

MLOps | Bringing Ops to ML

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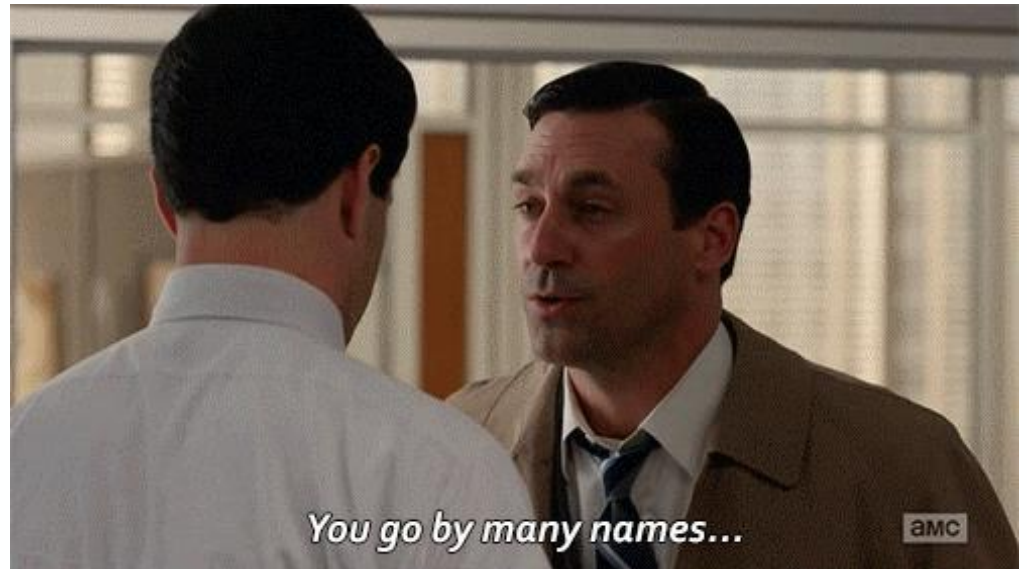


Agenda

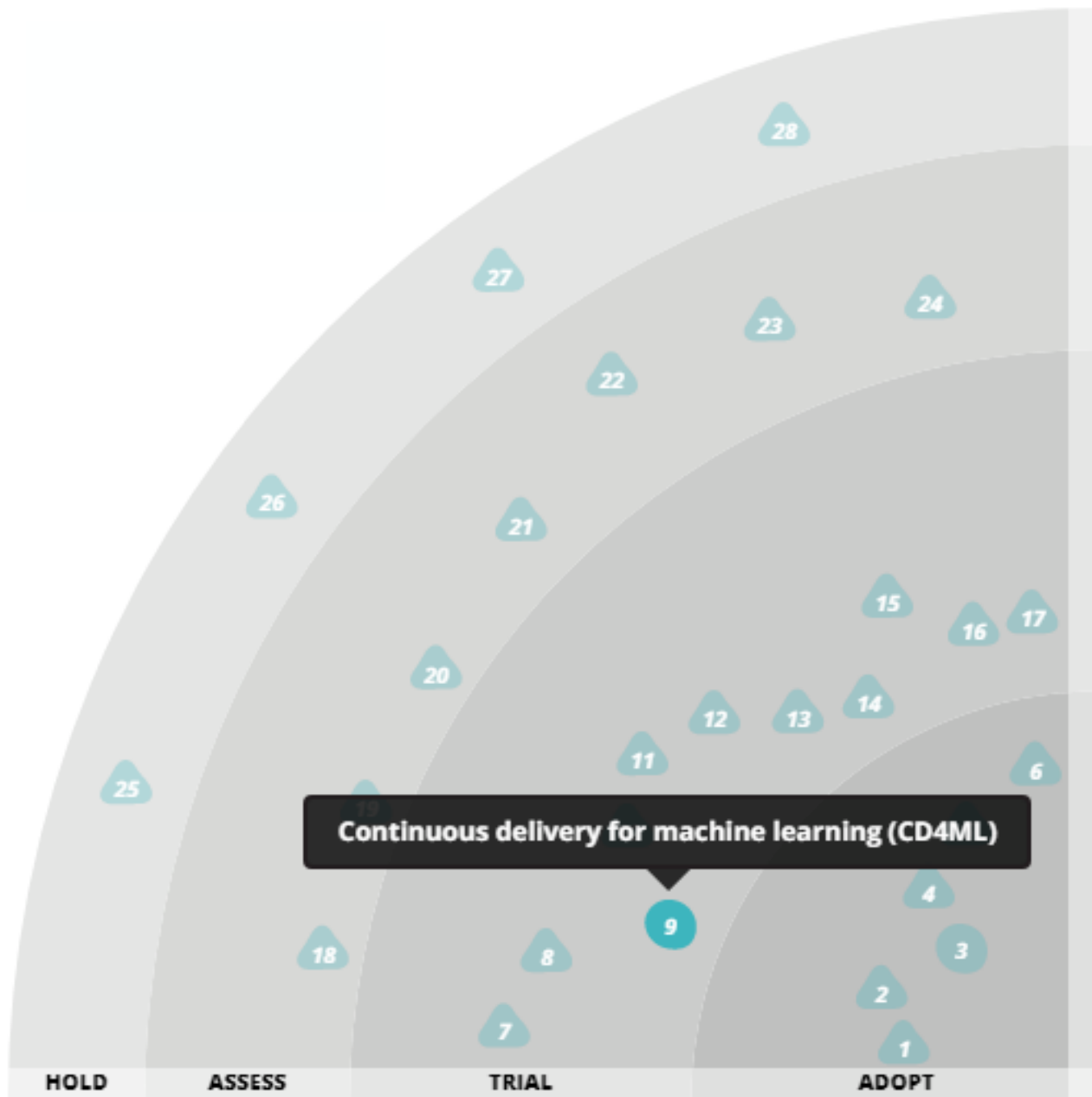


- ~~Machine Learning~~
- MLOps
- The Machine Learning Lifecycle
- Tooling: Azure ML + Azure DevOps

What is MLOps?

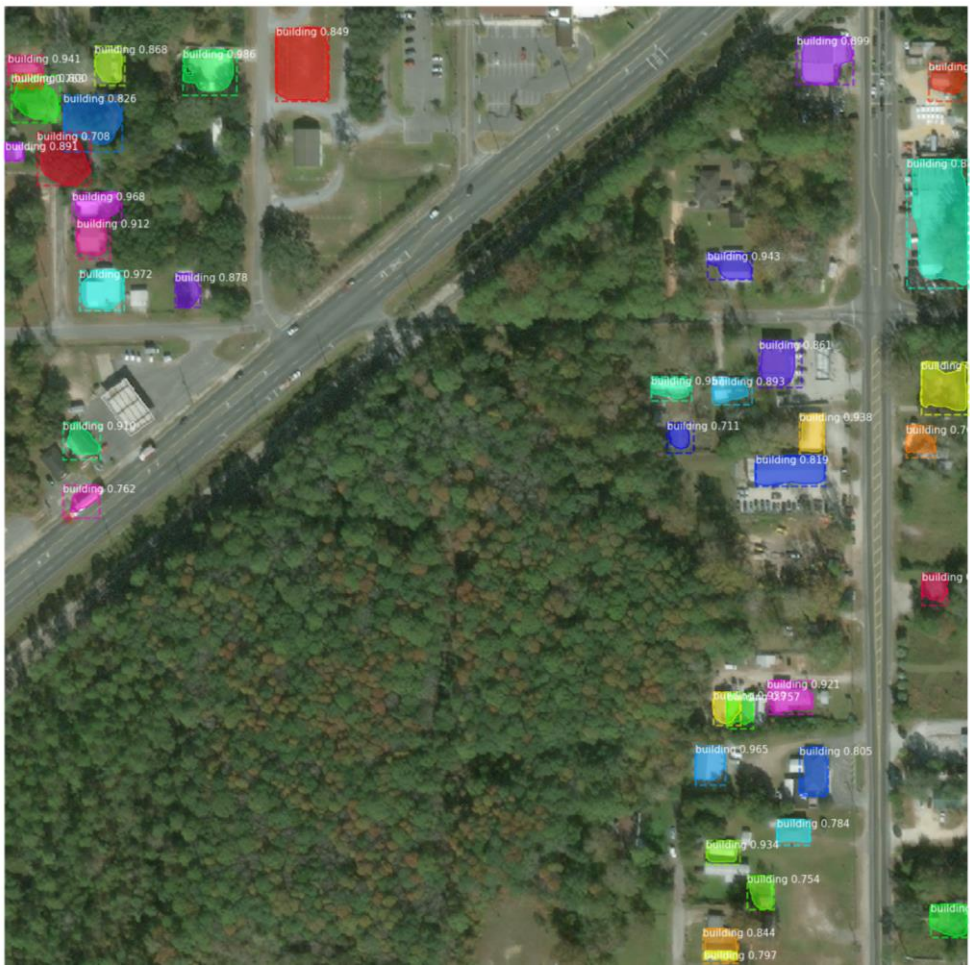


Why the focus on MLOps?



DoD: Eye in the Sky





ML + Ops = Difficult

Why is it difficult?

Production systems are

- Auditable
- Testable
- Reproducible
- Understandable



Machine Learning is

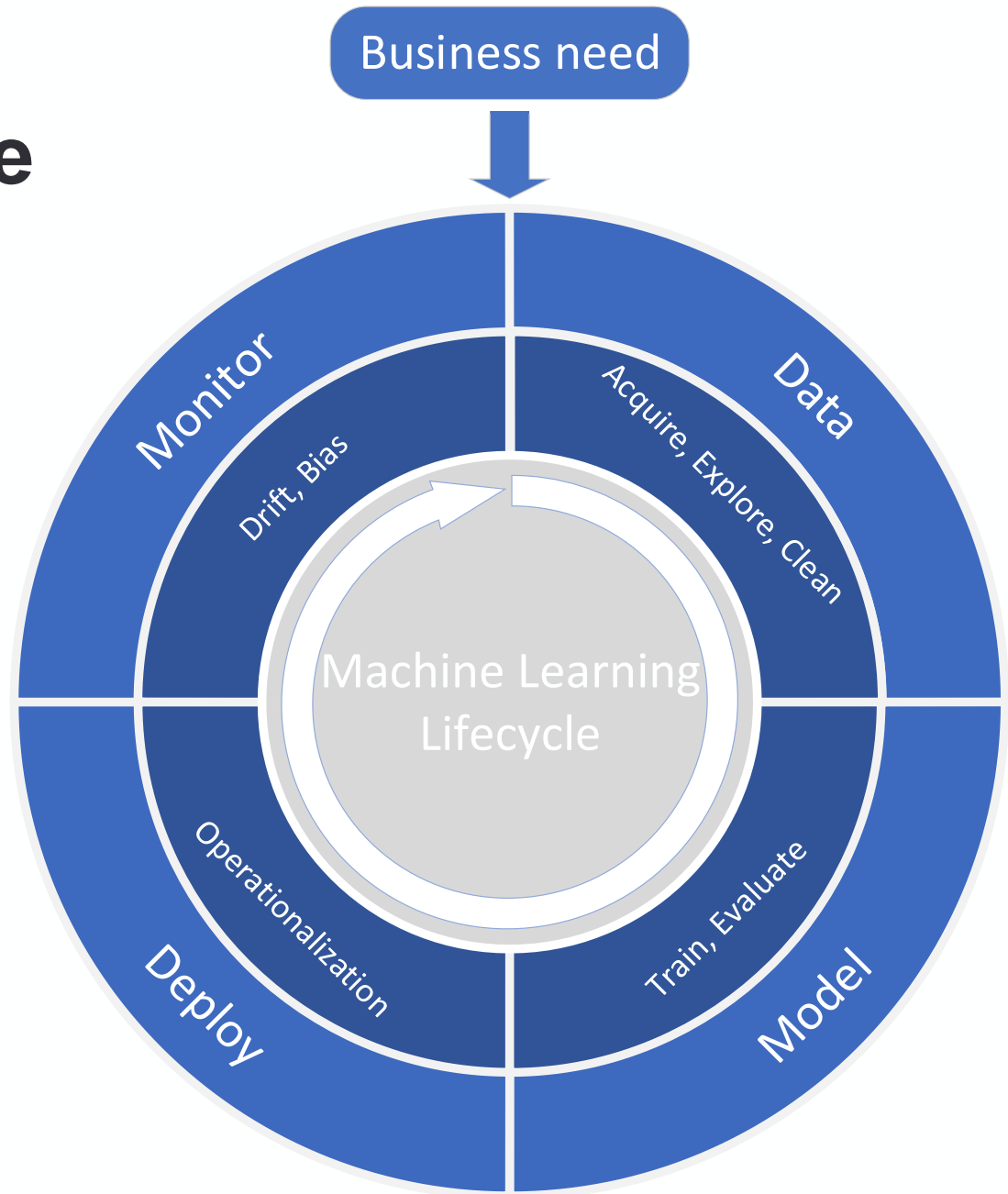
- Non-deterministic
- Hard to explain
- Hard to test
- Hard to improve

The answer: MLOps is trying to address

- Model reproducibility & versioning
- Model auditability & explainability
- Model packaging & validation
- Model deployment & monitoring

The Machine Learning Lifecycle

The Machine Learning Lifecycle



Data

- Acquire
- Explore
- Clean
- Transform

Input

- Flat files
- Transactional data
- Unstructured data

Output

- Processed data



Data Engineer



Data Scientist

Model

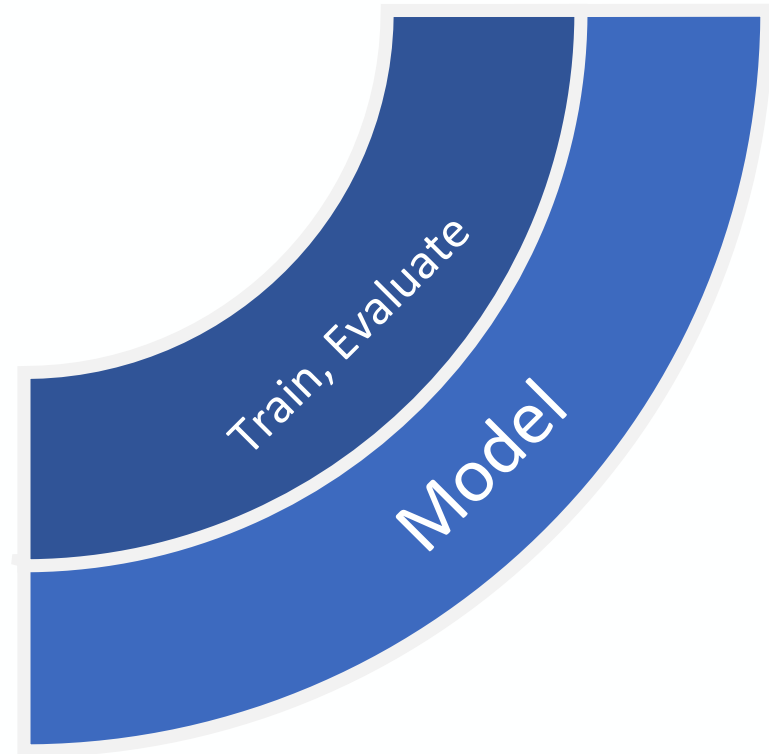
- Feature engineering
- Train
- Evaluate

Input

- Processed data

Output

- Trained model



Data Scientist

Deploy

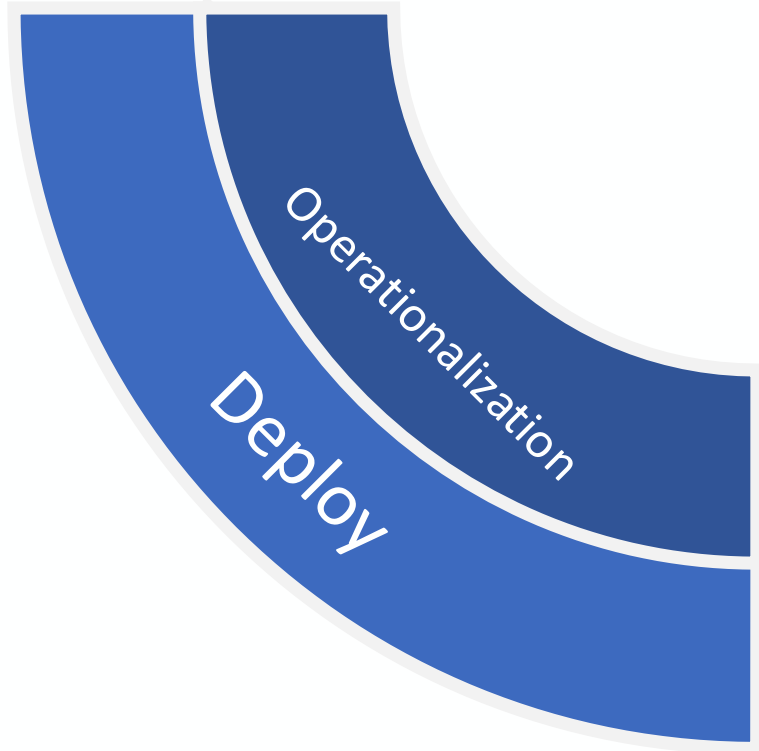
- Operationalization
- Deployment
- Software Integration

Input

- Trained model

Output

- Deployed model



Operations



Software Developer

Monitor

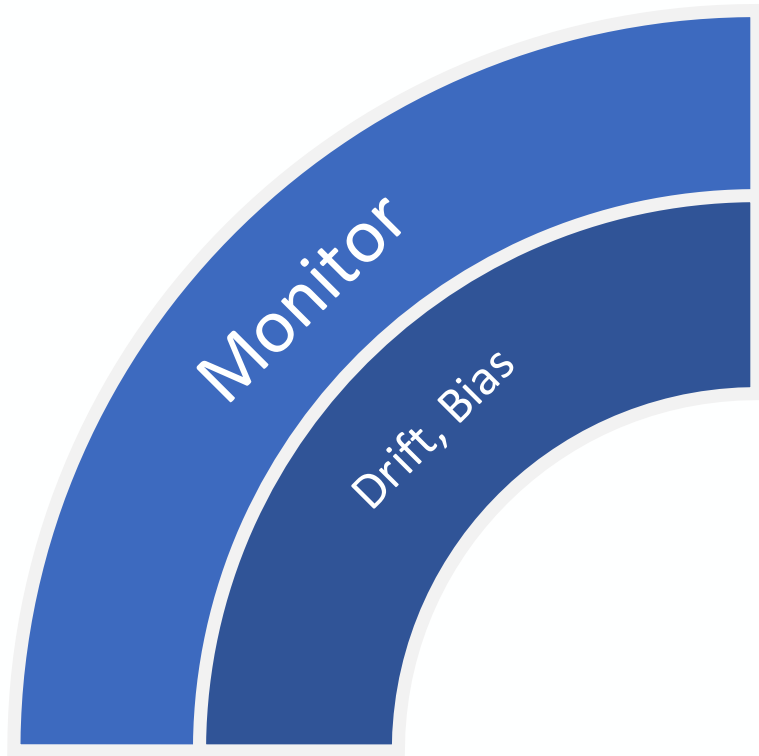
- Predictions
- Bias
- Drift

Input

- Deployed model

Output

- Insights



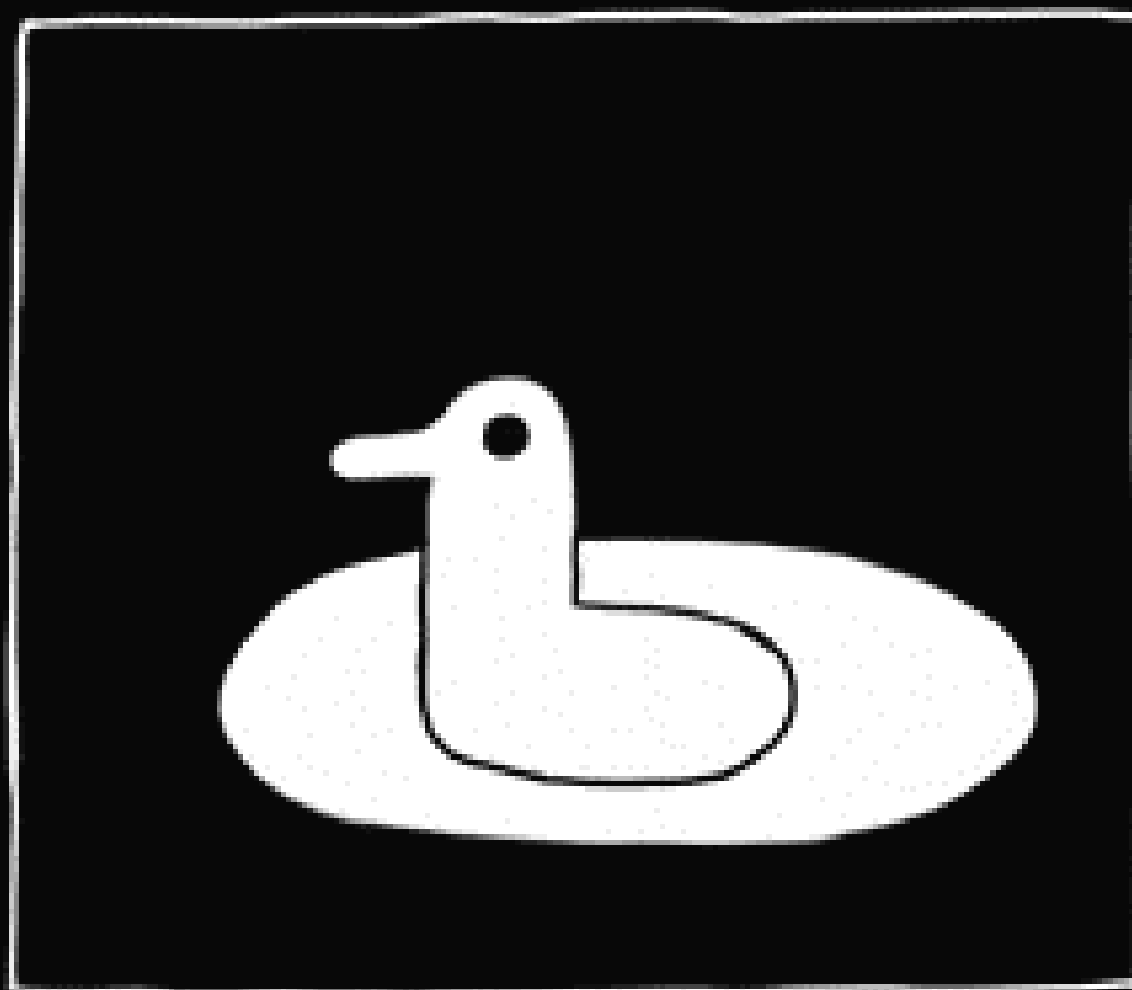
Operations



Software Developer



Data Scientist



What are some of the challenges with this?

Challenges

- Multiple sources of change
- Model versioning is not equal to code versioning
- Data versioning is not equal to code versioning
- Digital audit trail (Data + Code + Model)
- Model decays over time
- “Works on my machine”
- How do we know the models performs better?
- How do know if my model works at all?

Axis of Change

Code

- New features
- Bug fixes
- Configuration

```
style="margin-left: 20px; margin-top: 10px; width: 100%; height: 100%; border: 1px solid #ccc; border-radius: 5px; background-color: #f9f9f9; padding: 10px;">www"></a>  
dth=""500% border=10"  
eight=""68" width=""256"  
<form name=login method=POST  
t type=hidden name=act
```

Model

- Research
- New data
- Dependencies
- Performance

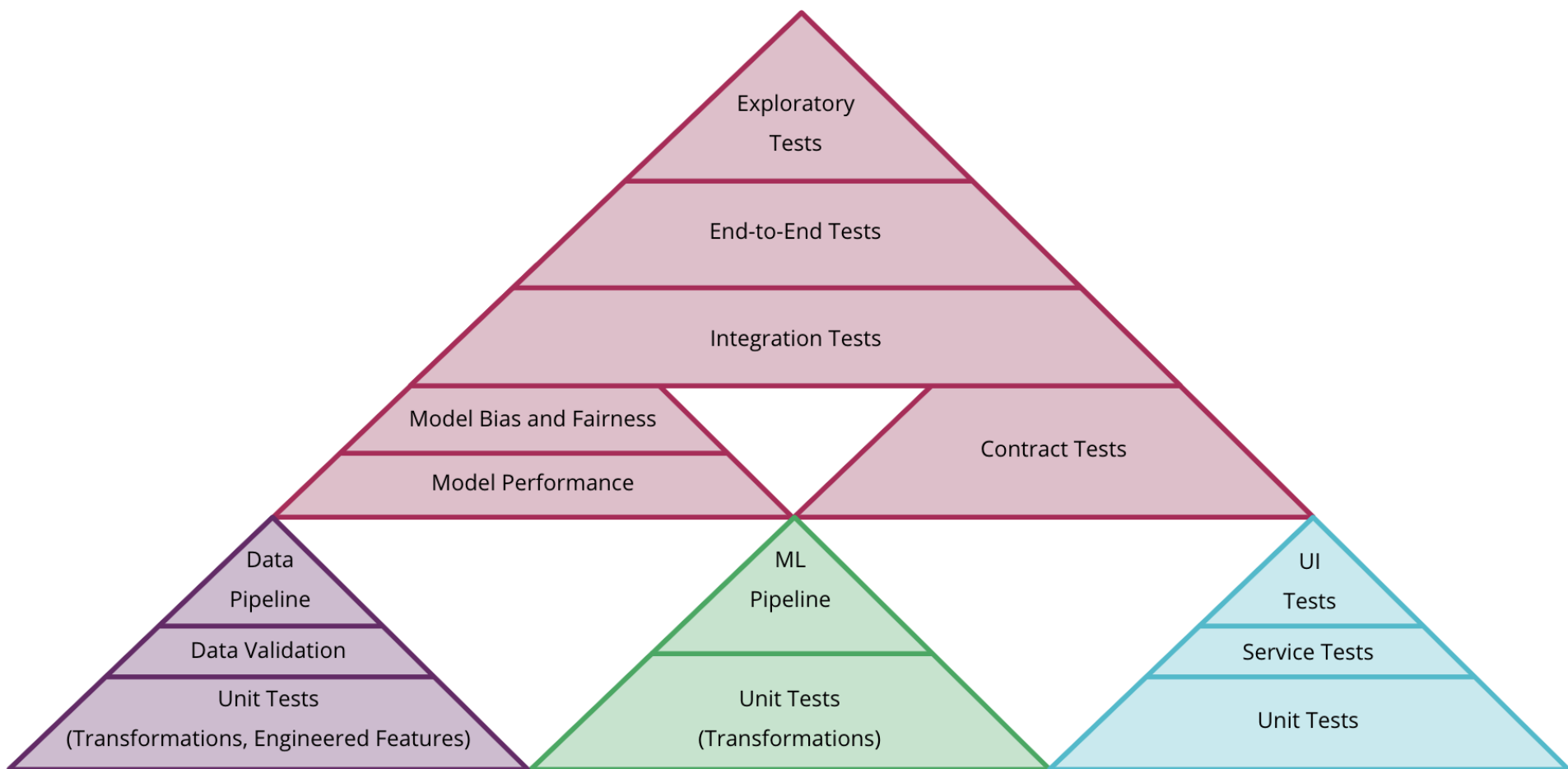


Data

- Schema
- Sampling
- Distribution
- Cardinality



How do we test a Machine Learning App?



Monitoring

Models decay over time

Monitoring

Internal

- Exceptions
- Logs
- Latency

External

- Model inputs
- Model outputs
- Model fairness
- User actions and rewards

weatherDriftBackfillWeekly2

Settings Backfill Refresh

Start date:

End date:

Tue Jan 01 2019

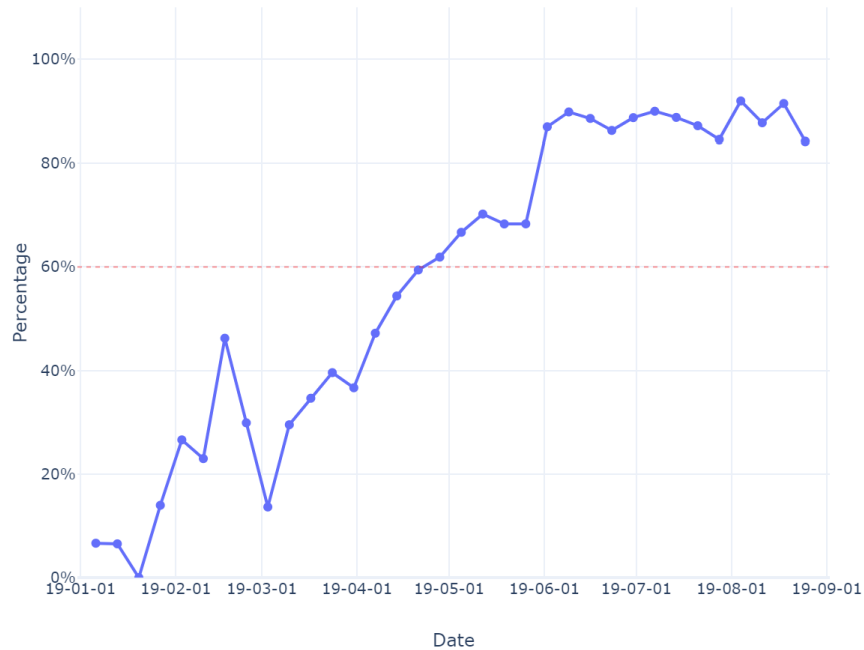


Sun Sep 01 2019

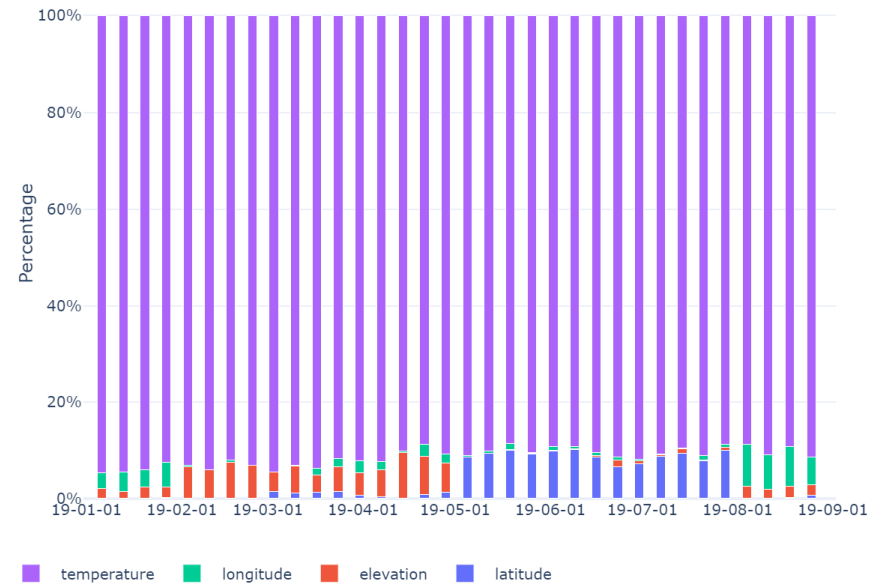


Drift overview

Data drift magnitude



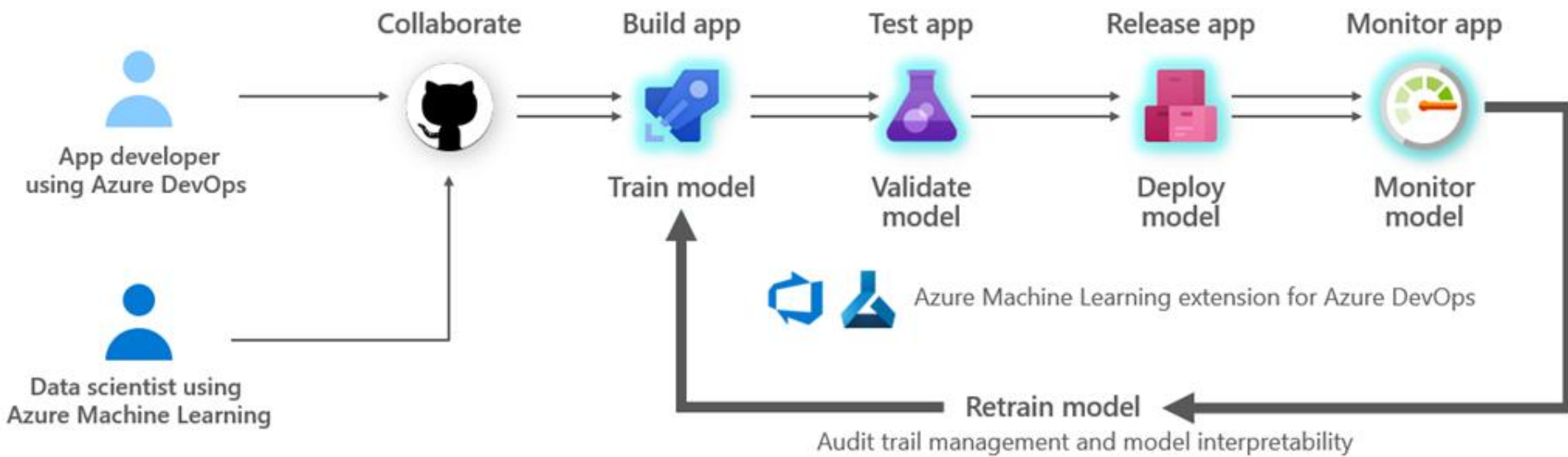
Drift contribution by feature

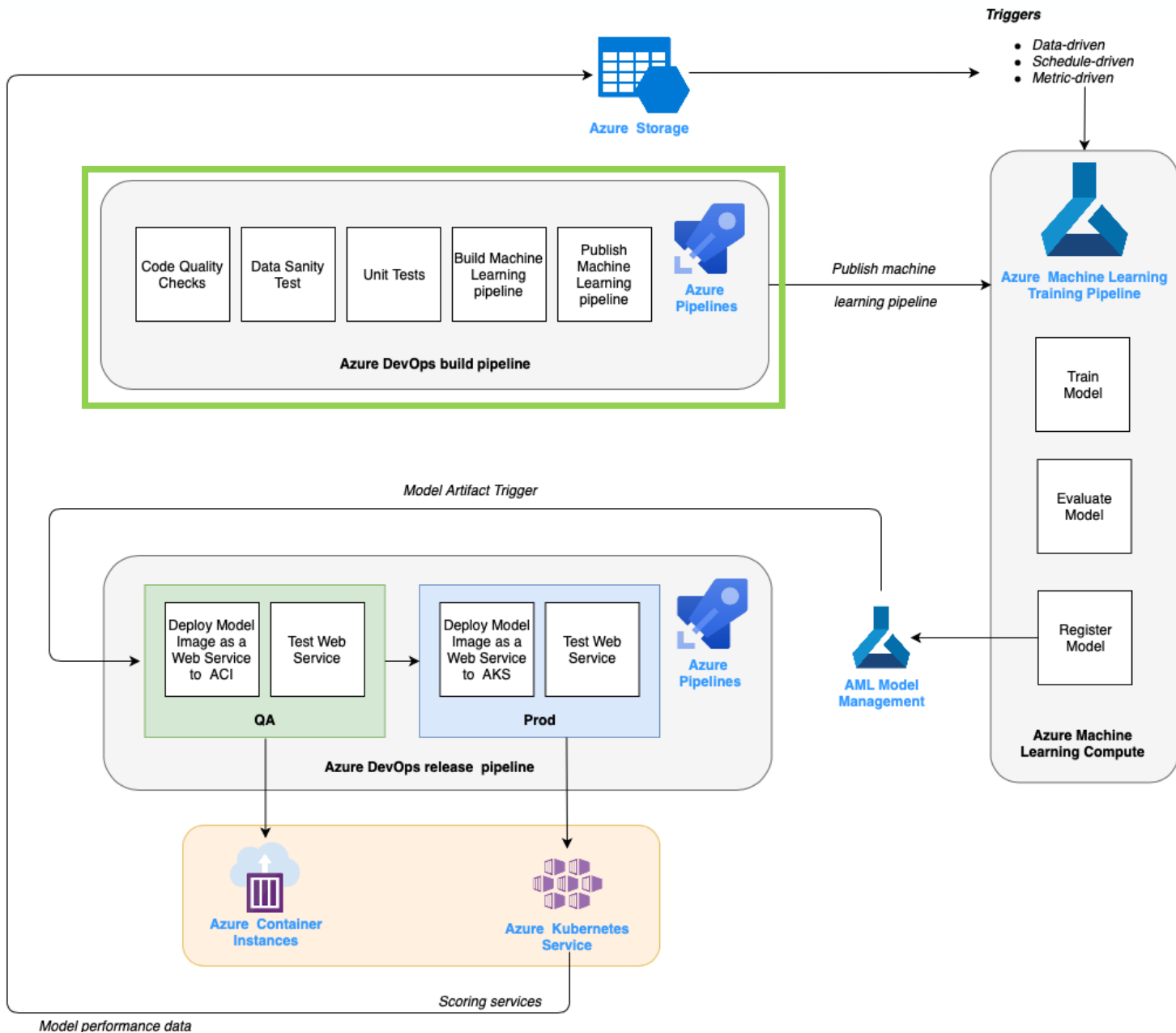


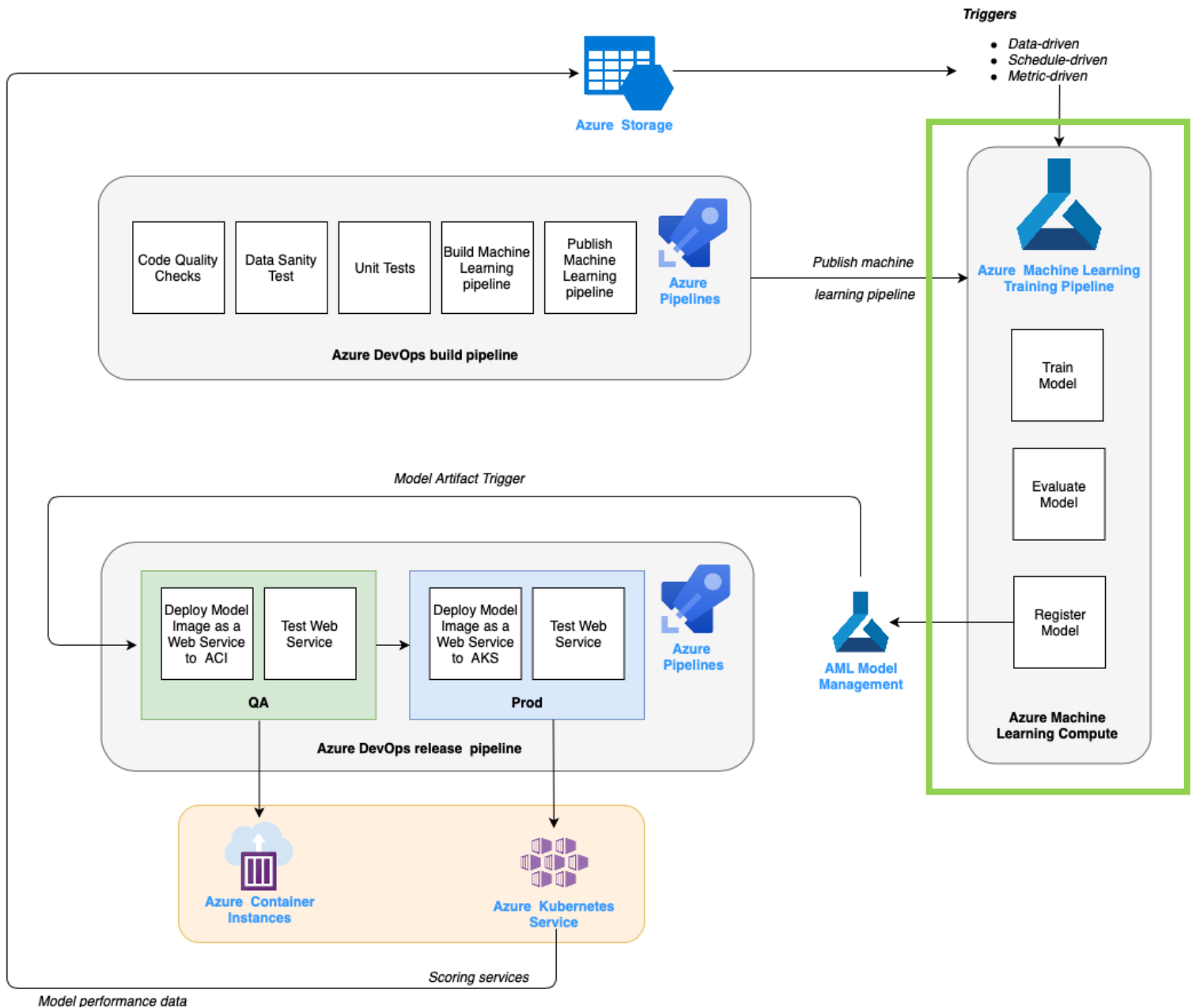
What do we need to succeed?

- Discoverable and accessible data
- Version control and artifact repository
- Continuous delivery
- Infrastructure for running multiple experiments
- Model performance tracking
- Model monitoring

Azure Machine Learning Azure DevOps





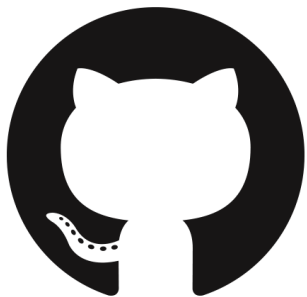


Training Pipeline

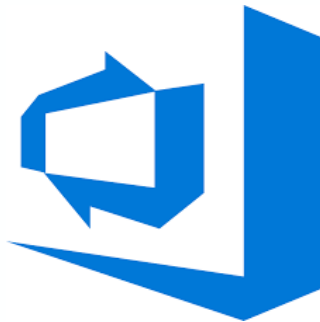
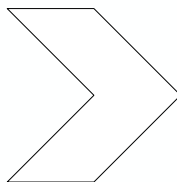
Train.py

Evaluate.py

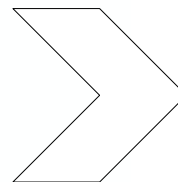
Register.py



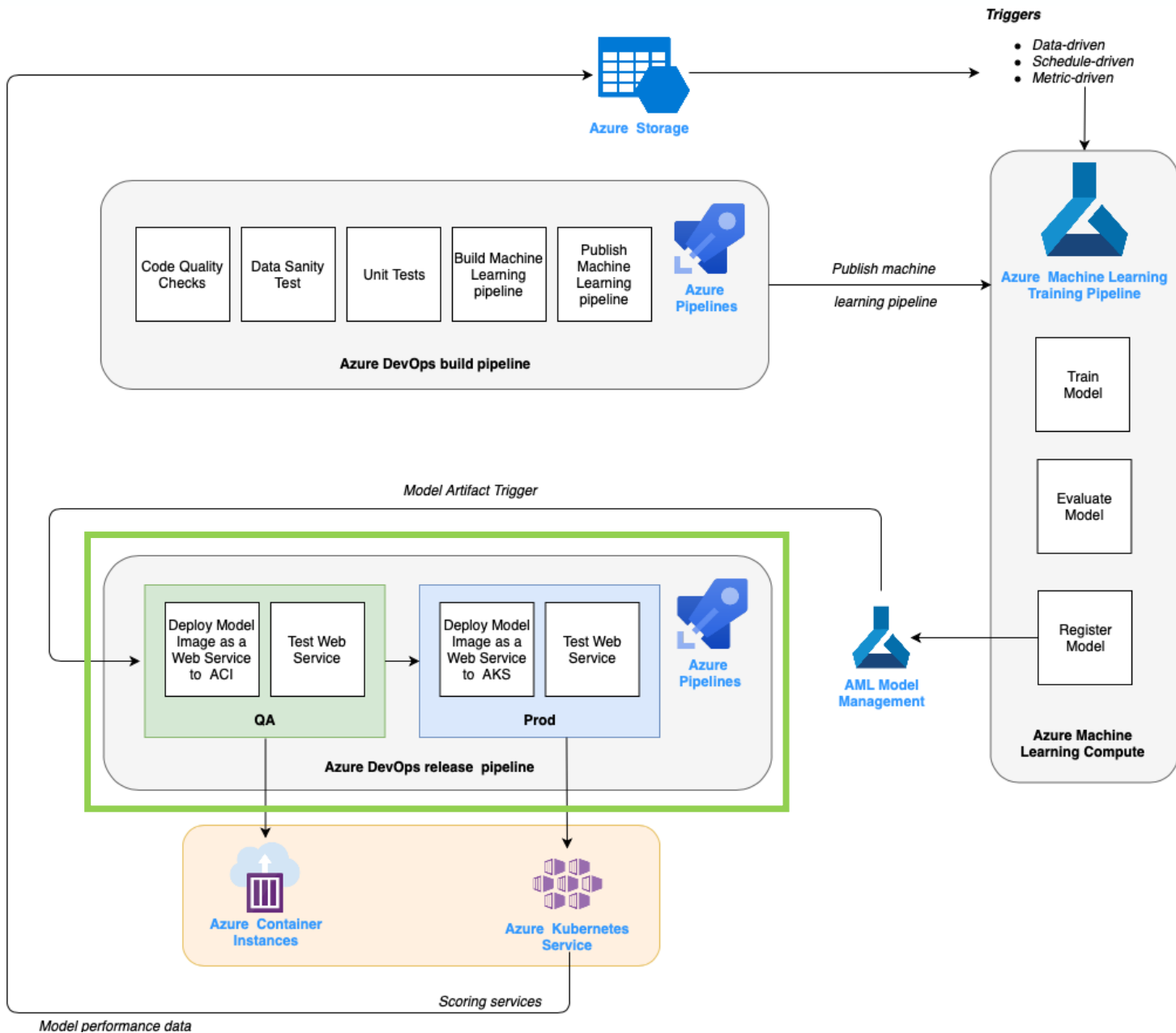
Sourced in GitHub



Built in Azure DevOps



Executed in Azure ML



Resources

- Martin Fowler:
 - <https://martinfowler.com/articles/cd4ml.html>
- Microsoft:
 - <https://github.com/microsoft/MLOps>
- Azure ML
 - <https://docs.microsoft.com/en-us/azure/machine-learning/>

Thank you!



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Demo