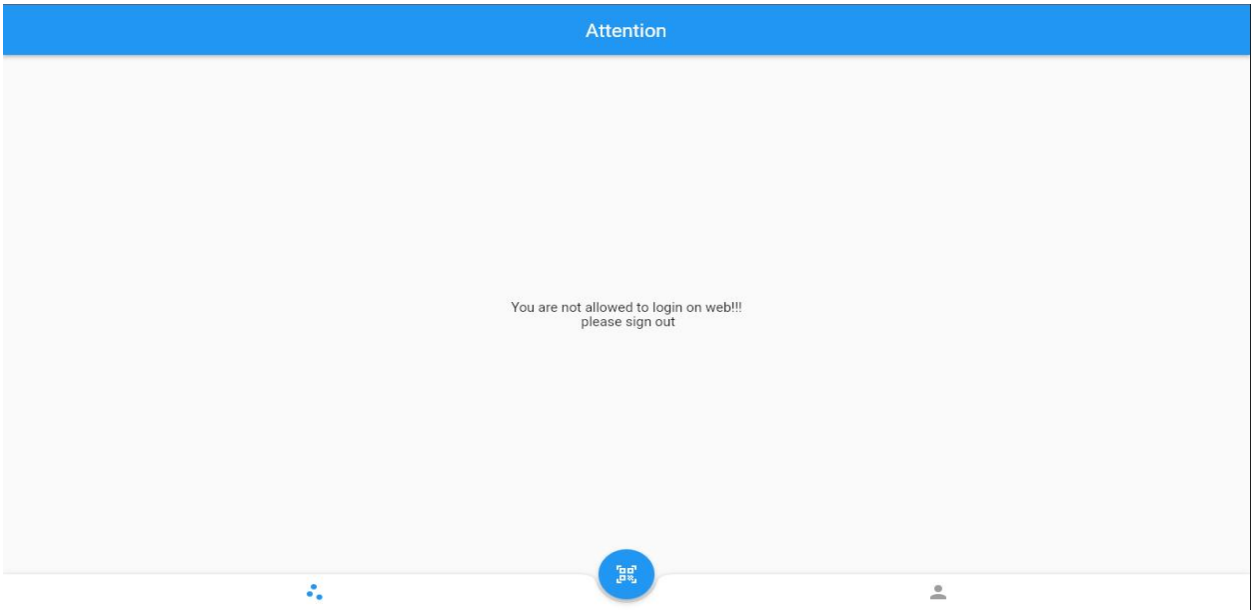
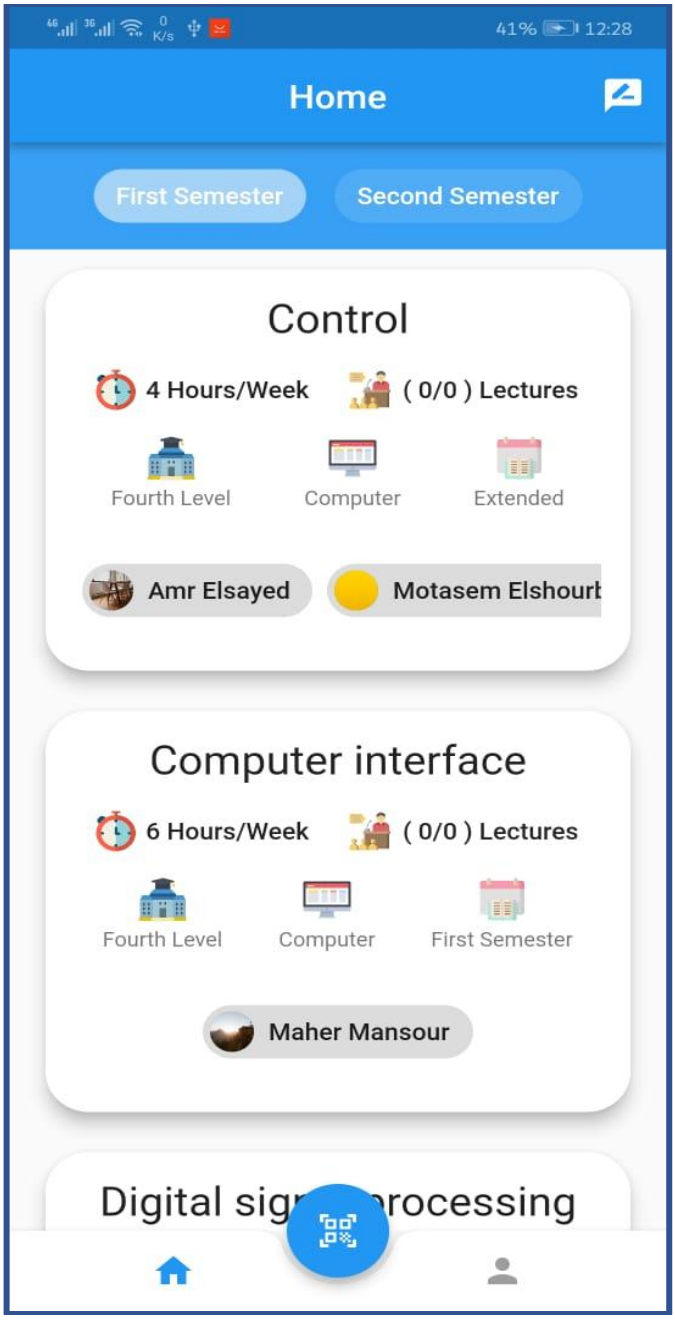


Figure 58: student home page on web

Student View:

- **Student Home Page & Profile on Mobile**



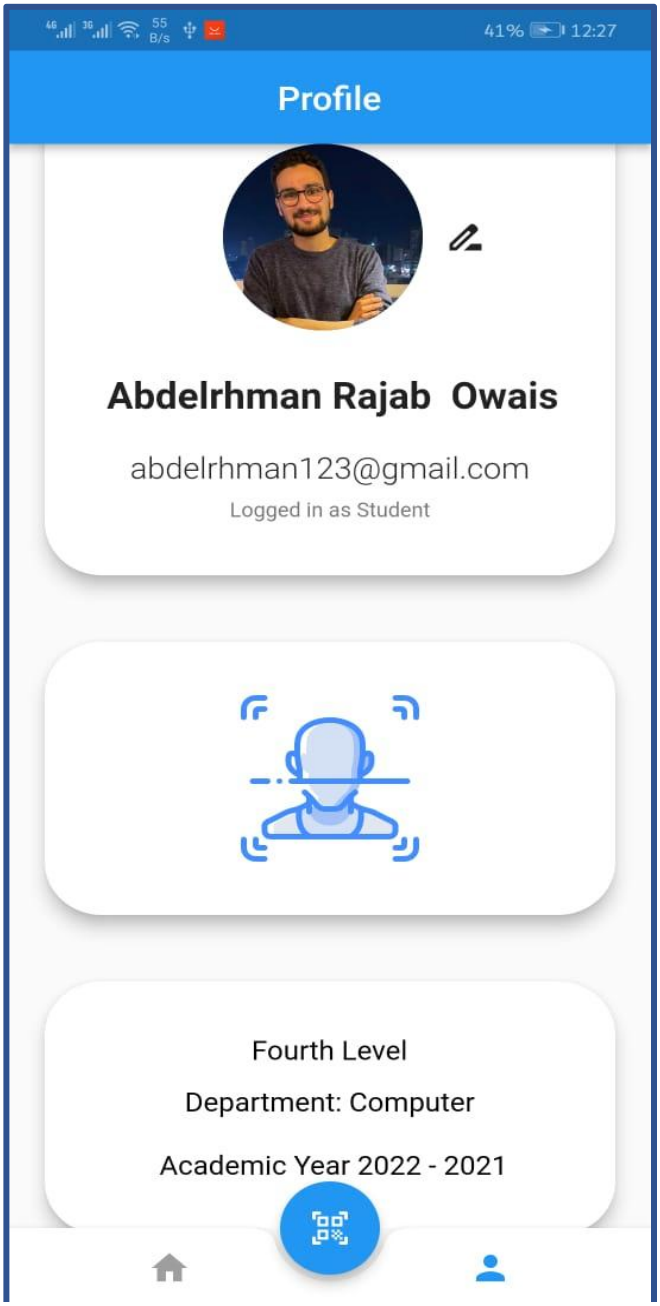


Figure 59: student home page & profile page

- **Image Registration & Verification Pages**

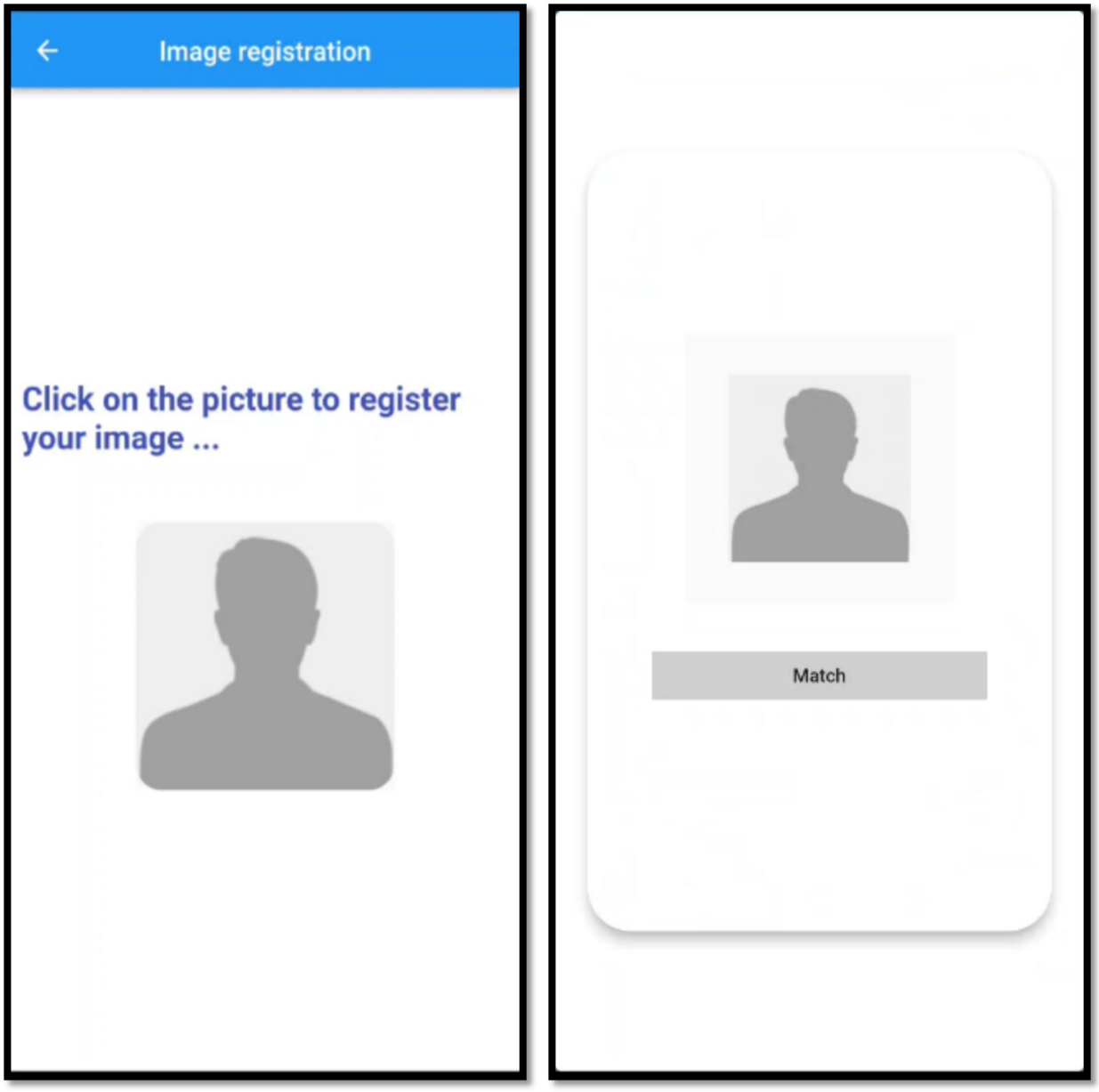


Figure 60 Image Registration & Verification Pages

- **Total Attendance**

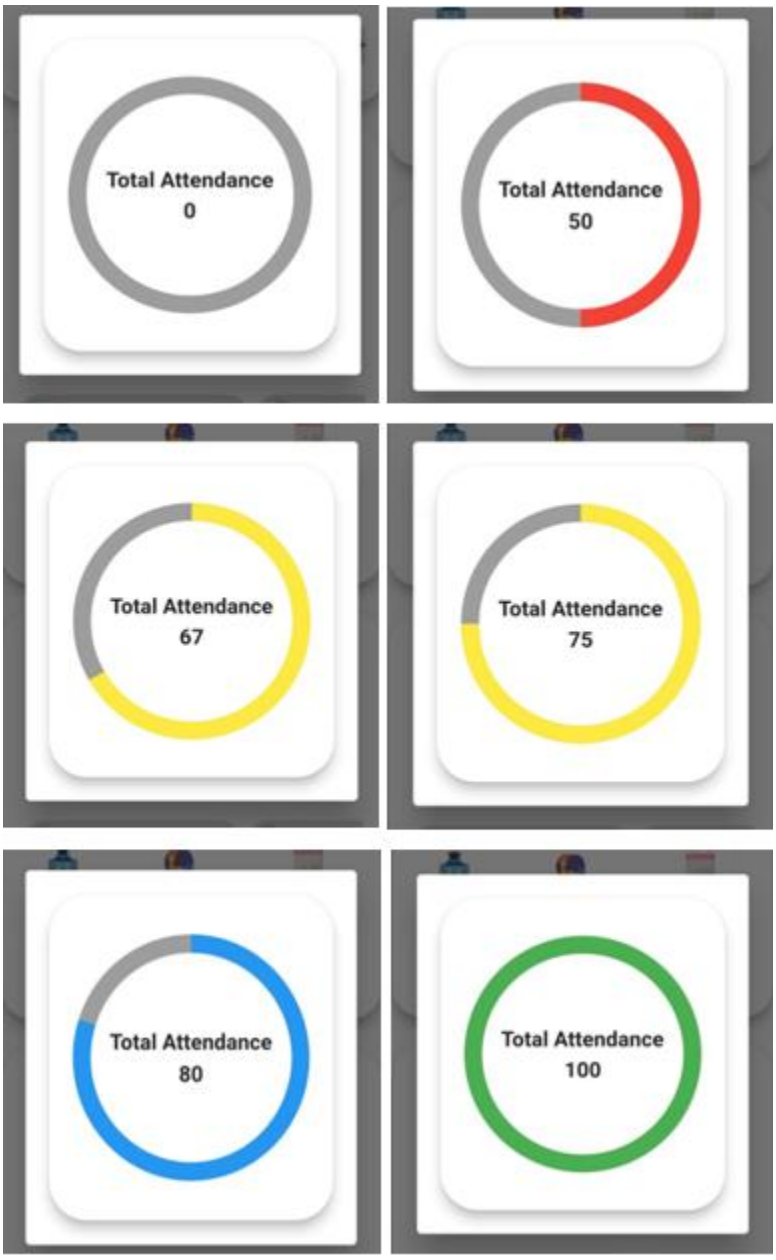


Figure 61 Student Total Attendance

Anonymous User View:

- Anonymous User Home Page & Profile:

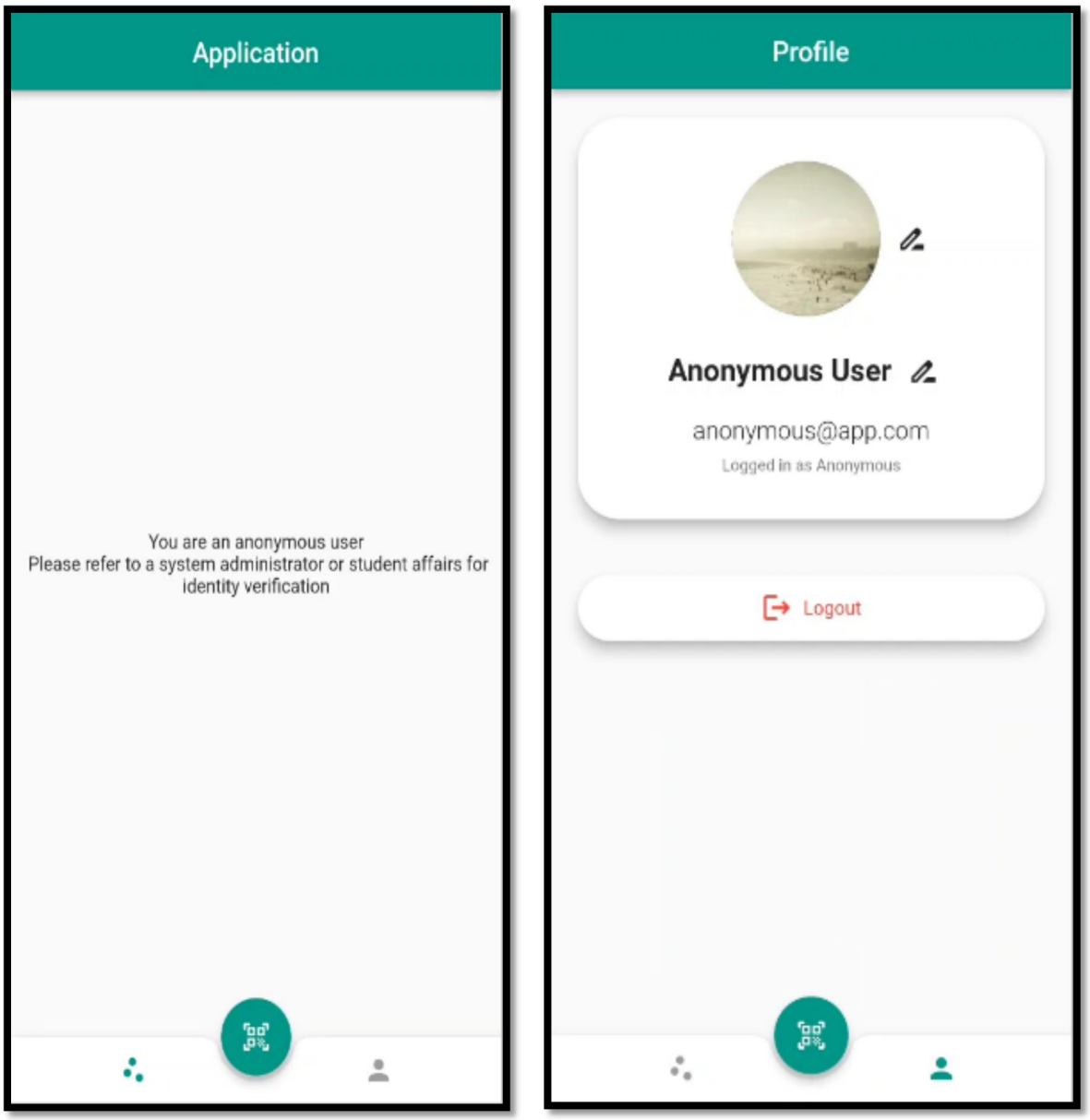


Figure 62 Anonymous User Home Page & Profile

Application Implementation on Phone Example:

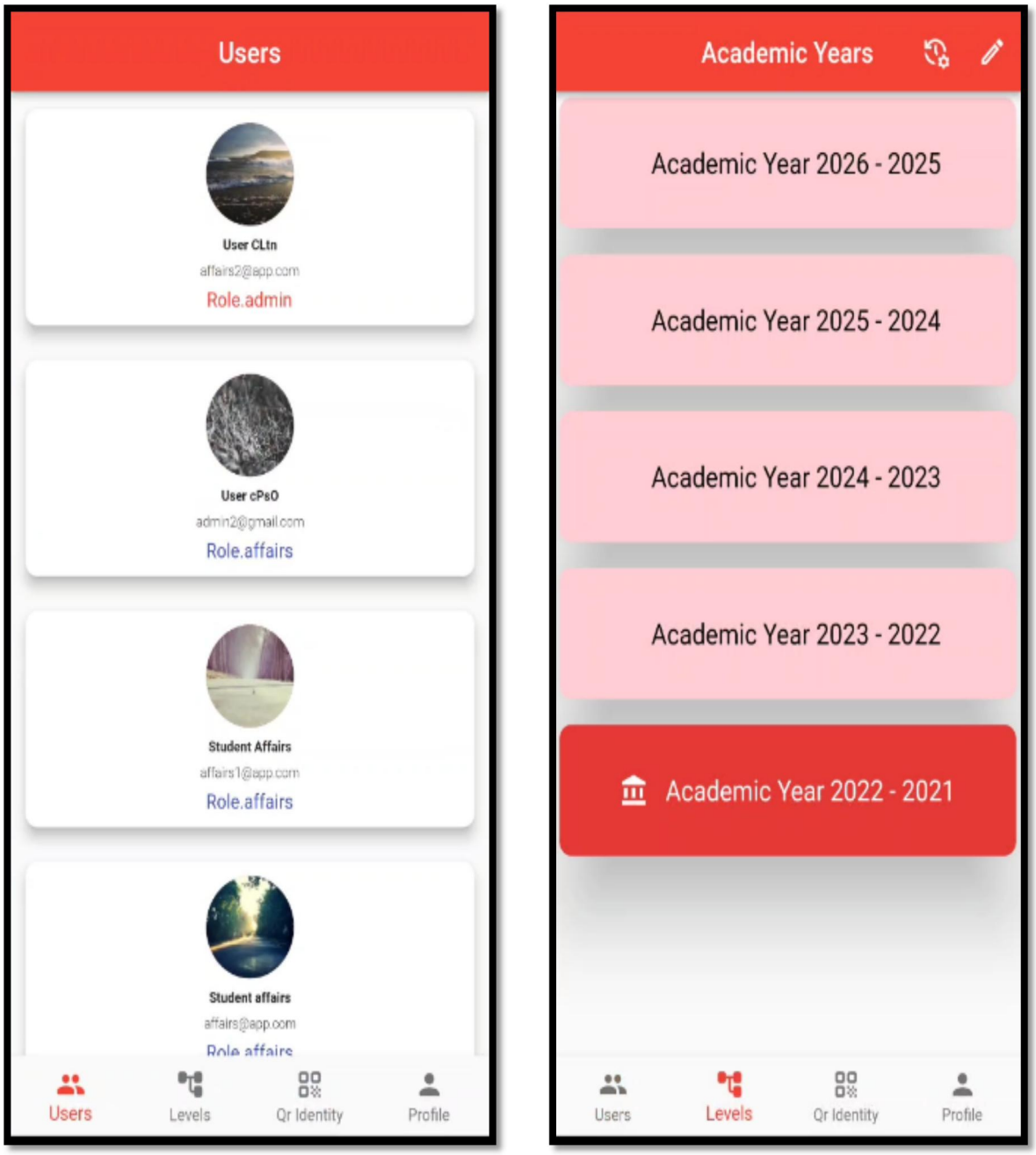


Figure 63 Admin Home Page & Levels tab on Phone

The Implementation of the Mobile Application is the same as the Implementation of the Web Application.

CHAPTER 6: TESTING

6.1 Unit testing

A Type of testing used to test separate functions and components black box testing included equivalence partitioning and determining set boundaries.

Test Cases:

- **Unit Testing of Adding a New Subject:**

Test Case Number	**Input Data**	**Expected Output**
TC_#1	Valid Data	Subject is added and only appears in
TC_#2	Invalid Name	Returns and doesn't complete.
TC_#3	Invalid Hours	Returns and doesn't complete.
TC_#4	Invalid Description	Returns and doesn't complete.

Unit Testing of Generating an Identity QR code as an Admin:

Selected Role: Admin

Test Case Number	**Input Data**	**Expected Output**
TC_#1	Valid National ID Selected Role: Admin	Admin Identity QR code Generated and Ready to Scan
TC_#2	Invalid National ID Selected Role: Admin	Returns and doesn't complete.
TC_#3	Empty National ID Selected Role: Admin	Returns and doesn't complete.

Selected Role: Affairs

Test Case Number	**Input Data**	**Expected Output**
TC_#4	Valid National ID Selected Role: Affairs	Affairs Identity QR code Generated and Ready to Scan
TC_#5	Invalid National ID Selected Role: Affairs	Returns and doesn't complete.
TC_#6	Empty National ID Selected Role: Affairs	Returns and doesn't complete.

Selected Role: Professor

Test Case Number	**Input Data**	**Expected Output**
TC_#7	Valid National ID Selected Role: Professor	Professor Identity QR code Generated and Ready to Scan
TC_#8	Invalid National ID Selected Role: Professor	Returns and doesn't complete.
TC_#9	Empty National ID Selected Role: Professor	Returns and doesn't complete.

Unit Testing of Generating an Identity QR code as Student Affairs:

Equivalence Classes:

EC for National ID:

EC1: empty → Invalid (0 Character)

EC2: numbers → Valid (14 Numbers)

EC3: numbers invalid length → Invalid (Not 14 Numbers)

EC4: alphanumeric → Invalid

EC5: Symbols → Invalid

Test Case Number	**Input Data**	**Expected Output**
TC_#1	Valid Name Valid National ID	Student Identity QR code Generated and Ready to Scan
TC_#2	Invalid Name Valid National ID	Returns and doesn't complete.
TC_#3	Valid Name Invalid National ID	Returns and doesn't complete.
TC_#4	Invalid Name Invalid National ID	Returns and doesn't complete.
TC_#5	Empty Name Valid National ID	Returns and doesn't complete.
TC_#6	Valid Name Empty National ID	Returns and doesn't complete.
TC_#7	Invalid Name Empty National ID	Returns and doesn't complete.
TC_#8	Empty Name Invalid National ID	Returns and doesn't complete.
TC_#9	Empty Name Empty National ID	Returns and doesn't complete.

Unit Testing of Generating a Batch Student Identity QR code:

Test Case Number	**Input Data**	**Expected Output**
TC_#1	Select Valid Excel File	Batch Student Identity QR codes Generated and Ready to Scan
TC_#2	Select Invalid Excel File	Returns and doesn't complete.
TC_#3	Select Empty Excel File	Returns and doesn't complete.

Unit Testing of QR Code Scan:

Test Case Number	**Input Data**	**Expected Output**
TC_#1	Students Scans an Attendance QR Code	Attendance QR Code Scanned Successfully
TC_#2	Anonymous User Scans Attendance QR Code	Attendance QR Code Scanned Successfully but doesn't Record Attendance and Shows Message
TC_#3	Student Scans an Identity QR Code	Identity QR Code Scanned Successfully, Updates Role and Deactivates
TC_#4	Anonymous User Scans an Identity QR Code	Identity QR Code Scanned Successfully, Updates Role and Deactivates

Unit Testing of Attendance Recording:

Test Case Number	**Input Data**	**Expected Output**
TC_#1	Associated Students Scan Attendance QR Code	Attendance Recorded Successfully and Shows Acceptance Message
TC_#2	Associated Students Scan Attendance QR Code when it's not shown by professor	Rejects Attendance Recording and Shows Rejection Message
TC_#3	Unassociated Student Scans Attendance QR Code	Rejects Attendance Recording and Shows Rejection Message
TC_#3	Anonymous User Scans Attendance QR Code	Rejects Attendance Recording and Shows Error Message
TC_#4	Random QR Scanner Scans QR Code	Rejects Attendance Recording

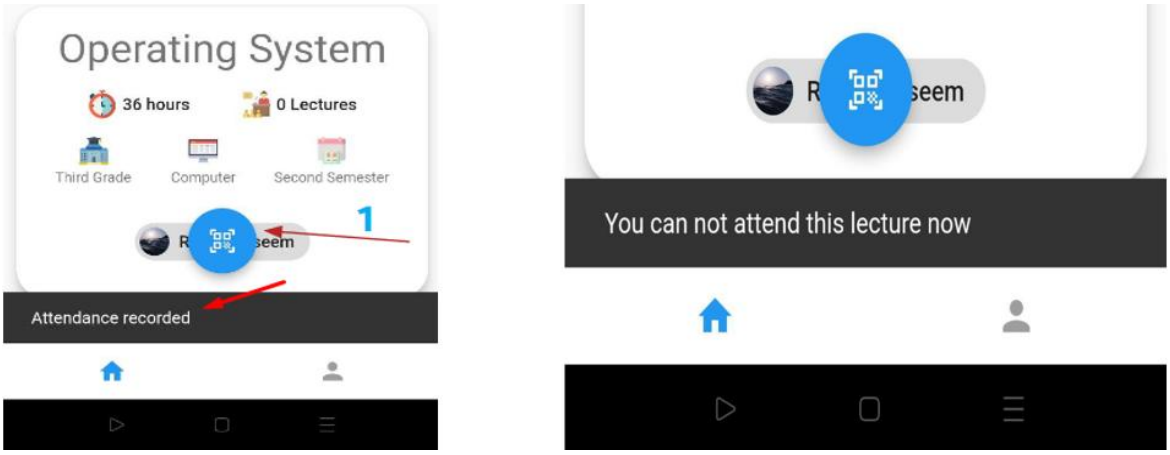


Figure 64: Attendance acceptance and rejection message

Unit Testing of Sign In:

Equivalence Classes:

EC for Email:

EC1: empty → Invalid (0 Character)

EC2: numbers → Invalid

EC3: alphanumeric → Invalid

EC4: email structure → valid (1 →50 Character)

EC5: email structure invalid length → invalid (>50 Character)

EC6: symbols → Invalid

EC for Password:

EC1: empty → Invalid

EC2: numbers → Invalid

EC3: alphanumeric but not correct → invalid

EC4: Correct Password → valid

EC5: symbols → Invalid

Test Cases:

Test Case Number	**Email**	**Password**	**Output**
TC_#1	Empty	Empty	Error
TC_#2		Numbers	Error
TC_#3		Incorrect Alphanumeric	Error
TC_#4		Correct Password	Error
TC_#5		Symbols	Error
TC_#6	Numbers	Empty	Error
TC_#7		Numbers	Error
TC_#8		Incorrect Alphanumeric	Error
TC_#9		Correct Password	Error
TC_#10		Symbols	Error
TC_#11	Alphanumeric	Empty	Error
TC_#12		Numbers	Error
TC_#13		Incorrect Alphanumeric	Error
TC_#14		Correct Password	Error
TC_#15		Symbols	Error
TC_#16	Email structure (Correct)	Empty	Error
TC_#17		Numbers	Error
TC_#18		Incorrect Alphanumeric	Error
TC_#19		Correct Password	**Login**
TC_#20		Symbols	Error
TC_#21	Email structure invalid length	Empty	Error
TC_#22		Numbers	Error
TC_#23		Incorrect Alphanumeric	Error
TC_#24		Correct Password	Error
TC_#25		Symbols	Error
TC_#26	Symbols	Empty	Error
TC_#27		Numbers	Error
TC_#28		Incorrect Alphanumeric	Error
TC_#29		Correct Password	Error
TC_#30		Symbols	Error

Unit Testing of Register:

EC for Name:

EC1: empty → Invalid (0 Character)

EC2: numbers → Invalid

EC3: alphanumeric → Invalid

EC4: Symbols → Invalid

EC5: Alphabetic → Valid

Test Cases Considering Name is Valid:

Test Case Number	**Email**	**Password**	**Output**
TC_#1	Empty	Empty	Error
TC_#2		Numbers	Error
TC_#3		Alphanumeric	Error
TC_#4		Symbols	Error
TC_#5	Numbers	Empty	Error
TC_#6		Numbers	Error
TC_#7		Alphanumeric	Error
TC_#8		Symbols	Error
TC_#9	Alphanumeric	Empty	Error
TC_#10		Numbers	Error
TC_#11		Alphanumeric	Error
TC_#12		Symbols	Error
TC_#13	Email structure (Correct)	Empty	Error
TC_#14		Numbers	Error
TC_#15		Alphanumeric	Register
TC_#16		Symbols	Error
TC_#17	Email structure invalid length	Empty	Error
TC_#18		Numbers	Error
TC_#19		Alphanumeric	Error
TC_#20		Symbols	Error
TC_#21	Symbols	Empty	Error
TC_#22		Numbers	Error
TC_#23		Alphanumeric	Error
TC_#24		Symbols	Error

6.2 Requirements testing

1. Test Case for Register, Login:

Test No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure a new user is able to register in the application	Insert Valid Name, Email & Password and click Sign Up button	Application redirects user to homepage after register and after login	Registers, Logs in and redirects user to homepage
2	Make sure the register function doesn't register with invalid data	Insert incorrect Name, Email or password and click Sign Up button	Application displays a message asking to enter valid data	Message is Shown
3	Make sure the login function works correctly	Insert Valid Email & Password and click Sign In	Application redirects to home page	Redirects to start page
4	Make sure the login function doesn't redirect to homepage with incorrect password	Insert a valid email but incorrect Password and click Sign In	Application displays a message asking to enter correct email & password	Message is Shown
5	Make sure the login function doesn't redirect to homepage with missing email	Insert an unregistered email and click Sign In	Application displays a message saying the email is not registered	Message is Shown

2. Test Case for Logout:

Test No.	Test Objective	Procedure	Expected outcome	Actual outcome
6	Make sure a new user is able to Logout of the application	Go to the profile tab and click the logout button	Application redirects user to start page	Application logs out and redirects to start page

3. Test Case for Edit User Role:

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure the admin can manage user roles for admins, student affairs and professors	Login as admin, click on a user in the user's tab and change role	User role changes successfully	User role changes successfully
2	Make sure the student affairs can manage user roles for students	Login as student affair, click on a user in the user's tab and change role	User role changes successfully	User role changes successfully

4. Test Case for Edit Academic Years List:

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure the admin can edit the Academic Years List of the system	Login as admin, click the levels tab, click the edit academic years button, change the academic year number	Academic Years List updated successfully	Academic Years List updated successfully

5. Test Case for Change Active Academic Year:

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure the admin can change the Active Academic Year	Login as admin, click the levels tab, click the change active academic year button, select the desired academic year	Active Academic Year changed successfully	Active Academic Year changed successfully

6. Test Case for Add or Delete Subject:

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure the admin can add a subject to an academic level	Login as admin, click a Level in the Levels tab, click a department, Click add subject button, enter subject name, hours per week, description, choose semester state and click save	Subject is added to an academic level successfully	Subject is added to an academic level successfully
2	Make sure the admin can delete a subject	Login as admin, click a Level in the Levels tab, click a department, Click delete button on a subject	Subject is deleted successfully	Subject is deleted successfully

7. Test Case for Edit Subject Details

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure the admin can edit subject details	Login as admin, click a Level in the Levels tab, click a department, Click a subject, click an edit button, enter new data	Subject Details is edited successfully	Subject Details is edited successfully

8. Test Case for Assign/Unassign Professor to Subject:

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure the admin can assign professors to a subject	Login as admin, click a Level in the Levels tab, click a department, click a Subject, Click Add professor, Select a professor from the list	Assigns a professor to a specific subject successfully	Assigns a professor to a specific subject successfully
2	Make sure the admin can unassign a professor	Click a Subject, Click the remove button associated with a professor	Unassigns a professor from a subject successfully	Unassigns a professor from a subject successfully

9. Test Case for Generate Identity QR for Admin, Student Affair and Professor:

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure the admin can Generate an identity QR Code for the admin, student affair or professor role	Login as admin, click on the QR Identity tab, Click New Identity button, Enter National ID & Name, select role & academic year and Click Save button	Identity QR Code generated successfully, stored in database and showed as active in the Identity QR Codes List	Identity QR Code generated successfully, stored in database and showed as active in the Identity QR Codes List
2	Make sure the admin cannot Generate an incomplete Identity QR code	Login as admin, click on the QR Identity tab, Click New Identity button, Leave National ID or name empty and Click Save button	New Identity QR Code box disappears and QR Code is not generated or stored in database or shown in the Identity QR Code List	New Identity QR Code box disappears and QR Code is not generated or stored in database or shown in the Identity QR Code List

10. Test Case for Generate Identity QR for Student:

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure student affair can Generate an Identity QR Code for students	Login as student affairs, click on the QR Identity tab, Click New Identity button, Enter National ID & Name, select student role, Level, Department and Academic Year and Click Save button	Identity QR Code generated successfully, stored in database and showed as active in the Identity QR Codes List	Identity QR Code generated successfully, stored in database and showed as active in the Identity QR Codes List
2	Make sure the student affair cannot Generate an incomplete Identity QR code	Login as student affairs, click on the QR Identity tab, Click New Identity button, Leave National ID or name empty or don't select Role, Level or Department and Click Save	New Identity QR Code box disappears and QR Code is not generated or stored in database or shown in the Identity QR Code List	New Identity QR Code box disappears and QR Code is not generated or stored in database or shown in the Identity QR Code List

11. Test Case for Batch Generate Identity QR for Student:

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure student affair can Generate a Batch of new Identity QR Codes automatically	Login as student affairs, click on the QR Identity tab, Click Batch Identity button, browse through the computer and select the appropriate CSV file and click save	Multiple Identity QR Codes are generated serially, stored in the database and shown in the Identity QR codes list	Multiple Identity QR Codes are generated successfully and stored
2	Make sure student affair cannot Generate Identity QR Codes from an incorrect file	Login as student affairs, click on the QR Identity tab, Click Batch Identity button, browse through the computer and select an incorrect CSV file and click save	Identity QR Codes are not generated	Identity QR Codes are not generated

12. Test Case for Start a New Lecture & Record Attendance:

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure a professor can start a new lecture and record attendance	Login as Professor, click an associated subject, Click Start a new lecture button, Click the show Attendance QR Code button	Attendance QR Code Unique for the lecture is shown on the screen ready to be scanned	Attendance QR Code Unique for the lecture is shown on the screen ready to be scanned

13. Test Case for Generate Subject Attendance Report:

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure a professor can generate attendance report and save a copy on the local machine	Login as Professor, click an associated subject, Click the download button	Generates and downloads a Total Attendance report sheet including all associated students and their total attendance	Attendance report generated successfully and saved to local machine

14. Test Case for Scan Identity & Attendance QR Codes:

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure student is able to scan Attendance QR Codes generated by the system	Login as student from the phone, Click the scan button and align the scanner correctly to a QR Code	Attendance QR Codes are scanned successfully and attendance is recorded	Attendance QR Codes are scanned successfully
2	Make sure a user can scan Identity QR Codes generated by the system	Login as any user role from the phone, Click the scan button and align the scanner correctly to a QR Code	Identity QR Code is scanned successfully and role is changed according to Identity QR Code	Identity QR Code is scanned successfully and role is changed according to Identity QR Code
3	Make sure a user cannot scan a QR Code not generated by the system	Login as any user role from the phone, Click the scan button and align the scanner correctly to a QR Code not generated by the system	QR Code is scanned but no respective function is started	QR Code is scanned but no respective function is started

15. Test Case for Face Reference-Image Registration:

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure student is able to Register a face identification reference image	Login as student from phone, go to profile tab, click the Face Recognition button, click on the image and position correctly to take a reference photo	Reference Image saved successfully	Reference Image saved successfully
2	Make sure student is unable to change the reference image after taking one	Login as student from phone, go to profile tab, click the Face Recognition button	Image Registration Page doesn't appear	Image Registration Page doesn't appear

16. Test Case for Face Identification:

Test Case No.	Test Objective	Procedure	Expected outcome	Actual outcome
1	Make sure the student can validate their identity through face identification	Login as student from phone, press the scan button, press the image button, take a photo for verification and press match	Student Identity verified successfully, phone switches to QR Code scan page	Student Identity verified successfully, phone switches to QR Code scan page
2	Make sure the face identification function doesn't verify mismatched students	Login as student from phone, press the scan button, press the image button, take a photo of another person for verification and press match	Student Identity is not verified and Rejection message is shown	Student Identity is not verified and Rejection message is shown
3	Make sure the face identification function doesn't verify an image with no faces	Login as student from phone, press the scan button, press the image button	Verification Image is not taken if no face is detected	Verification Image is not taken

CHAPTER 7: DEVELOPMENT TOOLS AND TECHNOLOGIES

7.1 Software Development Methodology

7.1.1 AGILE SDLC

we apply agile SDLC while developing the project process, so let's take a look at what is agile SDLC?

7.1.1.1 What is Agile SDLC?

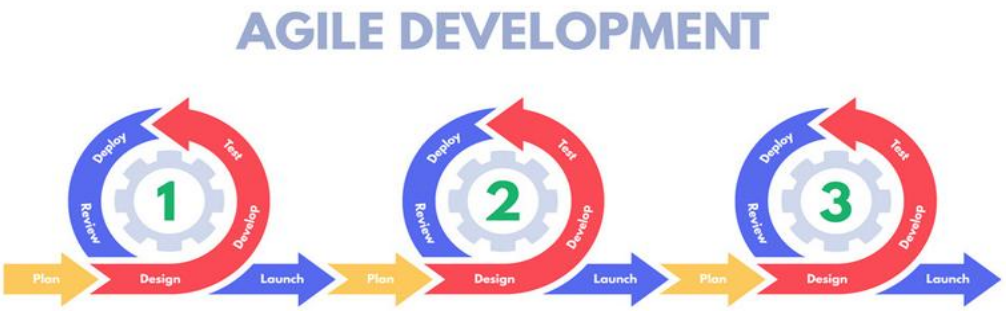


Figure 65: Agile Development

- The Agile methodology is a software development methodology. It was created twenty years ago by a team of 17 developers who want to improve the waterfall methodology and other software development methods. These developers created the agile manifesto, which holds the four key values and twelve principles.[12]

The Four Key Values of Agile SDLC:

I. Individuals and interactions over processes and tools
II. Deliver working software over comprehensive documentation
III. Customer collaboration over contract negotiation
IV. Responding to change over following a plan

- From its core working principles, the **Agile methodology focusses on satisfying the end-user** or customer needs through collaboration and delivering working software. Though only secondary, there are still development processes you should not overlook in Agile.[9]

Iteration - The Core Process of Agile Development Lifecycle:

- To comply with the end-user requirements during the development process, the Agile method involves a workflow process called iteration (called sprint in the scrum method).
- The iteration process is the time spent by all team members, such as business stakeholders and developers, during software production.
- At this stage, a fast-paced system development takes place with defined goals in mind.[10]

7.1.1.2 Stages of the Agile Iteration Workflow

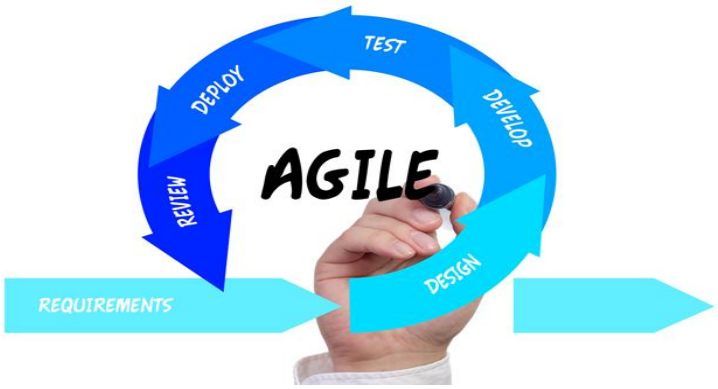


Figure 66: Agile Stages

Requirement Stage

- To begin the first iteration (also called sprint in scrum), make sure you have all the requirements ready. Consider documenting the process for future reference, as well. You should also include the project's clear objectives, useful features and support limitations. This will give the project a clear focus on what to achieve and also limit adding unnecessary features to the system design.

- Succeeding iterations will be dependent on the requirements listed on the product backlog (or a sprint backlog in scrum). Product backlogs are lists made from the feedback stage of the previous iterations. Keep in mind that the first stage is often the most crucial one. Focus on every preliminary step you need to cover– from the developing ideas to project release and post-project results.

Design Stage

- On the initial design process, the software development team will layout the project groundwork. From there, team members can now collaborate to analyze each item. The team discussion should include planning out the best course of action, best framework, and the best tools to achieve the best quality. We recommend using diagrams and product mock-ups during this stage. [10]

Coding/Testing Stage

- Once the team has determined the course of action in the design stage, they can now proceed to the coding/testing phase. To achieve optimal results, they will also conduct quality assurance testing. This is crucial, especially when you go along the release stage. Again, this requires proper documentation for future reference. [10]

Deployment Stage

- After coding and thorough checking, it is now time to implement the new design changes to the existing working software iteration. In some cases, users can also implement this through software updates. [10]

Feedback Stage

- After the system integration of the new software versions, users and stakeholders can now provide reviews or feedback. All feedback should be reviewed in the next iteration. Thus, starting another iteration workflow cycle. [10]

7.2 Development tools & Technologies

7.2.1 Hardware tools

Hardware	Description
Laptop	Intel R Core i5-7200U CPU RAM: 8 GB OS: WINDOWS10 • Used to develop the application.
Portable Hard disk	Used to store reports and projects.
Smart Mobile phone	Android Smartphone running Android OS version 4.0.3. • Used to run the application • Used to scan QR code.
Data Show projector	Used to show the QR of lecture to students for attendance.

7.2.2 Software tools

7.2.2.1 Tools and IDEs

I. Android Studio IDE

Android Studio IDE is a fast and high-performance tool to develop mobile apps using the flutter framework. As the official Integrated Development Environment or IDE of the Android operating system, Android Studio is well equipped for fast-paced development while ensuring high-quality output of apps across all Android devices. This IDE allows developers also to promptly incorporate changes by pushing code and facilitating quick changes without restarting the app altogether. This ensures awesome flexibility for bringing small app changes while the app is still in running condition.

II. MS Excel

To prepare data of students and put a batch in the system to create automatic QR identities according to the number of students in the sheet.

7.2.2.2 Database

Firebase

- Google Firebase is a Google-backed application development software that enables developers to develop iOS, Android, and web apps. Firebase provides tools for tracking analytics, reporting and fixing app crashes, creating marketing and product experiment.

- Firebase offers a number of useful services including Authentication, Cloud Messaging, Realtime Database, Cloud Firestore, firebase storage.
- To maintain the system's database we use the Authentication, Cloud Firestore, and storage services of firebase.

Firebase Authentication:

- Firebase Authentication aims to make building secure authentication systems easy while improving the sign-in and onboarding experience for end-users. It provides an end-to-end identity solution, supporting email and password accounts, phone auth, Google, Twitter, Facebook, GitHub login, and more.
- We use this service to secure login to the system. in this database when a user register with his account, the email, and password data will be saved here in firebase authentication to validate the user when he tries to log in and secure his email data.

Cloud Firestore:

- Cloud Firestore is a NoSQL document database that lets you easily store, sync, and query data for your mobile and web apps at a global scale.
- In this service, the database of the system “SSAS” will be saved with a NoSQL document database, this data includes the collections of subjects, users, grades, lectures, Identities, departments.

NoSQL Database:

- NoSQL databases are non-tabular databases and store data differently than relational tables. NoSQL databases come in a variety of types based on their data model. The main types are document, key-value, wide-column, and graph. They provide flexible schemas and scale easily with large amounts of data and high user loads.
- It contains collections, documents, and fields. instead of tables, rows, columns in the traditional rational tables. and it has the advantage of no structured query language which means that each document contains pairs of fields and values. The values can typically be a variety of types including things like strings, numbers, arrays, or objects.

Firebase Storage:

- Cloud Storage is designed to help quickly and easily store and serve user-generated content, such as photos, videos, and files.
- In this service, our system saves the user's content and allows to upload of files. And it can help the instructor to upload a lecture or an instruction for students.

7.2.2.3 Programming languages

Dart

Figure 67: Dart Programming

Dart is an open-source general-purpose programming language. It is originally developed by Google and later approved as a standard by ECMA. Dart is a new programming language meant for the server as well as the browser. Introduced by Google, the **Dart SDK** ships with its compiler – the **Dart VM**. The SDK also includes a utility **-dart2js**, a transpiler that generates JavaScript equivalent of a Dart Script.[19]

7.2.2.4 Libraries and Frameworks

- Flutter framework

Figure 68: Flutter App Development

What is the flutter framework ?

Flutter is an open-source UI software development kit created by Google. It is a newer cross-platform framework for creating native mobile applications with high performance. Flutter allows developers to build mobile applications for most platforms such as Android, IOS, and Web with a single code base and programming language. This capability makes building IOS and Android apps simpler and faster.

- The Flutter framework consists of both a software development kit (SDK) and a widget-based UI library. This library consists of various reusable UI elements, such as sliders, buttons, and text inputs. [20]

- Developers building mobile applications with the Flutter framework will do so using a **programming language called Dart**. With a syntax like JavaScript, Dart is a typed object programming language that focuses on front-end development.
- Although Flutter is a newer cross-platform framework, more and more companies have chosen Flutter over frameworks such as Xamarin, Cordova, and React Native. Some of the top reasons why development teams choose Flutter include:

  - **Increased productivity.** Using the same codebase for iOS and Android saves both time and resources. Flutter's native widgets also minimize time spent on testing by ensuring there is little to no compatibility issues with different OS versions.
  - **Easy to learn.** Flutter allows developers to build native mobile applications without needing to access OEM widgets or use a lot of code. This, in addition to Flutter's particularly appealing user interface, makes the mobile app creation process much simpler.
  - **Great performance.** Users report that it is difficult to notice the difference between a Flutter app and a native mobile app.
  - **Cost-effective.** Building iOS and Android apps with the same codebase is essentially building two apps for the price of one.

- **Available on different IDEs.** Developers are free to choose between Android Studio and VS Code to edit their code on Flutter.
- **Great documentation & community.** Flutter has many great resources to answer your questions, thanks to its ample documentation with easy-to-follow use cases. Flutter users also benefit from community hubs like Flutter Community and Flutter Awesome for exchanging ideas.

- We use the Flutter framework with the help of the Android Studio IDE to build the system on both platforms web and Android to build web and mobile applications faster and efficient.

Libraries:

TensorFlow

TensorFlow is an end-to-end open- source platform for machine learning. It has a comprehensive, flexible ecosystem of tools, libraries and community resources that lets researchers push the state-of-the-art in ML and developers easily build and deploy ML powered applications.

7.2.3 QR CODE?

A **QR code** (**Quick Response code**) is a type of matrix barcode (or two-dimensional barcode) invented in 1994 by the Japanese automotive company Denso Wave. A barcode is a machine-readable optical label that can contain information about the item to which it is attached. In practice, QR codes often contain data for a locator, identifier, or tracker that points to a website or application. A QR code uses four standardized encoding modes (numeric, alphanumeric, byte/binary, and kanji) to store data efficiently; extensions may also be used.

The Quick Response system became popular outside the automotive industry due to its fast readability and greater storage capacity compared to standard UPC barcodes. Applications include product tracking, item identification, time tracking, document management, and general marketing.

A QR code consists of black squares arranged in a square grid on a white background, which can be read by an imaging device such as a camera, and processed using Reed–Solomon error correction until the image can be appropriately interpreted. The required data is then extracted from patterns that are present in both horizontal and vertical components of the image.[21]

After the COVID-19 pandemic began spreading, QR codes began to be used as a "touchless" system to display information, show menus, or provide updated consumer information, especially in the hospitality industry. Restaurants replaced paper or laminated plastic menus with QR code decals on the table, which opened an online version of the menu. This prevented the need to dispose of single-use paper menus, or institute cleaning and sanitizing procedures for permanent menus after each use. Local television stations have also begun to utilize codes on local newscasts to allow viewers quicker access to stories or information involving the pandemic, including testing and immunization scheduling websites, or for links within stories mentioned in the newscasts overall.

In several Australian states, patrons are required to scan QR codes at shops, clubs, supermarkets and other service and retail establishments on entry to assist contact tracing. Singapore, Taiwan, the United Kingdom and New Zealand use similar systems.

QR codes are also present on COVID-19 vaccination certificates in places such as Canada, and the EU (EU Digital COVID certificate) where they can be scanned to verify the information on the certificate.

Design:

One-dimensional barcodes that were designed to be mechanically scanned by a narrow beam of light, a QR code is detected by a 2-dimensional digital image sensor and then digitally analyzed by a programmed processor. The processor locates the three distinctive squares at the corners of the QR code image, using a smaller square (or multiple squares) near the fourth corner to normalize the image for size, orientation, and angle of viewing. The small dots throughout the QR code are then converted to binary numbers and validated with an error-correcting algorithm.

Storage:

The amount of data that can be stored in the QR code symbol depends on the data type (*mode*, or input character set), version (1, ..., 40, indicating the overall dimensions of the symbol, i.e., 4 × version number + 17 dots on each side), and error correction level. The maximum storage capacities occur for version 40 and error correction level L (low), denoted by 40-L.[21]

Version 1 (21×21). Content: "Ver1"

Version 2 (25×25). Content: "Version 2"

Figure 69: Version 1 & 2 of QR code

Version 3 (29×29). Content: "Version 3 QR Code"

Version 4 (33×33). Content: "Version 4 QR Code, up to 50 char"

Figure 70: Version 3 & 4 of QR code

CHAPTER 8: CONCLUSION AND FUTURE IMPROVEMENT

8.1 Conclusion

In conclusion, Smart Student Attendance System (SSAS) is developed to improve the process of taking attendance by using QR code. QR code is the cheapest and adaptable option among all of the solutions. Smart Student Attendance System has met its objectives by providing an application that can generate a new QR code for each lecture, enable students to scan this QR code and validate their identity using face recognition, and then record the attendance. This project expected to help all the lecturers and students speed up the process of taking attendance and would save lecturing time and hence enhance the educational process.

8.2 Future improvement

In future, we may add new features to our system to improve it. We will mention some of these features.

- Smart Student Attendance System can be used to calculate monthly attendance by system and also report to student parents about less attendance if student has less than 50% attendance.
- The system also can be used in sections, labs, or even quizzes; where students have to scan the QR code in the system to take the quiz.
- The instructor can display a post in the application which all students can see, if he wants to cancel the lecture, he can tell them easily.

- We can connect our system with the local network of collage to prevent cheating in attendance and make the system more secure.

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