

# A DevOps process for deploying R to production

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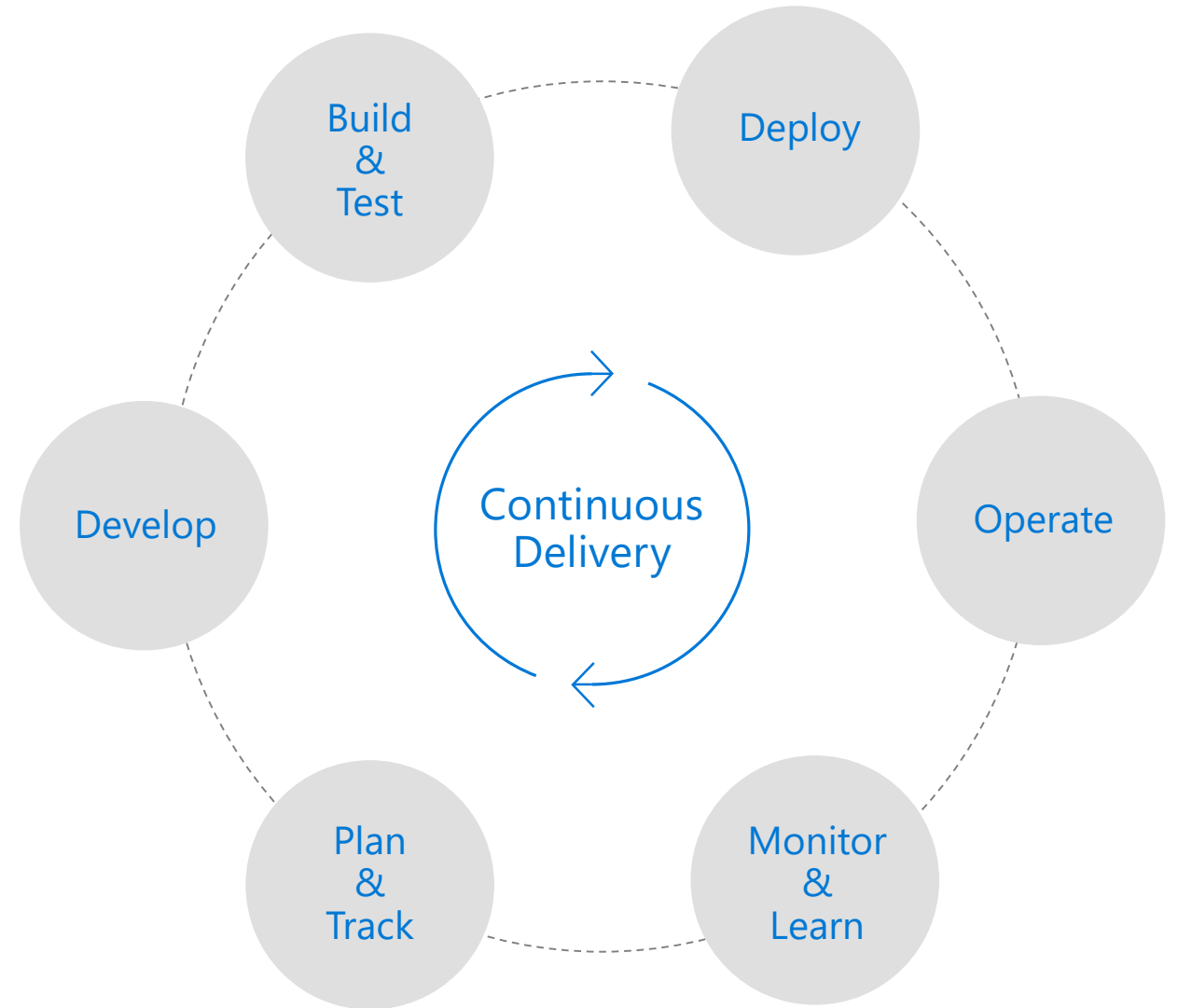
# What is DevOps?

People. Process. Products.

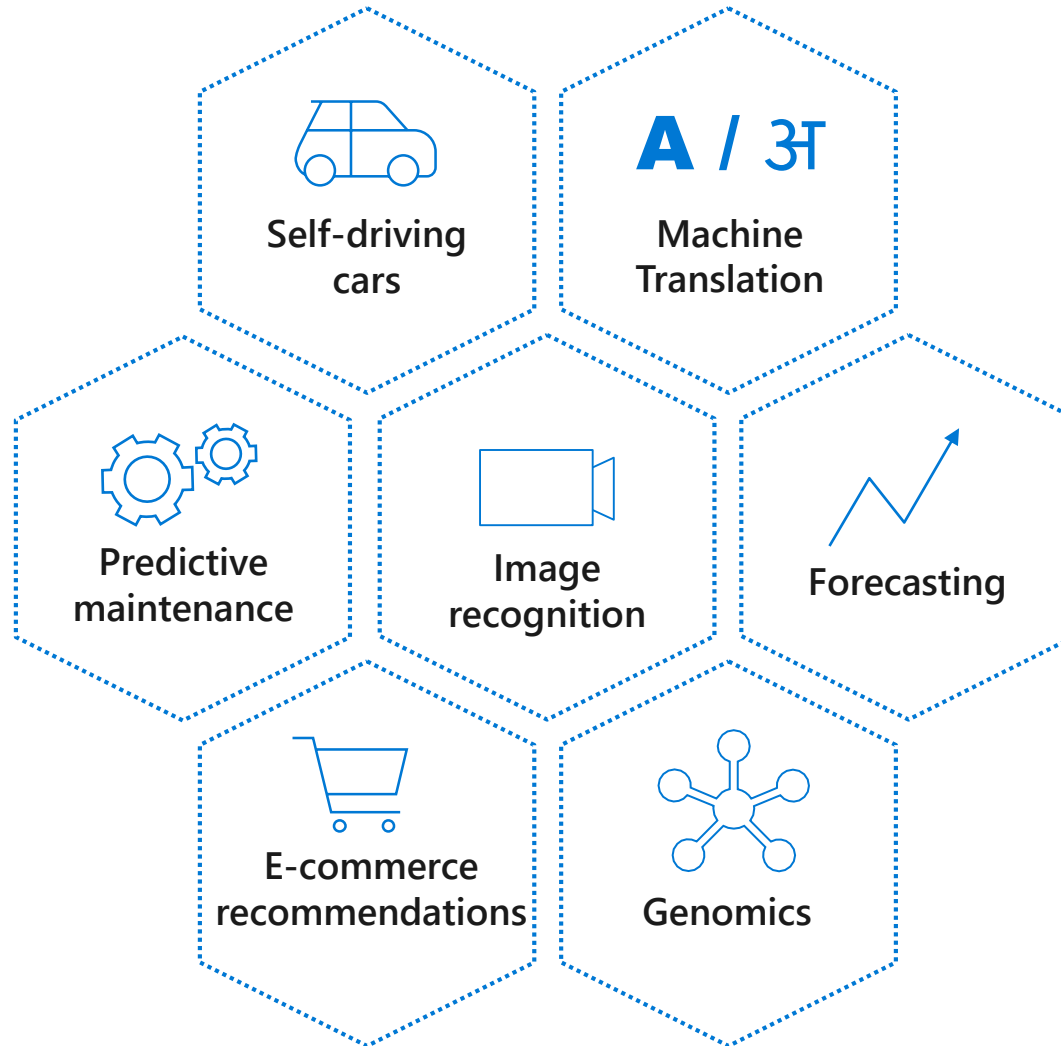


DevOps is the union of **people**, **process**, and **products** to enable continuous delivery of value to your end users. ”

Donovan Brown, Microsoft  
<http://bit.ly/WhatIs-DevOps>



# Machine Learning Applications



# Example: Automatic windscreen wipers



*"rain on windscreen" by [grace kat](#)*  
*licensed under [CC BY-SA 2.0](#)*

# Special considerations for MLOps

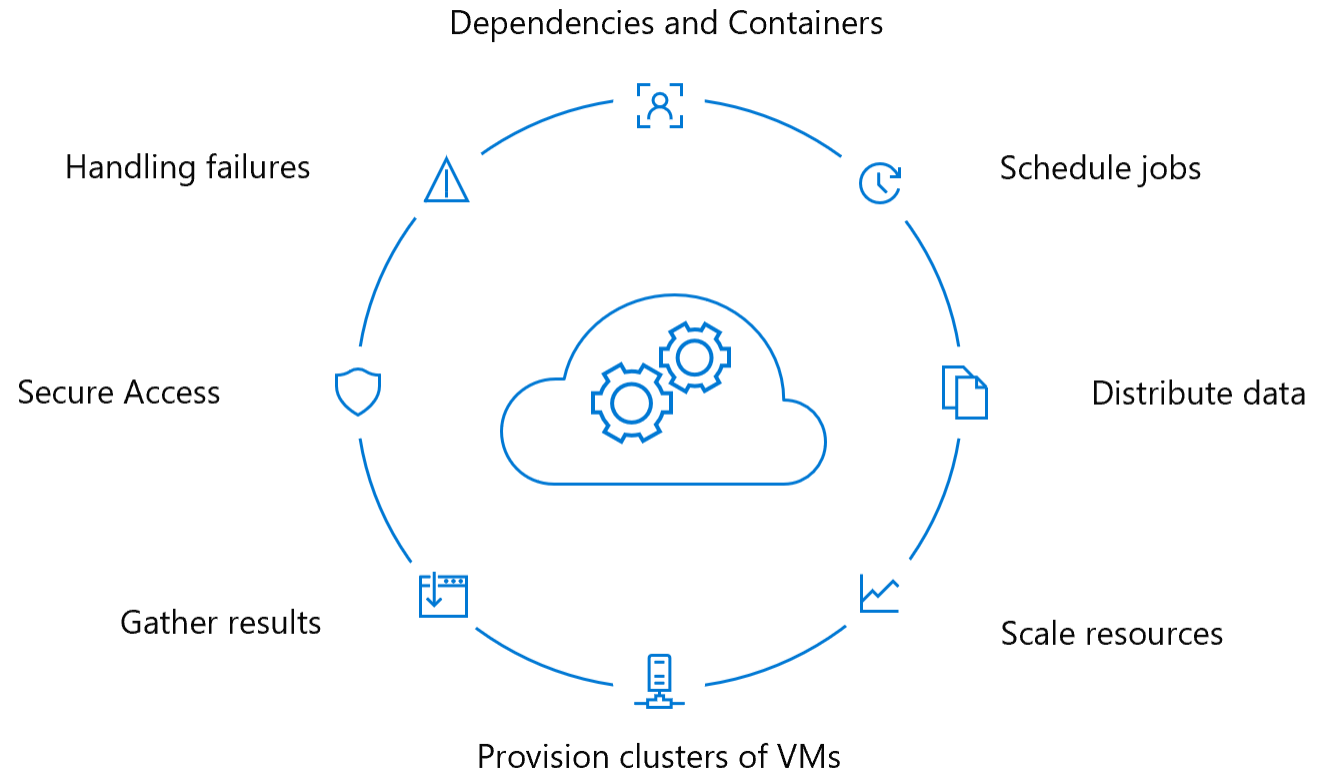
**People:** Data Scientists, ML Engineers

**Process:**

- Data as Code
- Model Lifecycle
- Tests
- Deployed APIs

**Products:**

- Hardware: Storage, GPUs
- Software: Datastores, Analytics Tools (R, Python, Tensorflow...)



# Azure Pipelines

Cloud-hosted pipelines for Linux, Windows and macOS, with unlimited minutes for open source



## 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.

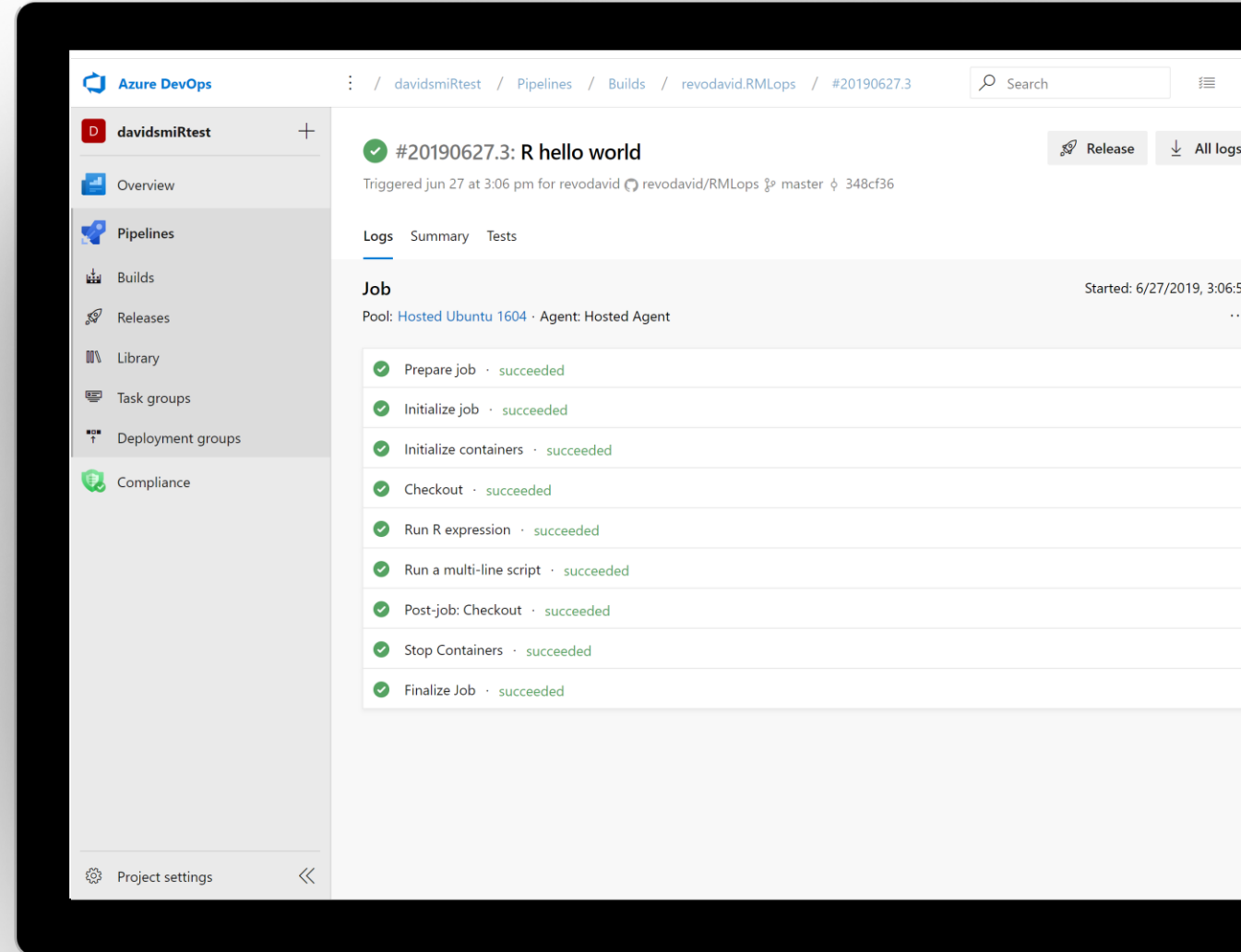


## Best-in-class for open source

Ensure fast continuous integration/continuous delivery (CI/CD) pipelines for every open source project. Get unlimited build minutes for all open source projects with up to 10 free parallel jobs across Linux, macOS and Windows



<https://azure.com/pipelines>



# Training R Models with Azure Pipelines

In Github Repo:

[github.com/revodavid/RMLOps](https://github.com/revodavid/RMLOps)

Data files

R scripts

YAML Pipeline specification

Status Badge



In Azure Pipelines:

[dev.azure.com/  
davidsmi0786/davidsmiRtest](https://dev.azure.com/davidsmi0786/davidsmiRtest)

Triggers

Build pipeline(s)

Release pipeline(s)

# Azure Pipelines: Process

Create Azure Pipeline with Github repository

Link RStudio project to Github repository

Develop R code as R script files as usual

Add steps to azure-pipelines.yml with Rscript commands

Check in updates to trigger builds

Branch: master ▼

[RMLops](#) / azure-pipelines.yml

```
9   pool:
10     vmImage: 'ubuntu-16.04'
11
12   container: 'rocker/r-ver:3.6.0'

14   steps:
15   - script: Rscript -e 'R.version'
16     displayName: 'Confirm R version'
17
18   - script: Rscript train-model.R
19     displayName: 'Train model'

6   trigger:
7     - master
```





# Containers and Azure Pipelines

Specify a container with your desired R version, packages, and any other software needed.

Container images can be hosted anywhere

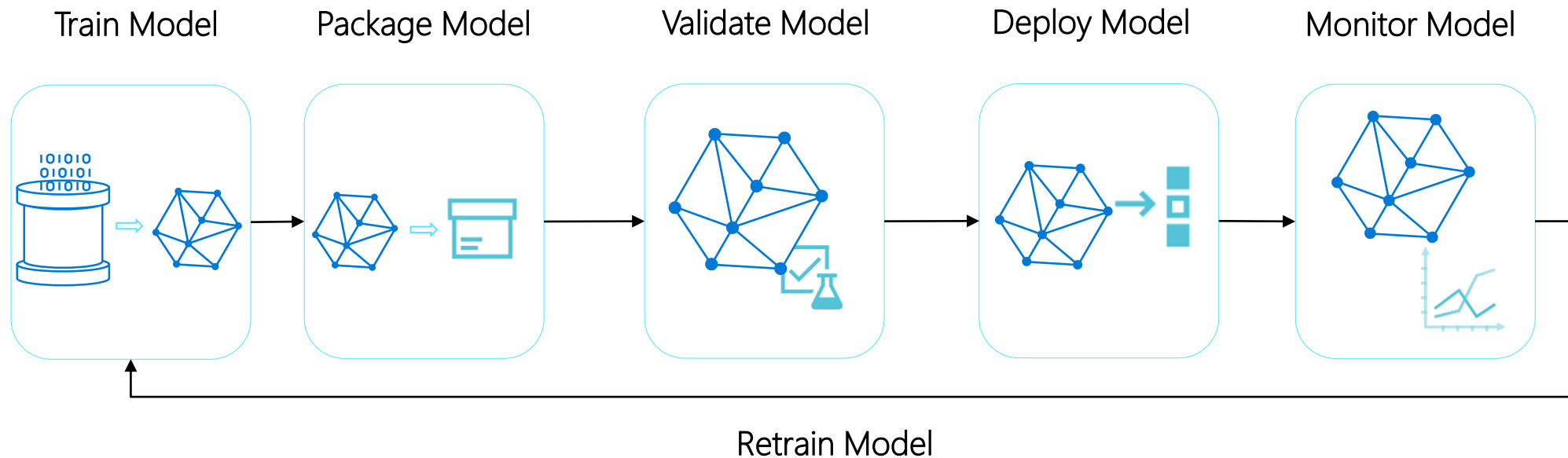
- Docker Hub, your own container registry, Azure Container Registry ...

**Tip 1:** The “Rocker” project provides pre-defined R containers for training:  
<https://www.rocker-project.org/>

**Tip 2:** You can also deploy with containers using the AzureContainers package:  
<https://blog.revolutionanalytics.com/2018/12/azurecontainers.html>

# The End-to-End Machine Learning Model Lifecycle

- **Develop & train model** with reusable ML pipelines
- **Package model** using containers to capture runtime dependencies for inference
- **Validate model behavior**—functionally, in terms of responsiveness, in terms of regulatory compliance
- **Deploy model**—to cloud & edge, for use in real-time/streaming/batch processing
- **Monitor model** behavior & business value, know **when to replace/deprecate a stale model**



# What is Azure Machine Learning service?

Set of Azure  
Cloud Services



Python  
SDK

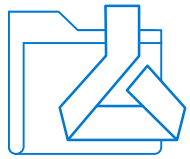
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That enables  
you to:

- ✓ Prepare Data
- ✓ Build Models
- ✓ Train Models

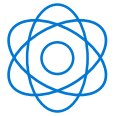
- ✓ Manage Models
- ✓ Track Experiments
- ✓ Deploy Models

# Azure Machine Learning Service



Workspace

Use any tool and language



Experiments

Share compute resources



Models

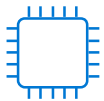


Pipelines

Register versioned models



Images



Compute Target

Containerized deployments



Deployments



Data Stores

Monitor performance

# Coming Soon: Azure ML Service R SDK

The screenshot displays the RStudio IDE interface with the Azure ML Service R SDK code in the editor and its documentation in the viewer pane.

**Source Editor:**

```
25 workspace_name <- "mlops"
26 resource_group <- "user19demo"
27 location <- "eastus2"
28
29 ws <- get_workspace(name = workspace_name,
30                     subscription_id = subscription_id,
31                     resource_group = resource_group)
32
33 experiment_name <- "train-r-script-on-remote-vm"
34 exp <- get_or_create_experiment(ws, experiment_name)
35
36 ds <- get_default_datastore(ws)
37
38 target_path <- "modeldata"
39 upload_files_to_azure_datastore(ds, c("./datafile.csv"),
40                                 target_path = target_path, overwrite = TRUE)
41
42 dr <- create_data_reference_configuration(ds$name, path_on_datastore = target_path, ove
43
44
45 # define script run config
46 data_reference <- create_data_reference(ds)
47 arguments <- c("--data_folder", get_data_reference_path_in_compute(data_reference))
48
49 src <- create_script_run_config(source_directory = ".", script="train.R",
50                                arguments = arguments, target = "dmsopserver",
51                                data_reference_configuration = dr)
52
53
```

**Environment Pane:**

Object	Value
ds	<azureml.data.azure_storage_d...
exp	Experiment(Name: train-r-scri...
src	<azureml.core.script_run_conf...
ws	Workspace.create(name='mlops'...

**Values:**

Variable	Value
arguments	chr [1:2] "--data_folder" "\$AZU...
experiment_...	"train-r-script-on-remote-vm"
location	"eastus2"
resource_gr...	"user19demo"
subscription...	"4080037c-d995-46ca-9e70-724ebd..."

**Viewer Pane:**

R: Get an existing workspace

## Get an existing workspace

**Description**

Get an existing workspace

Return a workspace object for an existing Azure Machine Learning Workspace.

**Usage**

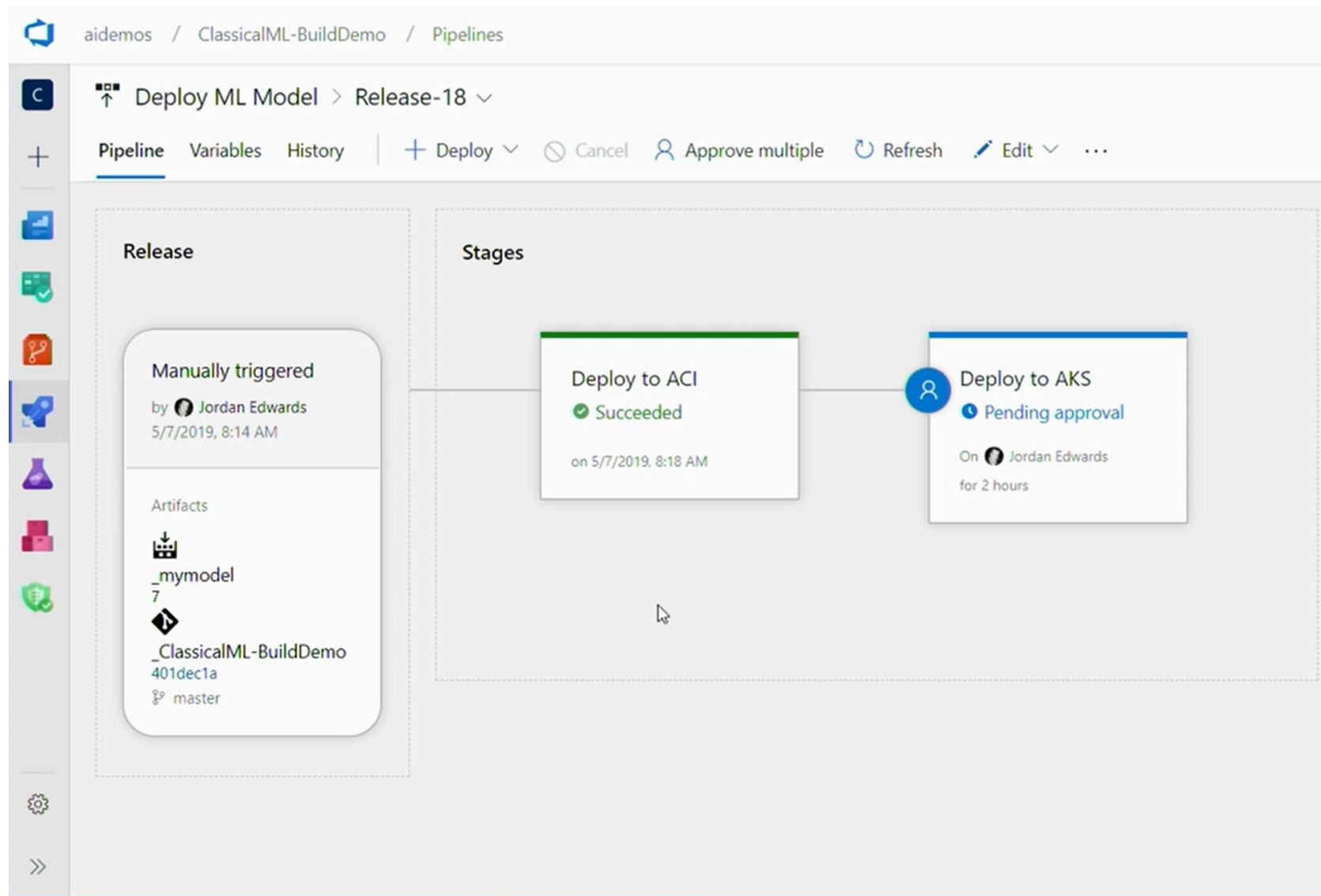
```
get_workspace(name, subscription_id = NULL, reso
get_workspace(name, subscription_id = NULL, reso
```

**Arguments**

Argument	Description
name	The workspace name to get.

# Pipelines with Azure MLOPS extension

Trigger builds/releases on model registration in Azure ML Services



The screenshot displays the Azure DevOps Pipelines interface for a release named "Release-18". The breadcrumb navigation at the top shows the path: aidemos / ClassicalML-BuildDemo / Pipelines. The main header indicates the release is triggered by "Deploy ML Model" and is currently in the "Release-18" state. Below the header, there are tabs for "Pipeline", "Variables", and "History", along with action buttons: "Deploy", "Cancel", "Approve multiple", "Refresh", "Edit", and a menu icon.

The interface is divided into two main sections: "Release" and "Stages".

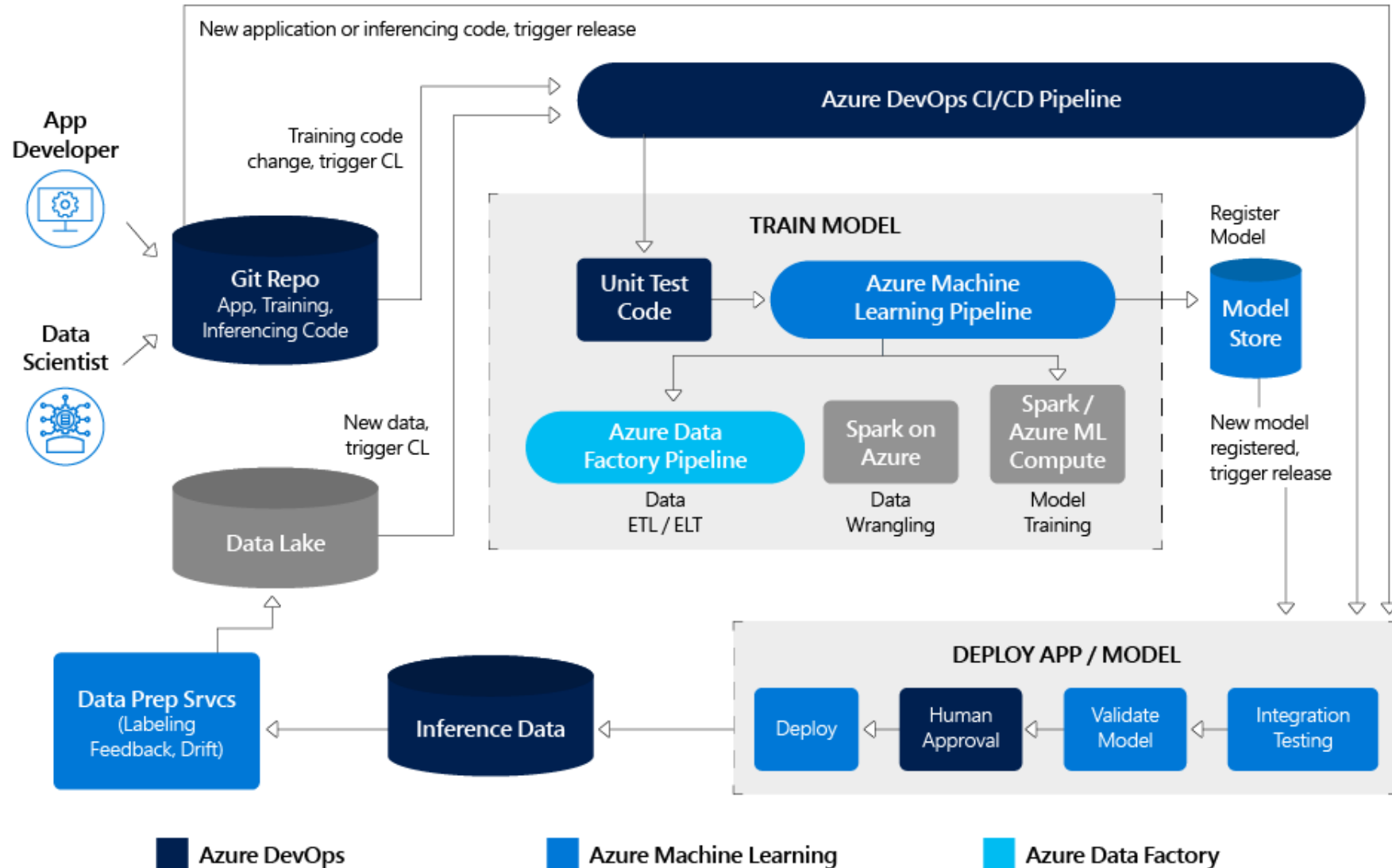
**Release Section:**

- Manually triggered:** Triggered by Jordan Edwards on 5/7/2019, 8:14 AM.
- Artifacts:** A list of artifacts including "\_mymodel" (version 7) and "\_ClassicalML-BuildDemo" (version 401dec1a) on the "master" branch.

**Stages Section:**

- Deploy to ACI:** Status is "Succeeded" (indicated by a green checkmark). It was completed on 5/7/2019, 8:18 AM.
- Deploy to AKS:** Status is "Pending approval" (indicated by a blue clock icon). It is currently on hold by Jordan Edwards for 2 hours.

# Complete MLOPS workflow







# Azure Pipelines

Free **unlimited** build minutes for public projects

Up to 10 free parallel jobs across Windows, Linux and macOS

 <https://azure.com/pipelines>



# Azure ML Service

**Free** workspaces, experiments, model registry

Standard Azure rates for compute and deployment **or** use your own servers for free

 <https://azure.com/ml>

# Resources

## Integrating the Data Science and App Development Cycles

Francesca Lazzeri, Microsoft

Medium: <https://aka.ms/AA5ib6c>

## MLOps: Manage, deploy, and monitor models with Azure Machine Learning Service

Microsoft Docs: <https://aka.ms/AA5kjqq>

## Train and deploy machine learning models with Azure Pipelines

Microsoft Docs: <https://aka.ms/AA5kjqq>

## Operationalizing R models using Python via Azure ML SDK

George Iordanescu, Microsoft

<https://github.com/Microsoft/AMLSDKRModelsOperationalization>

## These Slides

<https://github.com/revodavid/RMLops/user2019slides.pdf>

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# Thank you

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