DNN Comparative Study – Covid X-Ray Dataset

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Introduction

We aim to examine chest xrays of presumed COVID cases and further classify them as normal pneumonia or true COVID cases.

Open Data

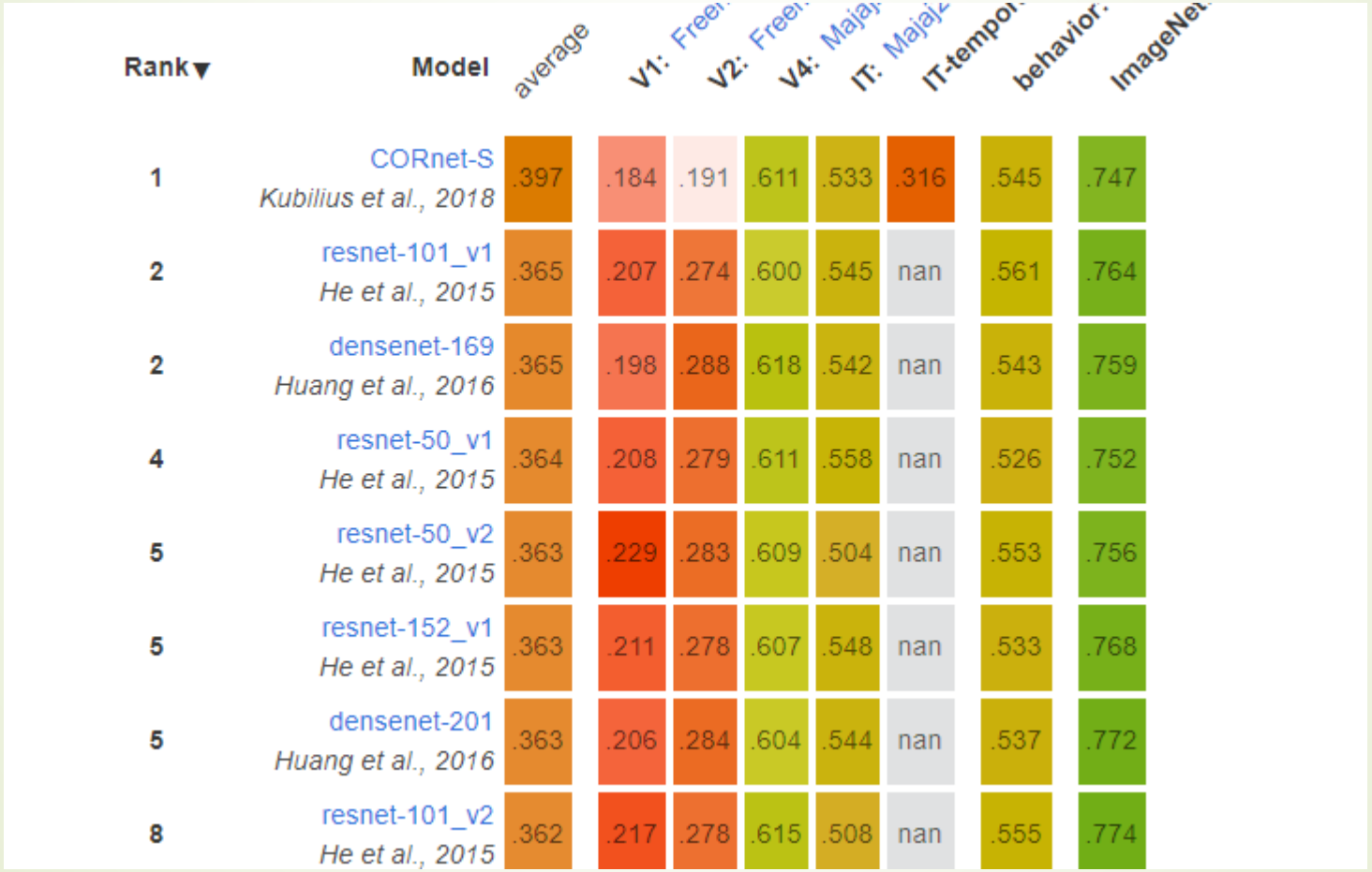
Toronto has released COVID data as an Open data. This data set contains demographic, geographic, and severity information for all confirmed and probable cases reported to and managed by Toronto Public Health since the first case was reported in January 2020. This includes cases that are sporadic (occurring in the community) and outbreak-associated. The data are extracted from the provincial communicable disease reporting system (iPHIS) and Toronto's custom COVID-19 case management system (CORES) and combined for reporting. Each line summarizes information for an individual case.

Selection of models.

But first, the inspiration.

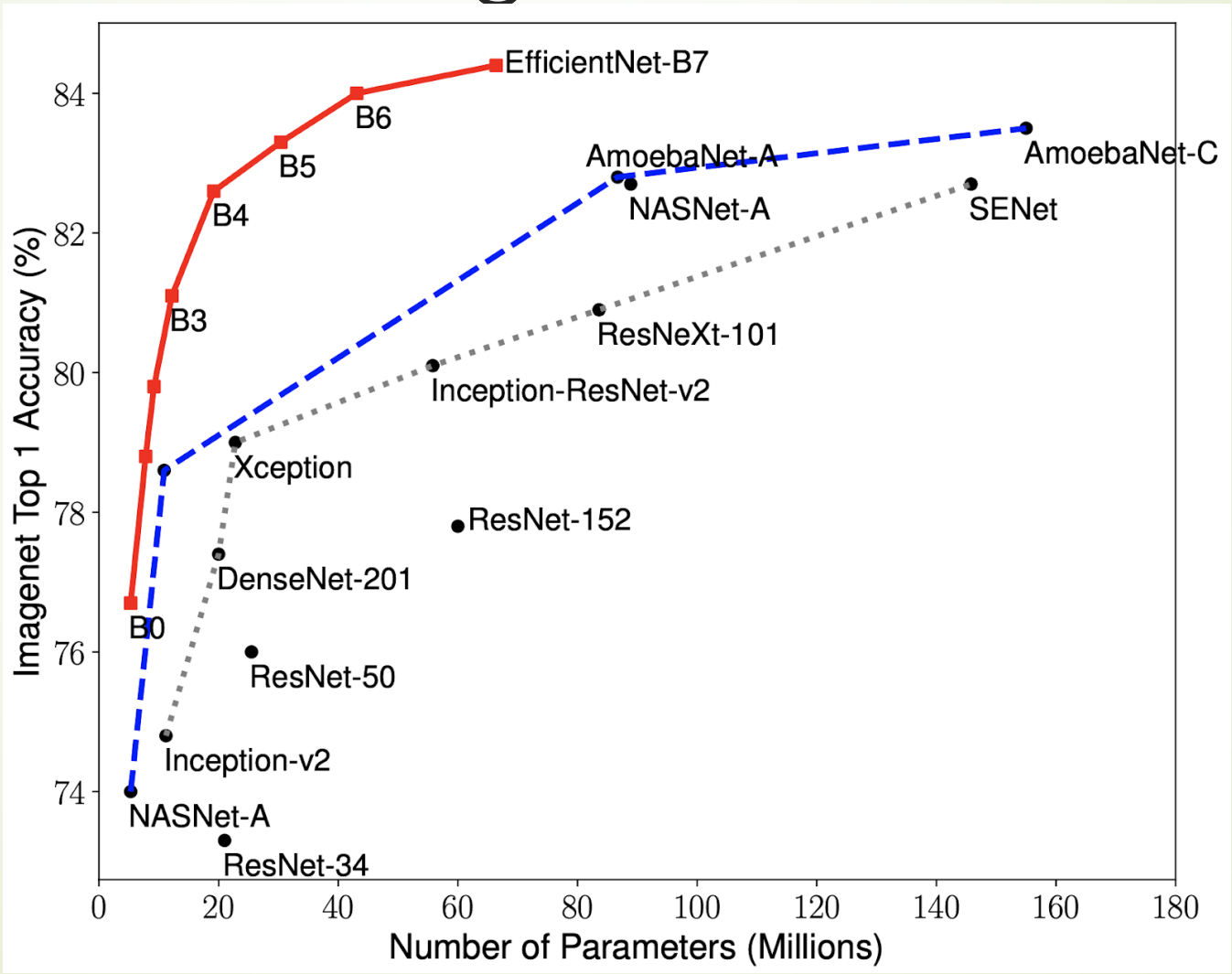
Regions of the brain involved in image recognition.
V1 (Primary visual cortex) – What is important in the global picture to guide the shift of attention.
Importance to simple properties such as orientation, spatial frequency, colour.
V2 (Secondary visual cortex) – Strong feedback connection to V1.
Sends strong connections to V3,4,5.
Role in object recognition memory.
V3 Role in global motion.
V4 Role in encoding stimulus salience, gated by signals coming frontal eye fields, shows changes in spatial profile with attention.
V5 Role in motion perception.

Selection of models



Rank	Model	average	V1: Freem	V2: Freem	V4: Majaj	IT: Majaj2	IT-tempor	behavior	ImageNet
1	CORnet-S *Kubilius et al., 2018*	.397	.184	.191	.611	.533	.316	.545	.747
2	resnet-101_v1 *He et al., 2015*	.365	.207	.274	.600	.545	nan	.561	.764
2	densenet-169 *Huang et al., 2016*	.365	.198	.288	.618	.542	nan	.543	.759
4	resnet-50_v1 *He et al., 2015*	.364	.208	.279	.611	.558	nan	.526	.752
5	resnet-50_v2 *He et al., 2015*	.363	.229	.283	.609	.504	nan	.553	.756
5	resnet-152_v1 *He et al., 2015*	.363	.211	.278	.607	.548	nan	.533	.768
5	densenet-201 *Huang et al., 2016*	.363	.206	.284	.604	.544	nan	.537	.772
8	resnet-101_v2 *He et al., 2015*	.362	.217	.278	.615	.508	nan	.555	.774

Transfer Learning –Ranking of various Models on ImageNet Dataset



Classes and shape for X-ray images

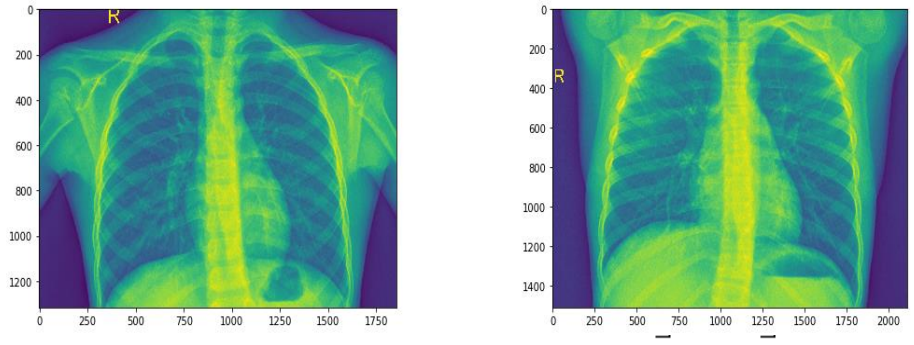
- names = ['normal','pneumonia']

```
# if num_channel==1:
#         img_data= np.expand_dims(img_data, axis=3)
#         print (img_data.shape)
# else:
#     if (K.image_data_format() == 'channels_first'):
#         img_data=np.rollaxis(img_data,3,1)

print (img_data.shape)
```

```
(5856, 128, 128, 3)
(5856, 128, 128, 3)
(5856, 128, 128, 3)
```

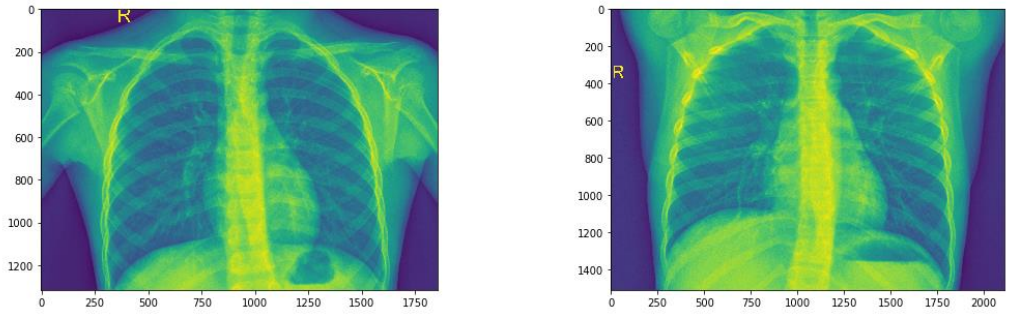
View images from Test

In [48]:
```
plt.figure(figsize = (17,17))
for iterator, filename in enumerate(sample_test_images):
    image = Image.open(filename)
    plt.subplot(4,2,iterator+1)
    plt.imshow(image)

plt.tight_layout()
```



View images from Train

```
from PIL import Image
plt.figure(figsize = (17,17))
for iterator, filename in enumerate(sample_train_images):
    image = Image.open(filename)
    plt.subplot(4,2,iterator+1)
    plt.imshow(image)

plt.tight_layout()
```



In [37]:
```
train_df.dropna(how = 'all')
train_df.isnull().sum()
```

Out[37]:
```
Unnamed: 0                  0
X_ray_image_name            0
Label                       0
Dataset_type                0
Label_2_Virus_category    5841
Label_1_Virus_category    1576
dtype: int64
```

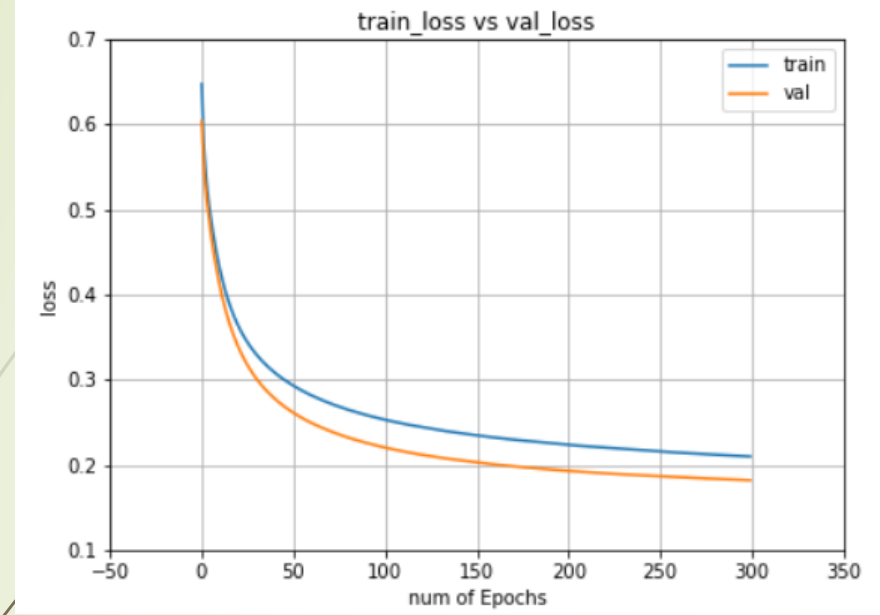
Image Classification Models Studied

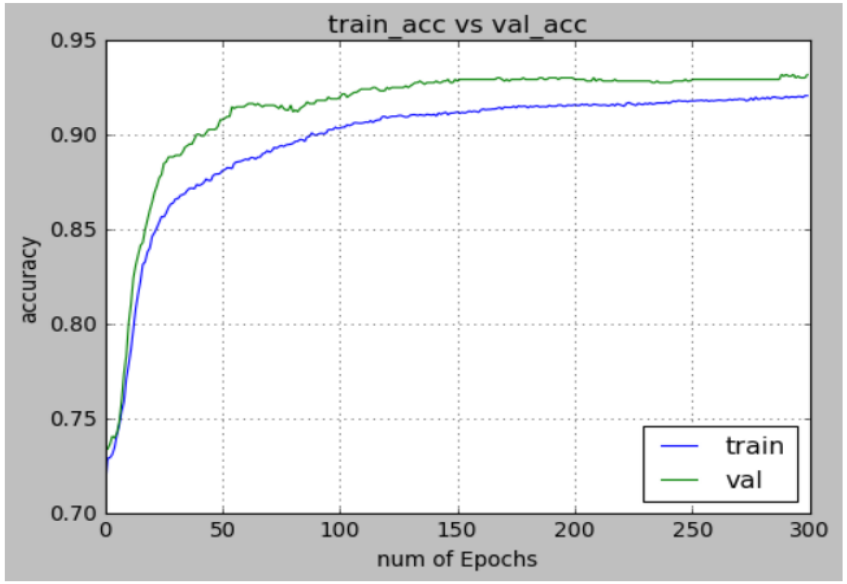
- **VGG19**
- **MobileNetV2**
- **InceptionV3**
- **ResNet50**
- **EfficientNetB0**

VGG19

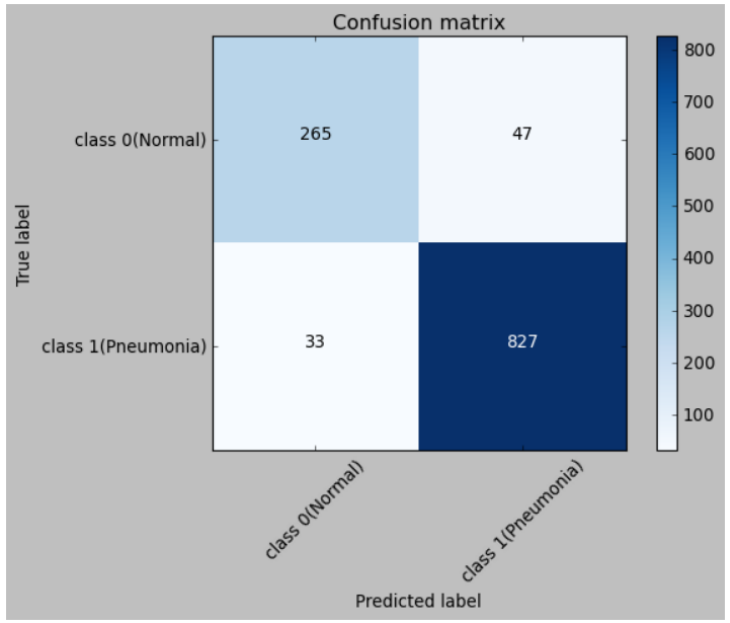
- Number of Epochs 300
- Loss Function: Categorical Cross Entropy, Optimizer: Adam & Metric: Accuracy
- Total params: 143,669,242, Trainable params: 2,002, Non-trainable params: 143,667,240
- Training time: 3709s
- loss=0.1818, accuracy: 93.1741%

VGG19 - Report





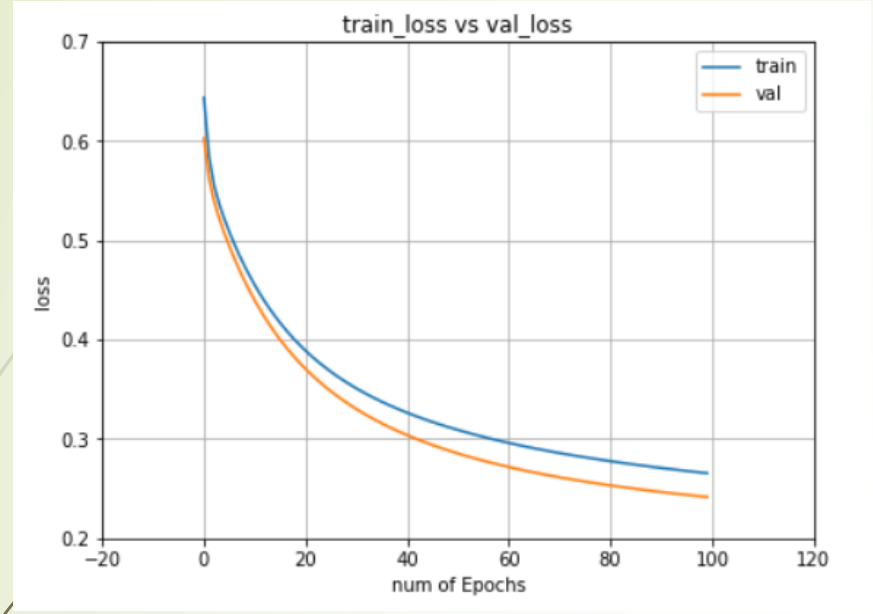
	precision	recall	f1-score	support
class 0(Normal)	0.89	0.85	0.87	312
class 1(Pneumonia)	0.95	0.96	0.95	860
accuracy			0.93	1172
macro avg	0.92	0.91	0.91	1172
weighted avg	0.93	0.93	0.93	1172

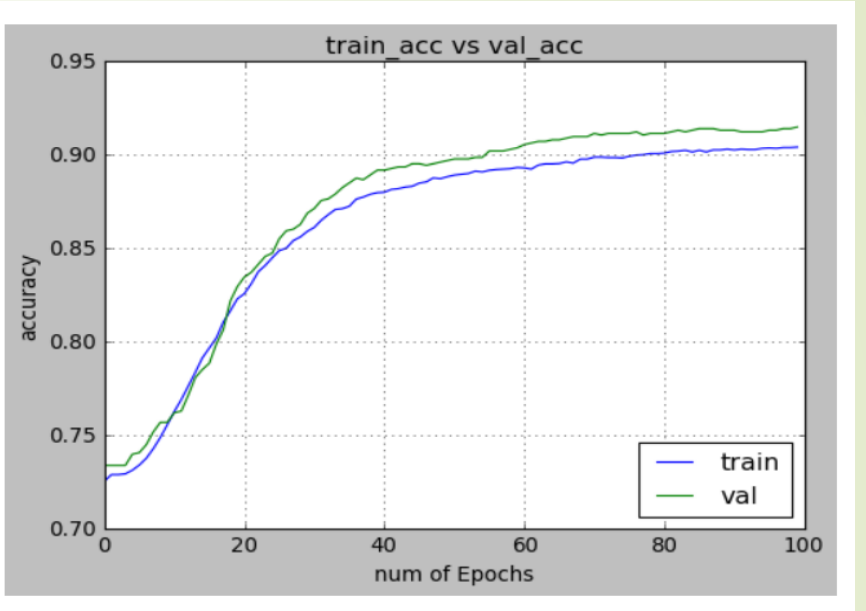


MobileNetV2

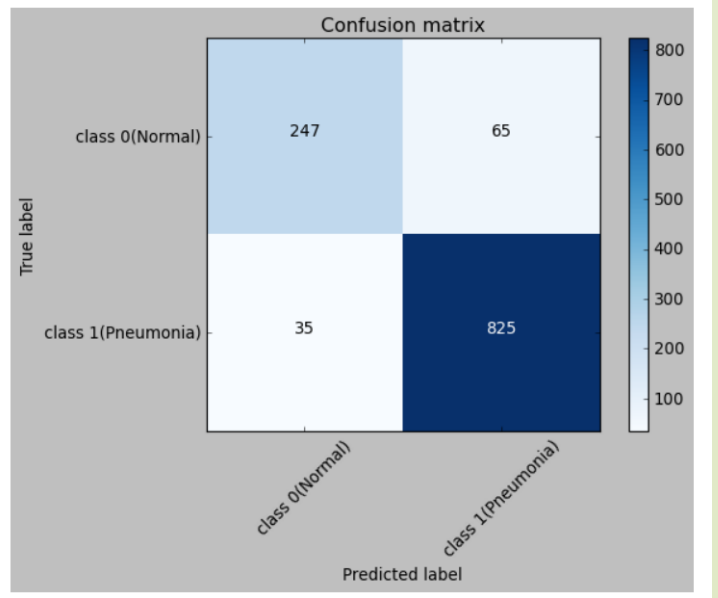
- Number of Epochs 100
- Loss Function: Categorical Cross Entropy, Optimizer: Adam & Metric: Accuracy
- Total params: 3,540,986, Trainable params: 3,506,874, Non-trainable params: 34,112
- Training time: 609.81s
- loss=0.2416, accuracy: 91.4676%

MobileNetV2 - Report





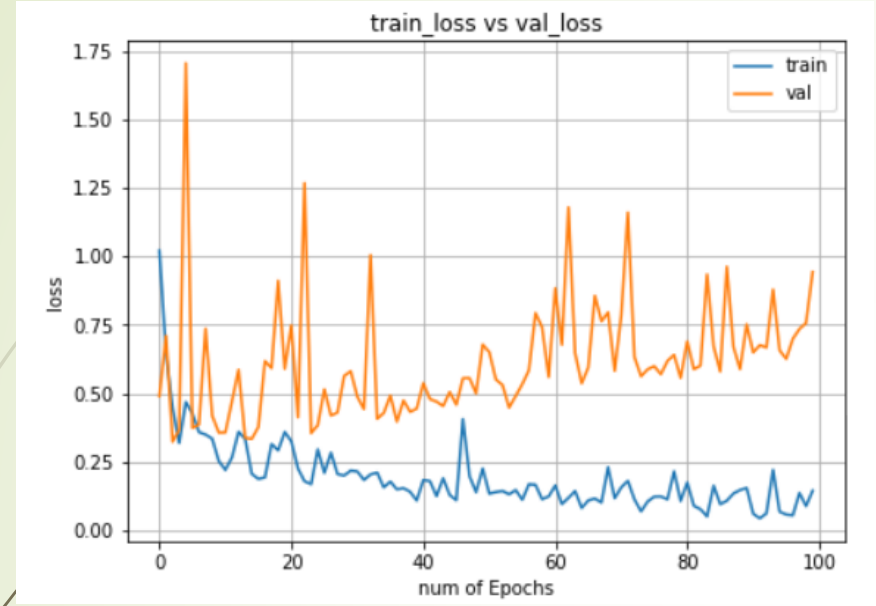
	precision	recall	f1-score	support
class 0(Normal)	0.88	0.79	0.83	312
class 1(Pneumonia)	0.93	0.96	0.94	860
accuracy			0.91	1172
macro avg	0.90	0.88	0.89	1172
weighted avg	0.91	0.91	0.91	1172

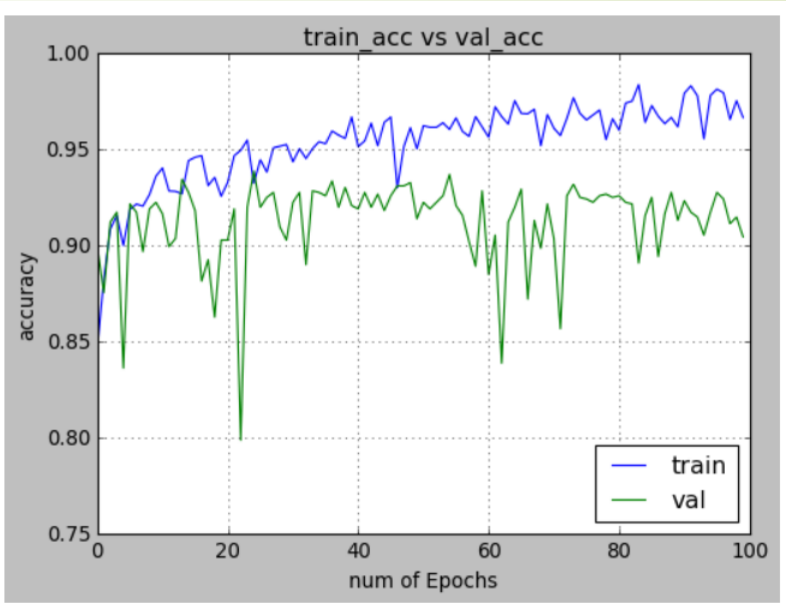


Inception V3

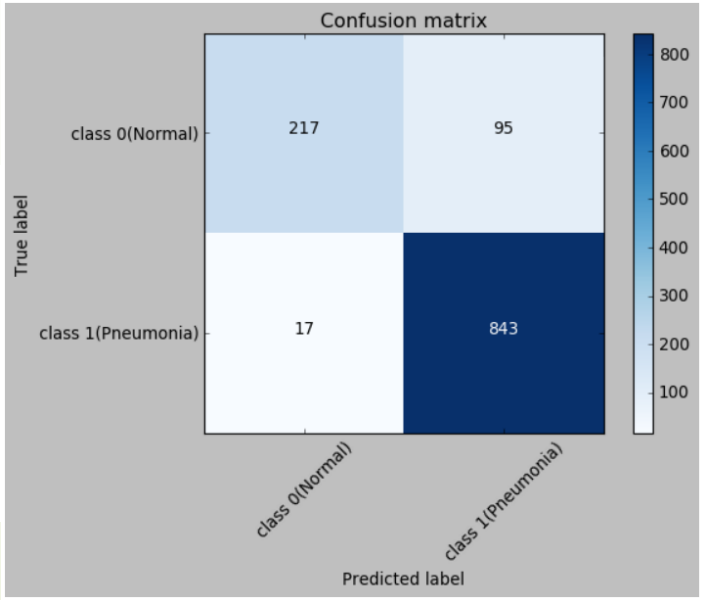
- Number of Epochs 100
- Loss Function: Categorical Cross Entropy, Optimizer: Adam & Metric: Accuracy
- Total params: 21,806,882, Trainable params: 4,098, Non-trainable params: 21,802,784
- Training time: 868.8s
- loss=0.9426, accuracy: 90.4437%

Inception V3 - Report





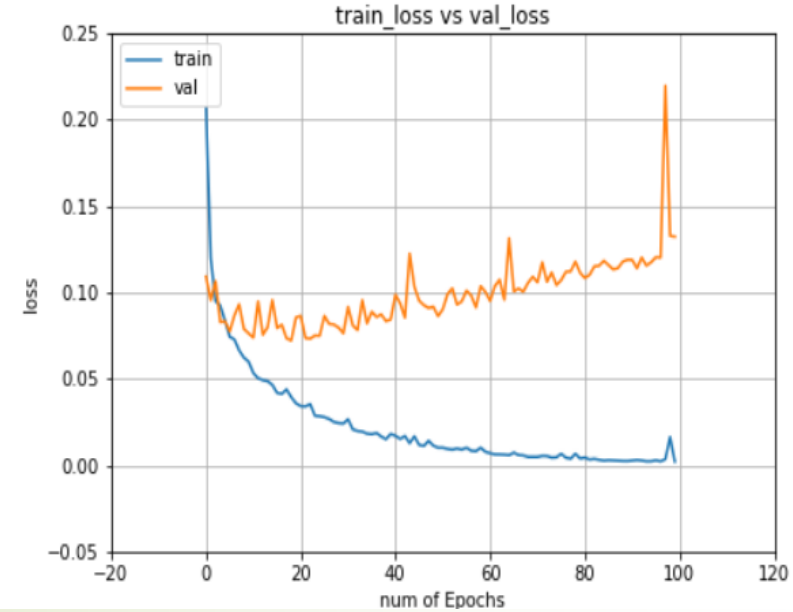
	precision	recall	f1-score	support
class 0(Normal)	0.93	0.70	0.79	312
class 1(Pneumonia)	0.90	0.98	0.94	860
accuracy			0.90	1172
macro avg	0.91	0.84	0.87	1172
weighted avg	0.91	0.90	0.90	1172

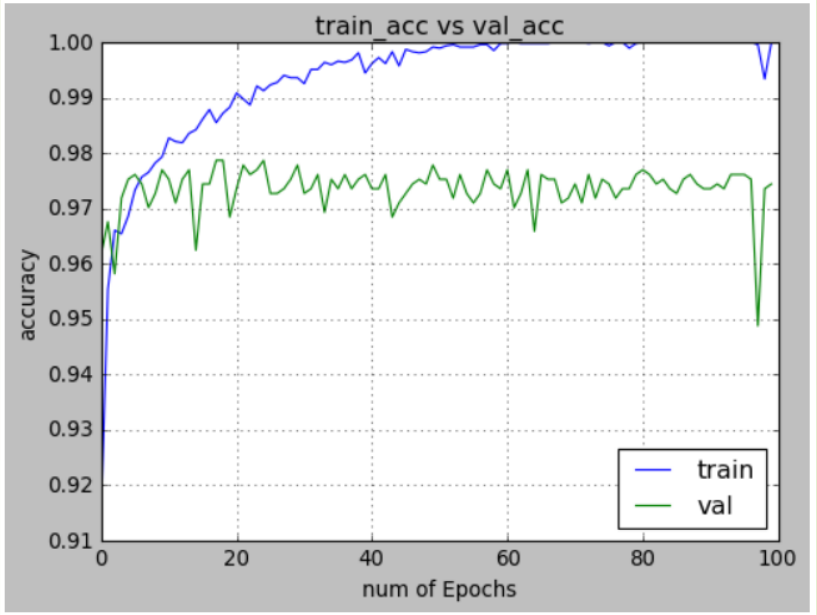


ResNet50

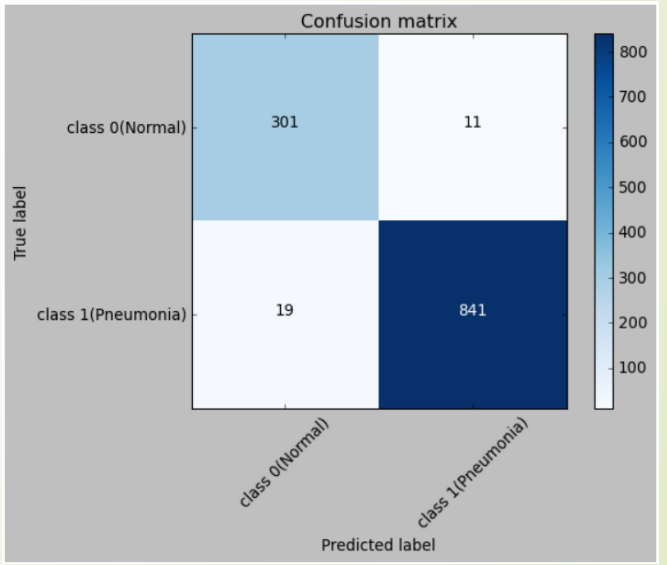
- Number of Epochs 100
- Loss Function: Categorical Cross Entropy, Optimizer: Adam & Metric: Accuracy
- Total params: 23,591,810, Trainable params: 4,098, Non-trainable params: 23,587,712
- Training time: 975.8s
- loss=0.1323, accuracy: 97.4403%

ResNet50 - Report





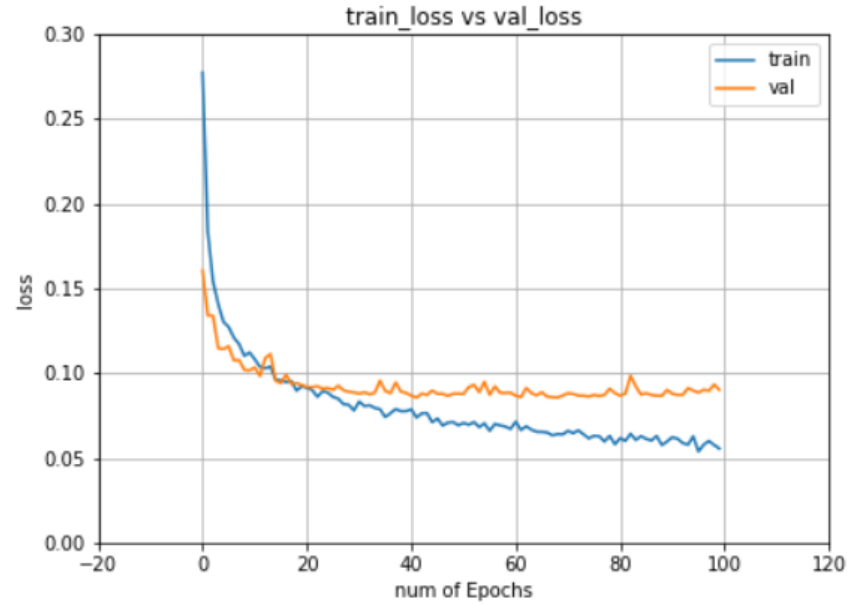
	precision	recall	f1-score	support
class 0(Normal)	0.94	0.96	0.95	312
class 1(Pneumonia)	0.99	0.98	0.98	860
accuracy			0.97	1172
macro avg	0.96	0.97	0.97	1172
weighted avg	0.97	0.97	0.97	1172

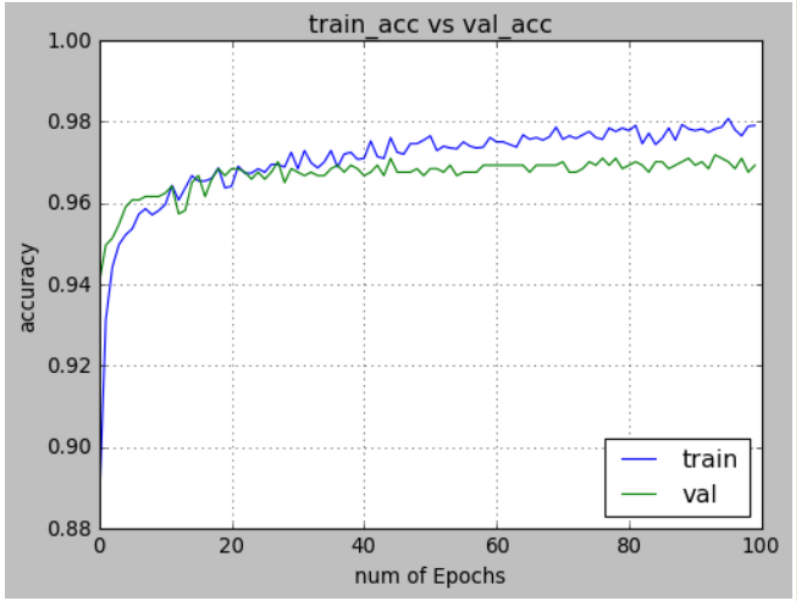


EfficientNetB0

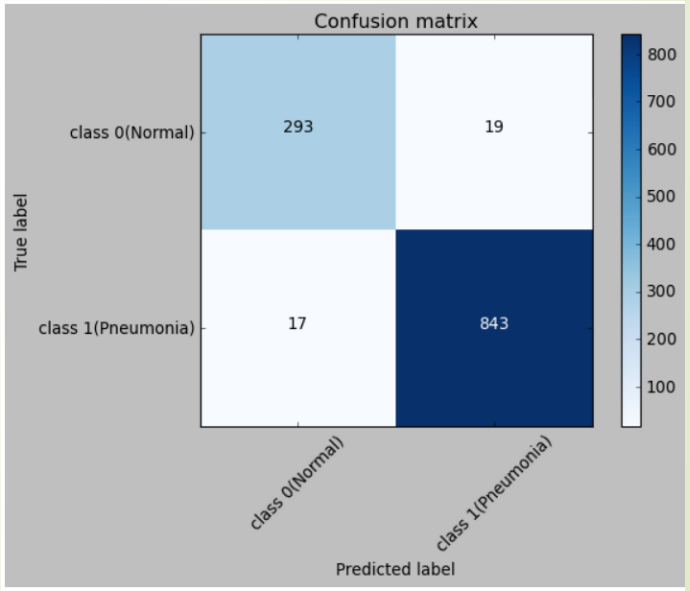
- Number of Epochs 100
- Loss Function: Categorical Cross Entropy, Optimizer: Adam & Metric: Accuracy
- Total params: 4,052,133, Trainable params: 2,562, Non-trainable params: 4,049,571
- Training time: 848.4s
- loss=0.0901, accuracy: 96.9283%

EfficientNetB0 - Report

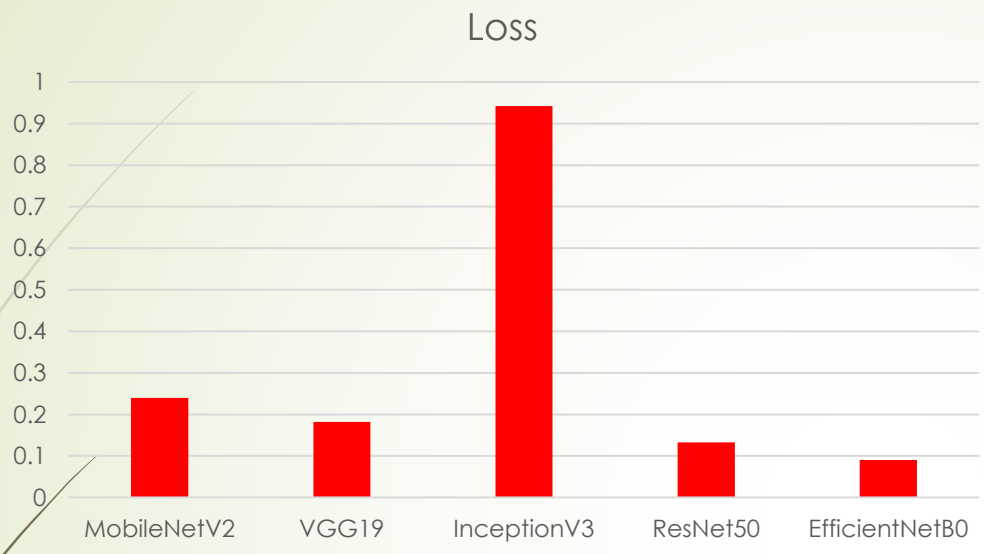


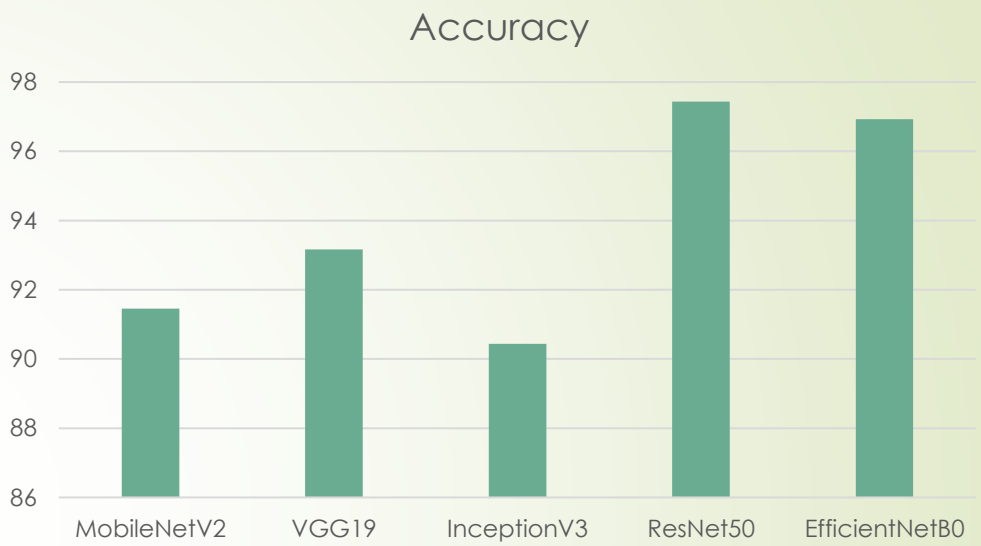


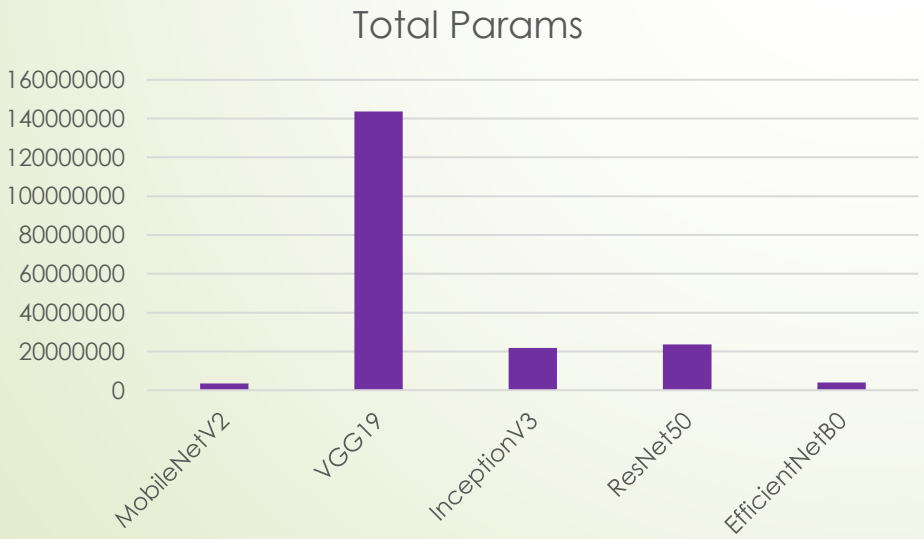
	precision	recall	f1-score	support
class 0(Normal)	0.95	0.94	0.94	312
class 1(Pneumonia)	0.98	0.98	0.98	860
accuracy			0.97	1172
macro avg	0.96	0.96	0.96	1172
weighted avg	0.97	0.97	0.97	1172

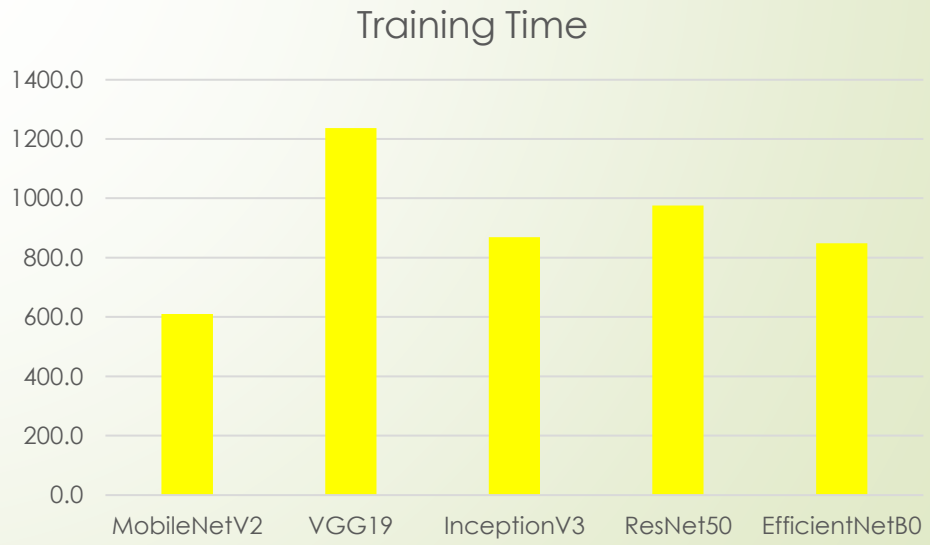


Comparison Chart

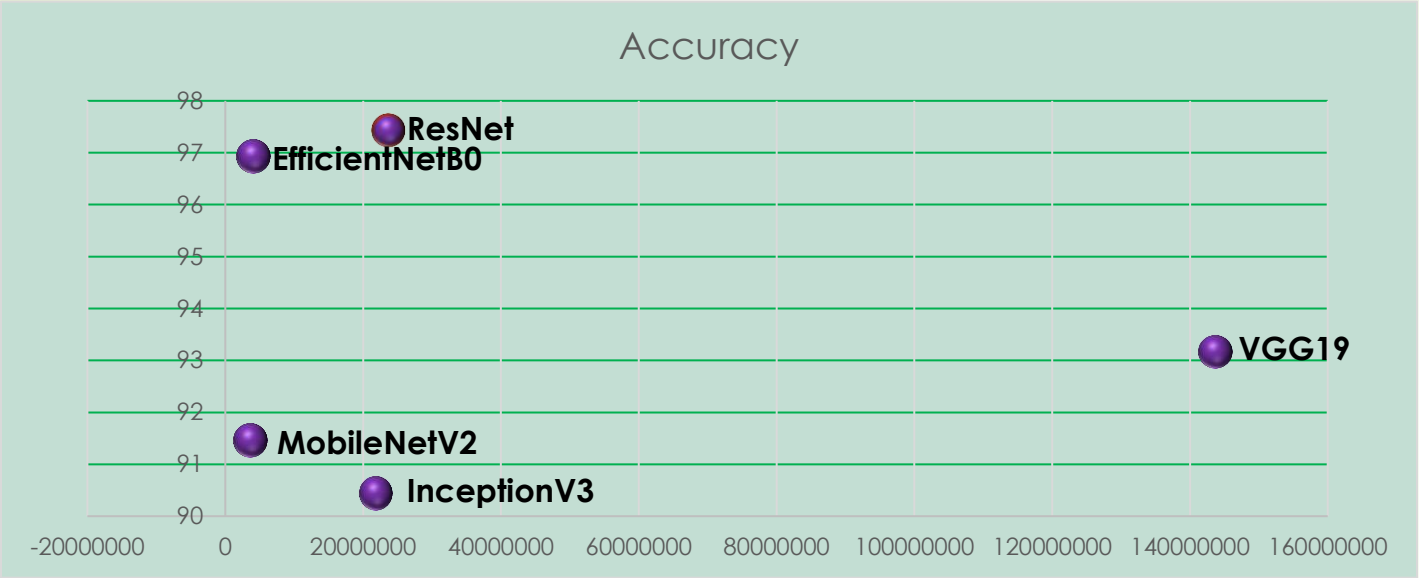








Conclusion and Inference



Accuracy vs No of Params

- ResNet Model has the highest validation accuracy, but the number of parameters are large and also has big model size
- EfficientNet Model has good accuracy, fewer number of parameters, small model and lowest loss

Code and Repository

https://github.com/mickykumar1/DL-final-project

References

- https://github.com/ieee8023/covid-chestxray-dataset
- https://keras.io/api/applications/
- https://keras.io/guides/transfer_learning/
- https://ai.googleblog.com/2019/05/efficientnet-improving-accuracy-and.html
- https://medium.com/@mahakkothari190.mk/comparison-of-different-deep-learning-models-for-image-classification-1c49f1159d7a

Thank You