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> Open source tools for machine learning models and data sets versioning

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HELLO

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AGENDA

> Do we need new tools for ML?
> MLFlow
> Git-LFS
> DVC
> Conclusion

|01|

> Do we need new tools for ML?

> MLFlow

> Git-LFS

> DVC

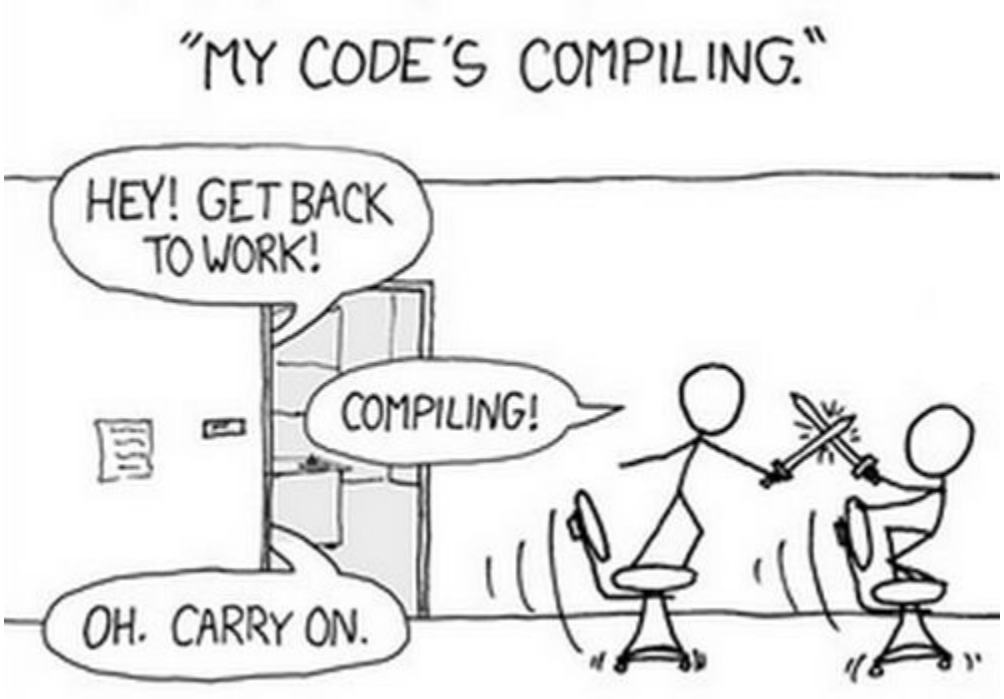
> Conclusion

Andrew Ng @AndrewYNg · Jan 3

1/The rise of Software Engineering required inventing processes like version control, code review, agile, to help teams work effectively. The rise of AI & Machine Learning Engineering is now requiring new processes, like how we split train/dev/test, model zoos, etc.

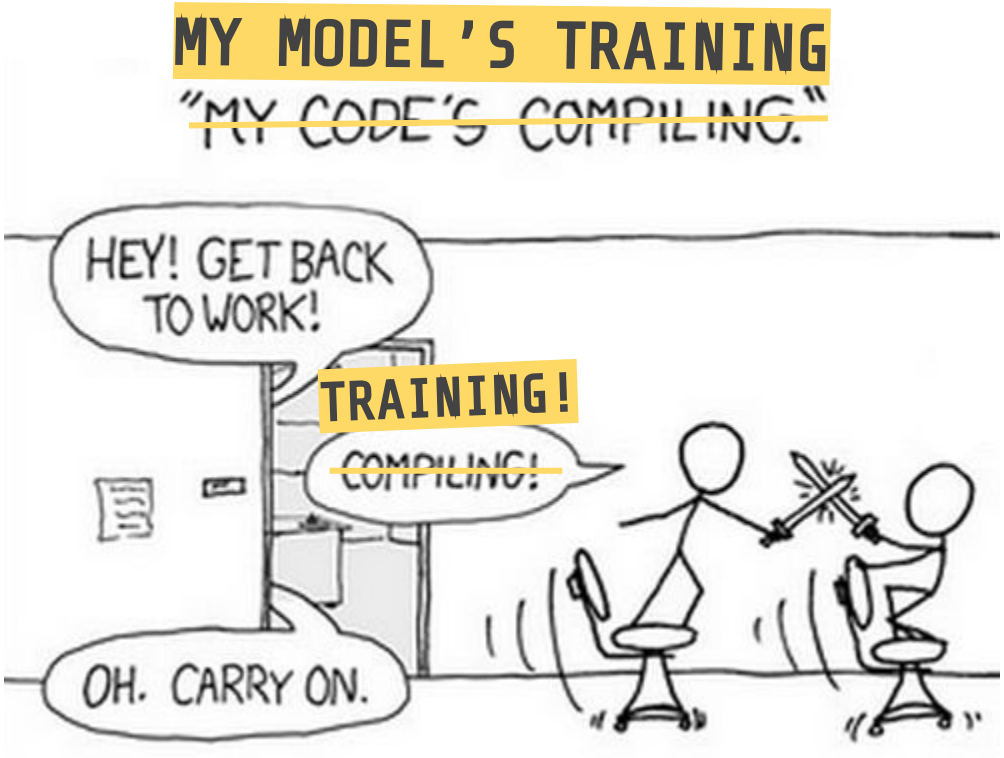
50 1.1K 3.5K

PROBLEM 1: ML IS SLOW



© xkcd

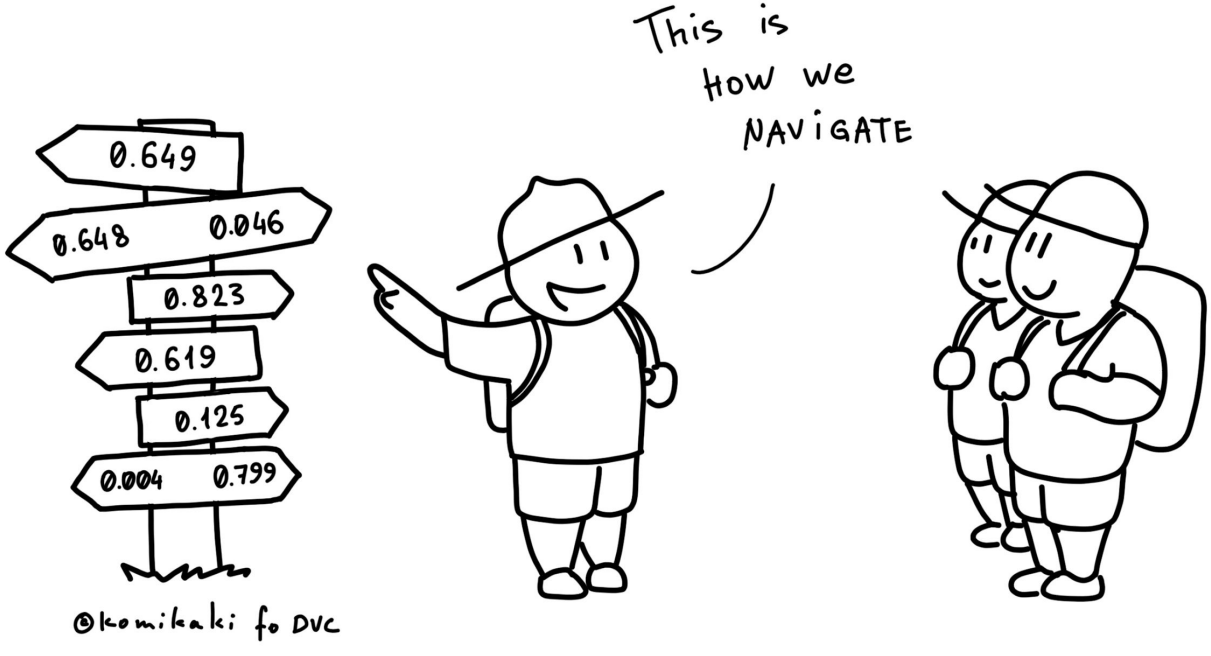
PROBLEM 1: ML IS SLOW



© xkcd

Solution: custom ML PIPELINES

PROBLEM 2: ML IS METRICS DRIVEN



PROBLEM 2: ML IS METRICS DRIVEN

>> EXPERIMENT = CODE + OUTPUTS

Outputs include **metrics and graphs** AUC, etc.

Solution: metrics tracking

	A	B	C	D	E	F
1	**Date**	**Alpha**	**L1_ratio**	**mea**	**r2**	**mse**
2	2019-04-03 1:00 PM	1	1	0.649	0.04	0.862
3	2019-04-03 4:00 PM	1	0.5	0.648	0.046	0.859
4	2019-04-04 9:00 AM	1	0.2	0.628	0.125	0.823
5	2019-04-04 11:00 AM	1	0	0.619	0.176	0.799

PROBLEM 3: MESS WITH DATA ARTIFACTS

>> EXPERIMENT = CODE + OUTPUTS + DATASET

Source code, Datasets, ML models

PROBLEM 3: MESS WITH DATA ARTIFACTS

>> EXPERIMENT = CODE + OUTPUTS + DATASET

Source code, Datasets, ML models

Solution: connect data to code

	A	B	C	D	E	F	G	H
1	**Date**	**Dataset**	**Model**	**Alpha**	**L1_ratio**	**mea**	**r2**	**mse**
2	2019-04-03 1:00 PM	data_v2	model_v7.p	1	1	0.649	0.04	0.862
3	2019-04-03 4:00 PM	data_v2	model_v7_l1-05.p	1	0.5	0.648	0.046	0.859
4	2019-04-04 9:00 AM	data_v2_upd_May	model_v7_l1-02_d3.p	1	0.2	0.628	0.125	0.823
5	2019-04-04 11:00 AM	data_v2_upd_May	model_v7_l1-zero_d3.p	1	0	0.619	0.176	0.799

SUMMARY OF DIFFERENCES

Software engineering	Data science \ ML
	Code versioning
Source code version control	Versioning of datasets, ML models, ML pipelines and connect data to code
Code review	Metrics tracking and visualization
Agile methodology	¯_(ツ)_/¯

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> Do we need new tools for ML?

> MLFlow

> Git-LFS

> DVC

> Conclusion

MLFLOW INTRO

Platform for the machine learning lifecycle

> Tracking
> Project
> Models

```
$ pip install mlflow
```

MLFLOW TRACKING

```
from mlflow import log_metric, log_param, log_artifact
log_param("lr", 0.03)
log_metric("loss", curr_loss)
log_artifact("model.p")
```

```
$ mlflow ui
```

MLFLOW TRACKING UI

				Parameters		Metrics		
Date	User	Source	Version	alpha	l1_ratio	mae	r2	rmse
2018-06-04 23:00:10	mlflow	train.py	05e956	1	1	0.649	0.04	0.862
2018-06-04 23:00:10	mlflow	train.py	05e956	1	0.5	0.648	0.046	0.859
2018-06-04 23:00:10	mlflow	train.py	05e956	1	0.2	0.628	0.125	0.823
2018-06-04 23:00:09	mlflow	train.py	05e956	1	0	0.619	0.176	0.799

From: mlflow.org

MLFLOW SUMMARY

Feature	Result	Comment
Versioning ML models	+	
Versioning datasets	-	
Versioning ML pipelines	-	
Connecting data and code	-/+	Manual only
Tracking metrics	+	
Visualize metrics	+	

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> Do we need new tools for ML?

> MLFlow

> Git-LFS Git Large File Storage

> DVC

> Conclusion

GIT-LFS INTRO

> Install

```
$ brew install git-lfs
$ git lfs install
```

> Specify data-files type in a Git repository

```
$ git lfs track '*.p'
$ git add .gitattributes
```

GIT-LFS ADD DATA FILES

```
$ python mytrain.py # your code generates mymodel.p
$ git add mytrain.py mymodel.p
$ git commit -m ‘Decay was added’
$ git push

Uploading LFS objects: 100% (1/1),
56 MB | 3.2 MB/s, done
```

GIT-LFS RETRIEVE DATA FILES

```
$ git clone https://github.com/dmpetrov/my-lfs-repo
$ cd my-lfs-repo
$ du -sh mymodel.p   # data file does not contain data yet
4.0K  mymodel.p
$ git pull

Downloading LFS objects:  75% (3/4),
44 MB | 4.5 MB/s
```

GIT-LFS PROS/CONS

- PROS
  - Simple, like Git

- CONS
  - Limited by data size <2Gb, <500Mb even better
  - Not every Git server supports Git-LFS
  - No ML\Data Science specific

GIT-LFS SUMMARY

Feature	Result	Comment
Versioning ML models	+	
Versioning datasets	-/+	Limited by size
Versioning ML pipelines	-	
Connecting data and code	+	
Tracking metrics	-	
Visualize metrics	-	

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> Do we need new tools for ML?

> MLFlow

> Git-LFS

> DVC Data Version Control

> Conclusion

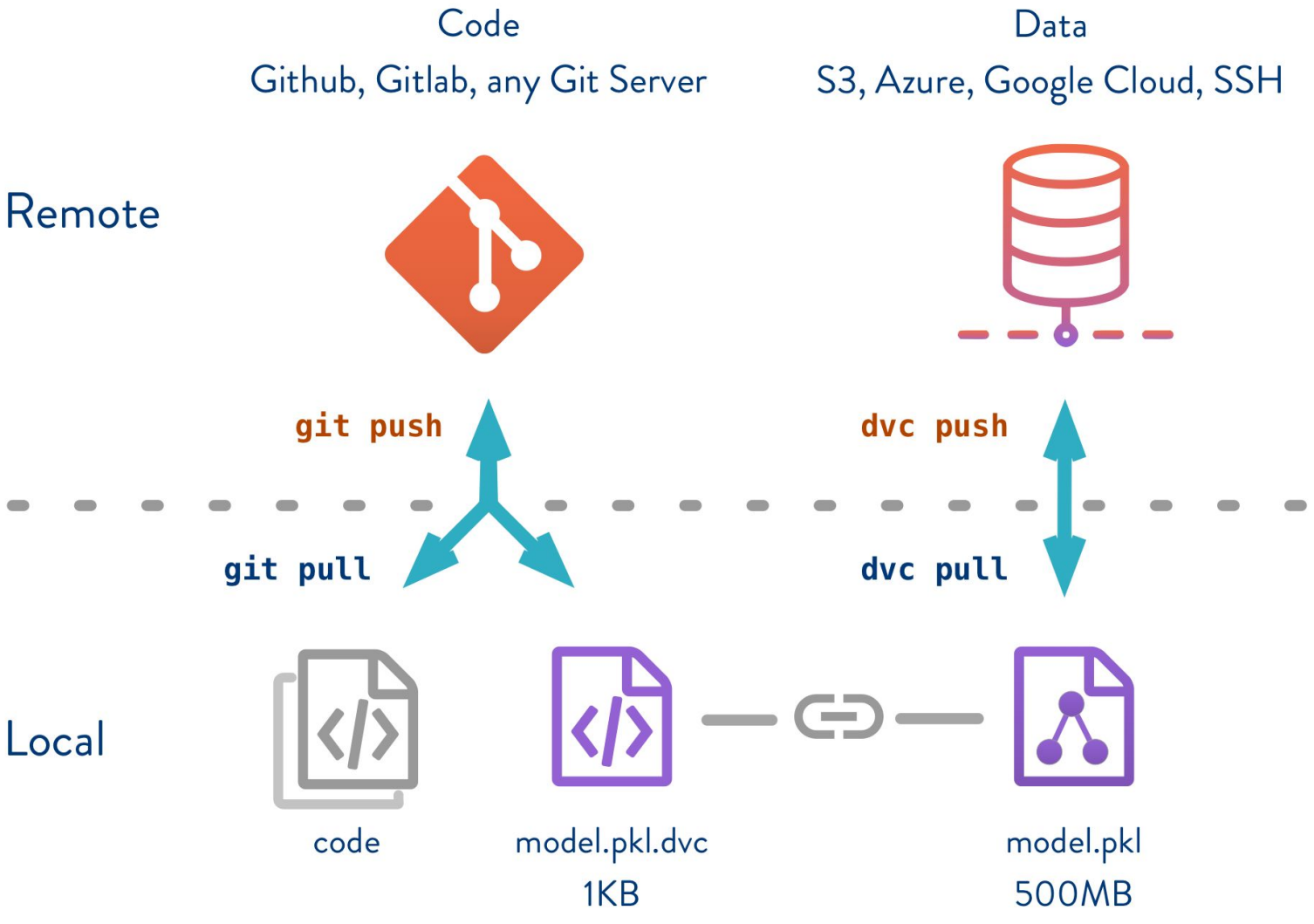
|DVC INTRO|

Website: http://DVC.org

> Install

```
$ pip install dvc
$ dvc init
```

> Git-like tool no infrastructure is required


Code
Github, Gitlab, any Git Server
Data
S3, Azure, Google Cloud, SSH
Remote
git push
git pull
dvc push
dvc pull
Local
code
model.pkl.dvc
1KB
model.pkl
500MB

DVC ADD DATA FILES

> Push data to storage

```
$ dvc add data.xml
$ dvc push
```

> Push meta information to Git server

```
$ git add .gitignore data.xml.dvc
$ git commit -m "add source data to DVC"
$ git push
```

DVC RETRIEVE DATA

```
$ git clone https://github.com/dmpetrov/my-dvc-repo
$ cd my-dvc-repo
$ dvc pull
...

$ du -sh data.xml
7G  data.xml
```

DVC PARTIAL DATA RETRIEVING

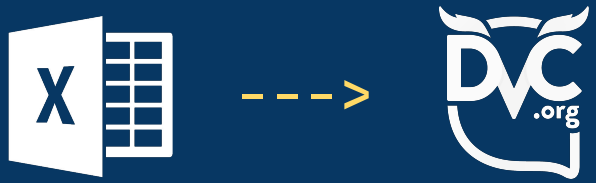
```
$ git clone https://github.com/dmpetrov/my-dvc-repo
$ cd my-dvc-repo
$ dvc pull train.dvc
...

$ du -sh cnn_model.p
54M cnn_model.p
```

DVC CHECKOUT

> Checkout data

```
$ git checkout vgg16_exp2
$ dvc checkout
```



|DVC SPEED|

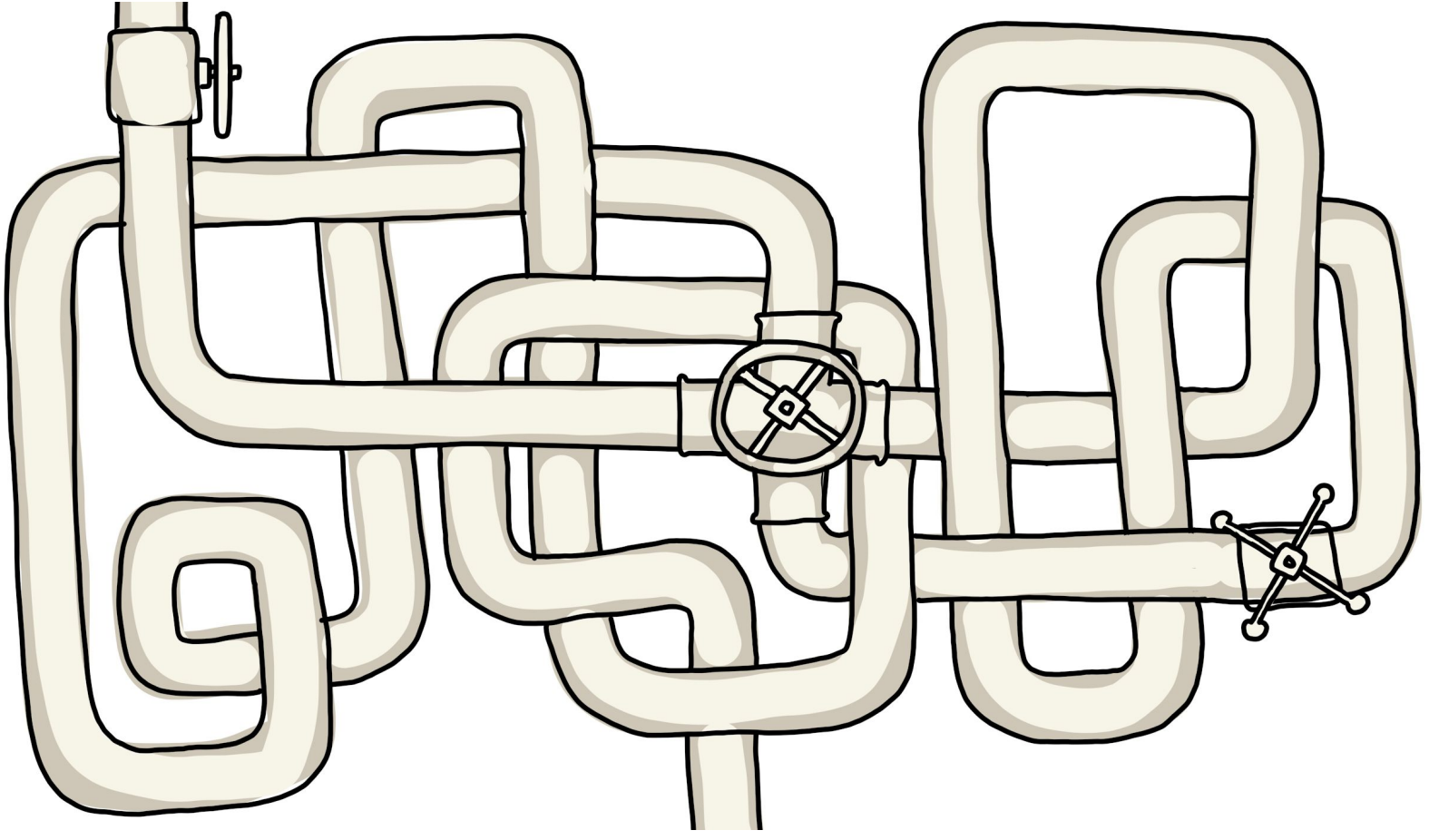
> Copy 50G directory with millions of images ~10 min

What about DVC?

```
$ git checkout image_update_20190310
$ time dvc checkout

real    0m12.958s
user    0m11.567s
sys     0m1.725s
```

ML PIPELINES



DVC PIPELINES

```
$ dvc add data/data.xml
$ dvc run -d src/prepare.py -d data/data.xml -o data/prepared \
        python src/prepare.py data/data.xml
$ dvc run -d src/featurization.py -d data/prepared -o
data/features \
        python src/featurization.py data/prepared data/features
$ dvc run -d src/train.py -d data/features -o model.pkl \
        python src/train.py data/features model.pkl
```

DVC PIPELINES: SHOW

```
$ dvc pipeline show --ascii train.dvc --commands

        +-------------------------------------+
        | python src/prepare.py data/data.xml |
        +-------------------------------------+
                          *
                          *
                          *
+-----------------------------------------------------------+
| python src/featurization.py data/prepared data/features |
+-----------------------------------------------------------+
                          *
                          *
                          *
     +----------------------------------------------+
     | python src/train.py data/features model.pkl |
     +----------------------------------------------+
```

DVC PIPELINES: REPRODUCIBILITY

> Reproduce your project

```
$ dvc repro
```

> Reproduce

```
$ dvc repro train.dvc
```

> Version DVC pipeline

```
$ git add train.dvc
$ git commit -m 'Reproduce with dataset update 2019-05-02'
```

DVC SUMMARY

Feature	Result	Comment
Versioning ML models	+	
Versioning datasets	+	
Versioning ML pipelines	+	
Connecting data and code	+	
Tracking metrics	-/+	Final metrics only
Visualize metrics	-	

05

> Do we need new tools for ML?
> Git-LFS
> MLFlow
> DVC
> Conclusion

SUMMARY

Feature	MLFLOW	Git-LFS	DVC
Versioning ML models	+	+	+
Versioning datasets	-	-/+	+
Versioning ML pipelines	-	-	+
Connecting data and code	-/+	+	+
Tracking metrics	+	-	-/+
Visualize metrics	+	-	-

THE WORLD IS CHANGING

> Data science as different from software as software was different from hardware
>
> Nick Elprin, Domino Data Lab

Hardware	Software	DS/ML
Waterfall	Agile	¯_(ツ)_/¯

HOW TO DESIGN OUR FUTURE

- Think about processes

HOW TO DESIGN OUR FUTURE

- Think about processes
- Try new ML tools

HOW TO DESIGN OUR FUTURE

- Think about processes
- Try new ML tools
- Share your feedback

|THANK YOU|

> Questions

Twitter	@FullStackML
Email	dmitry@iterative.ai

> Actions

Visit	dvc.org
Star	github.com/iterative/dvc

|06|

> Appendix

Andrew Ng @AndrewYNg · Jan 3

2/I'm also seeing many AI teams use new processes that haven't been formalized or named yet, ranging from how we write product requirement docs to how we version data and ML pipelines. This is an exciting time for developing these ideas!

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