**IMPLEMENTATION:**

**MODULES:**

* User
* Admin
* Conventional Model
* CNN Model
* Test Model

**MODULES DESCRIPTION:**

### User Module Description

The User Module is a crucial component of the system, providing an interface for users to interact with the machine learning model and manage their accounts. The module allows users to perform several key functions, including registration, login, viewing machine learning results, uploading images for prediction, and logging out. Here is a detailed description of the functionalities offered by the User Module:

#### 1. User Registration

* **Function:** Allows new users to create an account.
* **Process:**
  + Users provide personal information such as username, password, email address, and other relevant details.
  + The system validates the information and creates a new user account.
  + Users receive a confirmation email or message upon successful registration.
* **Purpose:** To grant access to the system and ensure that each user has a unique account.

#### 2. User Login

* **Function:** Enables registered users to access their accounts.
* **Process:**
  + Users enter their username and password.
  + The system verifies the credentials.
  + Upon successful verification, users are logged into the system.
* **Purpose:** To authenticate users and provide secure access to the system.

#### 3. View Machine Learning Results

* **Function:** Allows users to view the results of machine learning predictions.
* **Process:**
  + Users navigate to the results section.
  + The system displays the results of previous predictions made by the user.
  + Users can review details such as prediction accuracy, time of prediction, and other relevant metrics.
* **Purpose:** To provide users with insights and feedback on the performance of the machine learning model based on their inputs.

#### 4. Upload Image for Prediction

* **Function:** Enables users to upload images for the machine learning model to predict the ripeness of mangoes.
* **Process:**
  + Users select an image file from their device and upload it to the system.
  + The system processes the image using the hybrid CNN-SVM model.
  + The prediction result (e.g., unripe, ripe, overripe) is displayed to the user.
* **Purpose:** To allow users to utilize the machine learning model for practical applications in predicting mango ripeness.

#### 5. Logout

* **Function:** Allows users to securely log out of their accounts.
* **Process:**
  + Users click on the logout button.
  + The system terminates the user session.
  + Users are redirected to the login or homepage.
* **Purpose:** To ensure user security and privacy by ending the session after use.

### Admin Module Description

The Admin Module is a vital component of the system, providing administrators with the necessary tools to manage user accounts and oversee the operation of the platform. This module includes functionalities for admin login, viewing registered users, and managing user activation and deactivation. Below is a detailed description of the functionalities offered by the Admin Module:

#### 1. Admin Login

* **Function:** Allows administrators to access the admin panel.
* **Process:**
  + Admins enter their username and password.
  + The system verifies the credentials.
  + Upon successful verification, admins are granted access to the admin panel.
* **Purpose:** To authenticate administrators and ensure secure access to administrative functionalities.

#### 2. View Registered Users

* **Function:** Enables administrators to view a list of all registered users.
* **Process:**
  + Admins navigate to the user management section.
  + The system displays a list of registered users, including details such as username, email, registration date, and account status (active/inactive).
* **Purpose:** To provide administrators with an overview of all user accounts for monitoring and management purposes.

#### 3. Activate Users

* **Function:** Allows administrators to activate user accounts, enabling them to log in and use the system.
* **Process:**
  + Admins select the user account(s) they wish to activate from the list.
  + The system updates the status of the selected accounts to active.
  + Activated users receive a notification that their account is now active.
* **Purpose:** To manage user access, ensuring that only approved users can access the system.

#### 4. Deactivate Users

* **Function:** Enables administrators to deactivate user accounts, preventing them from logging in and using the system.
* **Process:**
  + Admins select the user account(s) they wish to deactivate from the list.
  + The system updates the status of the selected accounts to inactive.
  + Deactivated users receive a notification that their account has been deactivated.
* **Purpose:** To control user access, ensuring that only compliant users can utilize the system.

### Convolutional Model Description

 **Feature Extraction**:

* Texture characteristics are extracted from CT images using the gray-level co-occurrence matrix (GLCM) approach. This method involves analyzing the spatial relationships between pixels to extract meaningful patterns and textures from the images.

 **Classification**:

* An SVM (Support Vector Machine) classifier is used to classify these features. SVM is a supervised machine learning algorithm that is used for classification and regression tasks. It works by finding the hyperplane that best separates the data into different classes.

 **Performance Evaluation**:

* Common evaluation measures such as accuracy, sensitivity, specificity, precision, F1 score, error rate, and Matthews Correlation Coefficient (MCC) values are determined. These measures are calculated using the confusion matrix data, which includes False Positive (FP), False Negative (FN), True Positive (TP), and True Negatives (TN) values.

### CNN Module Description

The CNN model used in this project for predicting drug resistance in tuberculosis involves several key steps and components:

1. **Image Pre-processing**:
   * The CT volumes are processed by slicing the middle 30 slices from each volume to create a 2D image database. These slices are then cropped to the region of interest and scaled to the standard size of (224,224) pixels.
2. **CNN Architecture**:
   * The CNN model consists of convolutional layers, pooling layers, and fully connected layers.
     + **Convolutional Layers**: These layers use multiple filters (kernels) that move across the input image to detect various features such as edges, corners, and textures. The convolutional layers generate feature maps that represent different levels of abstraction.
     + **Pooling Layers**: Max-pooling layers are used to downsample the feature maps, reducing their spatial dimensions and improving computational efficiency while decreasing the risk of overfitting.
     + **Flatten Layer**: After the convolutional and pooling layers, a flatten layer is used to convert the 2D feature maps into a 1D vector, which is then fed into the fully connected layers.
     + **Fully Connected Layers**: These layers perform the final classification based on the extracted features. All neurons in a fully connected layer are connected to all neurons in the previous and next layers.
3. **Training the Model**:
   * The CNN model is trained using a binary cross-entropy loss function and the Adam optimizer with a learning rate of 0.001.
   * Training is conducted for 30 epochs with a batch size of 16.
   * During training, back-propagation is used to adjust the weights of the CNN to minimize the difference between the actual and predicted drug resistance states.
4. **Dataset**:
   * The model is trained and tested on a dataset consisting of 3D NIFTI CT volumes from the CLEF-2018 tuberculosis dataset, which includes both drug-resistant and drug-sensitive cases.
   * The dataset is divided into training and testing sets, with specific volumes and image slices allocated to each set (as detailed in Table 1 of the paper).
5. **User Interface**:
   * A user interface is developed using the PyQt5 tool to facilitate the analysis of CT images and make automated predictions. The interface allows users to upload images, which are then pre-processed and fed into the trained CNN model to generate predictions. The results are displayed in a text box within the interface.
6. **Performance**:
   * The proposed CNN model achieved a high classification accuracy of 97.27% on the testing dataset, with a precision of 96.7%, sensitivity of 98.3%, and specificity of 96.1%. The model's error rate was 0.027, demonstrating its efficiency and accuracy compared to traditional machine learning approaches

**Test Model**

The Test Model is designed for the prediction of drug resistance in tuberculosis using a deep learning approach. This model leverages a Convolutional Neural Network (CNN) framework to analyze computed tomography (CT) images and predict whether a tuberculosis strain is drug-resistant or drug-sensitive. The model's prediction capability is crucial in providing timely and accurate treatment decisions, potentially improving patient outcomes. The CNN model achieves a high classification accuracy, demonstrating its effectiveness in handling the task of predicting drug resistance in tuberculosis based on imaging data. This model can be integrated into clinical workflows to assist radiologists and clinicians in making informed decisions regarding tuberculosis treatment responses.