TensorFlow 101

Teeradaj Racharak (เอ็กซ์)
r.teeradaj@gmail.com

Outline

- Basics in TensorFlow
- Basics in TensorBoard

Basic Operations in TF

1. Operations
2. Tensors

Idea:

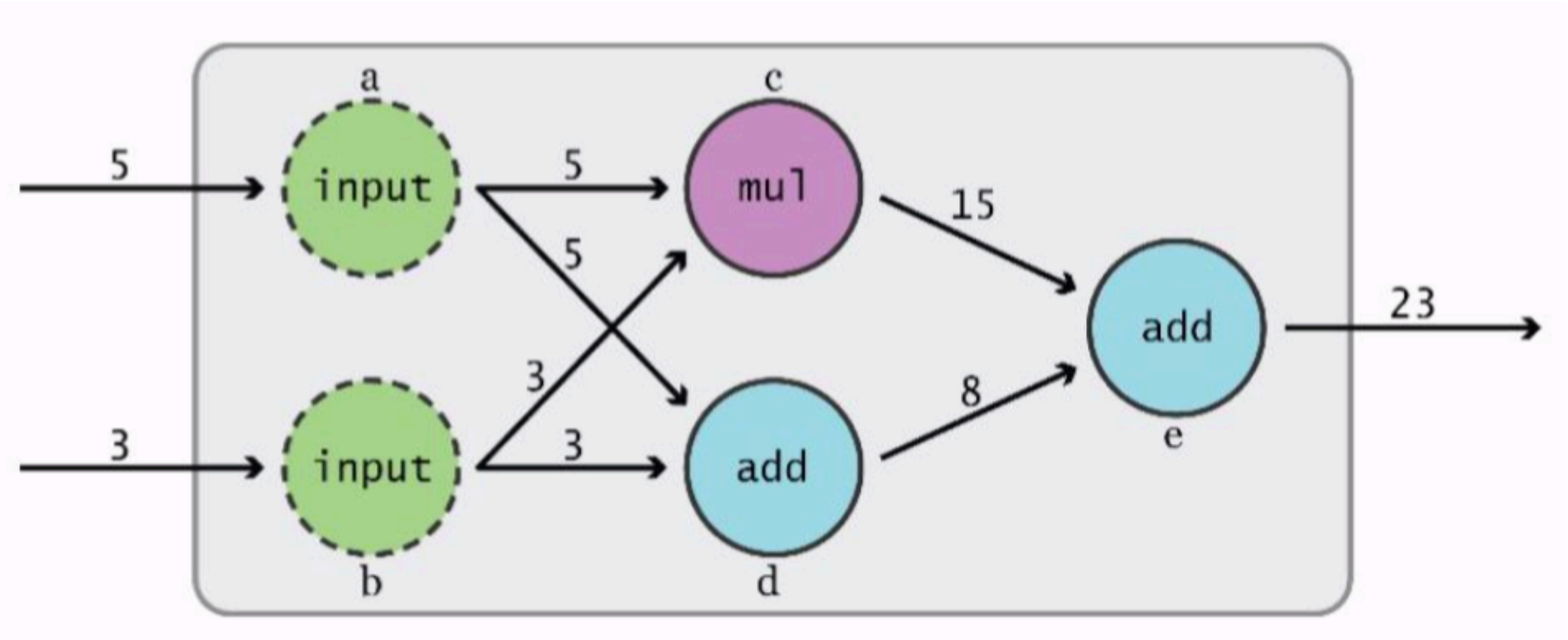
- Create a model that consists of a set of operations
- Feed the data into the models
- Tensors will flow between operations to get an ‘output’ tensor !!!

Data Flow Graphs

- TensorFlow separates definitions of computations from their execution

- Its execution is decided into 2 phases *i.e.*
  - Phase 1: assemble a graph
  - Phase 2: Use a session to execute operations in the graph

Data Flow Graphs



Nodes: operators, variables, constants, and placeholders
Edges: tensors

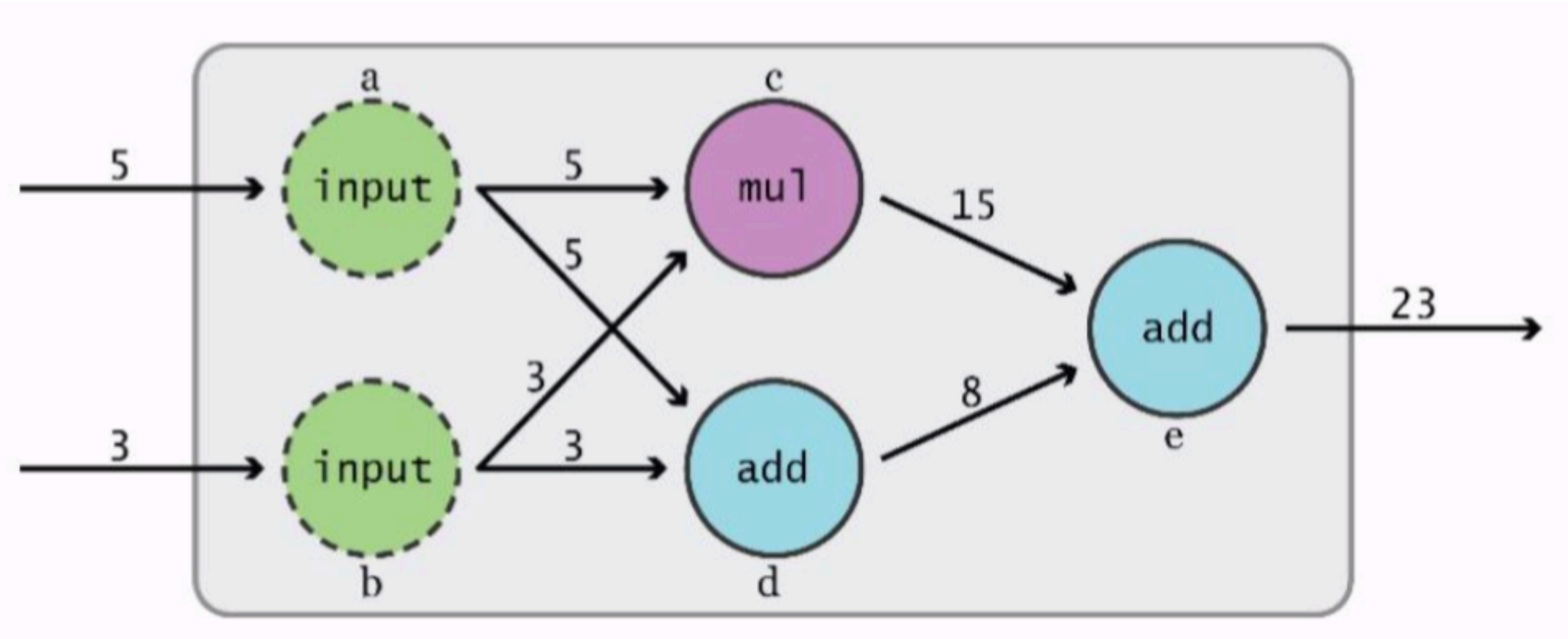
What's a tensor?

- An n-dimensional array

- 0-d tensor: scalar (number)
- 1-d tensor: vector
- 2-d tensor: matrix

⋮

Data Flow Graphs



Tensors are data !

∴ TensorFlow ⟺ DataFlow

Why graph?

- Save computation *i.e.* only subgraphs corresponding to an executed operation are run !
- Facilitate distributed computation, spread the work across multiple CPUs, GPUs, or devices
- Many common machine learning models are commonly taught and visualized as directed graphs.

Let’s do our 1st lab !

What’s TensorBoard?

- TensorBoard is a visualization software that comes with any standard TensorFlow installation.
- Google’s word: *The computations you’ll use TensorFlow for many things (like training a massive deep neural network) and they can be complex and confusing. To make it easier to understand, debug, and optimize TensorFlow programs, we’ve included a suite of visualization tools called TensorBoard.*

What to visualize?

1. Visualizing the graph
2. Writing summaries to visualize learning

To use TensorBoard, we need to **create event log files** using the code:

```
writer = tf.summary.FileWriter([logdir], [graph])
```

Visualizing a graph

To use TensorBoard, we need to **create event log files** using the code:

```
writer = tf.summary.FileWriter([logdir], [graph])
```

There are 2 ways to get the graph:

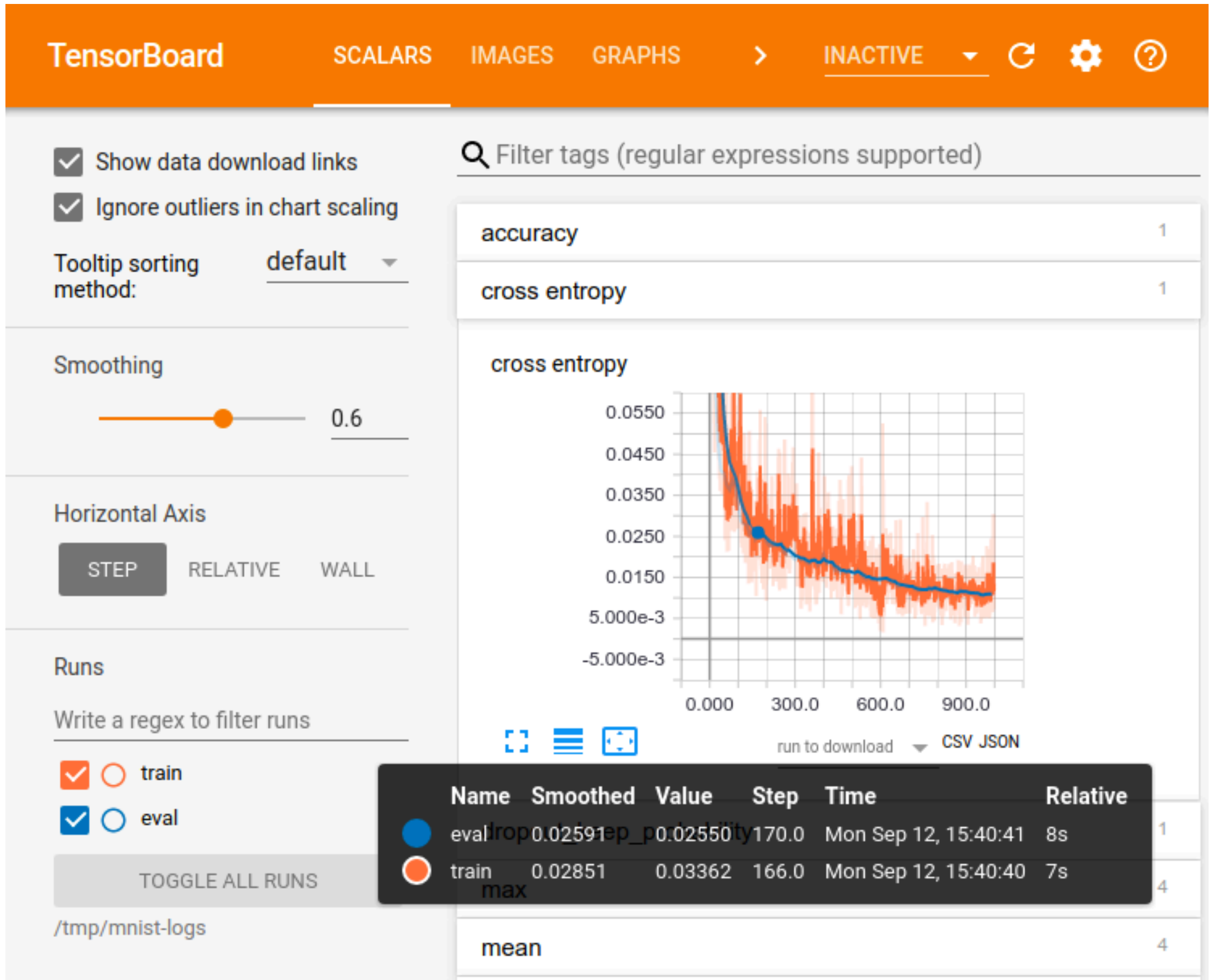
1. Call the graph using **tf.get_default_graph()**, which returns the default graph of the program
2. Set it as **session.graph** which returns the session's graph. This requires us to have a session created **(This is more common)**.

Either way, make sure to create a writer only after defining the graph.
Otherwise, the graph visualized on TensorBoard would be incomplete !!!

Types of summary

1. Scalars
2. Images
3. Audio
4. Histograms
5. Graphs

A summary is a special operation that TensorBoard takes in a regular tensor and outputs to your disk !



☑ Show data download links
☑ Ignore outliers in chart scaling
Tooltip sorting method: default

Smoothing 0.6

Horizontal Axis
STEP RELATIVE WALL

Runs
Write a regex to filter runs
☑ ○ train
☑ ○ eval
TOGGLE ALL RUNS
/tmp/mnist-logs

Name	Smoothed	Value	Step	Time	Relative
eval	0.02591	0.02550	170.0	Mon Sep 12, 15:40:41	8s
train	0.02851	0.03362	166.0	Mon Sep 12, 15:40:40	7s

Figure: TensorBoard's appearance

tf.summary.scalar

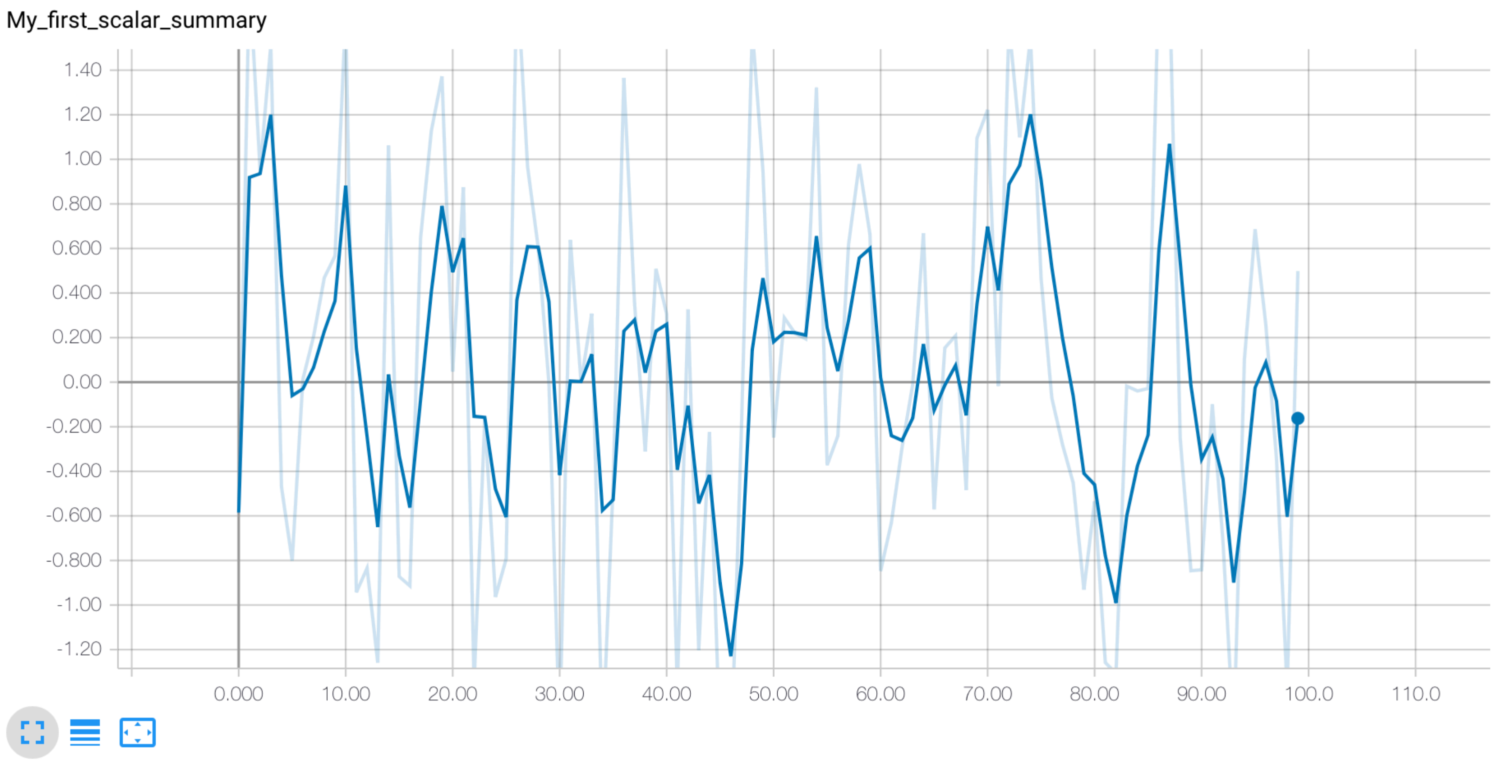
- Write the values of a scalar tensor that changes over time or iterations.
- It’s usually used to monitor the changes of loss function or classification accuracy.

https://www.quora.com/What-does-a-standardized-normal-distribution-of-mean-0-and-standard-deviation-1-mean

Example 1

- Provide a code to randomly pick 100 values from a standard normal distribution, $\mathcal{N}(0,1)$, and plot them on TensorBoard.

- Hint: *create a variable and initialize it from a normal distribution (with* $\mu = 0$ *and* $\sigma = 1$*), then run a for loop in the session and initialize it 100 times.*

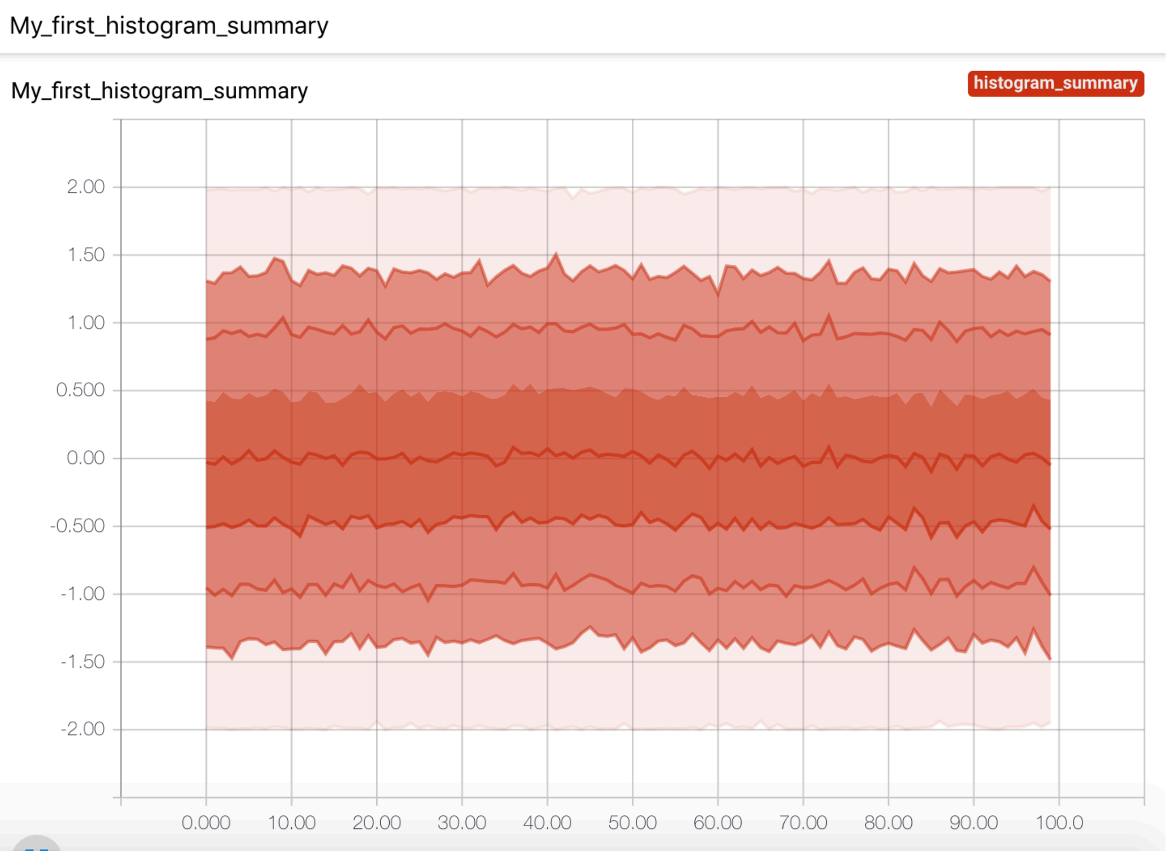


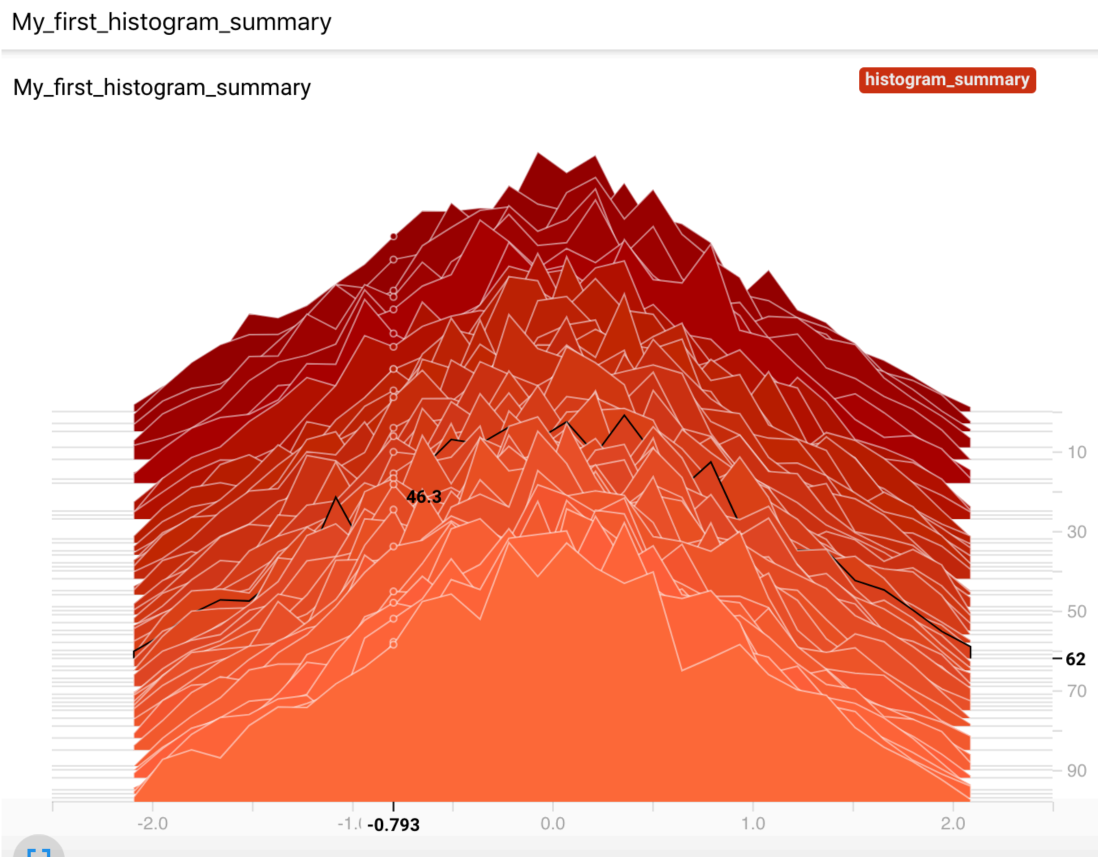
tf.summary.histogram

- Observe the change of a value over time or iterations.
- Used for plotting the histogram (and the distribution) of the values of a non-scalar tensor.
- In NN, it’s used commonly used to monitor the changes of weight and bias distributions.
- Helps detecting irregular behavior of the network parameters *e.g.* when our weights explode or shrink abnormally.

Example 2

- Continue the previous example by adding a matrix of size 30x40, whose entries come from a standard normal distribution. Initialize this matrix 100 times and plot the distribution of its entries over time.





Writing summaries

- In practice, we can use any number of summaries to track different parameters in our model.
  - This makes running and writing the summaries extremely insufficient.
- To handle this, we have to merge all summaries in our graph and run them at once inside your session.
  - use **tf.summary.merge_all()**

tf.summary.image

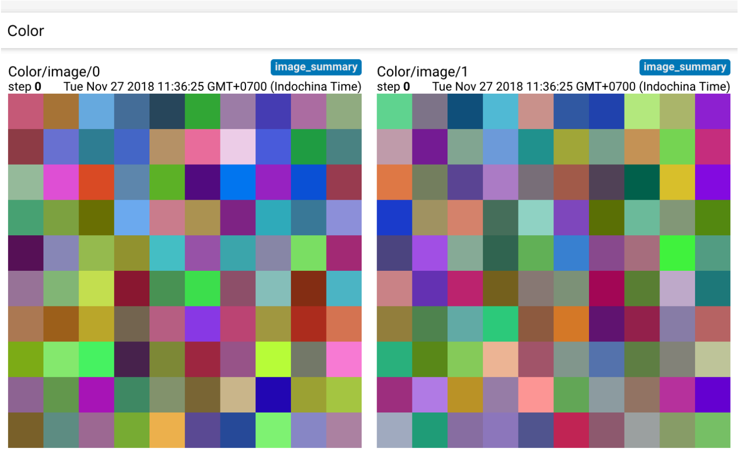
- Used for writing and visualizing tensors as images
- In NN, usually used for tracking images that are fed to the network (*e.g.* in each batch) or the images generated in the output.
- In general, this can be used to plot any tensors.

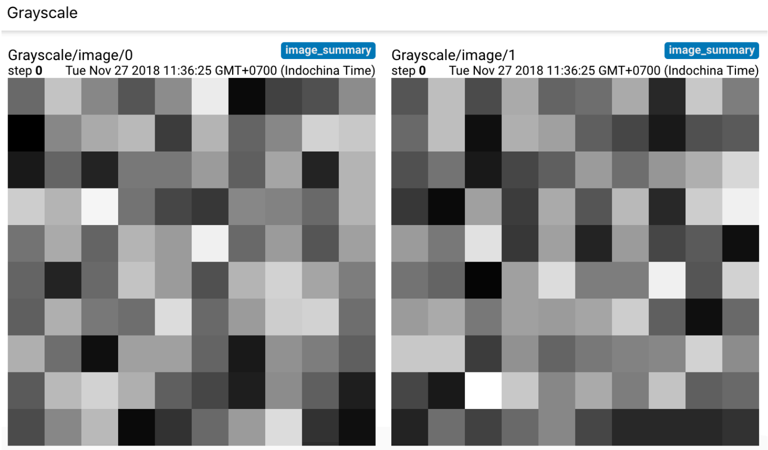
Example 3

Let’s define two variables:

1. Of size 30x10 as 3 grayscale images of size 10x10
2. Of size 50x30 as 5 color images of size 10x10

and plot them as images in TensorBoard.


Color
Color/image/0
image_summary
step 0 Tue Nov 27 2018 11:36:25 GMT+0700 (Indochina Time)
Color/image/1
image_summary
step 0 Tue Nov 27 2018 11:36:25 GMT+0700 (Indochina Time)


Grayscale
Grayscale/image/0
image_summary
step 0 Tue Nov 27 2018 11:36:25 GMT+0700 (Indochina Time)
Grayscale/image/1
image_summary
step 0 Tue Nov 27 2018 11:36:25 GMT+0700 (Indochina Time)

Further reading

- TensorBoard Github: https://github.com/tensorflow/tensorboard
- TensorBoard Graph Visualization: https://www.tensorflow.org/guide/graph_viz
- TensorBoard Visualized Learning: https://www.tensorflow.org/guide/summaries_and_tensorboard
- https://itnext.io/how-to-use-tensorboard-5d82f8654496