Which Mushroom Is That?

Thanks to Springboard mentor

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April 27th 2020 cohort

Springboard

Modeling accomplished with:

Paperspace

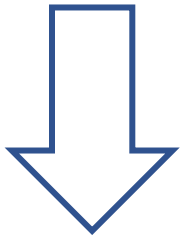
gradient

The Issue

- Mushroom hunting is rewarding, but daunting
- Huge variety of mushrooms
- Some are delicious
- Some are deadly
- How can you tell what you're looking at?

The Question

If you wanted some help identifying mushroom genus (for example, from an app on your smart phone), would it be possible?



Can a model be built to properly classify a mushroom based solely on an image of it?

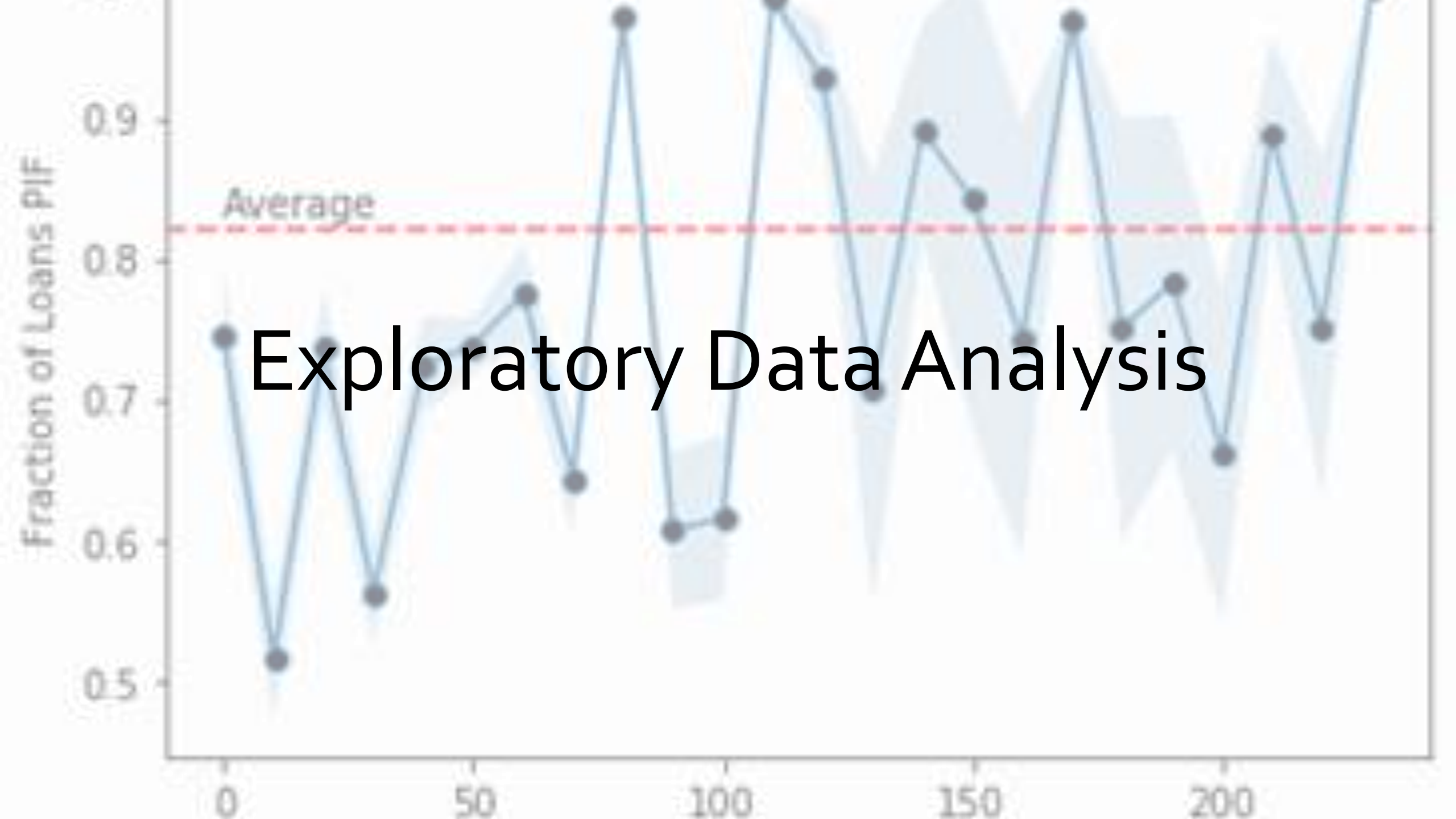
The Approach

Collect a large set of images for each genus of mushroom we want to classify

For this, we leverage the existing Kaggle dataset:

Mushrooms classification - Common genus's images

Consists of common mushrooms from Northern Europe (should be applicable to US as well)



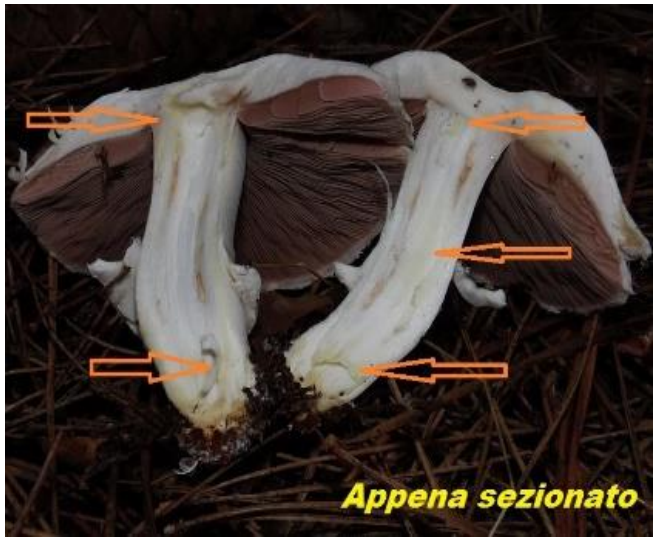
Exploratory Data Analysis

Not all images are useful

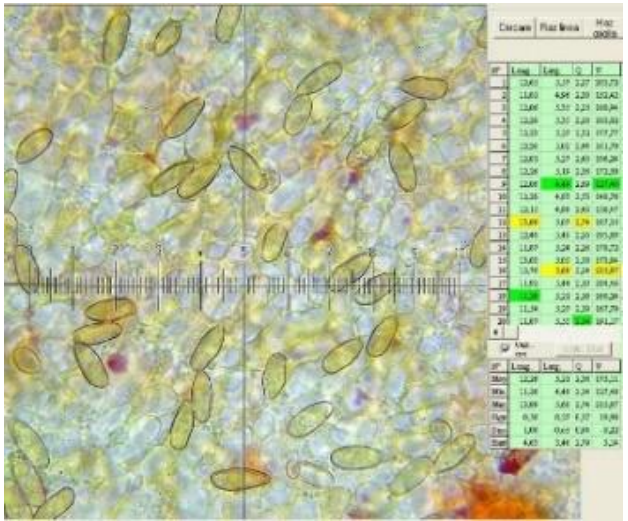
- We cull certain images from dataset, such as:

Not mushrooms

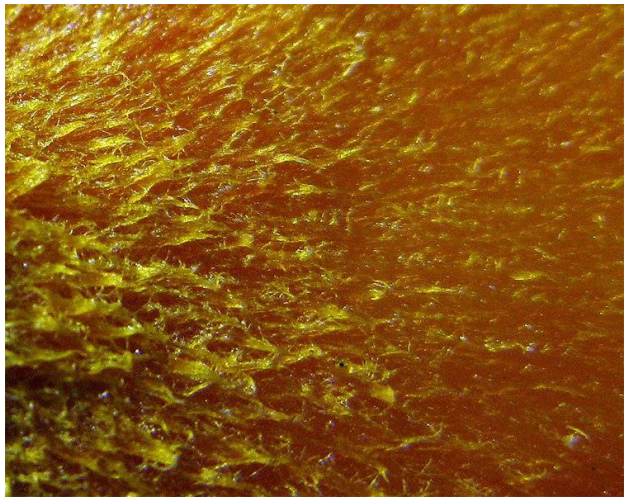
Closeups of stems



Arrows and text



Microscopic images



Extreme closeups

Some we leave in

Non-natural backgrounds

Sliced Mushrooms

Reasonable Closeups

Problems of Variety Within Genus

All of these mushrooms are from the Hygrocybe Genus









Problems of Similarity Across Genera

With a variety of appearance, there can be some overlap

Boletus

Suillus

Lactarius

Russula

Amanita

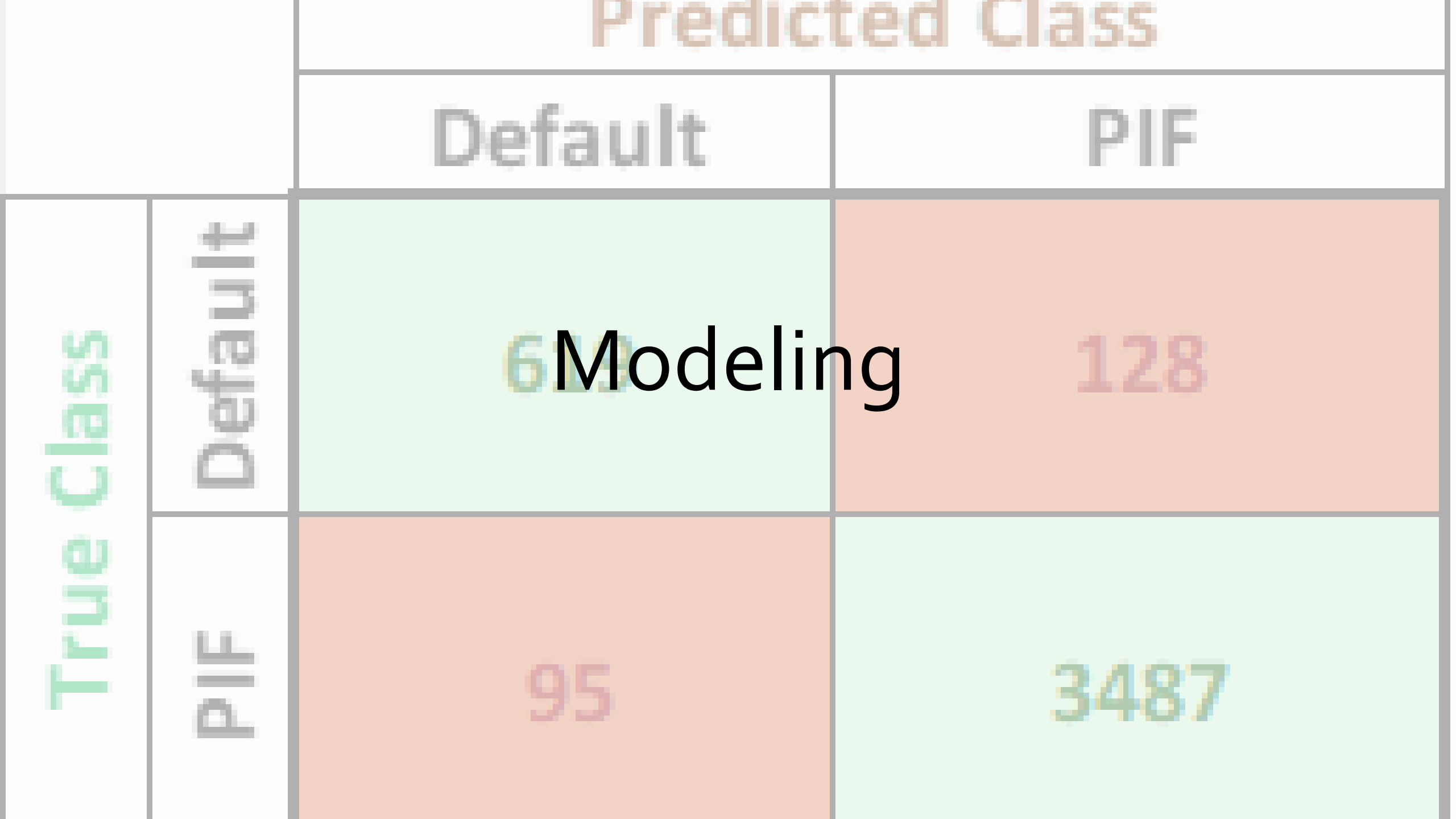
Entoloma

Making all Images Identical Inputs

- Wide range of sizes and aspect ratios
- Transform each image:
  - Center-crop
  - Resize each image to 300X300
  - Retain RGB channels

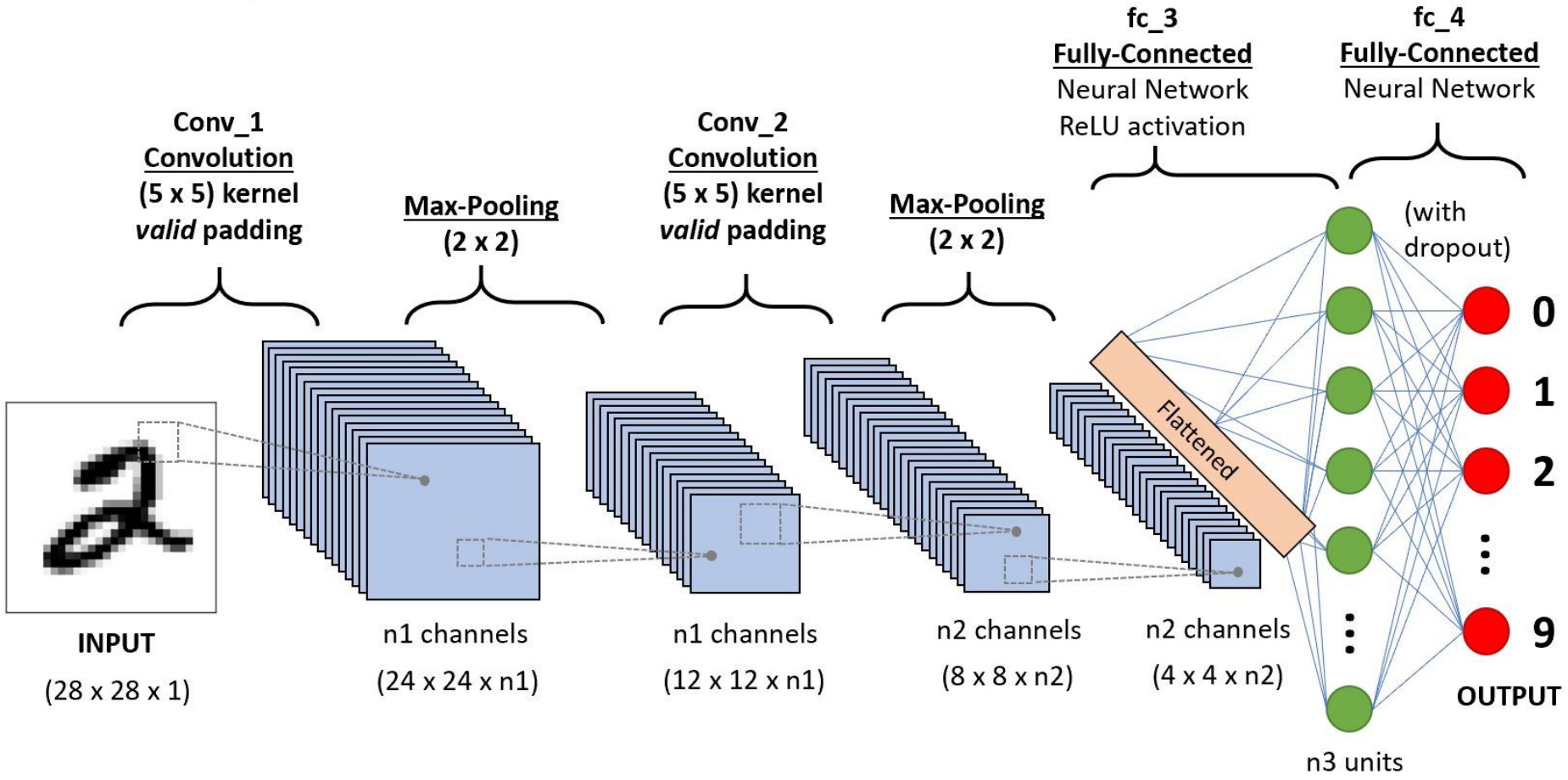
Original Image of a Hygrocybe

Cropped, then resized to 300 X 300


Predicted Class
Default
PIF
True Class
Default
PIF
610
128
95
3487
Modeling

Convolutional Neural Network

- Breaks an image down into a series of patterns ("channels")
- Uses Dropouts to prevent overfitting



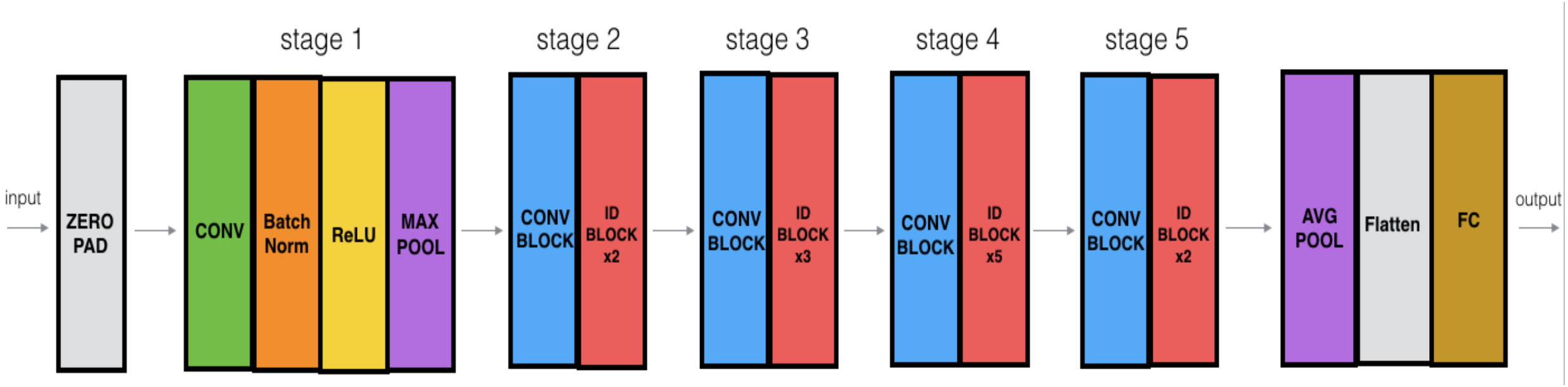
Convolutional Neural Network

- 131,000 Trainable parameters
- Performs very well with binary classification (e.g., a dataset consisting of only Boletus and Russula)

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 298, 298, 5)       140
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 149, 149, 5)       0
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 147, 147, 15)      690
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 73, 73, 15)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 71, 71, 15)        2040
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 35, 35, 15)        0
_________________________________________________________________
flatten (Flatten)            (None, 18375)             0
_________________________________________________________________
dropout (Dropout)            (None, 18375)             0
_________________________________________________________________
dense (Dense)                (None, 7)                 128632
=================================================================
Total params: 131,502
Trainable params: 131,502
Non-trainable params: 0
```

Residual Neural Network (ResNet50)

- Extremely deep learning (i.e., many layers) suffer from issues with vanishing gradients
- Skip connections across stages allow deep learning and greater classification accuracy
- ResNet50 comes pre-trained on ImageNet database (> 14 Million images)



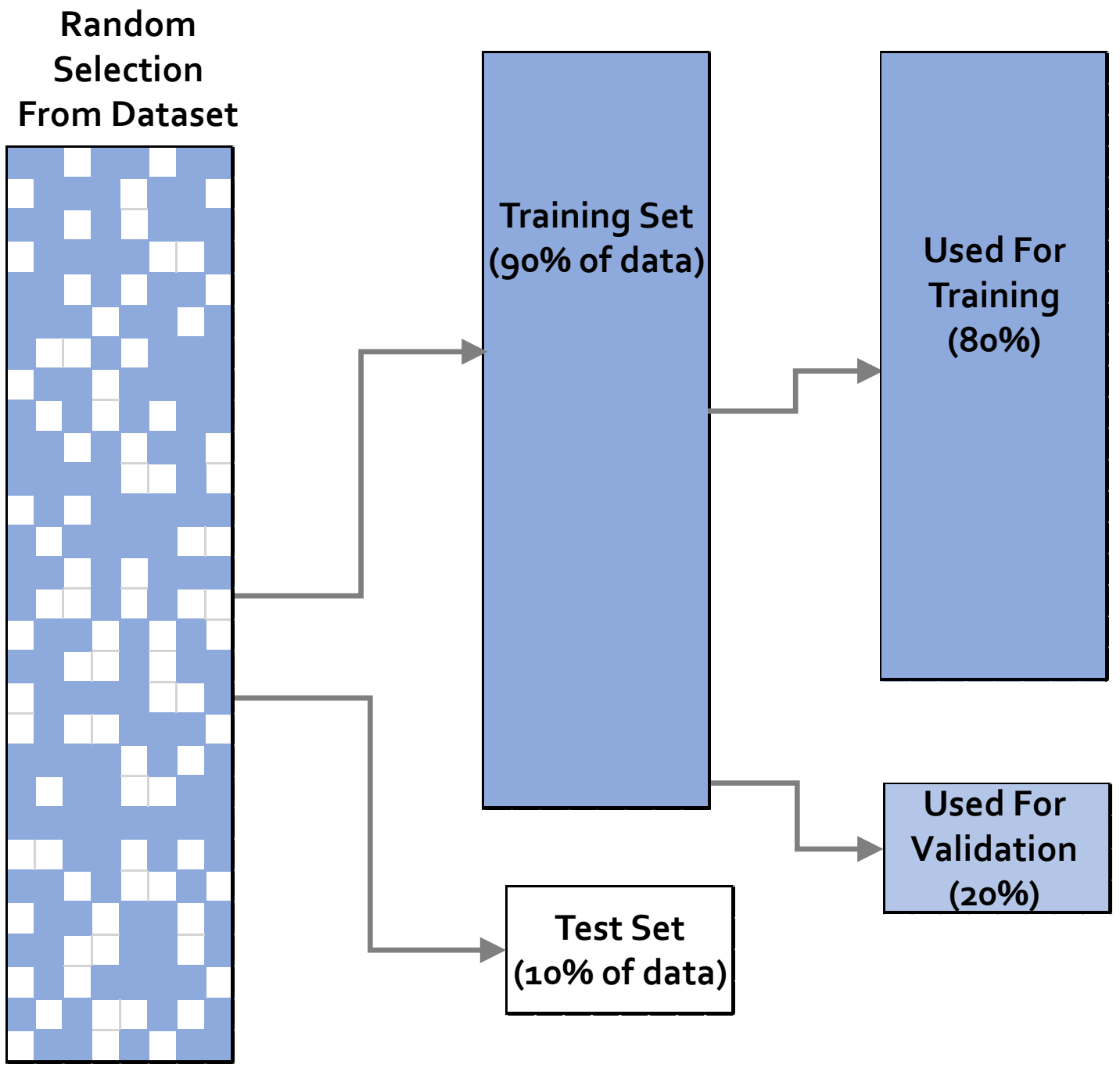
Residual Neural Network (ResNet50)

- Hold the ResNet50 layer as untrainable
- Still over half a million trainable parameters from Dense layers

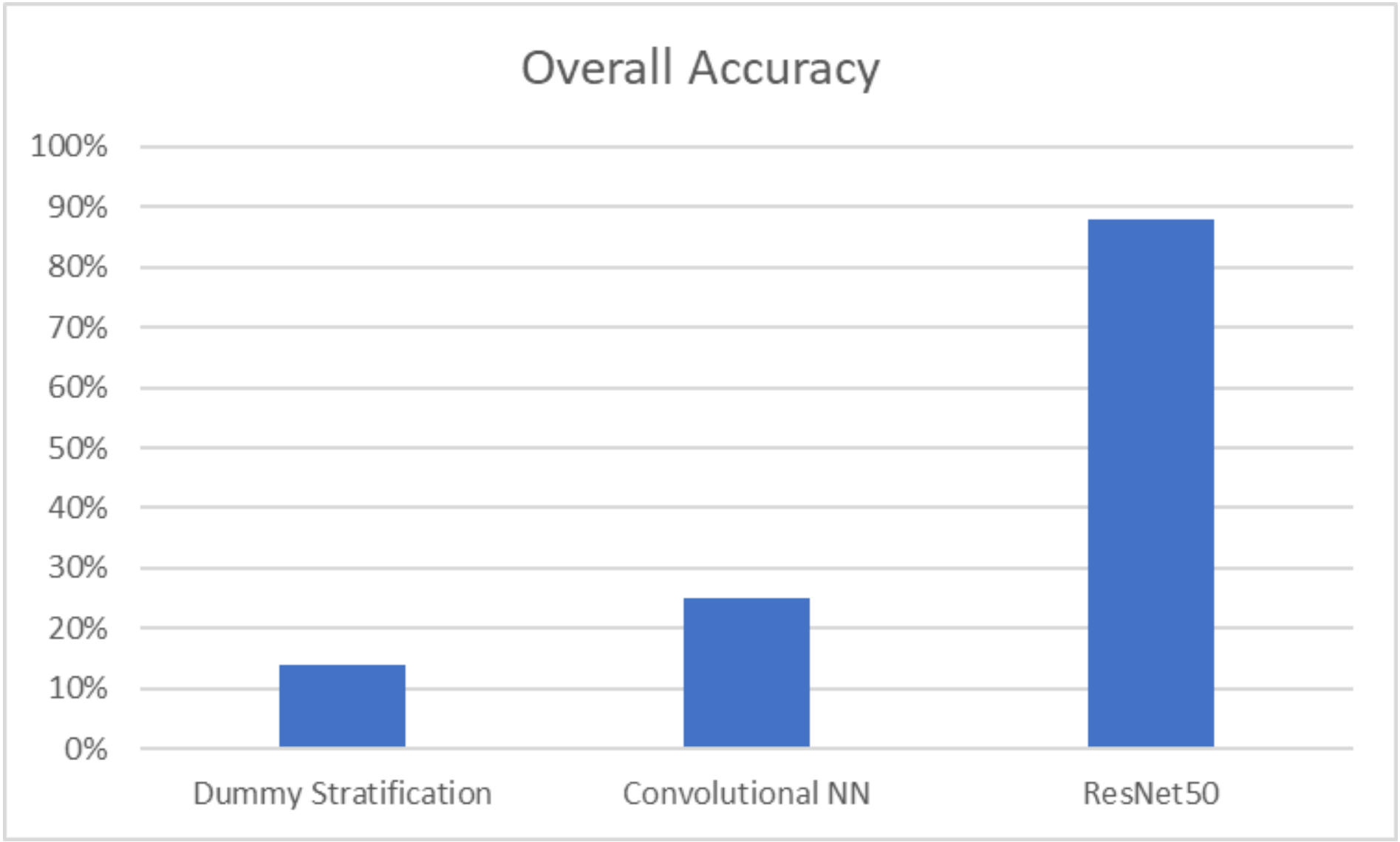
```
Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
resnet50 (Model)             (None, 2048)              23587712
_________________________________________________________________
batch_normalization (BatchNo (None, 2048)              8192
_________________________________________________________________
dense_1 (Dense)              (None, 256)               524544
_________________________________________________________________
batch_normalization_1 (Batch (None, 256)               1024
_________________________________________________________________
dense_2 (Dense)              (None, 128)               32896
_________________________________________________________________
batch_normalization_2 (Batch (None, 128)               512
_________________________________________________________________
dense_3 (Dense)              (None, 7)                 903
=================================================================
Total params: 24,155,783
Trainable params: 563,207
Non-trainable params: 23,592,576
```

Classifier Models

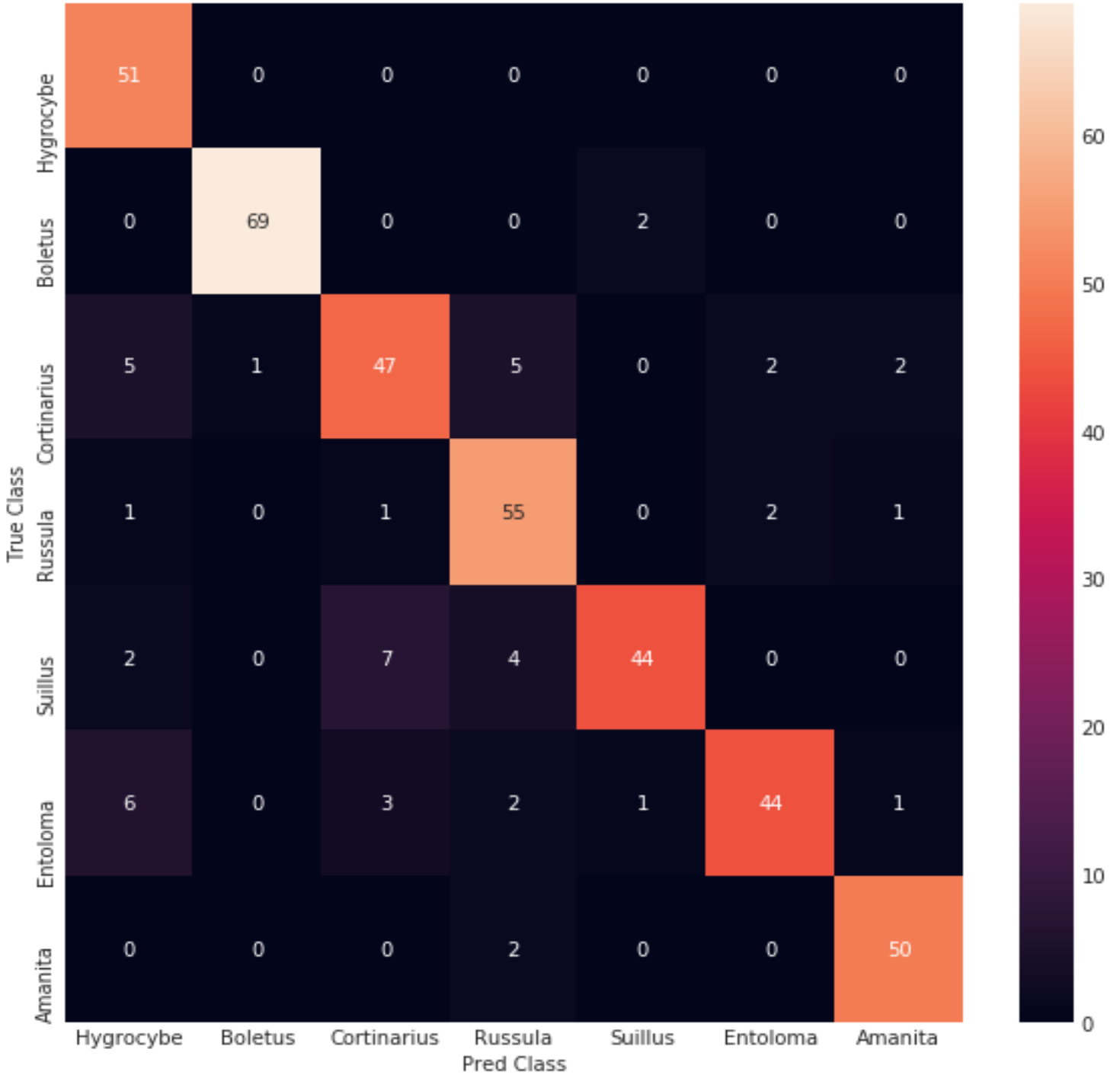
- Nearly 5000 images
- Each image is a row in dataset, 300 X 300 X 3 long.
- Sci-kit Learn's Train/test split
- Training data further divided into training and validation sets
- Optimize model for Validation Set accuracy
- Test on Hold-Out Set



Models Performance Comparison



ResNet50 Model Performance: Confusion Matrix



Model Performance Metrics

	TP	FP	TN	FN	Accuracy	Precision	Recall	F1-score
Hygrocybe	51.0	14.0	345.0	0.0	0.965854	0.784615	1.000000	0.879310
Boletus	69.0	1.0	338.0	2.0	0.992683	0.985714	0.971831	0.978723
Cortinarius	47.0	11.0	337.0	15.0	0.936585	0.810345	0.758065	0.783333
Russula	55.0	13.0	337.0	5.0	0.956098	0.808824	0.916667	0.859375
Suillus	44.0	3.0	350.0	13.0	0.960976	0.936170	0.771930	0.846154
Entoloma	44.0	4.0	349.0	13.0	0.958537	0.916667	0.771930	0.838095
Amanita	50.0	4.0	354.0	2.0	0.985366	0.925926	0.961538	0.943396

- False Positive: Thinking a mushroom is a certain type, when it's not
- False Negative: Thinking a mushroom is a different type, when it's not
- Best classification performance with Amanita and Boletes
- Worst classification performance overall with Cortinarius

Examples of Misclassified Mushrooms

- The model gets confused, because mushrooms can be, well, confusing!
- Dirty, sliced, upside down: many of these are non-ideal presentations

Called Russula, Really Cortinarius

Called Amanita, Really Entoloma

Called Hygrocybe, Really Suillus

Called Russula, Really Cortinarius

Called Cortinarius, Really Suillus

Called Suillus, Really Entoloma

Called Entoloma, Really Russula

Called Cortinarius, Really Entoloma

Called Entoloma, Really Russula

Conclusions

- ResNet50 model is way better at classifying mushrooms than a lay person such as myself. Aggregated accuracy across all seven mushroom genus is approaching 90%.
- Arguably on par with what a human mushroom expert could be expected to do based on images alone.
- Useful as a tool to identify edible mushrooms, such as Boletus (aka Porcini), with 99% accuracy.

Thank You!

more info at [github repository]

Springboard