Traffic sign recognition using CNN

TraffiKING

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Motivation

- why traffic sign detection?
- domain change testing
- state-of-the-art models vs custom built model

Content

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2. Convolutional neural networks
3. TraffiKING
4. State-of-the-art models
5. Traffic sign detection
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Computer vision

- enables computers to understand visual information from the world
- autonomous vehicles, medical diagnostics, security systems
- image classification, object detection, image segmentation, pattern recognition

Convolutional neural networks (CNN)

- deep neural networks designed to process images
- convolutional layers, pooling layers, fully connected layer

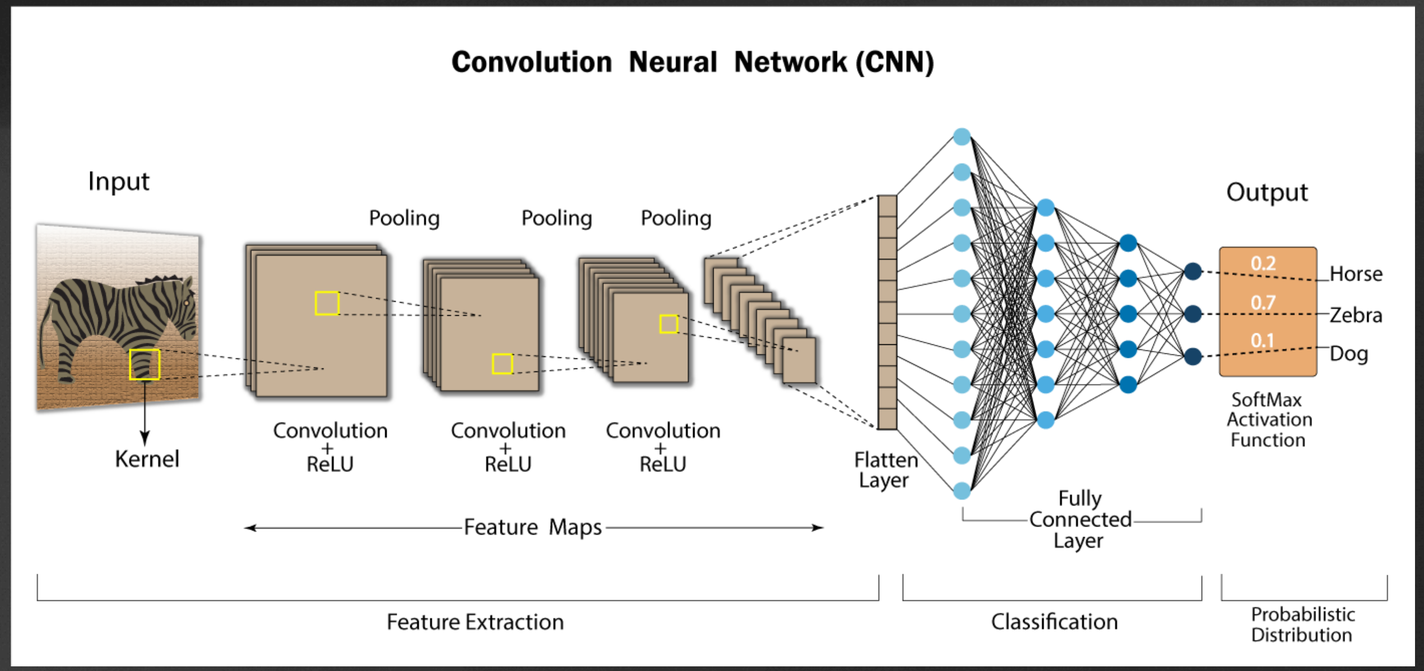


Image 1 - Convolutional neural network [1]

TraffiKING

- custom model
- BatchNorm -> ReLU -> Convolution
- 64×64×3 input
- 43×1 output

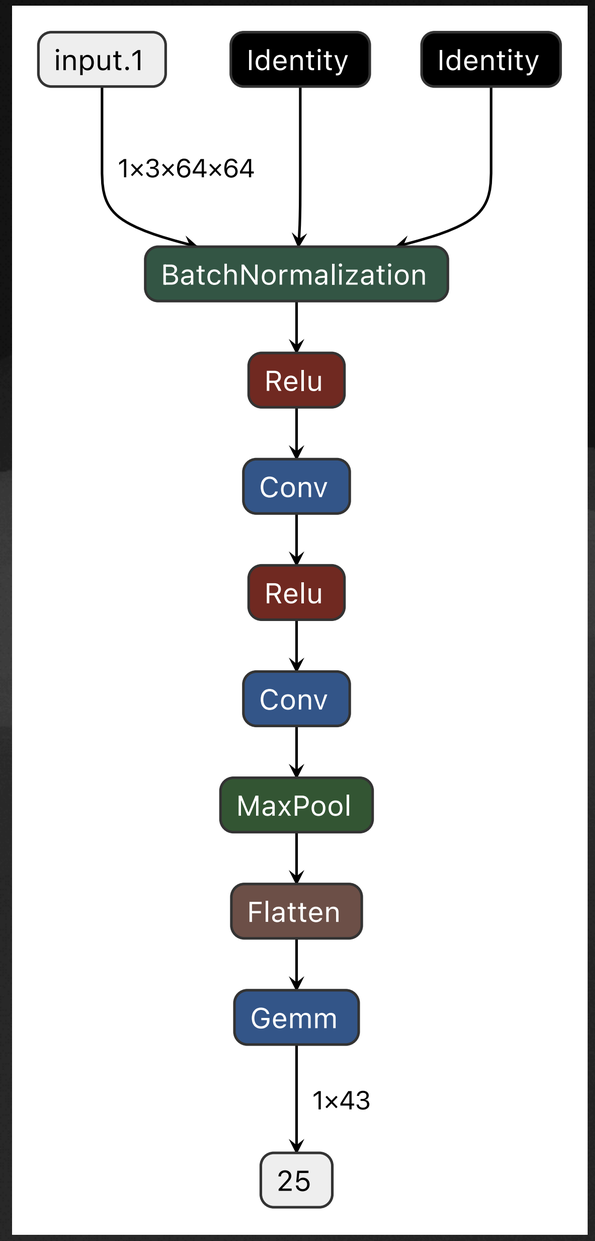


Image 2 - Custom TraffiKING model architecture

State-of-the-art models

ResNet-18

- residual blocks (bottleneck)
- skip connections
- downsampling

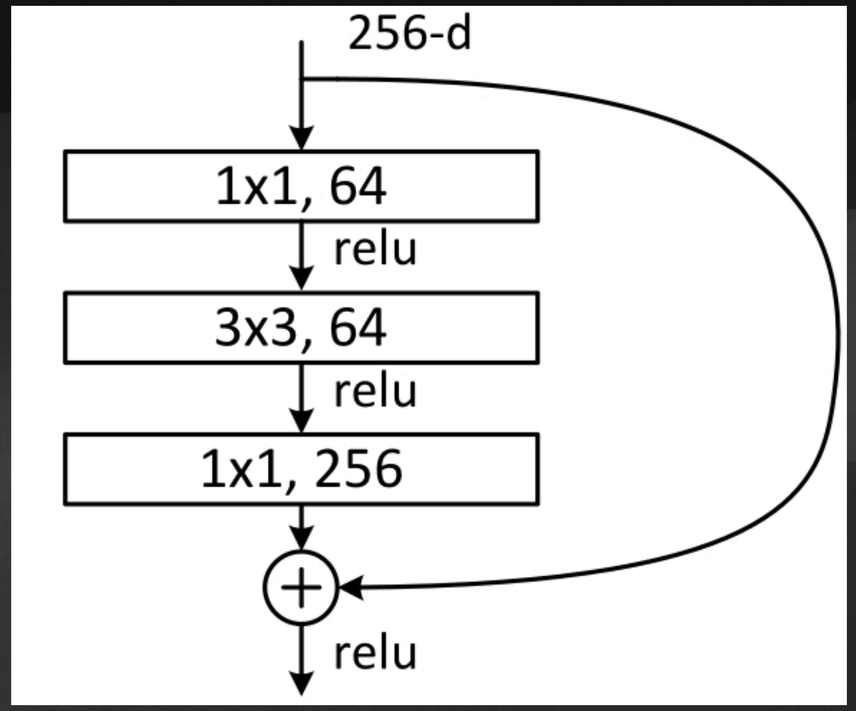


Image 3 - ResNet residual block [2]

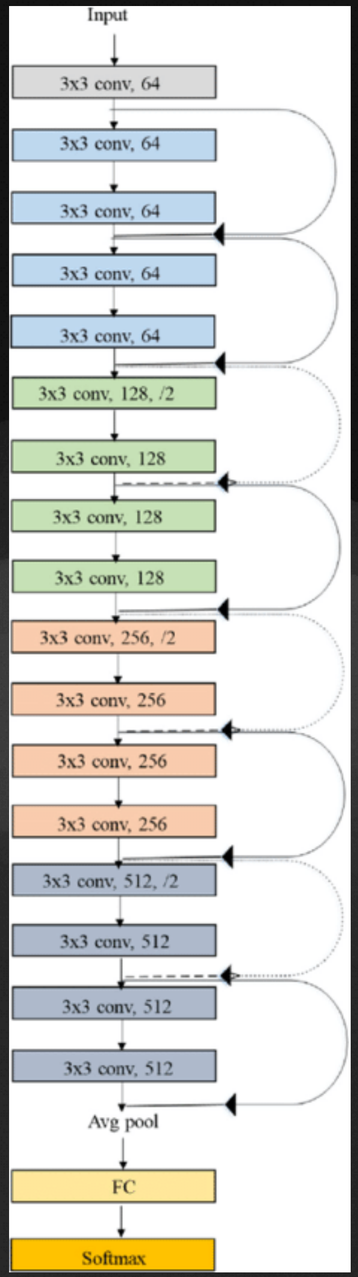


Image 4 - ResNet18 structure

EfficientNet-B0

- model scaling - width, depth, resolution scaling

$$\text{depth} \propto \alpha^{\phi}, \quad \text{width} \propto \beta^{\phi}, \quad \text{resolution} \propto \gamma^{\phi}$$

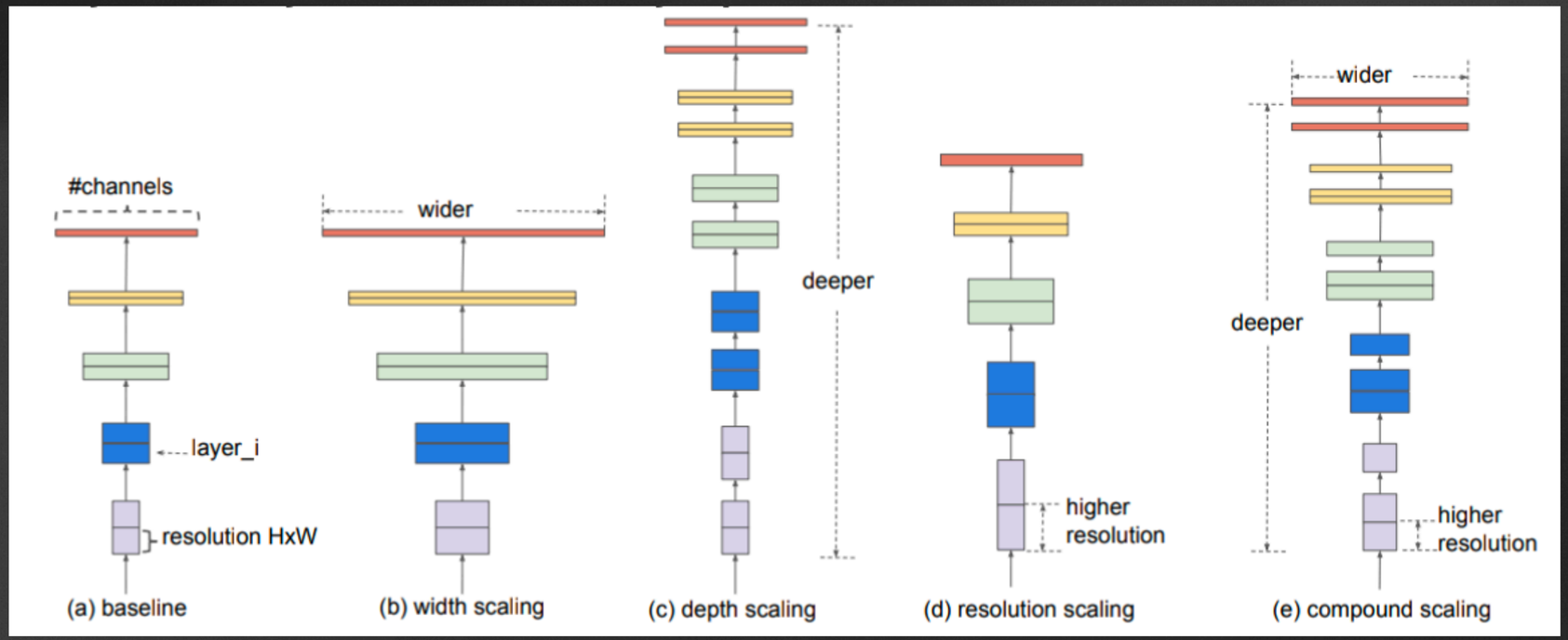


Image 5 - EfficientNet-B0 scaling [tan19icml]

MobileNetV2

- efficient architecture
- inverted residuals
- optimized for mobile devices

MobileNetV2

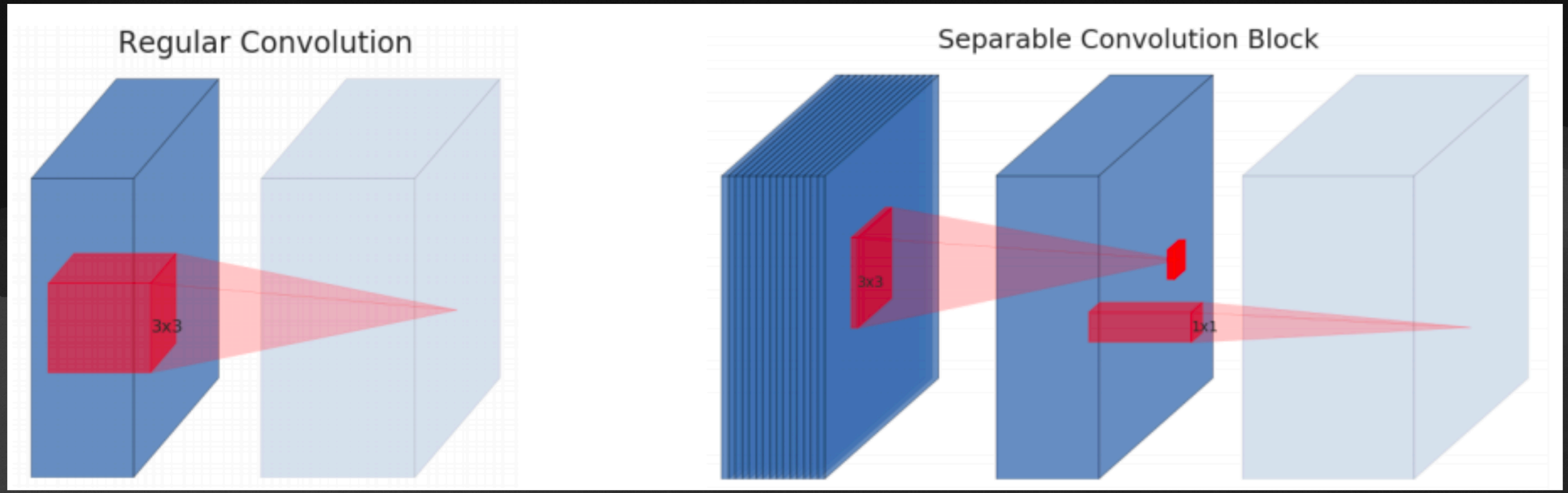


Image 6 - Regular convolution VS Separable Convolution block (MobileNet architecture) [sandler18cvpr]

DenseNet121

- dense connections
- improved gradient flow
- efficient use of parameters

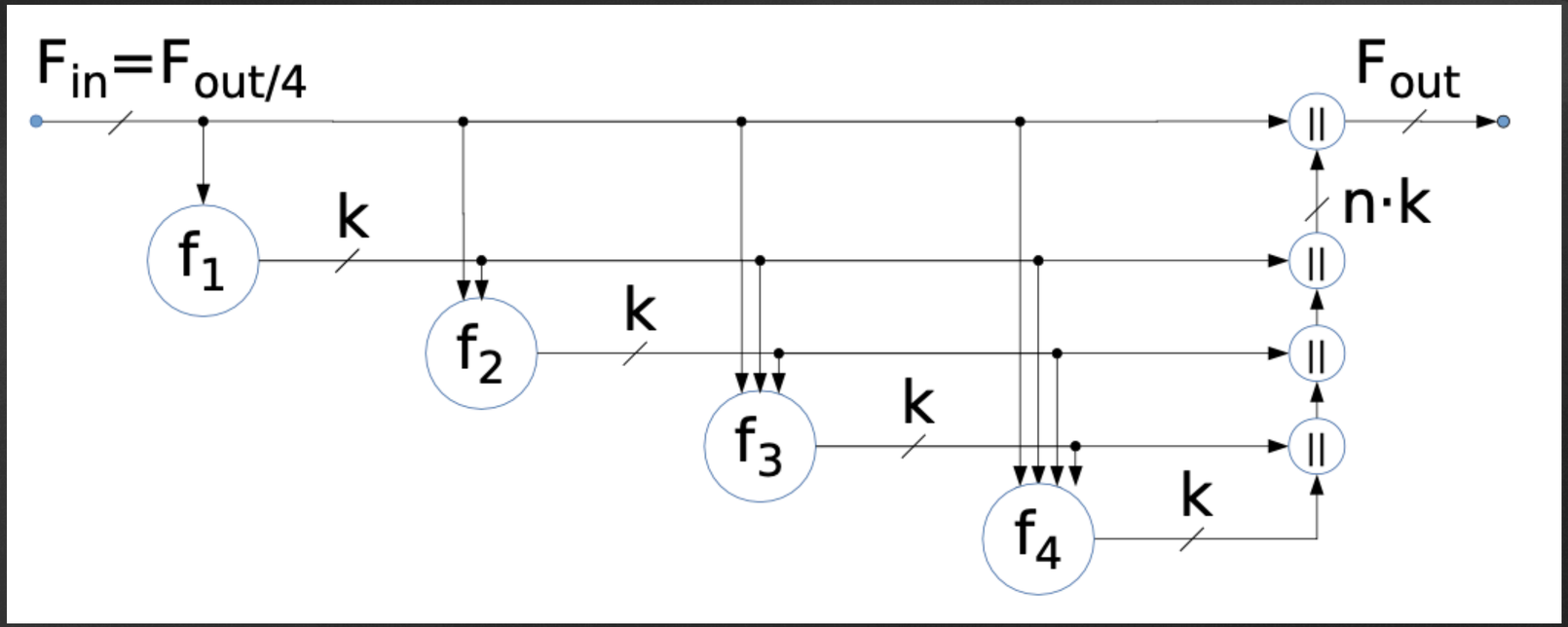


Image 7 - DenseNet architectural idea

Traffic sign detection

German Traffic Signs (GTSRB)

- single-image, multiclass classification problem
- 43 classes
- more than 50,000 images in total

German Traffic Signs (GTSRB)

Image 8 - GTSRB dataset visualisation [5]

Domain change

Traffic signs - 1 million image dataset

- same number of classes as the inital dataset
- different image parameters, diferent preprocessing

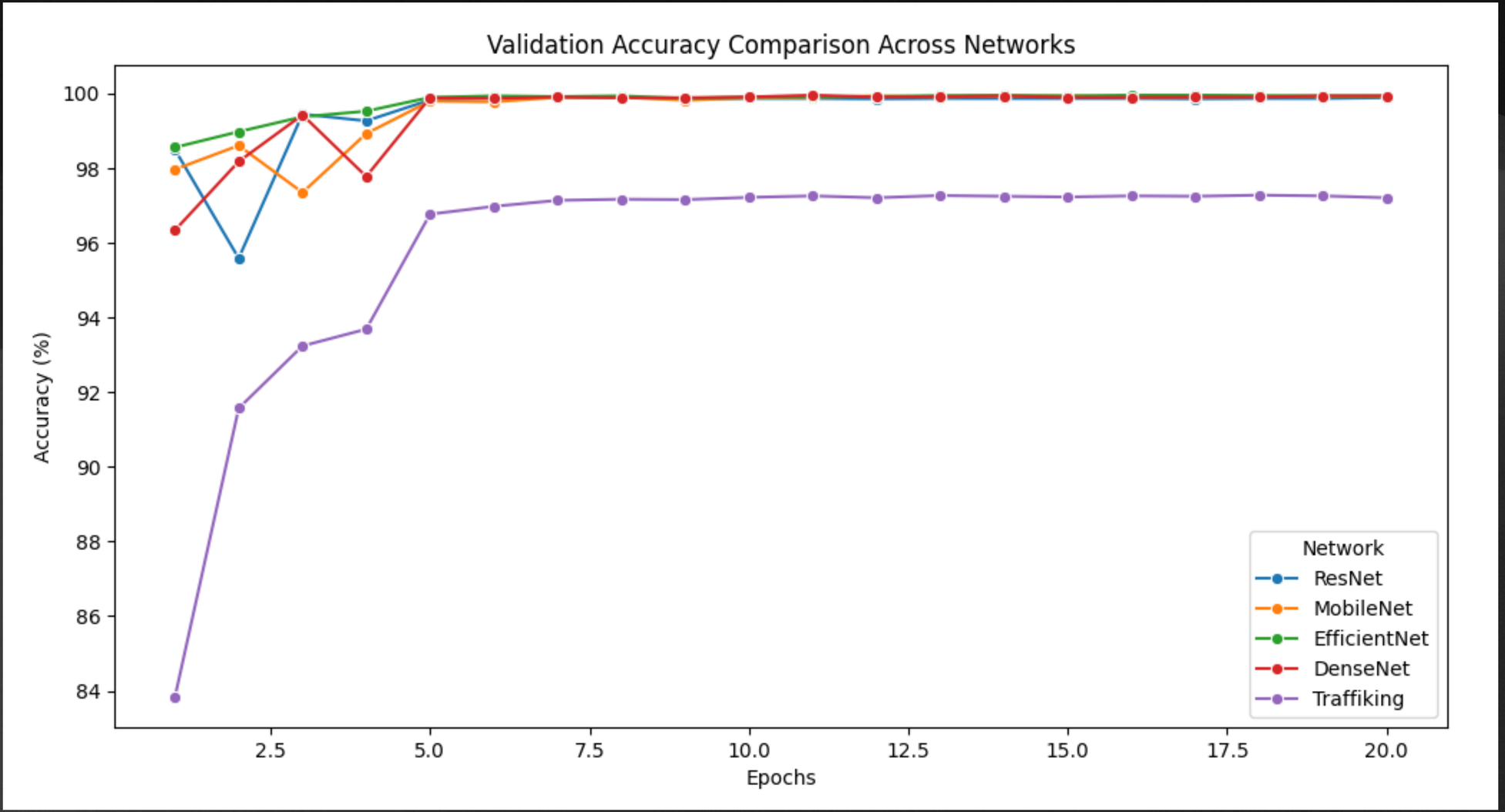
Traffic signs - 1 million image dataset

Image 9 - 1 million traffic signs images dataset visualisation [6]

Experiments

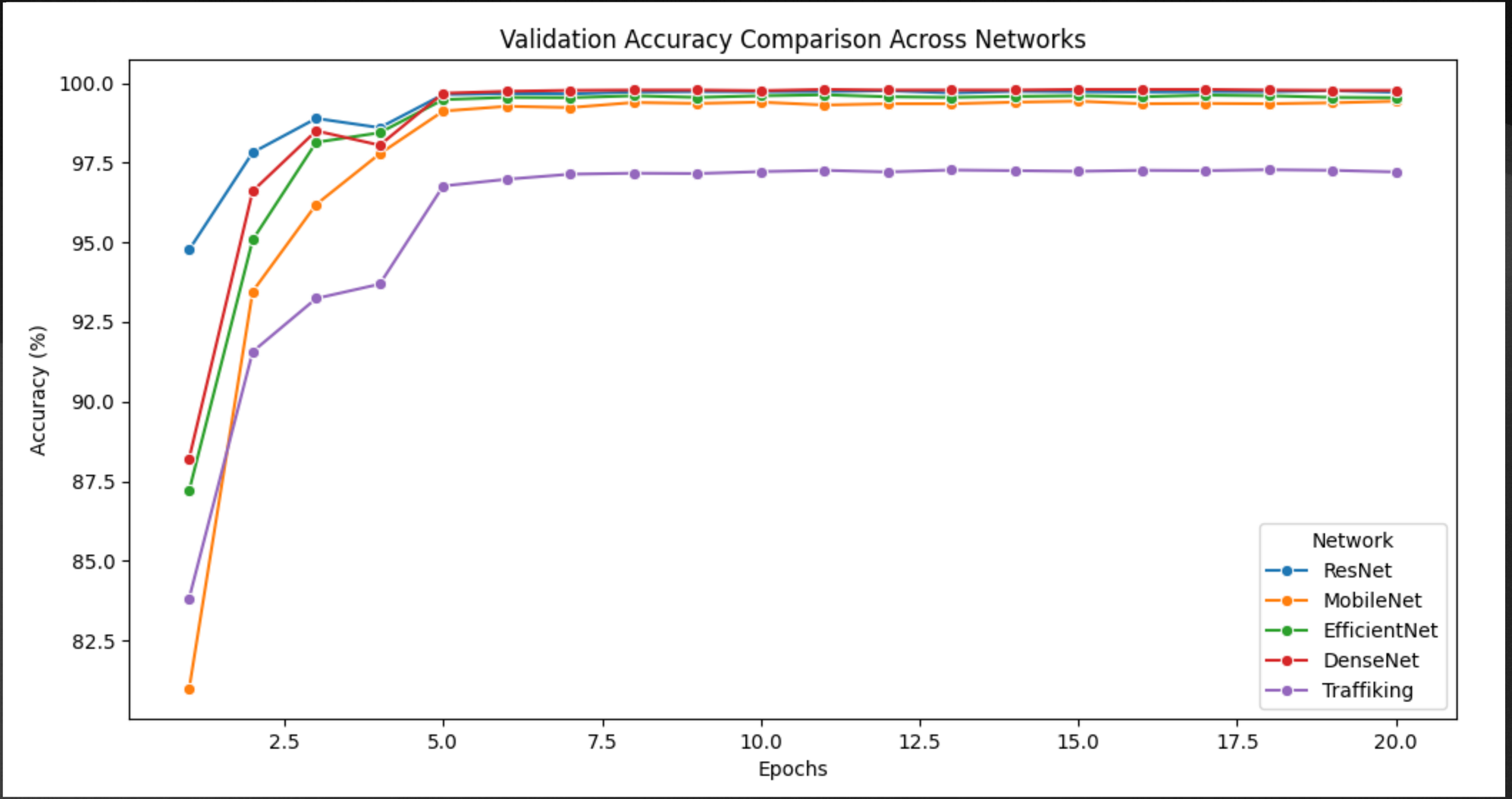
Accuracy metric progression through the learning epochs

- pretrained models (*ImageNet* [6])



Accuracy metric progression through the learning epochs

- random initialized models



Domain change test results

- used randomly initialized models

Conclusion

- significance of traffic sign detection
- domain change problems

THANK YOU!

References

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[2] Josip Šarić, Anja Delić, Ivan Martinović, Marin Kačan, Marin Oršić, Ivan Sabolić, Iva Sović, Siniša Šegvić - 3. laboratorijska vježba iz Računalnog vida

[3] A Deep Learning Approach for Automated Diagnosis and Multi-Class Classification of Alzheimer's Disease Stages Using Resting-State fMRI and Residual Neural Networks - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Original-ResNet-18-Architecture_fig1_336642248 [accessed 16 Jan 2025]

[4] https://www.kaggle.com/datasets/meowmeowmeowmeowmeow/gtsrb-german-traffic-sign

[5] https://www.kaggle.com/datasets/valentynsichkar/traffic-signs-1-million-images-for-classification

[6] Deng, J., Dong, W., Socher, R., Li, L.-J., Li, K., & Fei-Fei, L. (2009). Imagenet: A large-scale hierarchical image database. In 2009 IEEE conference on computer vision and pattern recognition (pp. 248–255).