

# Exploring TensorFlow on Android

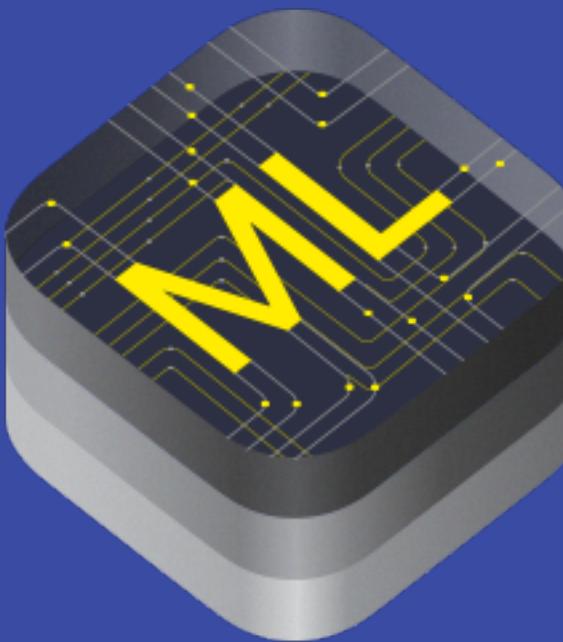
# Overview

- What is Machine Learning?
- TensorFlow Concepts
- Building our first model
- Deploy to an Android app

# What is Machine Learning?

In a nutshell Machine learning or ML is a field that gives computers the ability to learn without being explicitly programmed.

# Popular Libraries



# Examples of ML

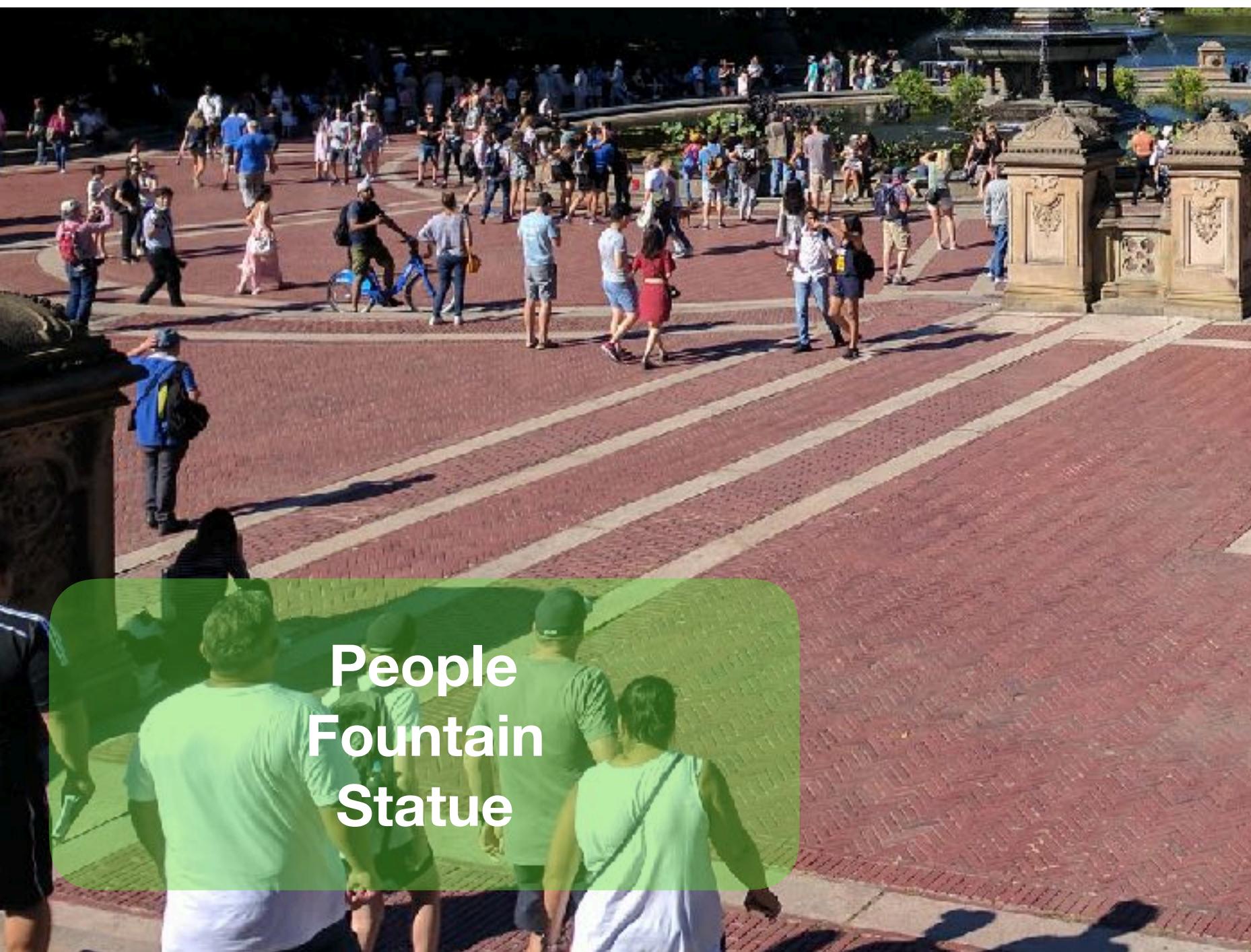
- Vision
- Natural language processing
- Game AI
- Speech Recognition and Generation







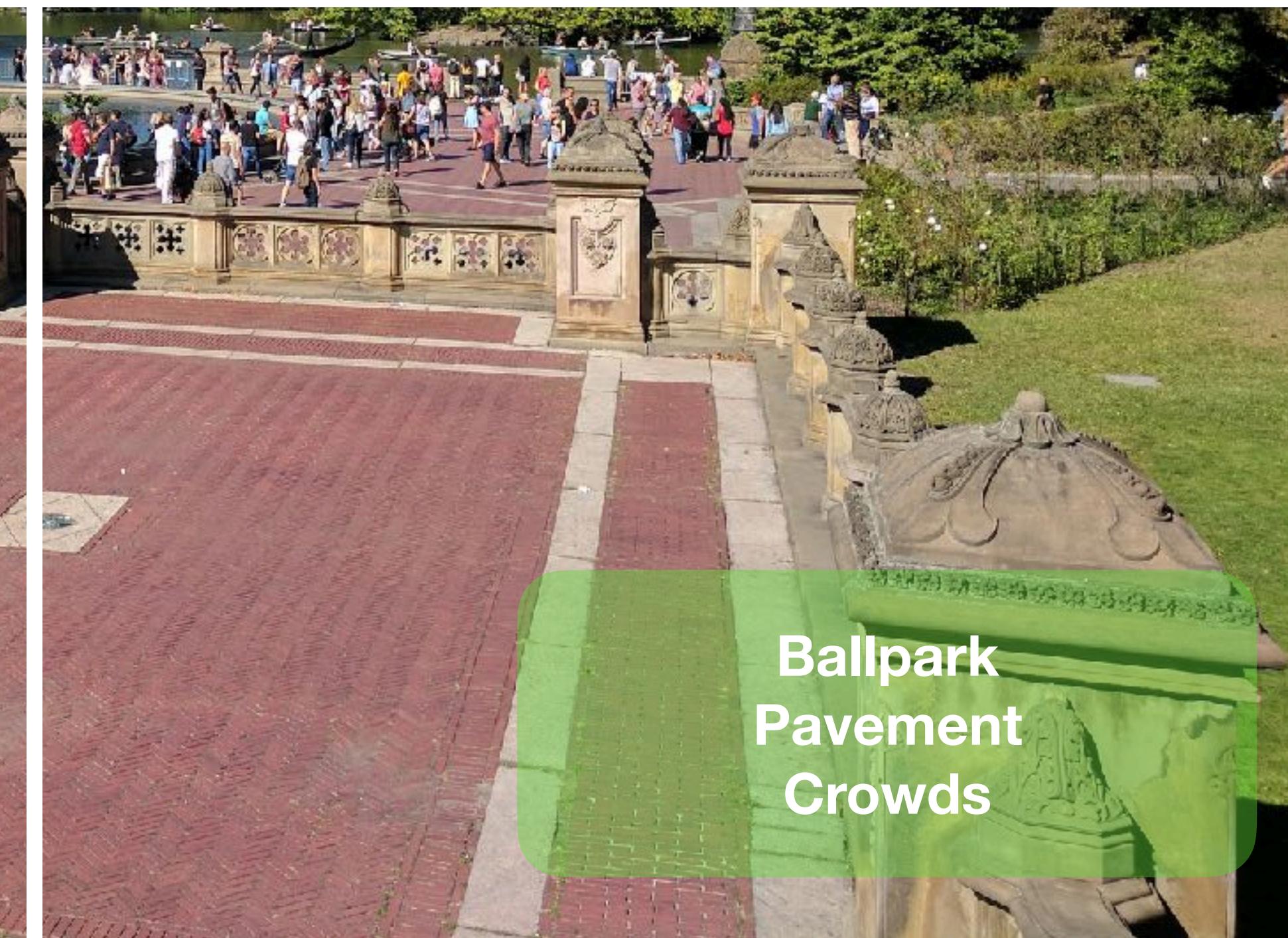
Trees  
Sky  
Statue



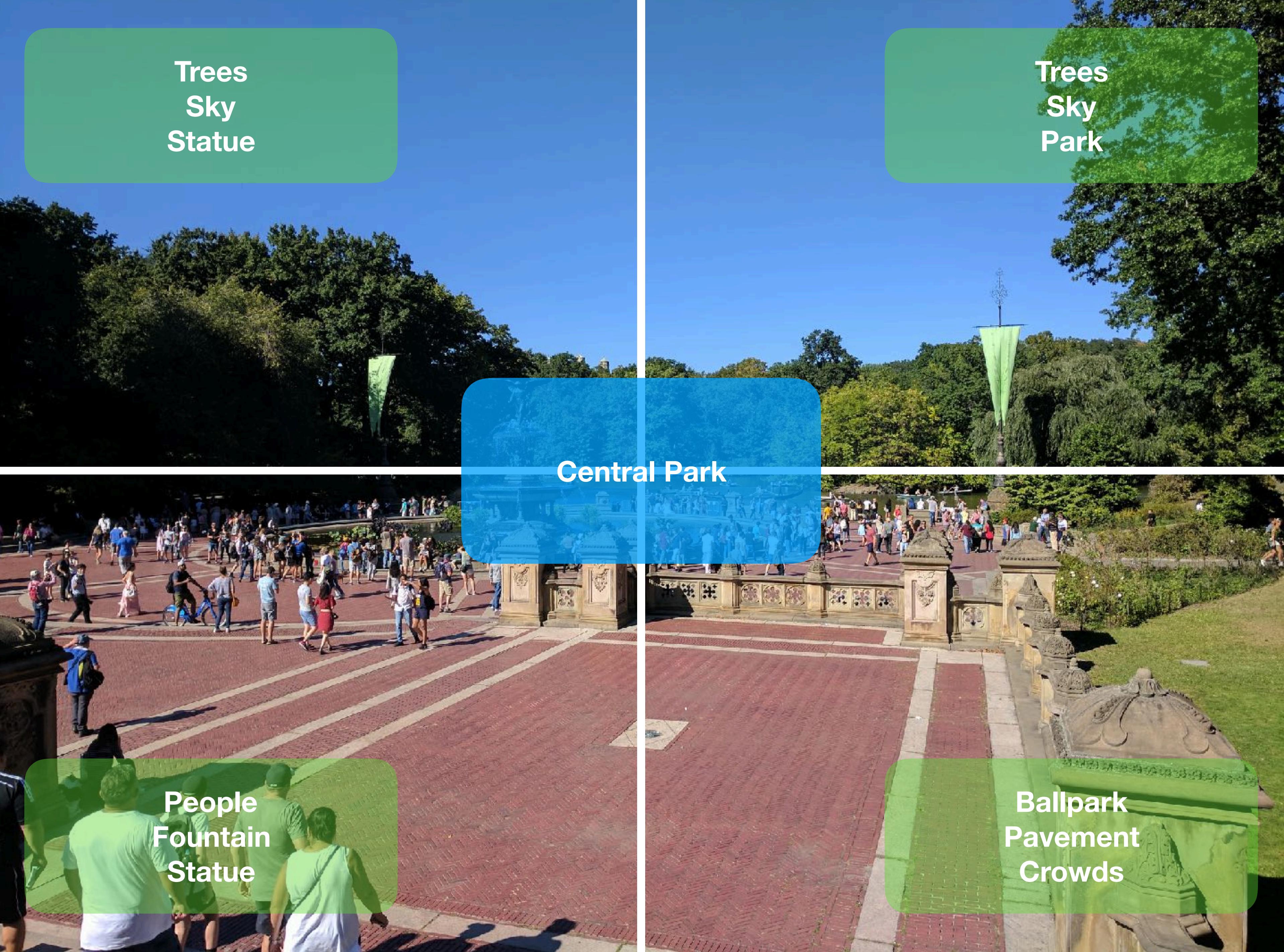
People  
Fountain  
Statue



Trees  
Sky  
Park



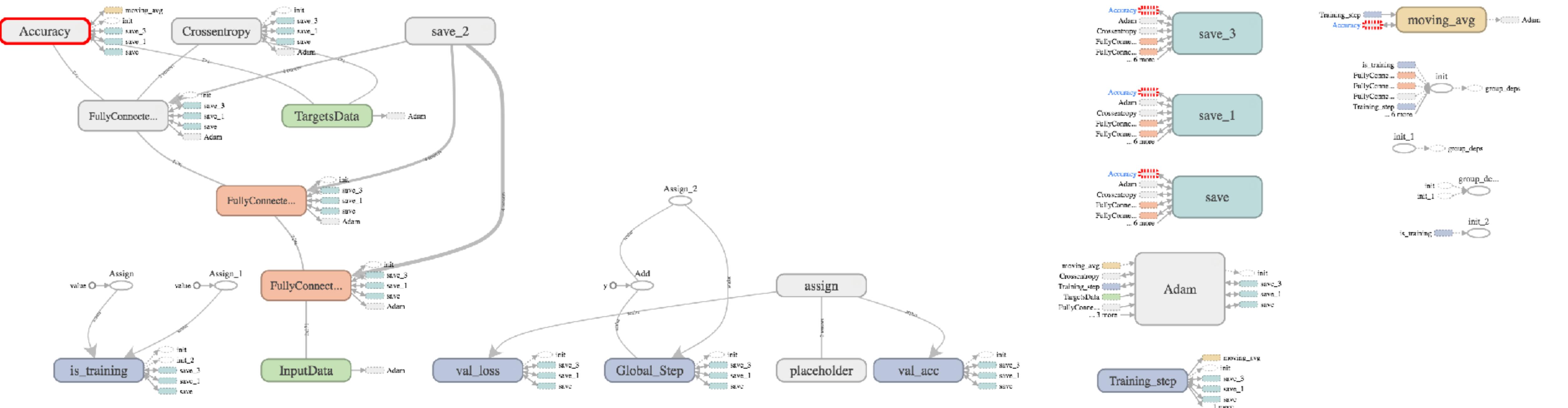
Ballpark  
Pavement  
Crowds



# Steps to building a model

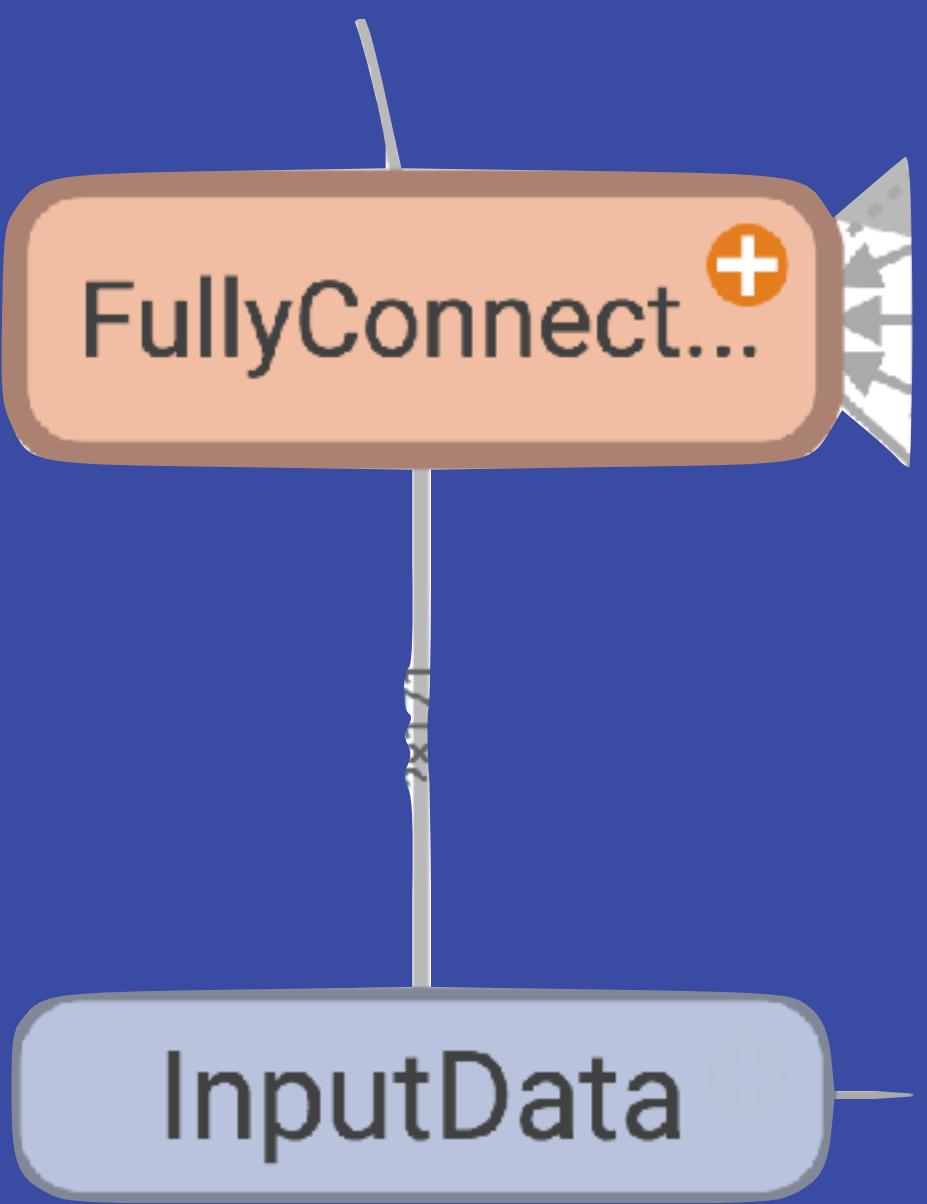
- Dataset or Corpus
- Normalization and/or cleanup of data (remove whales)
- Define hyperparameters
- Build / create your graph
- Run
- Validate

# TensorFlow Concepts



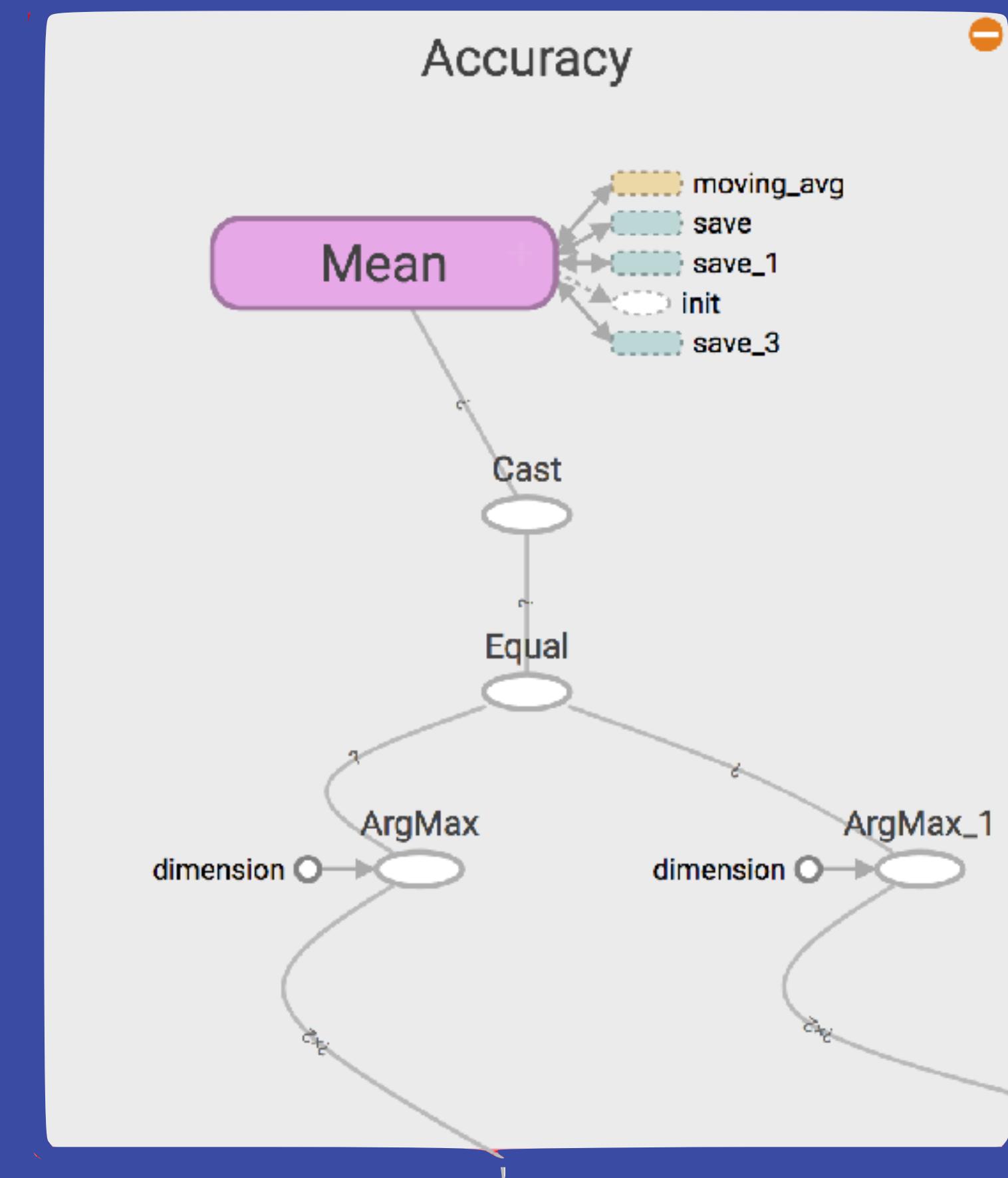
A graph contains a set of nodes called operations

Each operation could be something simple like adding two inputs or something much more complex.

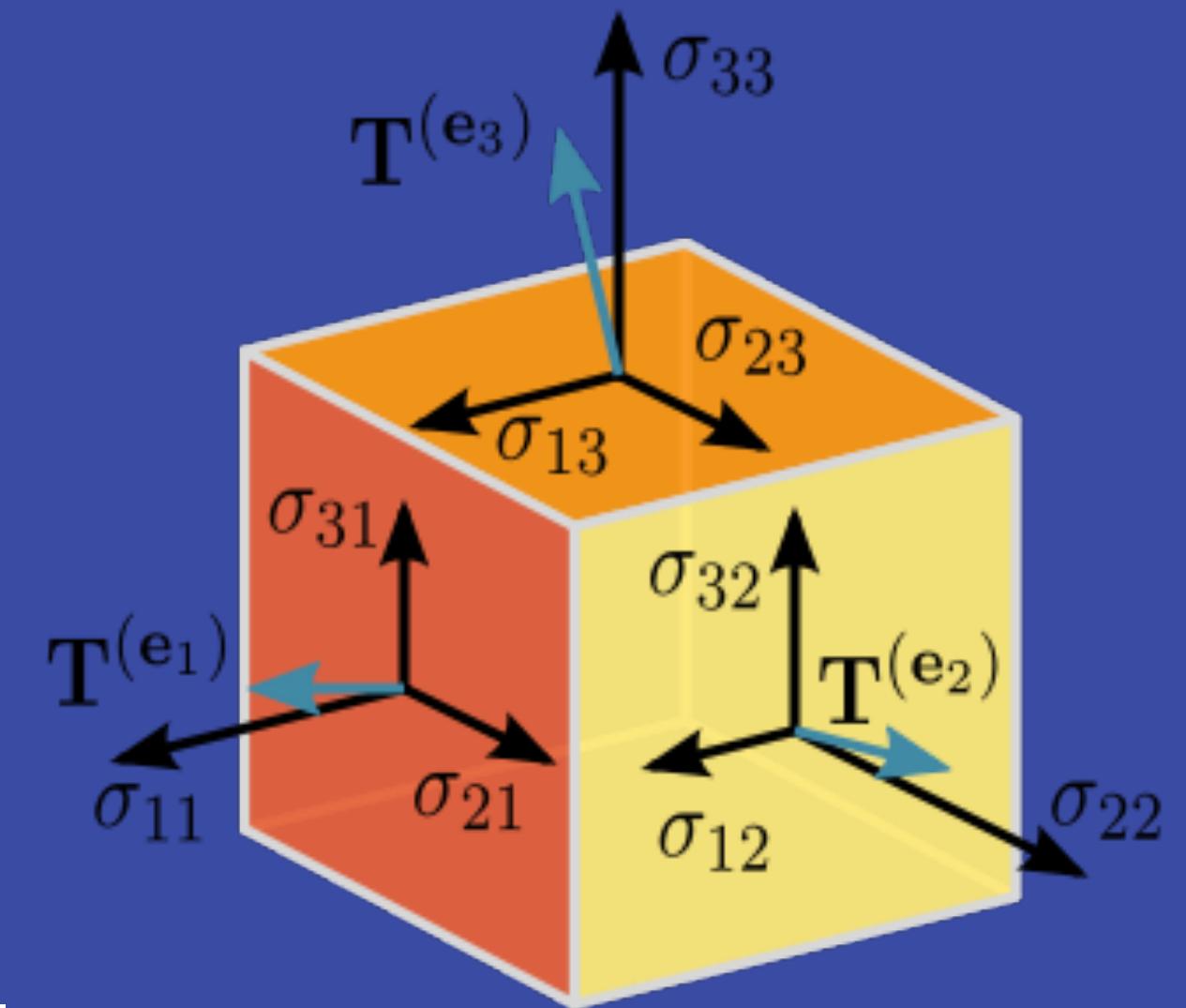


A graph contains a set of nodes called operations

Each operation could be something simple like adding two inputs or something much more complex.



# TensorFlow



Tensors are simply how data is represented in TensorFlow.  
They are multidimensional arrays.

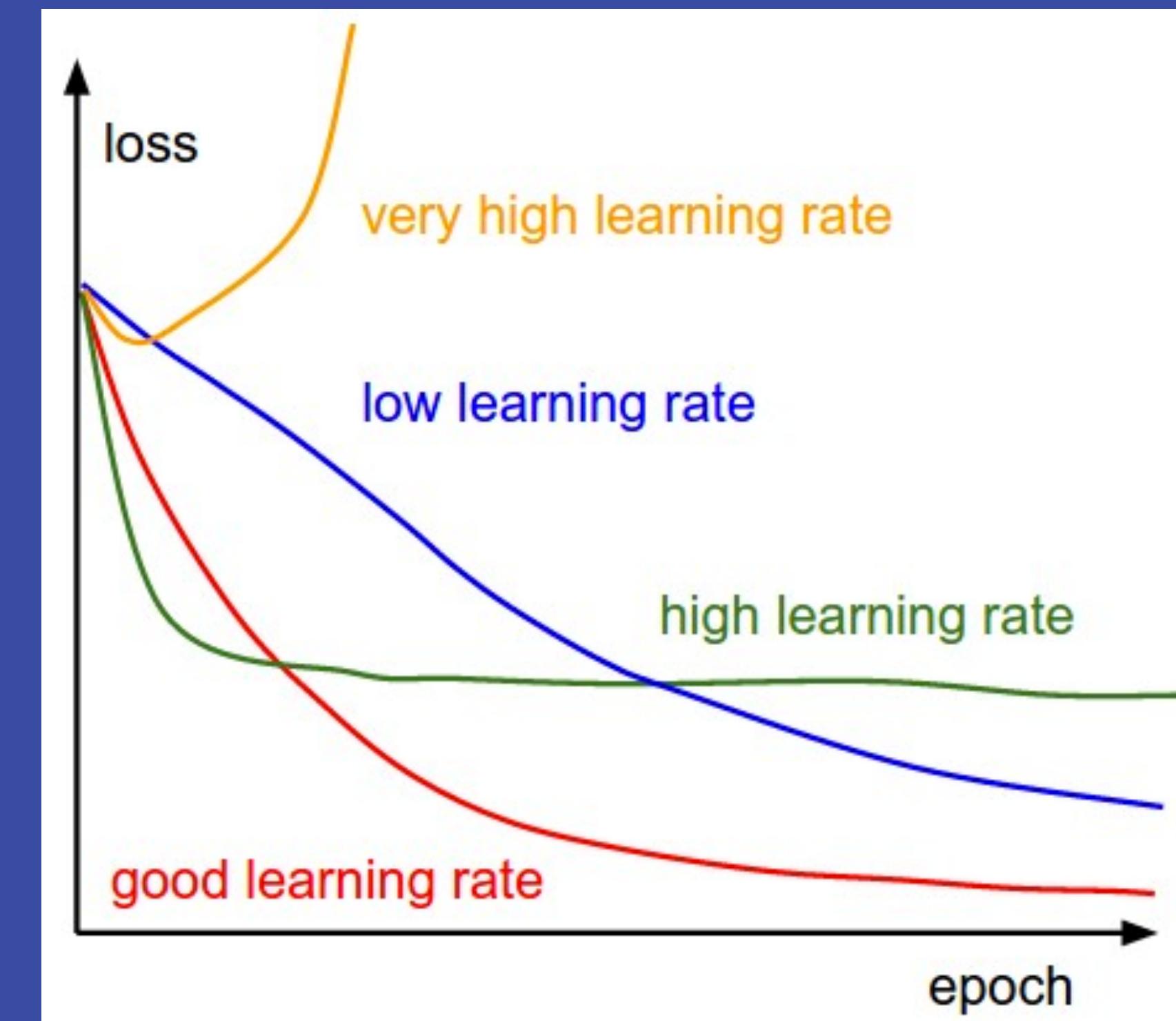
Tensors are passed as inputs and outputs for each operation or node.

So in a way, you could see Tensors flowing between operations... hence TensorFlow.

If our learning rate is too big, our model might skip the optimal solution.

If its too small, we might need too many iterations to train our model.

0.01 is a common good starting point for most models.



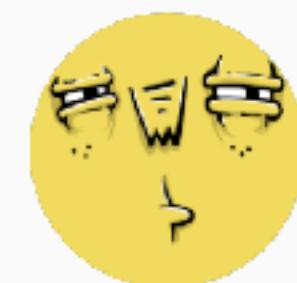
# TFLearn

For our first model we will use a library called TFLearn. TFLearn takes a lot of the boiler plate parts of defining and building a neural network and does it for us by use of layers that we create to describe our model.

 Home**6505551232**

Sep 25, 2017

Sorry! U can not unsubscribe yet. THE MOB offer package has a min term of 54 weeks> pls resubmit request after expiry. Reply THEMOb H...

**The Godfather**

Sep 25, 2017

I'm going to make him an offer he can't refuse.

**6505551221**

Sep 25, 2017

pdate\_Now - Double mins and 1000 txts on Orange tariffs. Latest Motorola, SonyEricsson & Nokia & Bluetooth FREE! Call MobileUpd8 on ...

**Richard Zanuck**

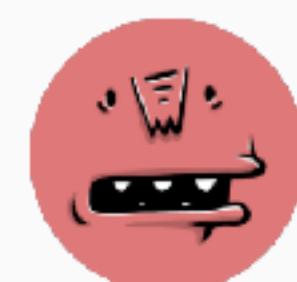
Sep 25, 2017

You're gonna need a bigger boat.

**6505551220**

Sep 25, 2017

"Last Chance! Claim ur 150 worth of discount vouchers today! Text SHOP to 85023 now! SavaMob, offers mobile! T Cs SavaMob POBOX...

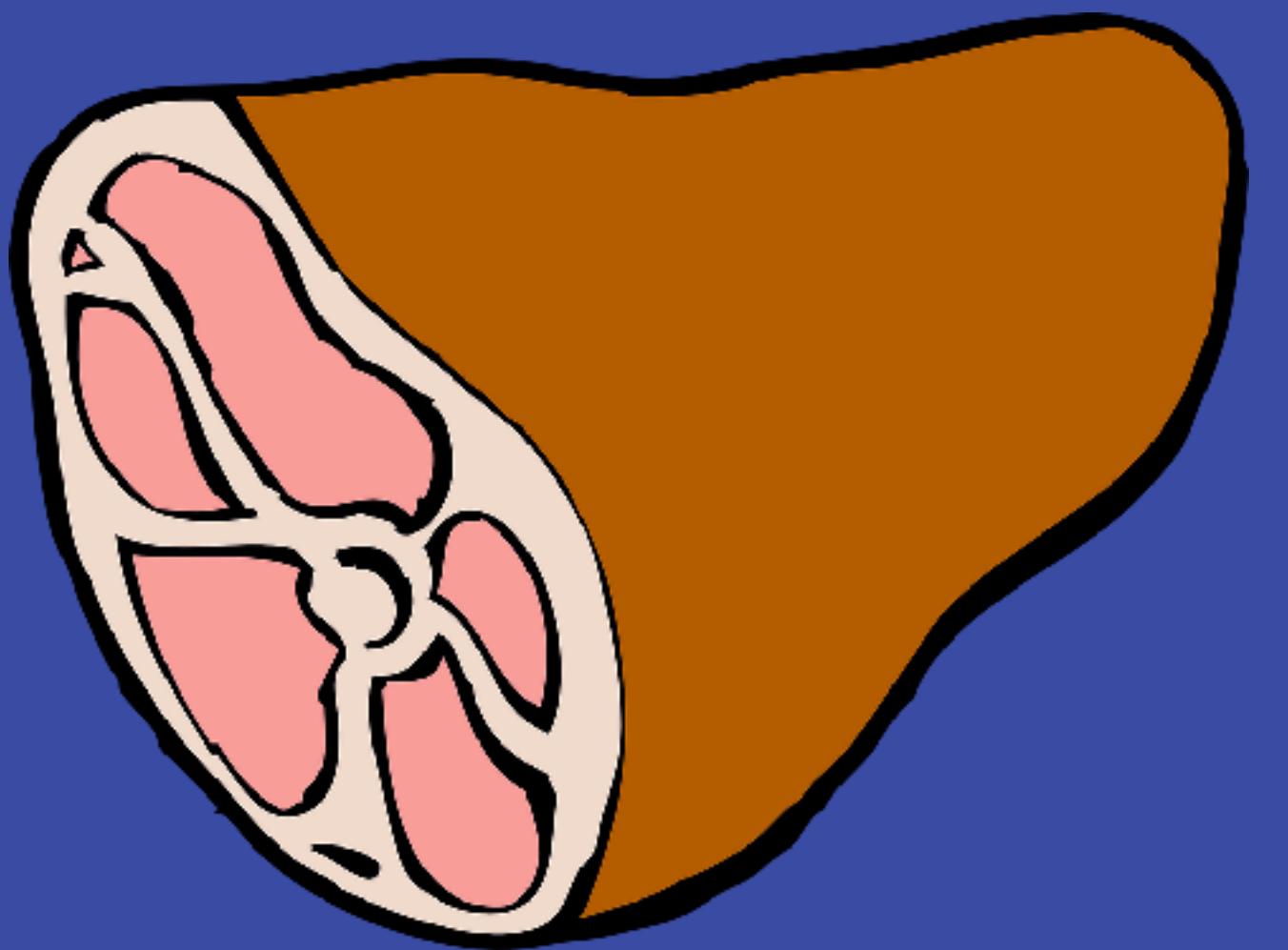
**6505551219**

Sep 25, 2017

INTERFLORA - It's not too late to order Inter flowers for christmas call 0800 505060 to your order before Midnight tomorrow



# Ham or Spam?



ham Go until jurong point, crazy.. Available only in bugis n great world la e buffet... Cine there got amore wat...  
ham Ok lar... Joking wif u oni...  
spam Free entry in 2 a wkly comp to win FA Cup final tkts. 21st May 2005. Text FA to 87121 to receive entry question(std txt rate)T&C's apply 08452810075over18's  
ham U dun say so early hor... U c already then say...  
ham Nah I don't think he goes to usf, he lives around here though  
spam FreeMsg Hey there darling it's been 3 week's now and no word back! I'd like some fun you up for it still? Tb ok! XxX std chgs to send, f1.50 to rcv  
ham Even my brother is not like to speak with me. They treat me like aids patent.  
ham As per your request 'Melle Melle (Oru Minnaminunginte Nurungu Vettam)' has been set as your callertune for all Callers. Press \*9 to copy your friends Callertune  
spam WINNER!! As a valued network customer you have been selected to receivea £900 prize reward! To claim call 09061701461. Claim code KL341. Valid 12 hours only.  
spam Had your mobile 11 months or more? U R entitled to Update to the latest colour mobiles with camera for Free! Call The Mobile Update Co FREE on 08002986030  
ham I'm gonna be home soon and i don't want to talk about this stuff anymore tonight, k? I've cried enough today.  
spam SIX chances to win CASH! From 100 to 20,000 pounds txt> CSH11 and send to 87575. Cost 150p/day, 6days, 16+ TsandCs. apply Reply HL 4 info  
spam URGENT! You have won a 1 week FREE membership in our £100,000 Prize Jackpot! Txt the word: CLAIM to No: 81010 T&C www.dbuk.net LCCLTD POBOX 4403LDNW1A7RW18  
ham I've been searching for the right words to thank you for this breather. I promise i wont take your help for granted and will fulfil my promise. You have been wonderful and a blessing at all times.  
ham I HAVE A DATE ON SUNDAY WITH WILL!!  
spam XXXMobileMovieClub: To use your credit, click the WAP link in the next txt message or click here>> http://wap.xxxxmobilemovieclub.com?n=QJKGIGHJJGCBL  
ham Oh k...i'm watching here:)  
ham Eh u remember how 2 spell his name... Yes i did. He v naughty make until i v wet.  
ham Fine if thats the way u feel. Thats the way its gotta b  
spam England v Macedonia - dont miss the goals/team news. Txt ur national team to 87077 eg ENGLAND to 87077 Try:WALES, SCOTLAND 4txt/ú1.20 POB0Xox36504W45WQ 16+  
ham Is that seriously how you spell his name?  
ham I'm going to try for 2 months ha ha only joking  
ham So ü pay first lar... Then when is da stock comin...  
ham Aft i finish my lunch then i go str down lor. Ard 3 smth lor. U finish ur lunch already?  
ham Fffffffffff. Alright no way I can meet up with you sooner?  
ham Just forced myself to eat a slice. I'm really not hungry tho. This sucks. Mark is getting worried. He knows I'm sick when I turn down pizza. Lol  
ham Lol your always so convincing.  
ham Did you catch the bus ? Are you frying an egg ? Did you make a tea? Are you eating your mom's left over dinner ? Do you feel my Love ?  
ham I'm back & we're packing the car now, I'll let you know if there's room  
ham Ahhh. Work. I vaguely remember that! What does it feel like? Lol  
ham Wait that's still not all that clear, were you not sure about me being sarcastic or that that's why x doesn't want to live with us  
ham Yeah he got in at 2 and was v apologetic. n had fallen out and she was actin like spoilt child and he got caught up in that. Till 2! But we won't go there! Not doing too badly cheers. You?  
ham K tell me anything about you.  
ham For fear of fainting with the of all that housework you just did? Quick have a cuppa  
spam Thanks for your subscription to Ringtone UK your mobile will be charged £5/month Please confirm by replying YES or NO

Type	Message
Ham	Ok lar... Joking wif u oni...
Spam	Free entry in 2 a wkly comp to win FA Cup final tkts 21st May 2005. Text FA to 87121 to receive entry question(std txt rate)T&C's apply 08452810075over18's
Ham	U dun say so early hor... U c already then say...
Spam	WINNER!! As a valued network customer you have been selected to receivea 900 prize reward! To claim call 09061701461. Claim code KL341. Valid 12 hours only.

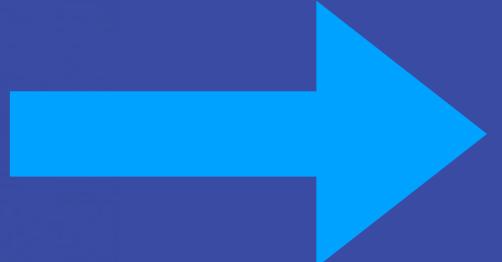
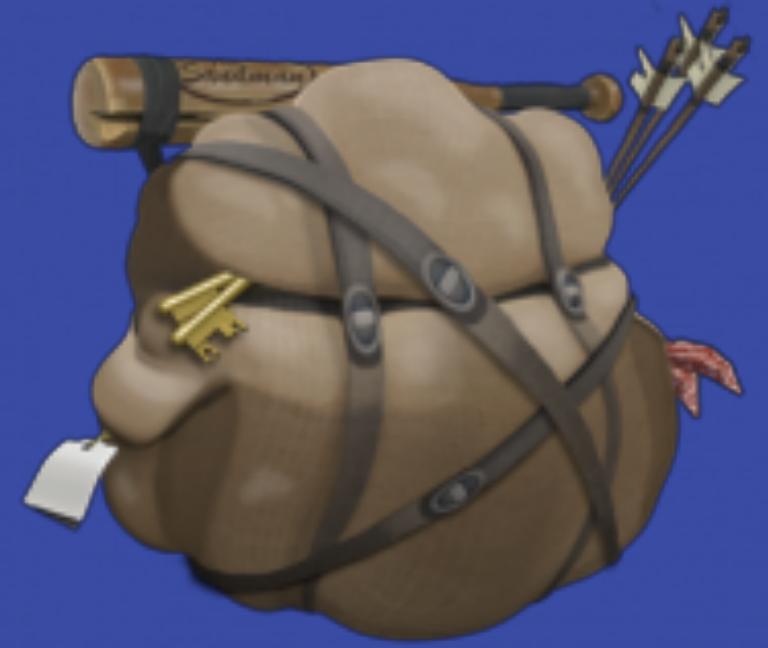
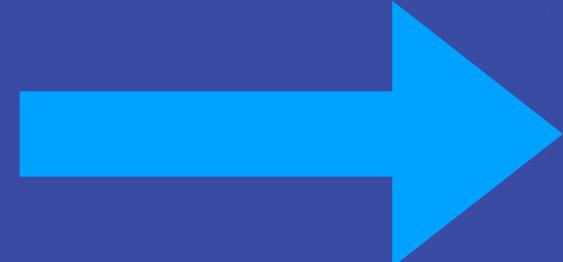
Type	Message
0	Ok lar... Joking wif u oni...
1	Free entry in 2 a wkly comp to win FA Cup final tkts 21st May 2005. Text FA to 87121 to receive entry question(std txt rate)T&C's apply 08452810075over18's
0	U dun say so early hor... U c already then say...
1	WINNER!! As a valued network customer you have been selected to receivea 900 prize reward! To claim call 09061701461. Claim code KL341. Valid 12 hours only.

# How do you represent words to a machine?



# Vocabulary Processor

I like dogs



[I, like, dogs, cats]

I like cats

[1, 2, 3, 4]



```
python3 (Python)  #1  tensorboard (Python)  #2  ..ingtensorflow (z...  #3  ..de/playground (...  #4  
0  
>>> messages = ["I like cats", "I like dogs"]  
>>> messages  
['I like cats', 'I like dogs']  
>>> vp = tflearn.data_utils.VocabularyProcessor(5)  
>>> np.array(list(vp.fit_transform(messages)))  
array([[1, 2, 3, 0, 0],  
       [1, 2, 4, 0, 0]])  
>>> vocab = np.array(list(vp.fit_transform(messages)))  
>>> vocab  
array([[1, 2, 3, 0, 0],  
       [1, 2, 4, 0, 0]])  
>>> 
```

{

# Looking at our data now

Type	Message
0	[ 47, 315, 0, 457, 6, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
1	[ 46, 464, 9, 4, 0, 0, 1, 178, 0, 0, 0, 0, 0, 236, 258, 69, 0, 1, 1, 318, 464]
0	[ 6, 230, 140, 23, 357, 0, 6, 155, 142, 58, 140, 0, 0, 0, 0, 0, 0, 0]
1	[ 0, 2, 42, 97, 70, 465, 1, 0, 70, 0, 202, 110, 472, 0, 0, 0, 0, 0, 0, 0]

# Writing our model



To start off we will just import some common libraries

```
1 import numpy as np
2 import tensorflow as tf
3 import tflearn
4 import string
5 from tflearn.data_utils import load_csv
```

**Here we will load our csv file into two variables**

```
6 data, labels = load_csv('spam.csv', target_column=0,  
categorical_labels=True, n_classes=2)
```



## 1. python3 (Python)

```
python3 (Python) ⌘1  tensorboard (Python)  ⌘2  ..ingtensorflow (z...  ⚪  ⌘3  ..de/playground (...  ⚪  ⌘4  
0  
>>> data, labels = load_csv('spam.csv', target_column=0, categorical_labels=True, n_classes=2)  
>>> d
```

**Now we need to clean up our data a bit**

```
6 data, labels = load_csv('spam.csv', target_column=0, categorical_labels=True, n_classes=2)

7 text_messages = np.concatenate(data, axis=0)
8 text_messages = [x.lower() for x in text_messages]
9 text_messages = [''.join(c for c in x if c not in string.punctuation) for x in text_messages]
10 text_messages = [''.join(c for c in x if c not in '0123456789') for x in text_messages]
11 text_messages = [''.join(x.split()) for x in text_messages]
```



## 1. python3 (Python)

X python3 (Python) #1 X tensorboard (Python) #2 X ...ingtensorflow (z... ● #3 X ...de/playground (... ● #4

```
0
>>> text_messages = np.concatenate(data, axis=0)
>>> [
```

]

# Now we can build our bag of words

We can pass our transformed data into X and our labels into Y for training

```
16 trainX = np.array(list(vp.fit_transform(text_messages)))  
17 trainY = labels
```

**Here we actually build our network and define  
our layers for the graph to be built**

```
18 tf.reset_default_graph()
19 net = tflearn.input_data([None, max_document_length])
20 net = tflearn.fully_connected(net, 32)
21 net = tflearn.fully_connected(net, 32)
22 net = tflearn.fully_connected(net, 2, activation='softmax')
23 net = tflearn.regression(net)
24 model = tflearn.DNN(net)
```

**Now we can fit our model or train it**

```
25 model.fit(trainX, trainY, n_epoch=10, batch_size=16,  
show_metric=True)
```

```
>>> import tensorflow as tf
>>> import tflearn
hdf5 is not supported on this machine (please install/reinstall h5py for optimal experience)
>>> import string
>>> from tflearn.data_utils import load_csv
>>>
>>> data, labels = load_csv('spam.csv', target_column=0, categorical_labels=True, n_classes=2)
>>> text_messages = np.concatenate(data, axis=0)
>>> text_messages = [x.lower() for x in text_messages]
>>> text_messages = [''.join(c for c in x if c not in string.punctuation) for x in text_messages]
>>> text_messages = [''.join(c for c in x if c not in '0123456789') for x in text_messages]
>>> text_messages = [' '.join(x.split()) for x in text_messages]
>>>
>>> max_document_length = max([len(x.split(" ")) for x in text_messages])
>>>
>>> min_word_freq = 2
>>> vp = tflearn.data_utils.VocabularyProcessor(max_document_length, min_frequency=min_word_freq)
>>> trainX = np.array(list(vp.fit_transform(text_messages)))
>>> trainY = labels
>>>
>>> tf.reset_default_graph()
>>>
>>> net = tflearn.input_data([None, max_document_length])
>>> net = tflearn.fully_connected(net, 32)
>>> net = tflearn.fully_connected(net, 32)
>>> net = tflearn.fully_connected(net, 2, activation='softmax')
>>> net = tflearn.regression(net)
>>> model = tflearn.DNN(net)
2017-09-25 02:25:22.826368: W tensorflow/core/platform/cpu_feature_guard.cc:45] The TensorFlow library wasn't compiled to use SSE4.1 instructions, but these are available on your machine and could speed up CPU computations.
2017-09-25 02:25:22.826402: W tensorflow/core/platform/cpu_feature_guard.cc:45] The TensorFlow library wasn't compiled to use SSE4.2 instructions, but these are available on your machine and could speed up CPU computations.
2017-09-25 02:25:22.826407: W tensorflow/core/platform/cpu_feature_guard.cc:45] The TensorFlow library wasn't compiled to use AVX instructions, but these are available on your machine and could speed up CPU computations.
2017-09-25 02:25:22.826411: W tensorflow/core/platform/cpu_feature_guard.cc:45] The TensorFlow library wasn't compiled to use AVX2 instructions, but these are available on your machine and could speed up CPU computations.
2017-09-25 02:25:22.826415: W tensorflow/core/platform/cpu_feature_guard.cc:45] The TensorFlow library wasn't compiled to use FMA instructions, but these are available on your machine and could speed up CPU computations.
>>> del tf.get_collection_ref(tf.GraphKeys.TRAIN_OPS)[:]
>>> █
```



1. zachwestlake@zachwestlake-C02QM: ~/code/playground (zsh)

X python3 (Python) #1

X ..de/playground (zsh) #2

X ..de/playground ... ● #3

~/code/playground ➜



Fit to screen



Download PNG

Run

Y46UXQ

(61)

Session

runs (0)

Upload

Choose File

Trace inputs



Color



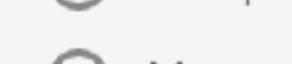
Structure



Device



XLA Cluster



Compute time



Memory

Graph

(\*=expandable)



Uniquesabstructure



OpNode



Unconnected series\*



Connected series\*



Constant



Summary



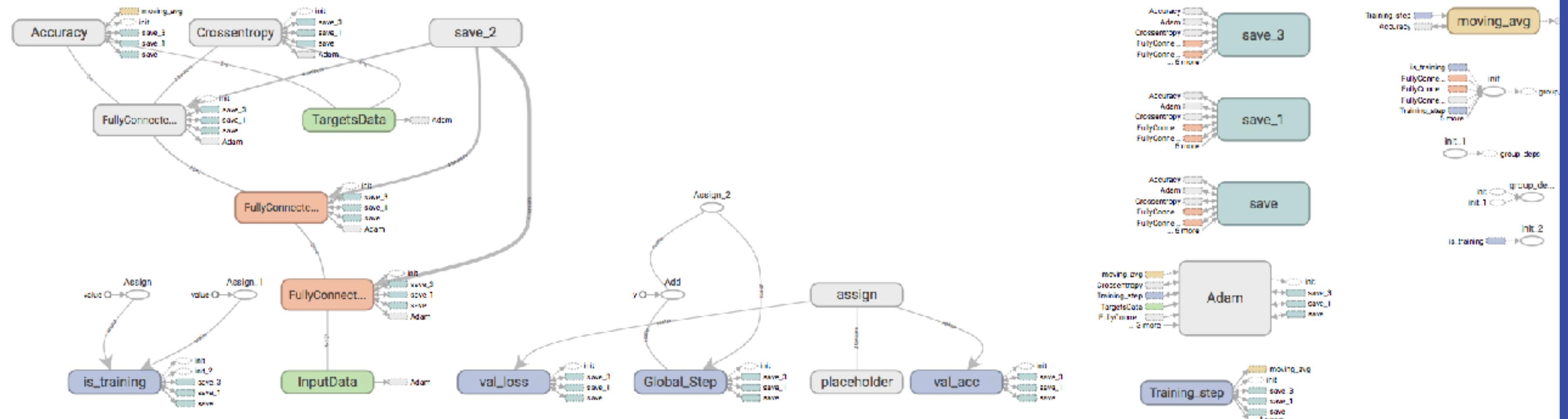
Dataflow edge

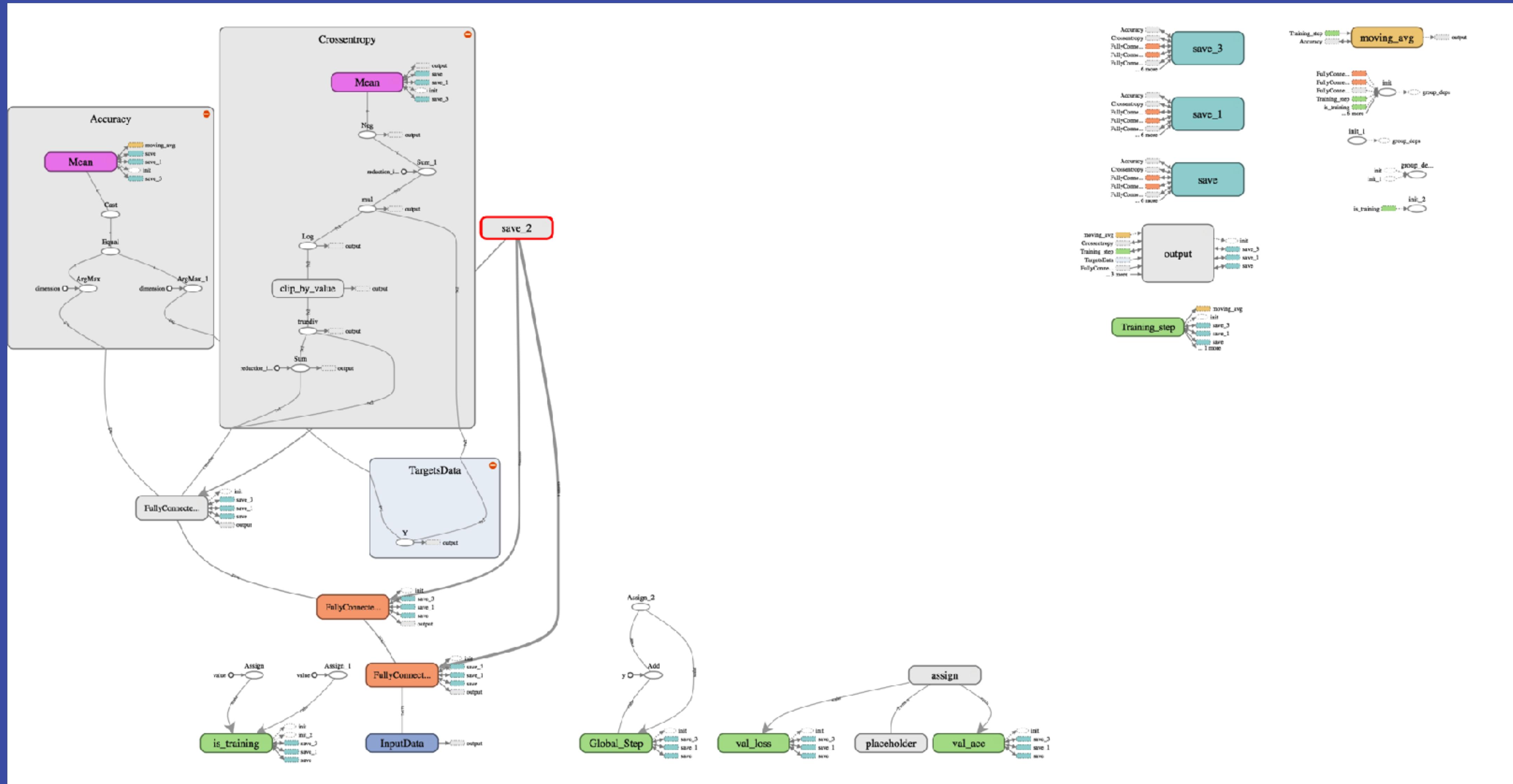


Control dependency edge



Reference edge





1. python3 (Python)

python3 (Python) #1 tensorboard (Python) #2 ..ingtensorflow (z... #3 ..de/playground (...) #4

```
>>> [REDACTED]
```

**Lastly we should save our model**

```
26 model.save('model/model')
```

```
~/code/playground ➔ ls model  
checkpoint          model.data-00000-of-00001 model.index      model.meta  
~/code/playground ➔
```

1. zachwestlake@zachwestlake-C02QM: ~/code/playground (zsh)

python3 (Python) #1 tensorboard (Python) #2 ...ingtensorflow (zsh) #3 ..de/playground (zsh) #4

```
~/code/playground ➜ python3 freeze.py --model_folder ./model
```

**In our Android app we can quickly flag a message as spam if its score is over a certain value**

```
private val inference = TensorFlowInferenceInterface(  
    assets, MODEL)  
  
private val outputs = FloatArray(1)  
private val outputNames = arrayOf(OUTPUT_NAME)  
  
fun isSpam(message: FloatArray): Boolean {  
    with(inference) {  
        feed(INPUT_NAME, message, 1, INPUT_SIZE)  
        run(outputNames)  
        fetch(OUTPUT_NAME, outputs)  
    }  
    return outputs[0] > SPAM_QUALIFIER  
}
```

 Home

-  **The Godfather** Sep 25, 2017  
I'm going to make him an offer he can't refuse.
-  **Dorothy** Sep 25, 2017  
Toto, I've a feeling we're not in Kansas anymore.
-  **Richard Zanuck** Sep 25, 2017  
You're gonna need a bigger boat.
-  **James Cromwell** Sep 25, 2017  
That'll do, pig. That'll do.
-  **Sherlock Holmes** Sep 25, 2017  
Elementary, my dear Watson.
-  **Dustin Hoffman** Sep 25, 2017  
I'm walking here! I'm walking here!
-  **Harrison Ford** Sep 25, 2017  
Chewie, we're home.



# Questions?

# Thanks!

Github: Zehhu

Twitter: @zachwestlake