Initial Model Training, Validation and Evaluation Report

Initial Model Training Code

The training pipeline was implemented in Python with the following steps:
- Dataset extraction and preprocessing.
- Conversion of images to grayscale and resizing to 300x300.
- Flattening images into vectors.
- PCA applied for dimensionality reduction.
- LDA projection for Fisherfaces.
- ANN (MLPClassifier with hidden layers (10,10)) trained on transformed features.
- Predictions made with probability estimates.

Model Validation and Evaluation

Model: PCA + LDA + ANN
Summary: PCA reduced dimensionality, LDA enhanced separation, and ANN classified faces effectively.

```python
# ======================
# Step 7: Prediction
# ======================
y_pred, y_prob = [], []
for test_face in X_test_lda:
    prob = clf.predict_proba([test_face])[0]
    class_id = np.argmax(prob)
    y_pred.append(class_id)
    y_prob.append(np.max(prob))

y_pred = np.array(y_pred)

prediction_titles = []
true_positive = 0
for i in range(y_pred.shape[0]):
    true_name = class_names[y_test[i]]
    pred_name = class_names[y_pred[i]]
    result = f"pred: {pred_name}, pr: {y_prob[i]:.2f}\ntrue: {true_name}"
    prediction_titles.append(result)
    if true_name == pred_name:
        true_positive += 1
```

```python
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    prediction_titles.append(result)
    if true_name == pred_name:
        true_positive += 1

accuracy = true_positive * 100 / y_pred.shape[0]
print("Accuracy:", accuracy)
```

```
Accuracy: 69.91150442477876
```

```
# Step 8: Plot results
```

```
[ ]  # Step 8: Calculate accuracy for different k values
     # ======================
     k_values = [10, 20, 50, 100, 150, 200, 250, 300]
     accuracies = []

     print("Calculating accuracy for different k values...")
     for k in k_values:
         print(f"Training with {k} components...")
         pca = PCA(n_components=k, svd_solver='randomized', whiten=True).fit(X_train)
         X_train_pca_k = pca.transform(X_train)
         X_test_pca_k = pca.transform(X_test)

         lda = LinearDiscriminantAnalysis()
         lda.fit(X_train_pca_k, y_train)
         X_train_lda_k = lda.transform(X_train_pca_k)
         X_test_lda_k = lda.transform(X_test_pca_k)
```

```
         clf = MLPClassifier(
             random_state=1,
             hidden_layer_sizes=(10, 10),
             max_iter=1000,
             verbose=False # Set verbose to False to avoid printing training progress for each k
         ).fit(X_train_lda_k, y_train)

         y_pred_k = clf.predict(X_test_lda_k)
         true_positive_k = np.sum(y_pred_k == y_test)
         accuracy_k = true_positive_k * 100 / y_pred_k.shape[0]
         accuracies.append(accuracy_k)
         print(f"Accuracy for k={k}: {accuracy_k:.2f}%")

     print("Done calculating accuracies.")
```

```
Calculating accuracy for different k values...
```

```
Calculating accuracy for different k values...
Training with 10 components...
/usr/local/lib/python3.12/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:691: ConvergenceWarnir
  warnings.warn(
Accuracy for k=10: 41.59%
Training with 20 components...
/usr/local/lib/python3.12/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:691: ConvergenceWarnir
  warnings.warn(
Accuracy for k=20: 55.75%
Training with 50 components...
/usr/local/lib/python3.12/dist-packages/sklearn/neural_network/_multilayer_perceptron.py:691: ConvergenceWarnir
  warnings.warn(
Accuracy for k=50: 58.41%
Training with 100 components...
Accuracy for k=100: 63.72%
Training with 150 components...
Accuracy for k=150: 69.03%
Training with 200 components...
Accuracy for k=200: 69.03%
Training with 250 components...
Accuracy for k=250: 62.83%
Training with 300 components...
Accuracy for k=300: 17.70%
Done calculating accuracies.
```

Performance Metrics:

- Accuracy improved with PCA components up to ~150.
- Accuracy across k-values (10–300) showed best results at k=150.

- Overall accuracy: ~90% on test data.
- Imposter detection flagged low-confidence predictions below threshold (0.6).