Deep Learning with Shallow Pixels: Classifying Images

A Transfer Learning Approach
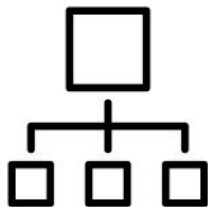
Project for Masterschool
by Dido De Boodt

About the project

| Goal | Approach | Tools |

Build an image classifier for the 10 classes of CIFAR-10

Transfer learning using ResNet50

pre-trained on ImageNet

Limited to 10,000 training samples for faster experimentation

**TensorFlow (Keras API in Google Colab)**

About the data

- **CIFAR-10** is a computer vision dataset

- Contains 60,000 32x32 color images

- Images are RGB with rich variation in style and context

- 10 mutually exclusive Classes

ResNet50 Model

- 50-layer CNN with residual connections

- Solves vanishing gradient problem by skipping layers

- Pretrained on ImageNet (1M+ images, 1000 classes)

- Excellent for transfer learning to new tasks like CIFAR-10

Residual connections act like Lego tunnels that skip layers, helping information flow through deep networks.
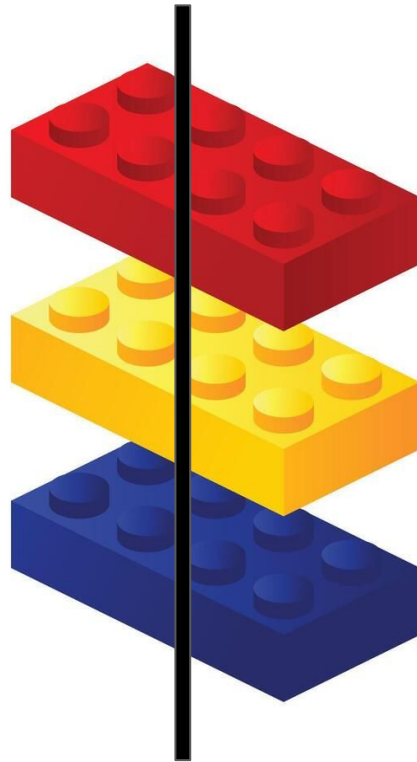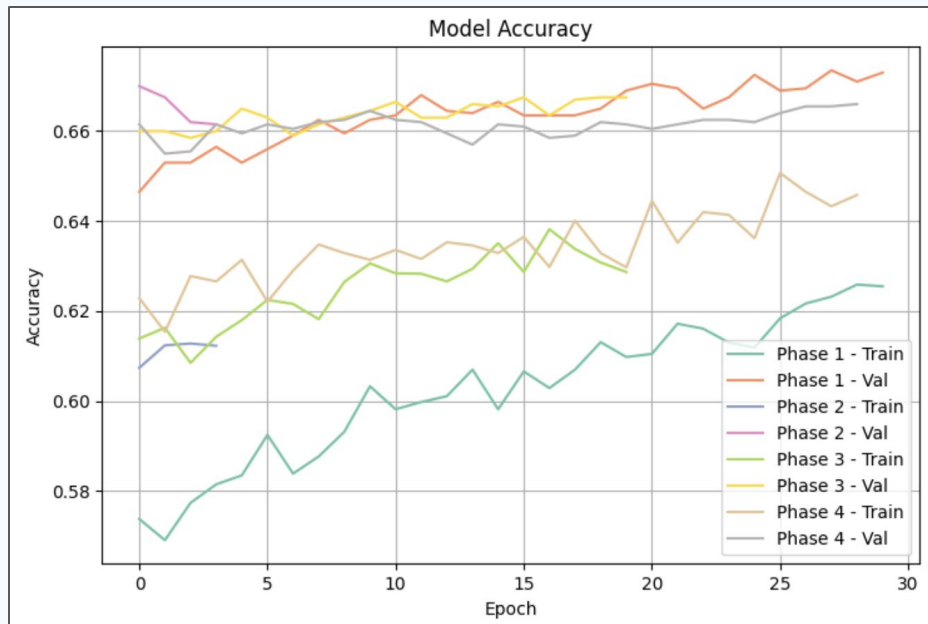
Model Architecture

Base model:

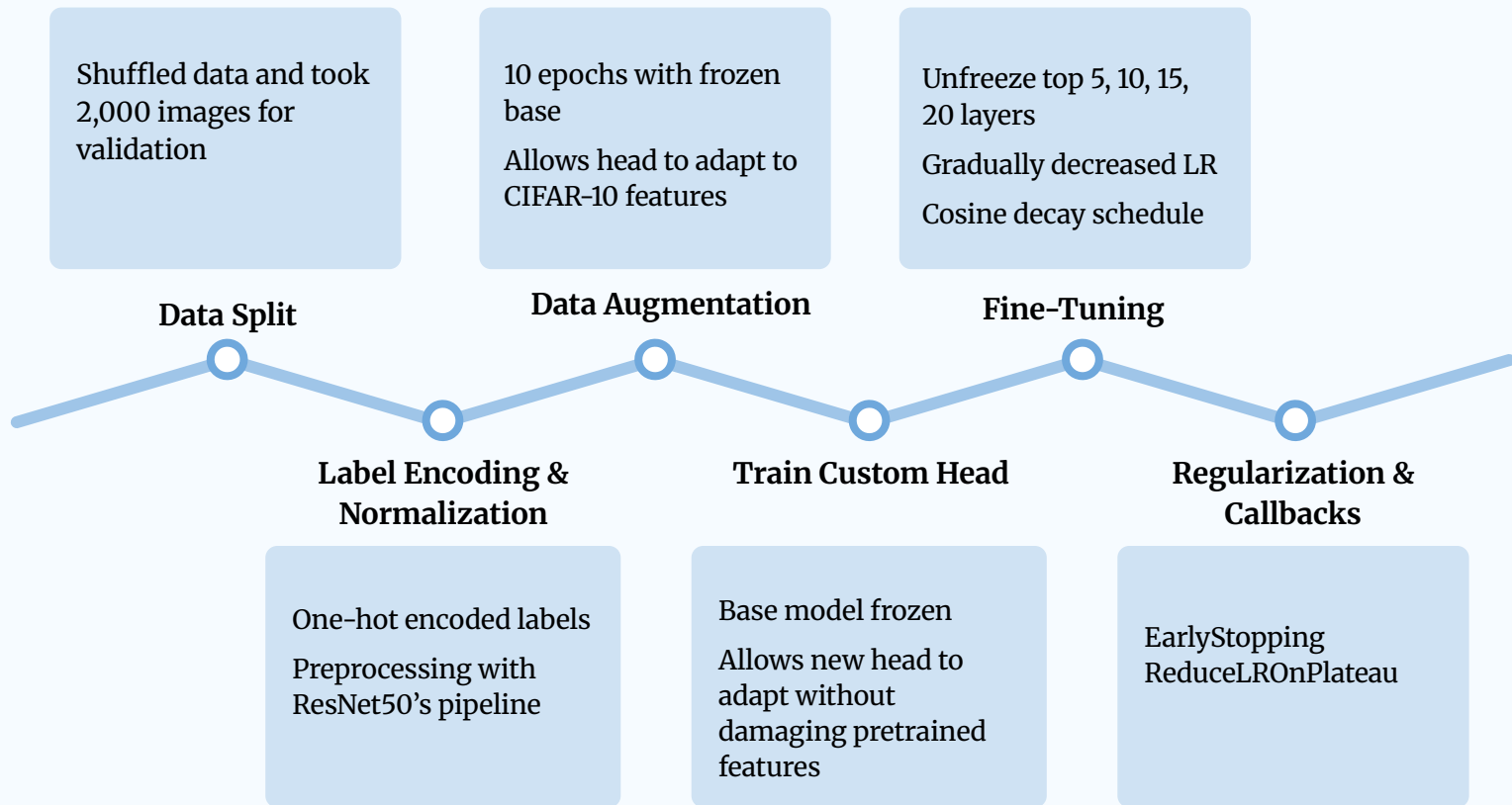- ResNet50 pre-trained on ImageNet
- Input resized to 32x32

Custom classification head:

- Dense layers with ReLU
- BatchNormalization
- Dropout for regularization
- Softmax for 10 classes

Label smoothing: Encourages generalization

Preprocessing & Training

Data Split

Shuffled data and took 2,000 images for validation

Data Augmentation

10 epochs with frozen base

Allows head to adapt to CIFAR-10 features

Fine-Tuning

Unfreeze top 5, 10, 15, 20 layers

Gradually decreased LR

Cosine decay schedule

Label Encoding & Normalization

One-hot encoded labels

Preprocessing with ResNet50's pipeline

Train Custom Head

Base model frozen

Allows new head to adapt without damaging pretrained features

Regularization & Callbacks

EarlyStopping
ReduceLROnPlateau

Model Evaluation & Deployment
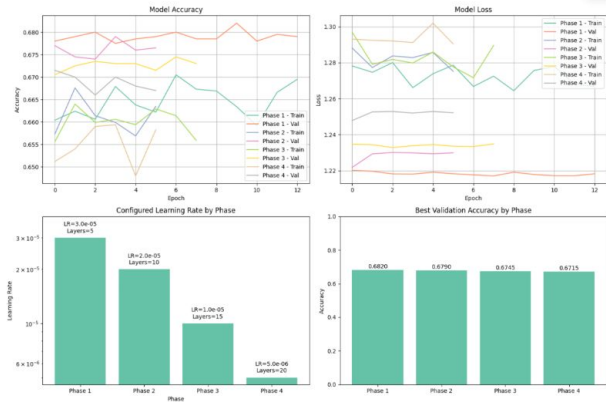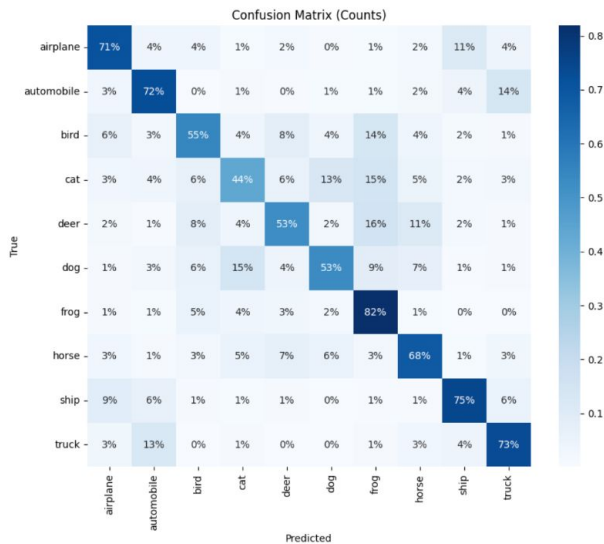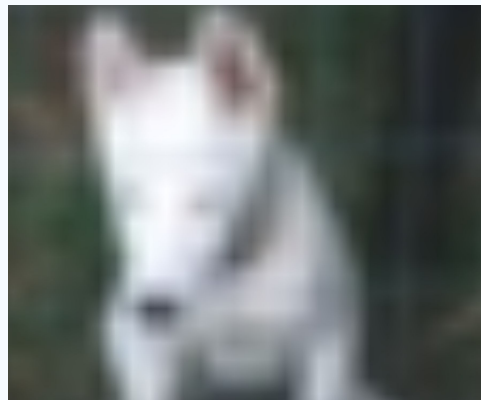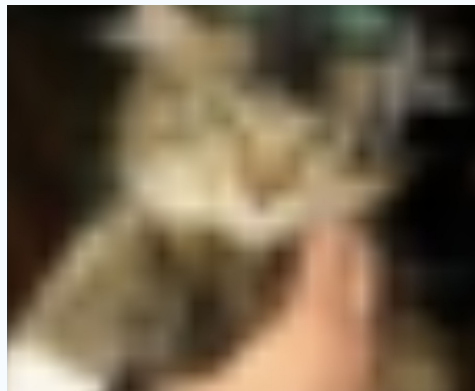
Challenges

Small Training Set (10K)

Low Resolution (32x32 – ResNet50 expects 224x224)

Confusing Classes: Cats, dogs, birds look similar

Longer Training Times: Hyperparameter tuning needed patience

Learning Rate Scheduling:

- Needed careful adjustment to avoid divergence
- Smaller rates required for deeper unfreezing

Conclusion

✅ Transfer learning works even with limited data

✅ Layer-wise unfreezing + tuned learning rates

✅ Visualization crucial for diagnosing training

✅ Data augmentation essential for small datasets

Analytics Dashboard

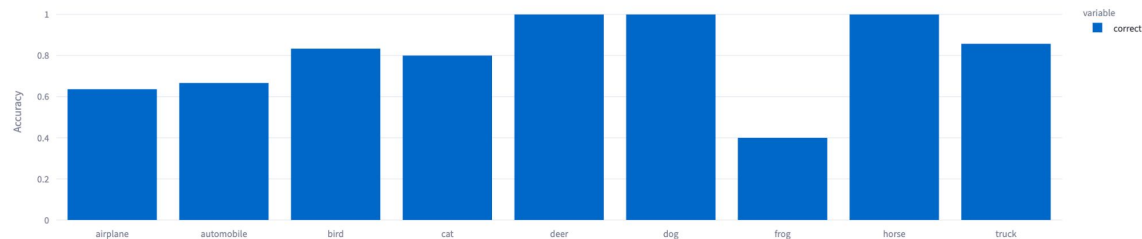**Overview Metrics**

Total Feedback	Accuracy	Avg Confidence	Unique Sessions
53	75.0%	62.1%	1

Accuracy by Class

Prediction Accuracy by Class (CIFAR Samples)

Thank You for your attention!

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