Using AI: Pneumonia Detection

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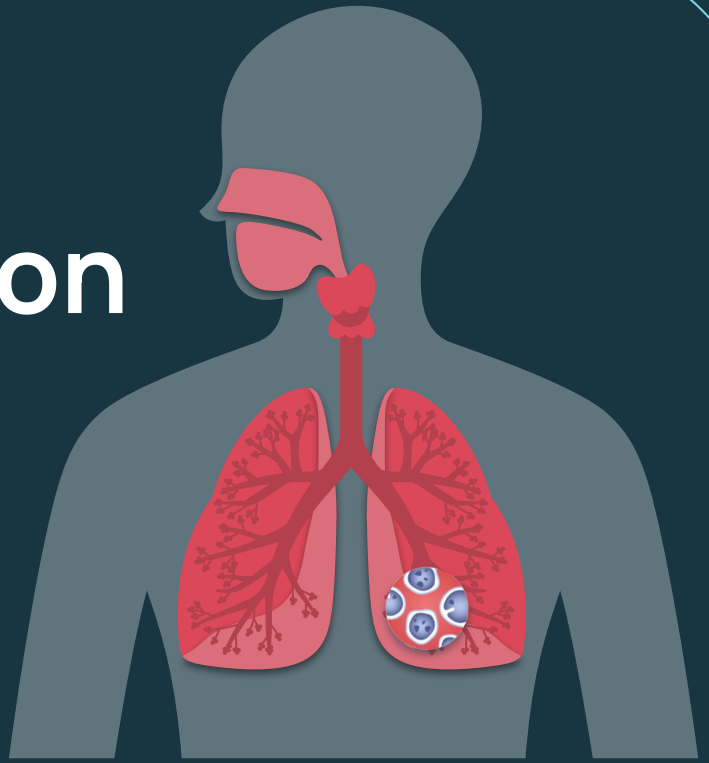

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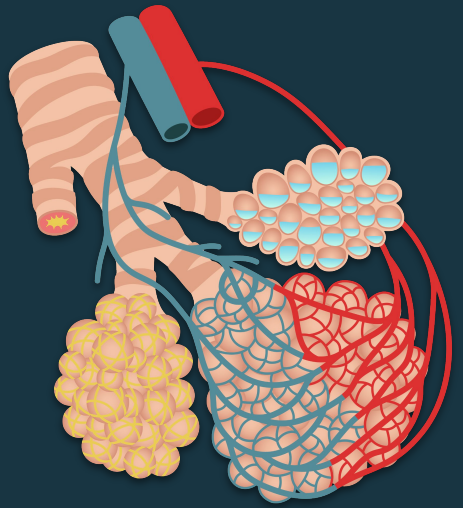
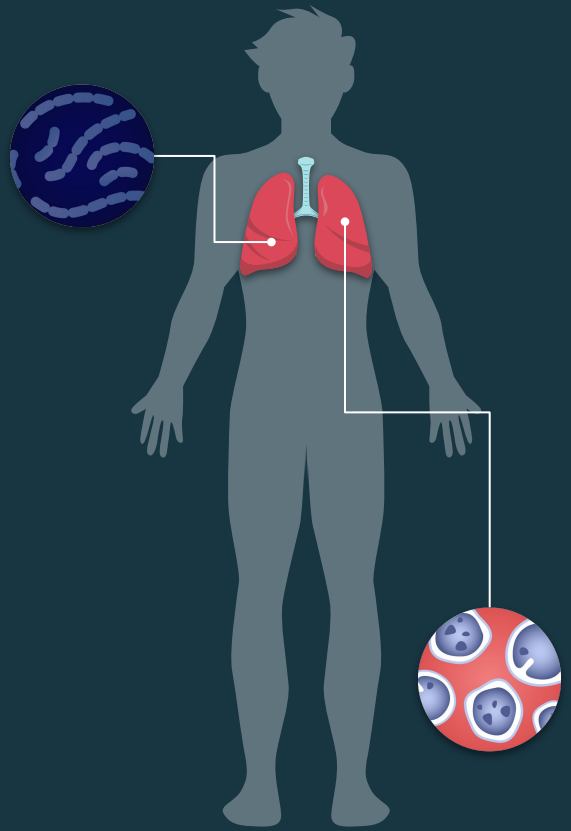
AI in medicine

What have you heard about the applications of AI in healthcare? Let us know in the chat!



What is pneumonia? How do we detect it?

- Inflammation of air sacs
- Fluid in the lungs
- Caused by viruses, bateria, or most recently strains due to COVID-19
- Blood tests
- X-Rays



2,500,000

People die of pneumonia every year
(and those are just the ones that are recorded!)

https://ourworldindata.org/grapher/death-rates-from-pneumonia-and-other-lower-respiratory-infections-vs-gdp-per-capita?xScale=linear&yScale=linear&tab=chart" loading="lazy" style="width: 100%; height: 600px; border: 0px none;" allow="web-share; clipboard-write"

The Coding Process

Building & Training our model

What is Metadata?

Metadata is the information about the images…

- Class: 0 (healthy) and 1 (pneumonia)
- Index: the location in our metadata
- Rows: How many images we have in total

	class	split	index
0	0.0	train	0
1	0.0	train	1
2	1.0	train	2
3	0.0	train	3
4	1.0	train	4
...	...	...	...
2395	1.0	test	2395
2396	0.0	test	2396
2397	0.0	test	2397
2398	1.0	test	2398
2399	0.0	test	2399

2400 rows × 3 columns

Our AI Model

CNN Model

- Combination of neurons
- Processes images like our visual system
- It uses the input images and learns about features using spatial relationships which are processed into patterns to classify the image.

MLP Model

- Flattened
- It processes data one step at a time to understand context and then adjusts to learn patterns and make predictions.

Our Datasets

1. Data Splits

- Training data: Labelled images
- Test data: Used to evaluate the model's performance after training.
- Field data: Real world data

```
X_train, y_train = get_train_data()
X_test, y_test   = get_test_data()
```

Initializing training and testing data

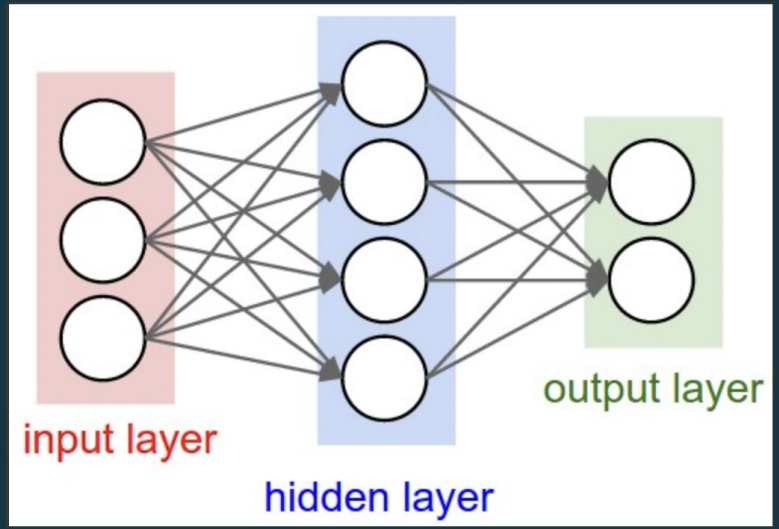
```
X_field , y_field = get_field_data()
```

Initializing field data

Our Datasets

2. Network Architecture

- Layers: Convolutional and Dense Layers
- Convolutional: ReLU activation, convolutional operations to images
- Dense : fully connected, flattened feature maps
- Transfer Learning: Faster training!



Code snippets!

```python
#@title Run this to test if your model is right!
model_1_answer = Sequential()
model_1_answer.add(InputLayer(input_shape=(3,)))
model_1_answer.add(Dense(4, activation = 'relu'))
model_1_answer.add(Dense(2, activation = 'softmax'))
model_1_answer.compile(loss='categorical_crossentropy',
optimizer = 'adam',
metrics = ['accuracy'])

model_1_config = model_1.get_config()

del model_1_config["name"]
for layer in model_1_config["layers"]:
  del layer["config"]["name"]

model_1_answer_config = model_1_answer.get_config()

del model_1_answer_config["name"]
for layer in model_1_answer_config["layers"]:
  del layer["config"]["name"]

if model_1_answer_config == model_1_config:
  print('Good job! Your model worked')
else:
  print('Please check your code again!')
```

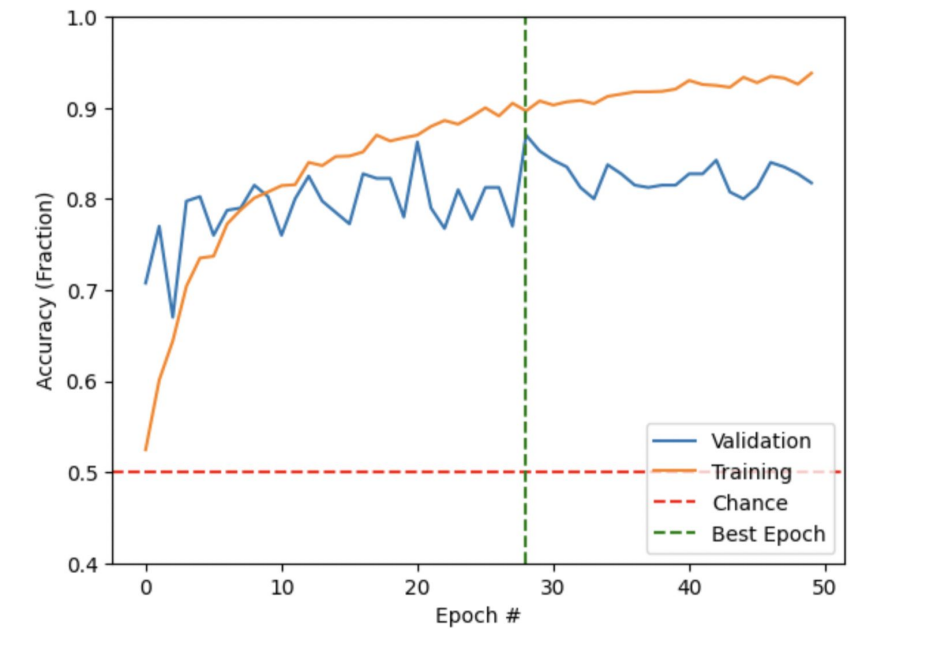
```
Good job! Your model worked
```

Testing

```python
[4]
### YOUR CODE HERE:
model_1 = Sequential()
model_1.add(InputLayer(input_shape=(3,)))
model_1.add(Dense(4, activation = 'relu'))
model_1.add(Dense(2, activation = 'softmax'))
model_1.compile(loss='categorical_crossentropy',
                optimizer = 'adam',
                metrics = ['accuracy'])
### END CODE
```

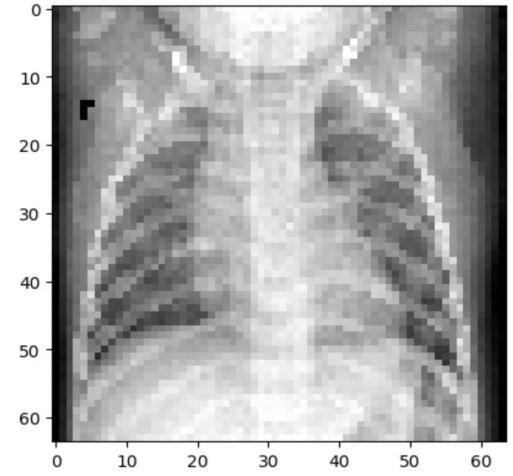
Initializing

Results



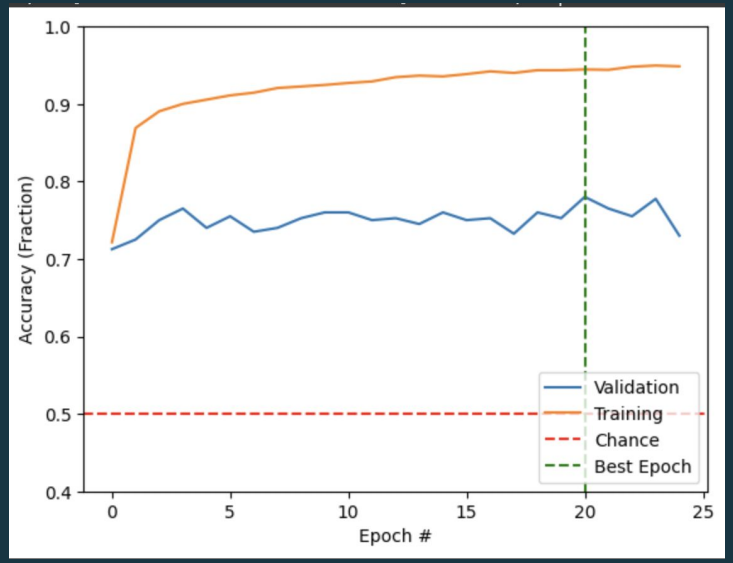

```
1  for i in range (3):
2    plot_one_image(X_train, y_train, i)
3    plot_one_image(X_test, y_test, 1)
4    plot_one_image(X_field, y_field, 1)
```

```
Label: 0.0
```




```
Label: 1.0
```

Code snippets(Transfer Learning)!



Result

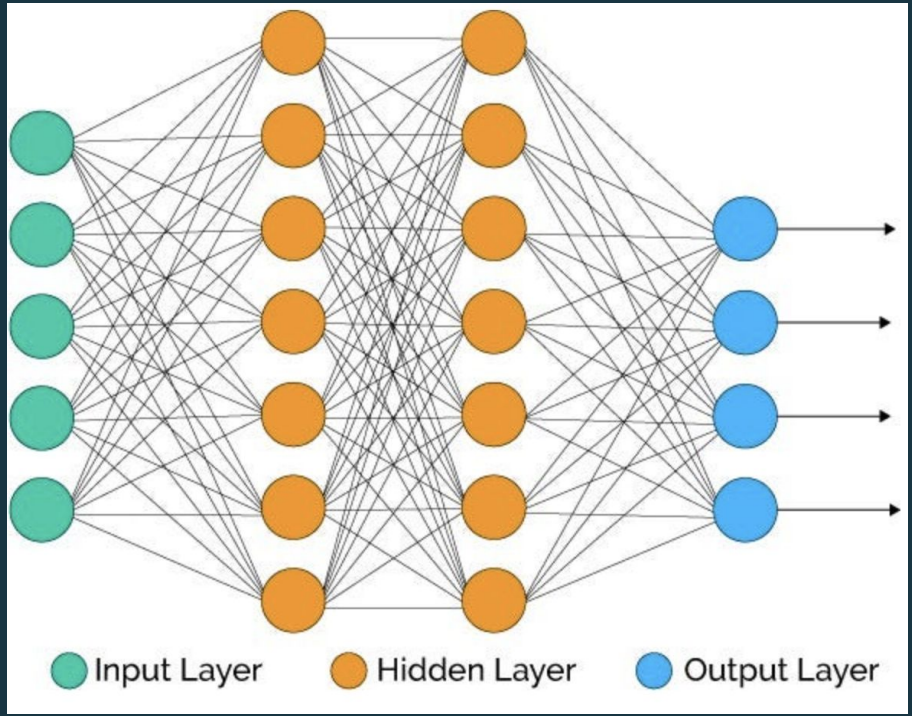
```
1  transfer = TransferClassifier(name = 'VGG16')
2  transfer.fit(X_train, y_train, epochs = 20, validation_data = (X_test, y_test),
   shuffle = True, callbacks = [monitor])
```

Initializing transfer learning

Our Datasets

Training

- Epochs: one complete pass of the training data set through the algorithm
- What does the number of epochs depend on?
- Accuracy: hidden layers, epochs and augmentation



Code snippets!

```
### YOUR CODE HERE

X_train, y_train = get_train_data()
X_test, y_test   = get_test_data()
X_field, y_field = get_field_data()

average_accuracy = 0.0
for i in range(5):
  cnn_temp = CNNClassifier(5)
  cnn_temp.fit(X_train, y_train, epochs = 5, validation_data = (X_test,
  y_test), shuffle = True, callbacks = [monitor])

  y_pred = (cnn_temp.predict(X_field) > 0.5)
  accuracy = accuracy_score(y_field, y_pred)
  print('Accuracy on this run: %0.2f' % accuracy)

  average_accuracy += accuracy / 5.0
print('Average accuracy: ', average_accuracy)
### END CODE
```

Code

```
Accuracy on this run: 0.50
Average accuracy:  0.5005000000000001
```

Accuracy can be very low!

Issues and Solutions

Throughout model-building, we encountered many problems. This is how we solved them:

#1: Field Data

Our friends have provided us some more data!
Hooray!

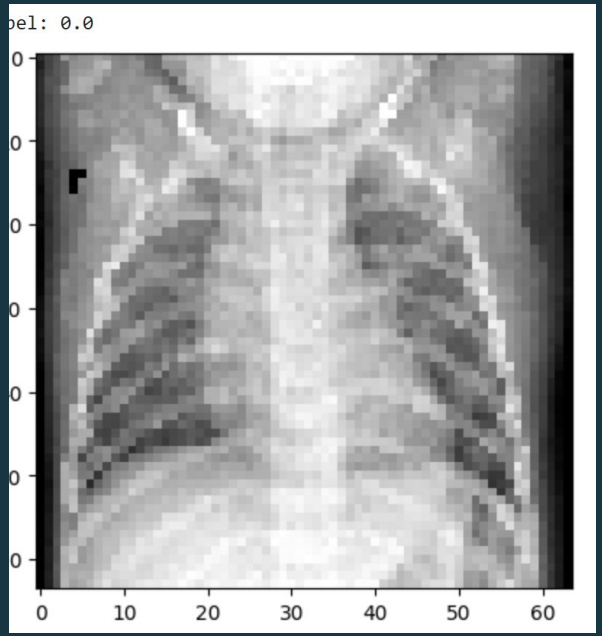
When we run .predict(), the resulting accuracy is only 74% :(

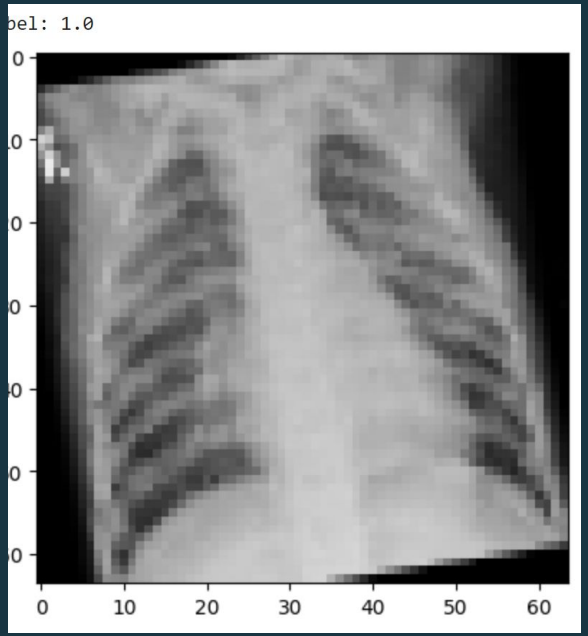
```
y_pred = cnn.predict(X_field) > 0.5
accuracy = accuracy_score(y_field, y_pred)
print(accuracy)
```

```
13/13 [==============================] - 0s 3ms/step
0.74
```

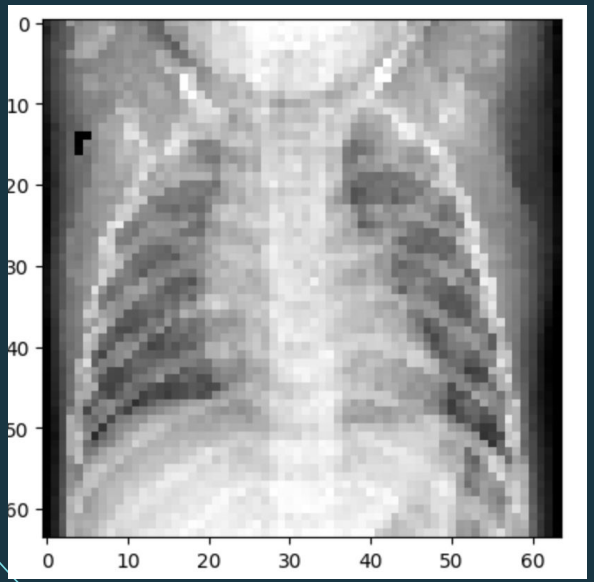
Why?

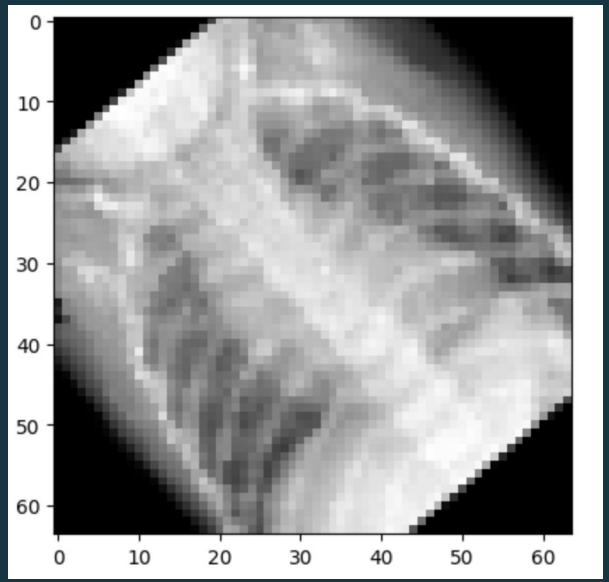
- Train
- Field





Fix - Augmentations





Train dataset

image = X_train

Augmented dataset

new_image = rotate(image, rotate = -40)

Creating More!

```
rotated_L10 = rotate(X_train, rotate=-10)
rotate_R90 = rotate(X_train, rotate=90)
rotate_L90 = rotate(X_train, rotate=-90)
shear_R20 = shear(X_train, shear=20)
shear_L20 = shear(X_train, shear=-20)
sh_ro_R90_R20 = shear(rotate_R90, shear=20)
sh_ro_R90_L20 = shear(rotate_R90, shear=-20)
sh_ro_L90_R20 = shear(rotate_L90, shear=20)
sh_ro_L90_L20 = shear(rotate_L90, shear=-20)
red_train  = remove_color(remove_color(X_train, channel = 1), channel = 2)
```

=

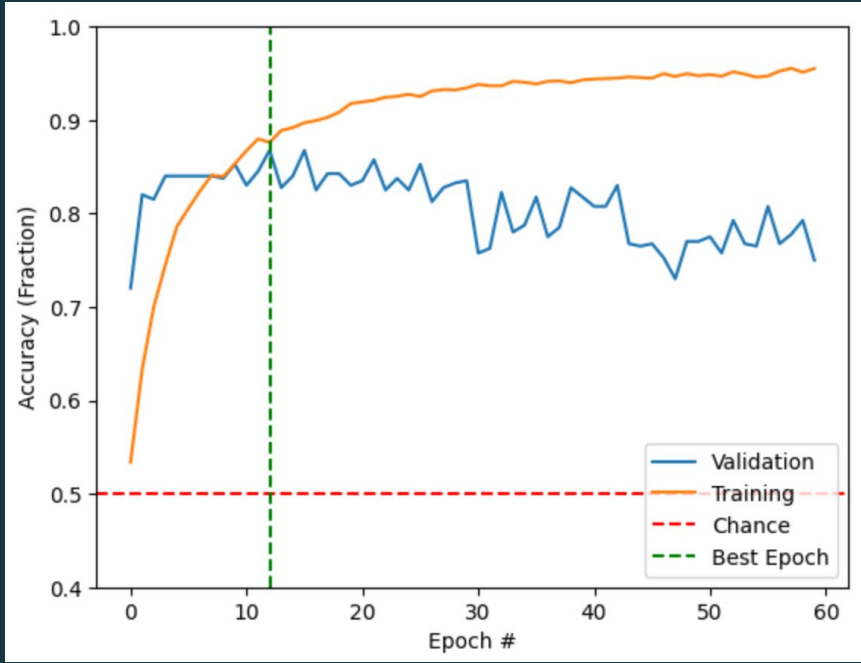
Higher Accuracy!
:)

#2: Overfitting

- Model is too specialized
- “Memorizes” the training data

What is it?

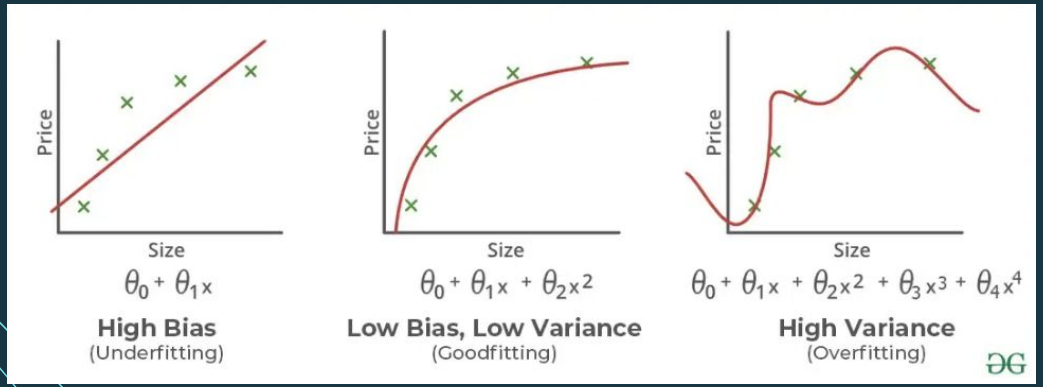
- Performing well on the training set but poorly on the validation set



Fix - Reduce Epochs

```
X_train, y_train = get_train_data()
X_test, y_test   = get_test_data()
cnn = CNNClassifier(num_hidden_layers=2)
history = cnn.fit(X_train, y_train,epochs=50, batch_size=32, validation_data=
(X_test, y_test),
callbacks=[monitor])
plot_acc(history)
```

```
63/63 [==============================] - 0s 8ms/step - loss: 1.2277 - accuracy: 0.9125 - val_loss: 1.3427 - val_accuracy: 0.8375
Epoch 36/50
63/63 [==============================] - 1s 8ms/step - loss: 1.2080 - accuracy: 0.9150 - val_loss: 1.3425 - val_accuracy: 0.8275
Epoch 37/50
63/63 [==============================] - 0s 8ms/step - loss: 1.1986 - accuracy: 0.9175 - val_loss: 1.3463 - val_accuracy: 0.8150
Epoch 38/50
63/63 [==============================] - 0s 7ms/step - loss: 1.1780 - accuracy: 0.9175 - val_loss: 1.3534 - val_accuracy: 0.8125
Epoch 39/50
63/63 [==============================] - 0s 7ms/step - loss: 1.1735 - accuracy: 0.9180 - val_loss: 1.3361 - val_accuracy: 0.8150
Epoch 40/50
63/63 [==============================] - 0s 7ms/step - loss: 1.1639 - accuracy: 0.9205 - val_loss: 1.3401 - val_accuracy: 0.8150
Epoch 41/50
```

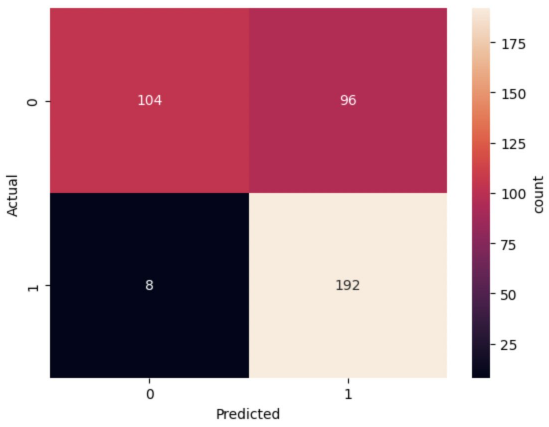


- Too many epochs = possible overfitting
- Not enough epochs = possible underfitting

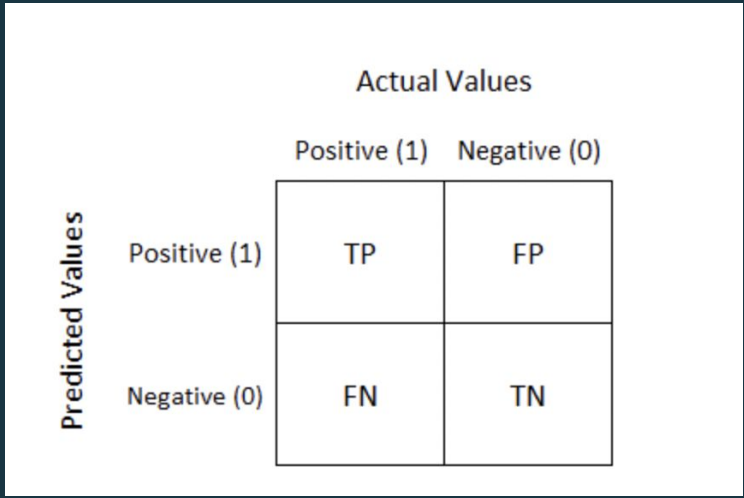
Confusion matrix

```
[ ]  1  # grab our plotting package
     2  import seaborn as sns
     3  import matplotlib.pyplot as plt
```

```
     1  sns.heatmap(confusion, annot = True, fmt = 'd', cbar_kws={'label':'count'});
     2  plt.ylabel('Actual');
     3  plt.xlabel('Predicted');
```



Visualisation of the confusion matrix



Model confusion matrix

Summary

1

Our goal

Pneumonia or healthy from chest X-rays

2

Classification

Images, Labelling and CNN

3

Types of Data

Training, test and field

4

Issues

Overfitting and variation

Real World Application & Integration

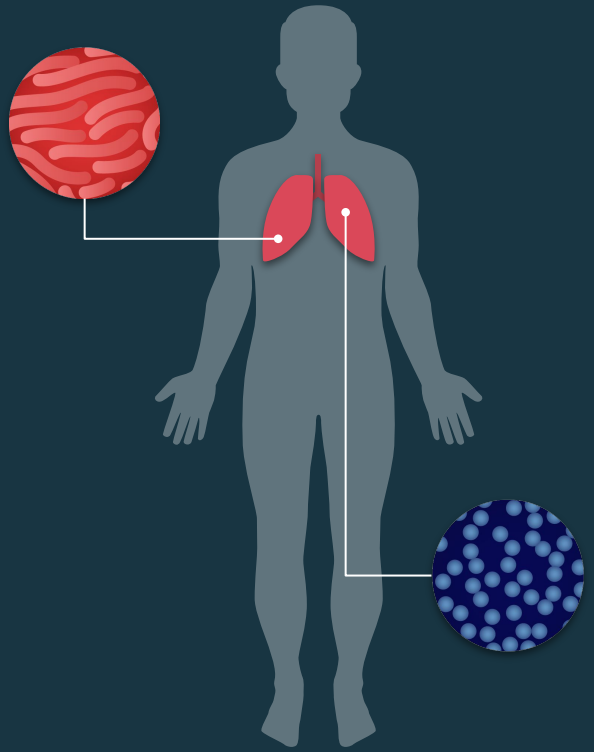
- This would be relatively easy to implement
- Start off by using it alongside doctors
- Develop a high enough accuracy rate to use alone

Benefits of using this model:

Accuracy Levels

Rate of Detection

Economic Factors



Thank you!

We are happy to answer questions-about the process, the coding, or anything else!