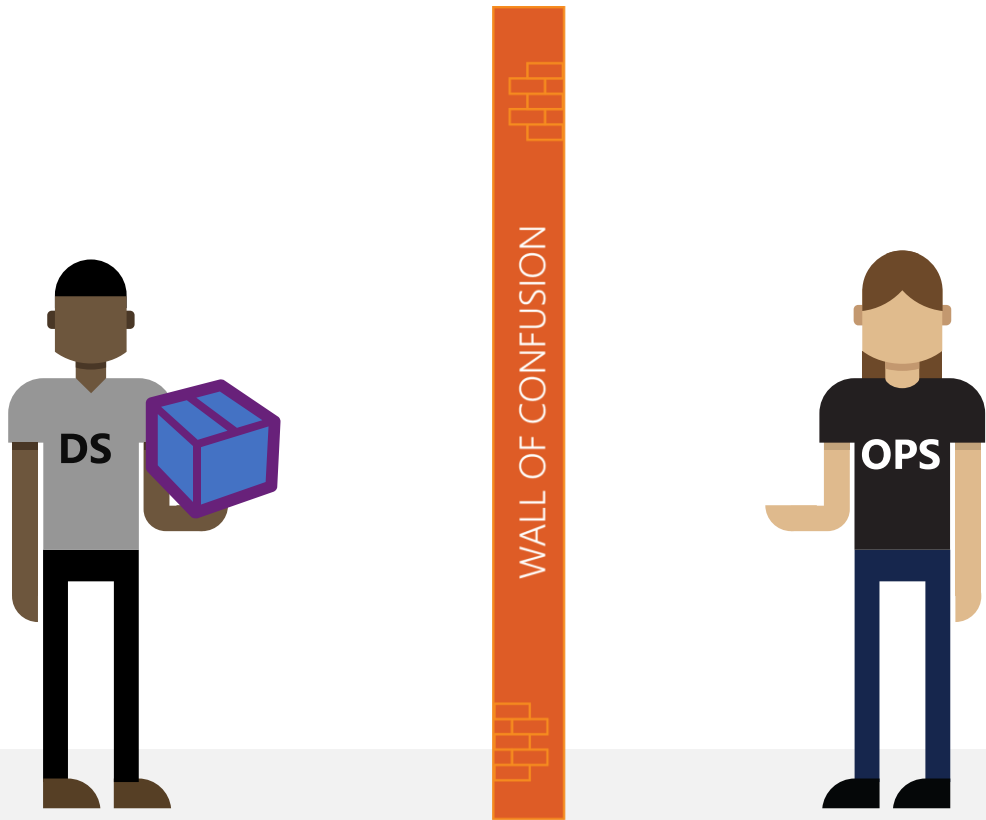




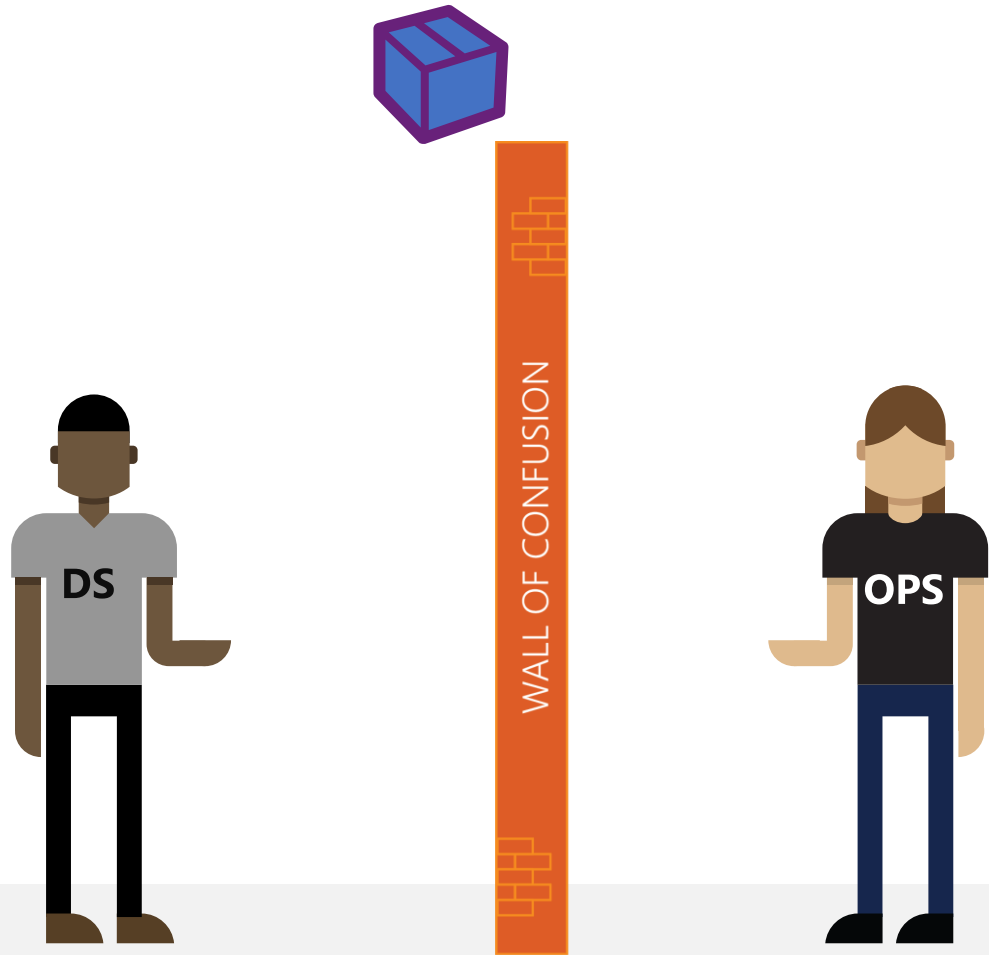
ML Ops with Spark, MLflow and Azure

Vancouver Spark Meetup – January 15, 2020

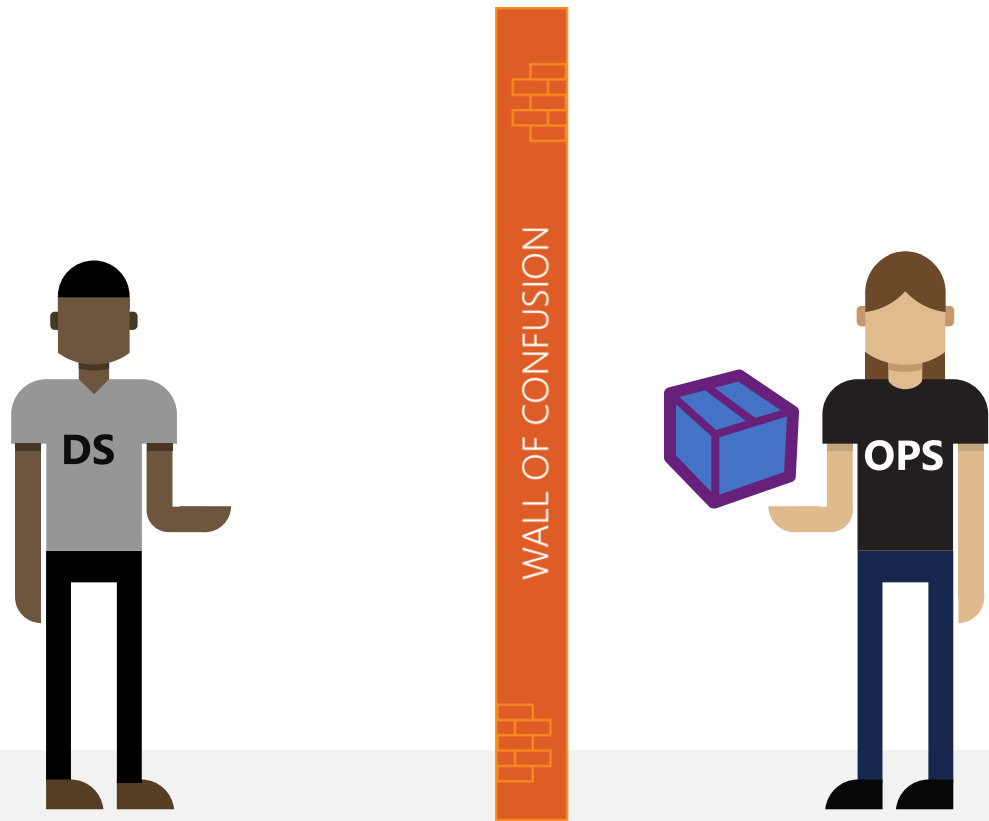
“Just give me the model”



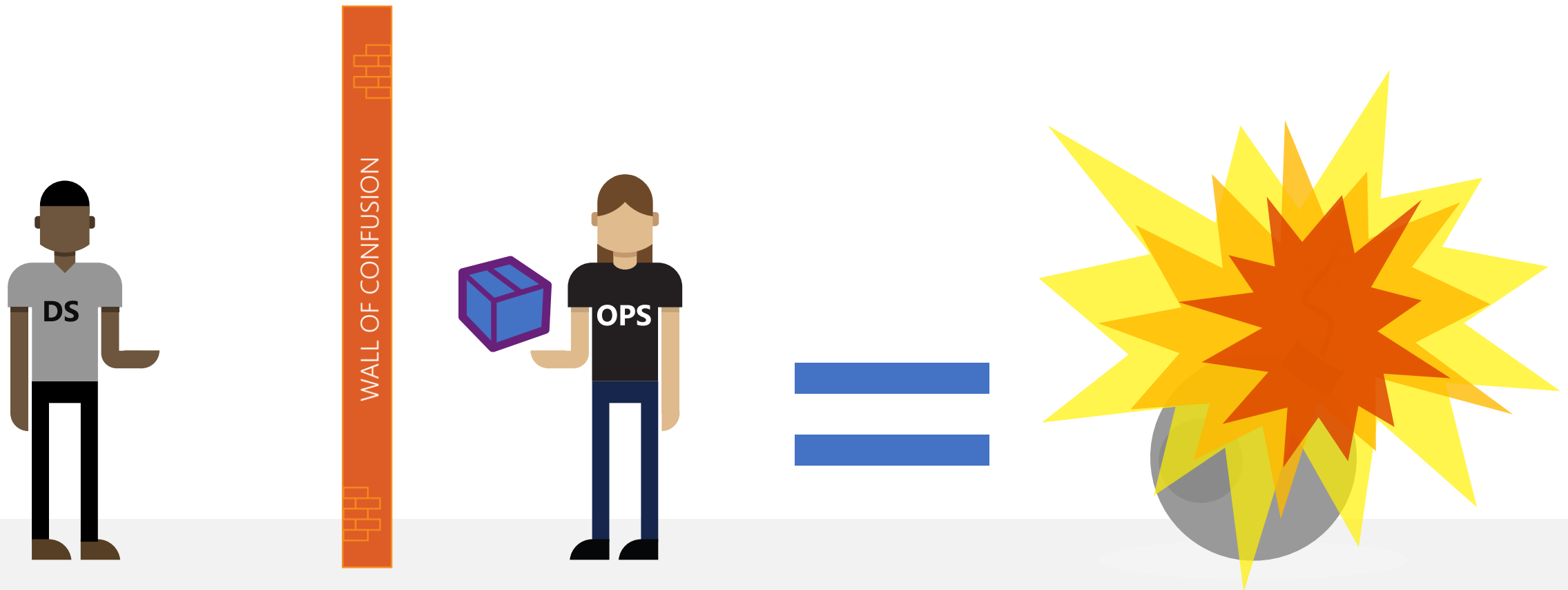
“Just give me the model”



“Just give me the model”



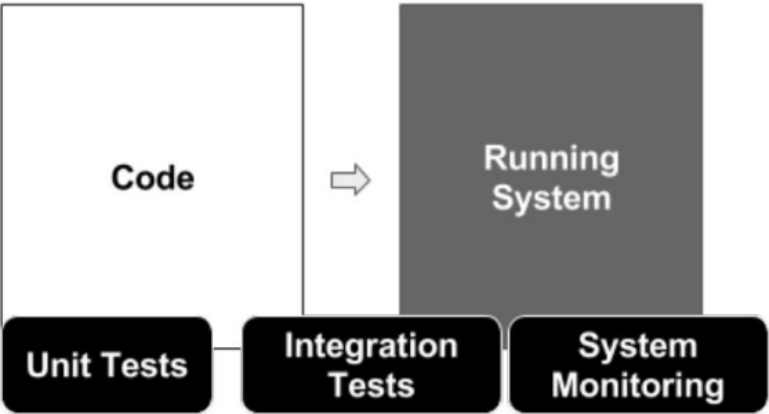
“Just give me the model”



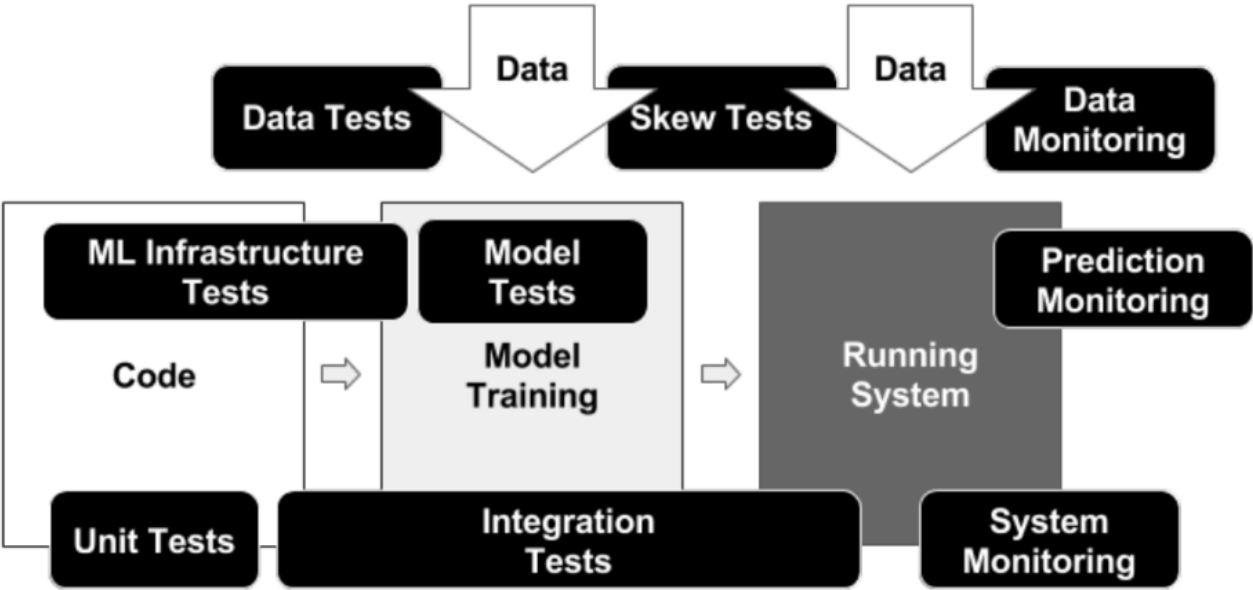


IT WORKED
ON MY MACHINE

Need DevOps process that works for ML...



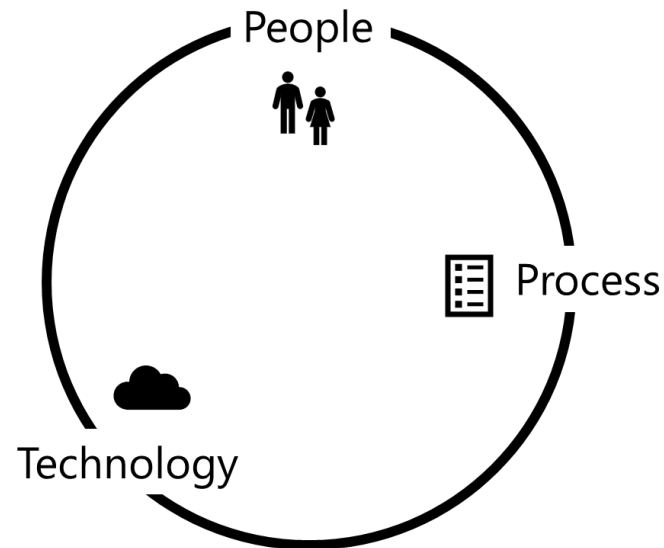
Traditional System Testing and Monitoring



ML-Based System Testing and Monitoring

What is ML Ops?

Principals involving **PEOPLE, PROCESS, TECHNOLOGY** that aim to best manage the entire ML lifecycle in production



Example of doing ML Ops well

TransLink expands AI planning to improve bus route estimates



Vincent Plana | Aug 13 2019, 4:03 pm



Compass Card (TransLink)

The AI is the result of a collaboration between Microsoft and T4G, an intelligent software and analytics company. According to TransLink, the program takes in different factors like weather conditions and travel times at different points of the day.

The algorithm also involves more than **16,000 machine learning models**, which is said to provide better predictions over TransLink's entire bus network.

"During the pilot phase, the difference between predicted and actual bus departure times **improved by 74%**," says **Kevin Desmond, TransLink CEO**.

Example of not considering ML Ops

How much the lack of MLOps can cost you!

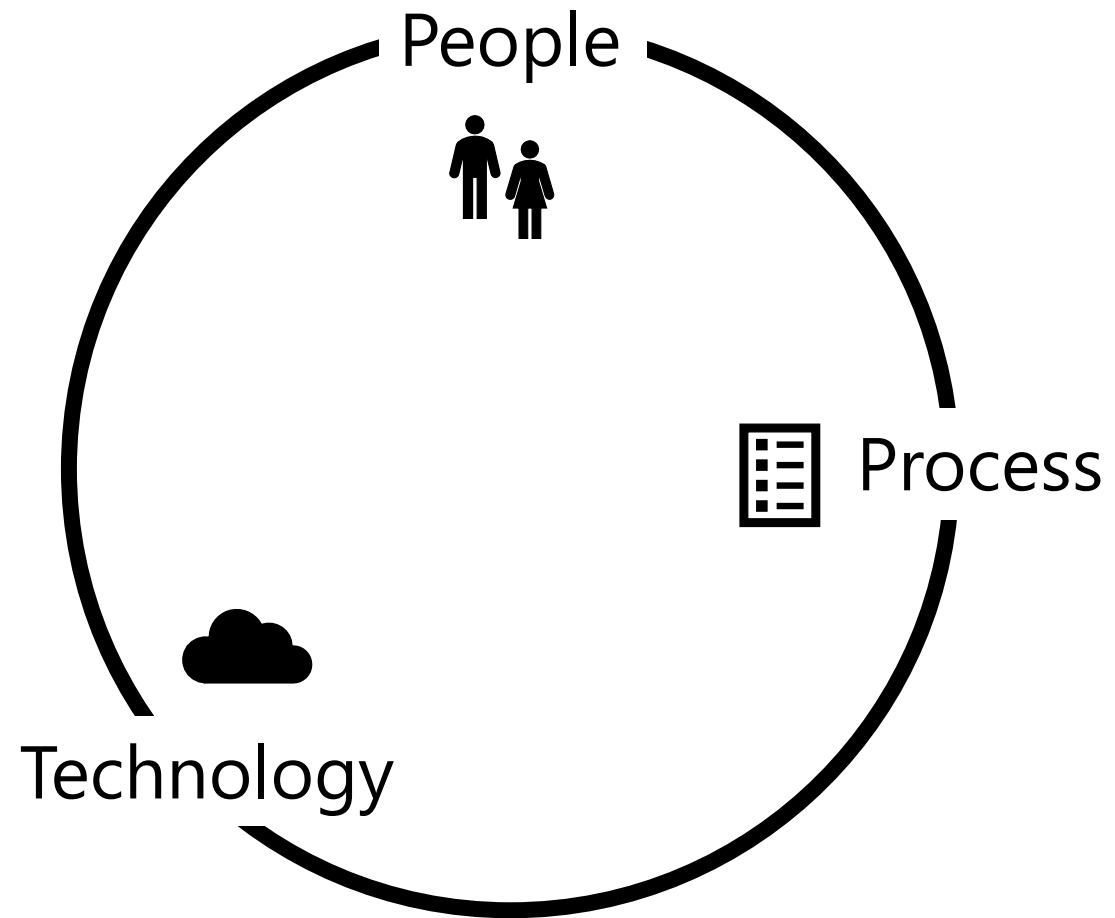
- In 2011, Knight Capital lost \$465 million for the lack of proper test to generate *automated* quotes

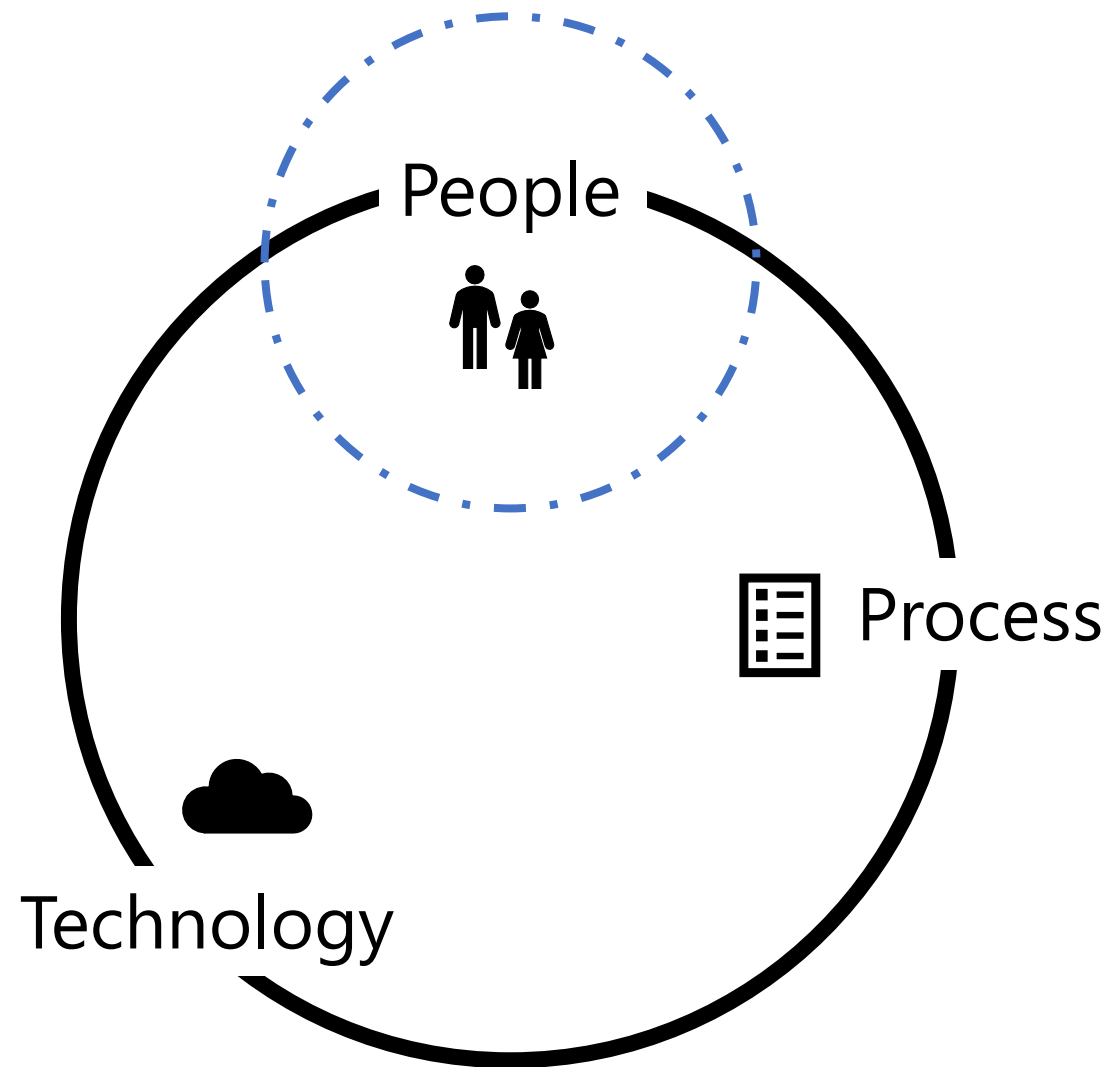
33. Several previous events presented an opportunity for Knight to review the adequacy of its controls in their entirety. For example, in October 2011, Knight used test data to perform a weekend disaster recovery test. After the test concluded, Knight's LMM desk mistakenly continued to use the test data to generate automated quotes when trading began that Monday morning. Knight experienced a nearly \$7.5 million loss as a result of this event. Knight responded to the event by limiting the operation of the system to market hours, changing the control so that this system would stop providing quotes after receiving an execution, and adding an item to a disaster recovery checklist that required a check of the test data. Knight did not broadly consider whether it had sufficient controls to prevent the entry of erroneous orders, regardless of the specific system that sent the orders or the particular reason for that system's error. Knight also did not have a mechanism to test whether their systems were relying on stale data.

SEC Charges Knight Capital With Violations of Market Access Rule (2013)

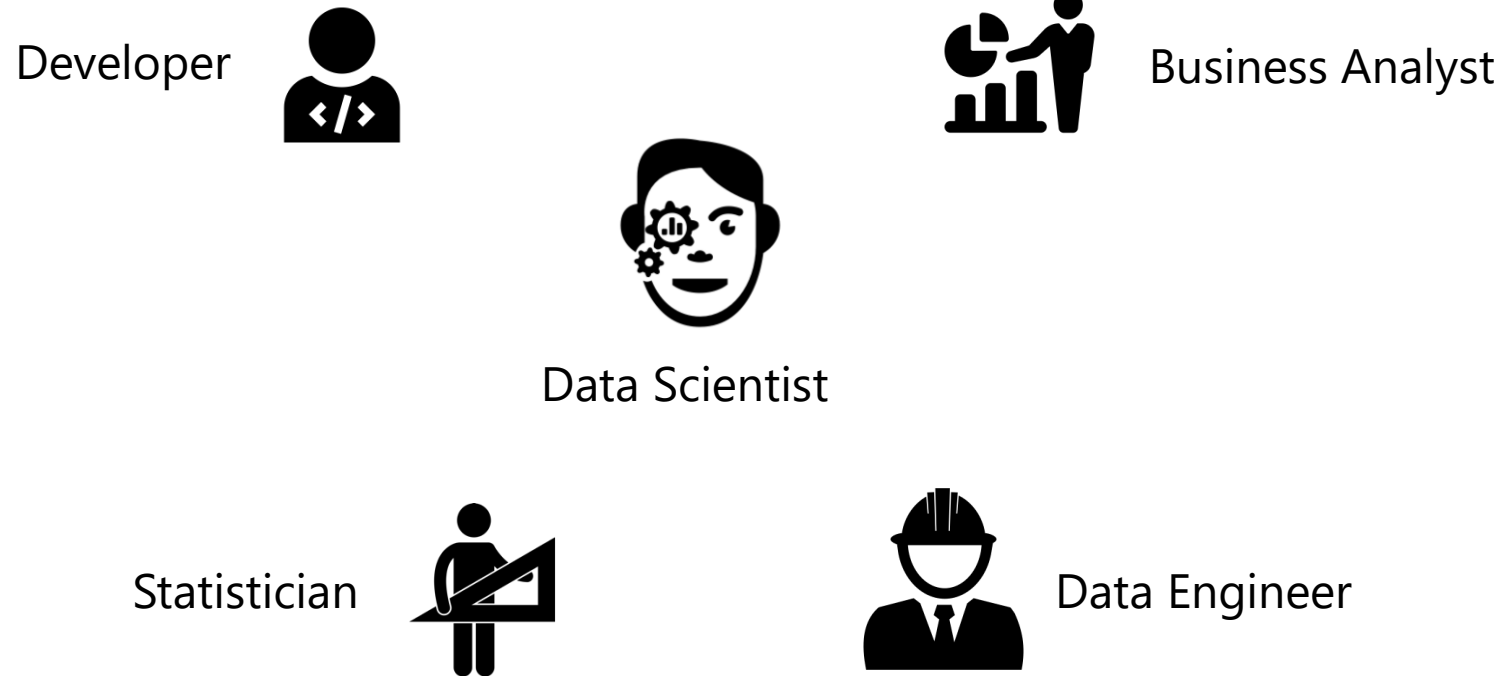
codepaths becomes difficult or impossible. A famous example of the dangers here was Knight Capital's system losing \$465 million in 45 minutes, apparently because of unexpected behavior from obsolete experimental codepaths [15].

"Hidden Technical Debt in Machine Learning Systems" (Sculley et al. 2015)

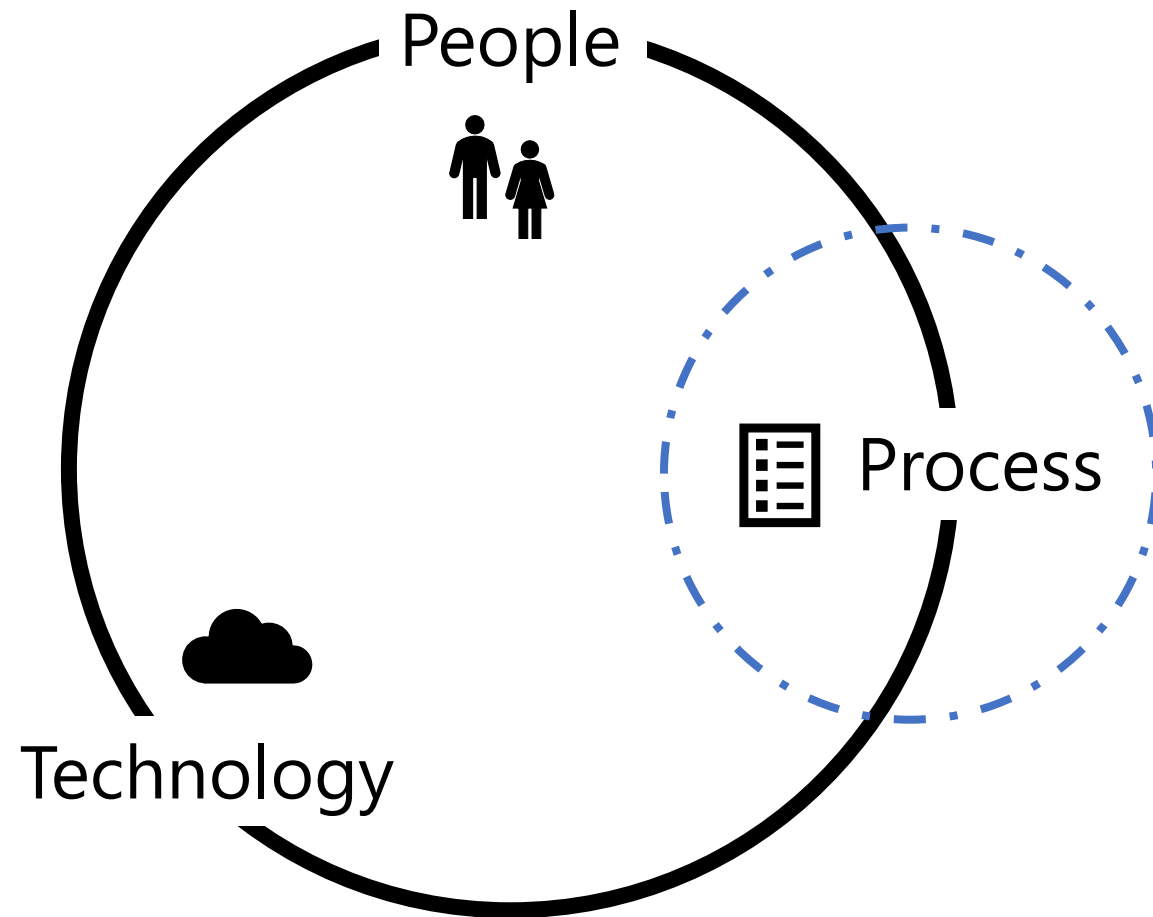




Surround your data scientist with a **team** to be **successful**¹



[1] *How Data Science Teams Leverage Machine Learning and Other Advanced Analytics*. Gartner. March 9, 2018.

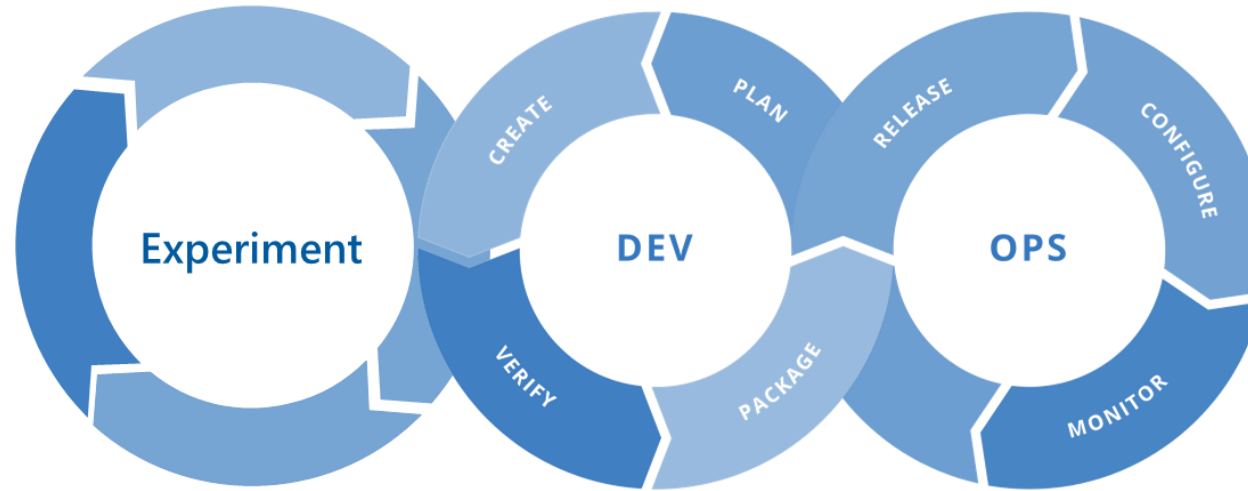


ML Ops combines TDSP with DevOps



Data Scientist

Team Data Science Process



Development and
Operations

Experiment

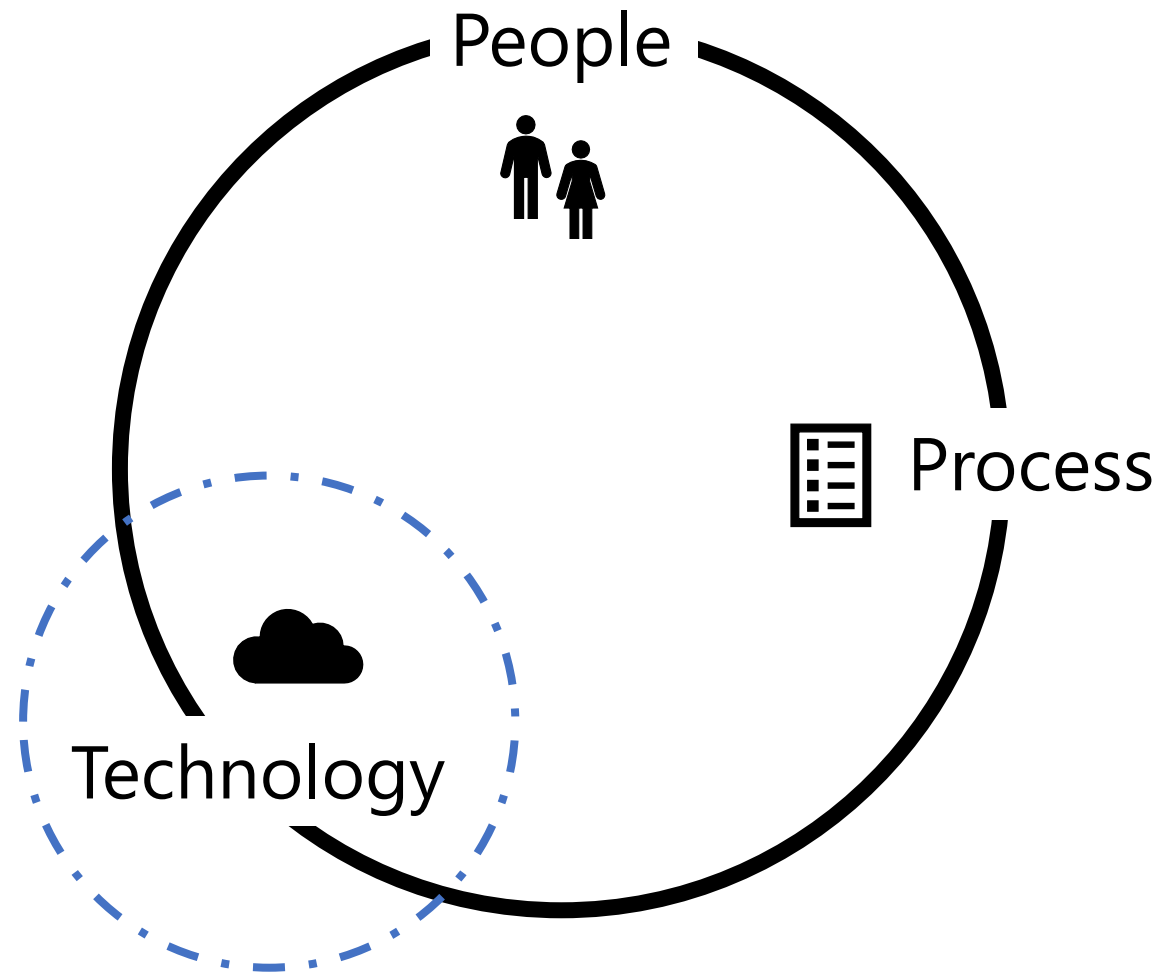
Data Acquisition
Business Understanding
Initial Modeling

Develop

Modeling + Testing
Continuous Integration
Continuous Deployment

Operate

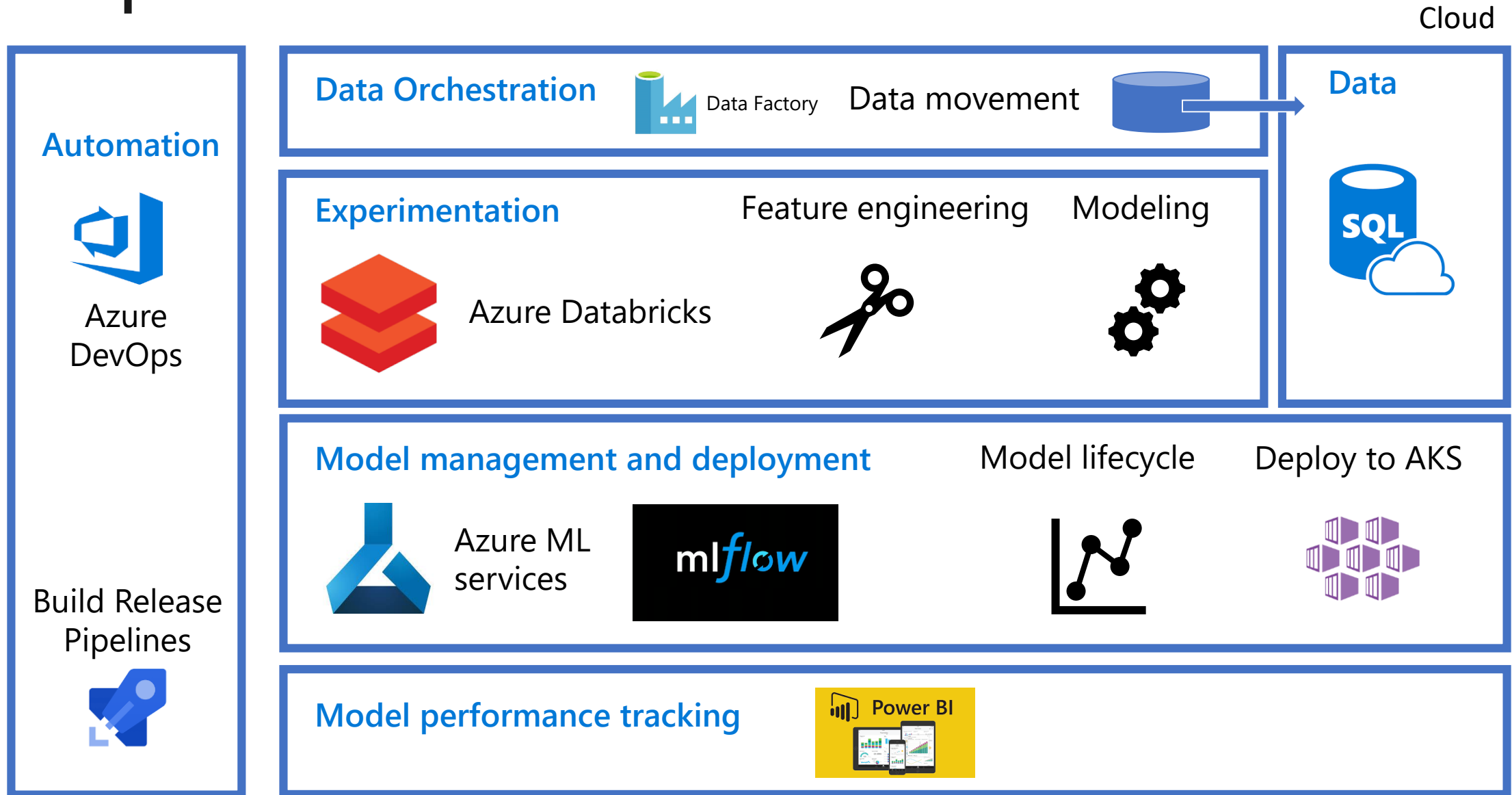
Continuous Delivery
Data Feedback Loop
System + Model Monitoring



Key goals for ML Ops

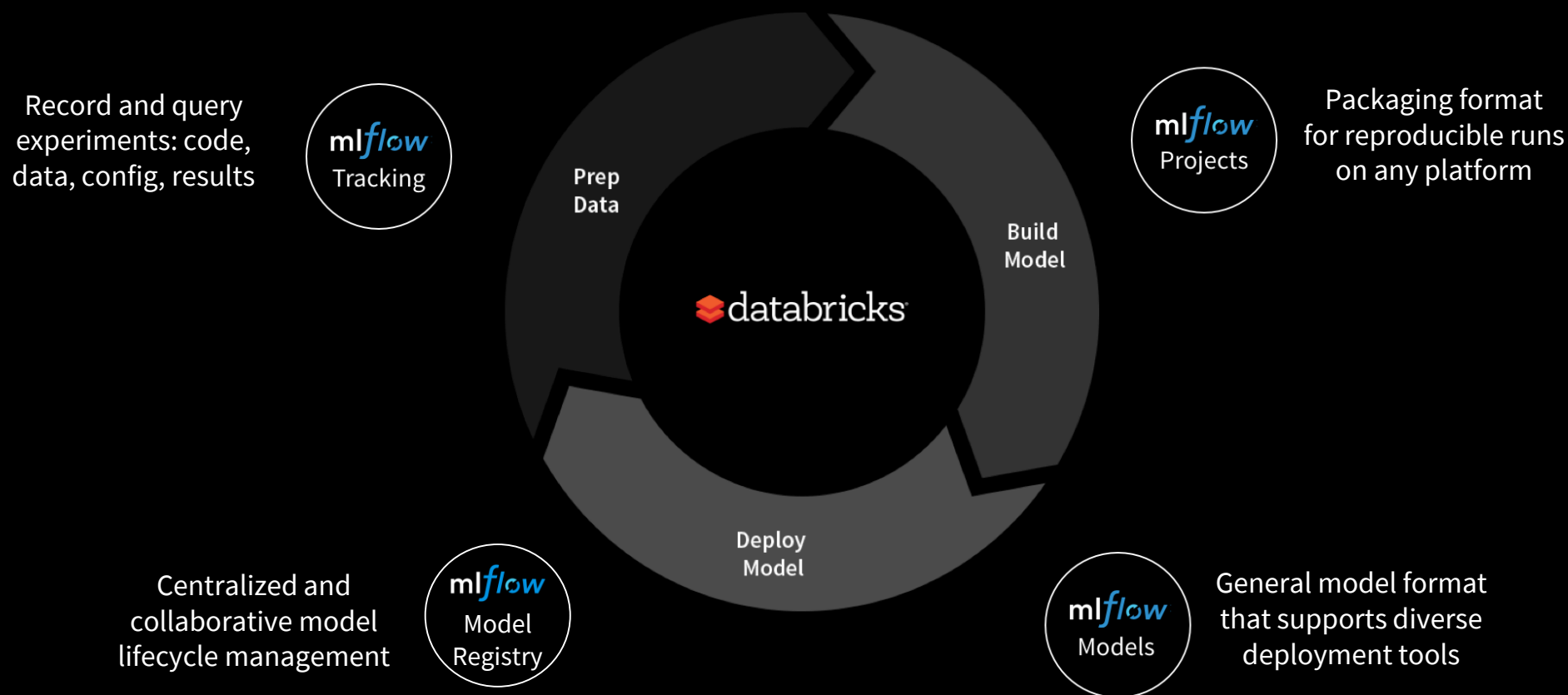
- **Produce repeatable experiments**
 - Repeatability of model creation & behavior
 - Evaluation of model predictions
- **Manage model lifecycle**
 - Different model versions, files, dependencies
 - Operationalization of the model
 - Monitoring of training, CI/CD, scoring pipelines
- **Help automate the circle in production**
 - Data > features > model > services > predictions > data

ML Ops reference architecture



Introducing MLflow

Unveiled in June 2018, MLflow is an open source platform designed to manage the complete Machine Learning Lifecycle.



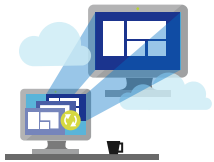


Azure Machine Learning service (Python SDK)

Bring AI to everyone with an end-to-end, scalable, trusted platform



Boost your data science productivity



Increase your rate of experimentation



Deploy and manage your models everywhere



Built with your needs in mind

- Automated machine learning
- Managed compute
- DevOps for machine learning
- Simple deployment
- Tool agnostic Python SDK
- Support for open source frameworks

Seamlessly integrated with the Azure Portfolio and ML Flow

Key goals for ML Ops

- **Produce repeatable experiments**
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Automation



Azure
DevOps

Build
pipeline

Model
training

Data Orchestration



Data Factory

Data movement



Data

Experimentation



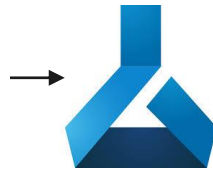
Azure Databricks

Standard Data Science Experiment:

- Pull data from SQL DB
- Train / evaluate model
- Report on accuracy



Model management



Azure ML
services

Leverage ML services

- Experiment logging
- Model management and registry
- Power BI refresh

Model performance tracking



Call remote compute job

Automation



Azure
DevOps

Release
pipeline

Deploy
model

Model performance tracking



Decide if accuracy is
sufficient to deploy model



Approval

Model management



Azure ML services

- Leverage ML services
- Deploy to ACI (QA)
 - Deploy to AKS (PROD)

Run pipeline