AI & Machine Learning

Implementing MLOps practices with Amazon SageMaker

Shelbee Eigenbrode
AI/ML Specialist Solutions Architect

Agenda

300 Level

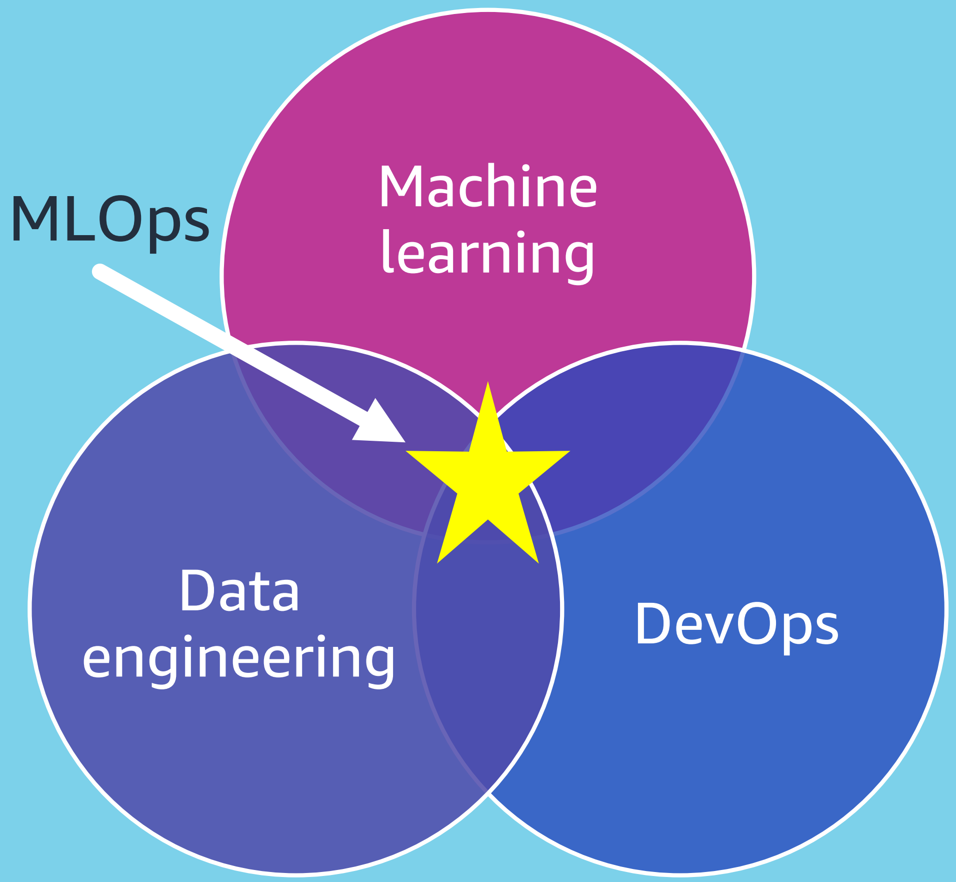
- MLOps: Setting the stage
- SageMaker MLOps-ready capabilities
- SageMaker Pipelines
- Wrap-up

MLOps: Setting the stage

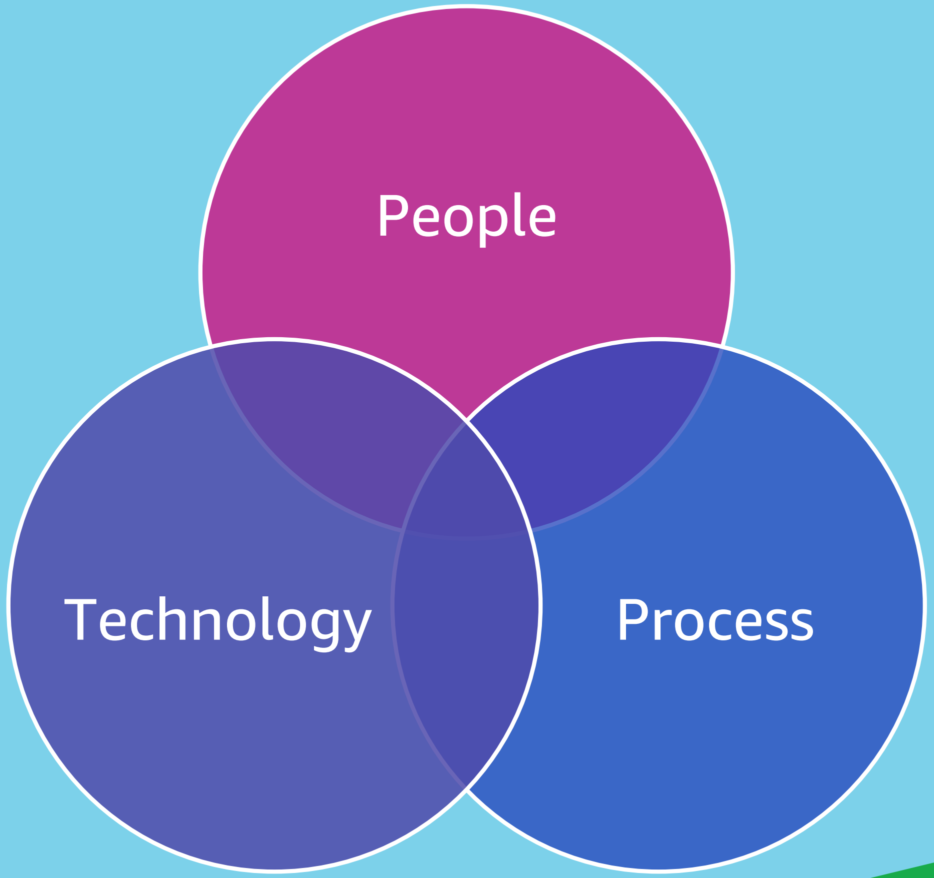
MLOps: High-level view

Intersection of Domains with Enabling Practices

Domains



MLOps practices



MLOps: High-level view

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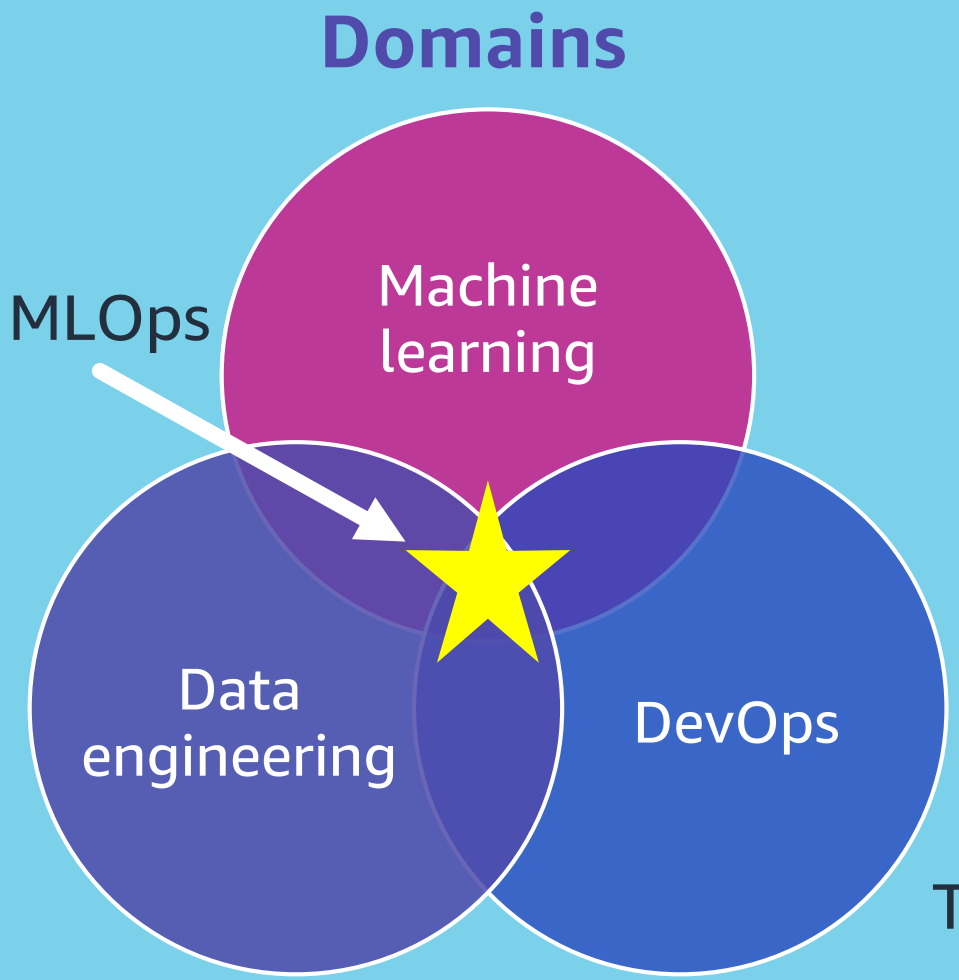

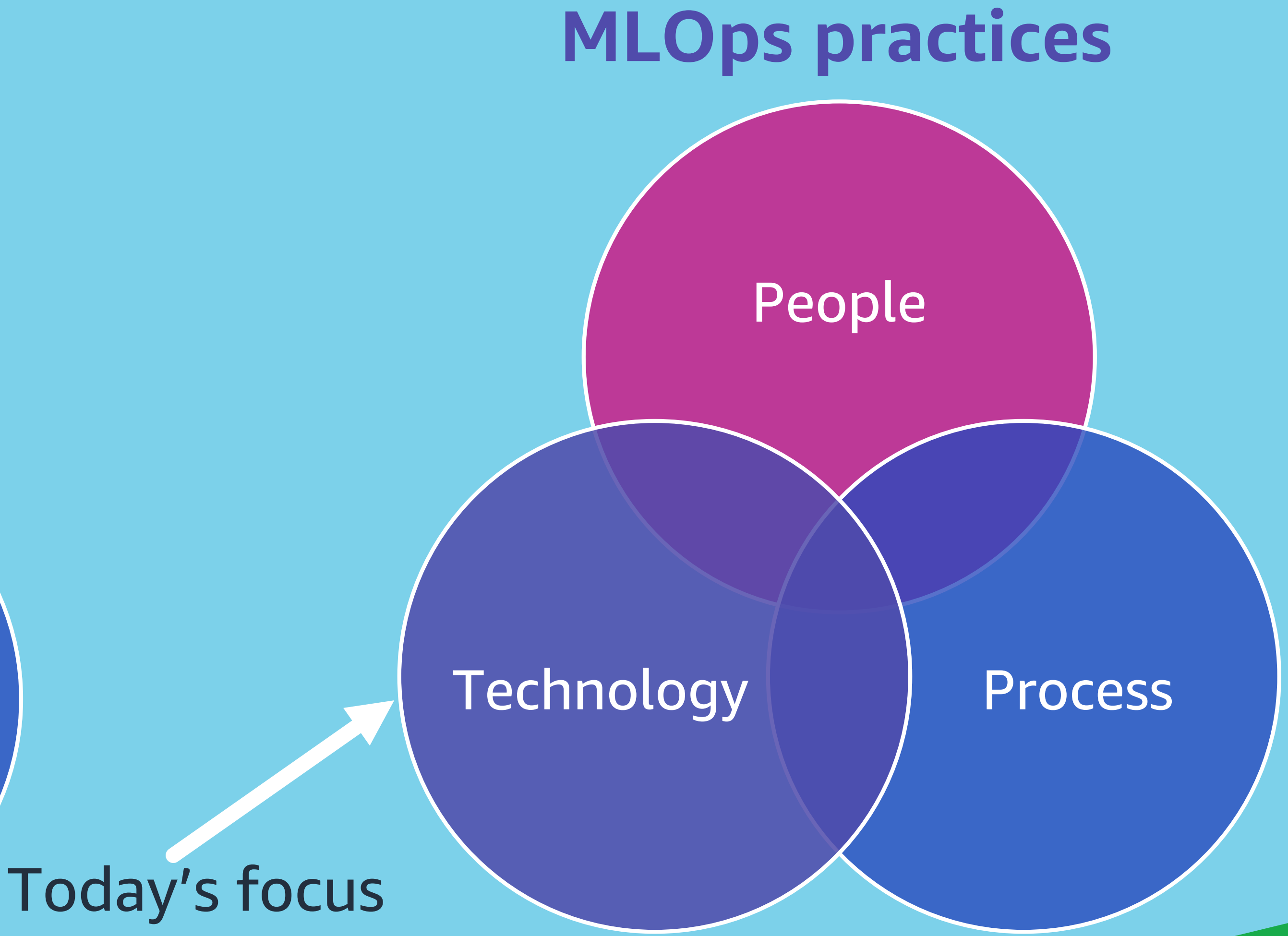

MLOps: The golden pipeline

While the technical implementation can vary, the core practices remain the same.

Machine learning pipelines

Technical Implementations: Services & Tooling

Purpose-built services for **automating machine learning tasks**

+

Purpose-built services for incorporating **everything-as-code** and **CI/CD practices**

Machine learning pipelines

Technical Implementations: Services & Tooling

Purpose-built services for **automating machine learning tasks**

AWS-native examples:

- Amazon SageMaker Pipelines
- Amazon Managed Workflows for Apache Airflow (Amazon MWAA)
- AWS Step Functions

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Purpose-built services for incorporating **everything-as-code** and **CI/CD practices**

Machine learning pipelines

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Amazon SageMaker Projects {

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Machine learning pipelines

Technical Implementations: Services & Tooling

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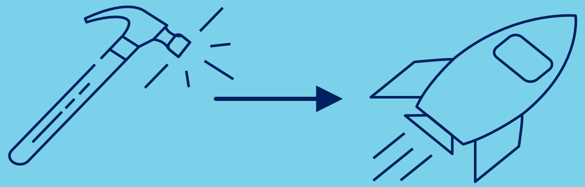

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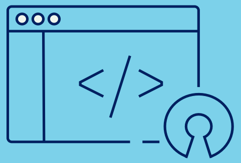

AWS-native examples:

Amazon SageMaker Projects

AWS CodeBuild

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Do-it-yourself, 3rd Party & Open Source

Machine learning pipelines

Technical Implementations: Services & Tooling

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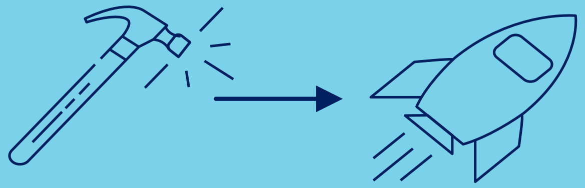

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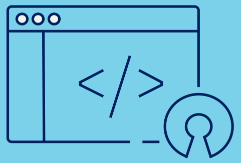

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Do-it-yourself, 3rd Party & Open Source

SageMaker MLOps-Ready Capabilities

MLOps: Core practices & benefits

Common challenges

Enabling innovation while balancing governance needs

MLOps practice

Everything as Code (DevOps)

Benefit

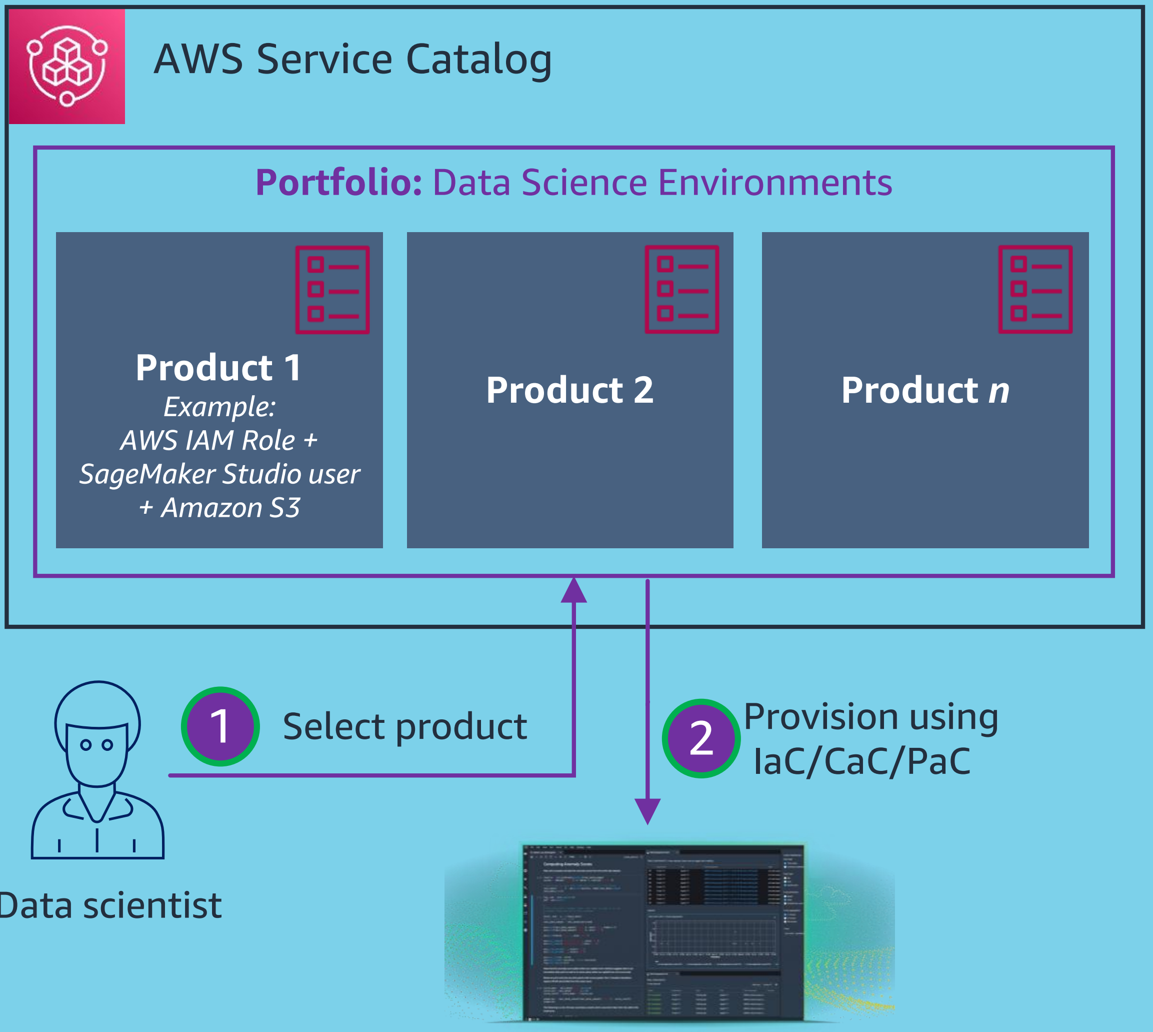
Self-service governed data science environments

Solution

AWS Service Catalog

Data science environments

Challenge: Enabling innovation while balancing governance needs



AWS Service Catalog

Portfolio: Data Science Environments

Product 1
Example:
AWS IAM Role +
SageMaker Studio user
+ Amazon S3

Product 2

Product *n*

1 Select product

2 Provision using IaC/CaC/PaC

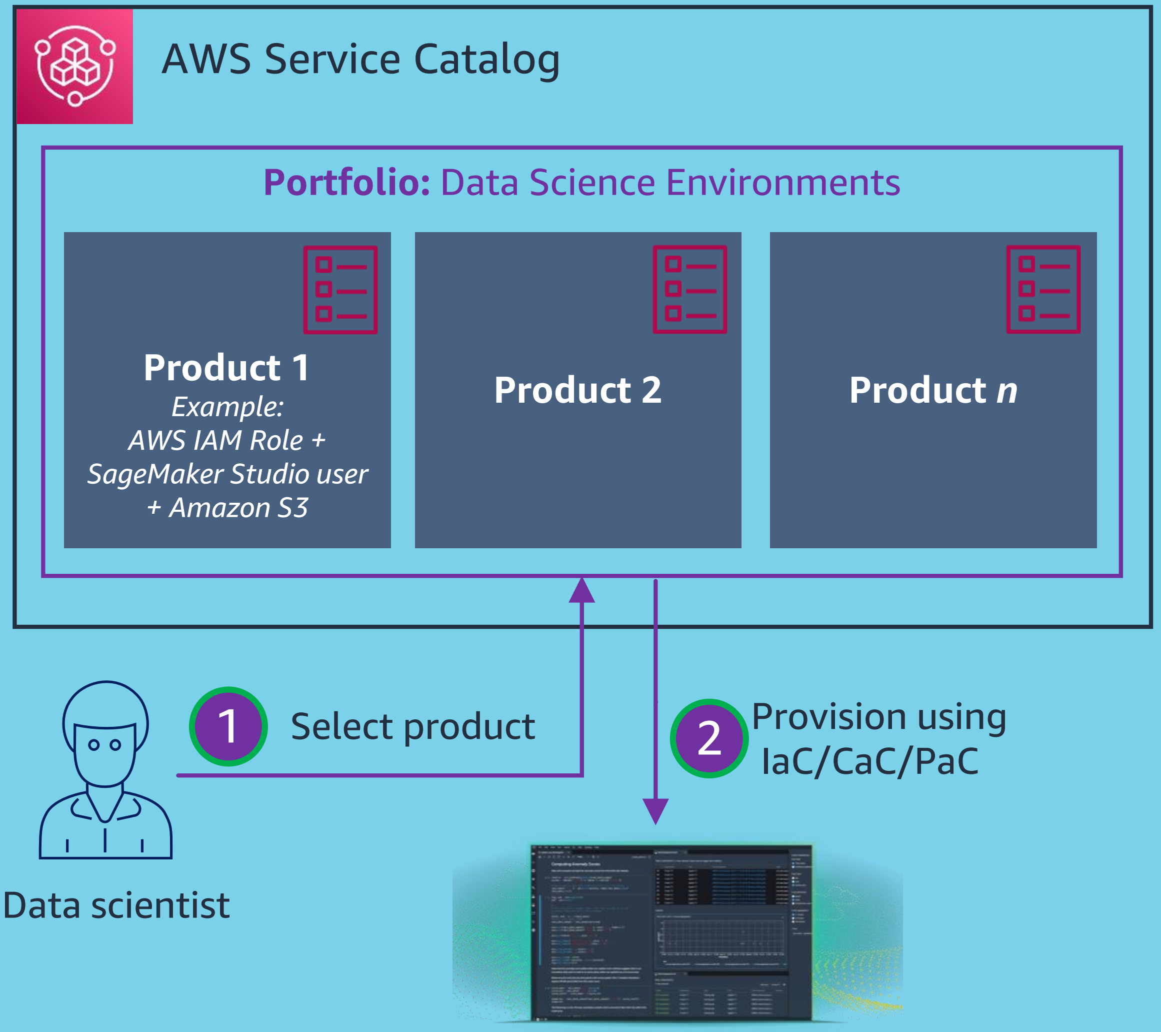
Data scientist

Solution

Utilize AWS Service Catalog to provision environments using infrastructure, configuration, or policy as code

Data science environments

Challenge: Enabling innovation while balancing governance needs



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Utilize AWS Service Catalog to provision environments using infrastructure, configuration, or policy as code

Benefits:

- Ensure repeatability and consistency
- Standardize data science environments
- Implement guardrails via code

MLOps: Core practices & benefits

Common challenges

- Enabling innovation while balancing governance needs
- Bridging the gap between model build and model deploy tasks

MLOps practice

- Everything as Code (DevOps)
- Lineage tracking and configuration management

Benefit

- Self-service governed data science environments
- Repeatable process to create workflows across personas

Solution

- AWS Service Catalog
- Amazon SageMaker Model Registry

MLOps: Core practices & benefits

Common challenges		
Enabling innovation while balancing governance needs	Bridging the gap between model build and model deploy tasks	Providing end-to-end traceability
MLOps practice		
Everything as Code (DevOps)	Lineage tracking and configuration management	CI/CD
Benefit		
Self-service governed data science environments	Repeatable process to create workflows across personas	Auditable ML pipeline
Solution		
AWS Service Catalog	Amazon SageMaker Model Registry	Amazon SageMaker projects

MLOps: Core practices & benefits

Common challenges			
Enabling innovation while balancing governance needs	Bridging the gap between model build and model deploy tasks	Providing end-to-end traceability	Building a repeatable and consistent process for deploying models
MLOps practice			
Everything as Code (DevOps)	Lineage tracking and configuration management	CI/CD	Continuous delivery and deployment
Benefit			
Self-service governed data science environments	Repeatable process to create workflows across personas	Auditable ML pipeline	Improve time-to-market
Solution			
AWS Service Catalog	Amazon SageMaker Model Registry	Amazon SageMaker projects	Amazon SageMaker projects and Pipelines

MLOps: Core practices & benefits

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<tr><th colspan="5">Common challenges</th></tr>
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MLOps-ready features and capabilities

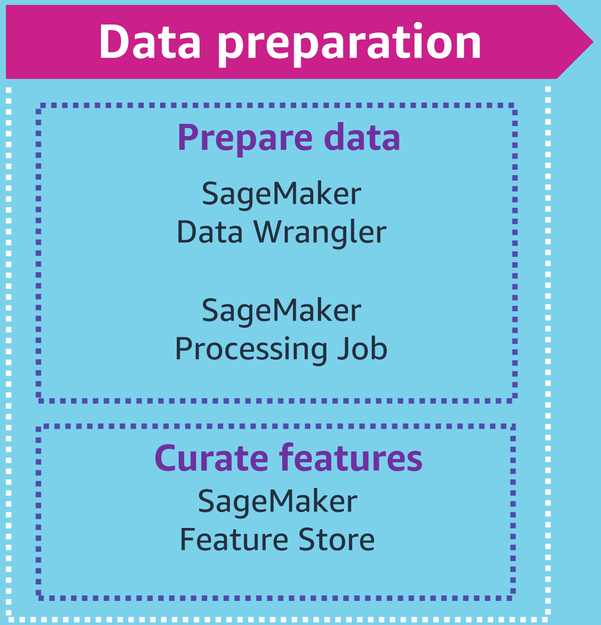
Data preparation

Prepare data

SageMaker
Data Wrangler

SageMaker
Processing Job

MLOps-ready features and capabilities



Data preparation

Prepare data

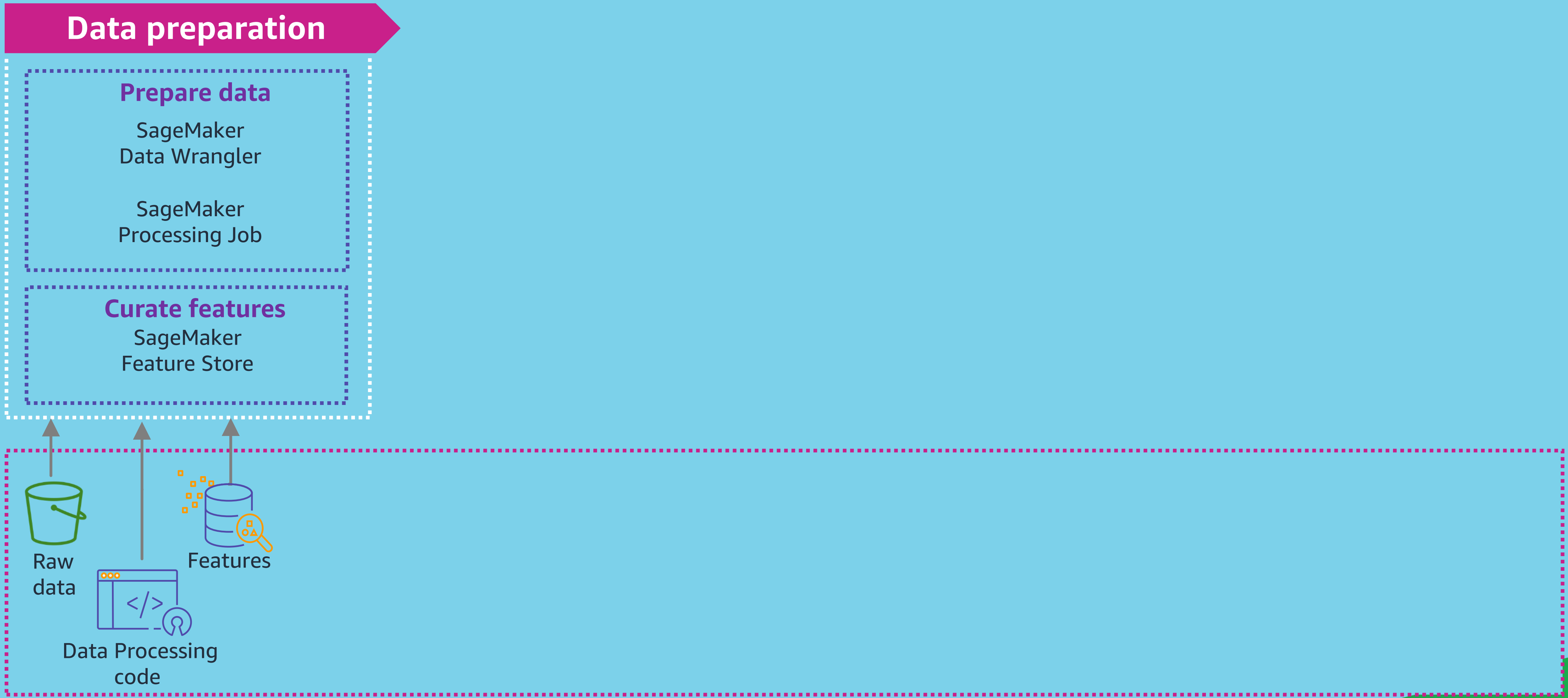
SageMaker Data Wrangler

SageMaker Processing Job

Curate features

SageMaker Feature Store

MLOps-ready features and capabilities



Data preparation

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Curate features

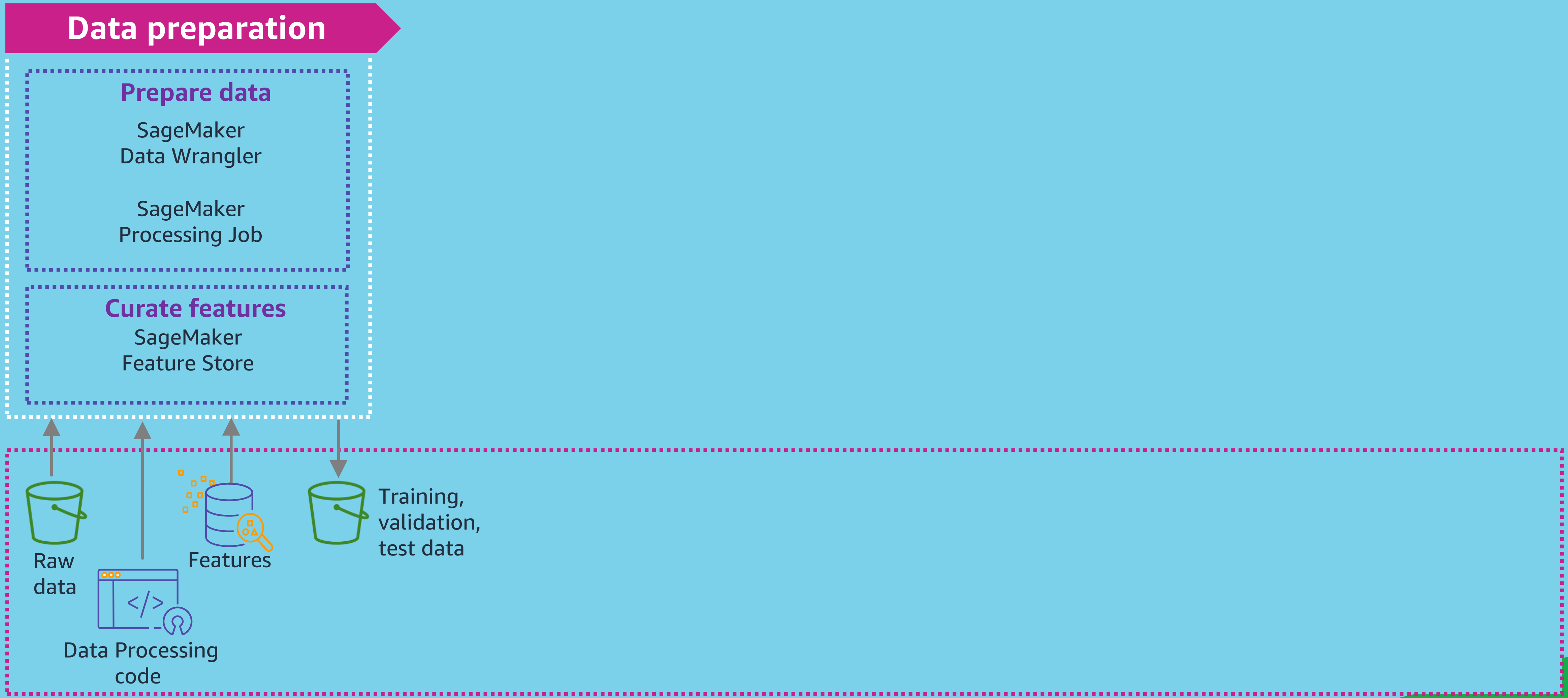
SageMaker
Feature Store

Raw data

Data Processing code

Features

MLOps-ready features and capabilities



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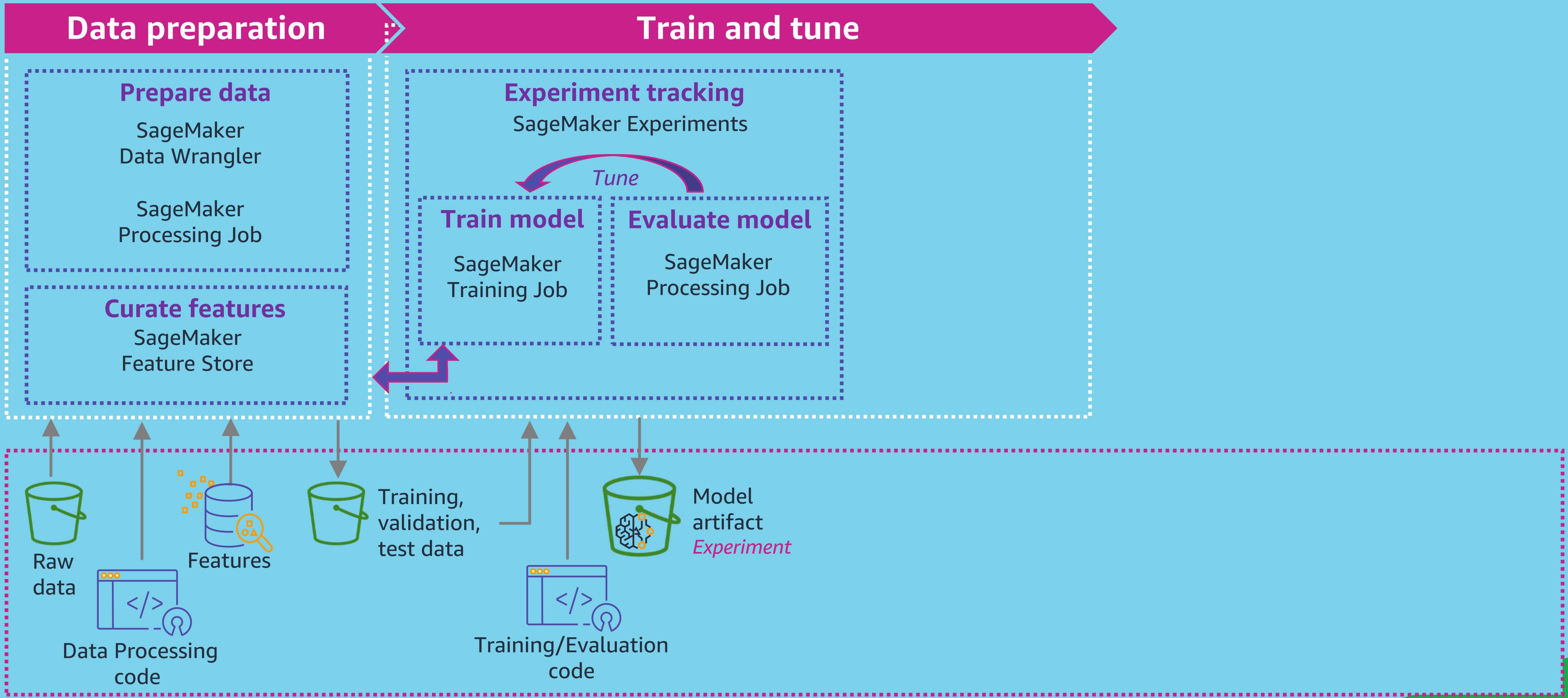

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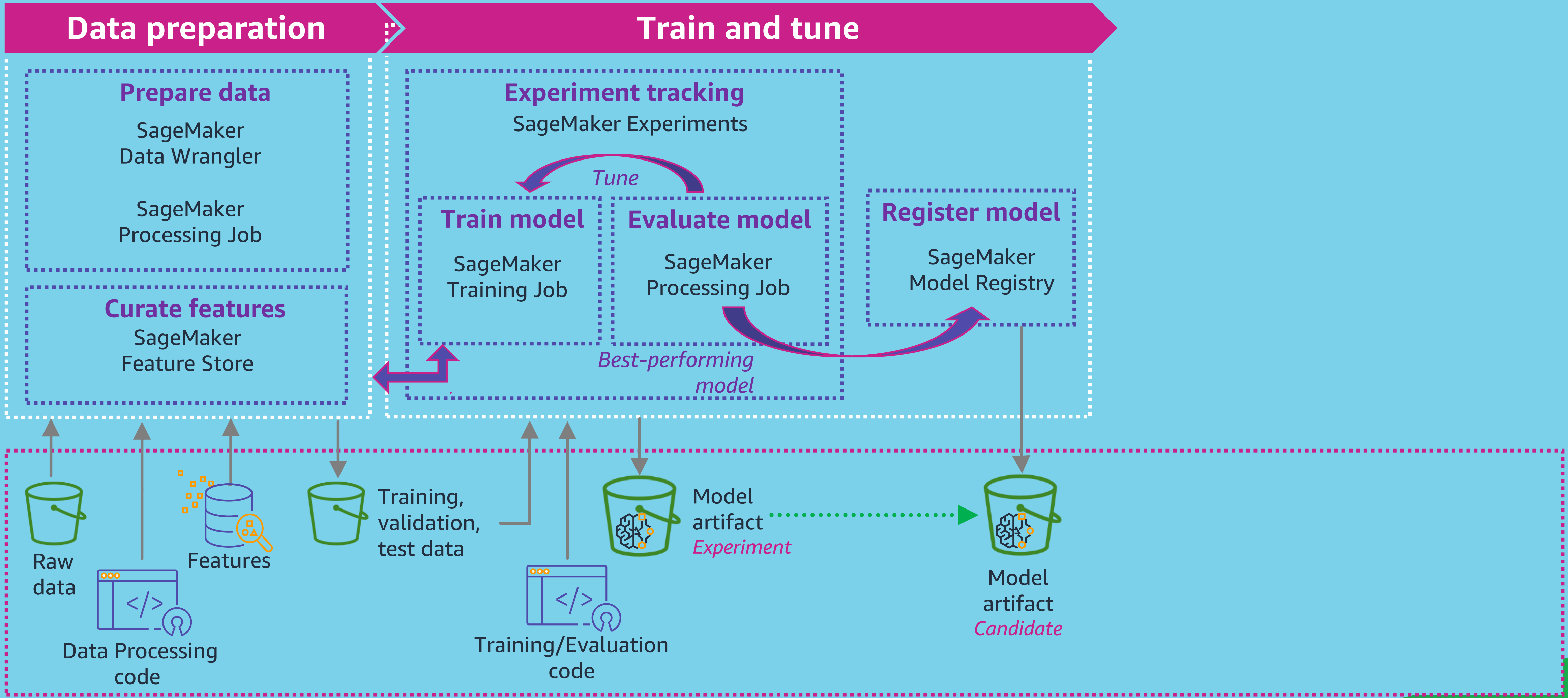


Data preparation

Train and tune

Prepare data

SageMaker Data Wrangler

SageMaker Processing Job

Curate features

SageMaker Feature Store

Experiment tracking

SageMaker Experiments

Tune

Train model

SageMaker Training Job

Evaluate model

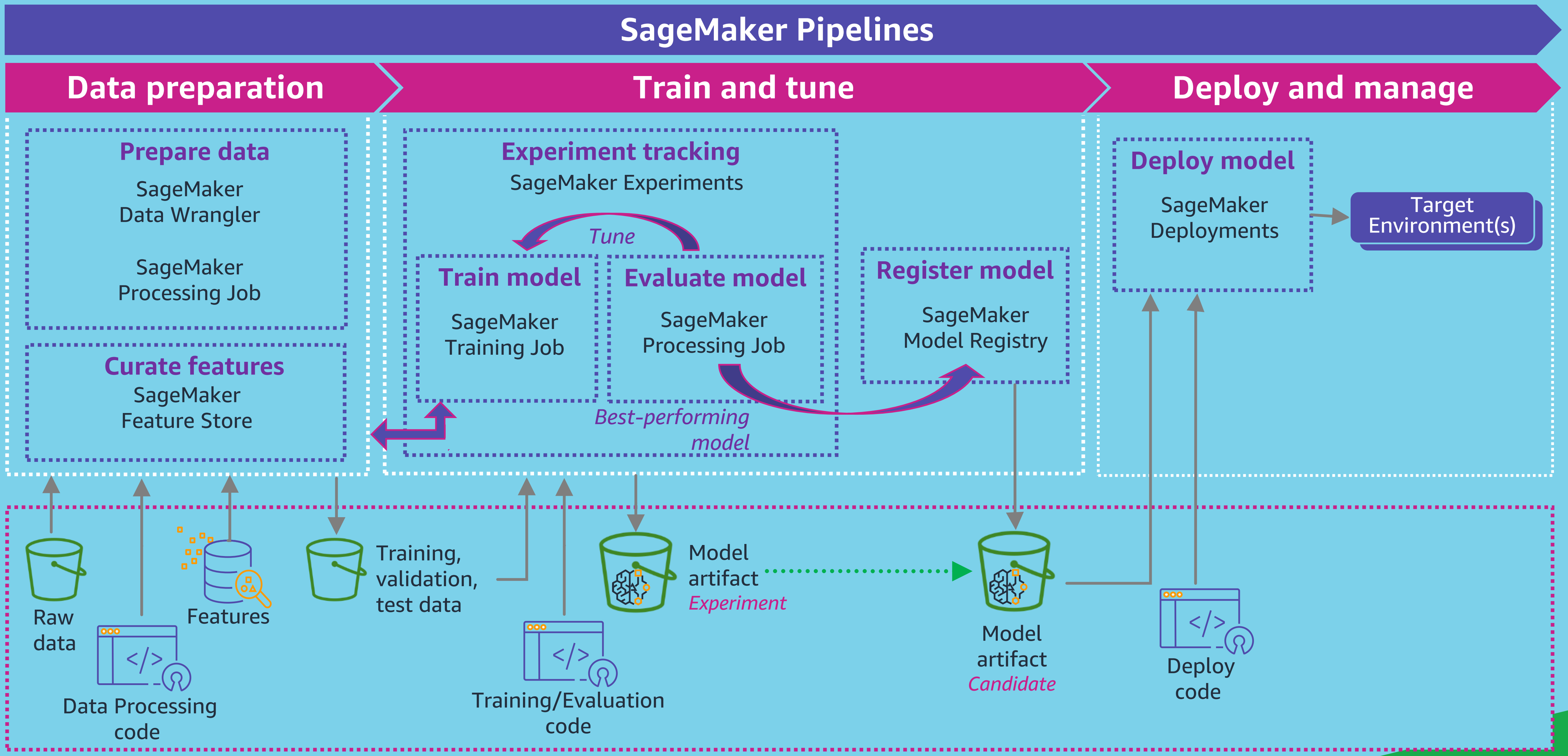
SageMaker Processing Job

Best-performing model

Register model

SageMaker Model Registry

MLOps-ready features and capabilities



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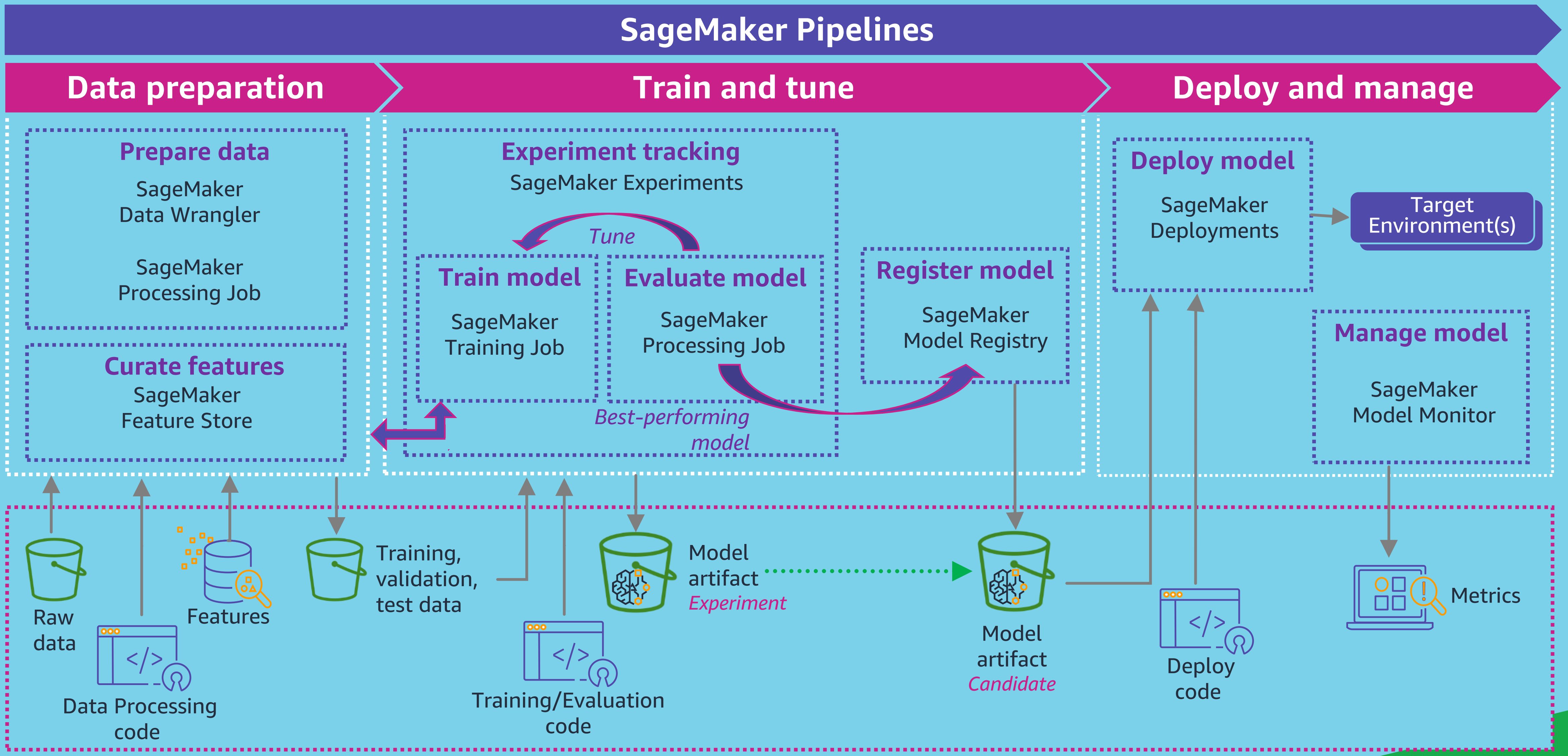


SageMaker Pipelines

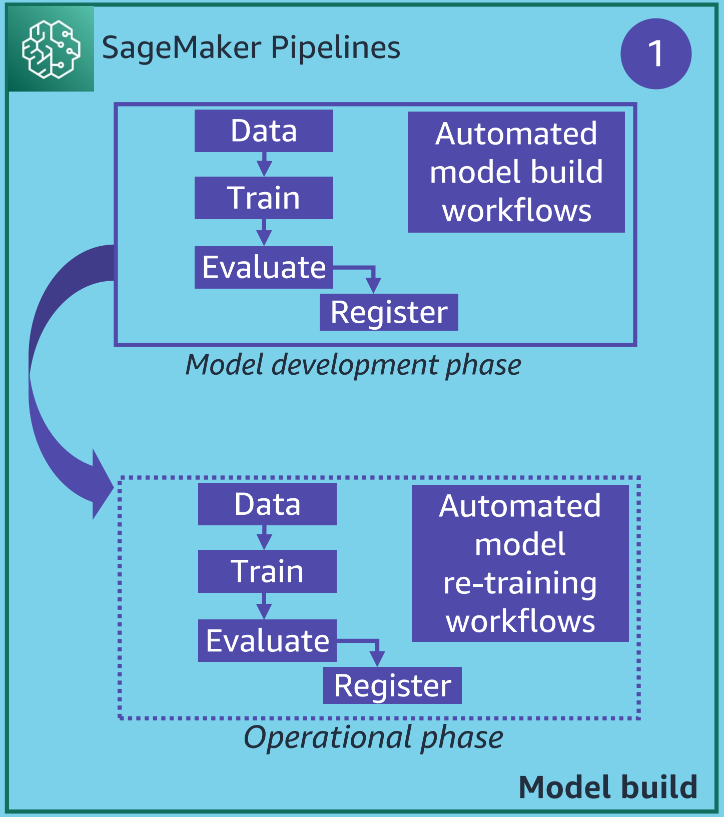
SageMaker Pipelines

Python SDK for quickly and easily building ML workflows

Catalog models to manage models at scale and trigger automated deployment workflows

Built-in support for CI/CD and end-to-end lineage tracking

SageMaker Pipelines: components



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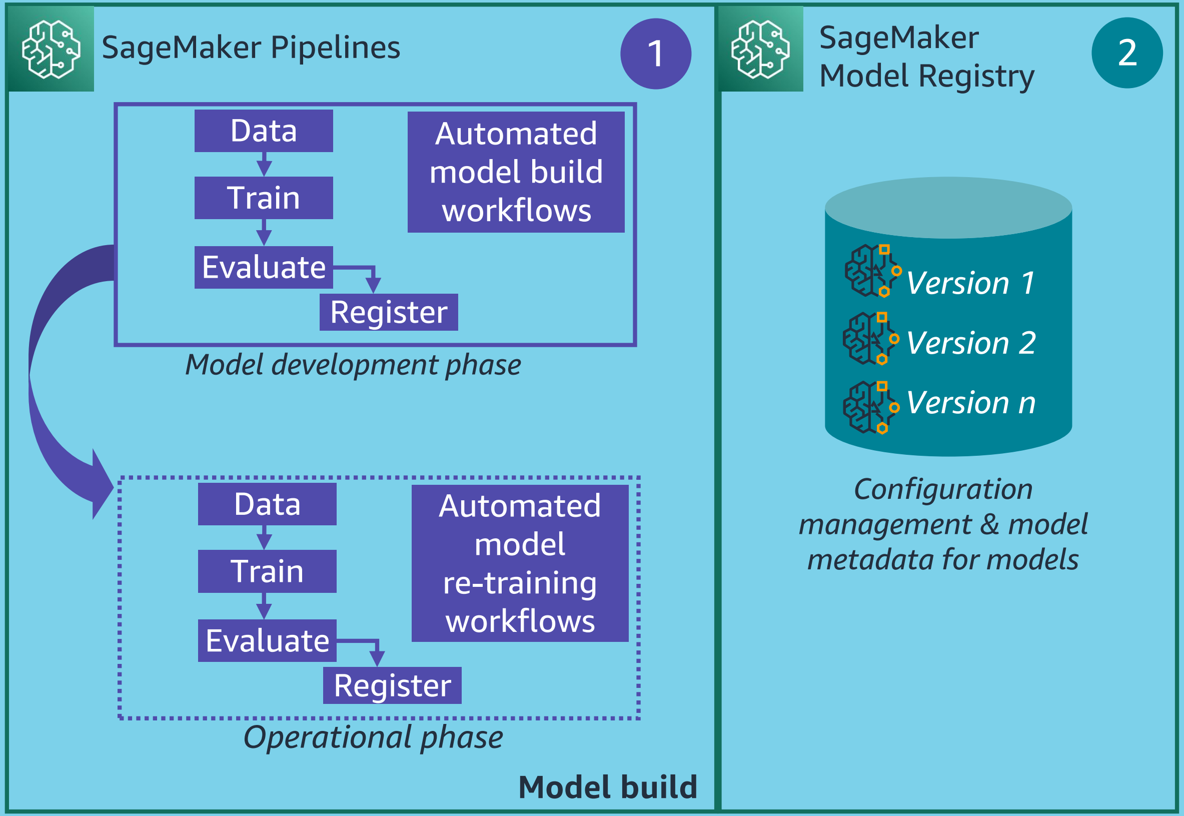

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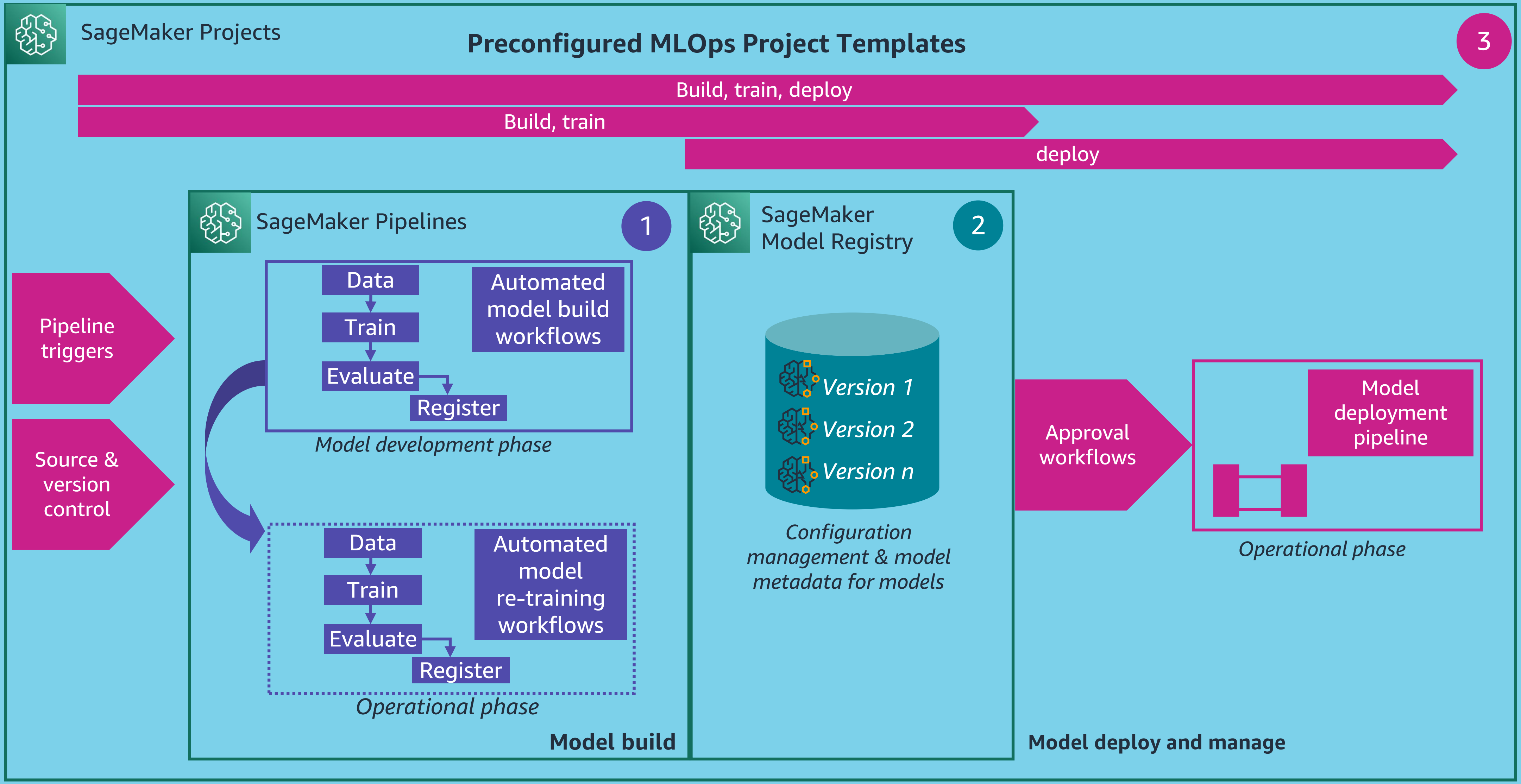
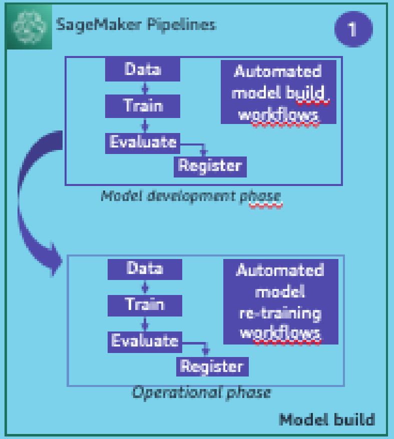


SageMaker Pipelines – Demo

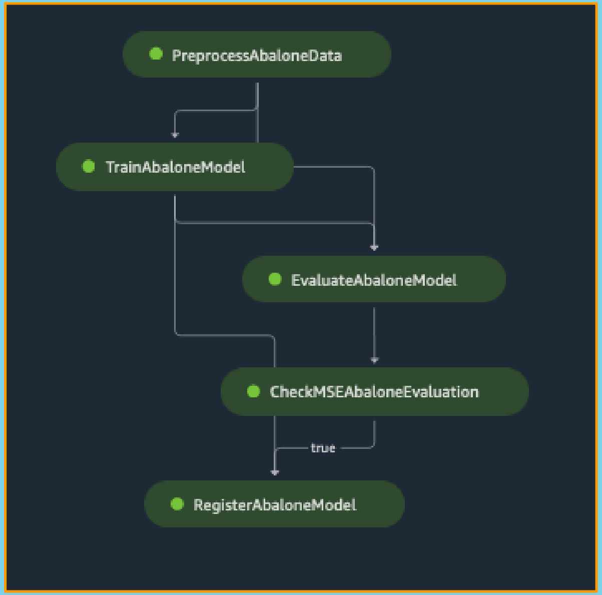
<<Insert Recorded Demo>>

SageMaker Pipelines: Model build pipelines

High Level Features



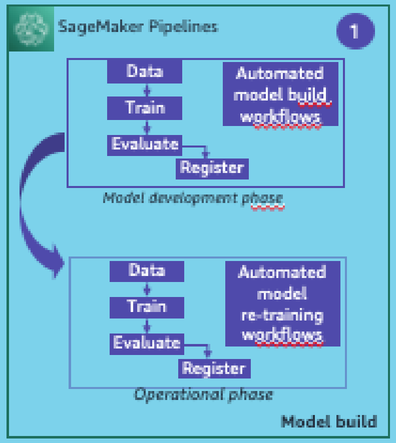
Built-in steps to support model build activities



- **SageMaker native:** Processing, Training, Tuning, Create Model, Register Model, Batch Transform, Clarify Check, Quality Check
- **AWS services:** Lambda, EMR
- **Extend to other AWS services & tasks using Callback step**
- **Conditional steps to assess next pipeline steps**

SageMaker Pipelines: Model build pipelines

High Level Features



Integration with SageMaker Experiments

Automatically track pipeline executions – no setup required!

Pipeline step retry policies

Retry failed steps in the pipeline without re-running the full pipeline

Step caching

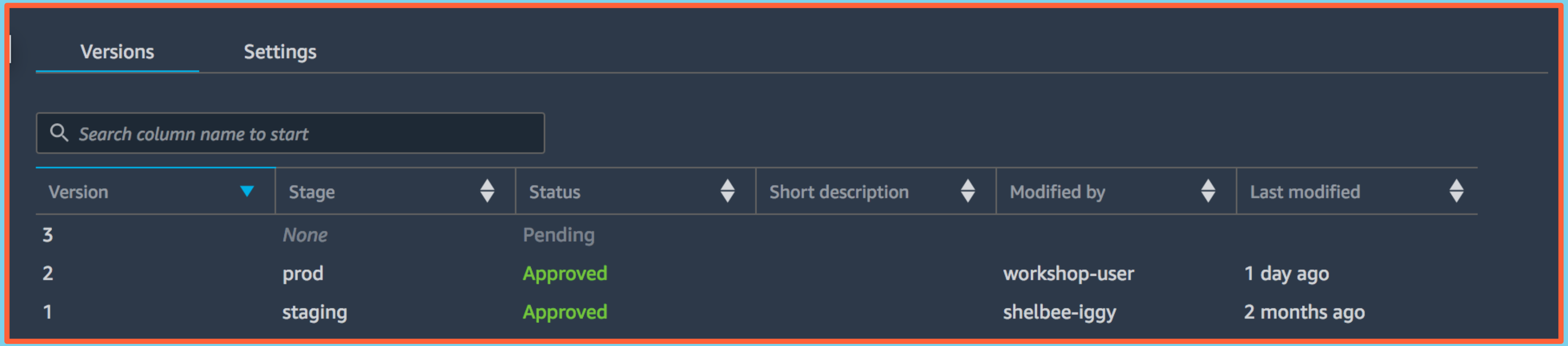
Enable step caching to avoid unnecessary runs of pipeline steps

Pipeline parameterization

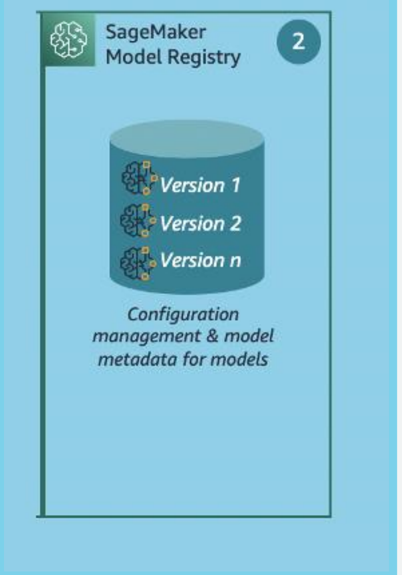
Use pipeline parameters to define configurations specific to a pipeline execution

SageMaker Pipelines: Model Registry

High Level Features



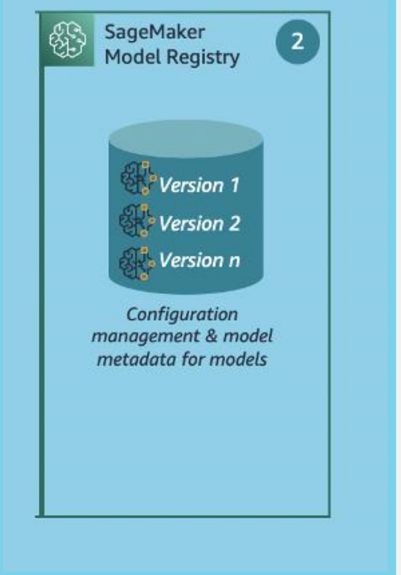
Version	Stage	Status	Short description	Modified by	Last modified
3	*None*	Pending			
2	prod	Approved		workshop-user	1 day ago
1	staging	Approved		shelbee-iggy	2 months ago

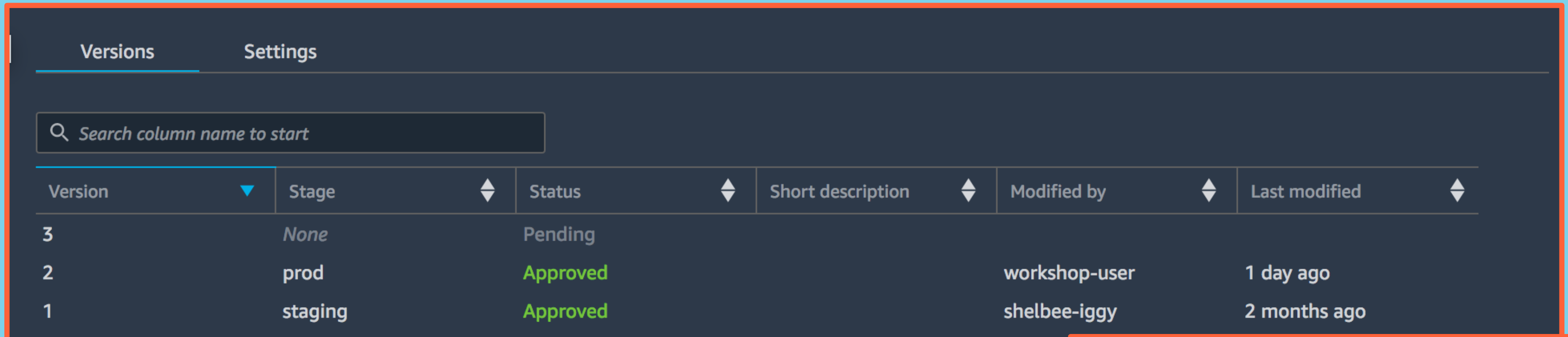


- Manage model versions & associated metadata
- Manage the approval status of a model
- Deploy models to production (with Projects)
- Support for cross-account model registration & deployments

SageMaker Pipelines: Model Registry

High Level Features





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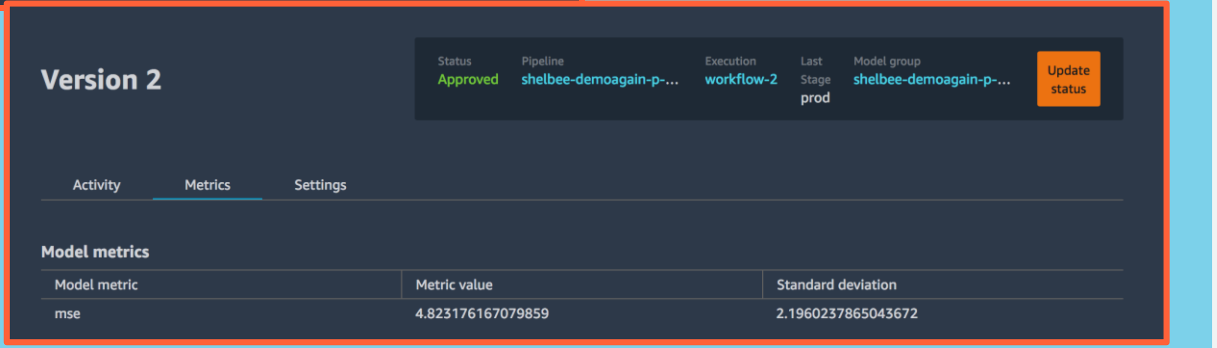

Version 2

Status: Approved
Pipeline: shelbee-demoagain-p-...
Execution: workflow-2
Last Stage: prod
Model group: shelbee-demoagain-p-...

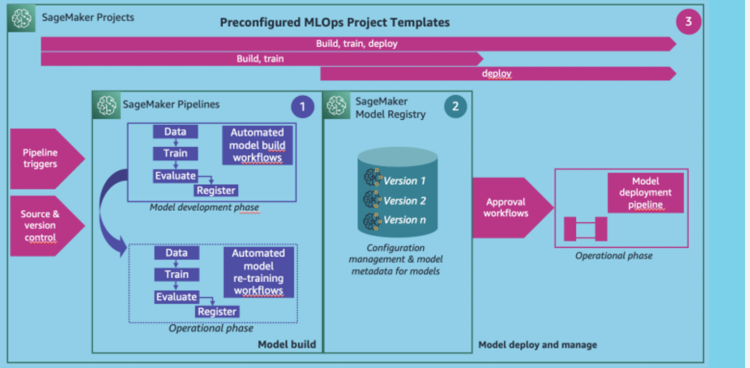
Model metrics

Model metric	Metric value	Standard deviation
mse	4.823176167079859	2.1960237865043672

- Track model performance metrics

SageMaker Pipelines: Projects

High Level Features



Enable CI/CD practices

source/version control, pipeline traceability, and automated triggers for training & deployment

Support for third-party tools

Including: GitHub, GitHub Enterprise, BitBucket Cloud, and Jenkins

Customizable MLOps Project templates

Utilize built-in templates or build custom templates to meet your requirements

Automatic rollback to previous model version

Rollback deployment to previous version of model

Wrap-up

SageMaker MLOps summary

Start small and iterate

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Practice Everything-as-Code for repeatability, consistency, and governance

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SageMaker MLOps summary

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Consider ML specific inputs, outputs, and artifacts for model and pipeline lineage

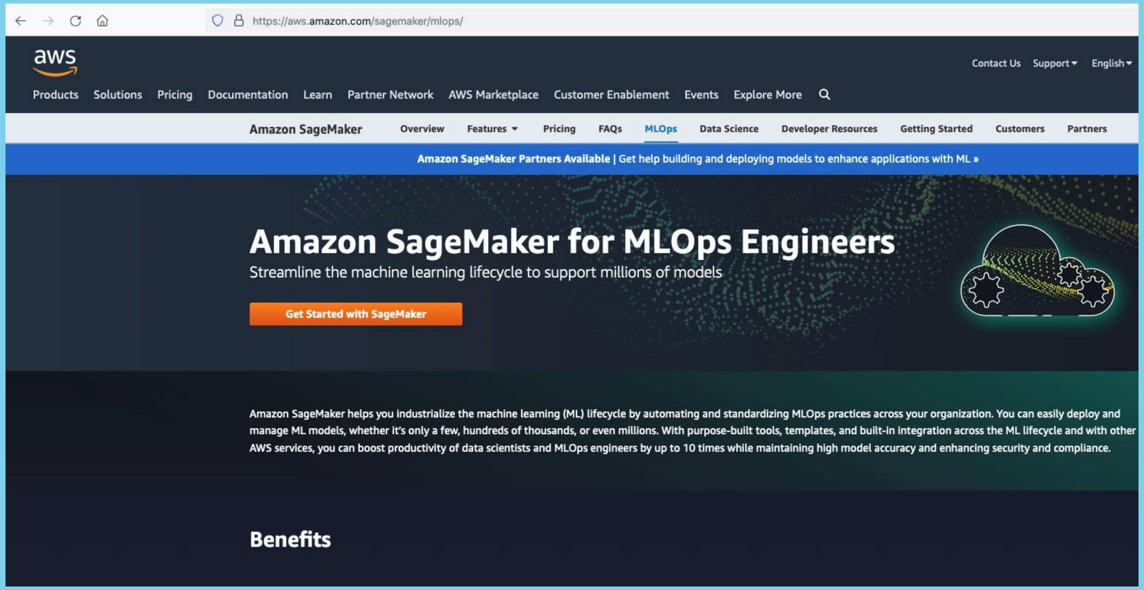
Use integrated SageMaker services when possible to reduce management and setup time

Implement a Model Registry as part of your ML pipeline for managing models

SageMaker MLOps: Resources & Next Steps

Check out the new MLOps Page

https://aws.amazon.com/sagemaker/mlops/



Amazon SageMaker Partners Available | Get help building and deploying models to enhance applications with ML »

Amazon SageMaker for MLOps Engineers

Streamline the machine learning lifecycle to support millions of models

Amazon SageMaker helps you industrialize the machine learning (ML) lifecycle by automating and standardizing MLOps practices across your organization. You can easily deploy and manage ML models, whether it's only a few, hundreds of thousands, or even millions. With purpose-built tools, templates, and built-in integration across the ML lifecycle and with other AWS services, you can boost productivity of data scientists and MLOps engineers by up to 10 times while maintaining high model accuracy and enhancing security and compliance.

Benefits

Additional Resources

1. SageMaker Documentation: https://docs.aws.amazon.com/sagemaker/latest/dg/pipelines.html
2. Custom Project Template Examples: https://github.com/aws-samples/sagemaker-custom-project-templates

Thank you!