

Deep Learning Walkthrough - 06

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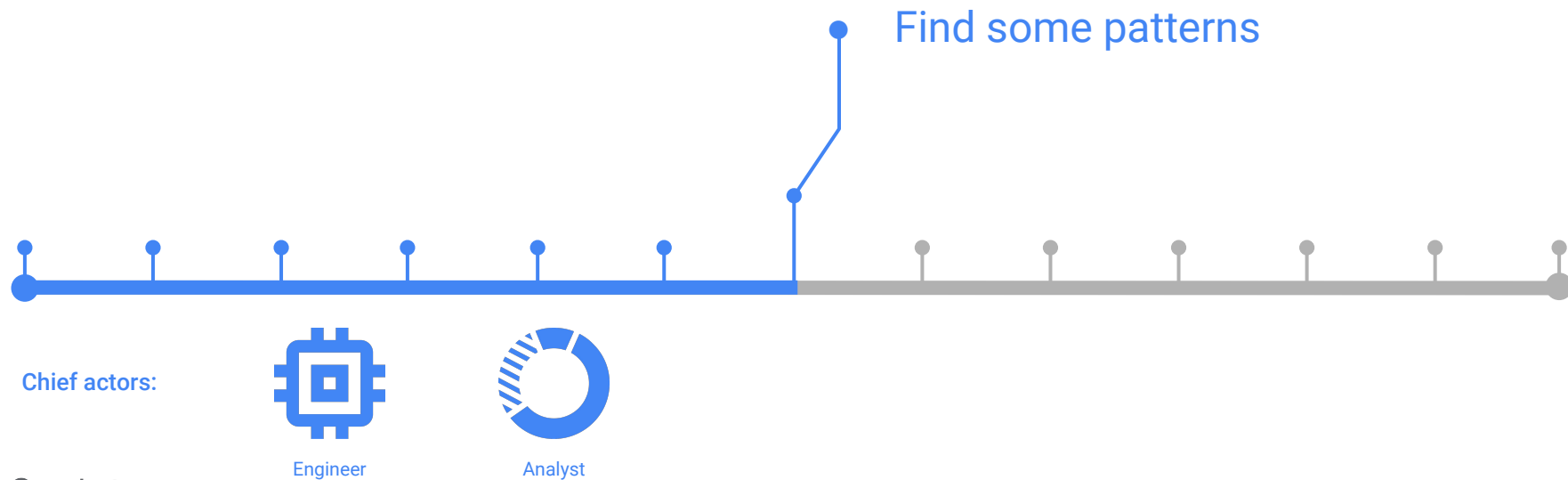
Chief Decision Scientist, Google Cloud

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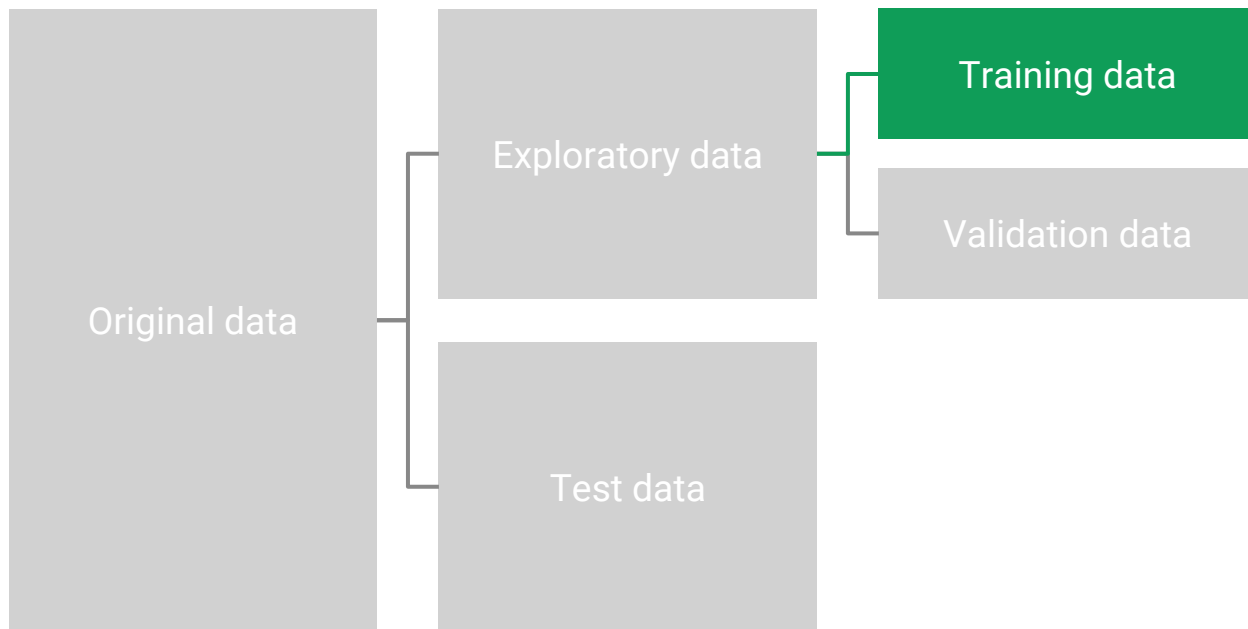
Google Cloud



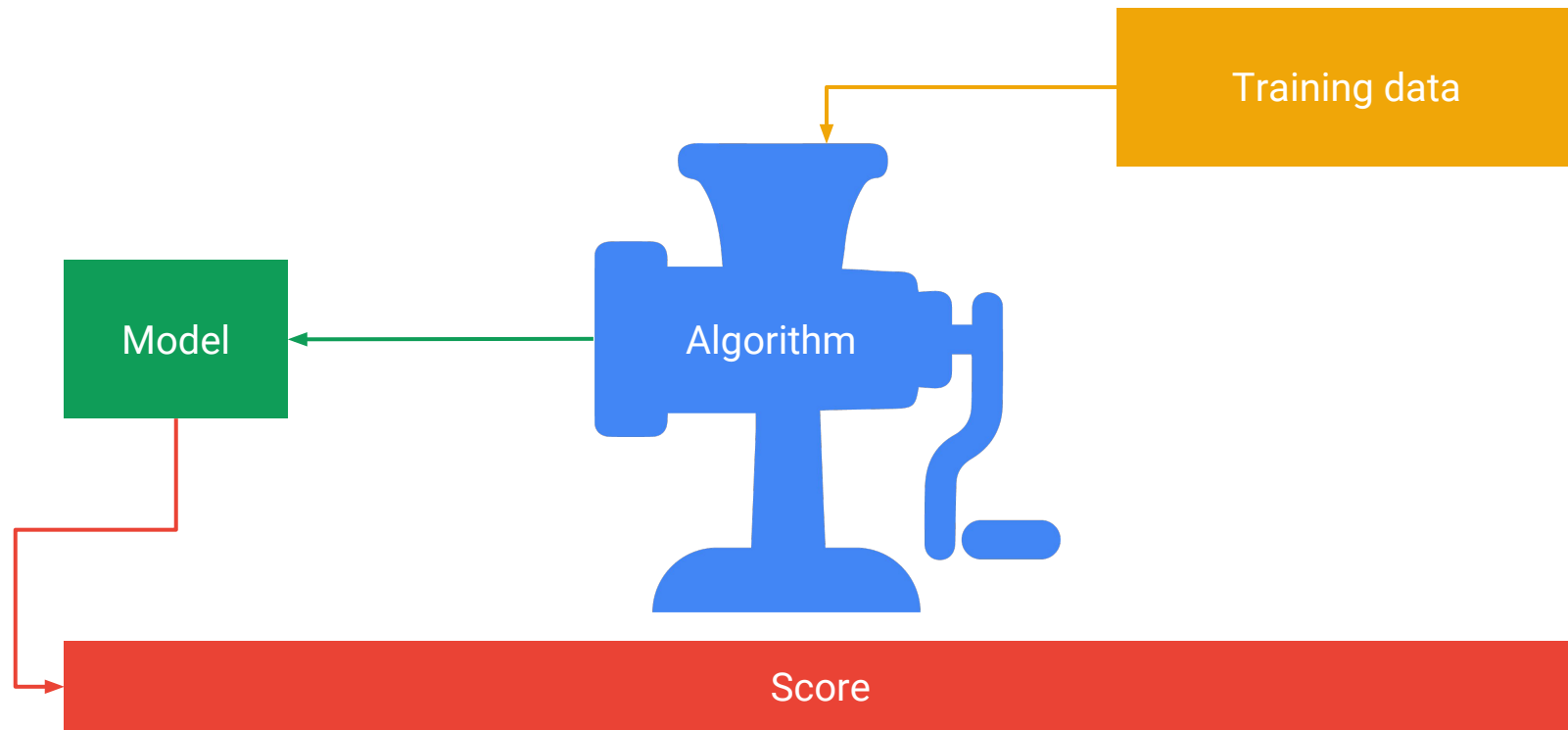
Step 6 | Train your models



Use this, not that



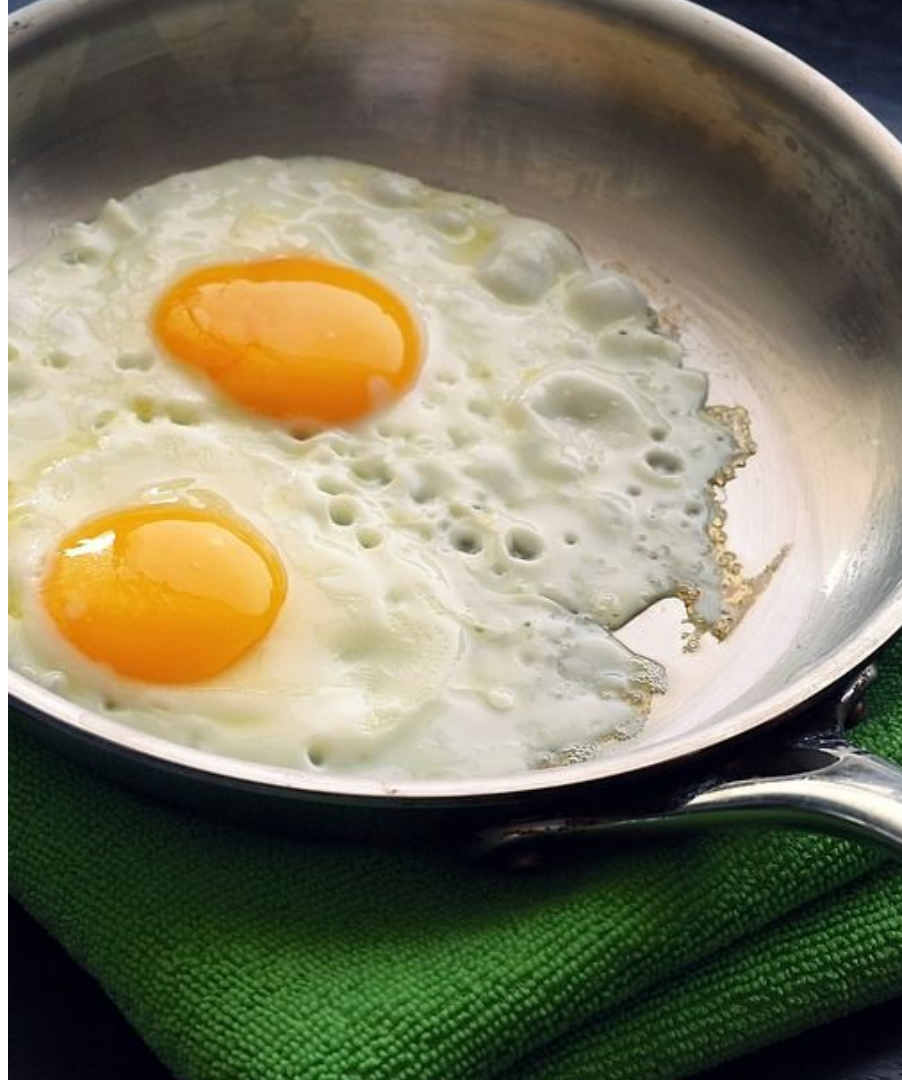
Process



In practice



Training is easy, but getting your data into lots of different methods at scale **takes engineering effort**



In practice

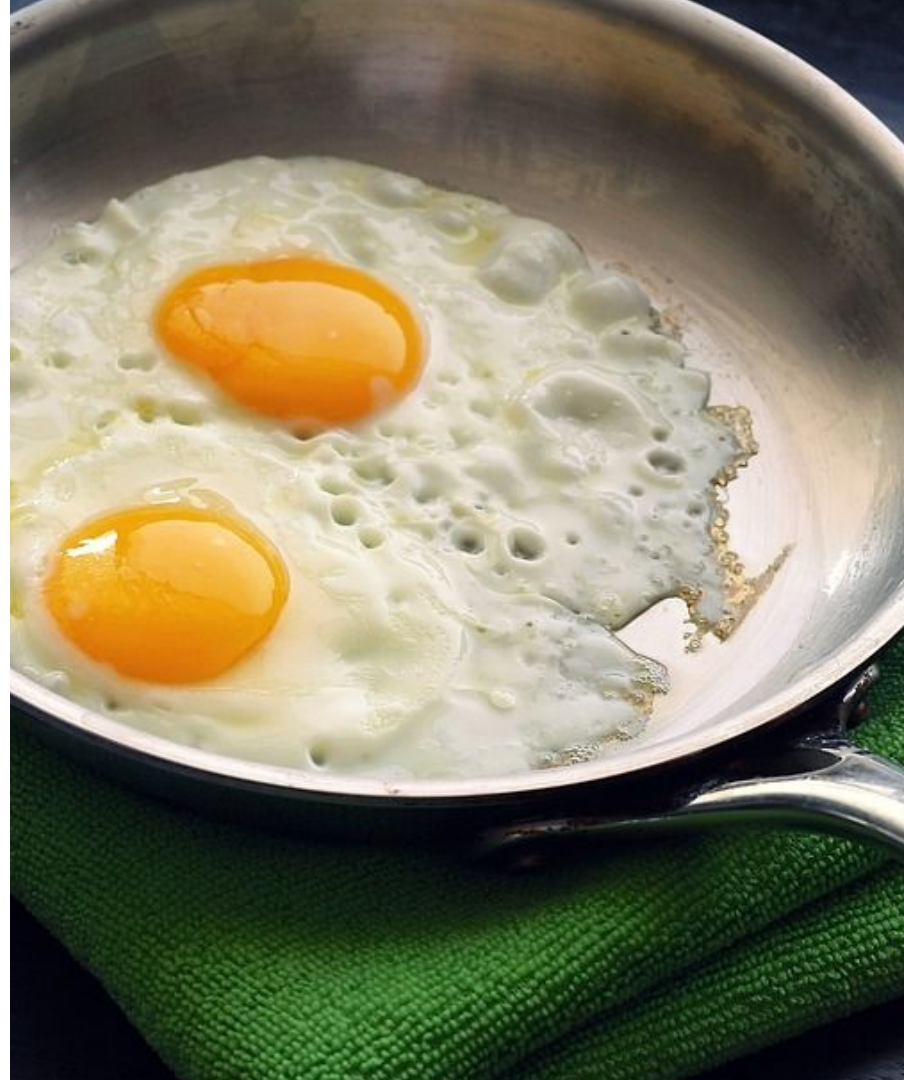


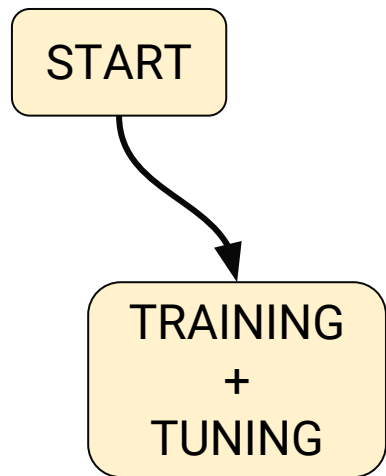
Tinkering can be slow when:

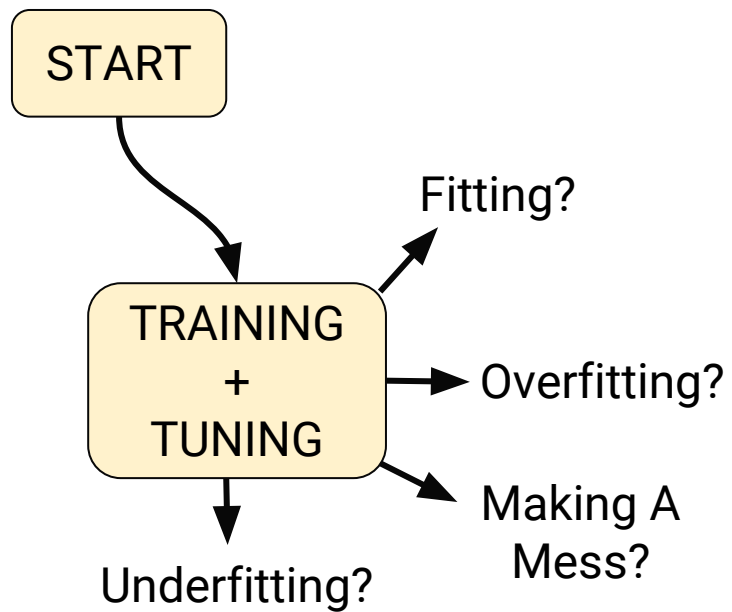
- You have a lot of data
- Software's geared at production

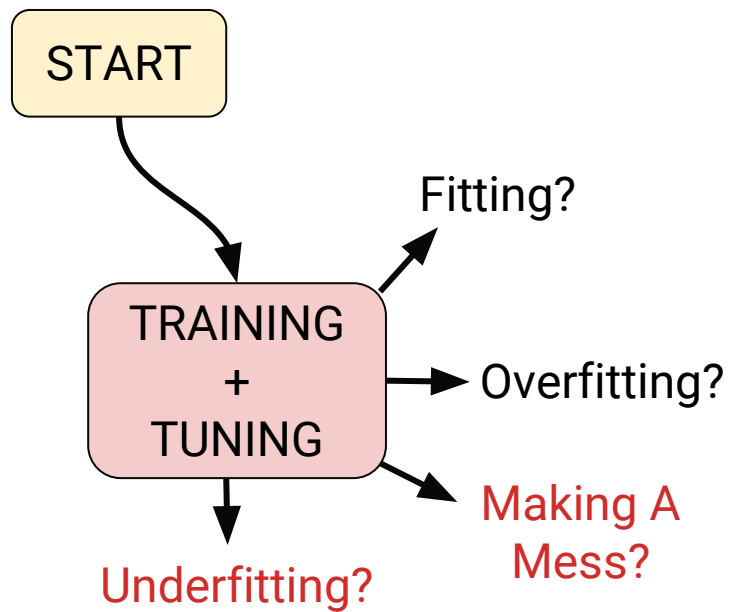
Solutions

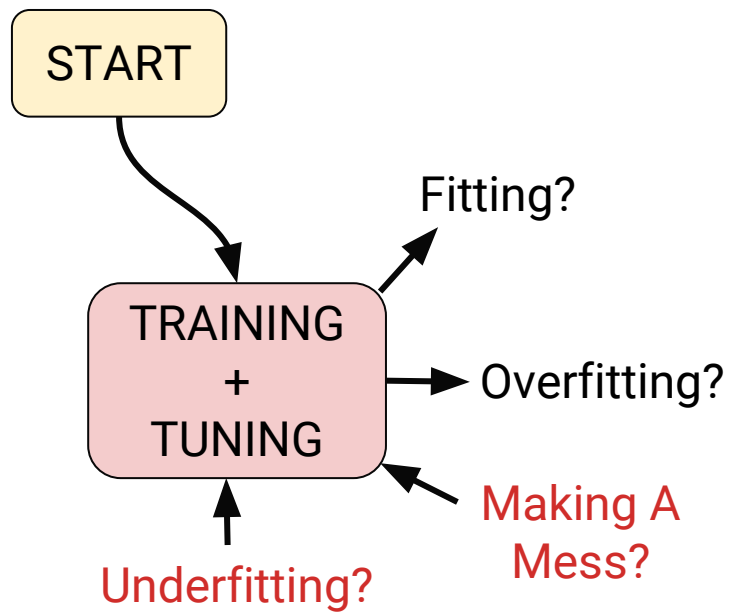
- Use prototyping tools
- Try it with a subset of your training data for inspiration

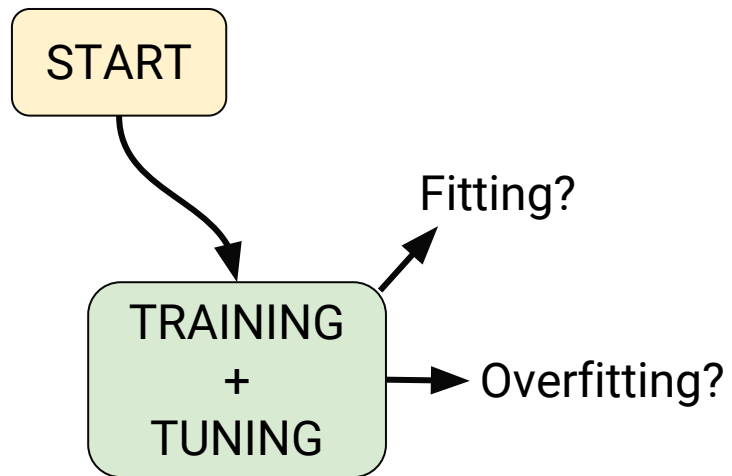


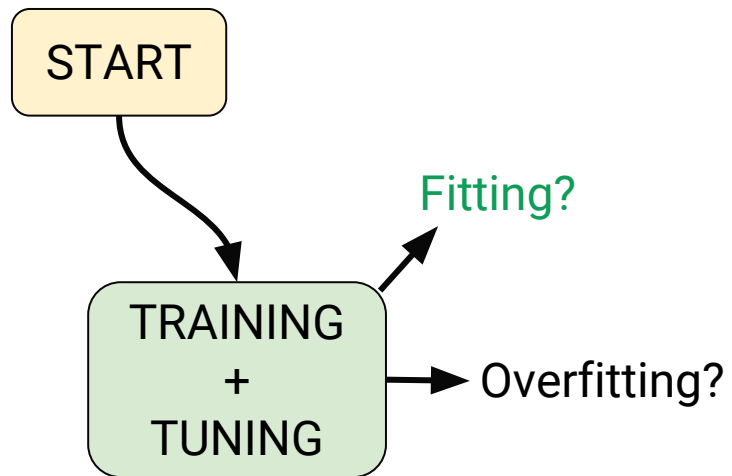


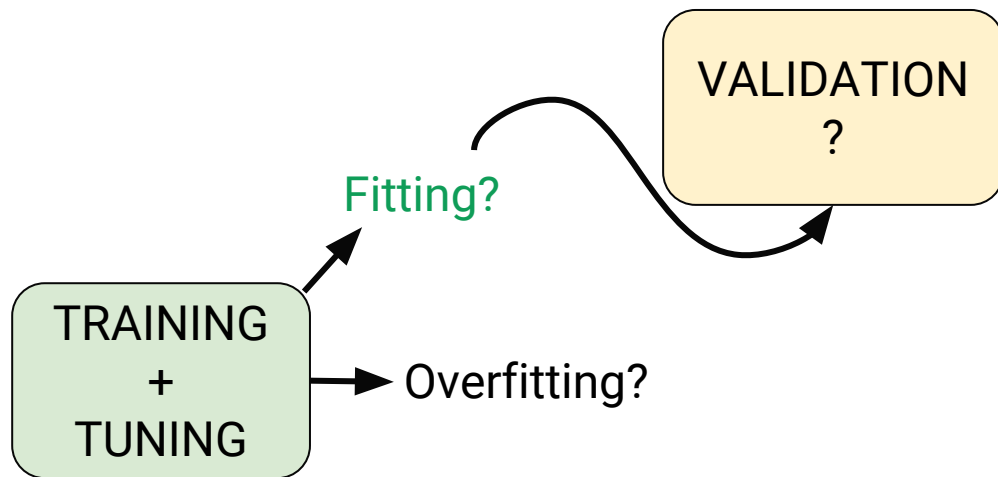


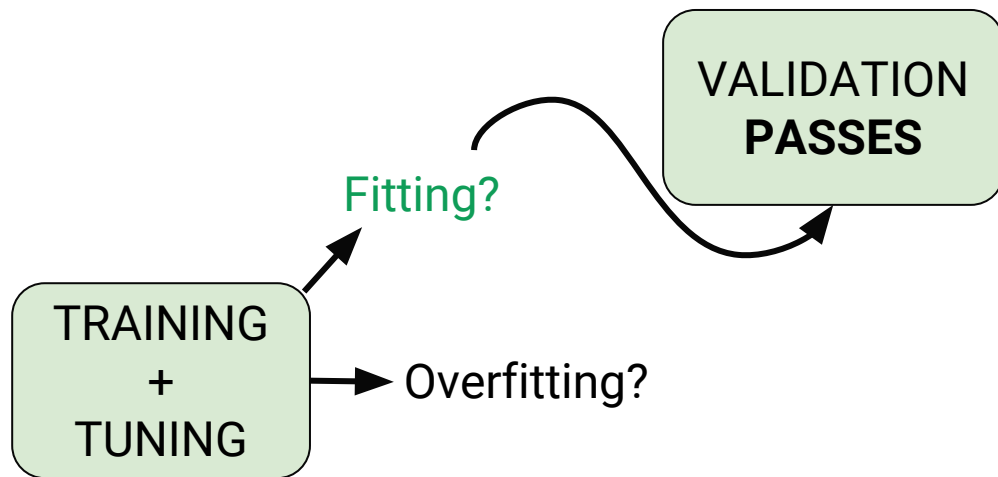


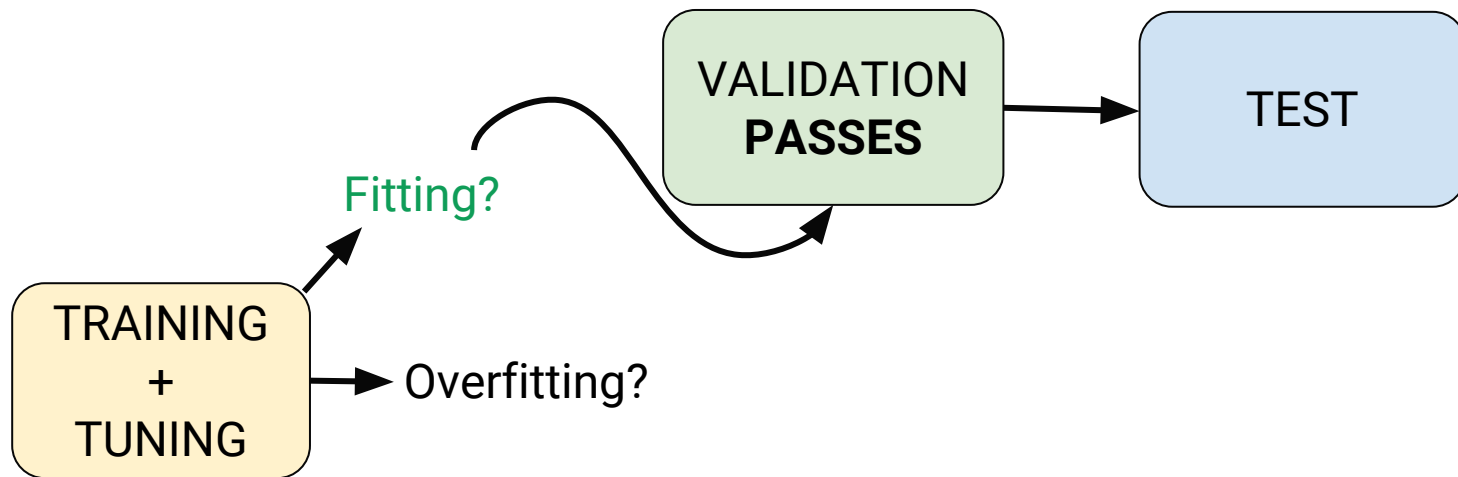


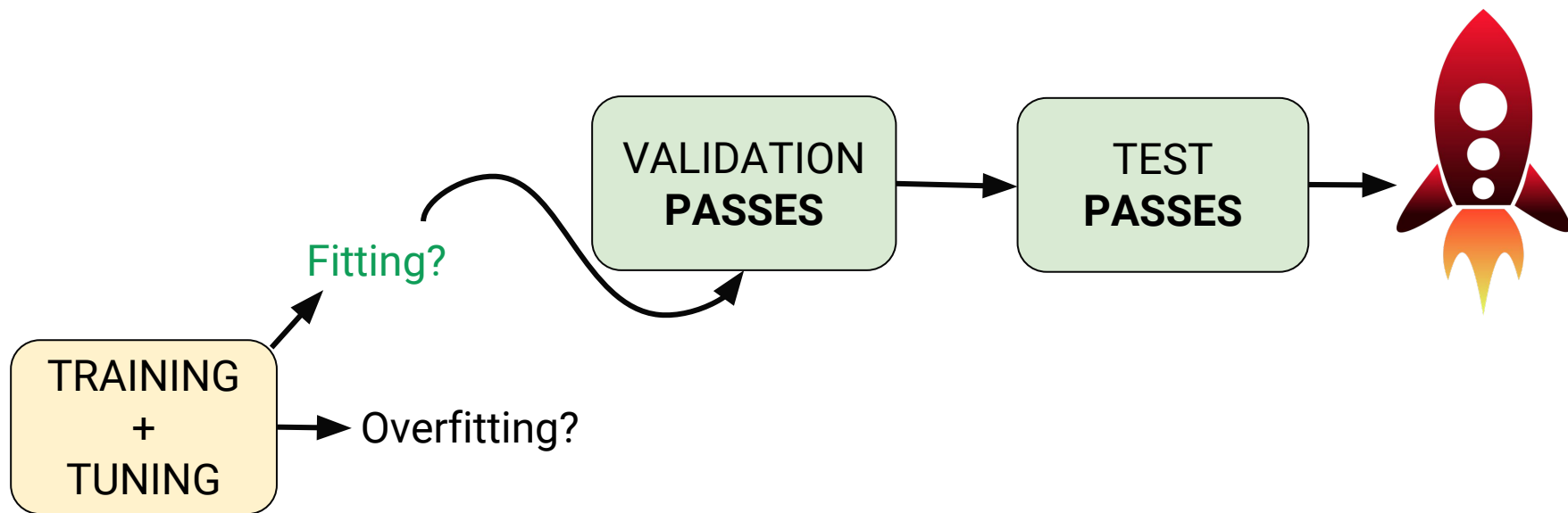


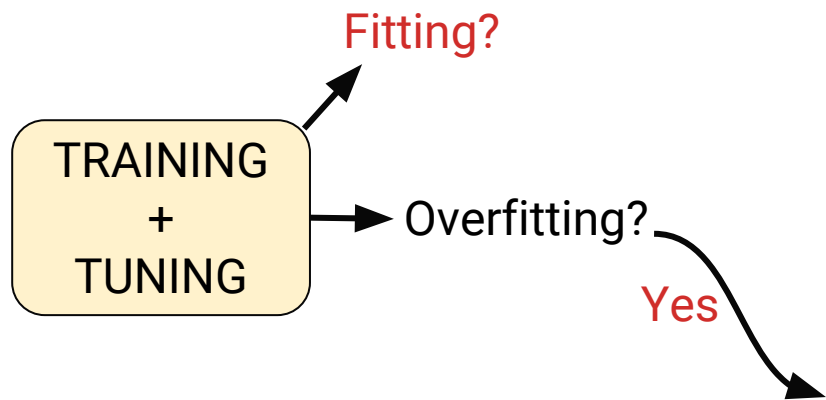


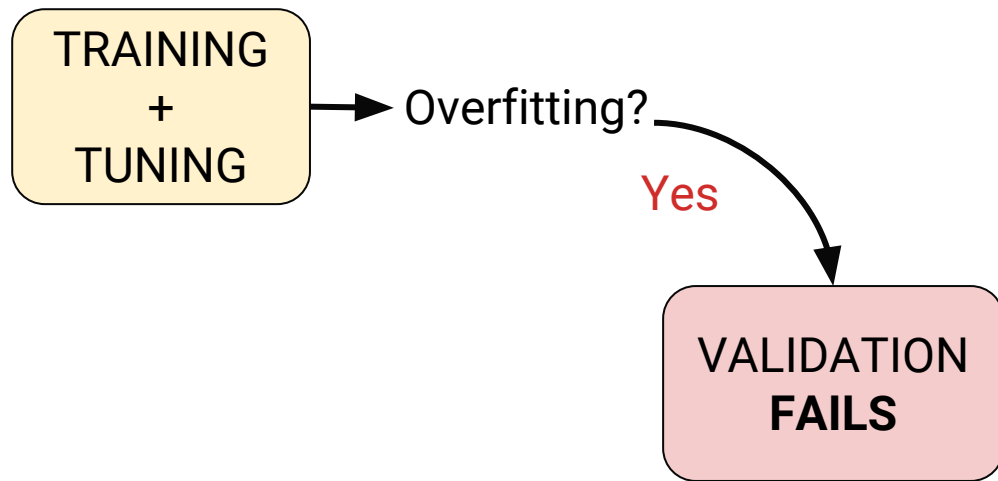


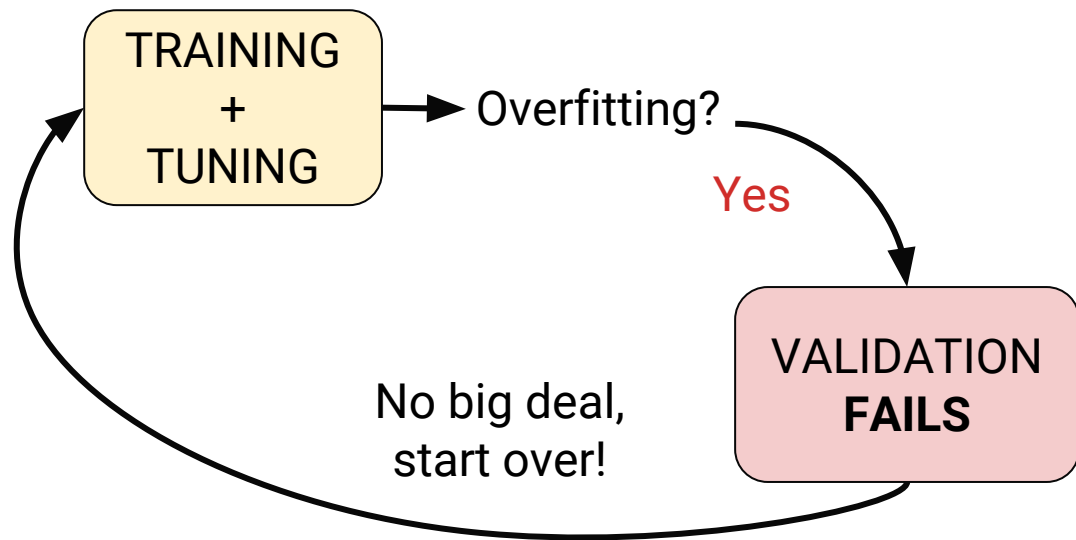




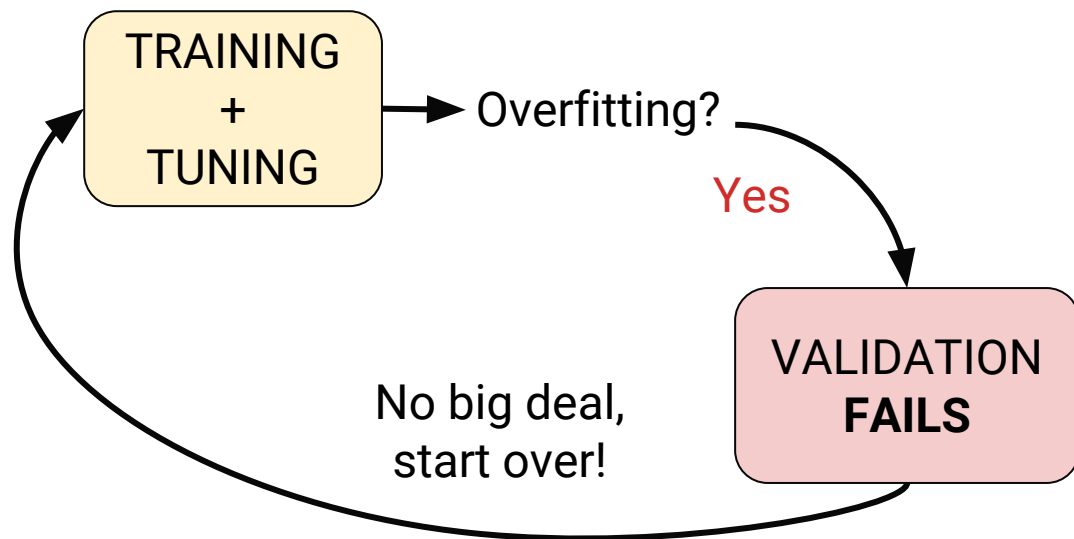






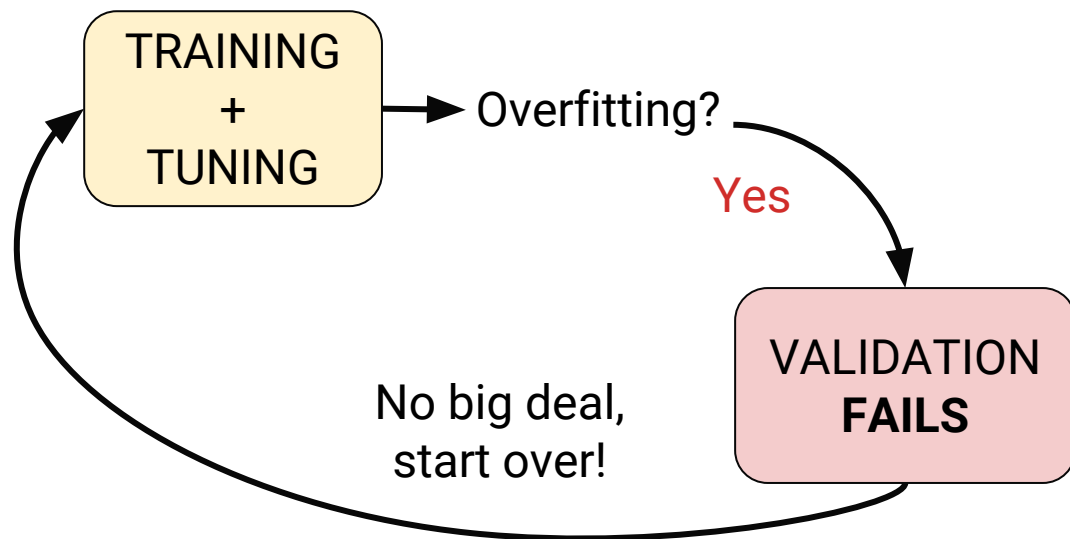


It's the dreaded infinite loop!!!



Welcome to overfitting limbo

It's the dreaded infinite loop!!!



STILL WAITING...



TO PASS VALIDATION

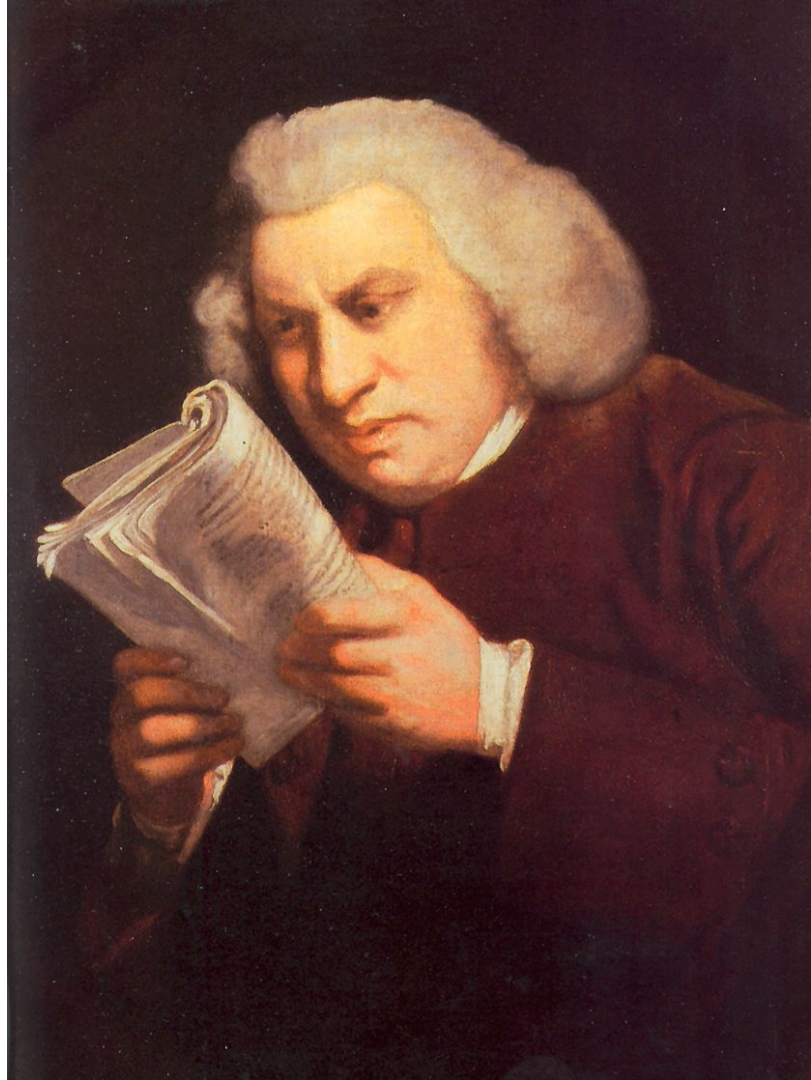
Solution? Start Simple!

Beware excessive complexity.

Model complexity increases the chances of overfitting.



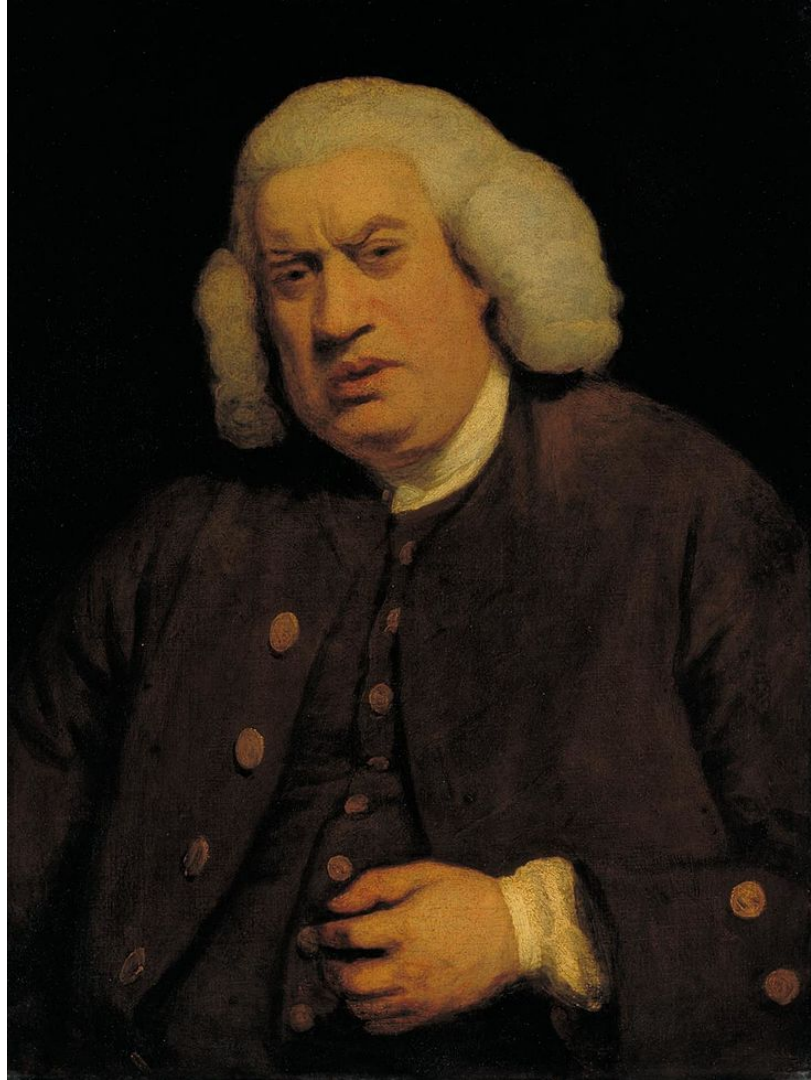
Regularization?



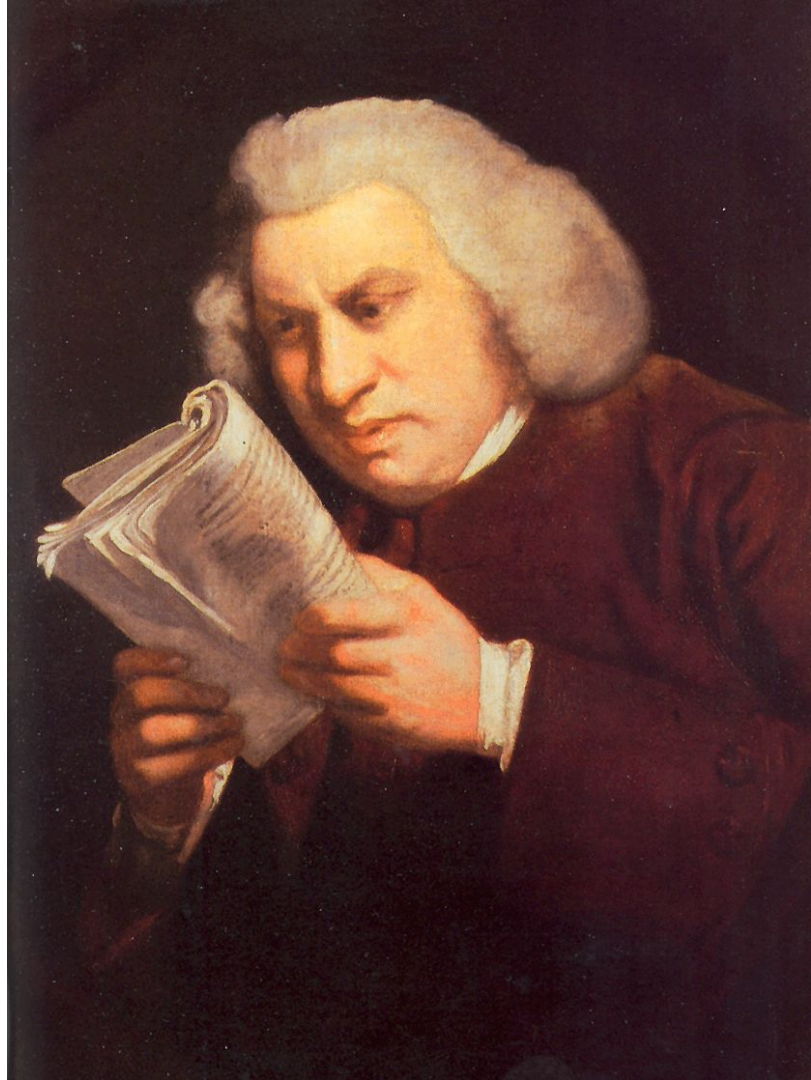
Regularization

“Learn to love simplicity.”

Complexity increases loss.



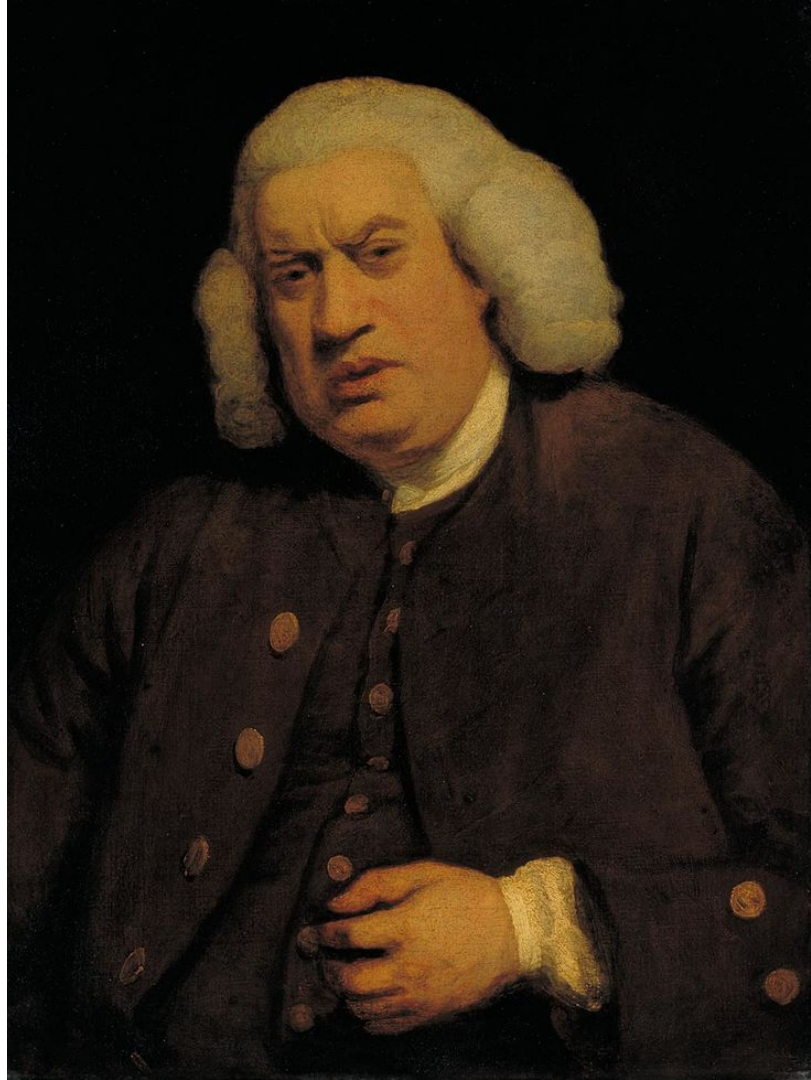
Dropout?



Dropout

“Make a neural network love simplicity by shooting some neurons.”

Don't train with all of the units.



Key message



Start simple and build up the complexity only when simple doesn't work well

You final solution might be sophisticated, but your first attempt shouldn't be



Logistic regression: run it!

Step 6: Train Logistic Regression with scikit-learn

Let's train!

```
In [8]: # Get the output predictions of the training and debugging inputs  
training_predictions = model.predict_proba(training_std)[: , 1]  
debugging_predictions = model.predict_proba(debugging_std)[: , 1]
```

That was easy! But how well did it do? Let's check the accuracy of the model we just trained.

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```
In [9]: # Accuracy metric:
def get_accuracy(truth, predictions, threshold=0.5, roundoff=2):
    """
    Args:
        truth: can be Boolean (False, True), int (0, 1), or float (0, 1)
        predictions: number between 0 and 1, inclusive
        threshold: we convert predictions to 1s if they're above this value
        roundoff: report accuracy to how many decimal places?

    Returns:
        accuracy: number correct divided by total predictions
    """

    truth = np.array(truth) == (1|True)
    predicted = np.array(predictions) >= threshold
    matches = sum(predicted == truth)
    accuracy = float(matches) / len(truth)
    return round(accuracy, roundoff)

# Compute our accuracy metric for training and debugging
print 'Training accuracy is ' + str(get_accuracy(training_labels, training_predictions))
print 'Debugging accuracy is ' + str(get_accuracy(debugging_labels, debugging_predictions))
```

Training accuracy is 0.76

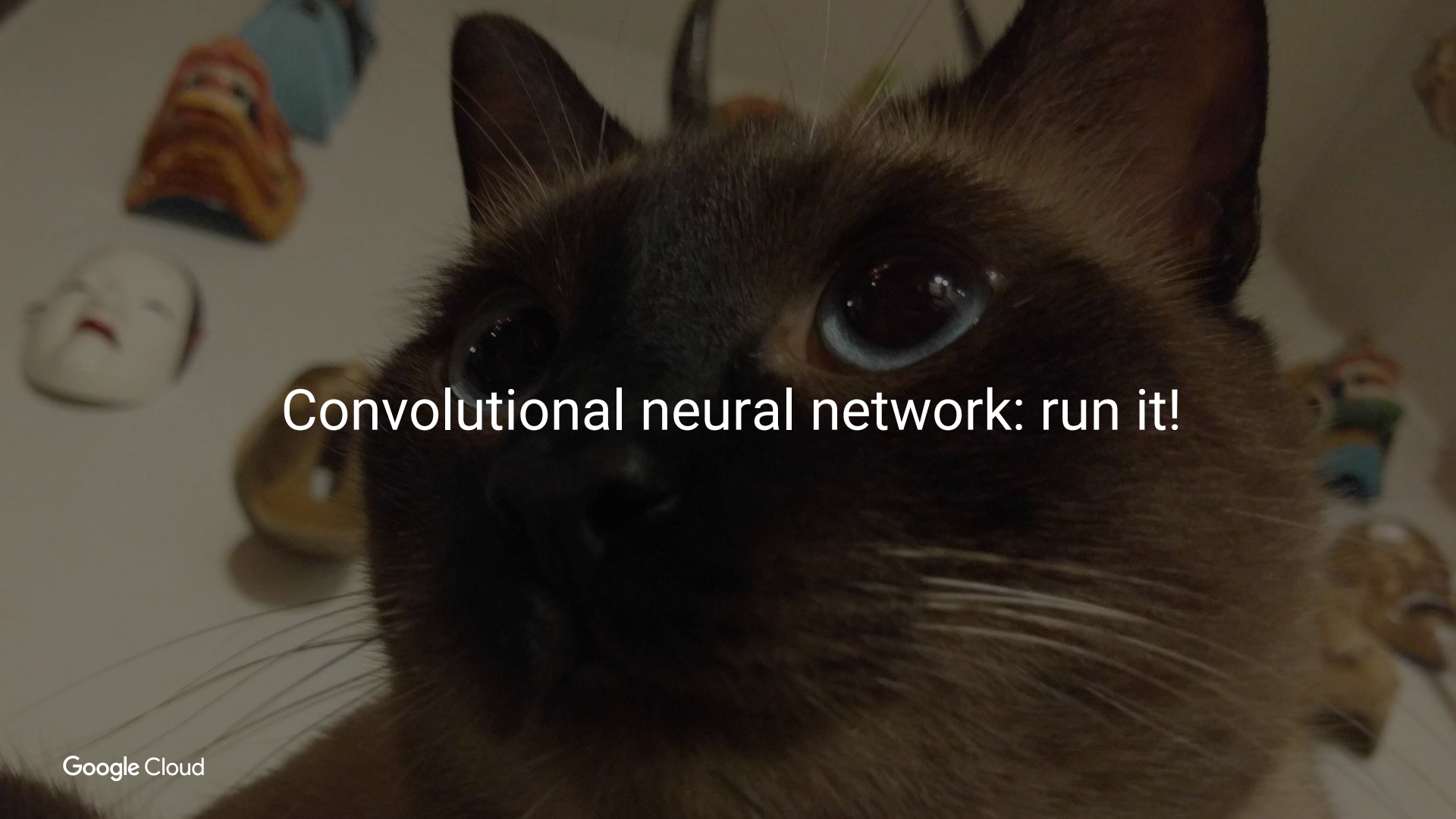
Debugging accuracy is 0.74

Step 6: Train Logistic Regression with TensorFlow

Unless you change TensorFlow's verbosity, there is a lot of text that is outputted. Such text can be useful when debugging a distributed training pipeline, but is pretty noisy when running from a notebook locally. The line to look for is the chunk at the end where "accuracy" is reported. This is the final result of the model.

```
In [13]: learn_runner.run(generate_experiment_fn(), OUTPUT_DIR + '-model-reg-' + str(REG_L1))
INFO:tensorflow:Restoring parameters from ../../kozyrkov/data/logreg/-model-reg-5.0/model.ckpt-20000
INFO:tensorflow:Evaluation [1/1]
INFO:tensorflow:Finished evaluation at 2018-01-03-21:14:58
INFO:tensorflow:Saving dict for global step 20000: accuracy = 0.734903, accuracy/baseline_label_mean = 0.474923, accuracy/threshold_0.500000_mean = 0.734903, auc = 0.812086, auc_precision_recall = 0.785532, global_step = 20000, labels/actual_label_mean = 0.474923, labels/prediction_mean = 0.480623, loss = 0.541839, precision/positive_threshold_0.500000_mean = 0.705411, recall/positive_threshold_0.500000_mean = 0.758621

Out[13]: ({'accuracy': 0.73490274,
  'accuracy/baseline_label_mean': 0.47492322,
  'accuracy/threshold_0.500000_mean': 0.73490274,
  'auc': 0.81208611,
  'auc_precision_recall': 0.78553176,
  'global_step': 20000,
  'labels/actual_label_mean': 0.47492322,
  'labels/prediction_mean': 0.48062292,
  'loss': 0.54183859,
  'precision/positive_threshold_0.500000_mean': 0.70541084,
  'recall/positive_threshold_0.500000_mean': 0.75862068},
[])
```

A close-up photograph of a Siamese cat's face, looking directly at the camera. The cat has dark brown fur on its face and ears, with lighter fur on its chest and paws. Its eyes are a striking blue. The background is a light-colored surface with several small, colorful objects scattered around, including what looks like a small white mask and some colorful rings. The text "Convolutional neural network: run it!" is overlaid in white, sans-serif font across the center of the cat's face.

Convolutional neural network: run it!

Step 6 - Train a model!

Let's run our lovely creation on our training data. In order to train, we need `learn_runner()`, which we imported from TensorFlow above. For prediction, we will only need `estimator.predict()`.

```
In [12]: # Enable TF verbose output:
tf.logging.set_verbosity(tf.logging.INFO)
start_time = datetime.datetime.now()
print('It\'s {:H:%M} in London'.format(start_time) + ' --- Let\'s get started!')
# Let the learning commence! Run the TF Experiment here.
learn_runner.run(generate_experiment_fn(), OUTPUT_DIR)
# Output lines using the word "Validation" are giving our metric on the non-training dataset (from DEBUG_DIR).
end_time = datetime.datetime.now()
print('\nIt was {:H:%M} in London when we started.'.format(start_time))
print('\nWe\'re finished and it\'s {:H:%M} in London'.format(end_time))
print('\nCongratulations! Training is complete!')
```

It's 18:54 in London --- Let's get started!

WARNING:tensorflow:From <ipython-input-11-10bb144e4fb2>:18: calling `__init__` (from tensorflow.contrib.learn.python.learn.experiment) with `local_eval_frequency` is deprecated and will be removed after 2016-10-23.

Instructions for updating:

`local_eval_frequency` is deprecated as `local_run` will be renamed to `train_and_evaluate`. Use `min_eval_frequency` and call `train_and_evaluate` instead. Note, however, that the default for `min_eval_frequency` is 1, meaning models will be evaluated every time a new checkpoint is available. In contrast, the default for `local_eval_frequency` is None, resulting in evaluation occurring only after training has completed. `min_eval_frequency` is ignored when calling the deprecated `local_run`.

WARNING:tensorflow:From /home/user/env/local/lib/python2.7/site-packages/tensorflow/contrib/learn/python/learn/monitors.py:269: `__init__` (from tensorflow.contrib.learn.python.learn.monitors) is deprecated and will be removed after 2016-12-05.

Instructions for updating:

Monitors are deprecated. Please use `tf.train.SessionRunHook`.

INFO:tensorflow:Skipping training since `max_steps` has already saved.

INFO:tensorflow:Starting evaluation at 2017-11-02-18:54:23

```
print('\nIt was {:%H:%M} in London when we started.'.format(start_time))
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INFO:tensorflow:Skipping training since max_steps has already saved.

INFO:tensorflow:Starting evaluation at 2017-11-02-18:54:23

INFO:tensorflow:Restoring parameters from ../../data/output/model.ckpt-100

INFO:tensorflow:Evaluation [1/2]

INFO:tensorflow:Evaluation [2/2]

INFO:tensorflow:Finished evaluation at 2017-11-02-18:54:24

INFO:tensorflow:Saving dict for global step 100: accuracy = 0.7, global_step = 100, loss = 0.466835

It was 18:54 in London when we started.

We're finished and it's 18:54 in London

Congratulations! Training is complete!

Get predictions and performance metrics

Create functions for outputting observed labels, predicted labels, and accuracy. Filenames must be in the following format: number_number_label.extension

```
In [13]: # Observed labels from filenames:
def get_labels(dir):
    """Get labels from filenames.

    Filenames must be in the following format: number_number_label.png

    Args:
        dir: directory containing image files

    Returns:
        labels: 1-d np.array of binary labels
    """
    filelist = os.listdir(dir) # Use all the files in the directory
    labels = np.array([])
    for f in filelist:
        split_filename = f.split('_')
        label = int(split_filename[-1].split('.')[0])
        labels = np.append(labels, label)
    return labels
```

```
In [14]: # Cat_finder function for getting predictions:
def cat_finder(dir, model_version):
    """Get labels from model.

    Args:
        dir: directory containing image files
```



```

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    Args:
        dir: directory containing image files

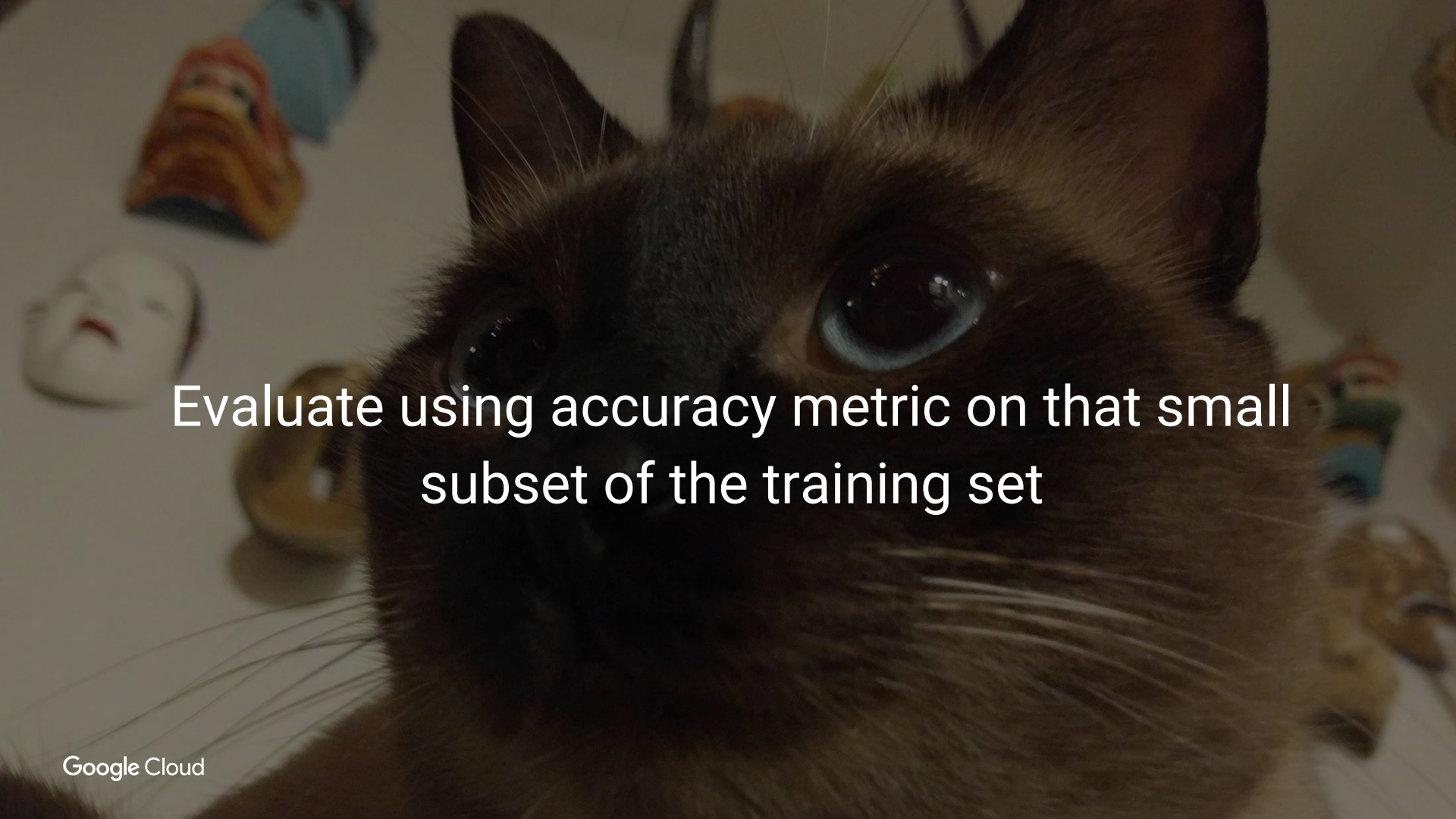
    Returns:
        predictions: 1-d np array of binary labels
    """

    num_predictions = len(os.listdir(dir))
    predictions = [] # Initialize array.

    # Estimator.predict() returns a generator g. Call next(g) to retrieve the next value.
    prediction_gen = estimator.predict(
        input_fn=generate_input_fn(dir=dir,
                                    batch_size=TRAIN_STEPS,
                                    queue_capacity=QUEUE_CAP
                                    ),
        checkpoint_path=model_version
    )

    # Use generator to ensure ordering is preserved and predictions match order of validation_labels:
    i = 1
    for pred in range(0, num_predictions):
        predictions.append(next(prediction_gen)) #Append the next value of the generator to the prediction array
        i += 1
        if i % 1000 == 0:
            print('{:d} predictions completed (out of {:d})...'.format(i, len(os.listdir(dir))))
    print('{:d} predictions completed (out of {:d})...'.format(len(os.listdir(dir)), len(os.listdir(dir))))
    return np.array(predictions)

```

A close-up photograph of a Siamese cat's face, looking directly at the camera. The cat has dark brown fur on its face and ears, with lighter fur on its body. Its eyes are a striking blue. The background is slightly blurred, showing some colorful objects like a small mask and a shell. Overlaid on the center of the image is white text.

Evaluate using accuracy metric on that small
subset of the training set

Get training accuracy

```
In [15]: def get_accuracy(truth, predictions, threshold=0.5, roundoff = 2):  
        """Compares labels with model predictions and returns accuracy.  
  
        Args:  
        truth: can be bool (False, True), int (0, 1), or float (0, 1)  
        predictions: number between 0 and 1, inclusive  
        threshold: we convert the predictions to 1s if they're above this value  
        roundoff: report accuracy to how many decimal places?  
  
        Returns:  
        accuracy: number correct divided by total predictions  
        """  
        truth = np.array(truth) == (1|True)  
        predicted = np.array(predictions) >= threshold  
        matches = sum(predicted == truth)  
        accuracy = float(matches) / len(truth)  
        return round(accuracy, roundoff)
```

```
In [17]: files = os.listdir(TRAIN_DIR)  
model_version = OUTPUT_DIR + 'model.ckpt-' + str(TRAIN_STEPS)  
predicted = cat_finder(TRAIN_DIR, model_version)  
observed = get_labels(TRAIN_DIR)
```

INFO:tensorflow:Restoring parameters from ../../data/output/model.ckpt-100

```
In [18]: print('Accuracy is ' + str(get_accuracy(observed, predicted)))
```

Accuracy is 0.89

Key message

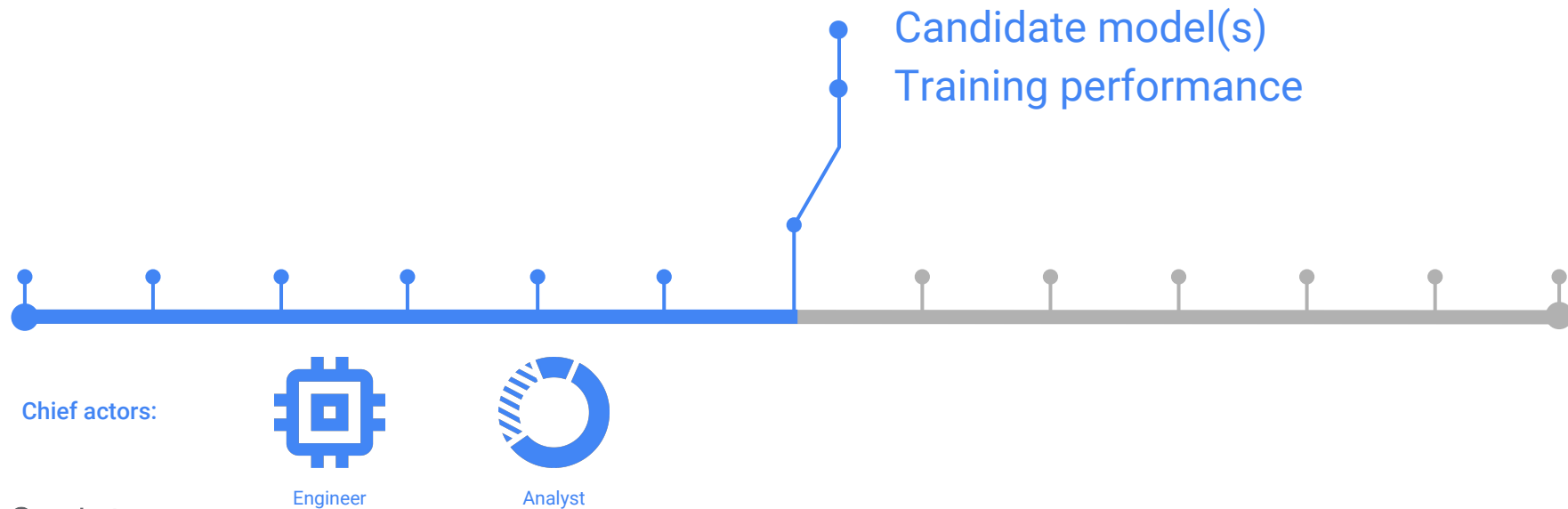


In training, your goal is to
find useful patterns in your data

You're making a **shortlist of models**
that seem to work

Don't worry about getting it right
immediately - **it'll take a few tries**

Step 6 is finished | You've run some algorithms and got:



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