Detection of Invasive Ductal Carcinoma

— Binary classification of Breast Histopathology Images

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Background

Invasive Ductal Carcinoma (IDC) is the **most common** subtype of breast cancers. Accurately identifying and categorizing breast cancer subtypes is an important clinical task, and automated methods can be used to **save time** and **reduce error**.

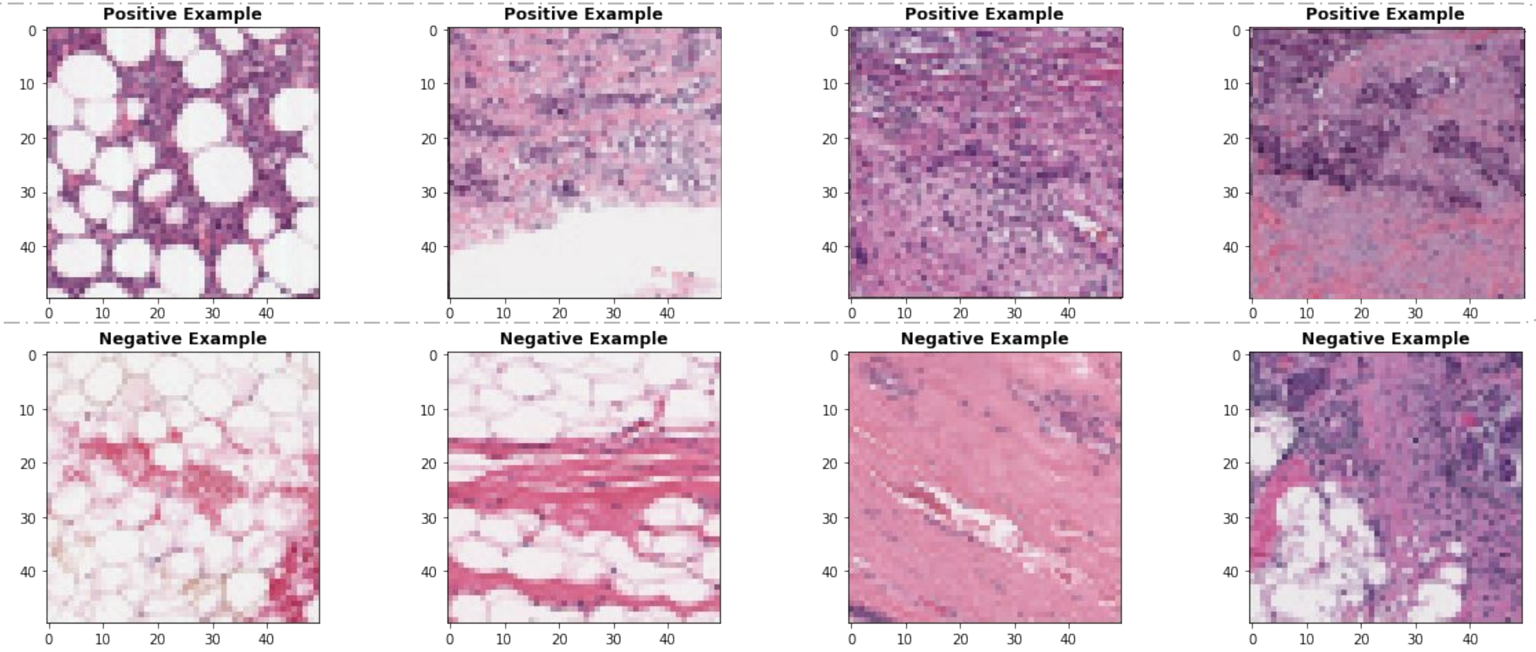
A common method for automatic aggressiveness grading is to **delineate the exact regions** of IDC inside of a whole slide images from patients.

We used **c**onvolutional **n**eural **n**etwork approaches to classify the positive or negative of IDC for more than **270,000** slide image patches with size **50x50** from 162 patients. This dataset is from Kaggle.

Image Data

Patches of 50 * 50 pixels

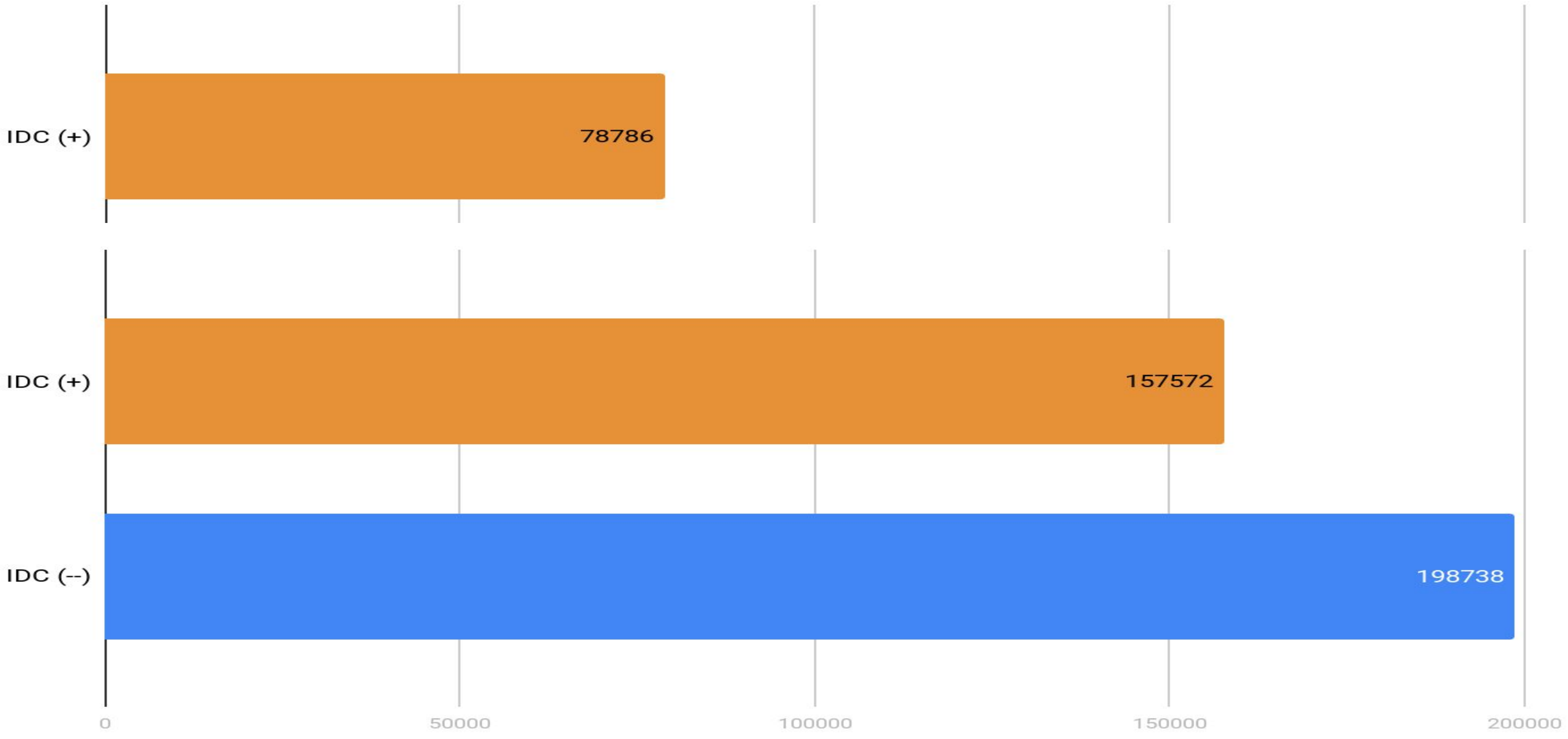
Random flip



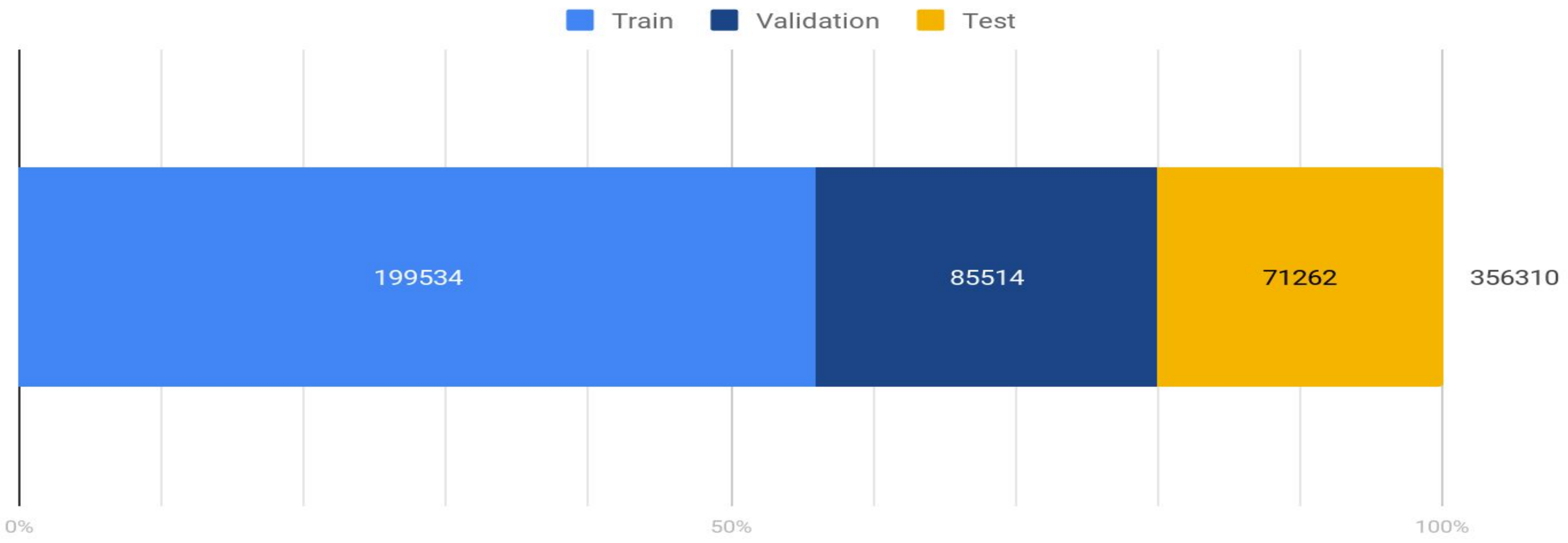

```
Total image count :  277524
Positive (idc+) image count : 78786
Negative (idc-) image count : 198738
```

Unbalanced!!!

Data Balancing



Data Split



Evaluation

predicted labels
(made by the classifier)

true labels
(given in the testing data)

	face	place
face	9	1
place	2	8

regular ("overall") accuracy

$$\frac{9+8}{9+1+2+8} = 0.85$$

$$\frac{TP+TN}{TP+FN+FP+TN}$$

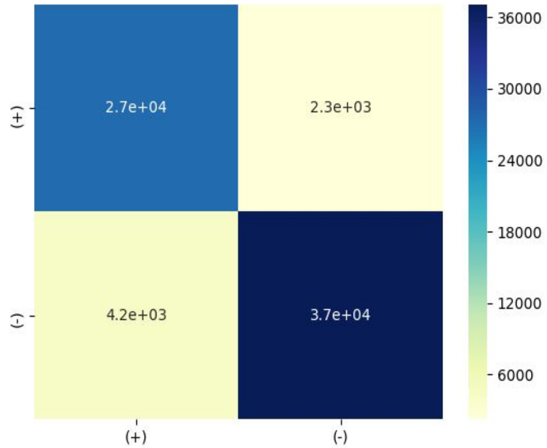
balanced accuracy

$$\left[\frac{9}{9+1} + \frac{8}{2+8}\right] / 2 = 0.85$$

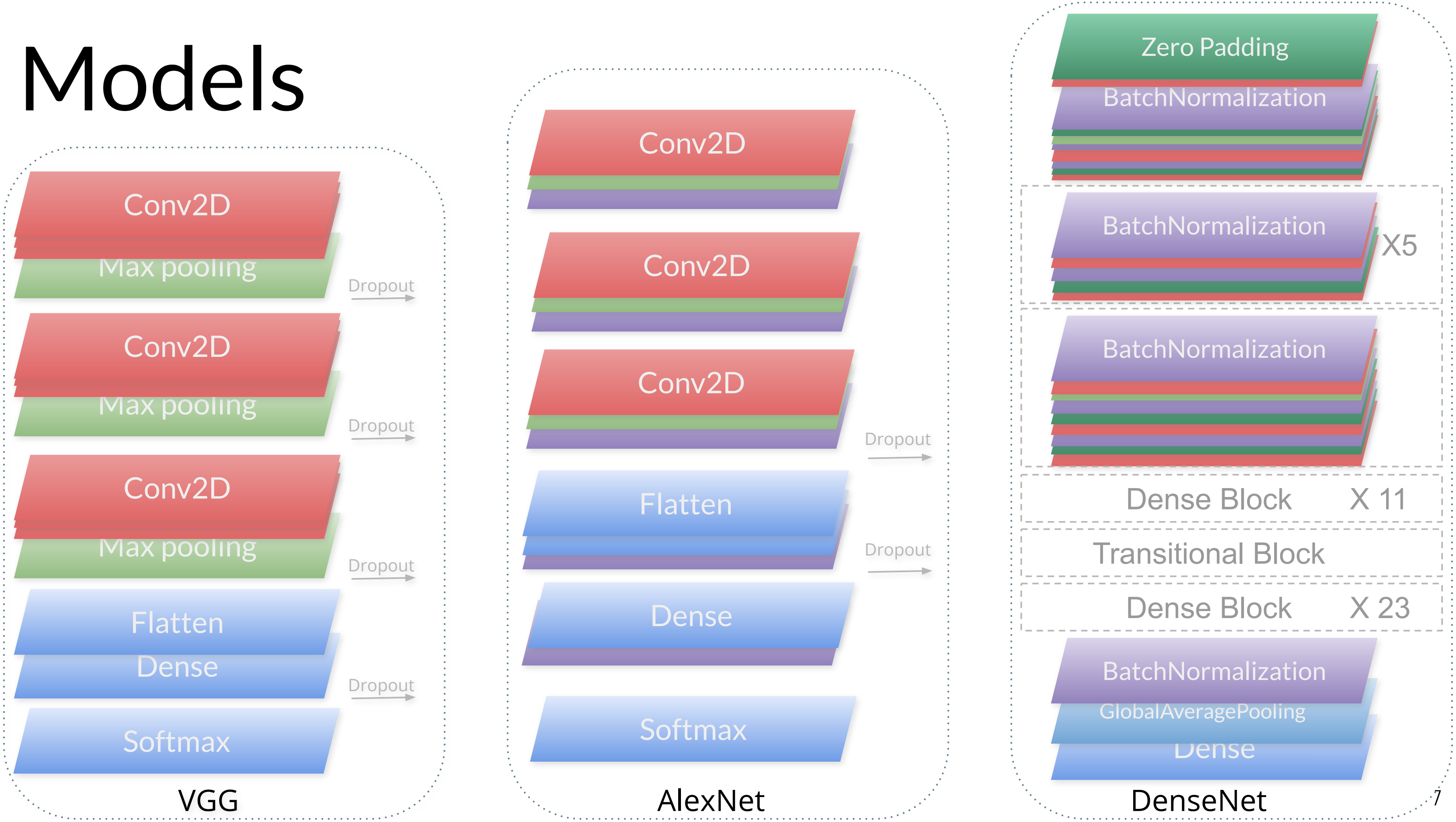
$$\left[\frac{TP}{TP+FN} + \frac{TN}{TN+FP}\right] / 2$$

Predicted Labels
Made by the classifier

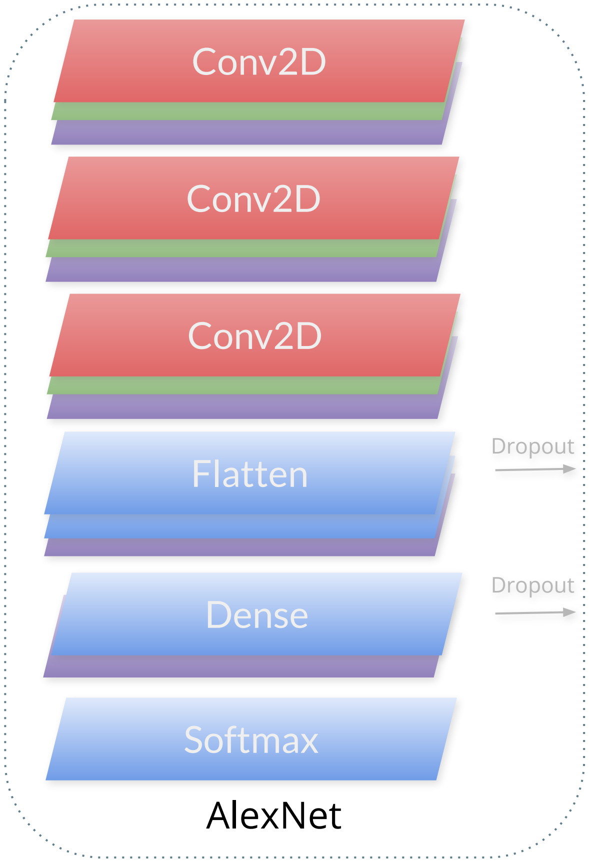
True Labels
Given in the testing data

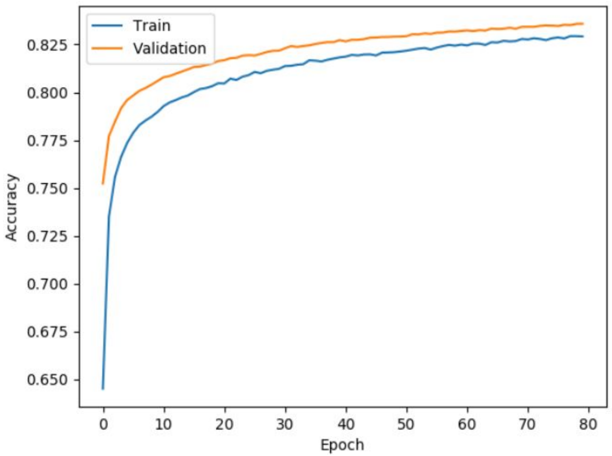


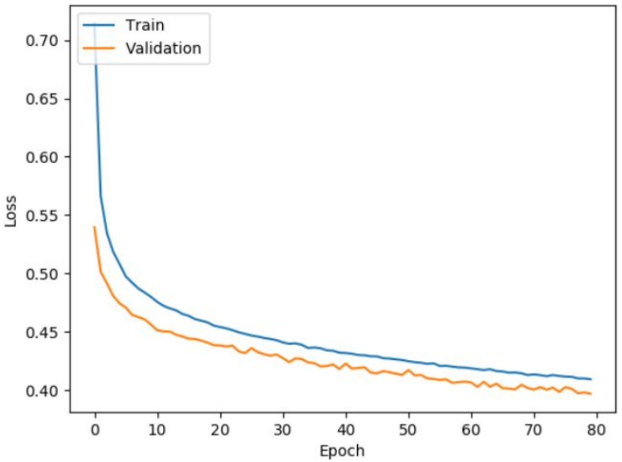
Models


Conv2D
Max pooling
Dropout
Conv2D
Max pooling
Dropout
Conv2D
Max pooling
Dropout
Flatten
Dense
Dropout
Softmax
VGG
Conv2D
Conv2D
Conv2D
Dropout
Flatten
Dropout
Dense
Softmax
AlexNet
Zero Padding
BatchNormalization
BatchNormalization
X5
BatchNormalization
Dense Block X 11
Transitional Block
Dense Block X 23
BatchNormalization
GlobalAveragePooling
Dense
DenseNet

AlexNet





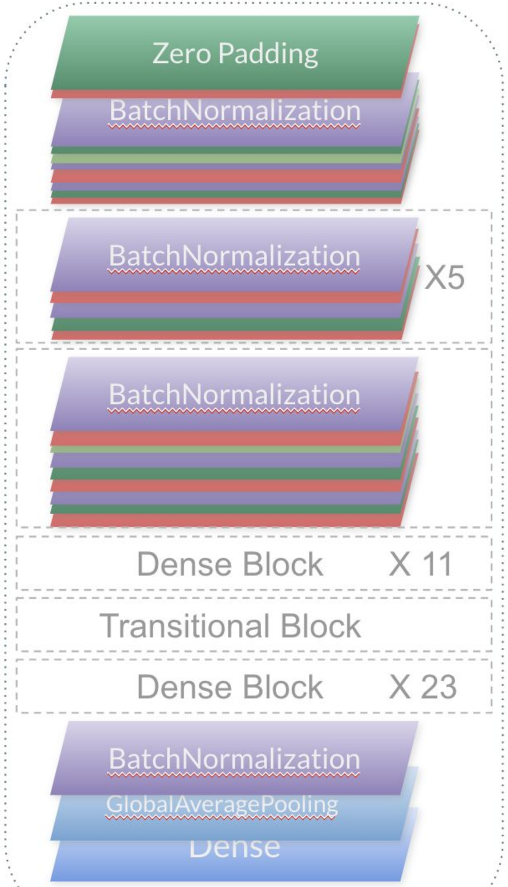


Regular accuracy is **83.37%**

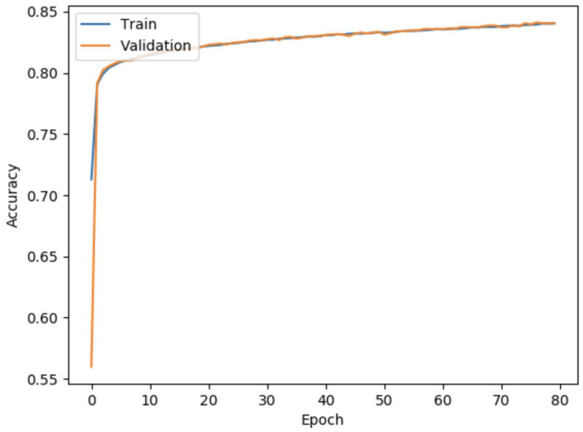
Balanced accuracy is **83.10%**

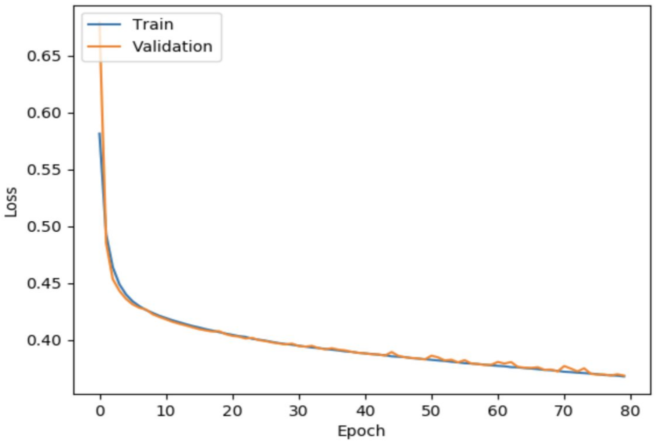
testing on **70,765** test examples

DenseNet



DenseNet



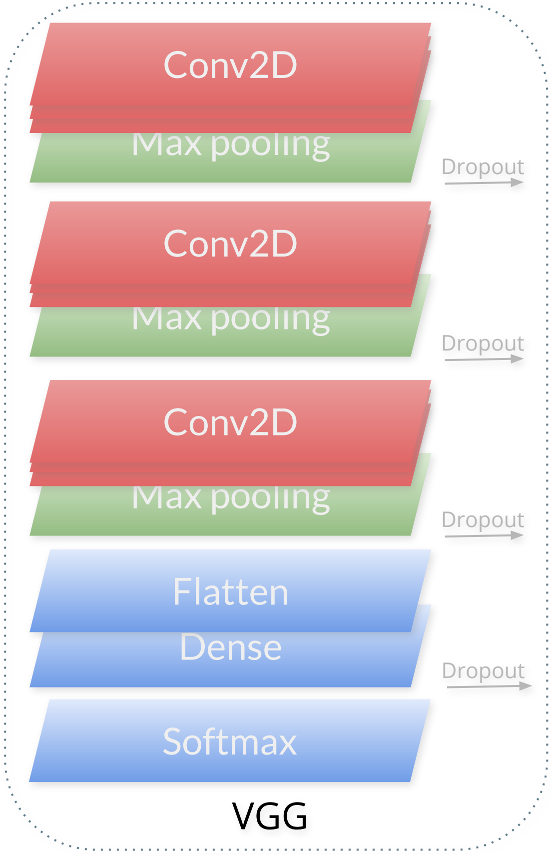


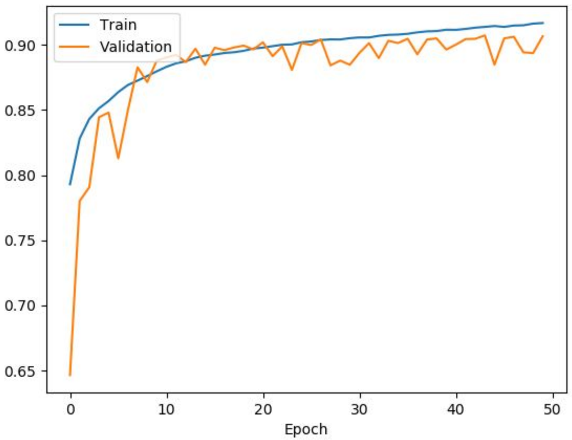
Regular accuracy is **85.28%**

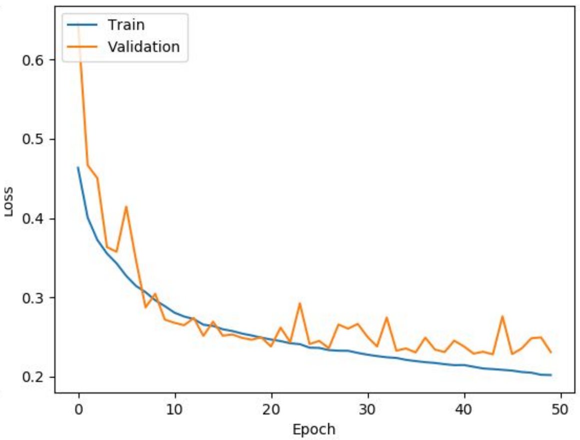
Balanced accuracy is **85.39%**

testing on **70,765** test examples

VGG







Regular accuracy is **90.90%**

Balanced accuracy is **90.50%**

over **70,765** test examples

Conclusion

	Pr	Rc/Sen	Spc	F1	BAC
CNN	0.6540	0.7960	0.8886	0.7180	0.8423
FCH	0.7086	0.6450	0.9298	0.6753	0.7874
RGBH	0.7564	0.5956	0.9493	0.6664	0.7724
GH	0.7102	0.5240	0.9434	0.6031	0.7337
JPEGCH	0.7570	0.4646	0.9605	0.5758	0.7126
M7Edge	0.7360	0.4372	0.9585	0.5485	0.6979
NT	0.6246	0.2851	0.9547	0.3915	0.6199
LBP	0.7575	0.2291	0.9806	0.3518	0.6048
NA	0.6184	0.2413	0.9606	0.3472	0.6009
HSVCH	0.7662	0.2223	0.9821	0.3446	0.6022

Cruz-Roa, A., Basavanhally, A., González, F., Gilmore, H., Feldman, M., Ganesan, S., ... & Madabhushi, A. (2014, March). Automatic detection of invasive ductal carcinoma in whole slide images with convolutional neural networks. In *Medical Imaging 2014: Digital Pathology* (Vol. 9041, p. 904103). International Society for Optics and Photonics.

Method	F-score	Balance accuracy
Alexnet, Resize	0.7648	0.8468
Alexnet, Resize + Dropout	0.757	0.8423
Alexnet, Cropping	0.7533	0.8415
Alexnet, Cropping + Additional Rotations	0.7558	0.8368

Janowczyk, A., & Madabhushi, A. (2016). Deep learning for digital pathology image analysis: A comprehensive tutorial with selected use cases. *Journal of pathology informatics*, *7*.

Our best is **90.50%** !!!

Thank you