Image Classification using CNN and Transfer Learning

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Problem & Dataset

Introduction to the dataset and strategies

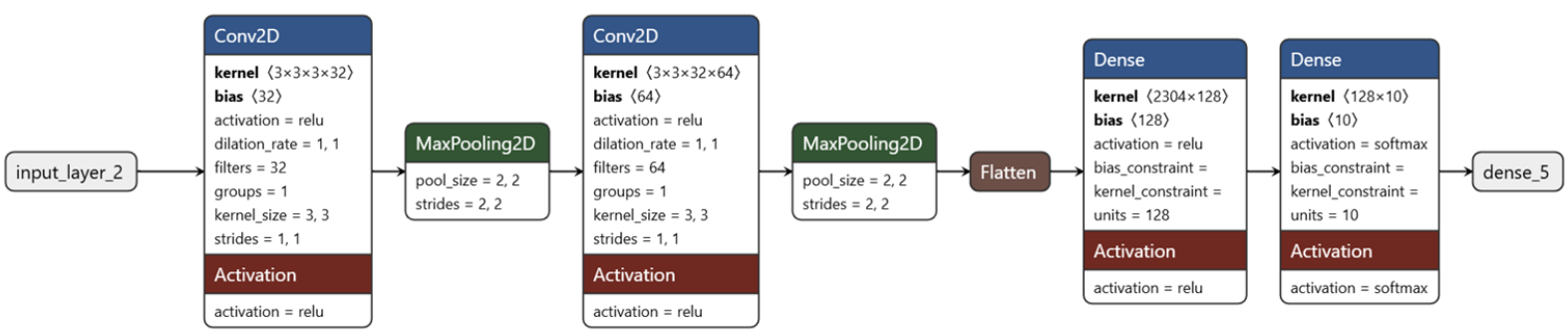
Introduction

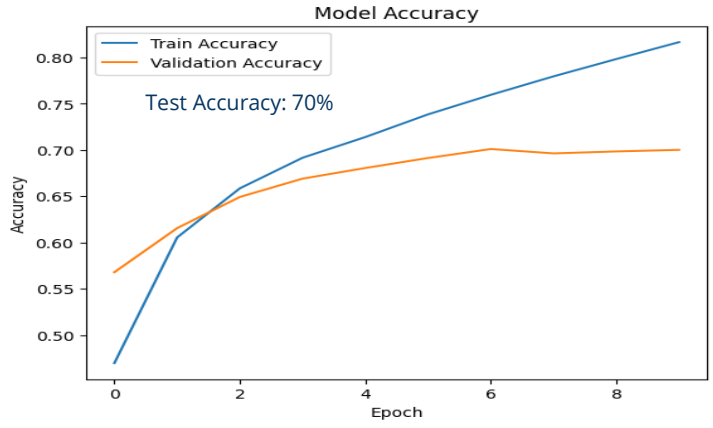
- Dataset - CIFAR-10
- Classes - 10 (airplane, car, bird, etc)
- Train/Test - 50000 / 10000
- Samples per class: Balanced (5000 per class)
- Image Size - 32 X 32 X 3

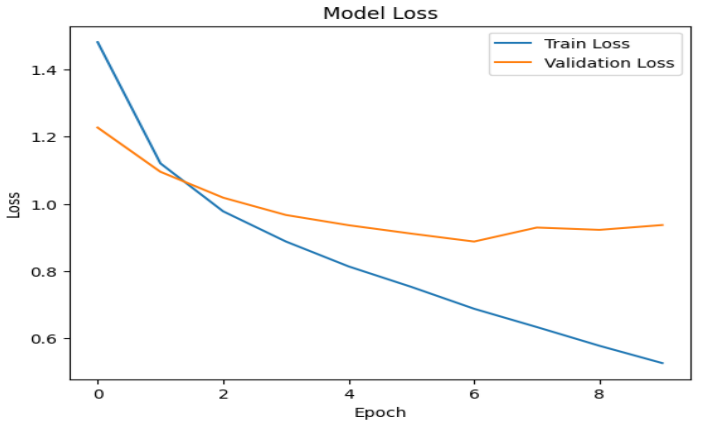
**** Small images, high noise – perfect for testing CNNs****

Baseline CNN Architecture

Baseline CNN: Simple but Limited

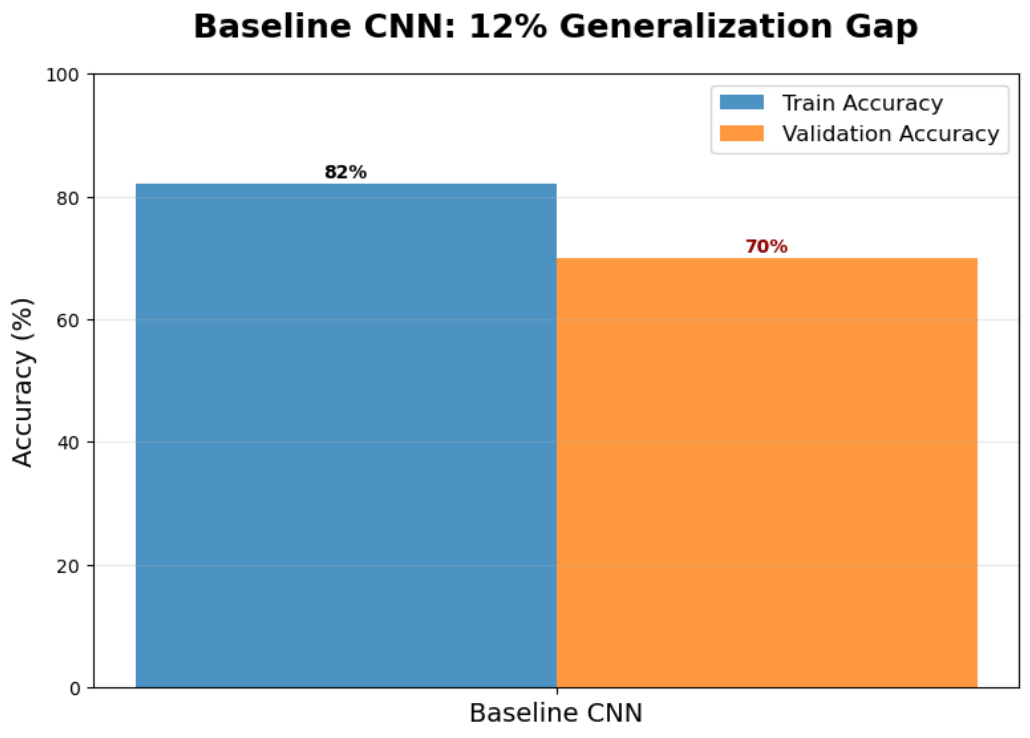






Simple 2-block CNN achieves 82% training accuracy but only 70% validation → 12% overfitting gap → Need better regularization & architecture

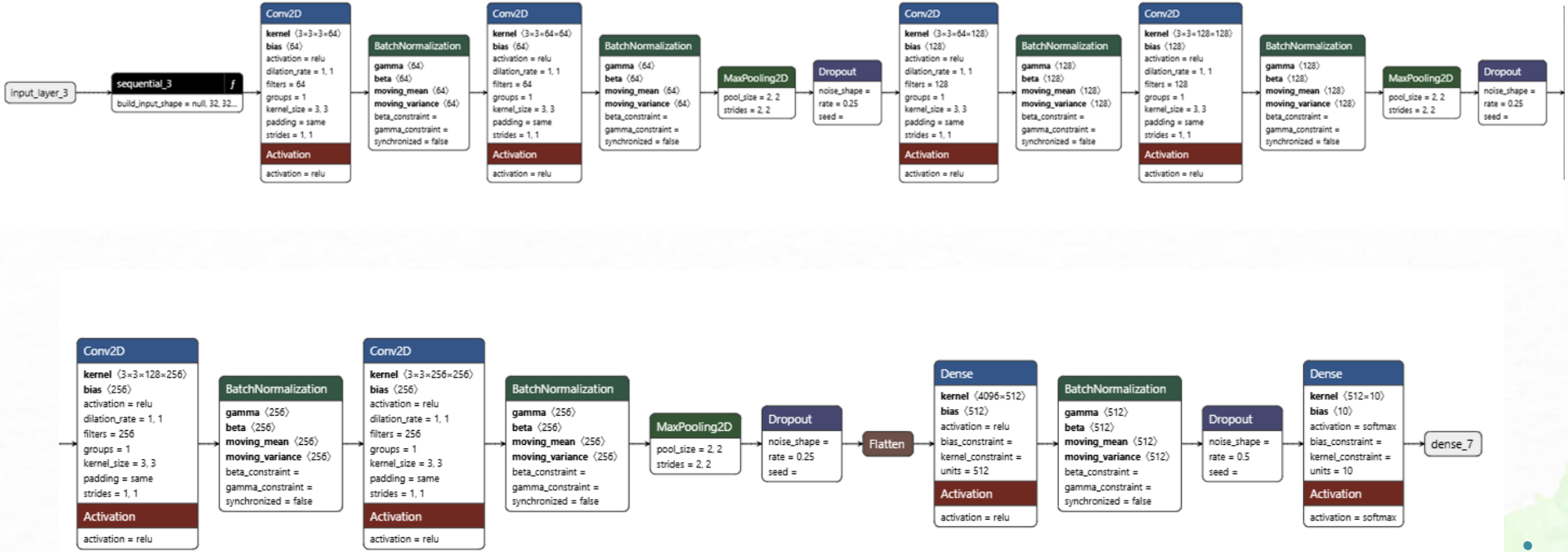
Why We Need Better Models



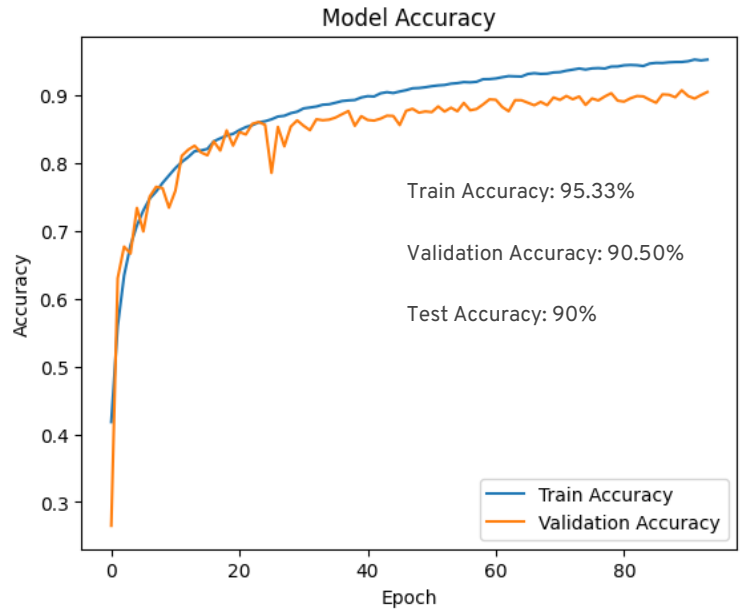
Clear overfitting → motivates move to optimized CNN & transfer learning

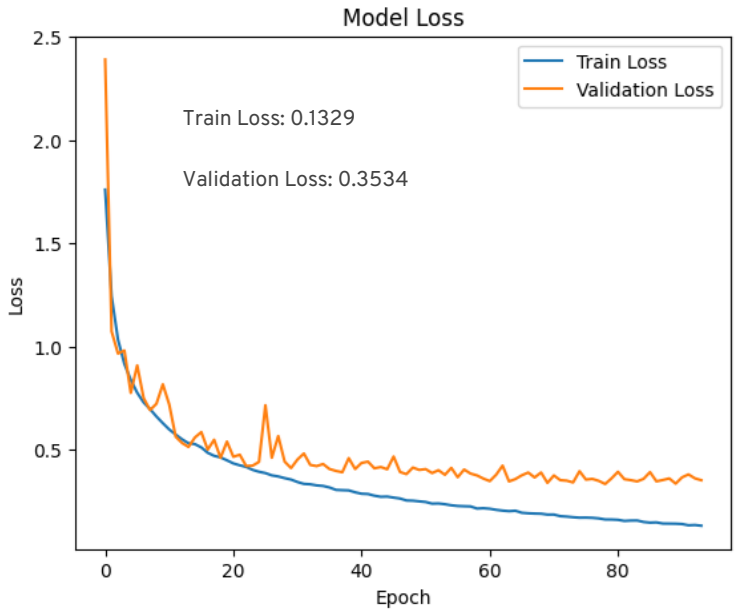
Optimized CNN Architecture

Optimized CNN: Deeper Architecture



Optimized CNN: Deeper Architecture

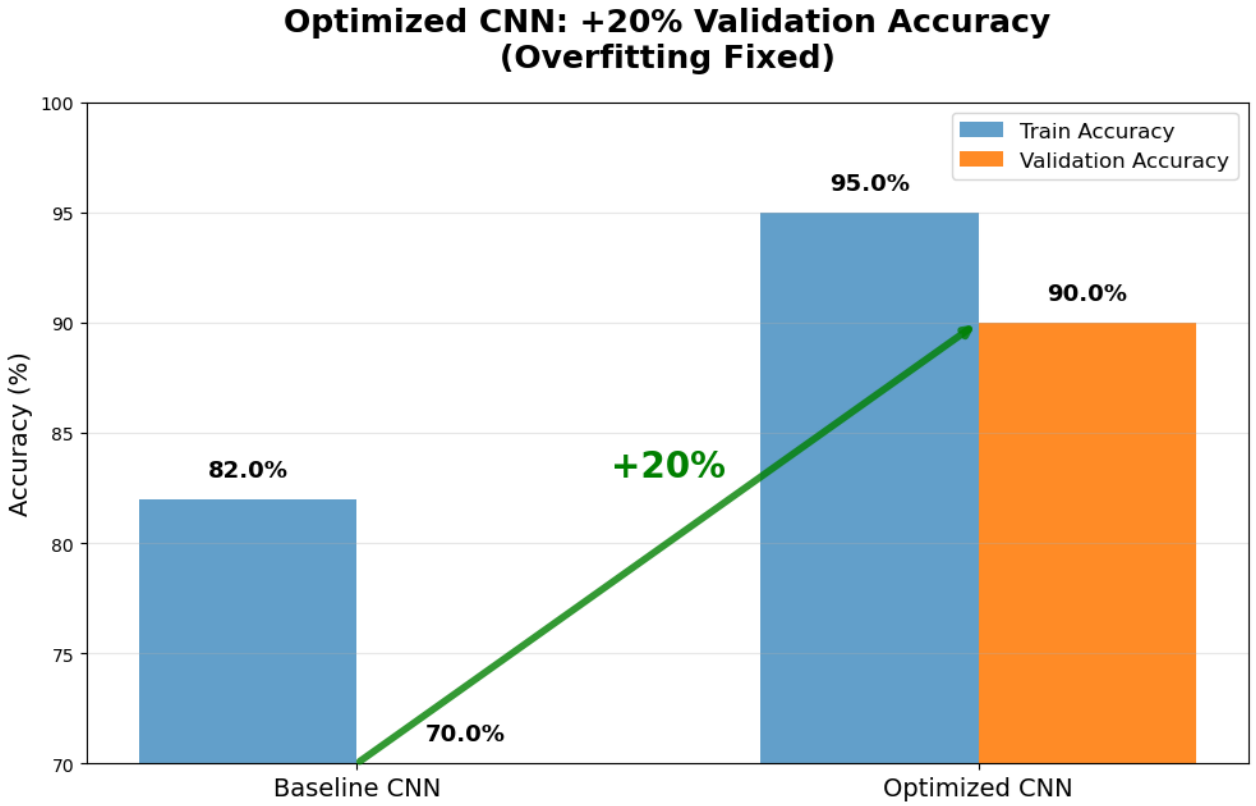




From 2 conv blocks → 6 conv blocks with BatchNorm, Dropout(0.25), Data Augmentation & LR scheduling

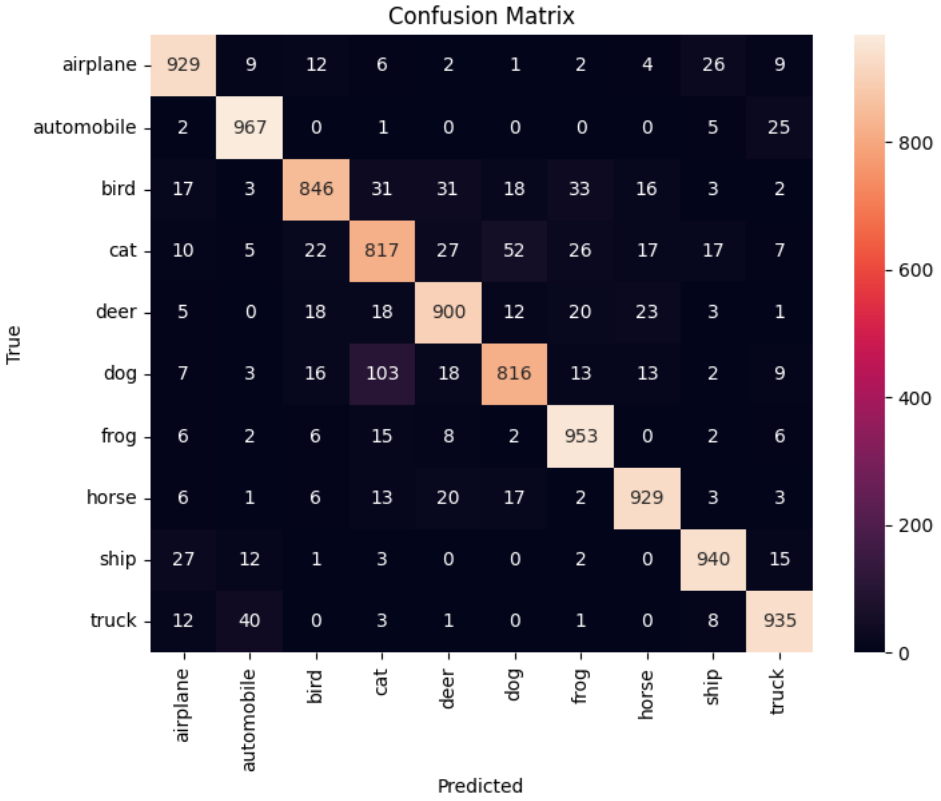
→ Validation accuracy: 70.0% → 90% (+20% absolute gain)

Optimized CNN vs Baseline: +20% Validation Accuracy



Optimized CNN Confusion Matrix

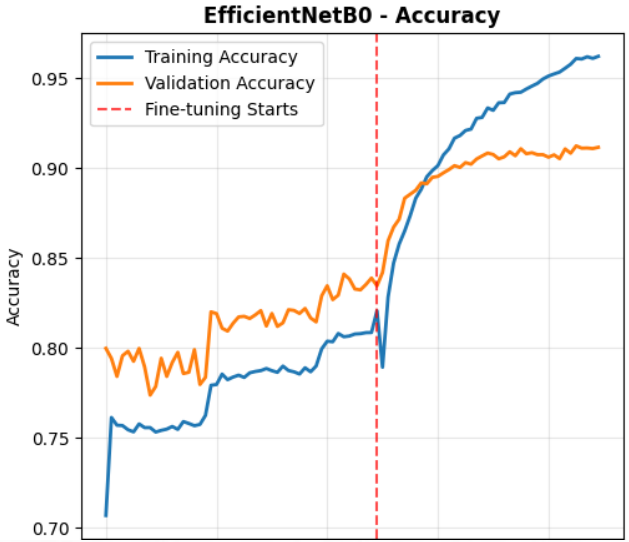
	precision	recall	f1-score	support
airplane	0.91	0.93	0.92	1000
automobile	0.93	0.97	0.95	1000
bird	0.91	0.85	0.88	1000
cat	0.81	0.82	0.81	1000
deer	0.89	0.90	0.90	1000
dog	0.89	0.82	0.85	1000
frog	0.91	0.95	0.93	1000
horse	0.93	0.93	0.93	1000
ship	0.93	0.94	0.94	1000
truck	0.92	0.94	0.93	1000
accuracy			0.90	10000
macro avg	0.90	0.90	0.90	10000
weighted avg	0.90	0.90	0.90	10000

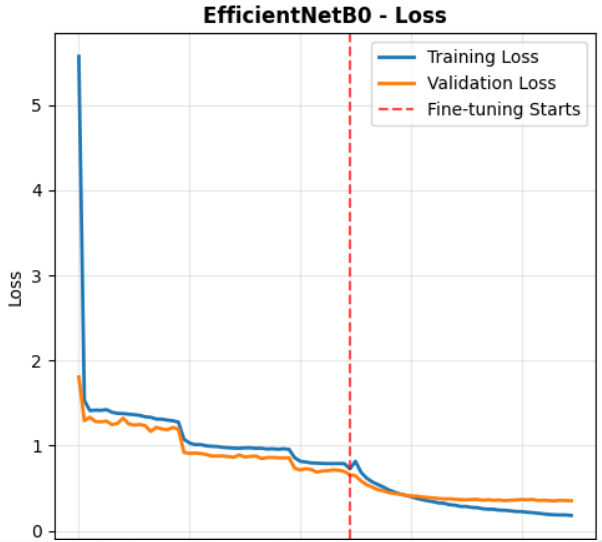


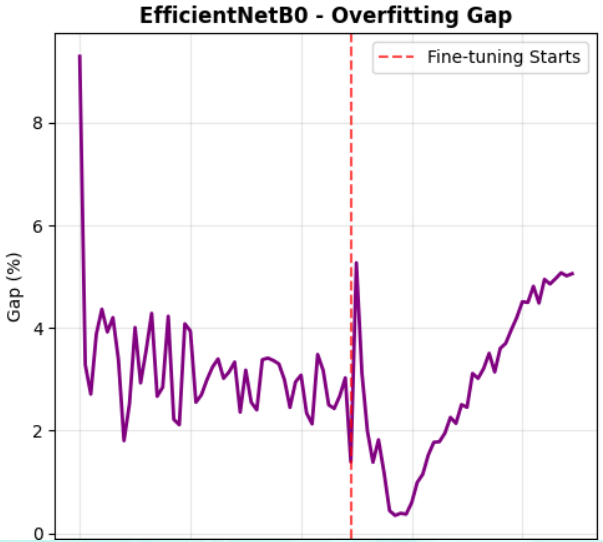
Transfer Learning

Transfer Learning: Two-Phase Fine-Tuning

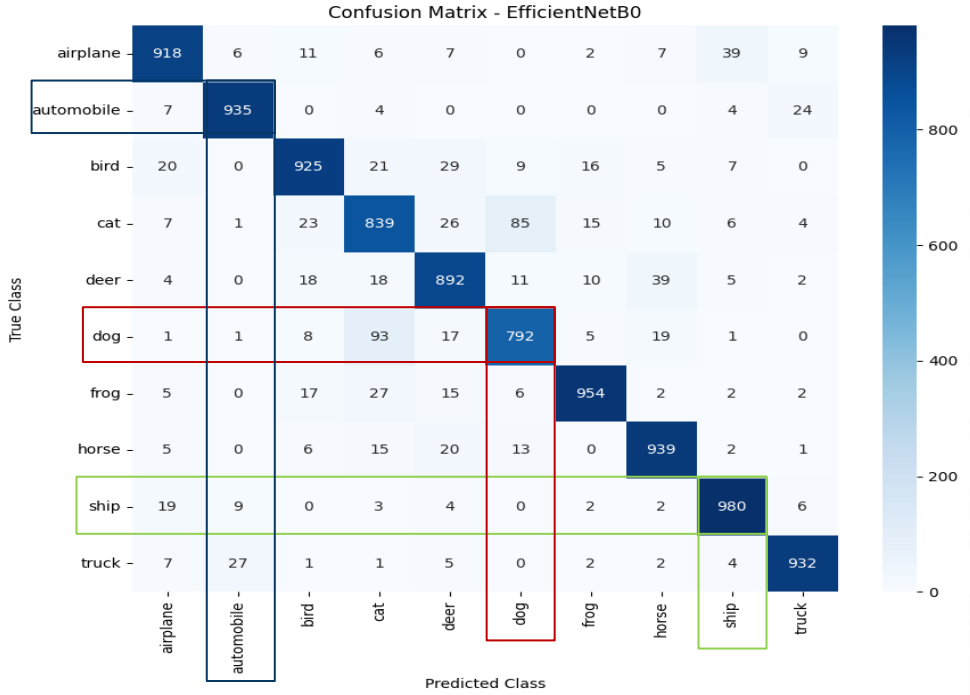
- Used EfficientNetB0 with partial layer unfreezing.
- Two-phase training with lower LR in fine-tuning.
- Achieved ~96% accuracy, ~93%validation accuracy.
- Fine-tuning improved feature learning and performance.





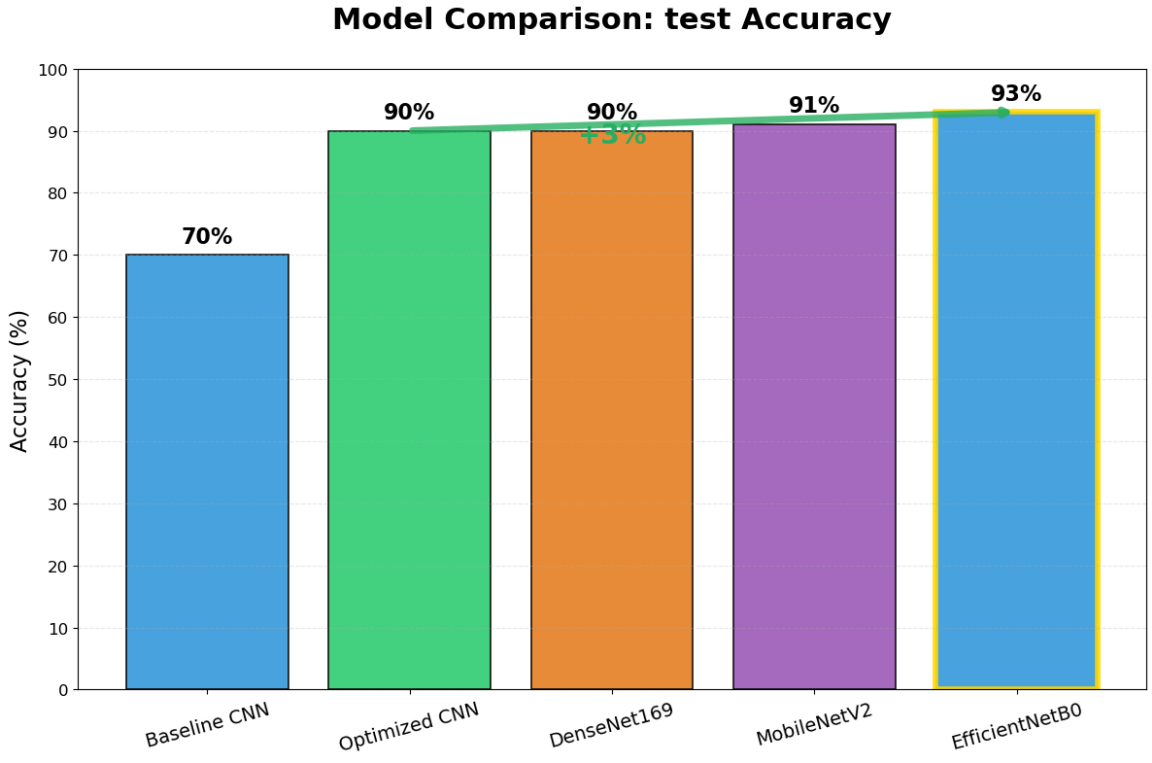


Transfer Learning: Confusion Matrix



- 918 airplanes correctly identified as airplanes
- 935 automobiles correctly identified as automobiles
- 980 ships correctly identified as ships (highest accuracy - marked in green)
- 792 dogs correctly identified as dogs (lowest accuracy - marked in red)

Model comparison & conclusion



Challenges & Limitations

- Overfitting on small datasets
- Low accuracy, weak features
- Training instability issues
- Data hungry, needs large datasets
- High computational cost
- Limited generalization across domains

Thank you!