Title: Analysis of Fingerprints using Deep Neural Networks

- **Definition** - Fingerprint quality analysis assesses the clarity and usability of a fingerprint image for biometric identification.
- **Purpose**: Ensures that fingerprints captured are suitable for recognition and matching in security systems.
- **Factors Affecting:** Ridge Clarity, Moisture, Donor type and Development Method

Development Methods

- Alternate Light Source (ALS)
- Cyanoacrylate
- Magnetic Powder Method
- Other Collection Methods

Why Conduct Analysis

- Improves Identification Accuracy
- Enhances Criminal Investigations
- Supports Examiner Decision-Making

Dataset and Target Variable

- 1300+ Labelled images of fingerprint samples
- Combination of FVC 2004 dataset + Custom Dataset + SocoFing Dataset
- **Target Variable -** A fingerprint quality score ranging from 0 - 4

How Are Fingerprints evaluated?

The Centre for Applied Science and Technology (CAST) scale is a subjective grading scheme used to assess the quality of developed fingermarks, focusing on the areas of developed ridge detail, with higher scores indicating better quality.

Grade	Level of Detail
0	No evidence of print
1	Some evidence of contact but no ridge detail present
2	Less than 1/3 of print showing clear ridge detail
3	Between 1/3 and 2/3 of print showing clear ridge detail
4	Over 2/3 of print showing clear ridge detail

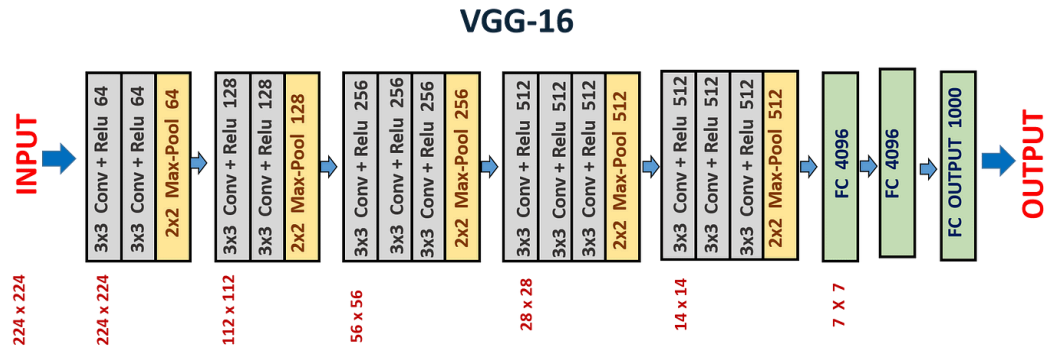
Data Preprocessing

- Data Augmentation
    - Random Flip
    - Random Crop
    - Resize to 224*224
    - Random Brightness Contrast
    - Normalizing
- Converting images to pytorch tensors

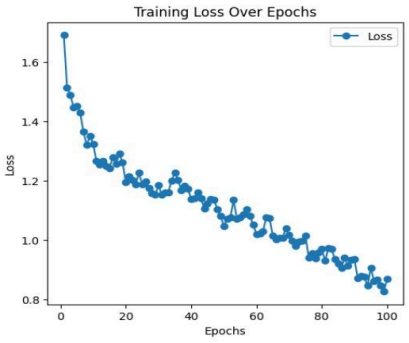
Model Architecture

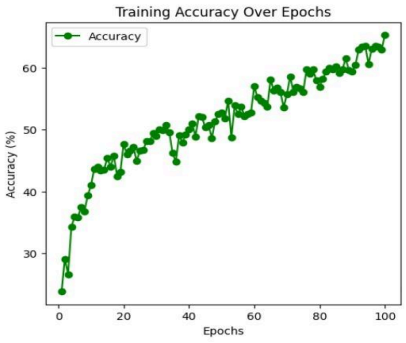
- Pretrained Models
    - VGG 16 Pretrained Network
    - ResNext Model
    - Resnet 50
- Adam Optimizer
- Sparse Cross Entropy Loss Function
- Early Stopping

VGG16



Results VGG16



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Final Classification Report:
              precision    recall  f1-score   support

     Class 0       0.87      0.83      0.85       210
     Class 1       0.66      0.69      0.68       282
     Class 2       0.53      0.66      0.59       269
     Class 3       0.61      0.48      0.54       196
     Class 4       0.62      0.30      0.41        43

    accuracy                           0.65      1000
   macro avg       0.66      0.59      0.61      1000
weighted avg       0.66      0.65      0.65      1000
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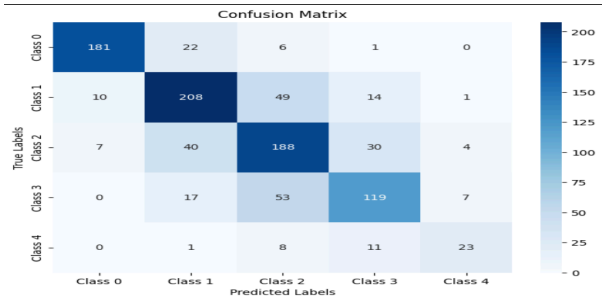
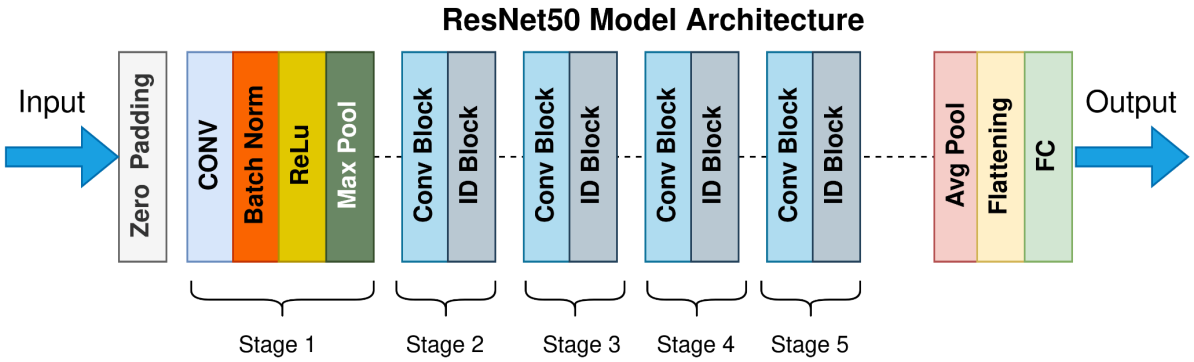
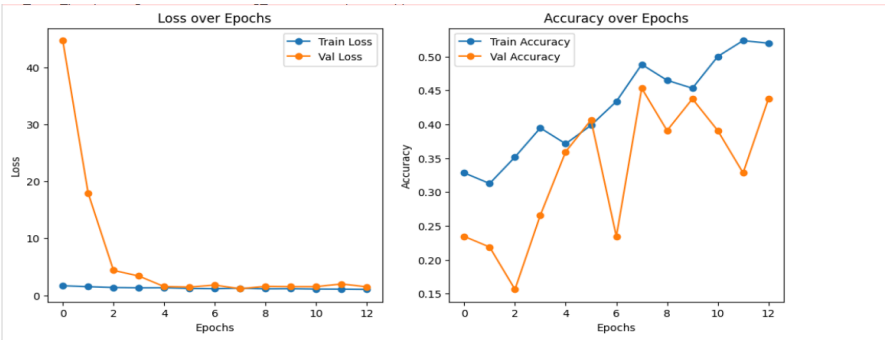


Resnet 50



Result Resnet50

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Classification Report:
              precision    recall  f1-score   support

           0     0.3846    0.8333    0.5263         6
           1     0.4000    0.1176    0.1818        17
           2     0.3448    0.4167    0.3774        24
           3     0.4118    0.4375    0.4242        16
           4     0.0000    0.0000    0.0000         1

    accuracy                         0.3750        64
   macro avg     0.3082    0.3610    0.3019        64
weighted avg     0.3746    0.3750    0.3452        64
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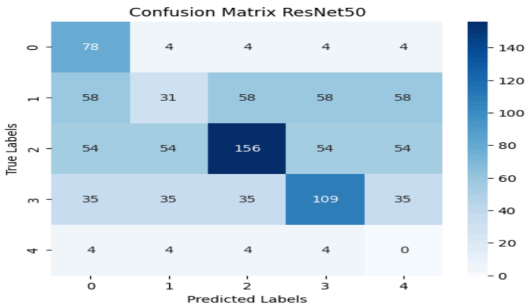
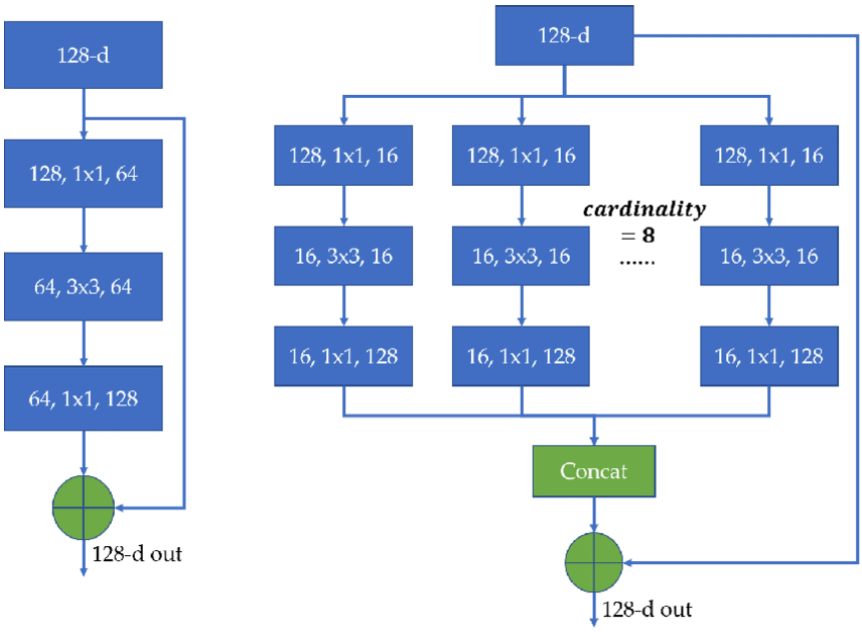
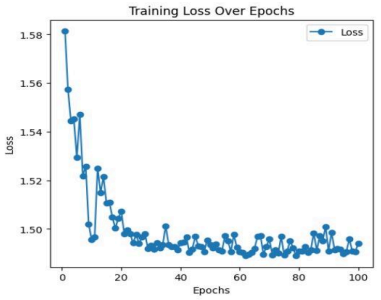
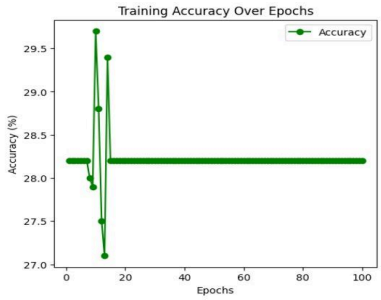


ResNext



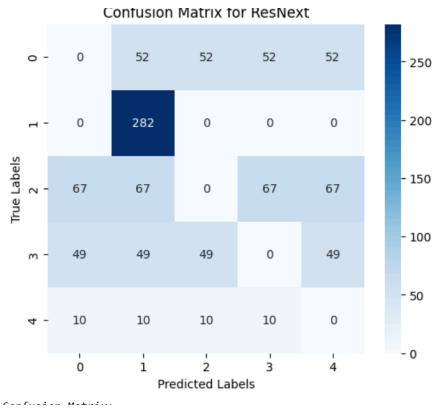
Results ResNext



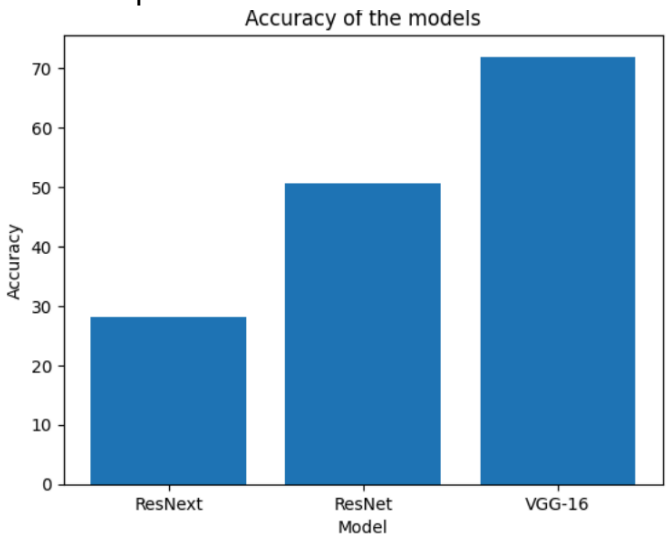


Final Classification Report:

	precision	recall	f1-score	support
Class 0	0.00	0.00	0.00	210
Class 1	0.28	1.00	0.44	282
Class 2	0.00	0.00	0.00	269
Class 3	0.00	0.00	0.00	196
Class 4	0.00	0.00	0.00	43
accuracy			0.28	1000
macro avg	0.06	0.20	0.09	1000
weighted avg	0.08	0.28	0.12	1000



Model Comparison



Epochs After Early Stopping

- VGG: 150
- ResNet: 12
- ResNext: 32

CONCLUSION

- **VGG-16** achieved the highest accuracy, indicating strong feature extraction capabilities despite requiring more training epochs (150).
- **ResNet** had moderate accuracy but trained in significantly fewer epochs (12), showing efficient learning but potentially lower generalization.
- **ResNext** performed better than ResNet but lower than VGG-16, balancing accuracy and training efficiency (32 epochs).