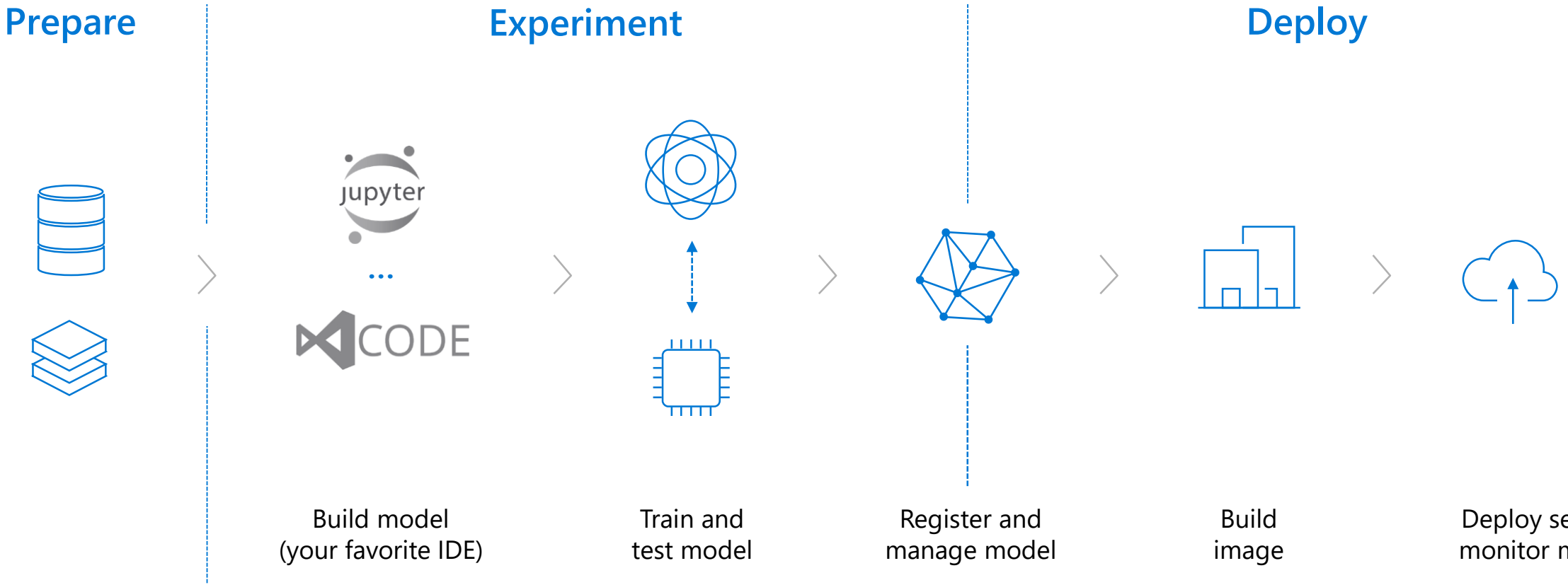
Microsoft

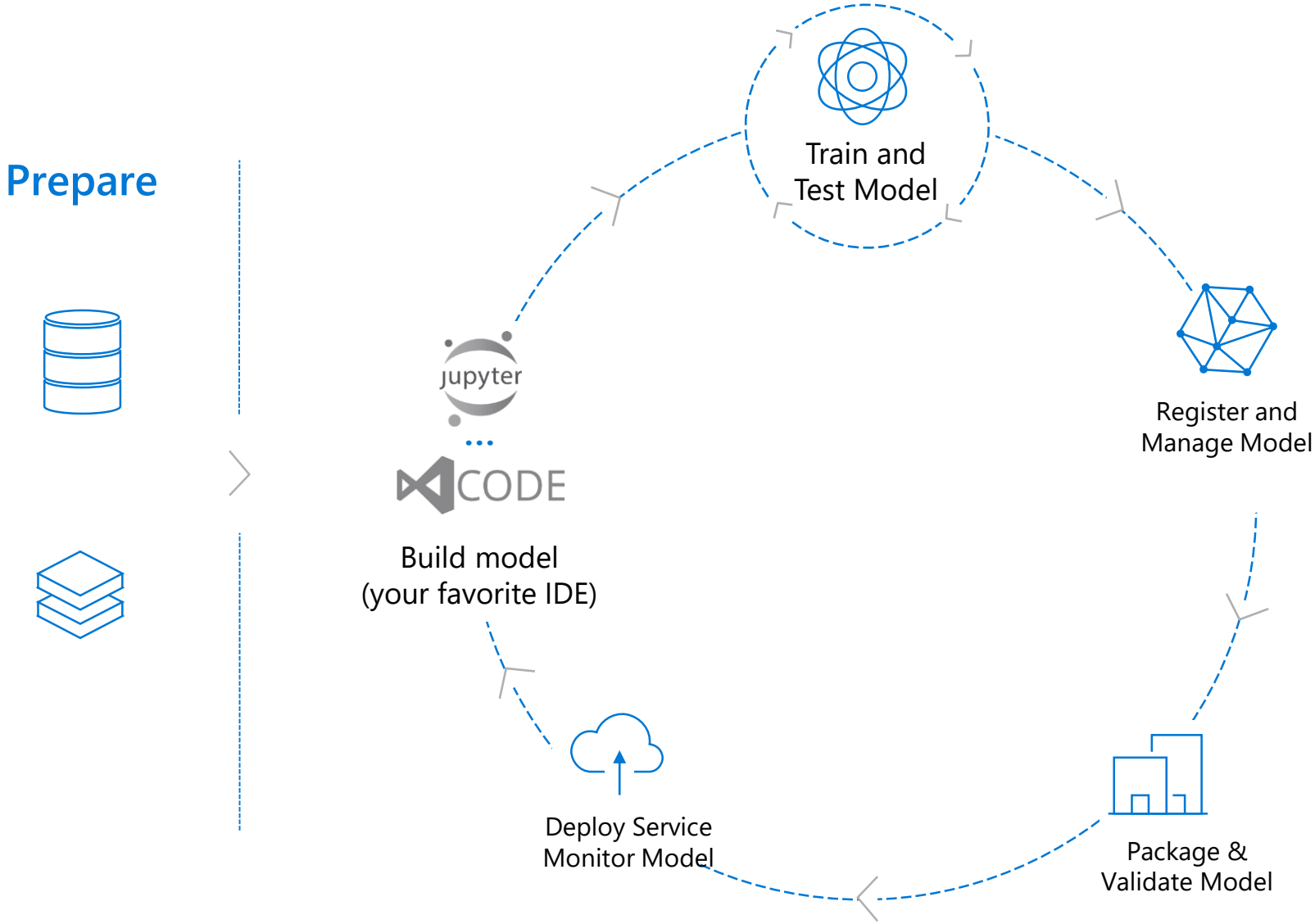
DevOps for Machine Learning (“ML Ops”)

Jordan Edwards, Azure Machine Learning

Azure Machine Learning accelerates DevOps for ML



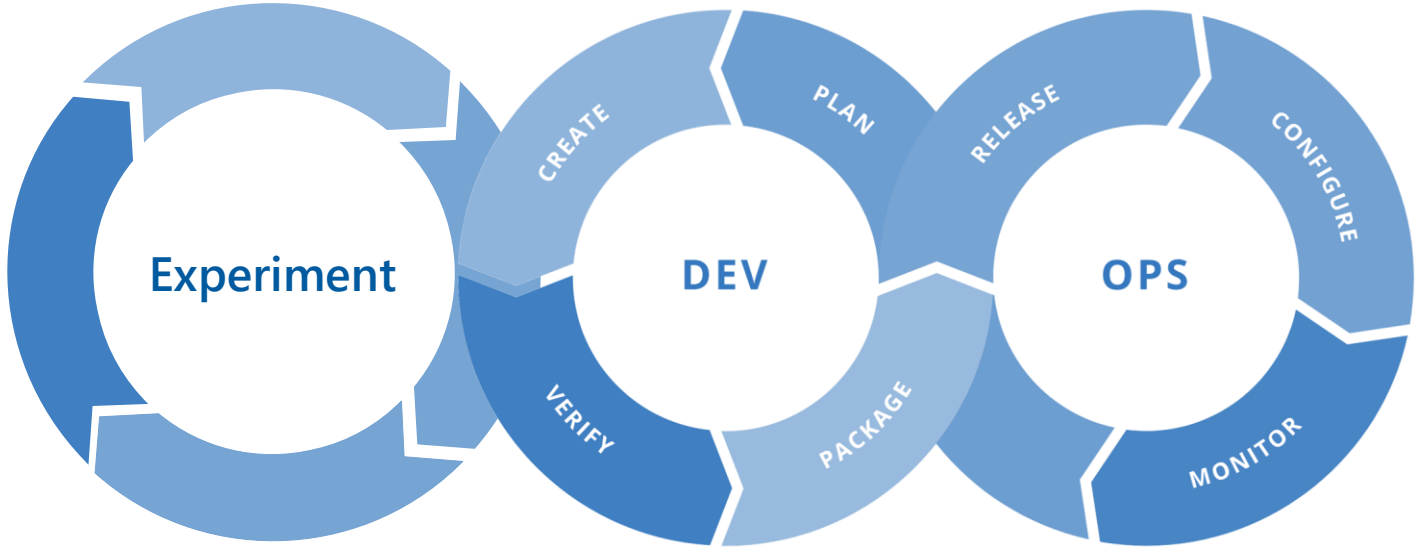
Azure Machine Learning accelerates DevOps for data science



Key Goals of DevOps for Machine Learning

- Repeatability of model creation & behavior
- Evaluation of model predictions
- Managing different model versions and files
- Operationalization of the model
- Monitoring of training and scoring pipelines

ML DevOps lifecycle

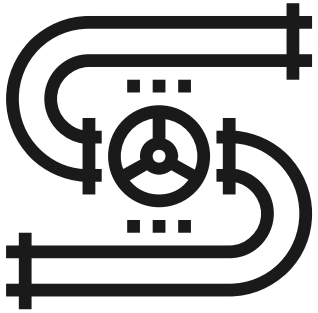


Experiment
Data Acquisition
Business Understanding
Initial Modeling

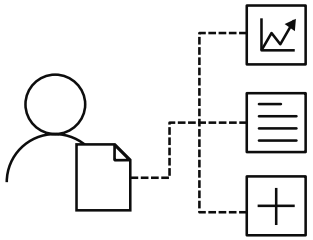
Develop
Modeling + Testing
Continuous Integration
Continuous Deployment

Operate
Continuous Delivery
Data Feedback Loop
System + Model Monitoring

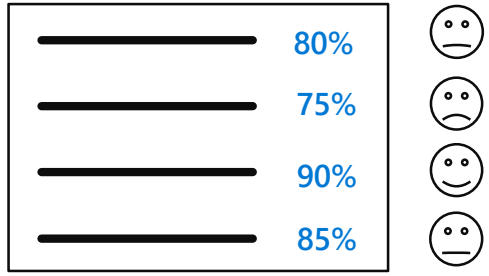
Produce Repeatable Experiments



Use well-defined pipelines to capture the E2E model training process



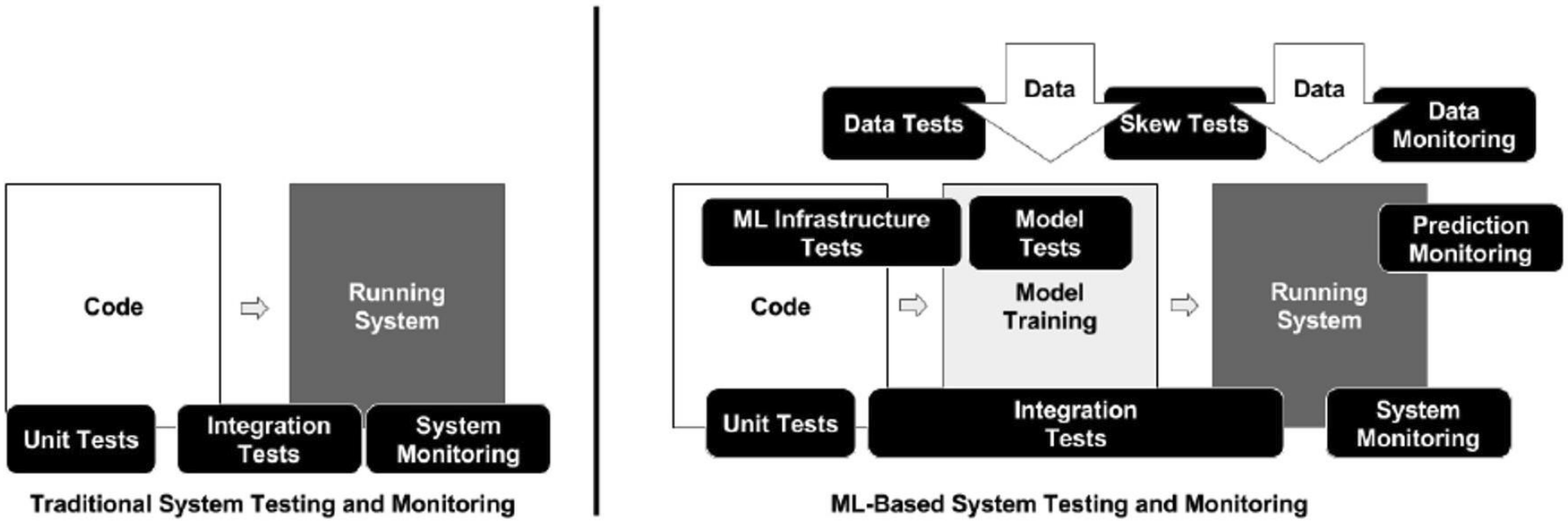
Capture run metrics, intermediate outputs, output logs and models



Use leaderboards, side by side run comparison and model selection

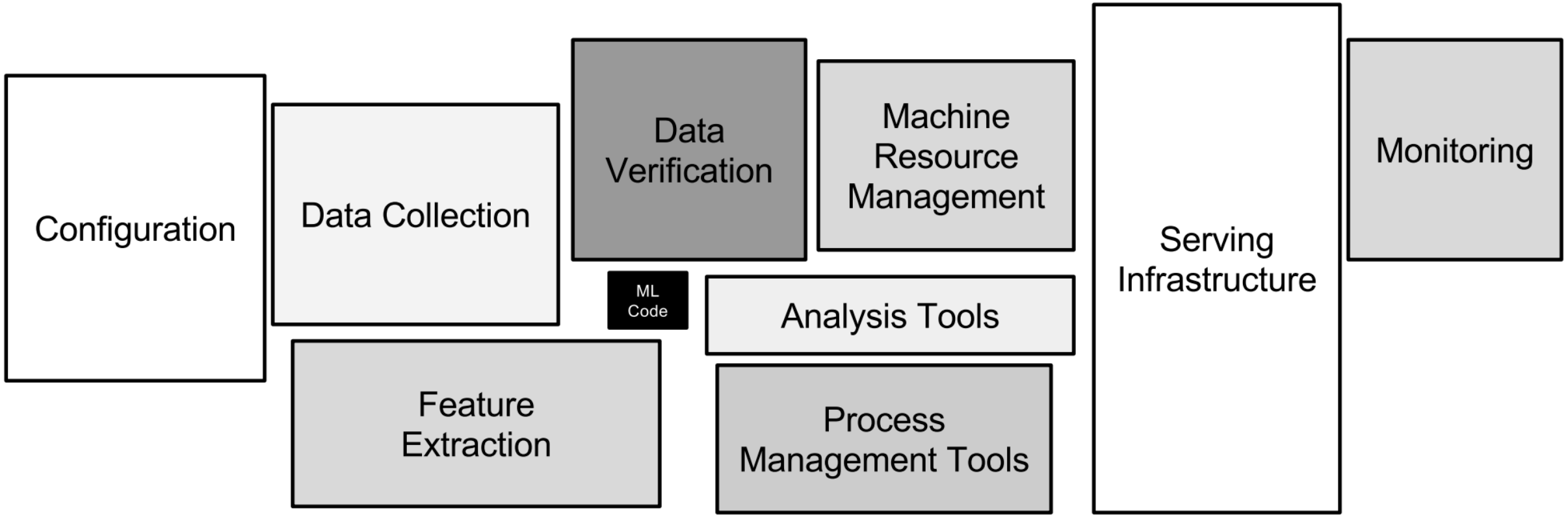
No matter where an experiment happens, track it in the cloud so you can explain how a model was created.

Traditional v/s AI application



Source: Google AI Paper "What's your ML test score? A rubric for ML production systems"

Technical debt / collateral in ML systems



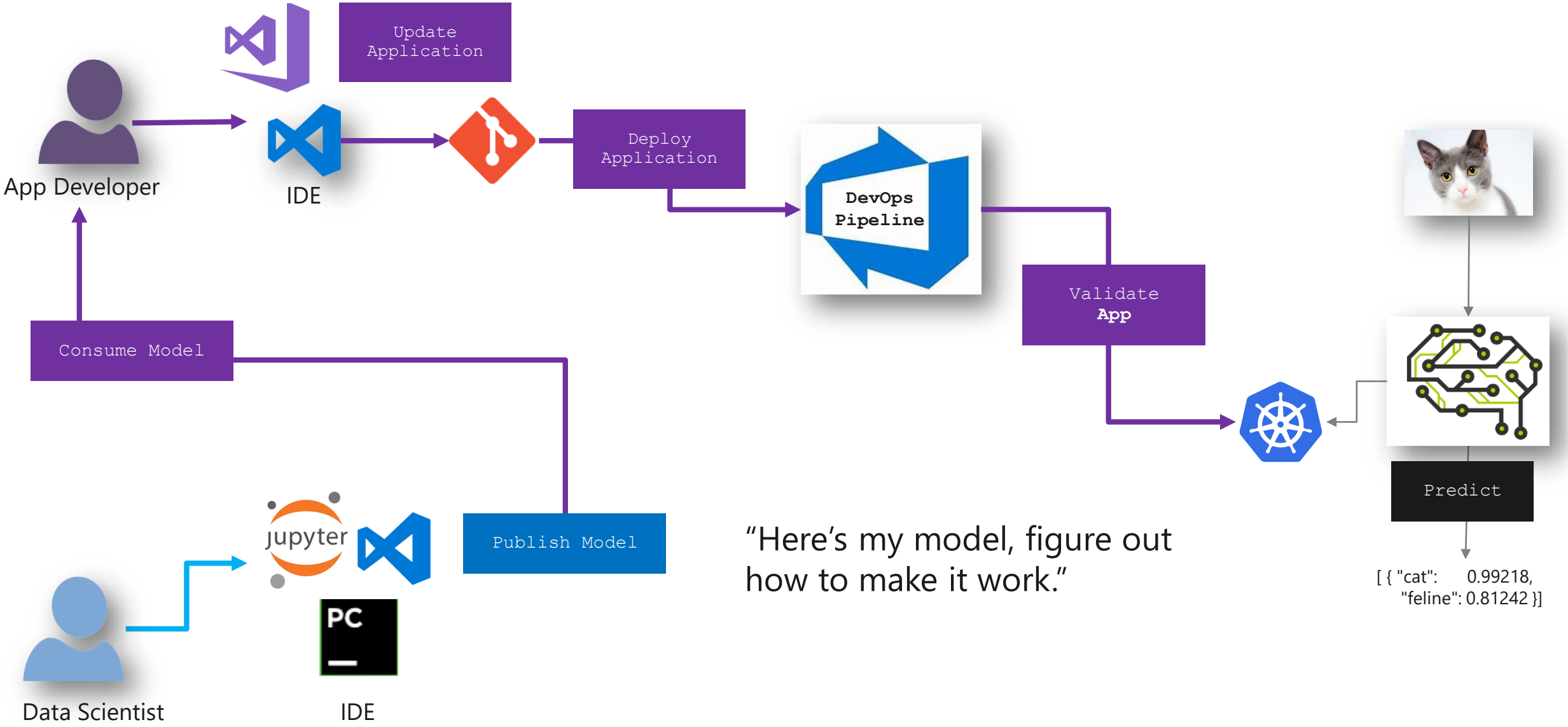
Hidden technical debt in Machine Learning systems

Microsoft

Evolution of the AI Application Development Process

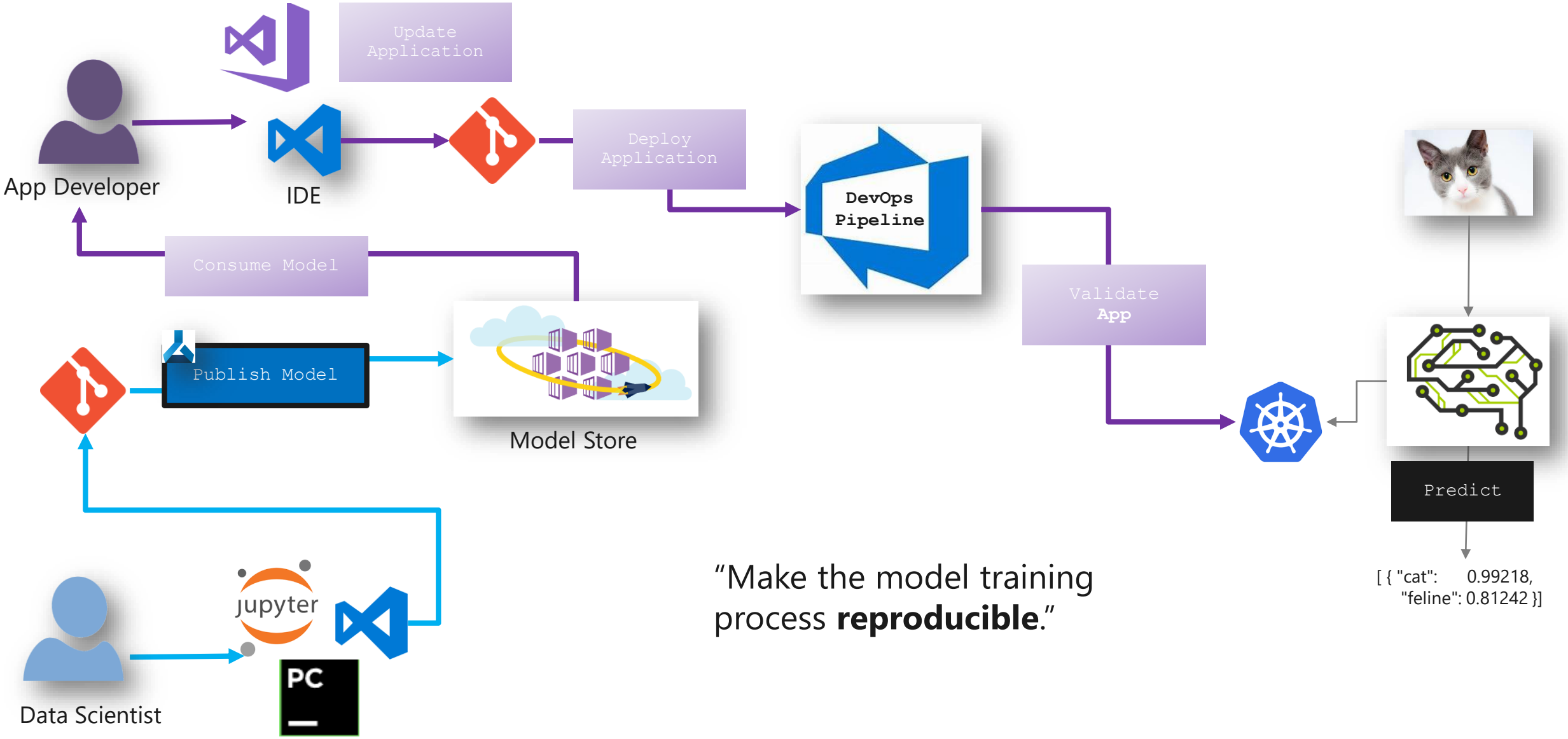
DevOps for AI

ML + App Dev Process – Phase 1



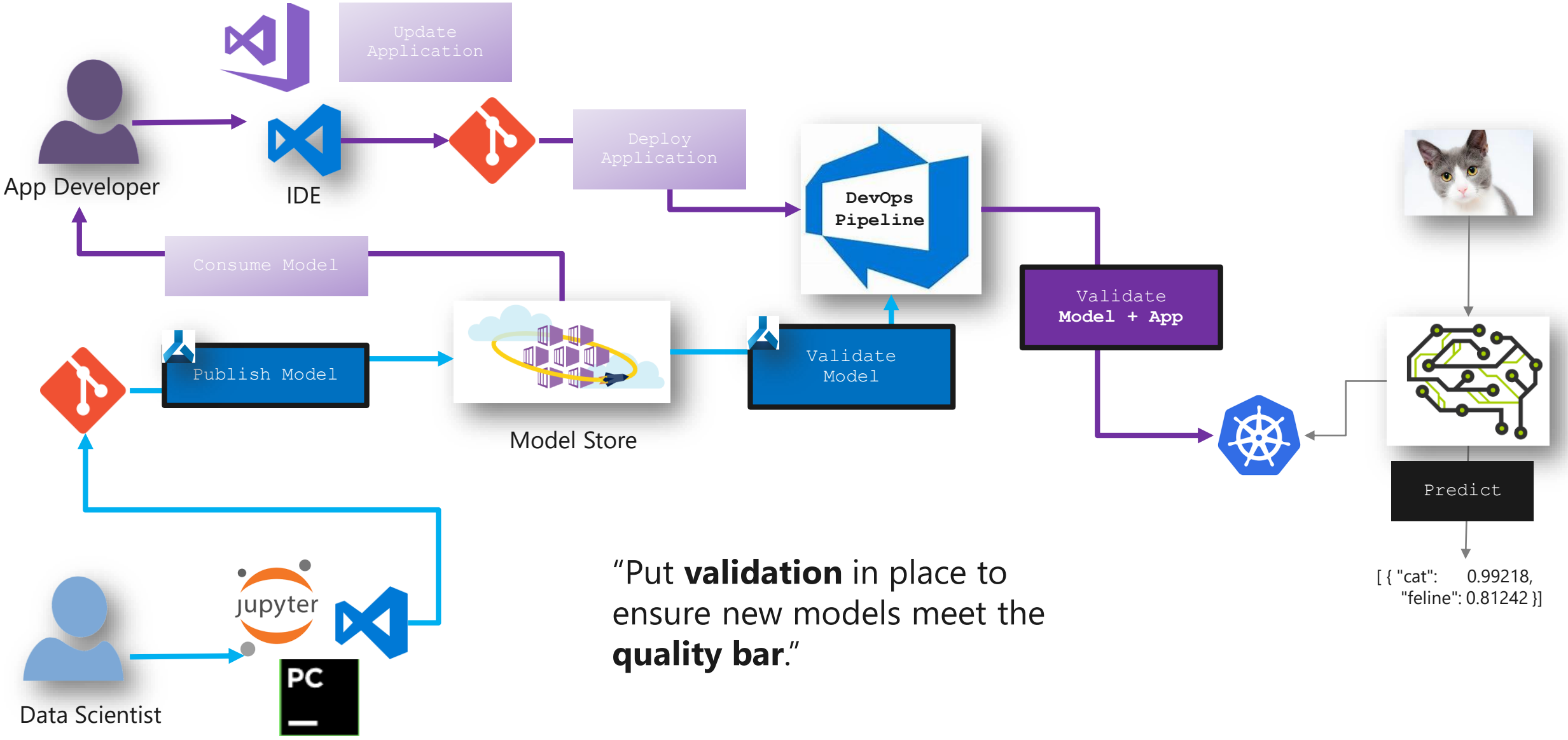
"Here's my model, figure out how to make it work."

ML + App Dev Process – Phase 2



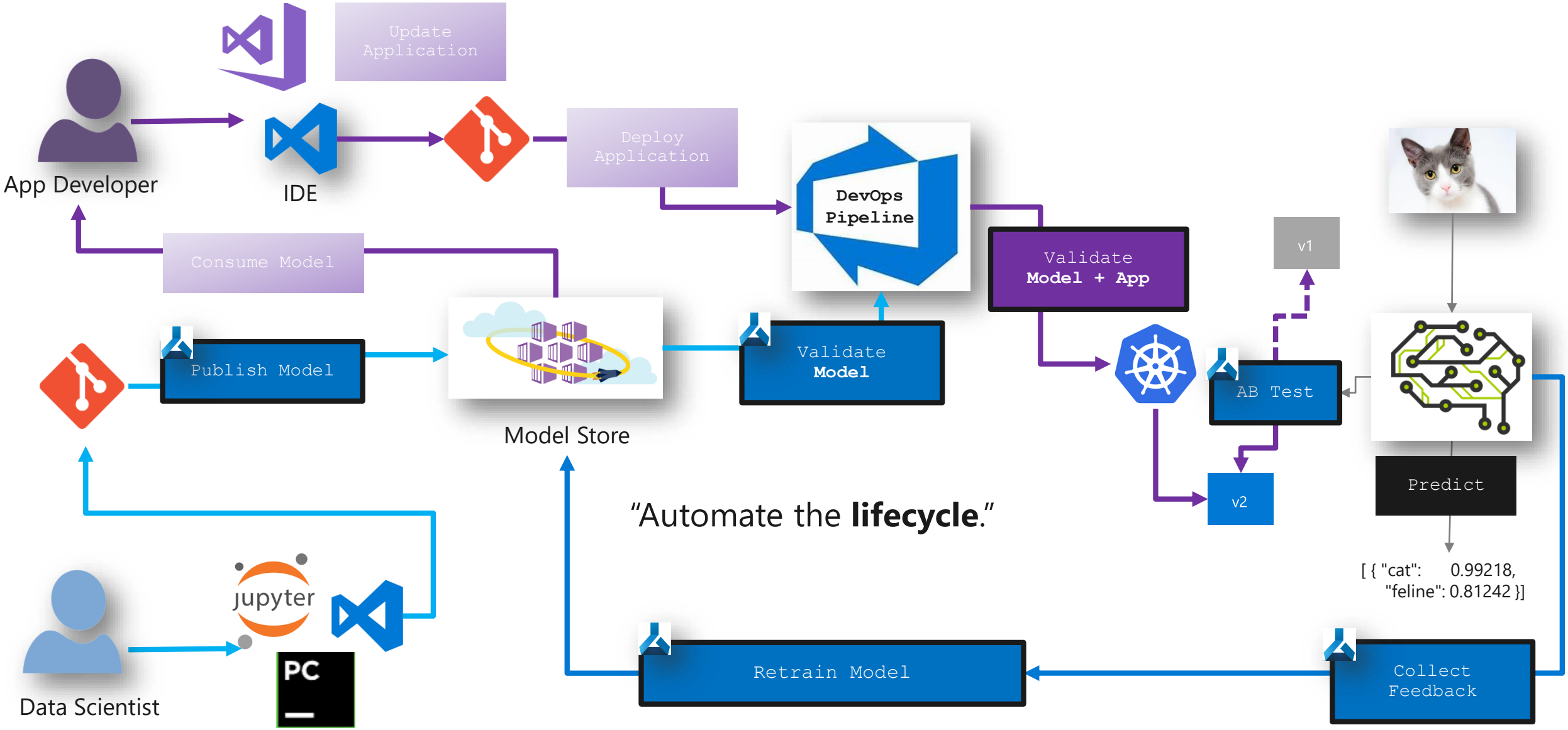
"Make the model training process **reproducible**."

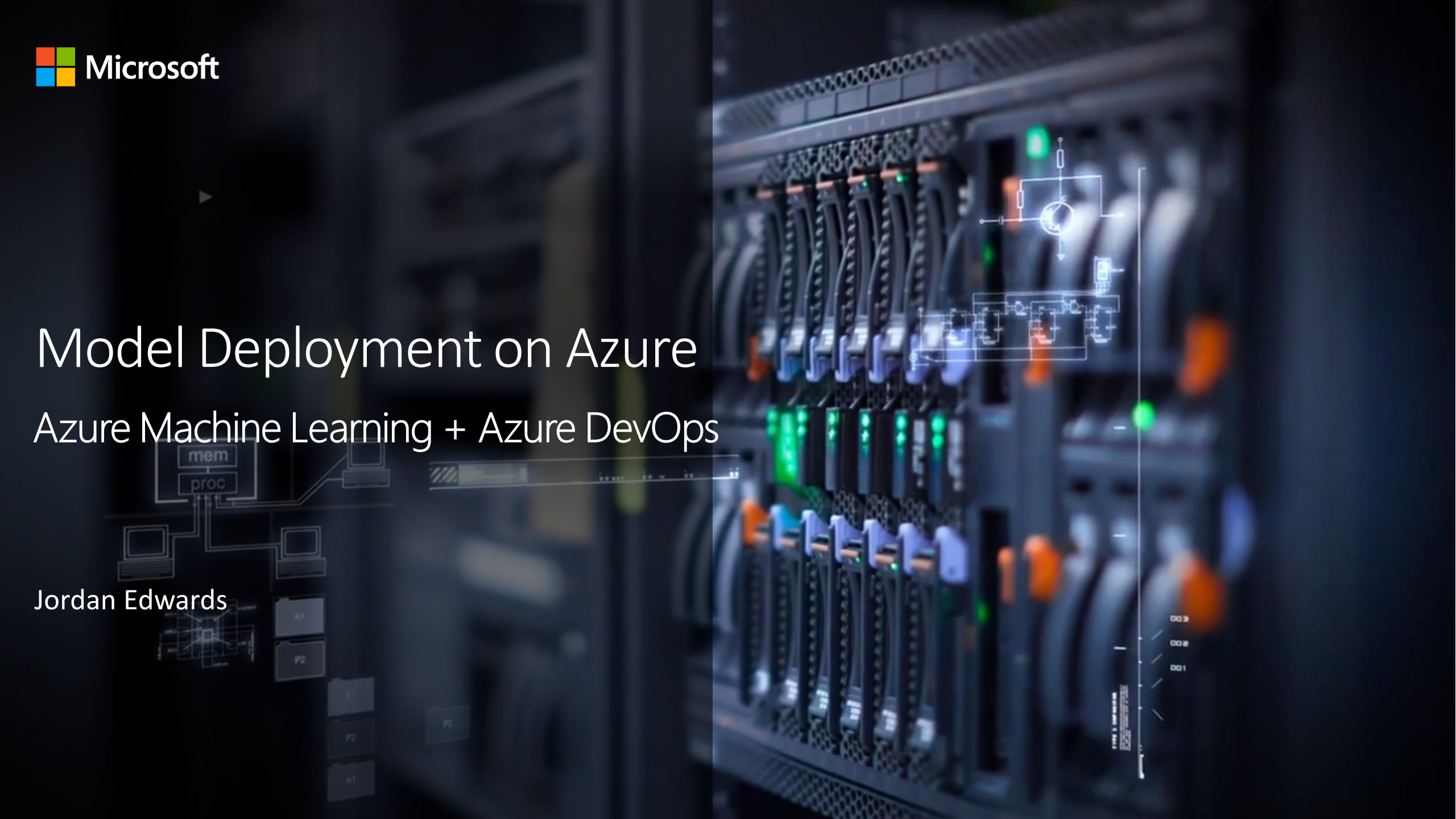
ML + App Dev Process – Phase 3



"Put **validation** in place to ensure new models meet the **quality bar**."

ML + App Dev Process – Phase 4





Microsoft

Model Deployment on Azure

Azure Machine Learning + Azure DevOps

Jordan Edwards

Model CI/CD

DataOps + MLOps + DevOps

Azure Machine Learning

Data Warehouse

Data **Curation** Pipeline

PREPARE DATA

prepare

Data Catalog

commit

TRAIN MODEL

Run Training Pipeline

Featurize

Train

Evaluate

register

Model Registry

Data Scientist

Data Engineer

Azure Data Factory

Source Repo

Data **Preparation** Pipeline

release

DEPLOY MODEL

DevOps Pipeline

Inference Data

collect

Deploy

Approve

Profile

Validate

Package

Azure DevOps

DevOps

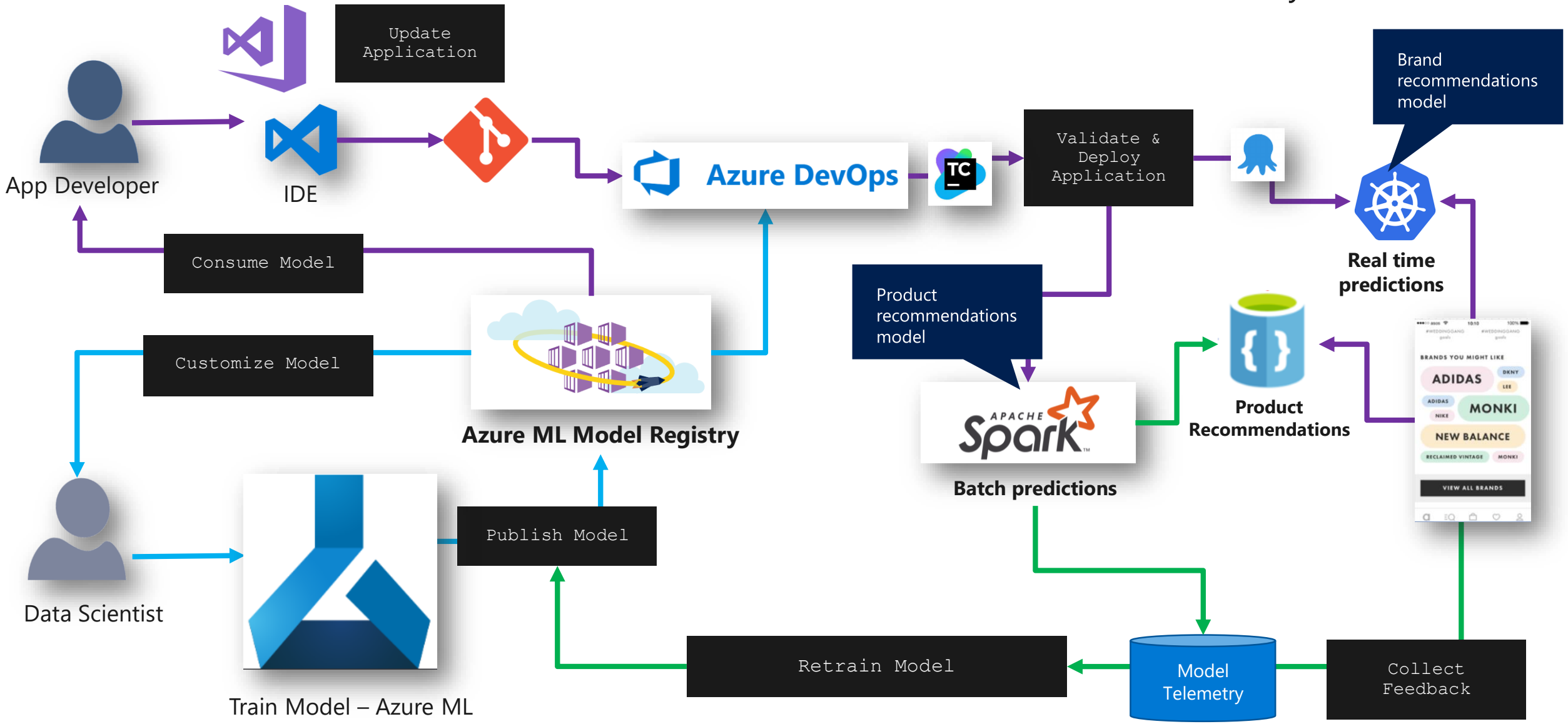
Microsoft

DevOps for ML

Customer Scenarios

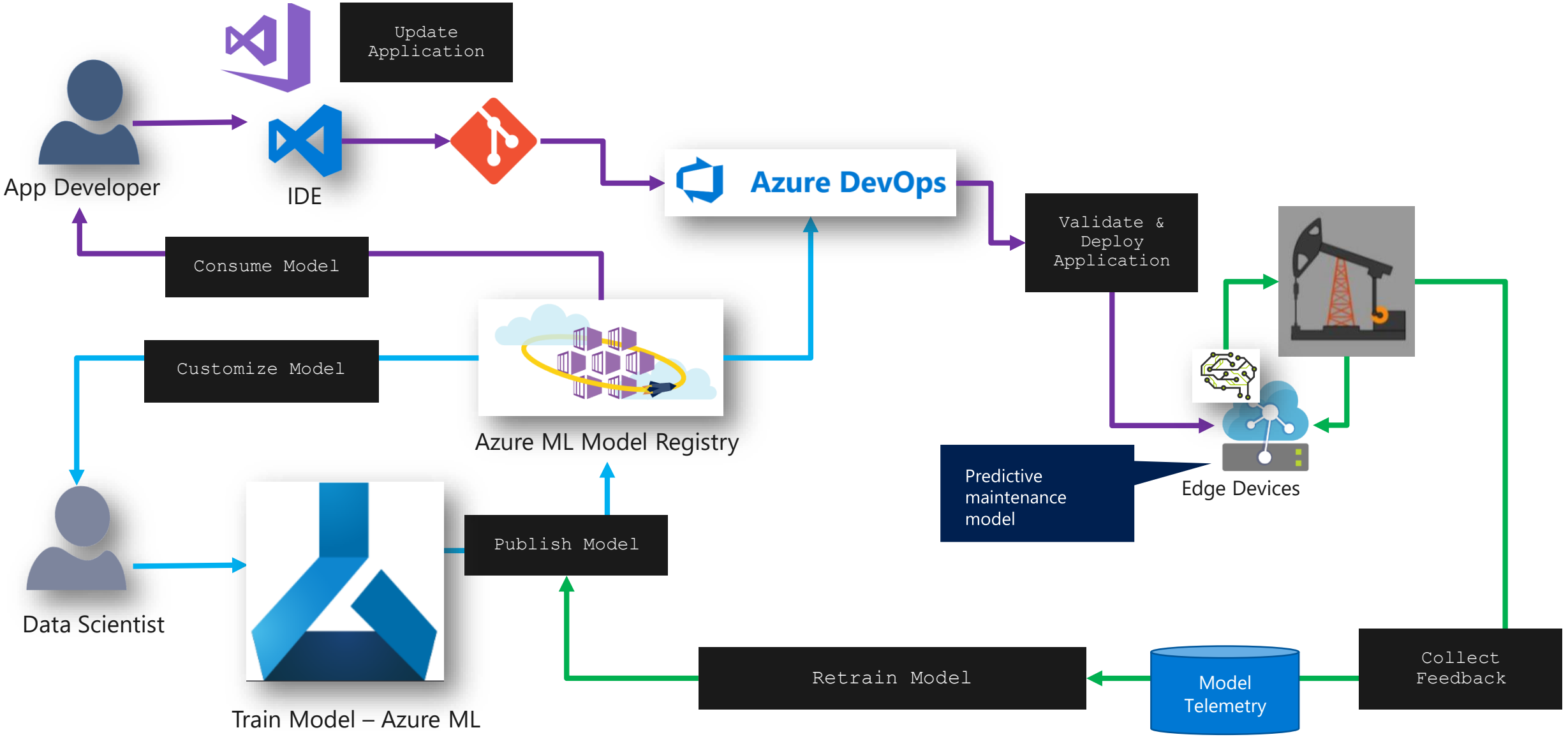
ML DevOps Process – ASOS

"Automate the E2E model lifecycle."

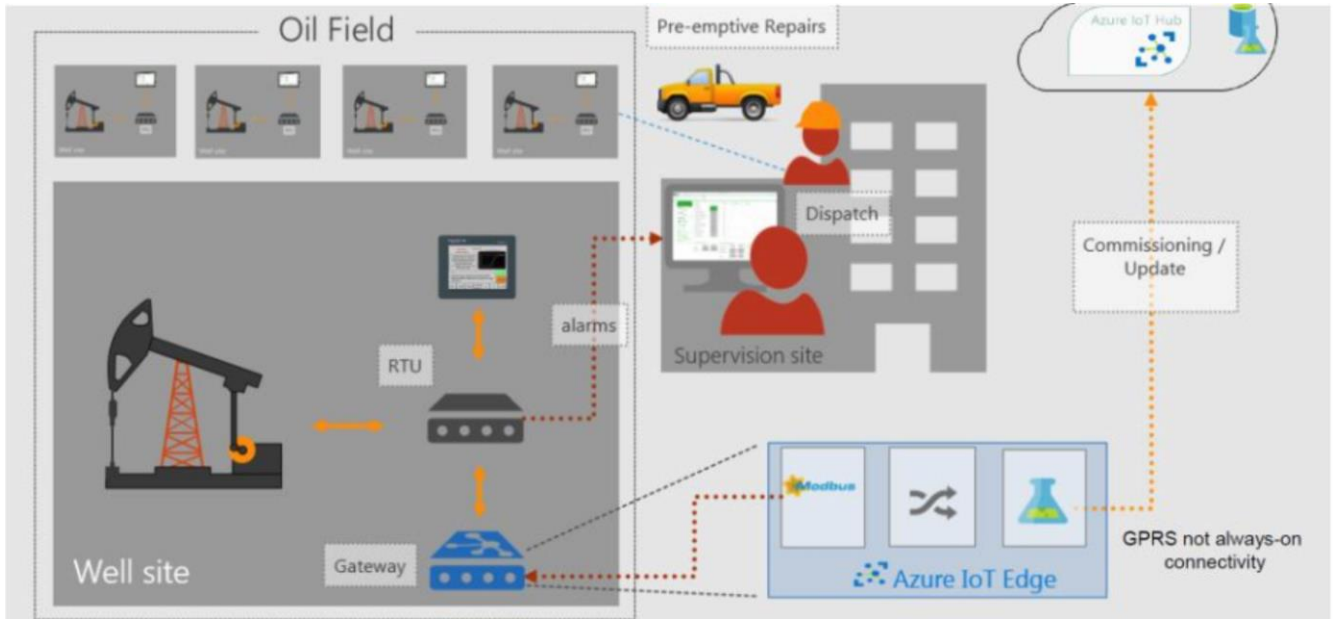


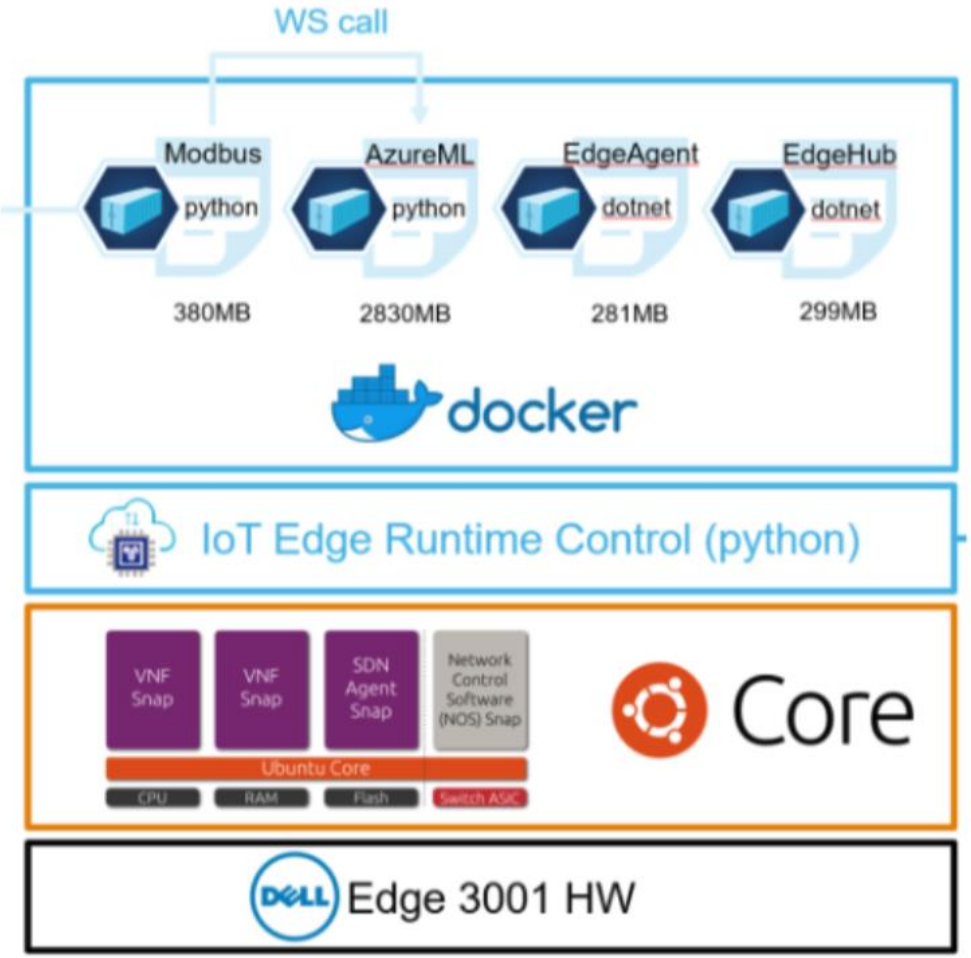
ML DevOps Process – Schneider (Realift)

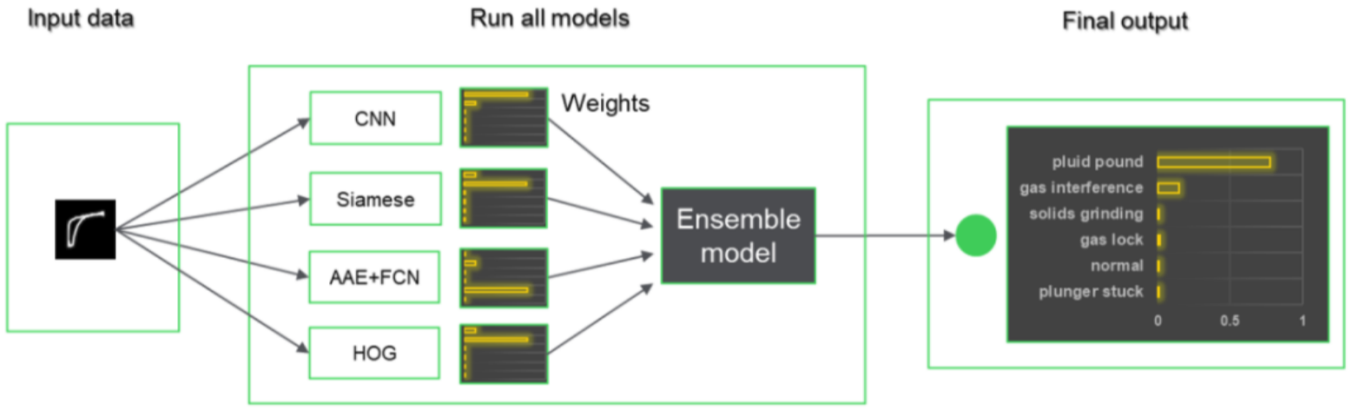
"Automate the E2E model lifecycle."



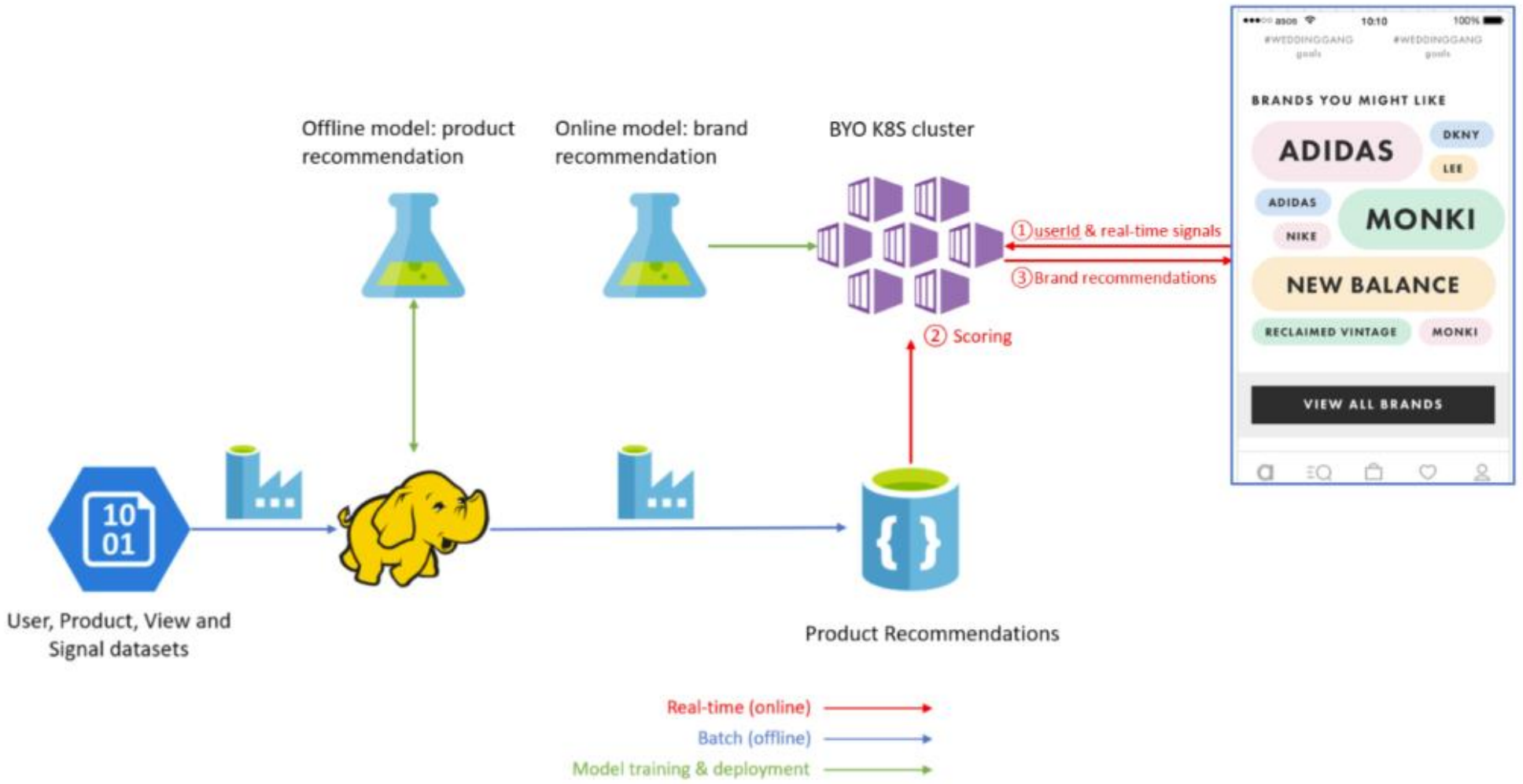
Schneider – what happens on the edge







MODEL Lifecycle Example - ASOS



ASOS Brand Recommendation Architecture

Microsoft

Azure DevOps + Azure ML

Better together

Azure DevOps Pipelines

Cloud-hosted pipelines for Linux, Windows and macOS.

Any language, any platform, any cloud

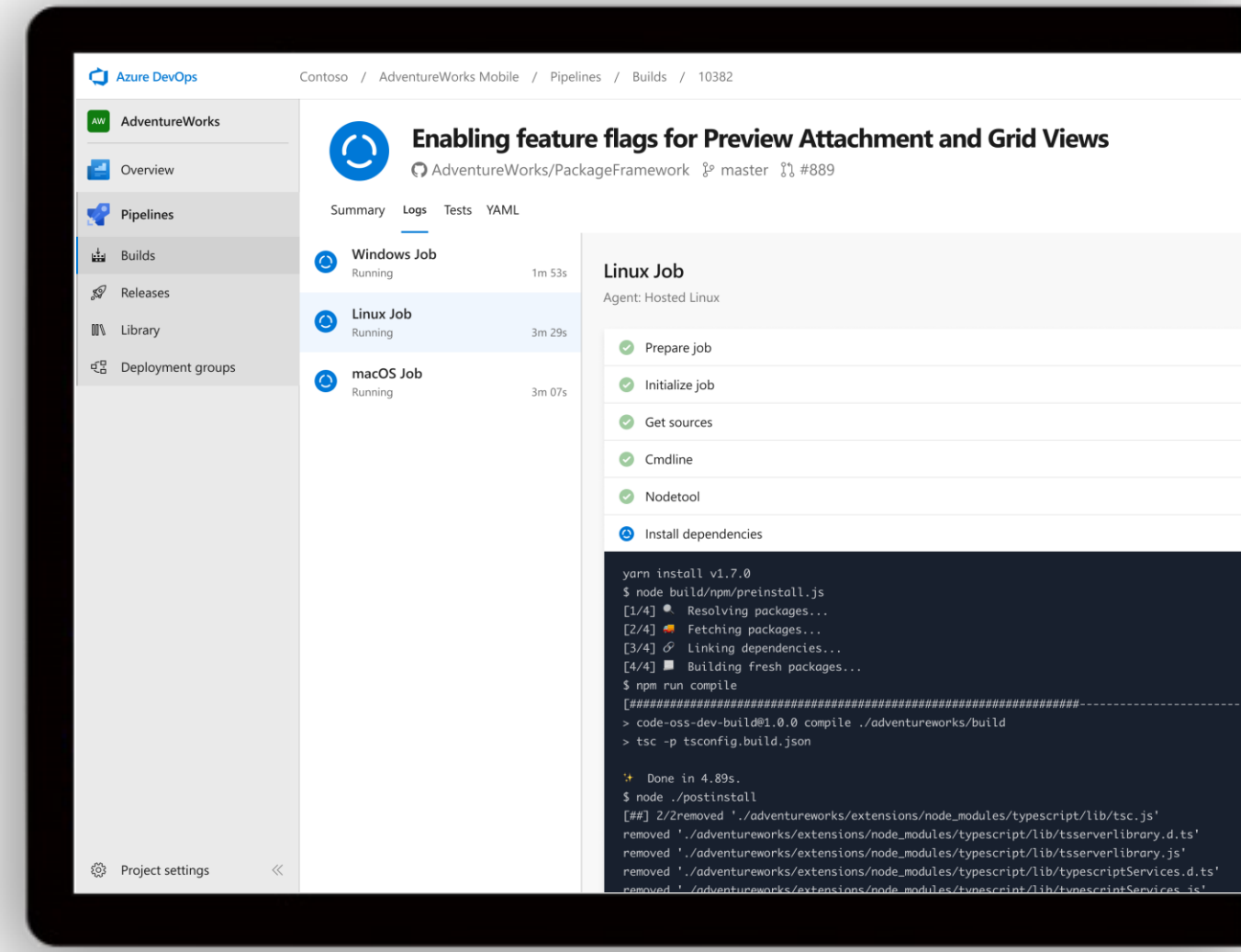
Build, test, and deploy Node.js, Python, Java, PHP, Ruby, C/C++, .NET, Android, and iOS apps. Run in parallel on Linux, macOS, and Windows. Deploy to Azure, AWS, GCP or on-premises

Extensible

Explore and implement a wide range of community-built build, test, and deployment tasks, along with hundreds of extensions from Slack to SonarCloud. Support for YAML, reporting and more

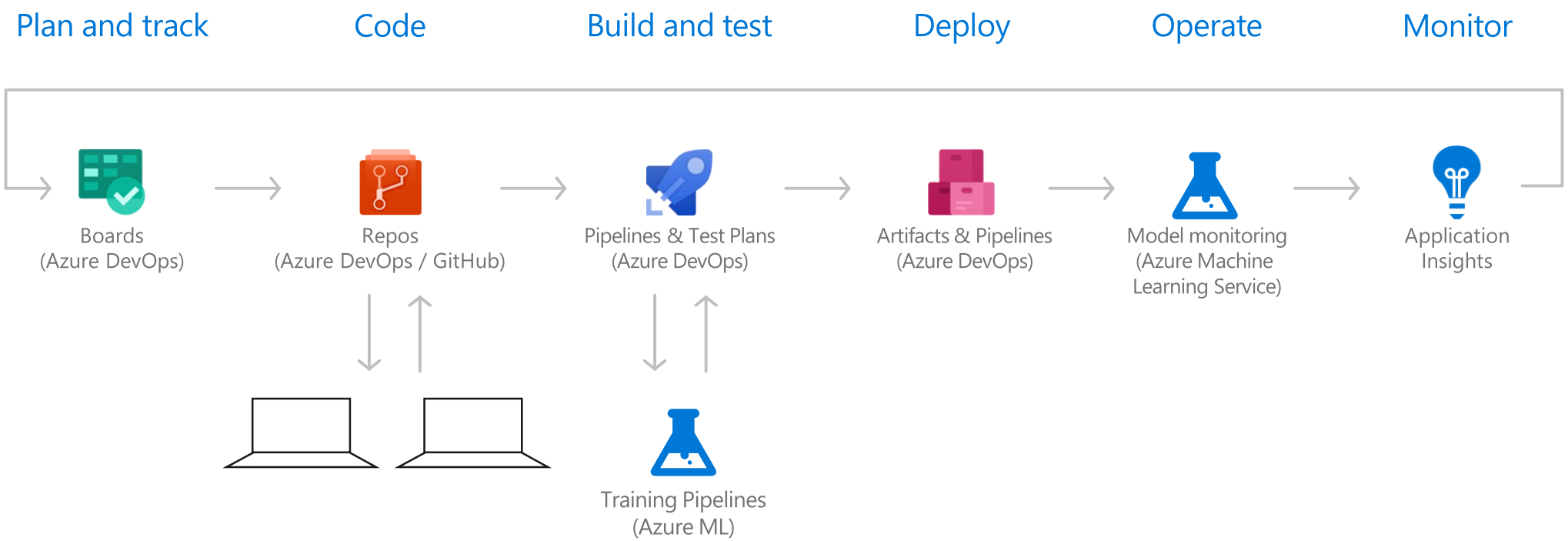
Containers and Kubernetes

Easily build and push images to container registries like Docker Hub and Azure Container Registry. Deploy containers to individual hosts or Kubernetes.

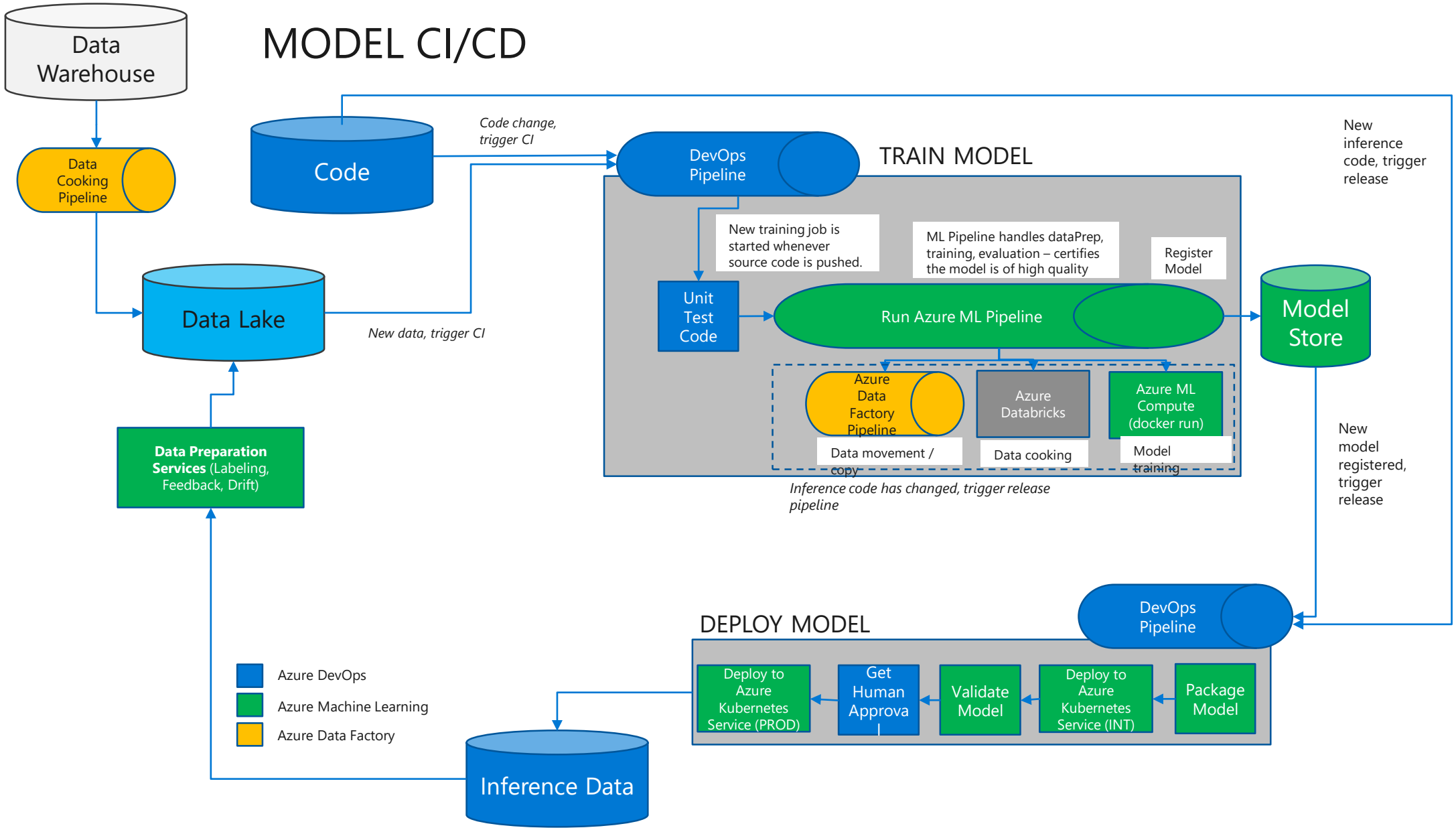


https://azure.com/pipelines

DevOps Framework for Azure AI Solutions



DevOps CI/CD Pipeline Deep Dive



Model Training

Provide the files and resources needed to train the machine learning model. The following files in the example project would be provided by the data scientists:

Training script (train.py)
The training script contains logic specific to the model that you are training.

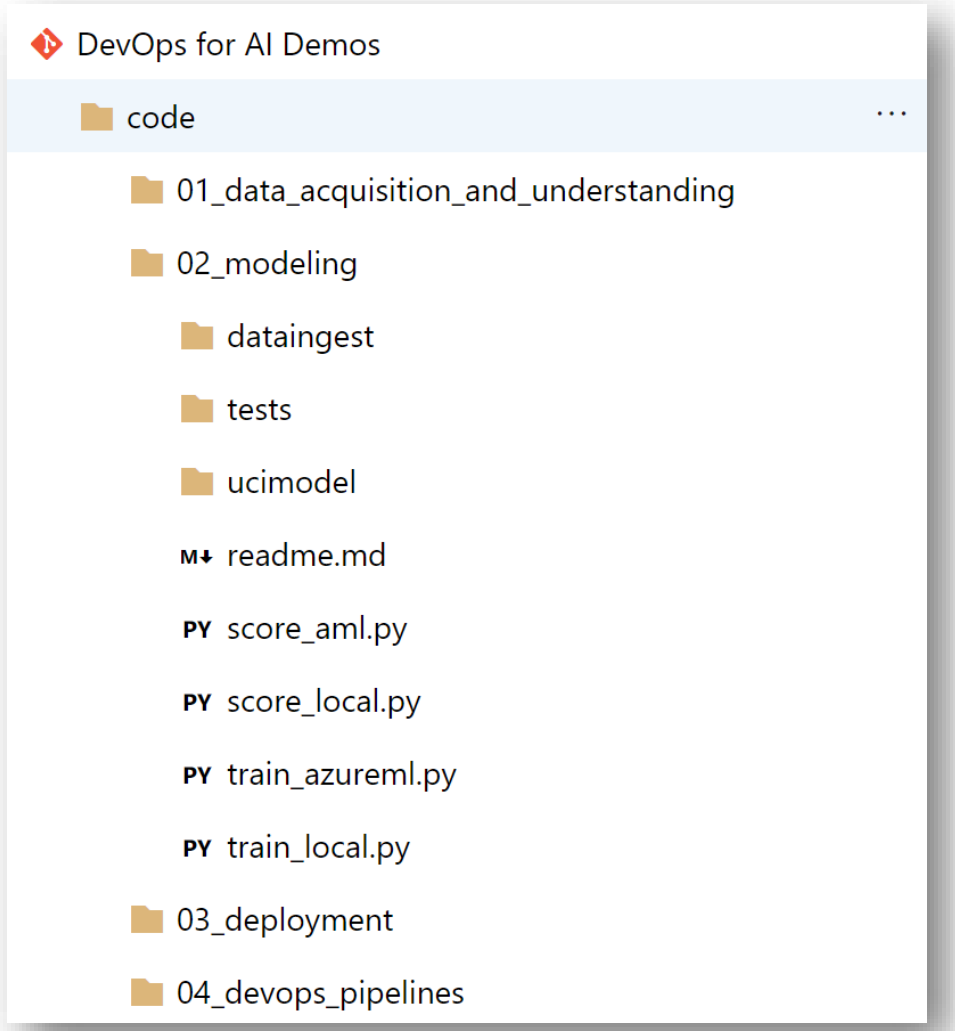
Scoring file (score.py)
When the model is deployed as a web service, the scoring file receives data from clients and scores it against the model. The output is then returned to the client.

Experiment settings (project.json)
Links your project (training.py and other files required for training) with an experiment in your workspace.

RunConfig settings (myconfig.runconfig)
Defines how the training script is ran on the compute target that is used for training.

Conda environment (conda_dependencies.yml)
Defines the packages needed to run the training script.

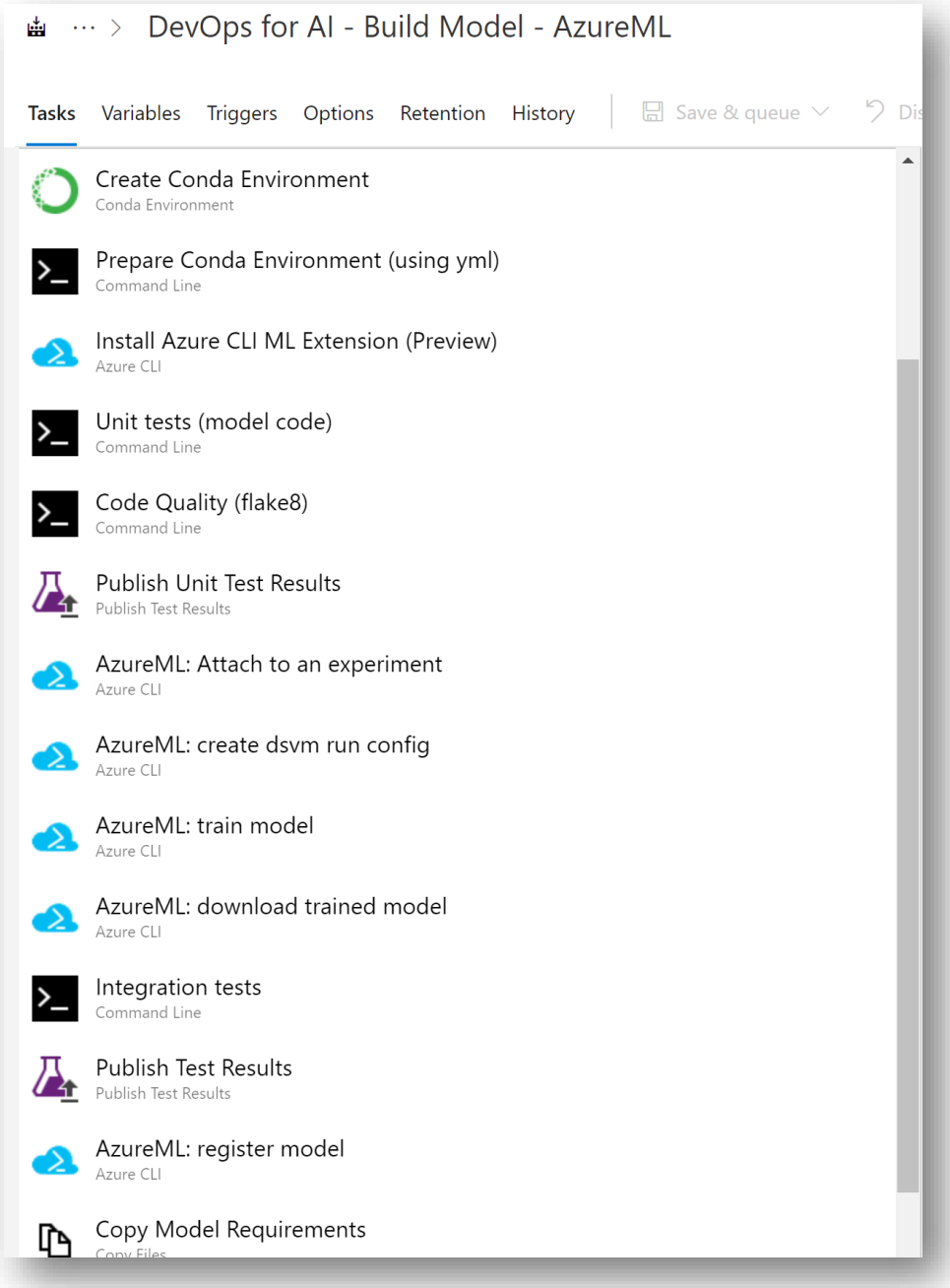
Deployment environment (prod_dependencies.yml)
Defines the packages needed to run the model and scoring file in the deployment environment.



Model Training

CI pipeline captures

1. Create sandbox
2. Run unit tests and code quality checks
3. Attach to compute
4. Train model
5. Evaluate model
6. Register model

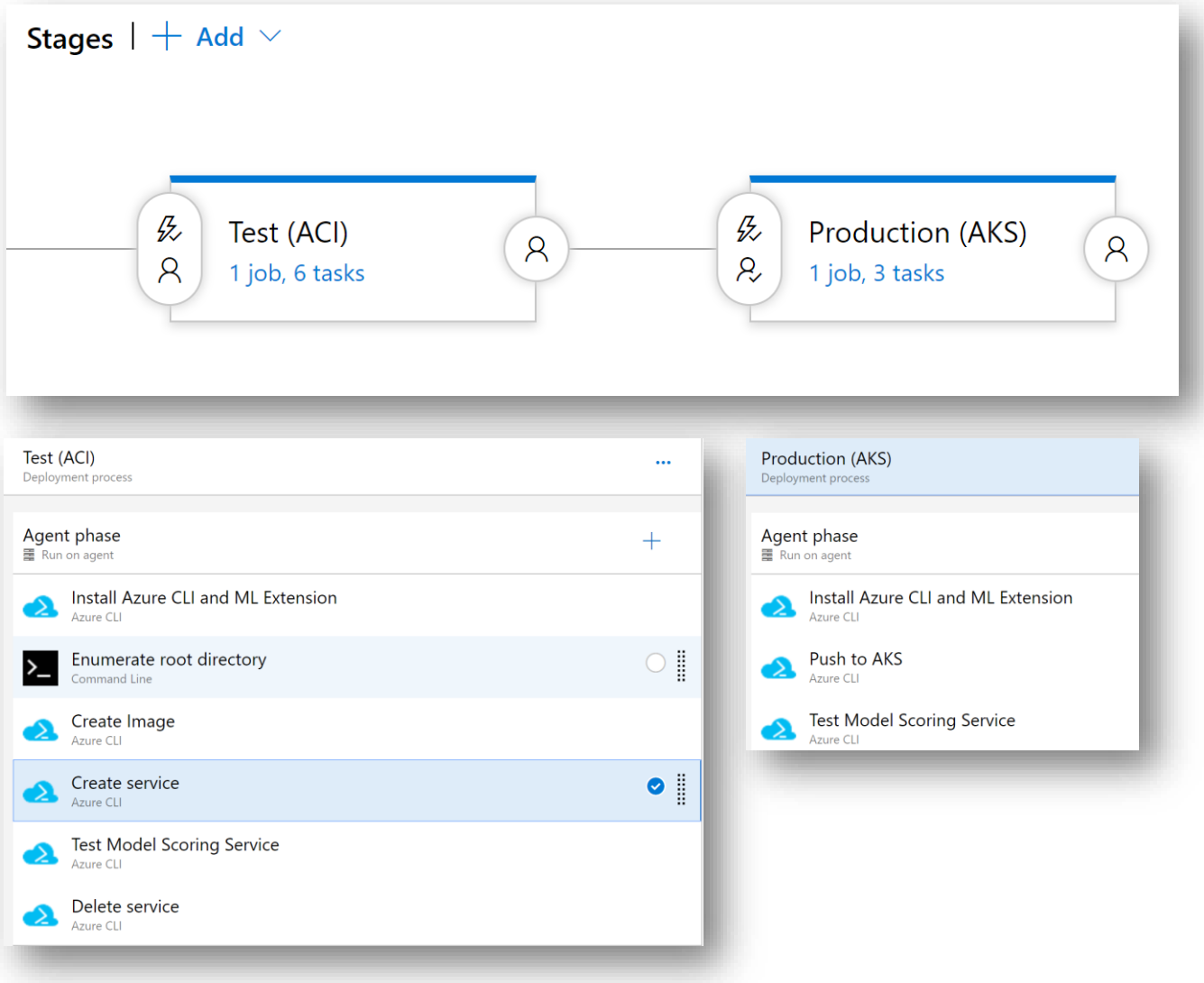


Model Deployment

CD pipeline captures

1. Package model (container image)
2. Validate & profile model
3. Deploy model to DevTest (ACI)
4. Validate & rollout to Prod (AKS)

Everything done via CLI



Key Takeaways

Better together: ML + DevOps mindset

DevOps for ML provides structure for building, deploying and managing and an enterprise-ready AI application lifecycle

MLOps enhances AI delivery

Adoption will increase the agility, quality and delivery of AI project teams.

More than technology

DevOps is a conversation about people, process and technology
AI principles and practices need to be understood by all roles