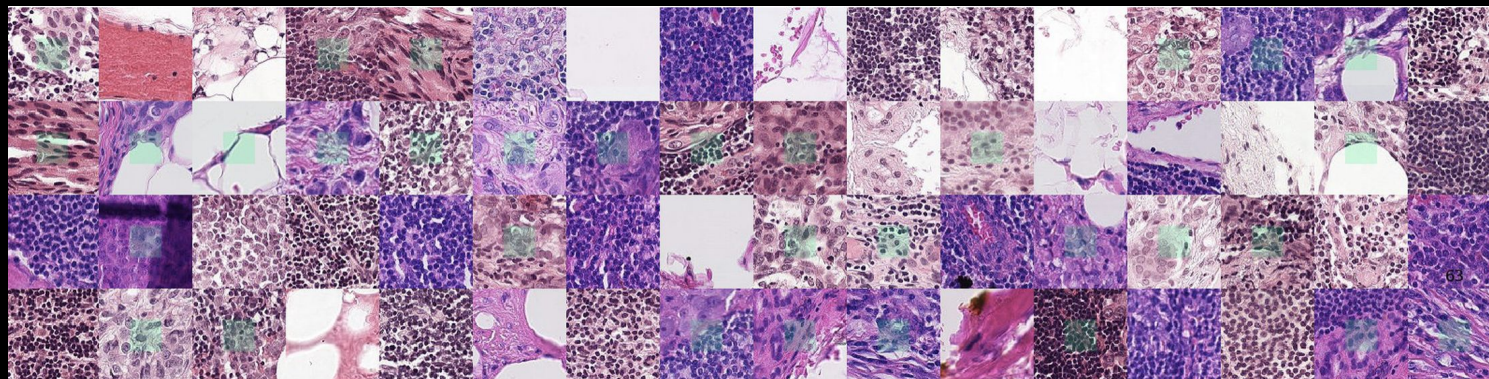Joakim Stoor

Classification of images from histopathologic scans of lymph node sections

The PatchCamelyon dataset

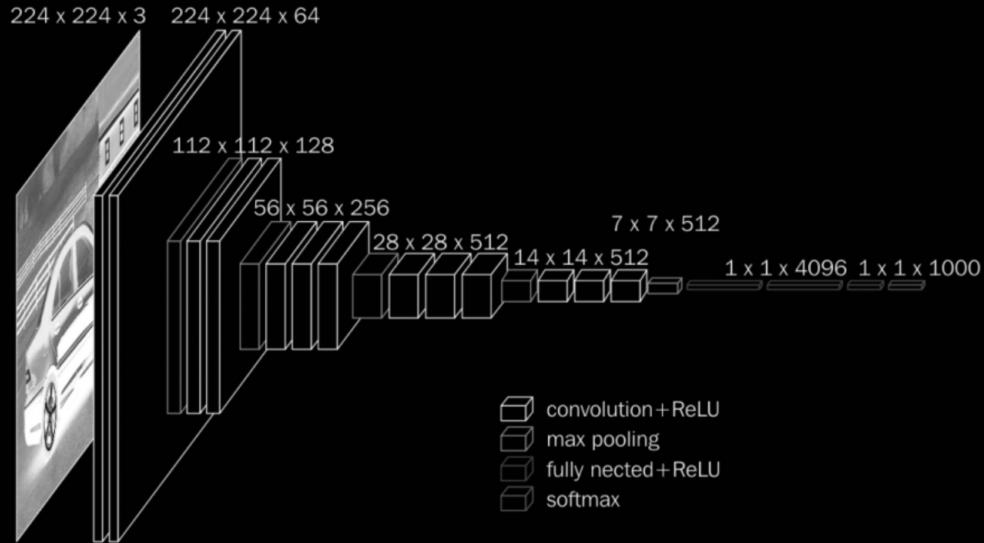- 327.680 color images (96 * 96 * 3)
- Division into training, validation and test datasets
- All sets are class balanced
- Each image is annotated with a binary label
- Positive label indicates that center 32 * 32 region of the patch contains metastatic tissue

Comparative study:
Analysis of different network architectures

VGG 16
ResNet50
DenseNet121
Ensemble learner

VGG 16

224 x 224 x 3
224 x 224 x 64
112 x 112 x 128
56 x 56 x 256
28 x 28 x 512
14 x 14 x 512
7 x 7 x 512
1 x 1 x 4096 1 x 1 x 1000

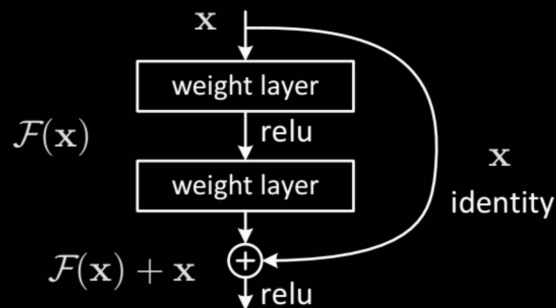convolution+ReLU
max pooling
fully nected+ReLU
softmax

- base: 16
- MLP : {256, 256, 1}
- ReLu
- sigmoid
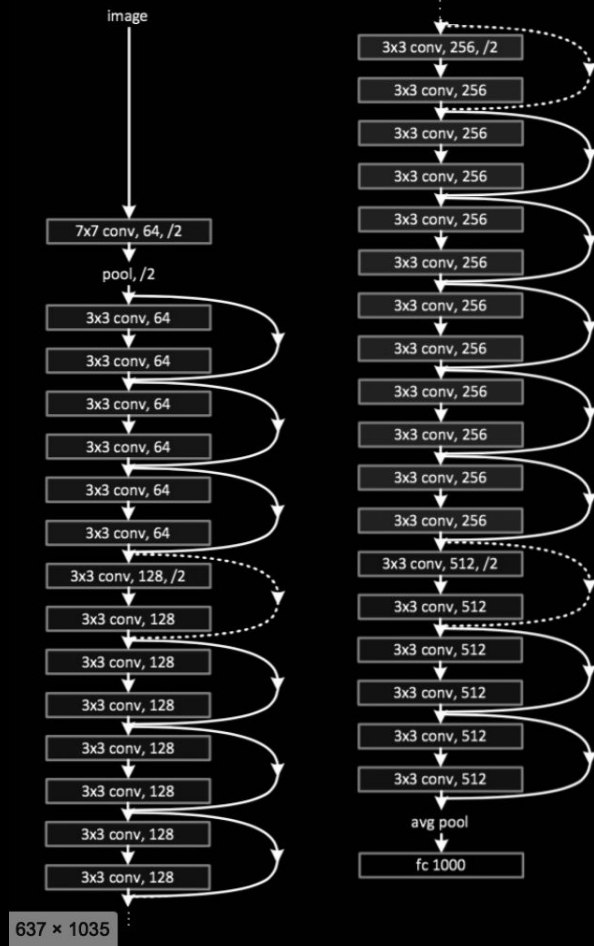- batchnorm: CNN part
- dropout for MLP part

Resnet 50

- base: 16
- Blocks: {3, 4, 6, 3}
- ReLu
- sigmoid
- batchnorm: CNN part
- 5*5 conv + 3*3 stride initially

- Global average
  pooling
- No MLP!

Residual block:

34-layer residual

image

7x7 conv, 64, /2

pool, /2

3x3 conv, 64
3x3 conv, 64
3x3 conv, 64
3x3 conv, 64
3x3 conv, 64
3x3 conv, 64

3x3 conv, 128, /2
3x3 conv, 128
3x3 conv, 128
3x3 conv, 128
3x3 conv, 128
3x3 conv, 128
3x3 conv, 128
3x3 conv, 128

3x3 conv, 256, /2
3x3 conv, 256
3x3 conv, 256
3x3 conv, 256
3x3 conv, 256
3x3 conv, 256
3x3 conv, 256
3x3 conv, 256
3x3 conv, 256
3x3 conv, 256
3x3 conv, 256
3x3 conv, 256

3x3 conv, 512, /2
3x3 conv, 512
3x3 conv, 512
3x3 conv, 512
3x3 conv, 512
3x3 conv, 512

avg pool

fc 1000

637 × 1035

$$\mathbf{x}$$

weight layer

$$\text{relu}$$

weight layer

$$\mathcal{F}(\mathbf{x})$$

$$\mathbf{x}$$ identity

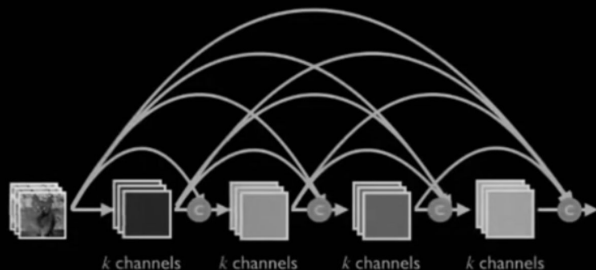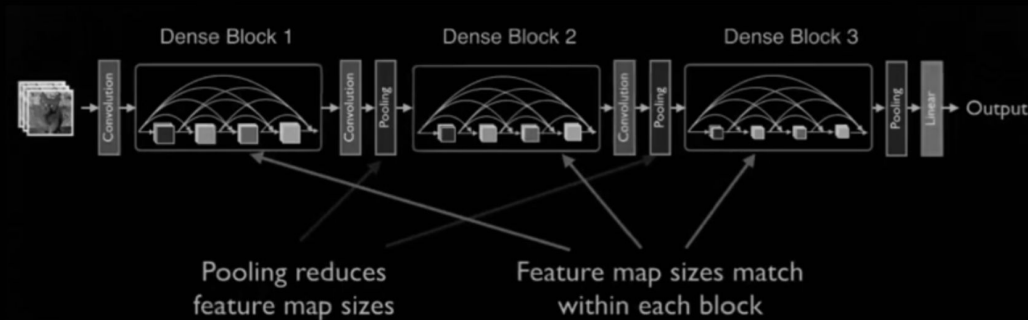$$\mathcal{F}(\mathbf{x}) + \mathbf{x}$$

$$\text{relu}$$

DenseNet 121

- base: 16
- growth_rate : 8
- Blocks: {6, 12 , 24, 16}
- Transition layer
- Bottleneck layer + conv layer
- 5*5 conv + 3*3 stride initially

- Global average pooling.
- No MLP!
- ReLu
- sigmoid
- batchnorm: CNN part

Block:

Network:

Pooling reduces feature map sizes

Feature map sizes match within each block

Training regimen

Data augmentation

- Horizontal flip
- Vertical flip
- Translation +- 4 pixels in both x- and y-axis

Metrics

- binary cross entropy
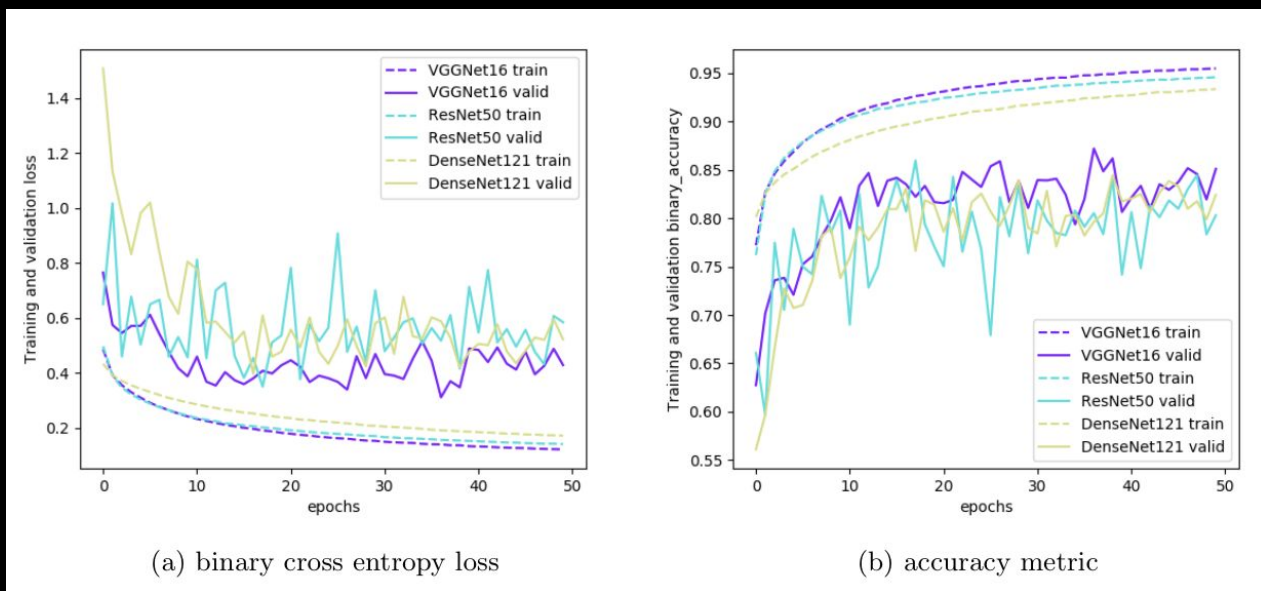- binary_accuracy
- precision
- sensitivity

Data handling

- Saved model with lowest validation loss
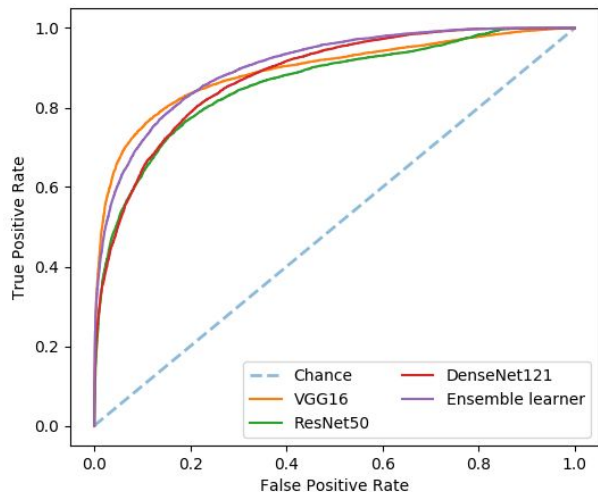- History to csv

Learning parameters

- Different learning rates
- 50 epoch of training/model

Findings: Learning curves

(a) binary cross entropy loss

(b) accuracy metric

Findings: evaluation on test data

ROC curve:

Test scores:

	accuracy	AUC	NLL	precision	sensitivity
VGG	81.5 (87.2)	89.2 (94.8)	.562 (.312)	61.9 (62.4)	45.7 (55.1)
ResNet	76.8 (86.0)	85.7 (93.4)	.706 (.350)	60.9 (61.8)	43.8 (56.9)
DenseNet	74.8 (83.1)	87.9 (93.4)	.680 (.397)	61.7 (62.7)	39.1 (50.6)
Ensemble	78.8 (88.0)	90.4 (95.4)	.495 (.289)	84.5 (85.6)	61.7 (76.8)

Table 1: Loss and metric scores for the networks on the PatchCamelyon test and validation datasets. The test scores are shown regularly and the validation scores are within parentheses. AUC is the area under curve measure and NLL is the negative log loss, i.e. the binary cross entropy loss.

Implementation - structure

Tensorflow + Keras
Images stored in
Hierarchical Data Format

- File system
- For teachers: If you
  want to run the code,
  the Results folder and
  its subfolders are
  created automatically

Implementation - execution

- *Generic network definitions*
- *Config. files (json)*
- *Argparsers*

```json
{
    "model" : "DenseNet",
    "modelparams" : {
        "base" : 16,
        "dense_blocks" : 4,
        "layers_per_block" : [6, 12 , 24, 16],
        "growth_rate" : 8,
        "dense_depth" : 5,
        "out_fnc": "sigmoid",
        "classes" : 1,
        "bottleneck" : true,
        "dropout_rate" : 0.5
    },
    "regimen" : {
        "lr" : 0.00001,
        "batch_size" : 16,
        "epochs" : 50,
        "loss" : "binary_crossentropy",
        "optimizer" : "Adam",
        "data_augmentation" : true,
        "metrics" : ["binary_accuracy", "precision", "sensitivity"]
    },
    "augmentation" : {
        "rotation_range" : 10,
        "width_shift_range" : 4,
        "height_shift_range" : 4,
        "horizontal_flip" : true,
        "vertical_flip" : true
    },
    "result" : {
        "history_file_name" : "DenseNet121.csv",
        "model_file_name" : "DenseNet121.h5"
    }
}
```

The end