TensorFlow Introduction:

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TensorFlow: What is it?

- A software library for machine learning
  - Computation using data flow graphs
  - Neural Networks
- Released by Google November 9, 2015
- An open source successor to DistBelief
  - Apache 2.0 License
- APIs:
  - **Python**
  - C++
  - Java
  - Go

TensorFlow: Alternatives

- Caffe
  - UC Berkeley (BVLC: Berkeley Vision and Learning Center)
- Microsoft Cognitive Toolkit (CNTK 2.0)
  - Microsoft
- Theano
  - Université de Montréal (MILA/LISA: Montreal Institute for Learning Algorithms)
- Torch

TensorFlow: Why?

- CPU/GPU/TPU support, easy to scale up
- Large and active user-base
  - Academia, industry, enthusiasts
- Rapid development, research, and support by Google
- TensorBoard visualizations
- Integration with Google Cloud Platform
- Pre-trained models and high-level libraries (Slim, Keras, TFLearn)

TensorFlow: Tensors

- *Mathematics*: Geometric objects defining linear relations
  - Generalization of vectors and matrices:
    - 0th Order (Scalar): 8
    - 1st Order (Vector): [4, 2, 9]
    - 2nd Order (Matrix): [[5, 1, 9], [2, 2, 0]]
- TensorFlow: unit for data and variables
  - 0th Order: `scalar_node = tf.constant(8.0, dtype=tf.float32)`
  - 4th Order: `weights = tf.Variable(tf.random_normal([3, 3, 256, 512]), name="conv_weights")`

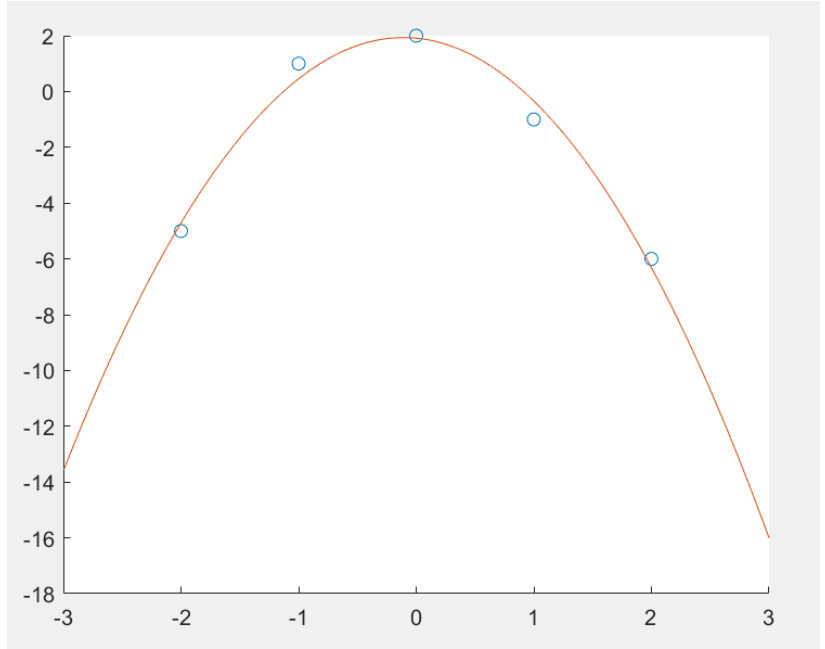
TensorFlow: Data Flow Graphs

- Typical computational program operates directly on the data:
  - Python:

```
import numpy
x = [-2, -1, 0, 1, 2]
y = [-5 , 1,  2,  -1,  -6]
p = numpy.polyfit(x, y, deg=2)

# y_hat = p[0] * x**2 + p[1] * x + p[2]
```

- Note that operations were performed on the variables holding the data itself



TensorFlow: Data Flow Graphs

- TensorFlow: 2 steps
  - Define a graph:

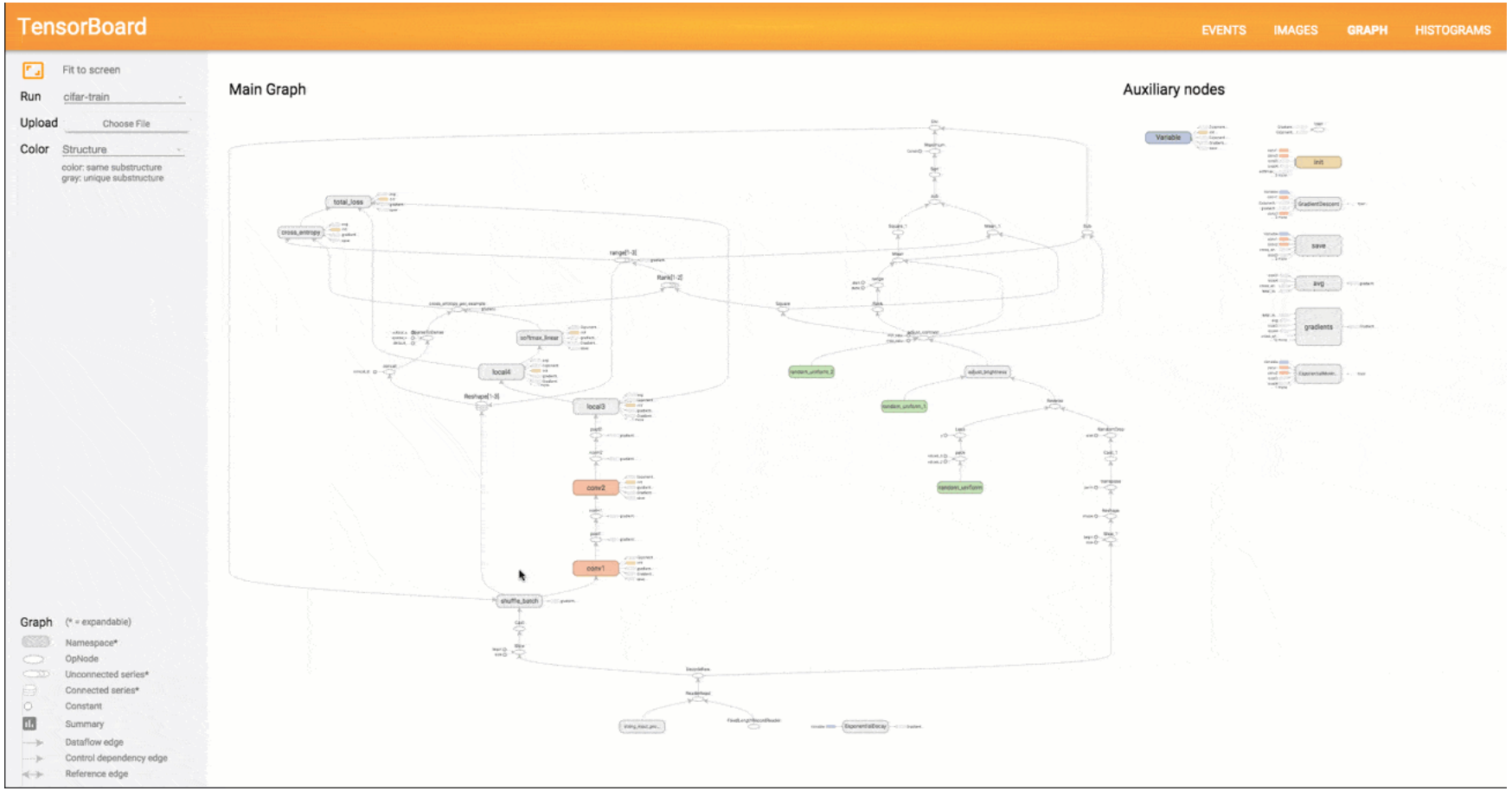
```
a = tf.constant(3.0, dtype=tf.float32)
b = tf.constant(4.0, dtype=tf.float32)
sum = tf.add(a, b)
```

  - Run the graph and get outputs:

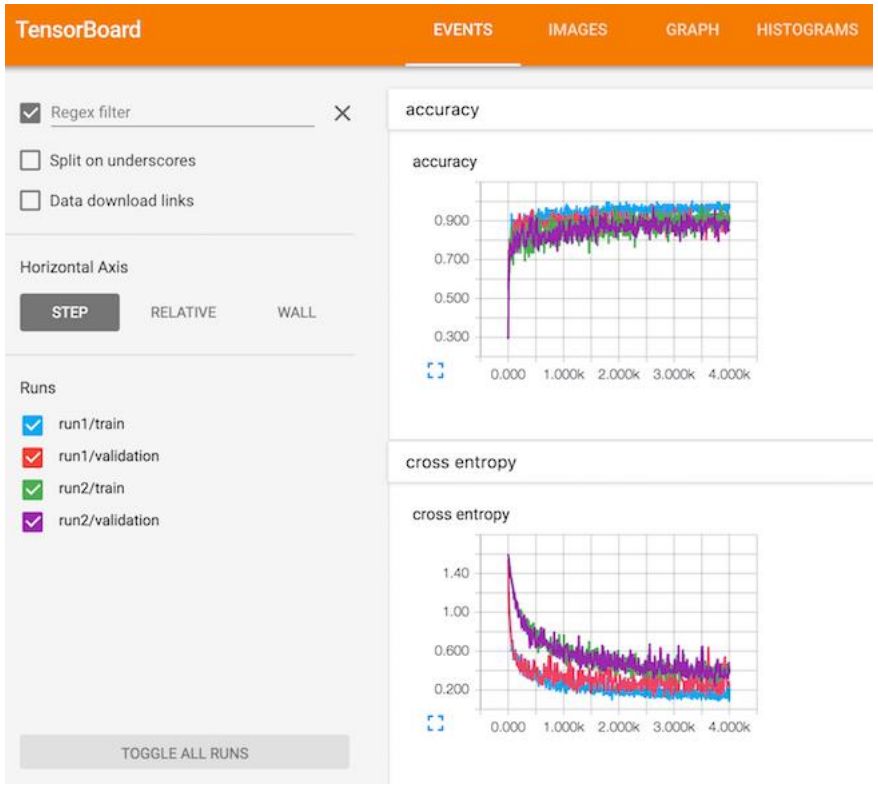
```
sess = tf.Session()
print(sess.run(sum))          # Prints "7.0" to the screen
sess.close()
```

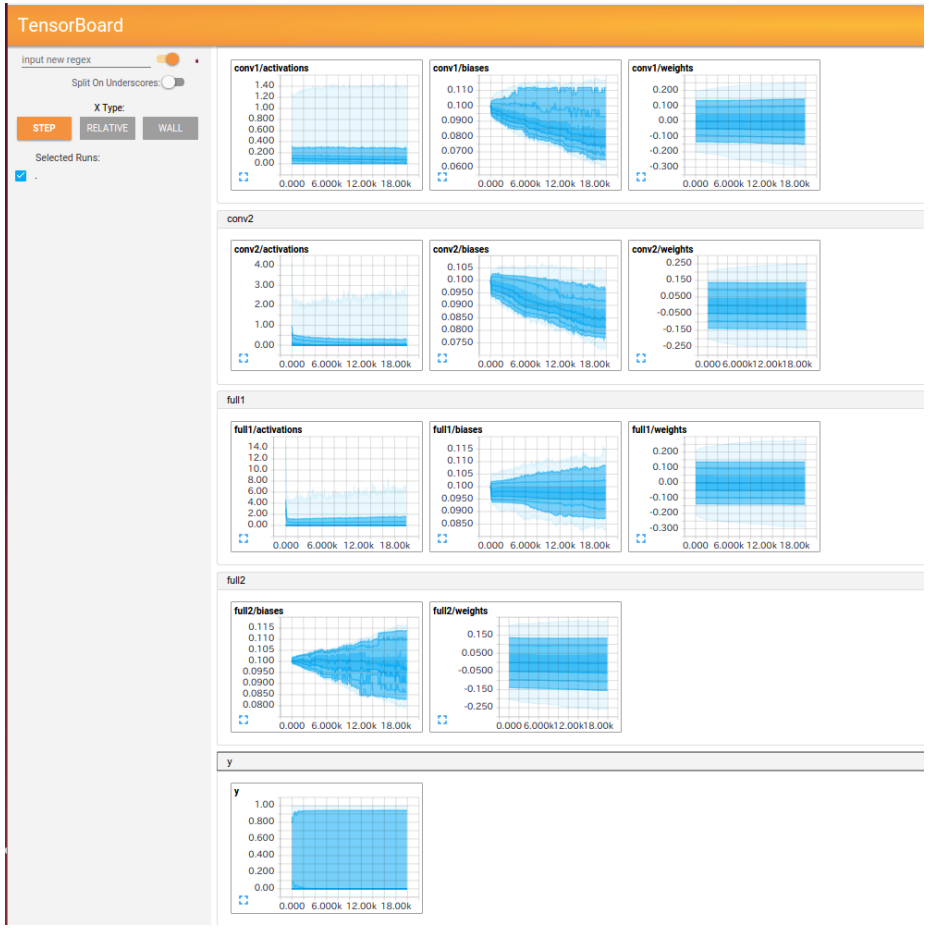
- More examples in tutorial: 02_TensorFlow_Basics.ipynb

TensorBoard: Graph Visualization

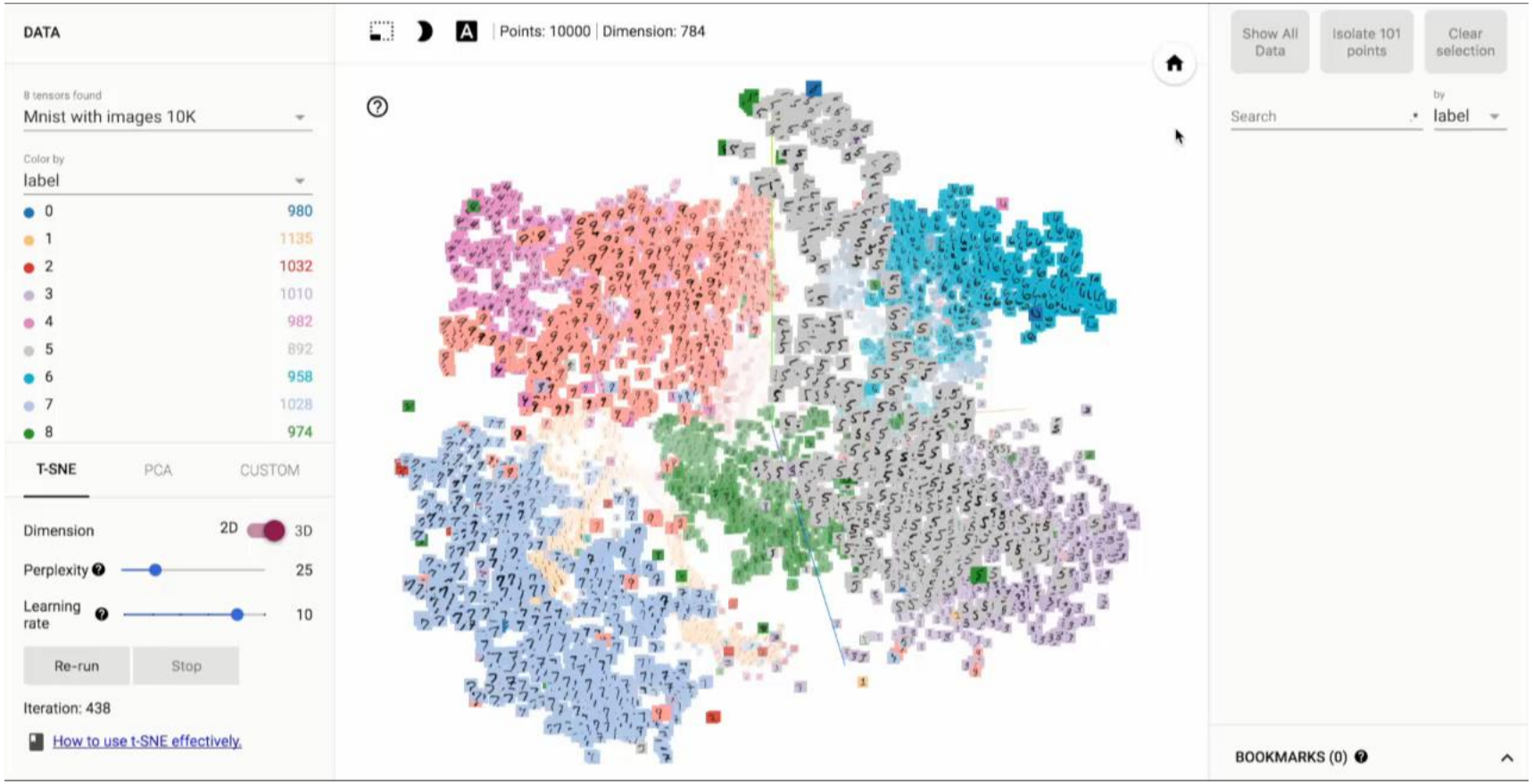


TensorBoard: Learning Visualization





TensorFlow: Embedding Visualization



Questions?