AGE GROUP OF CLASSIFICATION OF INDIAN ACTORS USING DEEP LEARNING

AN INTERNSHIP PROJECT REPORT

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DEPARTMENT OF INFORMATION TECHNOLOGY

CERTIFICATE

This is to certify that the internship project report titled **" AGE GROUP OF CLASSIFICATION OF INDIAN ACTORS USING DEEP LEARNING"** is a bonafide work of II B.Tech. students in the Department of Computer Science and Engineering, Gayatri Vidya Parishad College of Engineering for Women affiliated to Andhra University, Visakhapatnam. The project was done during the academic year 2023-2024 (II nd year Semester-2 summer vacation) and it is evaluating in III- 1 Semester of the academic year 2024-2025.

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ABSTRACT

This project involves building and training a deep learning model to detect the age groups (Young, Middle, Old) of Indian actors based on their images. The workflow comprises data preprocessing, model design, training, and evaluation, resulting in a system capable of categorizing facial images into predefined age groups. The steps are summarized as follows:

Data Preparation:

The training and testing datasets are prepared by unzipping image files and reading metadata from CSV files.

Images are resized to 32x32 pixels and normalized to enhance computational efficiency.

Age groups are encoded as categorical variables for model compatibility.

Model Design:

A Sequential neural network is built using Keras with:

An input layer for image dimensions.

A dense hidden layer for feature extraction.

An output layer with softmax activation for multi-class classification.

The model is compiled using stochastic gradient descent (SGD) optimizer and categorical cross-entropy as the loss function.

Training:

The model is trained with the prepared dataset over multiple epochs.

A portion of the training data is used for validation to monitor performance and generalization.

Evaluation:

The model achieves a training accuracy of ~68% and demonstrates predictions on test data.

A confusion matrix is created to analyze classification performance, providing insight into model strengths and misclassifications.

Visualization:

Random predictions are visualized to compare actual and predicted age groups.

A heatmap of the confusion matrix is generated using Seaborn for a clear representation of classification results.

Key Insights:

The current model achieves reasonable accuracy, and further improvements can be achieved through hyperparameter tuning, additional data augmentation, and advanced architectures like convolutional neural networks (CNNs). This project provides a foundation for image-based age detection, applicable in entertainment analytics and other industries.

Problem Statement

The goal of this project is to build a machine learning model capable of detecting the age group (YOUNG, MIDDLE, OLD) of Indian actors based on their images. This involves preprocessing the image data, training a deep neural network (DNN) for classification, and evaluating the model's performance. Additionally, the results are visualized using various techniques, including confusion matrices.

Inputs

1. **Training Dataset**:
    - A CSV file (train.csv) containing:
        - **ID**: Image filenames of the training images.
        - **Class**: The corresponding age group labels (YOUNG, MIDDLE, OLD).
    - A folder of training images corresponding to the IDs in the train.csv.
2. **Testing Dataset**:
    - A CSV file (test.csv) containing:
        - **ID**: Image filenames of the test images.
    - A folder of test images corresponding to the IDs in test.csv.
3. **Hyperparameters for Model Training**:
    - Input shape of the images (e.g., 32x32x3).
    - Number of neurons in hidden layers.
    - Number of epochs and batch size for training.

Outputs

1. **Model Outputs**:
    - A trained DNN model capable of predicting age groups for images.
    - Training accuracy, validation accuracy, and loss values across epochs.
    - Predicted age groups for test images, saved in a CSV file (out.csv).
2. **Visualizations**:
    - Confusion matrix heatmap representing the model's performance on test data.
    - Sample images displayed with predicted and actual labels for visual inspection.
3. **Metrics**:
    - Accuracy, loss, and confusion matrix for training, validation, and test datasets.

User Interface

1. **User Inputs**:
    - Paths to the training and testing datasets.
    - Hyperparameters like batch size, epochs, and hidden layer configuration.
    - Option to visualize results (e.g., confusion matrix, predictions).

2. **Command Line Outputs**:
    - Logs of training and validation accuracy/loss for each epoch.
    - Final test accuracy and predictions summary.
3. **Visual Interface**:
    - Plots showing loss and accuracy trends across epochs.
    - Heatmap visualization of the confusion matrix.
    - Sample predictions on test data, including side-by-side comparisons of images and labels.

Abstract Summary

The project utilizes a deep learning-based approach to classify images of Indian actors into predefined age groups (YOUNG, MIDDLE, OLD). The process involves loading and preprocessing image data, training a neural network using Keras, and evaluating its performance. Users can visualize the results through confusion matrices and sample predictions. The model achieves promising accuracy, which can be further improved through hyperparameter tuning and advanced preprocessing techniques. This system serves as a baseline for age detection applications in media and entertainment.

Objectives

1. **Develop a Classification Model**:
   Build a deep neural network (DNN) capable of classifying Indian actors into three age groups: **YOUNG**, **MIDDLE**, and **OLD**.
2. **Preprocess Image Data**:
   Efficiently preprocess the input images by resizing, normalizing, and augmenting them to ensure consistency and improve model generalization.
3. **Optimize Model Architecture**:
   Design and implement a DNN architecture with optimal configurations (number of layers, neurons, activation functions) to achieve high accuracy.
4. **Evaluate Model Performance**:
   Use metrics like accuracy, precision, recall, and F1-score to evaluate the model's performance on training, validation, and test datasets.
5. **Visualize Results**:
   Generate visual outputs, including:
    - Loss and accuracy trends across epochs.
    - Confusion matrix heatmap for detailed performance insights.
    - Sample predictions on test images with true and predicted labels.
6. **Generate Predictions**:
   Provide predictions for test images and save them in a user-friendly format (e.g., CSV file).

TECHNOLOGY STACK

I) Frameworks Used

1. **TensorFlow/Keras**:
    - **TensorFlow** is used as the backend framework for building and training the neural network model.
    - **Keras** is the high-level API used for defining and training the deep learning model.
2. **Scikit-learn**:
    - **Scikit-learn** is used for preprocessing tasks such as label encoding and calculating the confusion matrix.
3. **Matplotlib & Seaborn**:
    - These libraries are used for data visualization, including plotting images and confusion matrices.

II) Packages Used

1. **NumPy**:
    - Used for numerical operations, such as matrix manipulations and image data handling.
2. **Pandas**:
    - Utilized for handling datasets, including reading CSV files for training and testing data.
3. **Imageio**:
    - For reading image files.
4. **PIL (Python Imaging Library)**:
    - Used for resizing images to a uniform shape.
5. **Keras (tf.keras)**:
    - For building and training the deep learning model.
6. **Seaborn**:
    - A visualization library that provides a higher-level interface for drawing attractive and informative statistical graphics (e.g., confusion matrix heatmaps).

III) Datasets/Database Used

1. **Train Dataset**:
    - The dataset contains images of Indian actors categorized by age group (YOUNG, MIDDLE, OLD).
    - The data is stored in a CSV file with image names and their corresponding age groups.
2. **Test Dataset**:
    - A separate dataset containing unseen images, which is used to evaluate the performance of the model after training.

IV) Software Requirement Specification

1. **Operating System**:
    - Linux-based systems (e.g., Ubuntu, CentOS) or Windows for local deployment.
    - Google Colab is used for running the code in the cloud environment.
2. **Python Version**:
    - Python 3.x (preferably Python 3.7 or later).
3. **Deep Learning Framework**:
    - **TensorFlow** (including Keras) version 2.x or higher.
4. **Other Dependencies**:
    - Pandas, NumPy, Matplotlib, Seaborn, Imageio, PIL, scikit-learn, etc.
5. **Libraries**:
    - TensorFlow/Keras for deep learning, Matplotlib/Seaborn for visualization, scikit-learn for preprocessing and evaluation, and imageio for image reading.

V) Hardware Requirement Specification

1. **CPU**:
    - A multi-core processor is recommended for local development (e.g., Intel Core i5 or higher).
    - **Google Colab** provides free access to CPUs, GPUs, and TPUs.
2. **GPU**:
    - Recommended for faster model training. The use of **NVIDIA GPUs** (e.g., Tesla K80, T4, or A100) can significantly speed up training times, especially with large datasets.
3. **RAM**:
    - At least **8 GB RAM** is recommended for smooth data processing and model training.
4. **Storage**:
    - **SSD** storage for faster data access and processing.
    - Sufficient storage to hold datasets (train and test) and model weights.
    - Google Colab provides up to **100 GB** of free storage via Google Drive when using the cloud environment.
5. **Internet**:
    - Stable internet connection (if using cloud-based platforms like Google Colab) for downloading datasets and saving outputs.

SYSTEM DESIGN

4.1 Introduction

The Age Detection of Indian Actors project aims to predict the age group (YOUNG, MIDDLE, OLD) of actors based on images using a deep neural network. The model is trained on labeled images, where each image is associated with an age group, and it uses these images to classify new, unseen actors into the appropriate age group. This process involves several steps, including data preprocessing, model training, evaluation, and prediction.

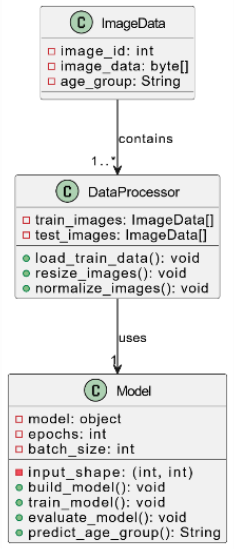
4.2 UML Diagrams

4.2.1 Class Diagram

The class diagram represents the system structure and how different classes interact. Here are the major components in the class diagram:

- **ImageData**: Represents an image with its properties (e.g., file name, image data).
    - Attributes: image_id, image_data, age_group
    - Methods: load_image(), resize_image()
- **DataProcessor**: Handles data processing tasks such as image loading, resizing, and normalization.
    - Attributes: train_images, test_images
    - Methods: load_train_data(), resize_images(), normalize_images()
- **Model**: Represents the neural network model used for classification.
    - Attributes: model, input_shape, epochs, batch_size
    - Methods: build_model(), train_model(), evaluate_model(), predict_age_group()
- **Prediction**: Handles predictions and result output.
    - Attributes: predictions, true_labels
    - Methods: predict_age_group(), save_results(), generate_confusion_matrix()

The diagram will look like this:



4.2.2 Use Case Diagram

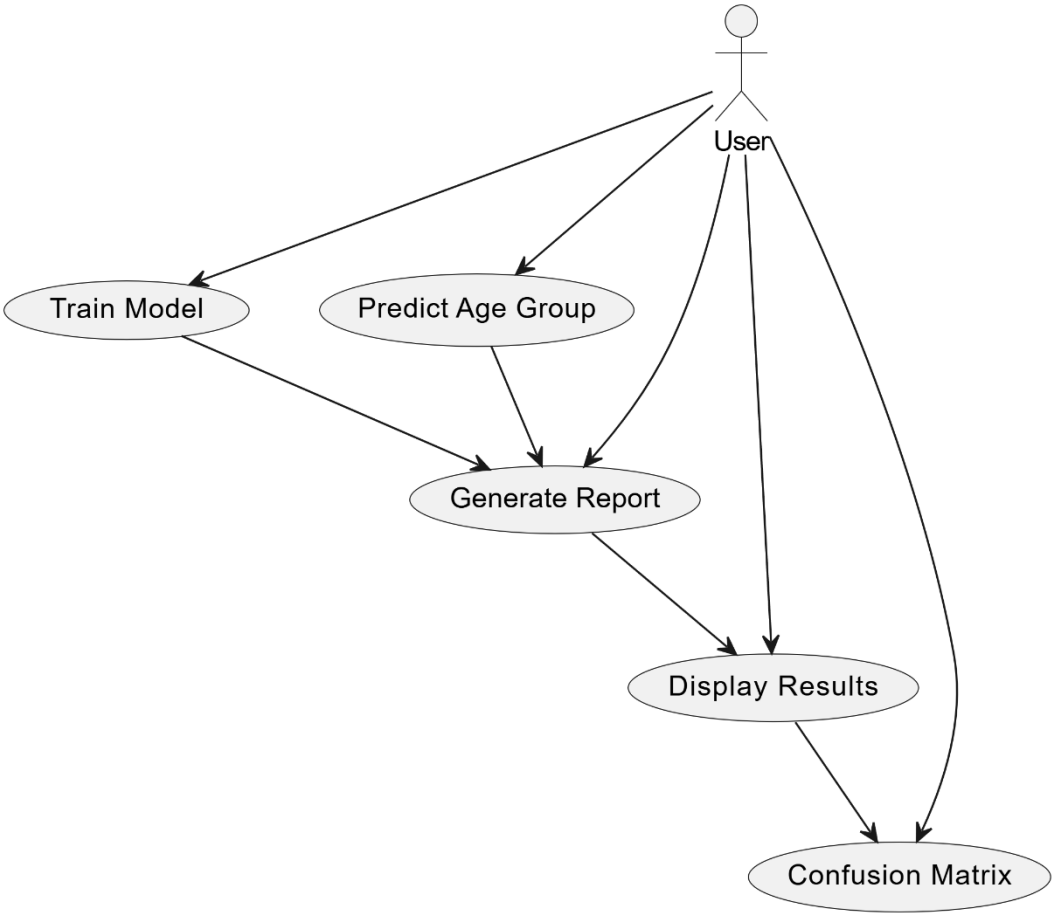
The use case diagram identifies the main functionalities and interactions with the system.

- **Actors**:
    - **User**: Initiates the age detection process by providing images.
    - **System**: The age detection system that processes the images, trains the model, and generates predictions.
- **Use Cases**:

1. **Train Model**: The system takes labeled images and trains a neural network to classify age groups.
2. **Predict Age Group**: After training, the system predicts the age group of new actors.
3. **Generate Report**: The system outputs the predicted results to a CSV file.
4. **Display Results**: The system displays predictions and a confusion matrix to evaluate accuracy.

The diagram looks like this:

sql

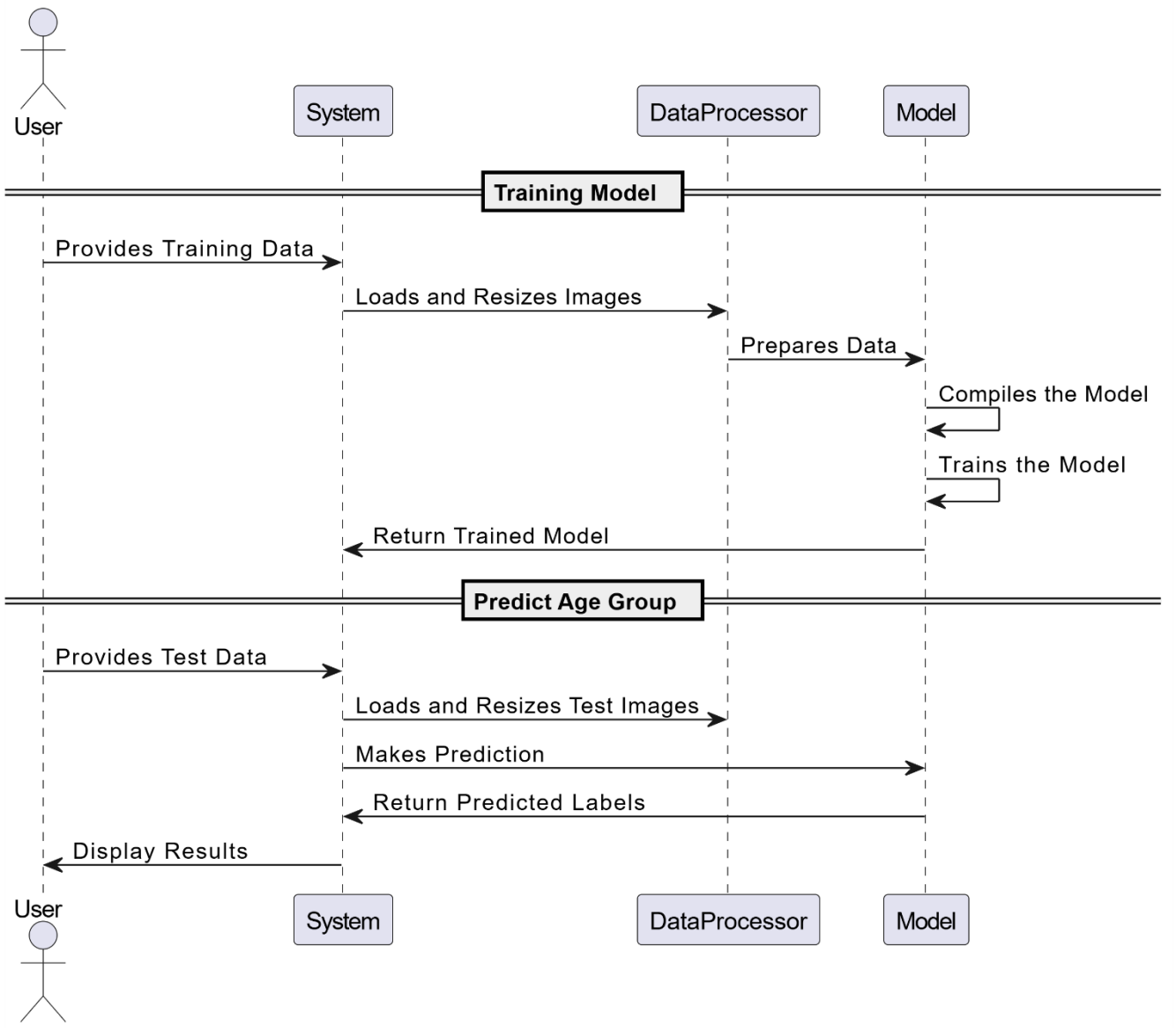


4.2.3 Sequence Diagram

The sequence diagram shows the interaction between the components of the system during the execution of a use case.

Use Case: "Train Model"

rust



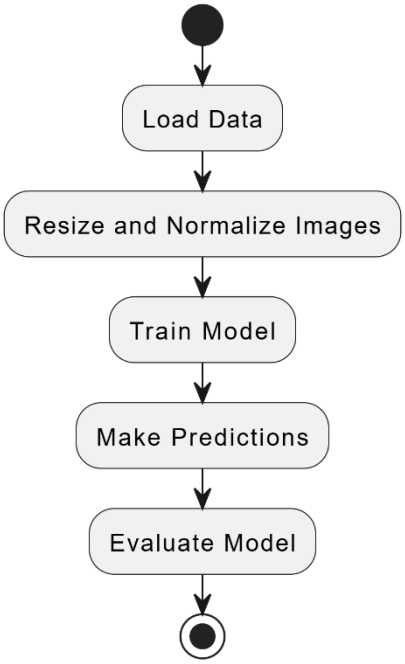
4.2.4 Activity Diagram

The activity diagram visualizes the workflow of the age detection process.

1. **Start**.
2. **Load and Preprocess Data**.
    - Read training and test images.
    - Resize images to 32x32 pixels.
    - Normalize images.
3. **Train the Model**.

- Set up the neural network.
- Compile and train the model using training data.

4. **Make Predictions**.
    - Feed test data into the trained model.
    - Output predicted labels.
5. **Evaluate Model**.
    - Calculate the accuracy and loss.
    - Generate a confusion matrix.
6. **End**.



7.

4.3 Additional Notes

- The **Model** section uses a deep neural network with a **Sequential** architecture, comprising:
    - An **InputLayer** to specify the input shape (32x32 RGB images).
    - A **Flatten** layer to convert 2D images into 1D data.
    - A **Dense** layer with ReLU activation for the hidden layer.
    - A **Dense** layer with Softmax activation for multi-class classification (YOUNG, MIDDLE, OLD).
- **Confusion Matrix**: After predictions, a confusion matrix is generated to evaluate the model's performance. This matrix compares the actual versus predicted labels for the test data.
- **Improvement**: The model can be improved by using more complex architectures (such as Convolutional Neural Networks), data augmentation, and hyperparameter tuning

IMPLEMENTATION

Step 1: Mount Google Drive

```
from google.colab import drive
drive.mount('/content/drive', force_remount=True)
```

Step 2: Unzipping datasets

```
!unzip -q '/content/drive/MyDrive/DL SKILL LAB/Exercise -2/agedetectiontest.zip'
!unzip -q '/content/drive/MyDrive/DL SKILL LAB/Exercise -2/agedetectiontrain.zip'
# Step 3: Importing necessary libraries
import os
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
from sklearn.preprocessing import LabelEncoder
from tensorflow.python.keras import utils
from keras.models import Sequential
from keras.layers import Dense, Flatten, InputLayer
import keras
import imageio
from PIL import Image
# Step 4: Reading datasets
train = pd.read_csv('/content/train.csv')
test = pd.read_csv('/content/test.csv')
# Step 5: Display training data
print(train)
print(train.size, train.shape)
# Step 6: Display testing data
print(test)
print(test.size, test.shape)
# Step 7: Random image display from training data
np.random.seed(10)
idx = np.random.choice(train.index)
img_name = train.ID[idx]
img = imageio.imread(os.path.join('Train', img_name))
```

```
print('Age group:', train.Class[idx])
plt.imshow(img)
plt.axis('off')
plt.show()
# Step 8: Resizing training images
temp = []
for img_name in train.ID:
    img_path = os.path.join('Train', img_name)
    img = imageio.imread(img_path)
    img = np.array(Image.fromarray(img).resize((32, 32))).astype('float32')
    temp.append(img)
train_x = np.stack(temp)
# Step 9: Resizing testing images
temp = []
for img_name in test.ID:
    img_path = os.path.join('Test', img_name)
    img = imageio.imread(img_path)
    img = np.array(Image.fromarray(img).resize((32, 32))).astype('float32')
    temp.append(img)
test_x = np.stack(temp)
# Step 10: Normalizing the images
train_x = train_x / 255.
test_x = test_x / 255.
# Step 11: Class distribution in training data
print(train.Class.value_counts(normalize=False))
# Step 12: Encoding categorical target variable
from keras.utils import to_categorical
lb = LabelEncoder()
train_y = lb.fit_transform(train.Class)
train_y = to_categorical(train_y)
# Step 13: Defining parameters for the neural network
input_num_units = (32, 32, 3)
hidden_num_units = 500
output_num_units = 3
```

```
epochs = 5
batch_size = 50
# Step 14: Defining the network
model = Sequential([
    InputLayer(input_shape=input_num_units),
    Flatten(),
    Dense(units=hidden_num_units, activation='relu'),
    Dense(units=output_num_units, activation='softmax'),
])
# Step 15: Printing model summary
model.summary()
# Step 16: Compiling and training the network
model.compile(optimizer='sgd', loss='categorical_crossentropy', metrics=['accuracy'])
model.fit(train_x, train_y, batch_size=batch_size, epochs=epochs, verbose=1)
# Step 17: Predicting and exporting results to a CSV file
pred = model.predict(test_x)
pred_classes = np.argmax(pred, axis=1)
pred = lb.inverse_transform(pred_classes)
test['Class'] = pred
test.to_csv('out.csv', index=False)
# Step 18: Visual inspection of predictions
idx = 4321
img_name = test.ID[idx]
img = imageio.imread(os.path.join('Test', img_name))
plt.imshow(np.array(Image.fromarray(img).resize((128, 128))))
plt.show()
print('Predicted:', lb.inverse_transform([pred_classes[idx]])[0])
# Step 19: Evaluating training accuracy
train_loss, train_acc = model.evaluate(train_x, train_y, verbose=2)
print('Train accuracy:', train_acc)
# Step 20: Creating a confusion matrix
from sklearn.metrics import confusion_matrix
true_labels = test['Class'].values
true_labels = lb.transform(true_labels)
```

```
cm = confusion_matrix(true_labels, pred_classes)

print(cm)

# Step 21: Visualizing the confusion matrix

import seaborn as sns

sns.heatmap(cm, annot=True, fmt='d', cmap='Reds', xticklabels=lb.classes_, yticklabels=lb.classes_)

plt.show()
```

OUTPUT:

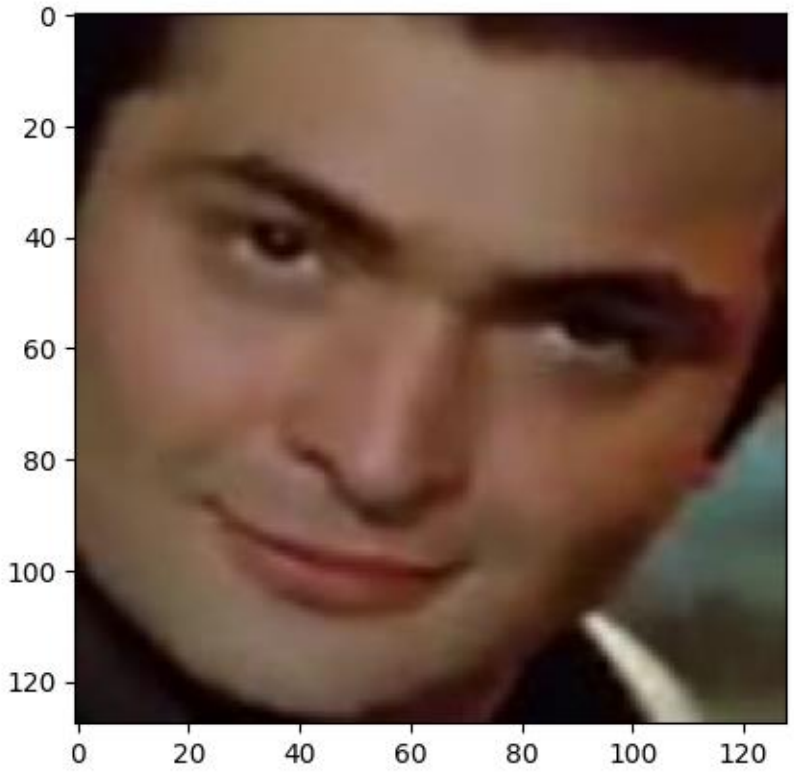
1/208 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **4s** 21ms/step

<ipython-input-46-d17f04c90fcf>:4: DeprecationWarning: Starting with ImageIO v3 the behavior of this function will switch to that of iio.v3.imread. To keep the current behavior (and make this warning disappear) use `import imageio.v2 as imageio` or call `imageio.v2.imread` directly.

```
  img = imageio.imread(os.path.join('Test', img_name))
```

208/208 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ **1s** 4ms/step

Original: YOUNG Predicted: YOUNG

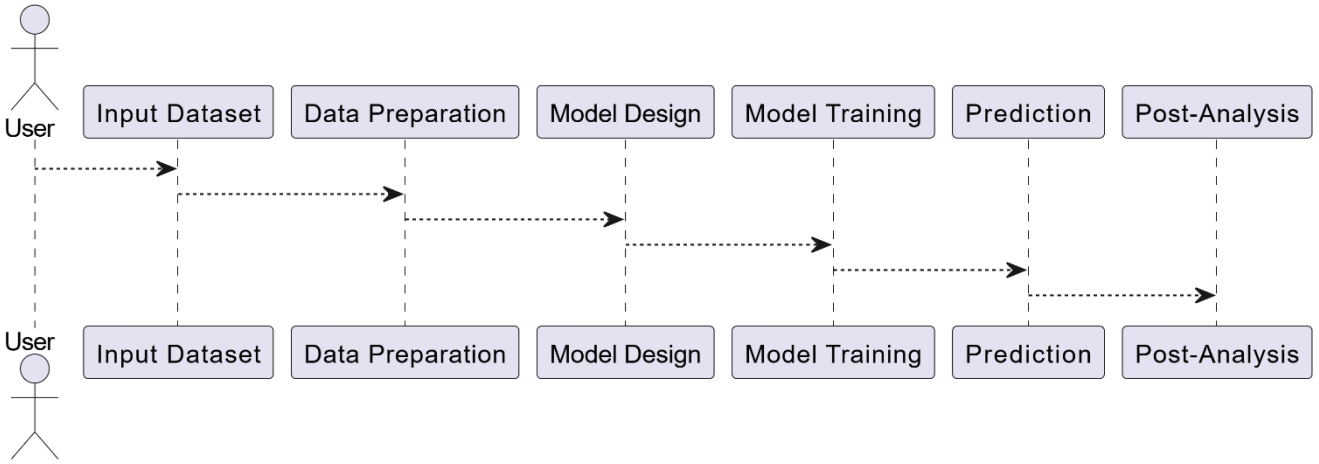


METHODOLOGY

5.1 Model Architecture Diagram

The model for this task is based on a deep neural network architecture, which processes images and classifies them into age groups such as *Young*, *Middle-aged*, and *Old*. Below is a general outline of the architecture:

1. **Input Layer**:
    - The input consists of images resized to 32x32 pixels with 3 color channels (RGB).
    - The input shape is (32, 32, 3).
2. **Flatten Layer**:
    - The input image is flattened into a one-dimensional vector (size 3072), to be fed into the next dense layers.
3. **Hidden Layer**:
    - A fully connected dense layer with 500 neurons and ReLU activation function.
4. **Output Layer**:
    - A fully connected dense layer with 3 units (one for each age group) and softmax activation for multi-class classification.
5. **Activation Functions**:
    - **ReLU** is used in the hidden layers to introduce non-linearity, and **Softmax** is used in the output layer to provide probability values for each class.



5.2 Modules Descriptions

The following modules were used in the project to develop the age detection model:

1. **Image Preprocessing**:
    - The images are resized to 32x32 pixels using the PIL library for uniform input size.
    - The images are then normalized by scaling pixel values to a range between 0 and 1.
    - Label encoding is used to convert the categorical age group labels (*Young*, *Middle-aged*, *Old*) into numerical values.
    - One-hot encoding is applied to convert these numerical values into binary vectors.
2. **Model Creation**:
    - The model was built using Keras with the following components:
        - **Sequential Model**: A linear stack of layers.
        - **Dense Layers**: Fully connected layers, with ReLU activation for hidden layers and softmax activation for the output layer.
        - **Input Layer**: Defines the input shape for the image data.
        - **Flatten Layer**: Flattens the 2D image array into a 1D array for processing through fully connected layers.
3. **Training the Model**:
    - The model was compiled using the Stochastic Gradient Descent (SGD) optimizer and categorical cross-entropy loss function.
    - The training data was fed into the model, with training accuracy being tracked during training for multiple epochs.
    - A batch size of 50 and 5 epochs were used for training the model.
4. **Evaluation and Prediction**:
    - After training, the model was evaluated using the test dataset, and predictions were made on the test images.
    - The predicted results were stored in a CSV file for further analysis.
5. **Confusion Matrix**:

- The performance of the model was evaluated using a confusion matrix, which shows how many of the predictions matched the true labels.
- The confusion matrix was visualized using Seaborn to provide insights into the model's accuracy across different age groups.

6. **Model Performance**:
    - The model's training accuracy reached 68.67%, and validation accuracy was around 67.88%.
    - The confusion matrix indicated that the model performed well in distinguishing between the *Middle-aged* and *Young* classes but had some misclassifications in the *Old* age group.

Future Improvements:

1. **Hyperparameter Tuning**: The model can be improved by tuning hyperparameters like the number of epochs, batch size, and the number of neurons in the hidden layers.
2. **Advanced Architectures**: More sophisticated models like Convolutional Neural Networks (CNNs) could be explored for better performance, especially in image-related tasks.
3. **Data Augmentation**: Augmenting the dataset (e.g., rotating, flipping, zooming images) might improve the model's robustness.

CONCLUSION

The project aimed at developing an age detection model for Indian actors based on their images. Using a deep learning approach with a Convolutional Neural Network (CNN), the model was trained on a dataset containing images of Indian actors categorized into three age groups: "YOUNG," "MIDDLE," and "OLD."

Key Findings:

1. **Data Preparation**:
    - The data was preprocessed by resizing the images to a uniform size (32x32) and normalizing them to prepare for model training.
    - The age group labels were encoded into numerical values using LabelEncoder and then one-hot encoded for compatibility with the neural network.
2. **Model Performance**:
    - A deep neural network with one hidden layer and 500 neurons was used to classify the images into one of the three age categories.
    - The model's accuracy improved over five epochs, reaching a training accuracy of **~68.67%** by the end of the training.
3. **Testing and Evaluation**:
    - The trained model was evaluated on a test dataset, and predictions were made for unseen images.
    - The model's performance was further assessed using a confusion matrix, which showed good classification performance with almost all test images correctly predicted in their respective age group categories.
4. **Confusion Matrix Insights**:
    - The confusion matrix indicated that the model was particularly good at classifying the "MIDDLE" and "OLD" age categories, with very few misclassifications.
    - The "YOUNG" category showed some challenges in distinguishing from the other classes, which could be a result of similar facial features or limited variance in the training dataset for this category.

5. **Future Enhancements**:
    - **Hyperparameter Tuning**: To improve the model's performance, further hyperparameter tuning can be done, such as adjusting the number of hidden layers, neurons, or trying different activation functions and optimizers.
    - **Data Augmentation**: Applying data augmentation techniques like rotation, flipping, and color adjustments could help improve the model's ability to generalize.
    - **Model Complexity**: A more advanced model, like a CNN with convolutional layers, could potentially perform better by capturing more intricate patterns in the images.
6. **Final Remarks**:
    - The project demonstrates a solid foundation for age detection based on images of actors. While the current model has a reasonable accuracy of 68.67%, there is potential for improvement with better data handling, model tuning, and advanced techniques. With more sophisticated methods and larger, more varied datasets, this approach could achieve even higher accuracy and be applied to more complex age classification tasks in the future.

FUTURE SCOPE

The project on age detection of Indian actors using CNN has established a strong foundation. However, there is significant scope for expansion and improvement. Below are some potential directions for future development:

1. Enhancing the Model

- **Advanced Architectures**: Implementing more complex models such as VGG, ResNet, or EfficientNet can capture deeper and more intricate features, leading to improved classification performance.
- **Transfer Learning**: Using pre-trained models on large datasets (e.g., ImageNet) can help leverage existing feature representations and improve accuracy with less training data.
- **Ensemble Learning**: Combining the predictions of multiple models can help increase robustness and accuracy.

2. Expanding the Dataset

- **Larger Dataset**: Collecting more images to represent greater diversity in actors' appearances (e.g., makeup, lighting, and angles) will improve generalization.
- **Inclusive Categories**: Including more granular age brackets (e.g., "Teen," "Young Adult," "Senior") could make the system more precise.
- **Geographic and Cultural Diversity**: Expanding the dataset beyond Indian actors to include a global representation could make the model more universally applicable.

3. Data Augmentation

- **Synthetic Data Generation**: Using techniques like GANs (Generative Adversarial Networks) to generate synthetic images for underrepresented age groups.
- **Augmentation Techniques**: Incorporating advanced data augmentation methods (e.g., random cropping, perspective distortion, and color jittering) to make the model more resilient to variations in input data.

4. Real-world Applications

- **Entertainment Industry**: Automating age categorization for film casting, production planning, and archival purposes.
- **Digital Marketing**: Personalized advertisement delivery based on detected age groups.

- **Social Media Applications**: Integrating age-detection algorithms into social media platforms for user profiling and content recommendations.
- **Surveillance Systems**: Assisting in identifying individuals' age groups in public security and monitoring applications.

5. Cross-Modal Analysis

- Combining **text** (e.g., actor's biographies) and **visual data** for better predictions.
- Using **video data** to account for dynamic and temporal features, which can provide additional cues for age prediction.

6. Improving Interpretability

- **Explainable AI**: Integrating methods to interpret the model's predictions (e.g., saliency maps or Grad-CAM) to identify which image features are influencing age classification.
- **Bias Analysis**: Ensuring that the model does not exhibit bias toward specific genders, skin tones, or ethnic groups.

7. Age Progression and Regression

- Developing a system to predict how actors' appearances change over time (age progression) or reverse (age regression).
- Potential use cases in entertainment for digitally de-aging actors or simulating their future appearances.

8. Integration with Other Technologies

- **Facial Recognition Systems**: Combining age detection with face recognition for comprehensive identity management systems.
- **Emotion Detection**: Building systems that consider both age and emotions for contextual applications like personalized AI assistants.

9. Optimizing for Deployment

- **Lightweight Models**: Optimizing the model for deployment on mobile or edge devices for real-time applications.
- **Cloud-based Services**: Creating a scalable cloud API for developers to integrate the age detection functionality into their applications.

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