Building data pipelines with `tf.data`

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Turkey

TensorFlow

Experts

Agenda

- Why care about data pipelines?
- What is `tf.data`?
- How it is different from the existing options?
- Building data pipelines with `tf.data`
  - Simpler ones
  - More complex ones (w/ `ImageDataGenerator`)
- Performance comparisons

Acknowledgements

- The entire team at PyImageSearch
- Picsou Balthazar

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    - For example, the data input pipelines for image and text can be completely different.

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- Allows us to define the data input pipelines with a lot of dynaminicity
  - For example, the data input pipelines for image and text can be completely different.
  - `tf.data` gives you *programmable interfaces* to aid your use cases.

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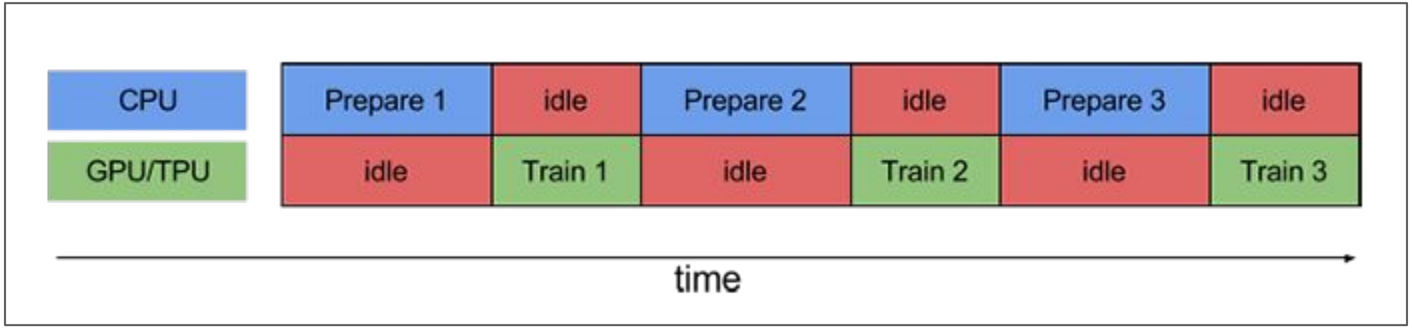

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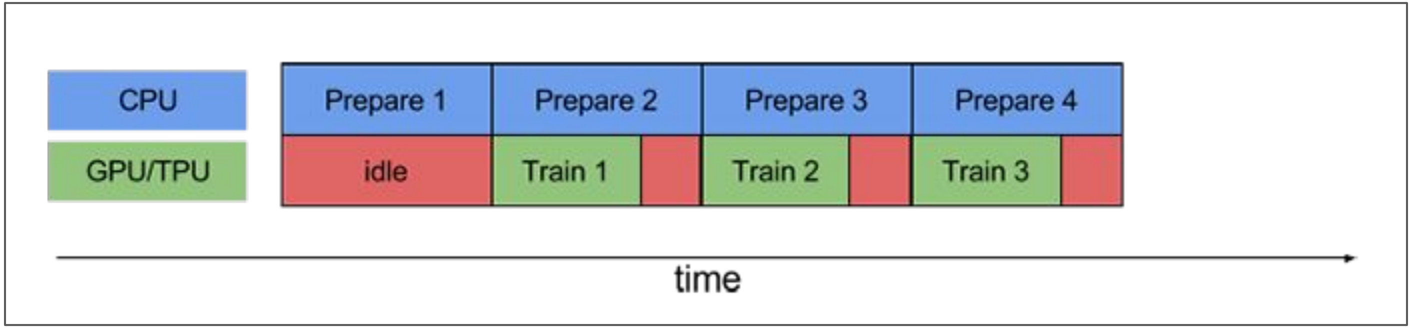

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Salient features of `tf.data`

- Efficient *pipelining* to reduce any additional time it takes to stream your data to the model ⟵ `tf.data.Dataset.prefetch()`
- *Parallelizable* data transformation ⟵ `tf.data.Dataset.map(preproc_fn)`

TLDR; *parallelization* made easier!

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Know more here: https://www.tensorflow.org/guide/data_performance.

Enough talking! Show me some `code`!

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```
# FashionMNIST data along with images and labels
(train, test) = tf.keras.datasets.fashion_mnist.load_data()

# Create tf.data.Dataset!
X_train, y_train = train
train_dataset = tf.data.Dataset.from_tensor_slices((X_train, y_train))
X_test, y_test = test
test_dataset = tf.data.Dataset.from_tensor_slices((X_test, y_test))
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```

```
train_dataset

<TensorSliceDataset shapes: ((28, 28), ()), types: (tf.uint8, tf.uint8)>
```

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```
train_dataset = train_dataset.\
    shuffle(buffer_size=1000).\
    repeat().\
    batch(256).\
    prefetch(buffer_size=1000)
```

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train_dataset = train_dataset.\
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```

Verify shapes!

```
for (images, labels) in train_dataset.take(1):
    pass

print(images.shape) # TensorShape([256, 28, 28])
```

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```python
# Define and compile a model
model = tf.keras.models.Sequential([
  tf.keras.layers.Flatten(input_shape=(28, 28)),
  tf.keras.layers.Dense(128, activation='relu'),
  tf.keras.layers.Dropout(0.2),
  tf.keras.layers.Dense(10, activation='softmax')
])

model.compile(optimizer='adam',
              loss='sparse_categorical_crossentropy',
              metrics=['accuracy'])
```

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```
model.fit(train_dataset,
    steps_per_epoch=len(X_train)//256,
    epochs=5,
    validation_data=test_dataset.batch(256))
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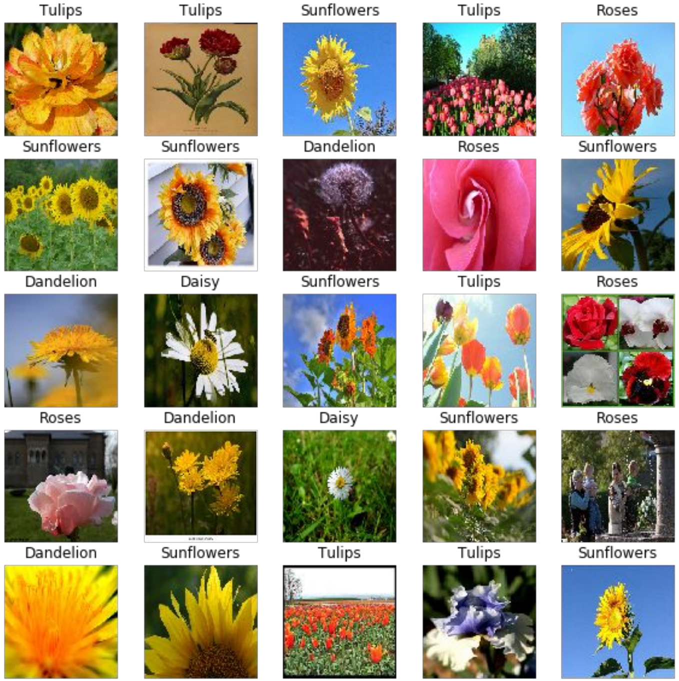
You can play with the notebook here: http://bit.ly/tfdata1

`tf.data` + `ImageDataGenerator` =

We will use the **Flowers dataset**.



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```
train_aug = ImageDataGenerator(
    rotation_range=30,
    zoom_range=0.15,
    width_shift_range=0.2,
    height_shift_range=0.2,
    shear_range=0.15,
    horizontal_flip=True,
    fill_mode="nearest")
```

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```
train_set = tf.data.Dataset.from_generator(
    lambda: train_aug.flow_from_directory(flowers,
            class_mode="categorical",
            target_size=(224, 224),
            color_mode="rgb",
            shuffle=True),
    output_types=(tf.float32, tf.float32),
    output_shapes=([None,224,224,3],[None,5])
)
```

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- Initialize `ImageDataGenerator` with the augmentations.
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- And voila!

```
model = get_me_a_good_model()
model.fit(train_set,
          steps_per_epoch=train_data//32,
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You can play with the notebook here: http://bit.ly/tfdata2

In case you were wondering ...

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    - Data loading with `ImageDataGenerator:`

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1000 batches: 4.16782808303833 s
61422.87899 Images/s
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```

    - Data loading with `tf.data`:

```
1000 batches: 0.6213550567626953 s
412002.76269 Images/s
```

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```
114/114 [==============================] - 144s 1s/step - loss: 5.5306 - accuracy: 0.5962
Epoch 2/5
114/114 [==============================] - 135s 1s/step - loss: 3.3431 - accuracy: 0.7526
Epoch 3/5
114/114 [==============================] - 135s 1s/step - loss: 2.7142 - accuracy: 0.7974
Epoch 4/5
114/114 [==============================] - 135s 1s/step - loss: 2.4073 - accuracy: 0.8120
Epoch 5/5
114/114 [==============================] - 135s 1s/step - loss: 2.0779 - accuracy: 0.8378
It took 685.5545630455017 seconds
```

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```
Epoch 1/5
Found 3670 images belonging to 5 classes.
114/114 [==============================] - 80s 704ms/step - loss: 5.2687 - accuracy: 0.6757
Epoch 2/5
114/114 [==============================] - 82s 715ms/step - loss: 0.9821 - accuracy: 0.7883
Epoch 3/5
114/114 [==============================] - 79s 695ms/step - loss: 0.6616 - accuracy: 0.8219
Epoch 4/5
114/114 [==============================] - 79s 695ms/step - loss: 0.4871 - accuracy: 0.8535
Epoch 5/5
114/114 [==============================] - 80s 699ms/step - loss: 0.3722 - accuracy: 0.8821
It took 399.8591330051422 seconds
```

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Additionally, check out this blog post: http://bit.ly/tf-data-comp. It includes a comprehensive comparison on computation footprints.

Explore more about `tf.data`

- https://www.tensorflow.org/guide/data
- https://www.tensorflow.org/guide/data_performance
- PyImageSearch future blogs
- PyImageSearch's book **DL4CV** will be updated with `tf.data` in a future release
- Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (2nd ed.)

Slides available here:

http://bit.ly/MLWeekend19

See you next time

Find me here:
sayak.dev

Thank you very much :)

Experts

pyimagesearch