Practical Data Science – How to Track your Development Process with DVC

About Us

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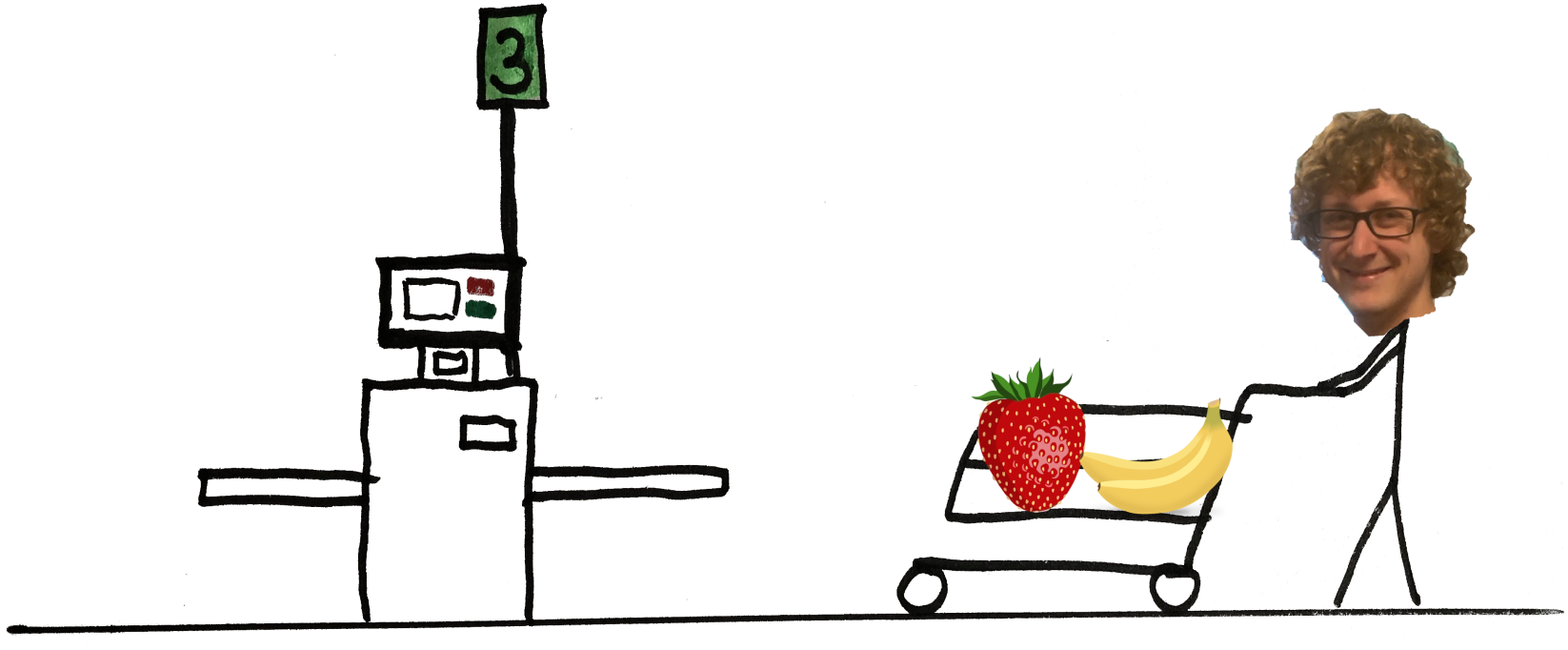
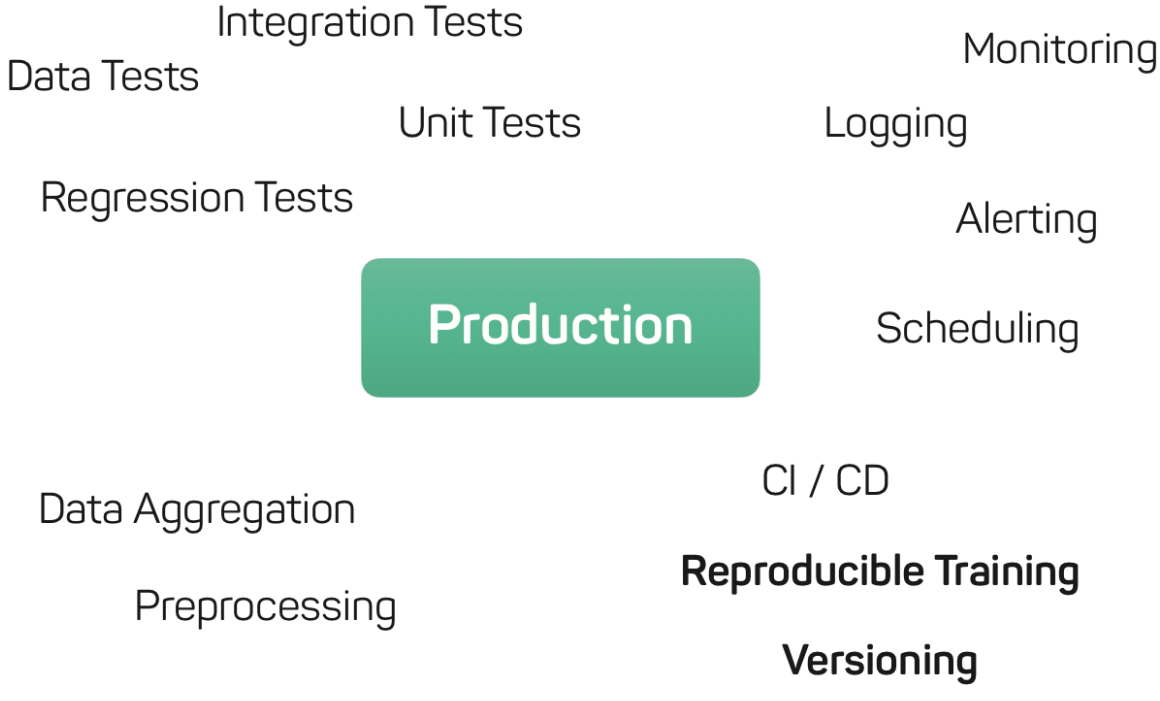
Our Project

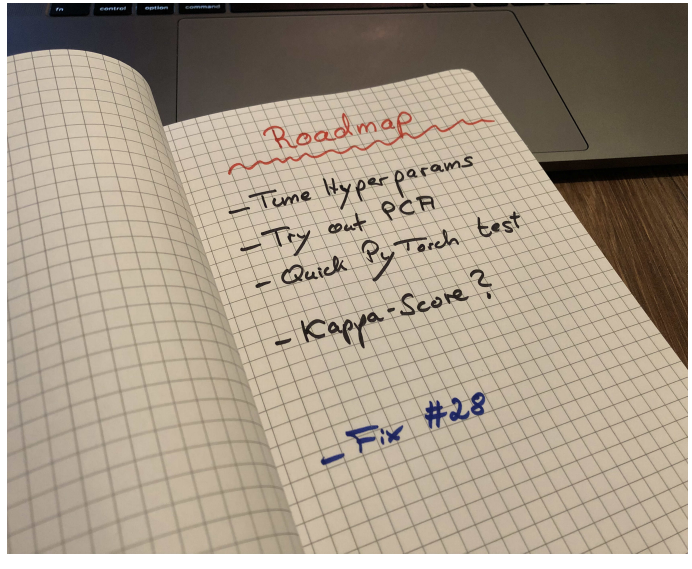


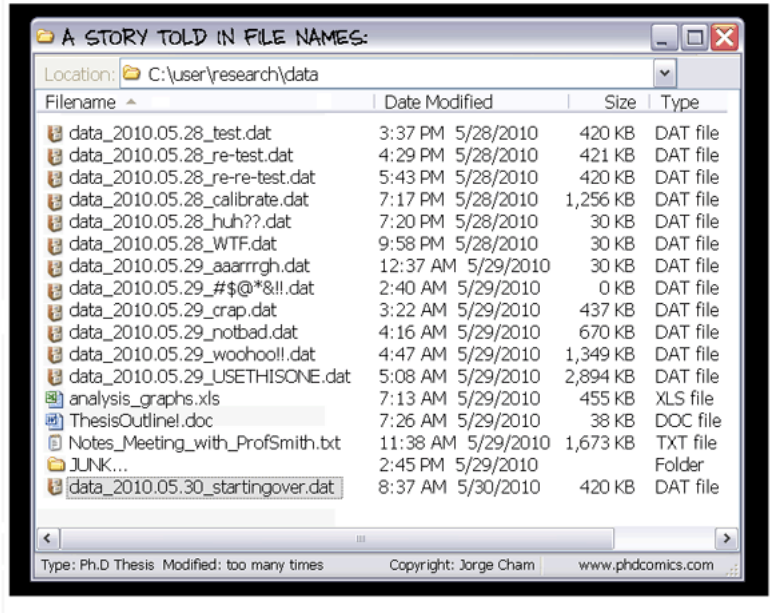

Integration Tests
Data Tests
Monitoring
Unit Tests
Logging
Regression Tests
Alerting
Production
Scheduling
Data Aggregation
CI / CD
Reproducible Training
Preprocessing
Versioning

Data and Model Versioning with DVC

Why should I use this? Reproducibility!

Data Science is experiment-driven …



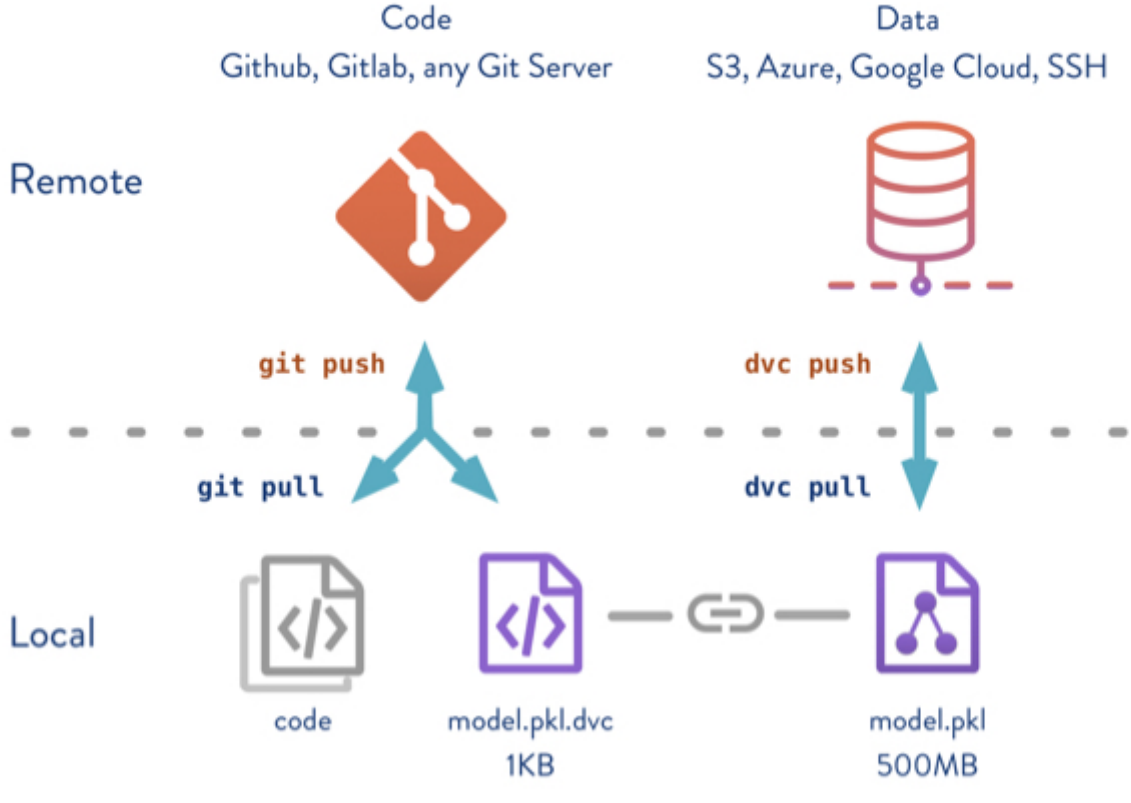


… and collaborative!

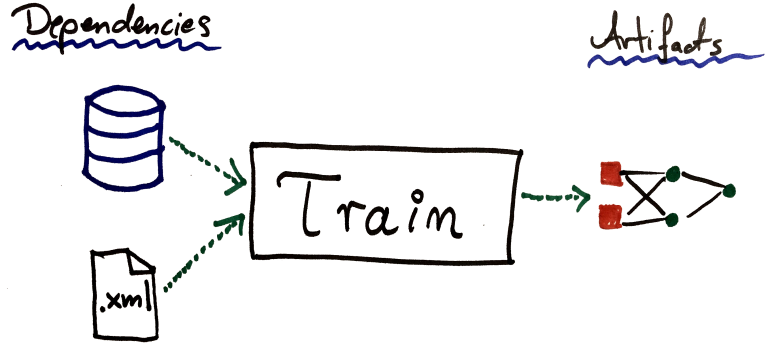
```
Tims-MacBook-Pro:code tsabsch$ git log --graph --decorate --oneline
*   fc88d36 (HEAD -> master) Merge branch 'tim_fix_zerodivisionerror'
|\
| * 2cc23f0 (tim_fix_zerodivisionerror) Fix ZeroDivisionError
* |   e486d76 Merge branch 'mark_batchnorm'
|\ \
| |/
|/|
| * b988f6e (mark_batchnorm) Decrease BN threshold
| * c83736d Add batch normalisation
* | f80b108 Add preprocessing
|/
* a87aa63 Add simple tensorflow model
* 7c0d21e Initial commit
Tims-MacBook-Pro:code tsabsch$
```

DVC to the Rescue!

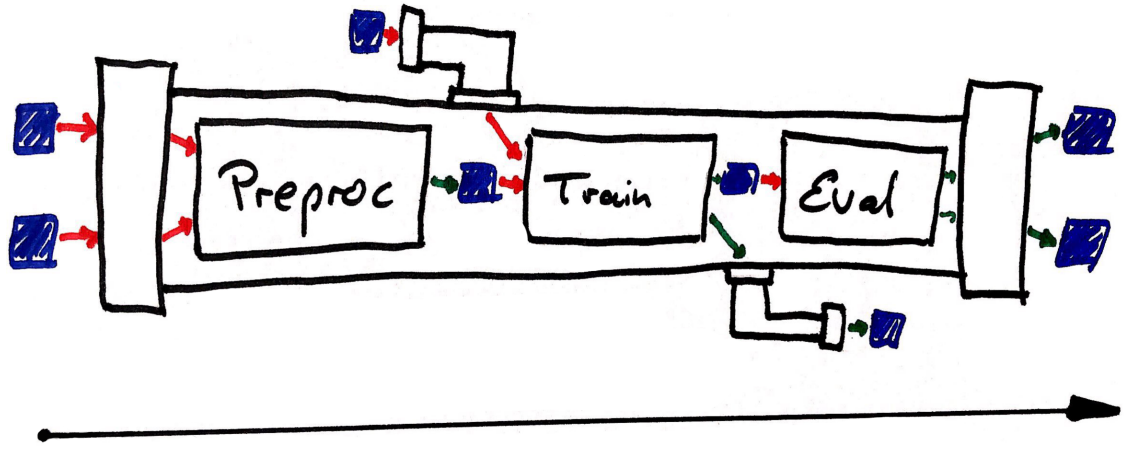
- Large File Storage (similar to git-lfs)
  - Metadata in git (name, hashsum etc.)
  - Contents in cache + remote storage



- Pipelines
    - Optimise reproduction by splitting your process into stages
    - Stages store dependencies, processing and output artifacts

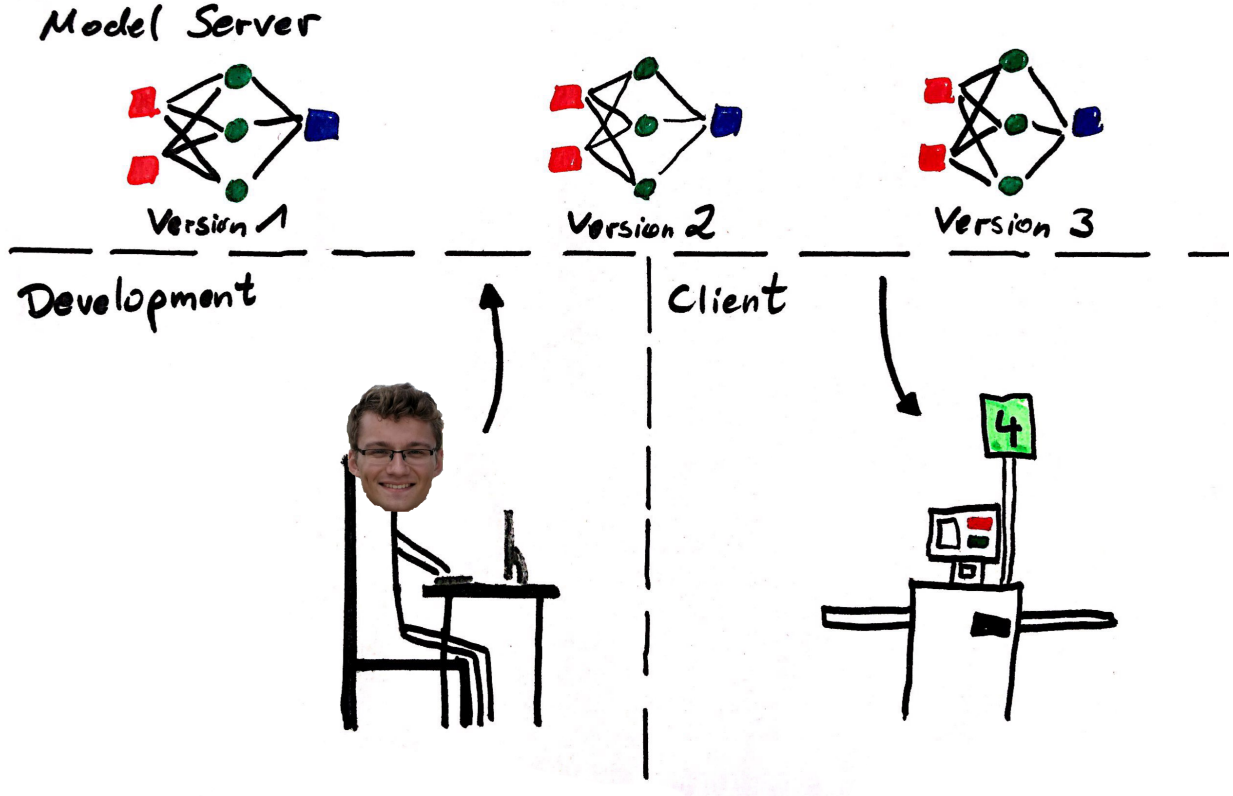


- Pipelines
    - Connect stages to pipeline via dependencies



Continuous Delivery with TensorFlow Serving

TensorFlow Serving



Developing a fruit classifier ”the proper way”

Tools + Software Stack

- Data: Fruits360 (https://www.kaggle.com/moltean/fruits) data set (Kaggle, Github)
- Classification with Tensorflow + Keras
- Versioning with DVC
- Continuous delivery with Tensorflow Serving
- Live prediction on our webcam

Prepare our version control

In [1]:
```
%cd /dvc/code
!git init
!dvc init
```

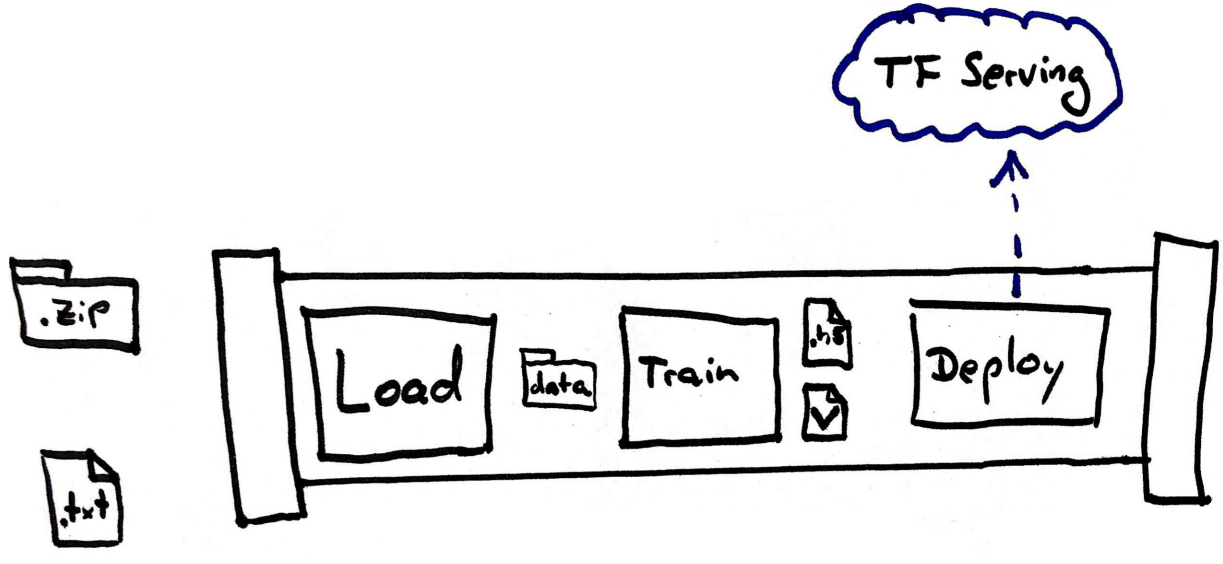
```
/dvc/code
Initialized empty Git repository in /dvc/code/.git/
Adding '.dvc/lock' to '.dvc/.gitignore'.
Adding '.dvc/config.local' to '.dvc/.gitignore'.
Adding '.dvc/updater' to '.dvc/.gitignore'.
Adding '.dvc/updater.lock' to '.dvc/.gitignore'.
Adding '.dvc/state-journal' to '.dvc/.gitignore'.
Adding '.dvc/state-wal' to '.dvc/.gitignore'.
Adding '.dvc/state' to '.dvc/.gitignore'.
Adding '.dvc/cache' to '.dvc/.gitignore'.

You can now commit the changes to git.
```

Set remote storage location for large files

In [2]:
```
!git init --bare /tmp/git-storage/.git
!git remote add local /tmp/git-storage/.git
!dvc remote add -d -f  local_storage /tmp/dvc-storage
```

```
Initialized empty Git repository in /tmp/git-storage/.git/
Setting 'local_storage' as a default remote.
```

Create Pipeline: Load data → Train → Deploy



In [3]:

```
# our fruits to be classified
!echo Banana,Strawberry > fruits.txt

# Start with the first pipeline step
!dvc run -f load_data.dvc \
         -d load_data.sh -d Fruit-Images-Dataset-master.zip -d fruits.txt \
         -o data \
         ./load_data.sh
```

```
Running command:
        ./load_data.sh
Adding 'data' to '.gitignore'.
Computing md5 for a large number of files. This is only done once.
Multi-Threaded: ...Saving information to 'load_data.dvc'.

To track the changes with git, run:

        git add .gitignore load_data.dvc
```

In [4]:
```
!git add load_data.sh load_data.dvc
!git commit -m "Add data loading"
!git push -u local master
!dvc push
```

```
[master (root-commit) 2136165] Add data loading
 4 files changed, 40 insertions(+)
 create mode 100644 .dvc/.gitignore
 create mode 100644 .dvc/config
 create mode 100644 load_data.dvc
 create mode 100755 load_data.sh
Counting objects: 7, done.
Delta compression using up to 6 threads.
Compressing objects: 100% (6/6), done.
Writing objects: 100% (7/7), 957 bytes | 0 bytes/s, done.
Total 7 (delta 0), reused 0 (delta 0)
To /tmp/git-storage/.git
 * [new branch]      master -> master
Branch master set up to track remote branch master from local.
Multi-Threaded: ...
```

In [5]:

```
!dvc run -f train.dvc -d fruit_detector.py -d data -o /tmp/model.h5 -o /tmp/VERSIO
N \
         python fruit_detector.py

!git add fruit_detector.py train.dvc
!git commit -m "Add training" && git push
!dvc push
```

```
Running command:
        python fruit_detector.py
Using TensorFlow backend.
Found 982 images belonging to 2 classes.
Found 330 images belonging to 2 classes.
2019-09-19 17:37:25.286049: I tensorflow/core/platform/cpu_feature_guard.cc:14
1] Your CPU supports instructions that this TensorFlow binary was not compiled
to use: AVX2 FMA
2019-09-19 17:37:25.289657: I tensorflow/core/platform/profile_utils/cpu_util
s.cc:94] CPU Frequency: 2592000000 Hz
2019-09-19 17:37:25.290359: I tensorflow/compiler/xla/service/service.cc:150]
XLA service 0x5653b7aea510 executing computations on platform Host. Devices:
2019-09-19 17:37:25.290427: I tensorflow/compiler/xla/service/service.cc:158]
StreamExecutor device (0): <undefined>, <undefined>
Epoch 1/5
Epoch 2/5
Epoch 3/5
Epoch 4/5
Epoch 5/5
[5.486854553222656, 0.5306462645530701]
Saving '../../tmp/model.h5' to '.dvc/cache/cd/4425c716813656b54f29f078607308'.
Saving '../../tmp/VERSION' to '.dvc/cache/c4/ca4238a0b923820dcc509a6f75849b'.
Saving information to 'train.dvc'.

To track the changes with git, run: ...
```

In [6]:

```
!dvc run -f deploy.dvc -d deploy.py -d /tmp/model.h5 -d /tmp/VERSION \
         python deploy.py

!git add deploy.py deploy.dvc
!git commit -m "Add deployment" && git push
!dvc push
```

```
Running command:
        python deploy.py
Using TensorFlow backend.
2019-09-19 17:38:25.286595: I tensorflow/core/platform/cpu_feature_guard.cc:14
1] Your CPU supports instructions that this TensorFlow binary was not compiled
to use: AVX2 FMA
2019-09-19 17:38:25.290254: I tensorflow/core/platform/profile_utils/cpu_util
s.cc:94] CPU Frequency: 2592000000 Hz
2019-09-19 17:38:25.291294: I tensorflow/compiler/xla/service/service.cc:150]
XLA service 0x55afe89fb870 executing computations on platform Host. Devices:
2019-09-19 17:38:25.291337: I tensorflow/compiler/xla/service/service.cc:158]
StreamExecutor device (0): <undefined>, <undefined>
Saving information to 'deploy.dvc'.

To track the changes with git, run: ...
```

Our pipeline is ready! Let's check it out!

In [7]:
```
%%bash
dvc pipeline show deploy.dvc --ascii
```

```
+---------------+
| load_data.dvc |
+---------------+
        *
        *
        *
  +-----------+
  | train.dvc |
  +-----------+
        *
        *
        *
  +------------+
  | deploy.dvc |
  +------------+
```

What about our live prediction?

In [9]:
```
!echo Banana,Strawberry,Walnut > fruits.txt
!dvc repro deploy.dvc
```

```
WARNING: Dependency 'fruits.txt' of 'load_data.dvc' changed because it is 'mod
ified'.
WARNING: Stage 'load_data.dvc' changed.
Running command:
        ./load_data.sh
Computing md5 for a large number of files. This is only done once.
Multi-Threaded: ...
Saving information to 'load_data.dvc'.
WARNING: Dependency 'data' of 'train.dvc' changed because it is 'modified'.
WARNING: Stage 'train.dvc' changed.
Running command:
        python fruit_detector.py
Using TensorFlow backend.
Found 1717 images belonging to 3 classes.
Found 579 images belonging to 3 classes.
2019-09-19 17:40:13.730103: I tensorflow/core/platform/cpu_feature_guard.cc:14
1] Your CPU supports instructions that this TensorFlow binary was not compiled
to use: AVX2 FMA
2019-09-19 17:40:13.733645: I tensorflow/core/platform/profile_utils/cpu_util
s.cc:94] CPU Frequency: 2592000000 Hz
2019-09-19 17:40:13.734250: I tensorflow/compiler/xla/service/service.cc:150]
 XLA service 0x562416e6a880 executing computations on platform Host. Devices:
2019-09-19 17:40:13.734284: I tensorflow/compiler/xla/service/service.cc:158]
StreamExecutor device (0): <undefined>, <undefined>
Epoch 1/5
Epoch 2/5
Epoch 3/5
Epoch 4/5
Epoch 5/5
[0.001984937349334359, 1.0]
Saving '../../tmp/model.h5' to '.dvc/cache/f2/67cf039a7e3a4172b713216bffb74b'.
Saving '../../tmp/VERSION' to '.dvc/cache/c8/1e728d9d4c2f636f067f89cc14862c'.
Saving information to 'train.dvc'.
WARNING: Dependency '../../tmp/model.h5' of 'deploy.dvc' changed because it is
```

```
WARNING: Dependency '../../tmp/model.h5' of 'deploy.dvc' changed because it is
'modified'.
WARNING: Stage 'deploy.dvc' changed.
Running command:
        python deploy.py
Using TensorFlow backend.
2019-09-19 17:40:33.783824: I tensorflow/core/platform/cpu_feature_guard.cc:14
1] Your CPU supports instructions that this TensorFlow binary was not compiled
to use: AVX2 FMA
2019-09-19 17:40:33.788088: I tensorflow/core/platform/profile_utils/cpu_util
s.cc:94] CPU Frequency: 2592000000 Hz
2019-09-19 17:40:33.788858: I tensorflow/compiler/xla/service/service.cc:150]
 XLA service 0x55e5c34a78b0 executing computations on platform Host. Devices:
2019-09-19 17:40:33.788920: I tensorflow/compiler/xla/service/service.cc:158]
StreamExecutor device (0): <undefined>, <undefined>
Saving information to 'deploy.dvc'.

To track the changes with git, run:

        git add train.dvc load_data.dvc deploy.dvc
```

But wait, there's more!

- Track metrics
- Import versioned artefacts from other projects
- Support for S3, GCS, HDFS, ...
- Remote caching
- ...

But does it also cover my use case %s?

- It depends ¯\(ツ)/¯
- Plenty of alternatives: Sacred, MLFlow, Pachyderm, Polyaxon
- See also https://github.com/EthicalML/awesome-production-machine-learning (https://github.com/EthicalML/awesome-production-machine-learning)

Thanks! :-)