Diagnosis of Pneumonia Based on X-rays of the Patient Using Machine Learning

Motivation

Artificial intelligence in medicine

- Faster processing of images
- More accurate diagnosis
- Automatization of chest X-Ray reading

Goal

Apply different AI models

- Achieve recognition of different pneumonia types
- Discuss their performance

Applied architectures

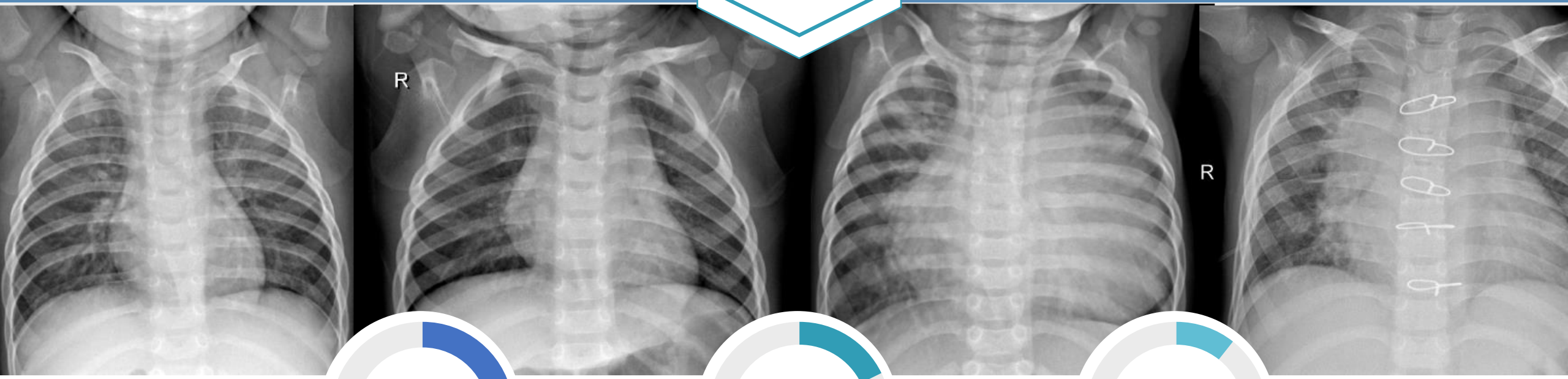
AlexNet	VGG	ResNet	DenseNet
5 convolutional layers	13 convolutional layers	20 convolutional layers	162 convolutional layers
Max and adaptive average pooling	Max and adaptive average pooling	Max and adaptive average pooling	Max and average pooling
ReLU	ReLU	ReLU	ReLU
95.19%	**94.71%**	**95.48%**	**97.12%**

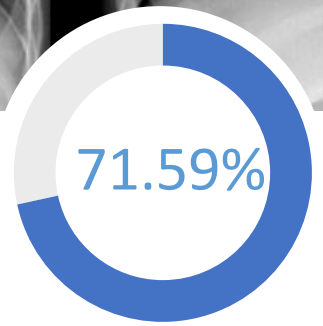
Strategies:

1. **Re-initialize all the weights**
2. **Use pre-trained weights**

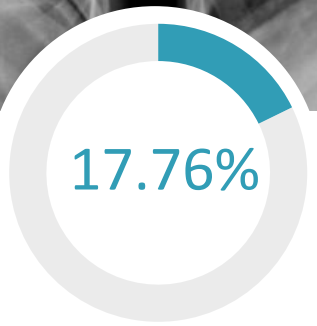
Healthy patients

Pneumonia patients





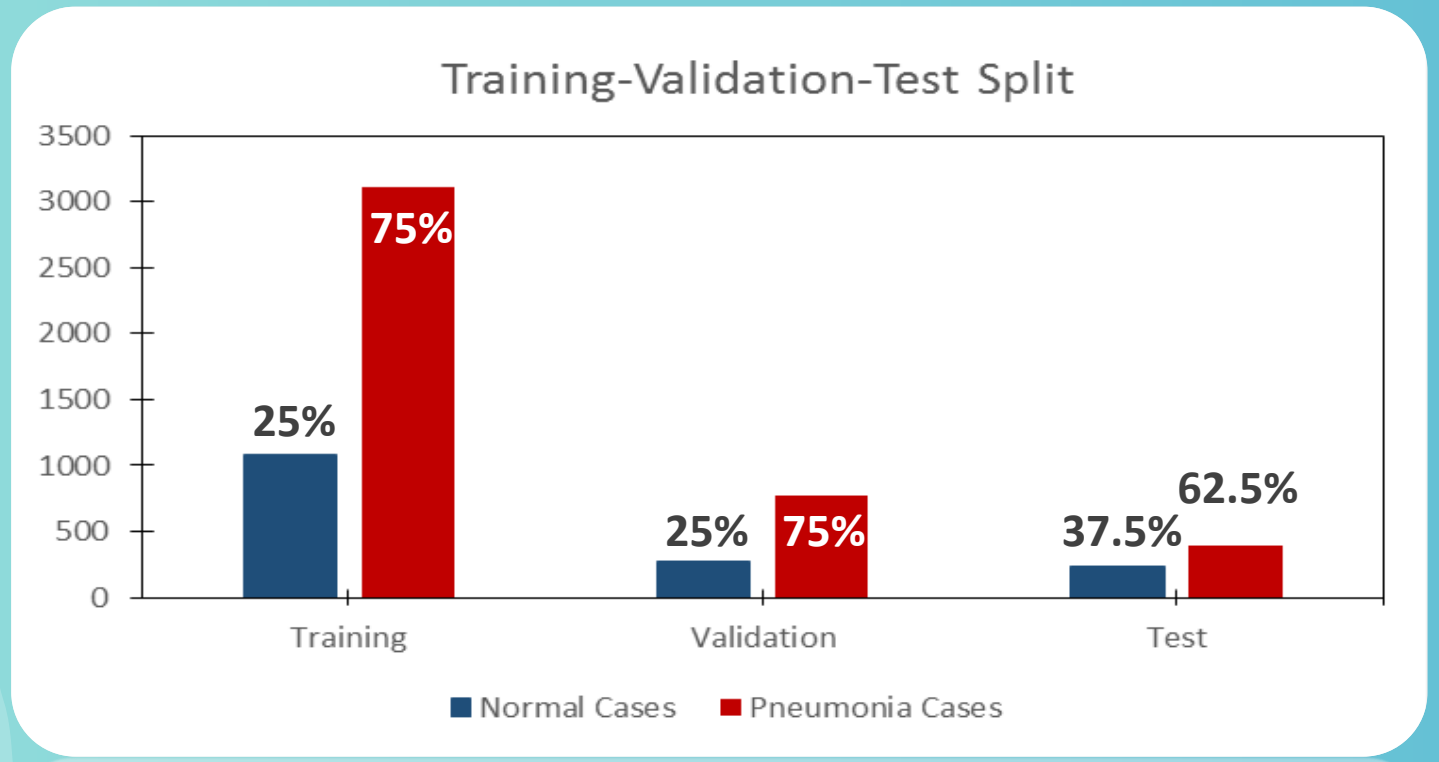
Training set



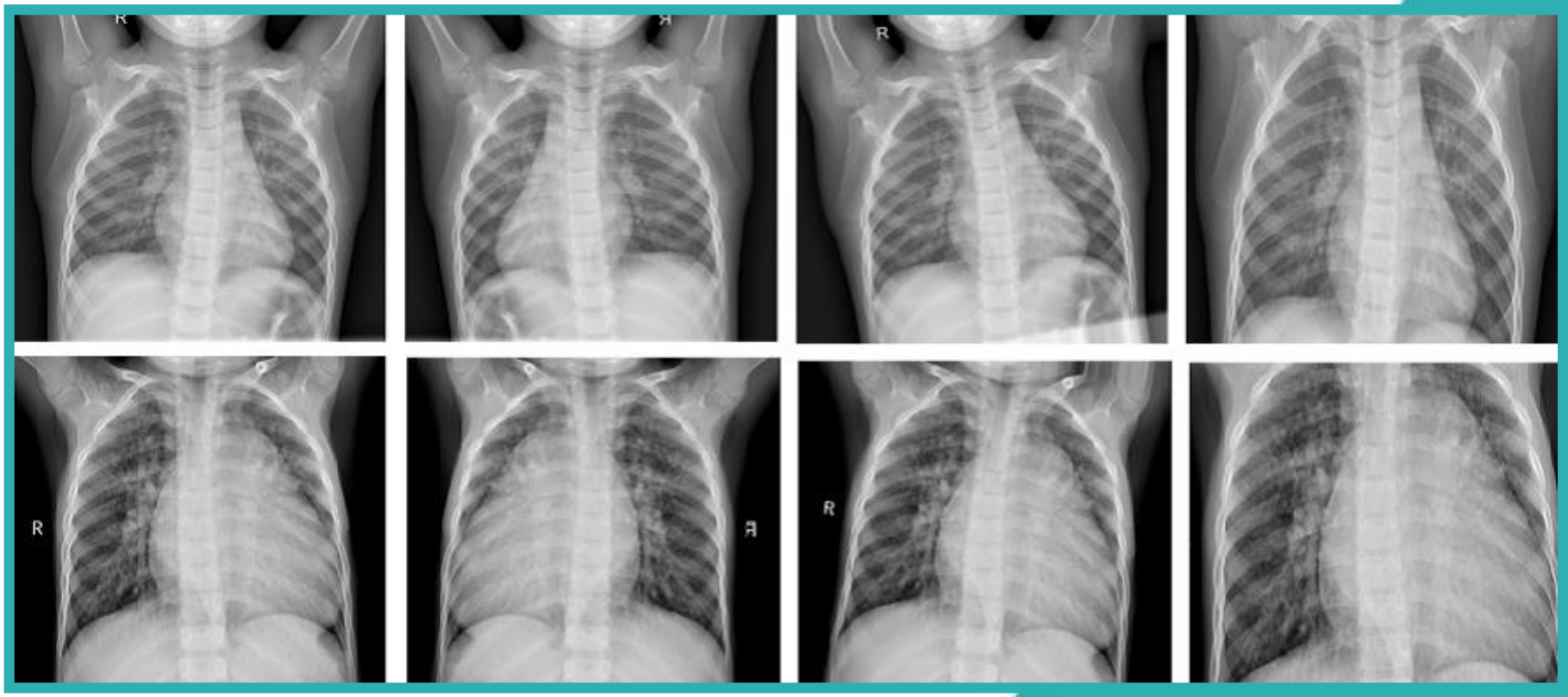
Validation set

Testing set

Proportionately divided images



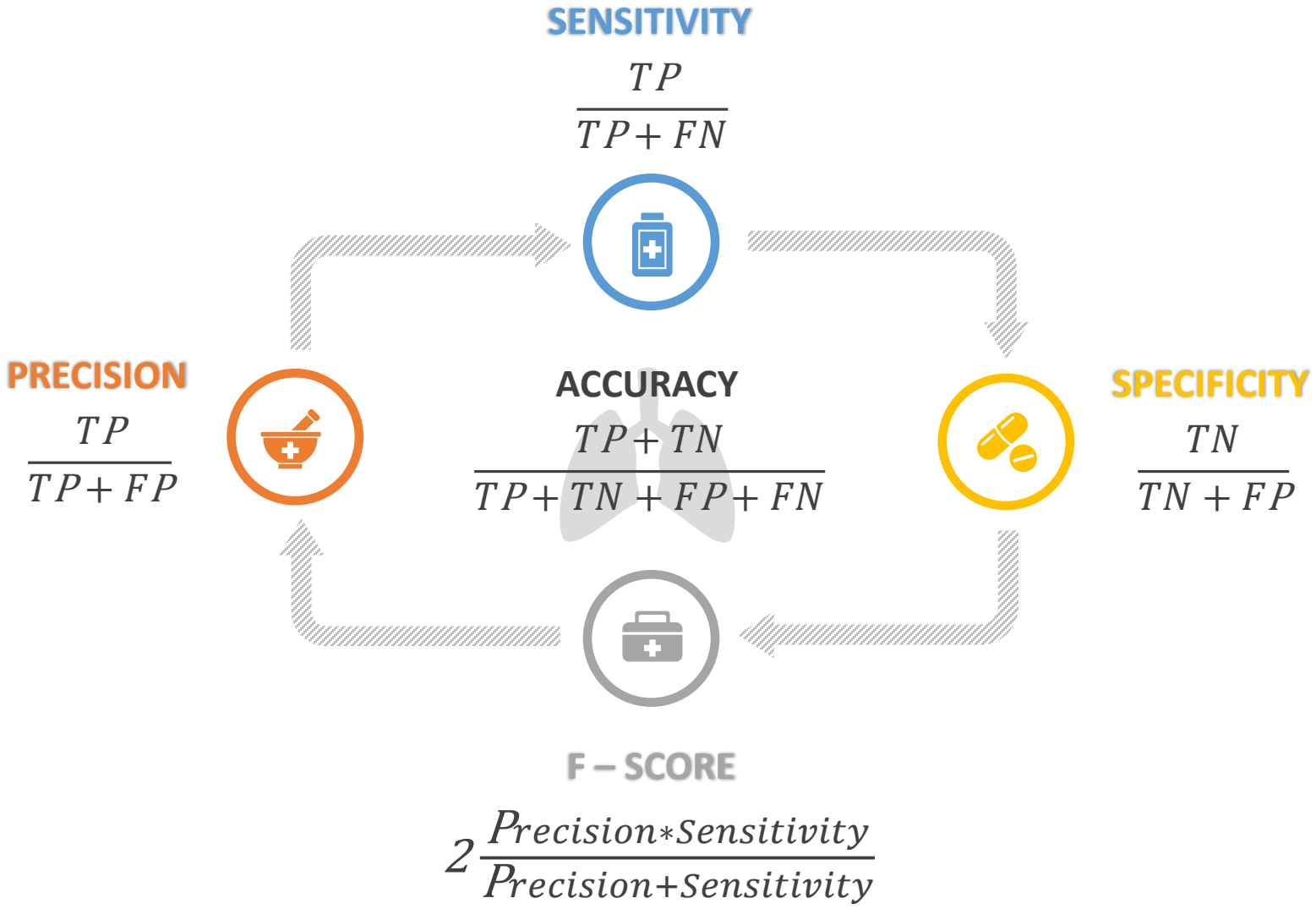
Data Augmentation



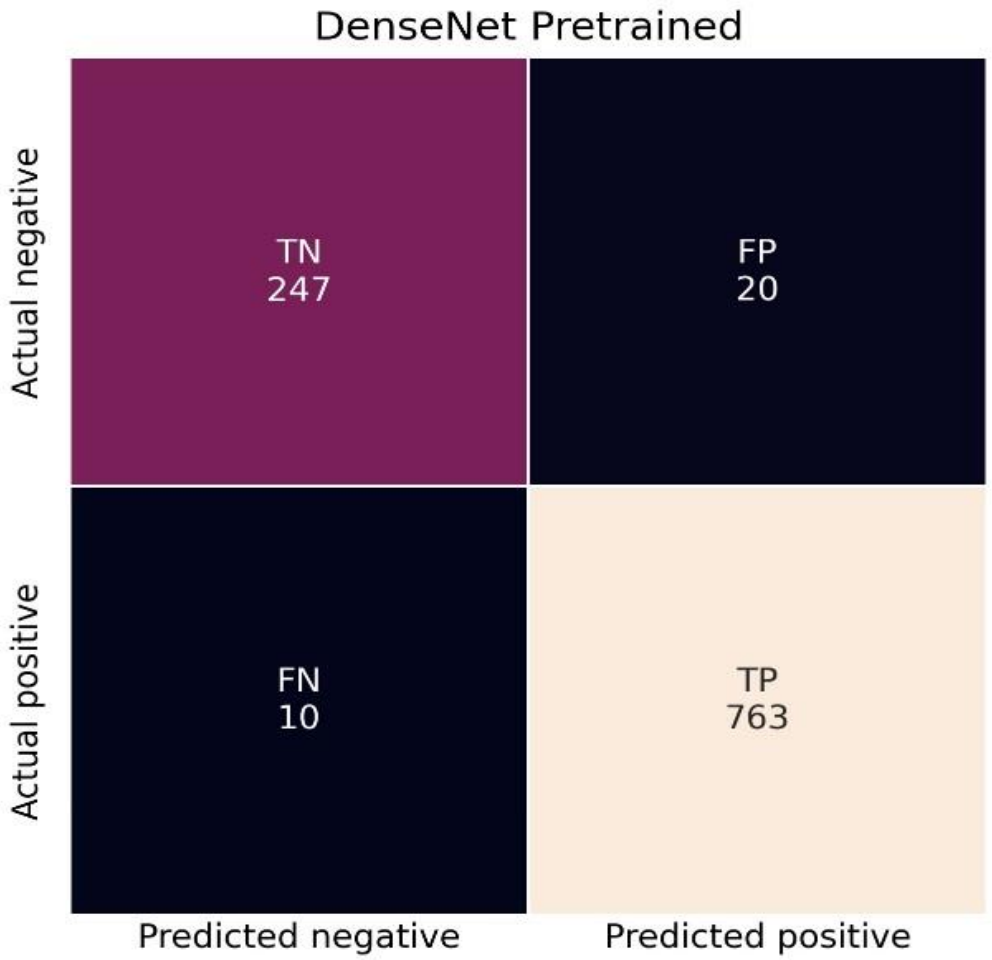
- Image resizing to 256x256
- Rotation $-10° < \alpha < 10°$
- Horizontal flip
- Zoom in/out

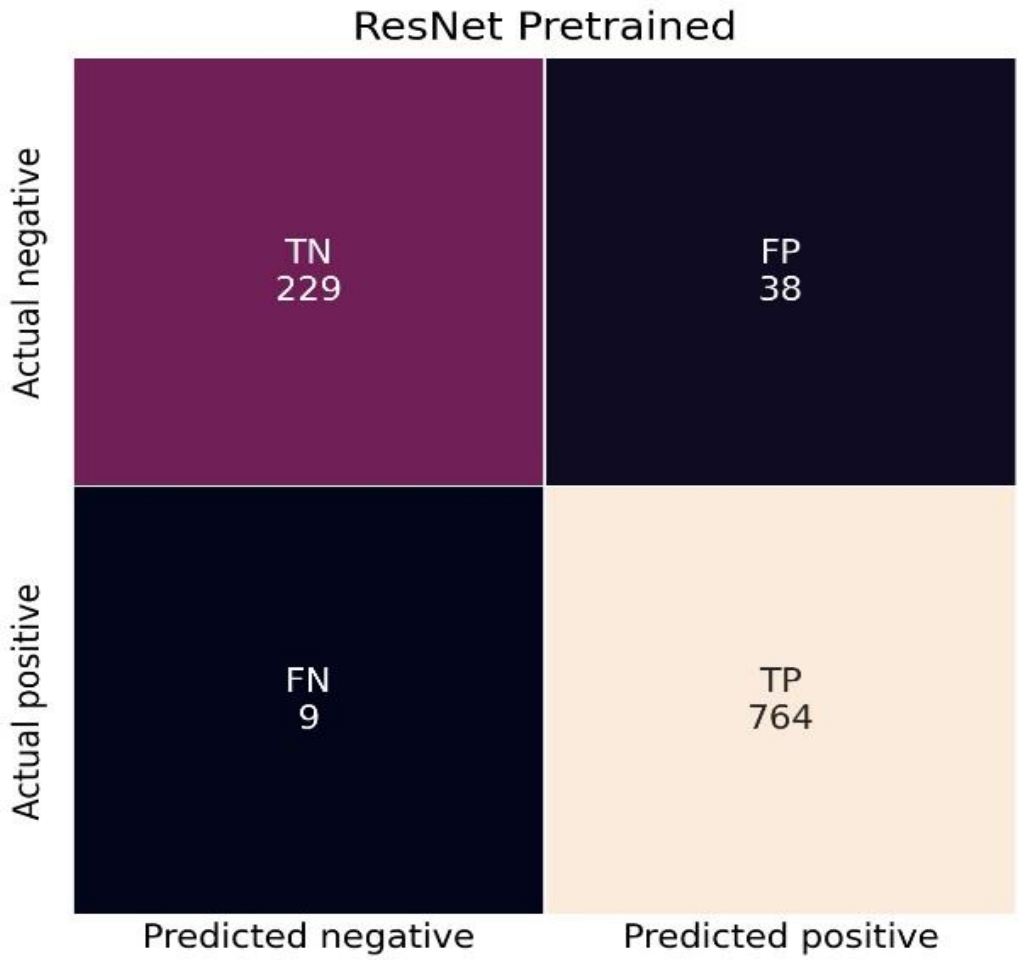
Evaluation metrics

- TP – True Positive
- TN – True Negative
- FP – False Positive
- FN – False Negative



	Accuracy	Sensitivity	Specificity	Precision	F – Score
Pretrained weights					
AlexNet	0.9519	0.9793	0.8727	0.9570	0.9680
DenseNet	**0.9712**	0.9871	**0.9251**	**0.9745**	**0.9807**
ResNet	0.9548	**0.9884**	0.8577	0.9526	0.9702
VGG	0.9471	0.9702	0.8801	0.9591	0.9646
Re-initialize weights					
AlexNet	0.9519	0.9702	0.8989	0.9653	0.9677
DenseNet	0.9500	0.9871	0.8427	0.9478	0.9670
ResNet	0.9404	0.9754	0.8390	0.9460	0.9605
VGG	0.9356	0.9625	0.8577	0.9514	0.9569





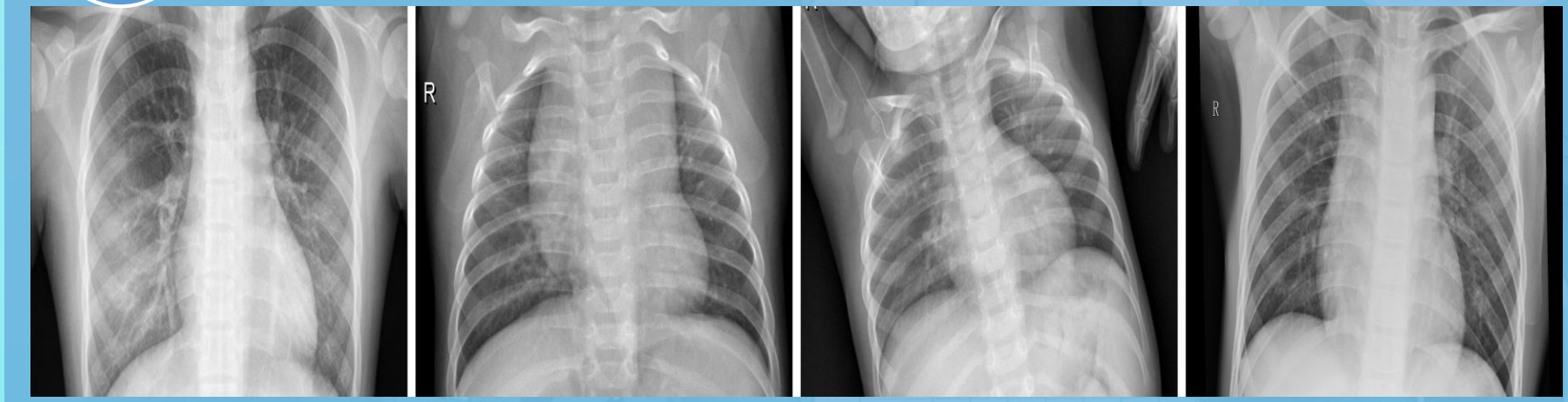
- 7.5% error – normal
- 1.3% error – pneumonia

- 14.3% error – normal
- 1.2% error – pneumonia

False positives

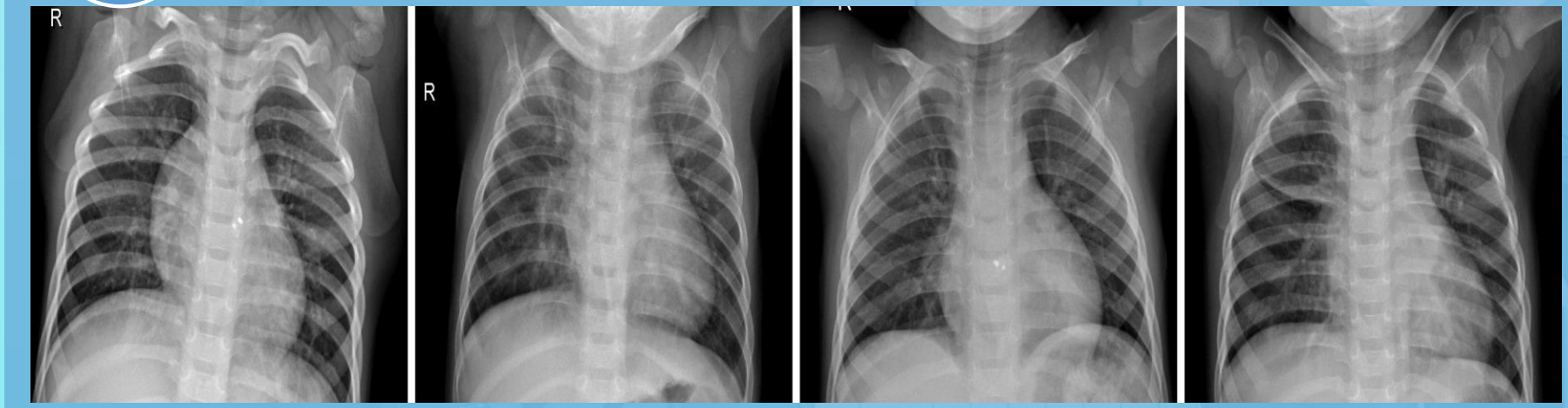
	Example 1		Example 2		Example 3		Example 4	
	Class	%	Class	%	Class	%	Class	%
AlexNet	1	98.07	1	96.58	0	61.59	1	92.47
DenseNet	1	82.70	1	68.93	0	85.24	0	52.08
ResNet	1	84.19	1	70.79	1	87.49	1	52.09
VGG	1	89.50	1	98.98	1	59.23	1	93.99

Chest X-Ray images of healthy patients



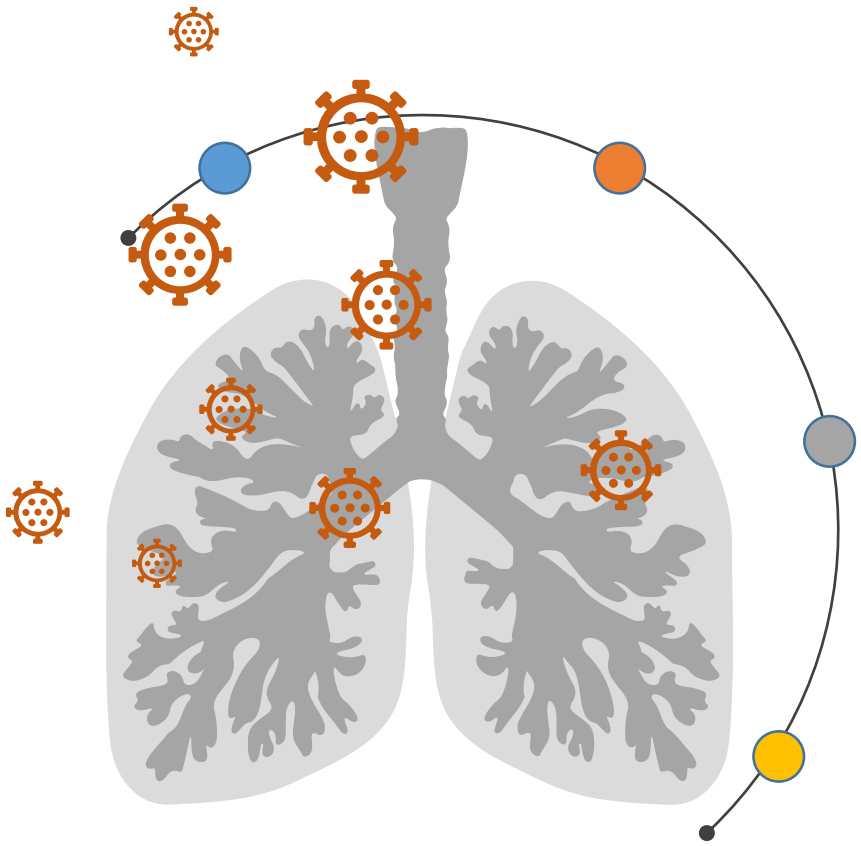
	Example 5		Example 6		Example 7		Example 8	
	Class	%	Class	%	Class	%	Class	%
AlexNet	0	95.29	0	69.16	0	71.09	1	80.42
DenseNet	0	98.43	1	76.96	0	77.79	1	90.36
ResNet	0	98.01	1	78.52	0	57.50	0	57.03
VGG	0	98.31	0	65.82	1	62.87	0	69.05

Chest X-Ray images of pneumonia patients



False negatives

Conclusion



- High performance of all tested models
- Accuracy of over 95%
- DenseNet and ResNet overall winners

Future work

Class balance

Include under/over-sampling in data augmentation

Image segmentation

Train models to detect inflamed regions

Specialized models

Train models to recognize different pneumonia types

Patient metadata

Include additional information about the patient, e.g. gender, age, lifestyle…

Thank you for your attention!