

Detecting Pneumonia in X-Ray images using Convolution Neural Networks

Bob Spoonmore

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Problem Statement

How can images of infant chest X-Rays be viewed algorithmically such that Pneumonia can be detected from Normal conditions with a level of confidence above 90%?

A Deep Learning algorithm of Convolution Neural Networks will be applied to images of pediatric X-Rays separated into Pneumonia and Normal labeled groups to determine if images can predict results based on training a supervised image model

Exploratory Data Analysis

Images from the Kaggle Dataset:

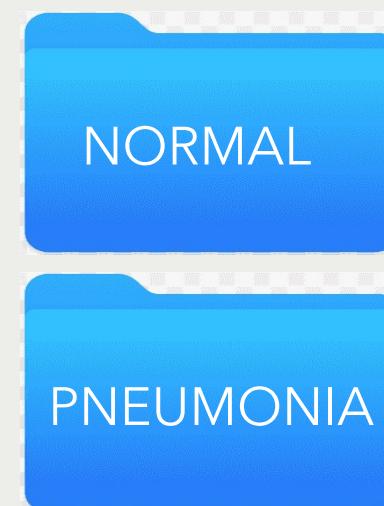
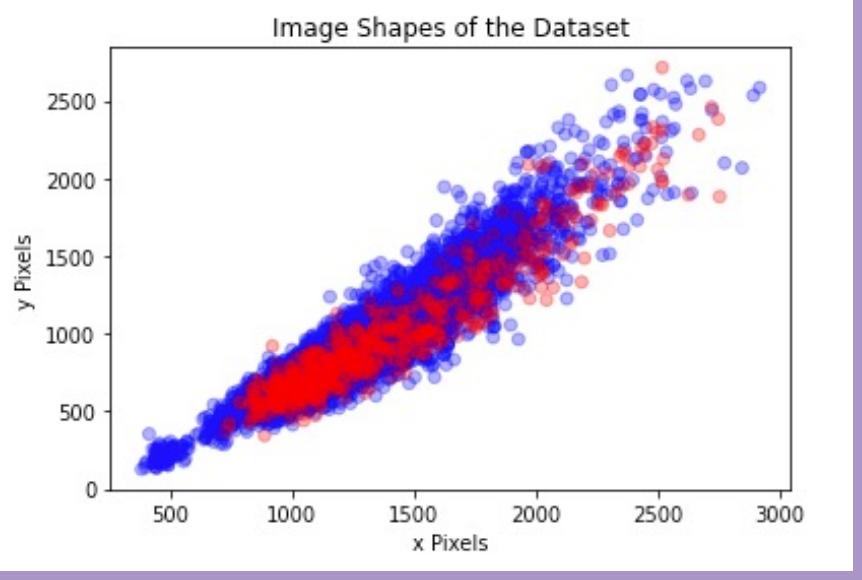
Pediatric Pneumonia Chest X-ray <https://www.kaggle.com/andrewmvd/pediatric-pneumonia-chest-xray>

Dataset by Daniel Kermany and Michael Goldbaum in 2018. All images labelled as either pneumonia or normal
Kermany, Daniel; Zhang, Kang; Goldbaum, Michael (2018), "Labeled Optical Coherence Tomography (OCT) and Chest X-Ray Images for Classification", Mendeley Data, v2 <http://dx.doi.org/10.17632/rschjbr9sj.2>

Data set 5856 images in folders: All images jpeg with various resolutions and proportions, no missing data
Final Train, Test, Valid split: 80%, 10%, 10%

Model Dataset:

test	NORMAL	157 files
	PNEUMONIA	157 files
train	NORMAL	1267 files
	PNEUMONIA	1799 files
valid	NORMAL	157 files
	PNEUMONIA	157 files



Unbalanced number of files:

- Pics: 1583 Normal, 4274 pneumonia
- Small number of files lower in resolution
- Most image ratios within consistent spread
- Copied files into modeling folders
- Test: 10% of data, equal # norm, pneu
- Train: 80% of data, rest of norm, % above pneu
- Valid: 10% of data, equal # norm, pneu

Modeling Files:

New folder structure (test,train,valid)

Unbalanced file count - could impact analysis

Copied % of pneumonia train to discard folder to balance file counts

Image Preprocessing

Preprocess to make images similar and comparable

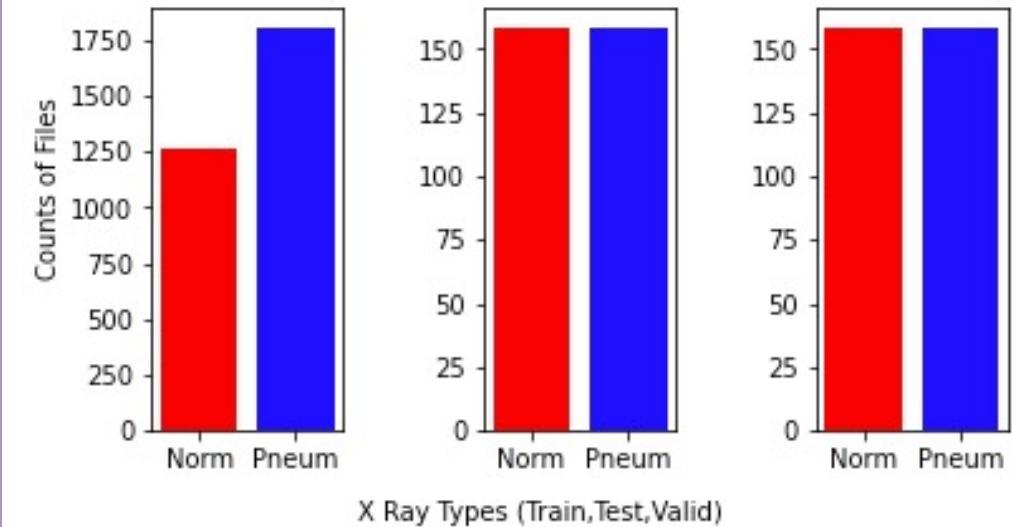
Read each file individually, and applied the following:

- Resize: set all to 300 pixels x 300 pixels. (square)
- Alpha: Contrast, set to 1.0
- Beta: Brightness, set to 1.0

(note: multiple runs tested alpha, beta combos between 0.5 and 1.2 inclusively and best results found for 1.0 each)

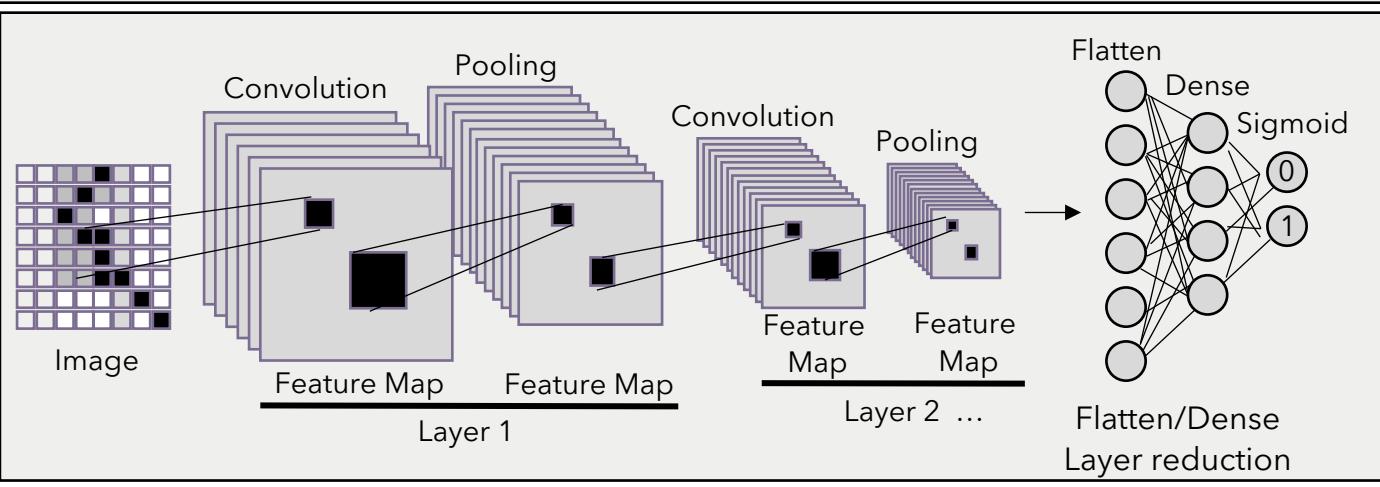
- Grayscale: all images changed from RGB to gray
- Normalize: all values normalized to 1 based on #/255

Image File Counts by Category



Multiple test sets established: varied between Train folder holding same number of files each to progressive steps of 10% more pneumonia files. Was worried about tradeoff between biasing results and removing files from training.

CNN Model Build



Sequential Model: all outputs lead to inputs next layer

Rectified Linear approach: directed outputs- easy to train

Sigmoid: final reduction results in a 1 or 0 - used for predictions

Optimizer = 'adam'

Loss = 'binary_crossentropy'

Early stopping: metric "accuracy", min_delta=0.01, patience=2

Model: "sequential_1"

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 298, 298, 32)	320
max_pooling2d_1 (MaxPooling2D)	(None, 149, 149, 32)	0
conv2d_2 (Conv2D)	(None, 147, 147, 32)	9248
max_pooling2d_2 (MaxPooling2D)	(None, 73, 73, 32)	0
conv2d_3 (Conv2D)	(None, 71, 71, 64)	18496
max_pooling2d_3 (MaxPooling2D)	(None, 35, 35, 64)	0
flatten_1 (Flatten)	(None, 78400)	0
dense_2 (Dense)	(None, 64)	5017664
dense_3 (Dense)	(None, 1)	65
Total params: 5,045,793		
Trainable params: 5,045,793		
Non-trainable params: 0		

Three models were applied on each analysis:

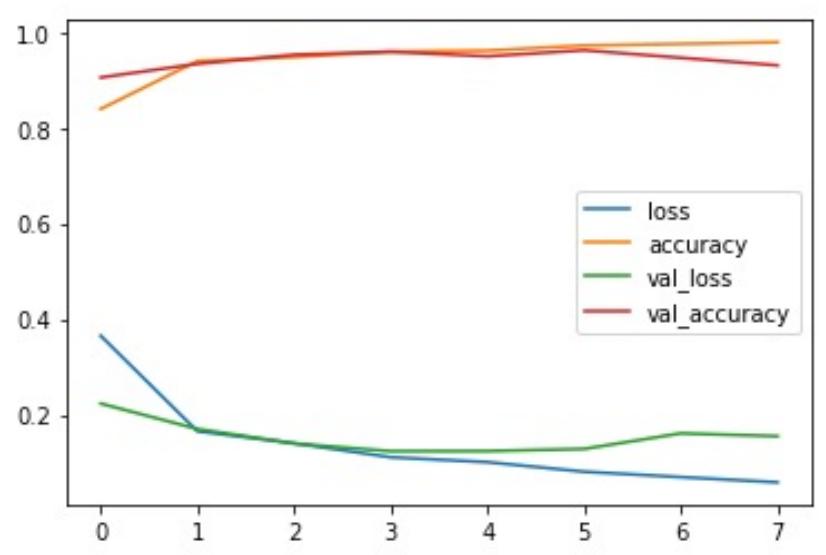
Model 1 = 1 layer

Model 2 = 3 Layers (shown above)

Model 3 = 5 Layers

Three models used for analysis on which was better fit: Not known initially

Model Performance



Model 2 chosen:

Performed better for all parameters
Best for dataset with 40% more pneumonia files than normal files

Model stopped at 7 Epochs

Accuracy : 95.8%

Precision : 96.8%

Recall : 94.9%

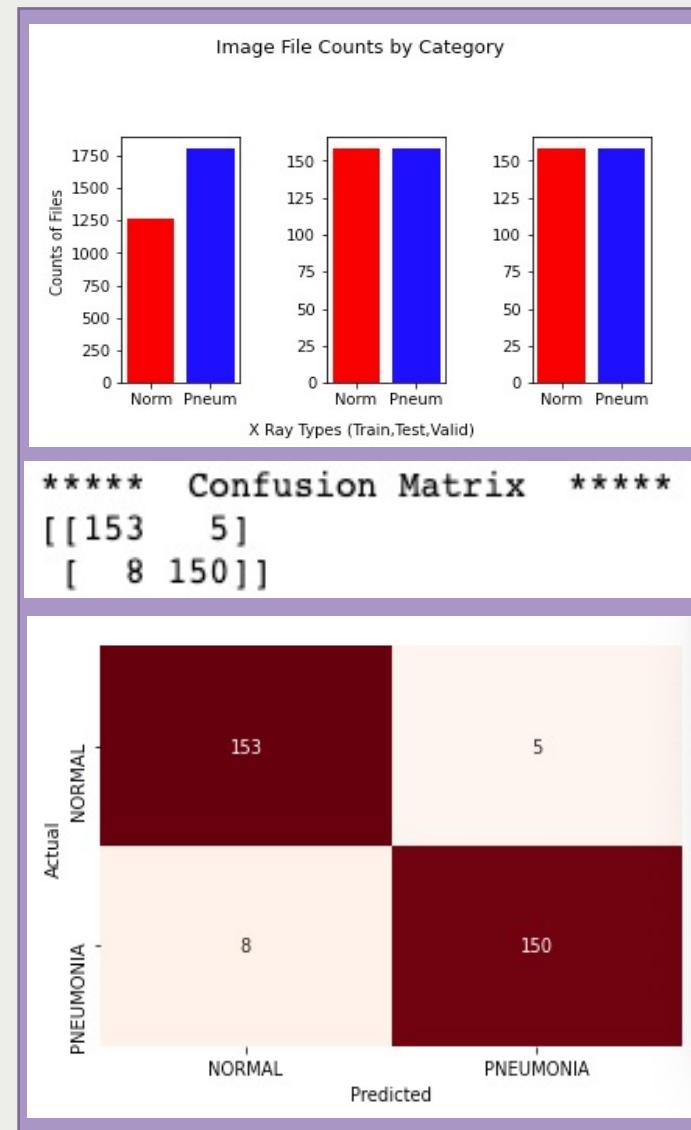
F1 score : 95.8%

***** Classification Report *****				
	precision	recall	f1-score	support
NORMAL	0.95	0.97	0.96	158
PNEUMONIA	0.97	0.95	0.96	158
accuracy			0.96	316
macro avg	0.96	0.96	0.96	316
weighted avg	0.96	0.96	0.96	316

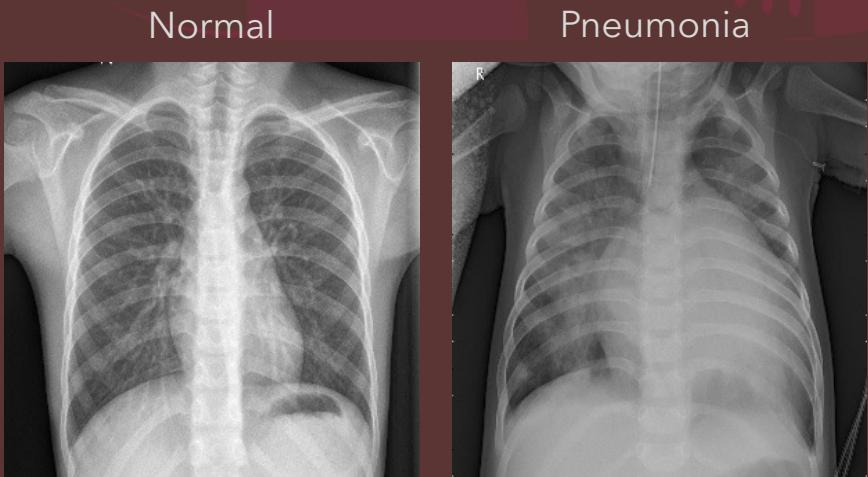
***** Metric Scores *****
Accuracy : 0.958861
Precision: 0.967742
Recall : 0.949367
F1 score : 0.958466

This model accurately predicted pneumonia 150 times, incorrectly Predicted it as normal only 8 times.

This model accurately predicted normal 153 times, incorrectly predicted it as pneumonia only 5 times.



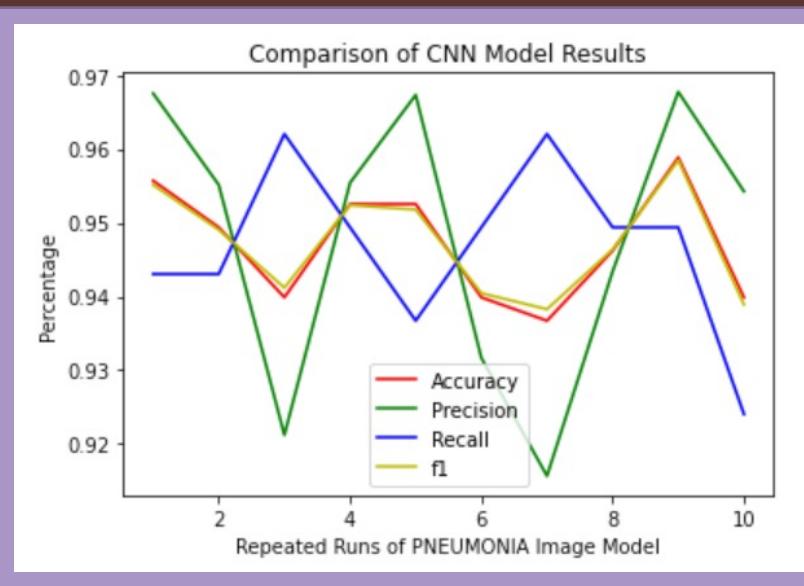
Recommendations



The image evaluation model produced accurate results with 94.7% accuracy¹

The model met the objectives and did predict with a level of confidence above 90%.

This model had a balanced level of precision and recall to avoid bias towards normal or pneumonia.



¹The model was run 10 consecutive times on the same dataset, it was shown that a potential range of accuracy of 93.6% to 95.8% was possible. The average accuracy over these 10 runs was 94.7% with a standard deviation of 0.8%