AWS Solutions Training for Partners:

Machine Learning (ML) on AWS for ML Practitioners – Technical

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“Machine Learning”

When you think about **machine learning**, what is the **first word** that comes to mind?

3 minutes

Type in chat.

Machine Learning on AWS – Technical

Course Introduction

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Course Agenda

- Module 1: Introduction to Machine Learning
- Module 2: Artificial Intelligence Services on AWS
- Module 3: Machine Learning Process
- Module 4: Data Collection, Integration, Preparation and Visualization, and Analysis
- Module 5: Deep Learning Amazon Machine Images
- Module 6: Amazon SageMaker Concepts
- Module 7: Amazon SageMaker Notebooks
- Module 8: Amazon SageMaker Built-In Algorithms
- Module 9: Amazon SageMaker – Debugging and Monitoring
- Module 10: Introduction to MLOps
- Module 11: Next Steps and Additional Learning

Workbook 0.1: Personas

- Which persona are you?
- What do you want to take away from this course?

Your role and skill level

Type in the chat and let your colleagues know:

- Your role?
  - Data Scientist
  - TAM
  - Developer
  - Other
- Your skill level with AWS?
  - New
  - Beginner
  - Intermediate
  - Expert

3 minutes

Type in chat.

Your role today

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- Participate in class discussions and ask questions
- Complete individual and group exercises
- Be open to learn about AWS machine learning (ML), Amazon SageMaker services, ML Pipeline and related solutions
- Review case studies
- Answer knowledge check questions
- Complete the course assessment

Module 1: Introduction to Machine Learning

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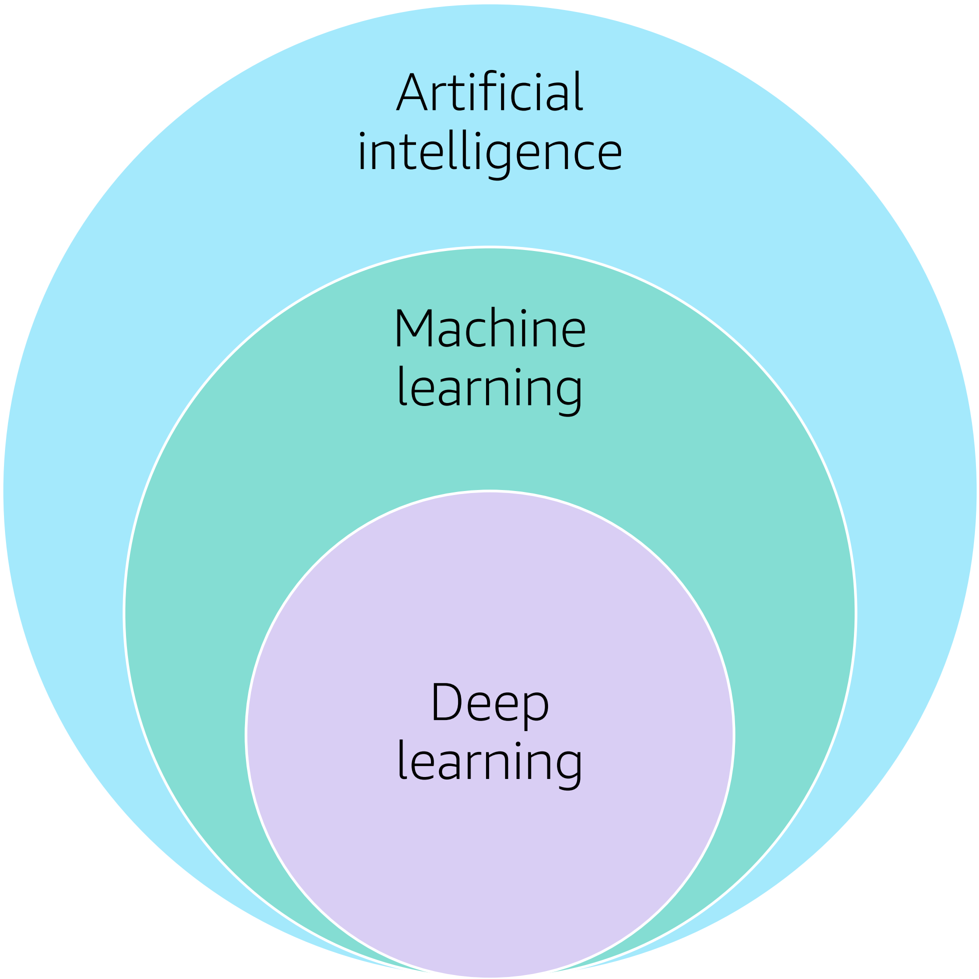
Module 1:

Introduction to Machine Learning

- Identify machine learning, artificial intelligence, and deep learning (DL)
- Explain how traditional programming differs from solving problems with machine learning
- List and explain the various types of machine learning
- Identify key machine learning terms
- Key Challenges and limitations of AI
- Insurance Fraud use case

Let's define AI, ML, and DL



Traditional Programming vs. ML

Traditional programming: You write the business rules

Human Programmer

Input

Age	Gender	Purchase Date	Items
30	M	3/1/2017	Toy
40	M	1/3/2017	Books
….	……	…..	…..

Rule 1: 15 <age< 30
Rule 2: Bought Toy=Y, Last Purchase<30 days
Rule 3: Gender = 'M', Bought Toy ='Y'
Rule 4: ……..
Rule 5: ……..

Output

Age	Gender	Purchase Date	Items
30	M	3/1/2017	Toy
….	……	…..	…..

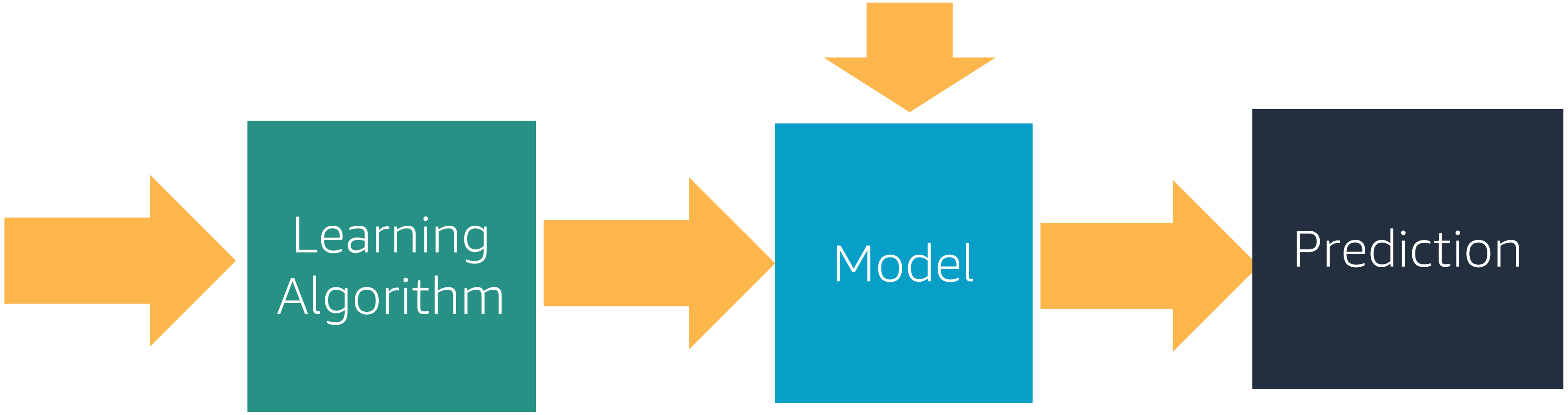
In ML: The data writes the business rules

Input - New Unseen Data

Age	Gender	Items
35	F	
39	M	Toy

Age	Gender	Purchase Date	Items
30	M	3/20/2017	Toy *
40	M	1/3/2017	Books
….	……	…..	…..

Historical Purchase Data
(Training Data - Input)

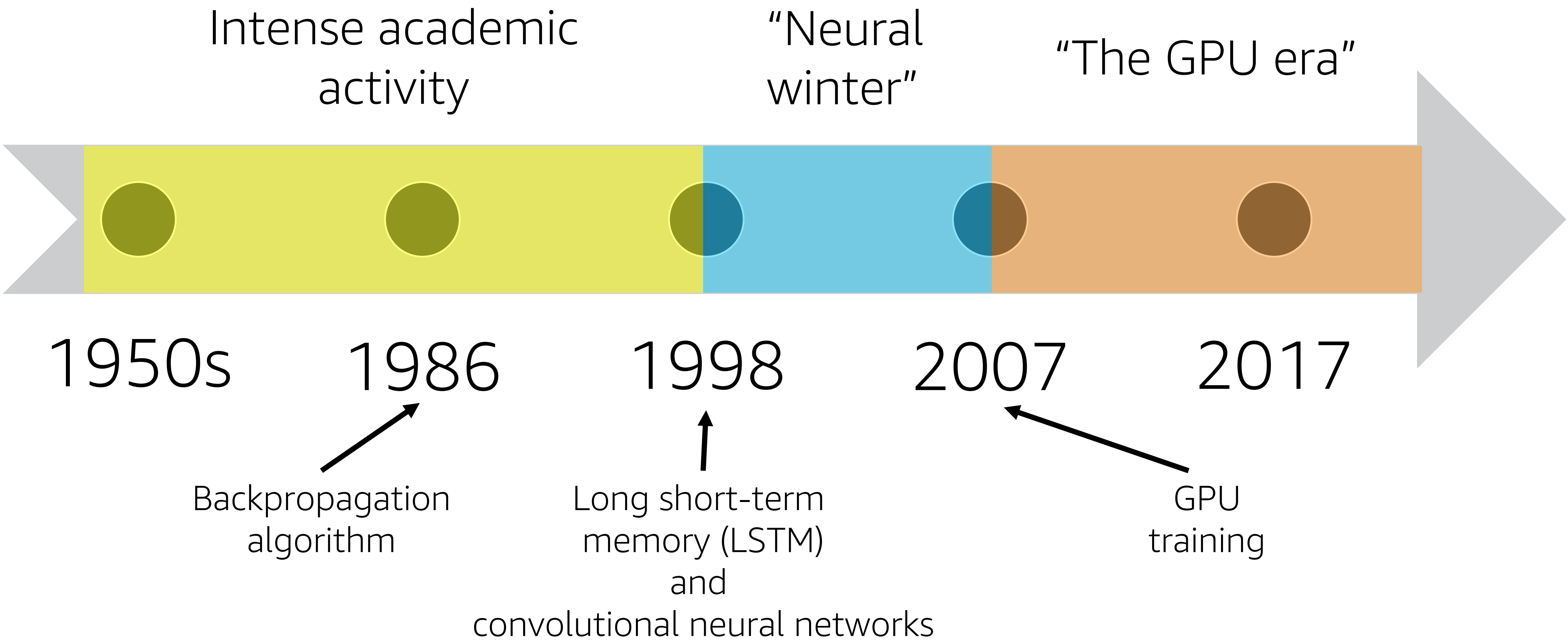


Output

When to use machine learning

- Use ML when you **can't code it**
  - Complex tasks where deterministic solutions don't suffice
    - E.g., recognizing speech/images
- Use ML when you **can't scale it**
  - Replace repetitive tasks needing human-like expertise
    - E.g., recommendations, spam, fraud detection, machine translation
- Use ML when you have to **adapt/personalize**
  - E.g., recommendation and personalization
- Use ML when you **can't track it**
  - E.g., automated driving

ML timeline



Intense academic activity
"Neural winter"
"The GPU era"
1950s
1986
1998
2007
2017
Backpropagation algorithm
Long short-term memory (LSTM) and convolutional neural networks
GPU training

Types Of Machine Learning

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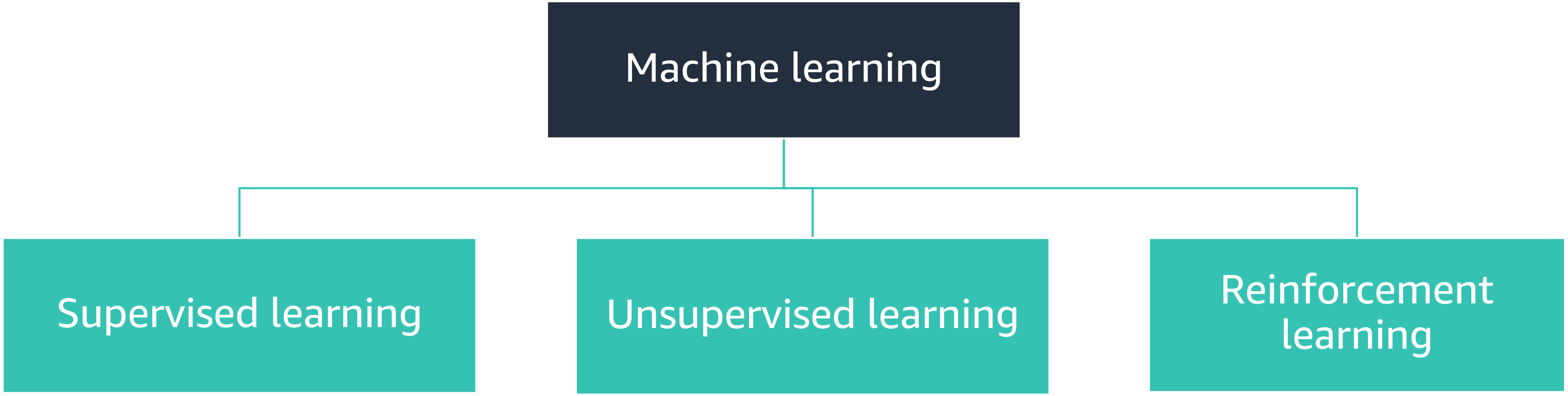
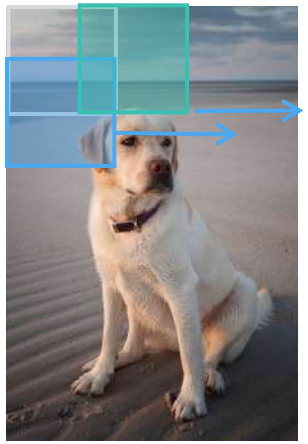
Machine learning types



Supervised learning: How humans learn

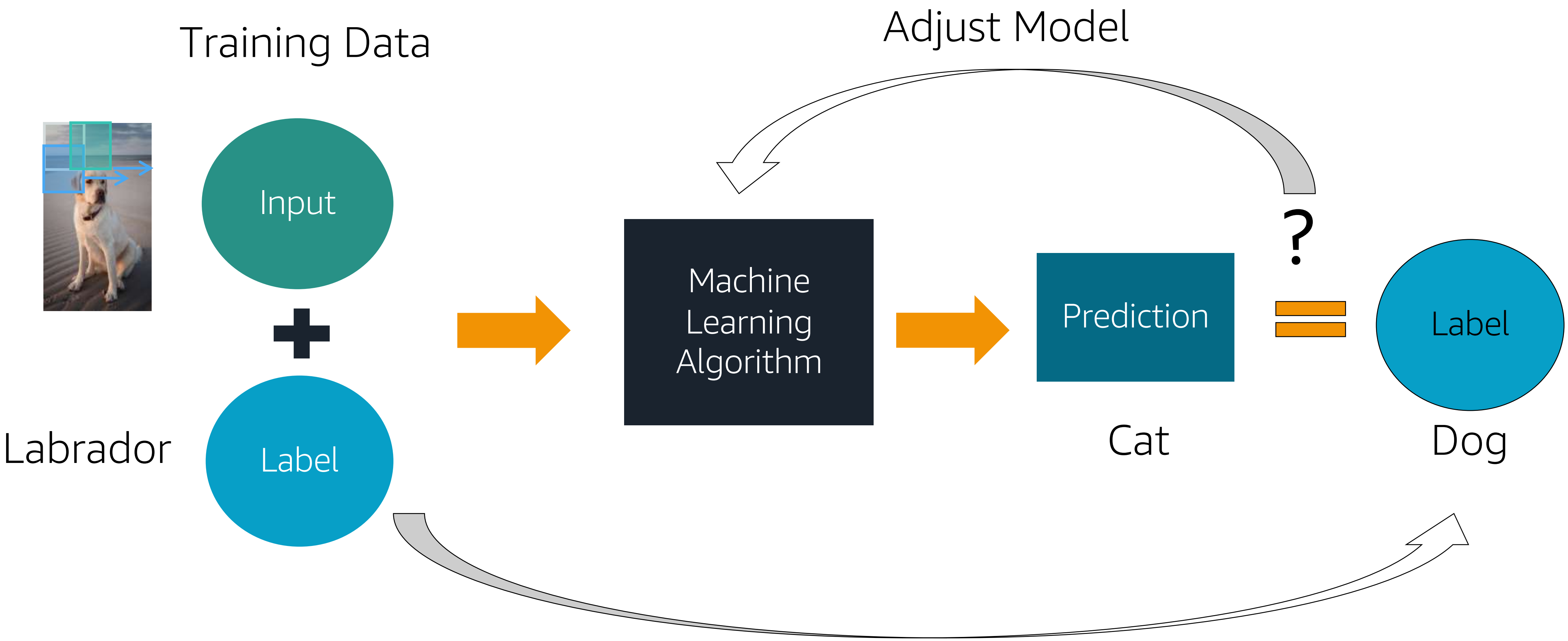
It's a cat!



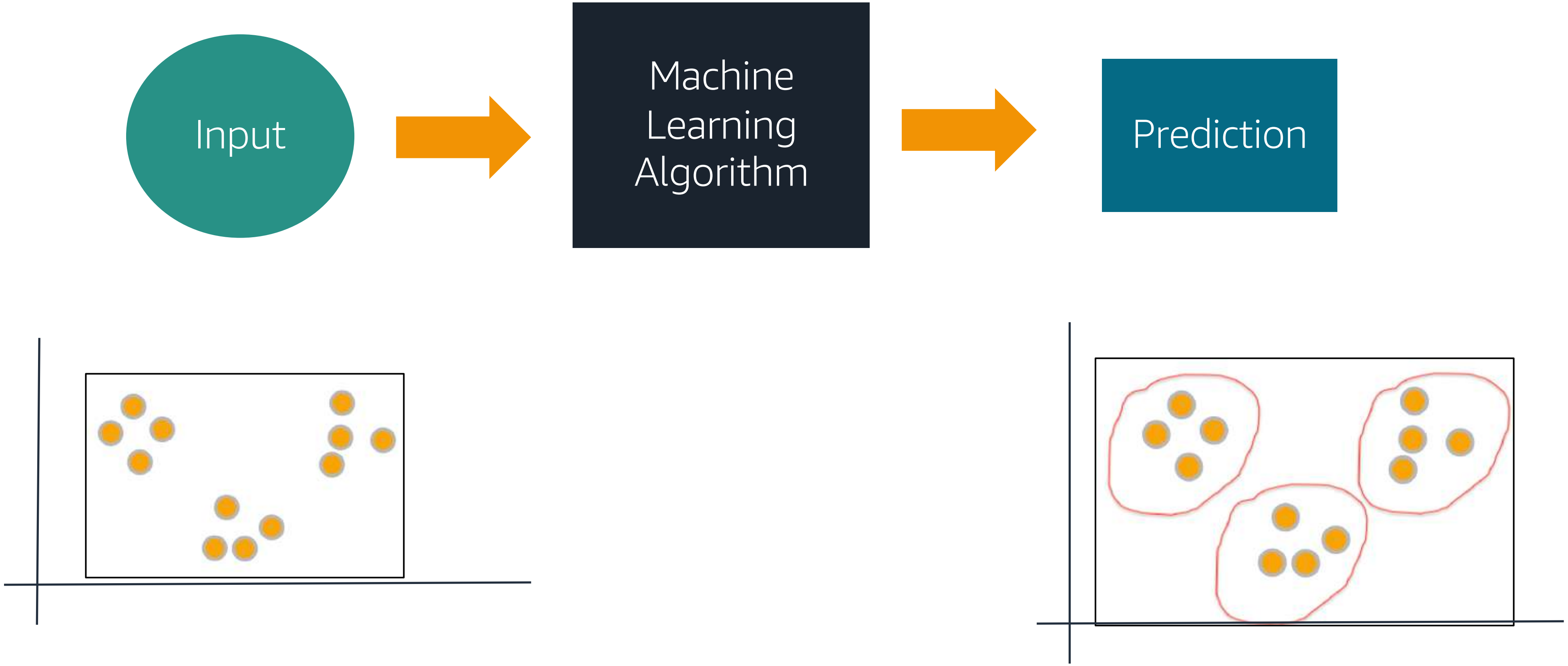
No, it's a dog.

Supervised learning: How machines learn

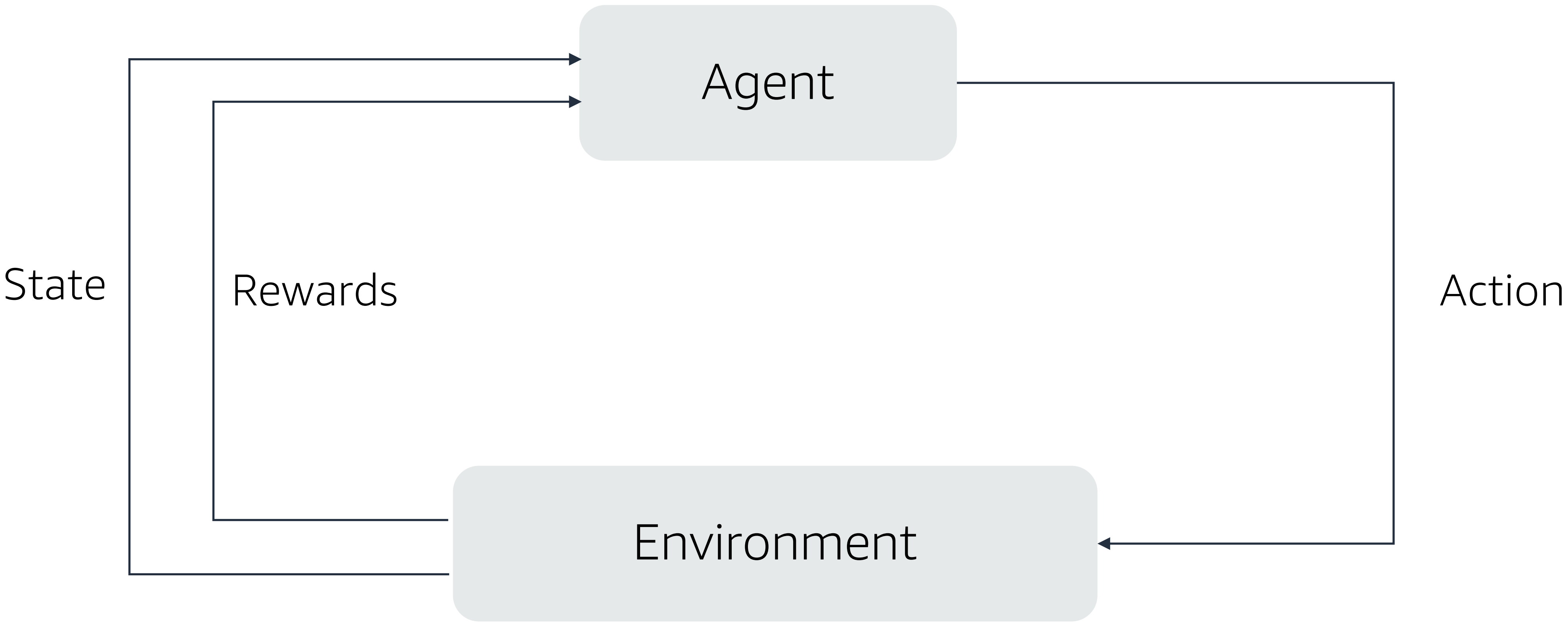
Human intervention and validation required; e.g., photo classification and tagging



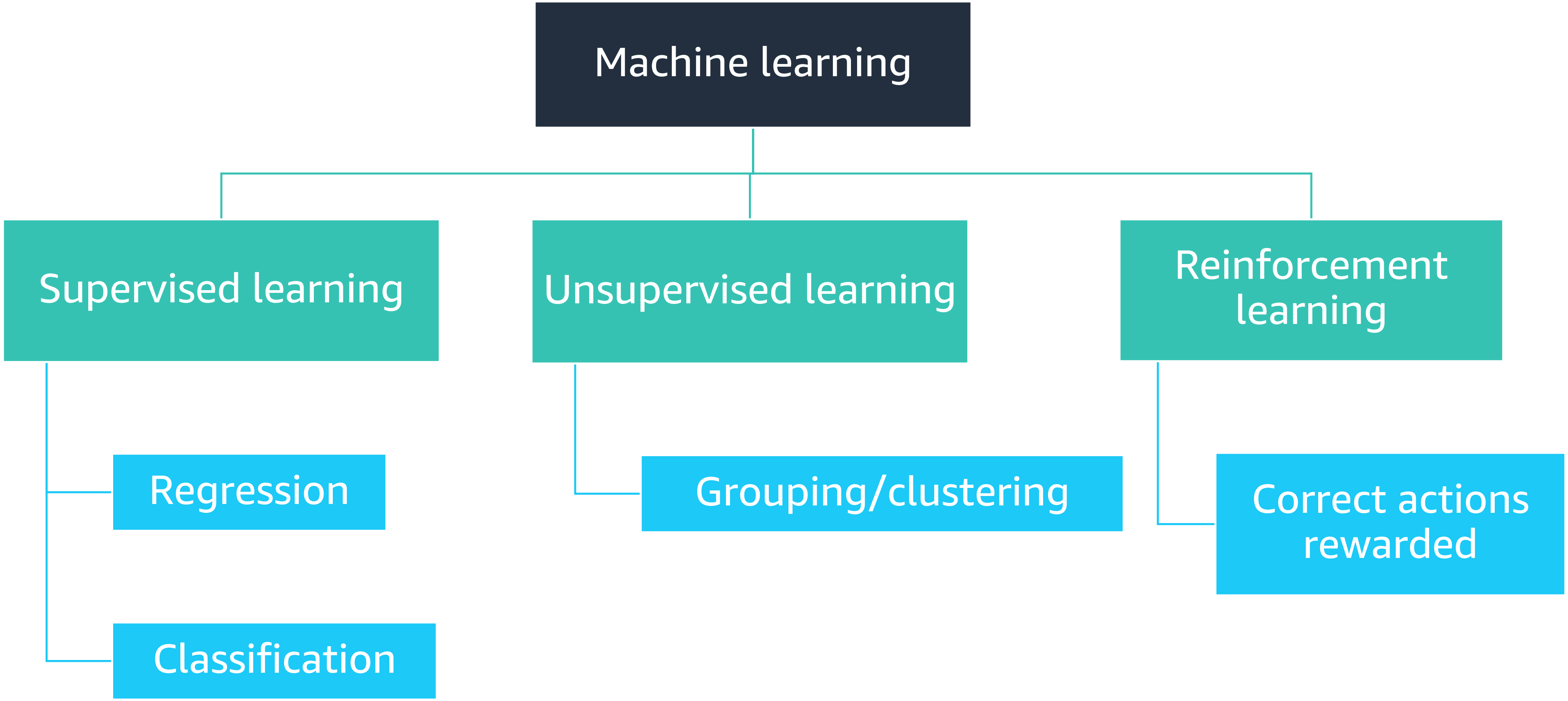
Unsupervised learning



Reinforcement learning



Machine learning types



Terminology and concepts

	Statistical Definition	Everyday Definition
Label/Target	Dependent variable	What you are trying to predict
Feature	Independent variable	Data that helps you make predictions
Feature Engineering	Data transformation	Process of reshaping data to get more value out of it
Feature Selection	Variable/subset selection	Process of using the most valuable data

ML: Common Use Cases

Common use cases

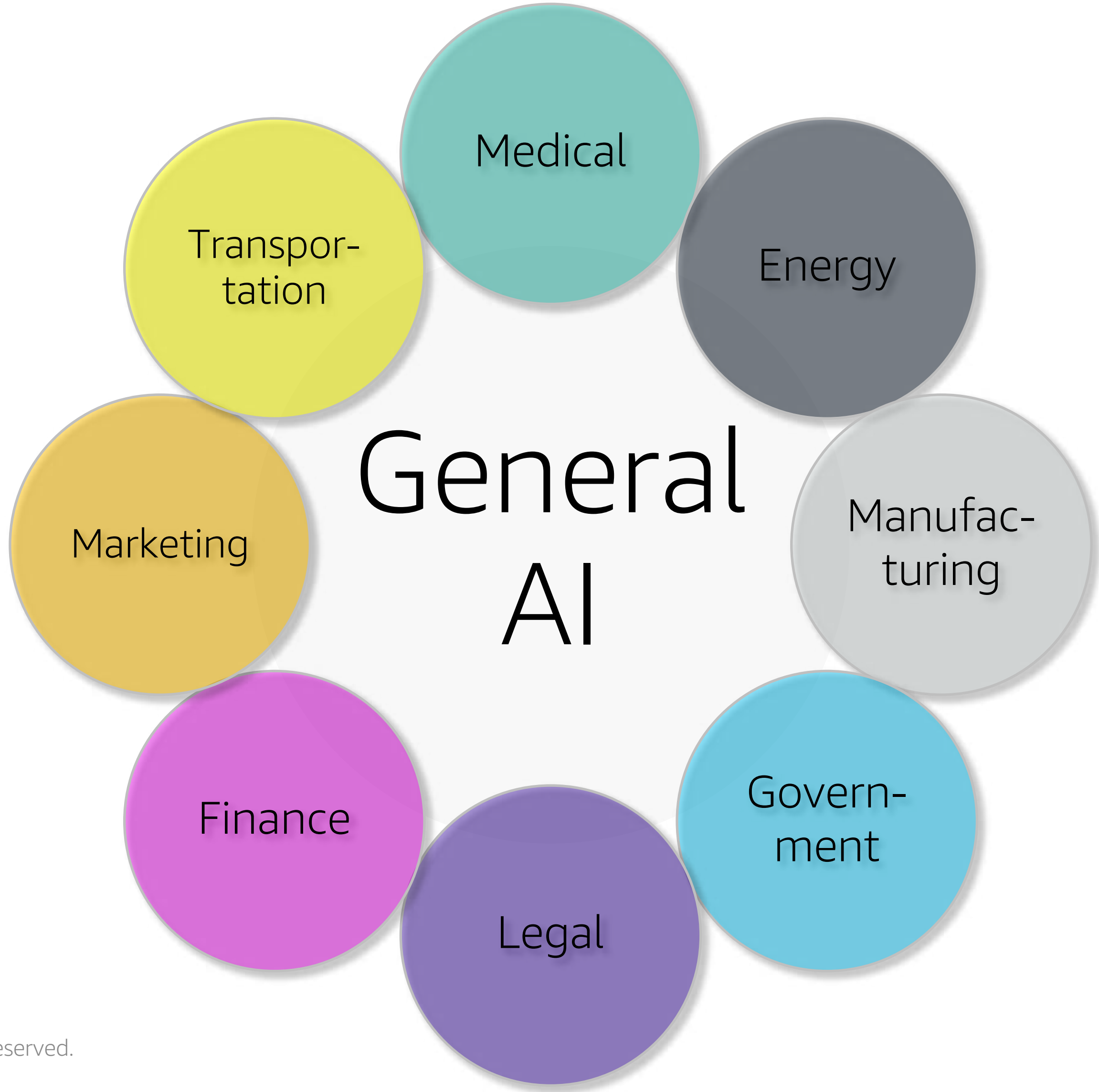
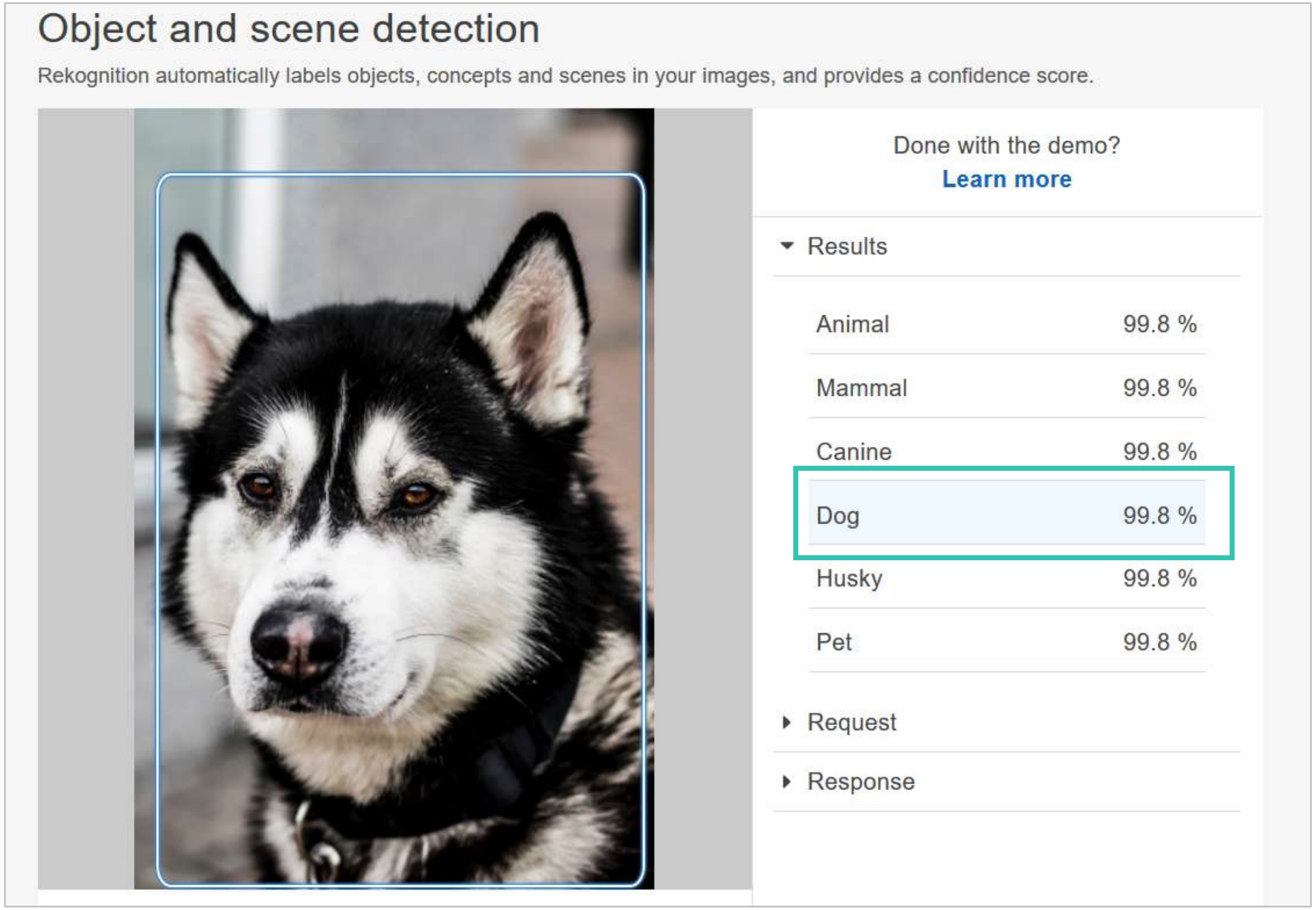


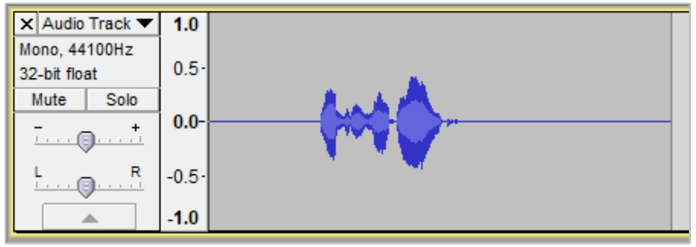
Image recognition

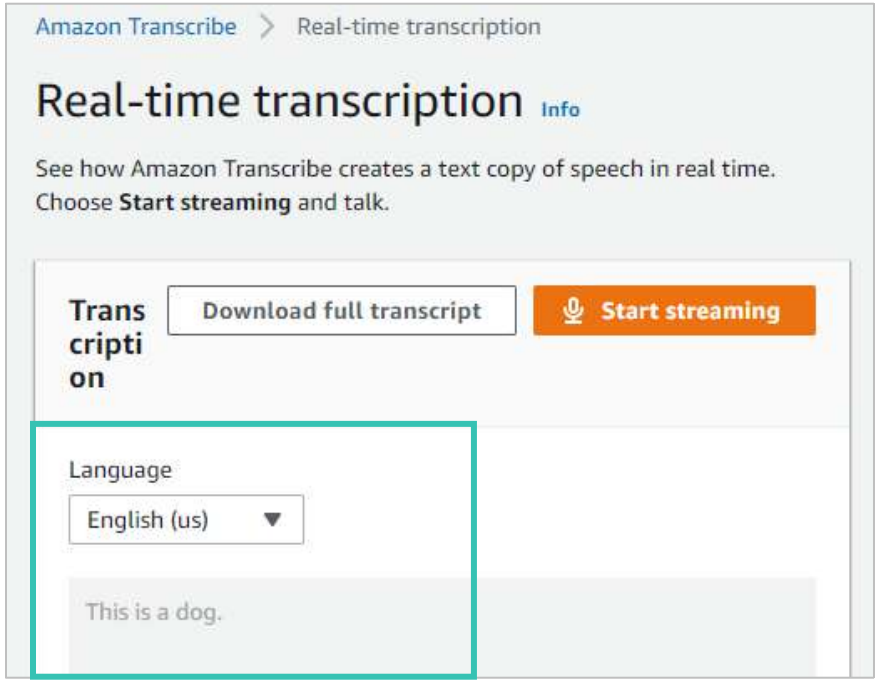
Amazon Rekognition

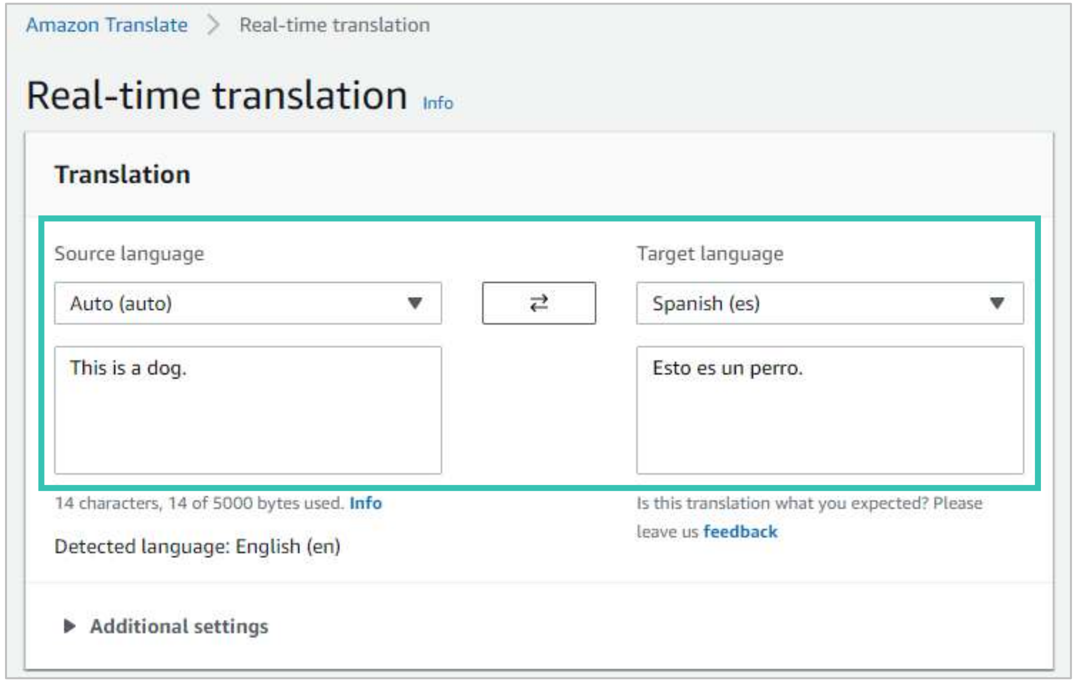


Translation and transcription

This is a dog.



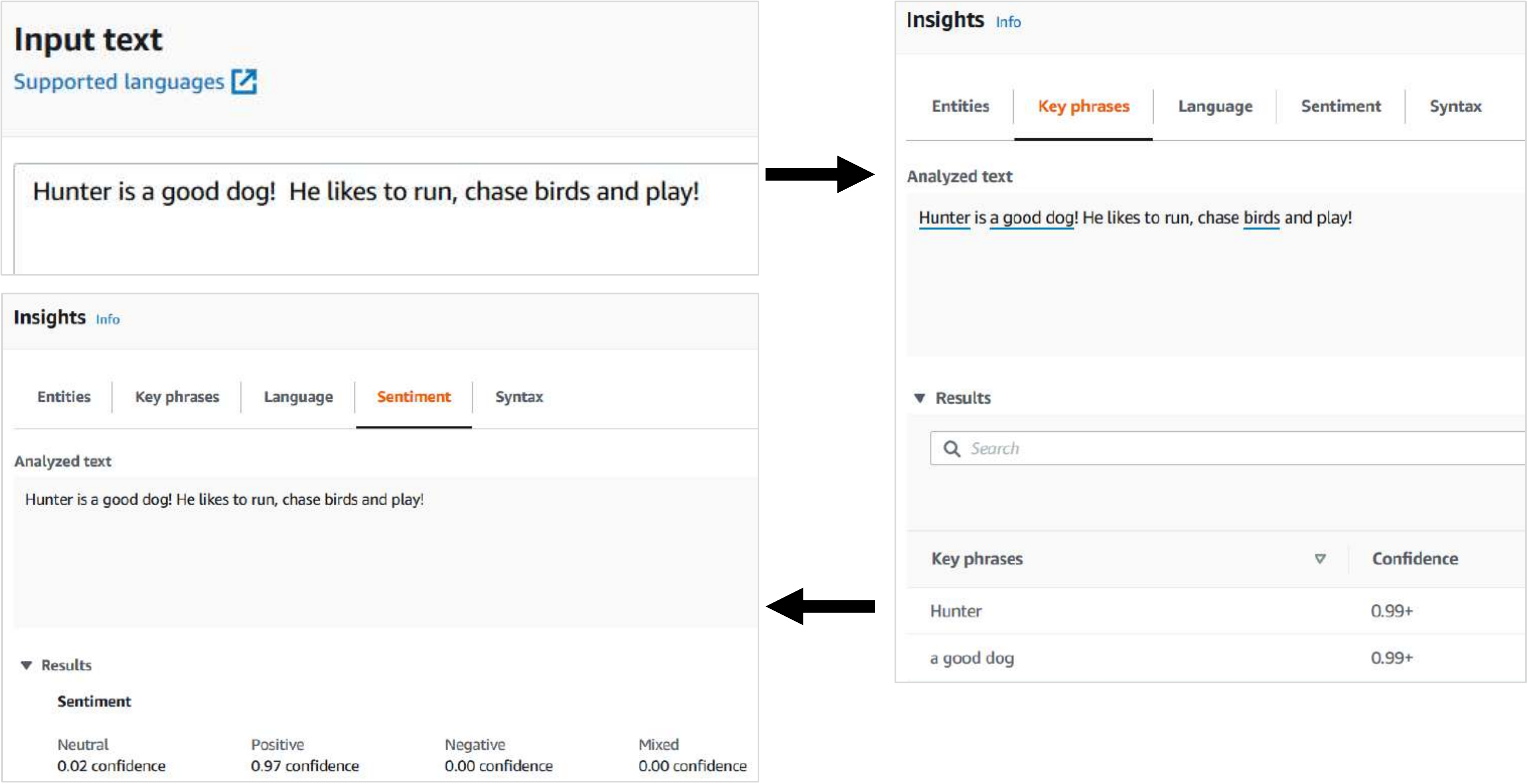




Amazon Translate

Amazon Transcribe

Text analysis



Amazon Comprehend

Key Challenges and Limitations of AI

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Some AI limitations

- **Data**: It fuels ML, so garbage-in / garbage-out still applies
- **Bias**: Poor predictions and decisions can be traced back to biased data
- **Explainability**: How and why the model makes certain predictions
- **Narrow AI**: Lack of generalized AI, where the current AI can only perform specific tasks within a narrow domain
- **Algorithm transparency**: Ability to see internal implementation used
- **Transfer learning**: Ability of ML models to take learning from one arena and apply to another
- **Emotional intelligence**: Basic human trait is still a challenge in ML

Key challenges in ML: Biases and responsible AI

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- Biases in ML that we need to be aware of and deal with, such as
  - Sample bias
  - Prejudicial bias
  - Exclusion bias
  - Measurement bias
  - Algorithmic bias

  https://developer.ibm.com/technologies/machine-learning/articles/machine-learning-and-bias

- Responsible AI: harnessing the power of AI in an ethical, fair, and responsible manner with full transparency, accountability, and freedom from bias.

  https://www.pwc.co.uk/issues/data-analytics/artificial-intelligence/what-is-responsible-ai.html

Key challenges in ML: Transparency

- **Data lineage** tracks:
  - The origin of the data
  - What happens to it
  - Where it moves over time during data analytics processes
- **Reproducibility/Auditability**: Any results should be documented by making all data and code available in such a way that computations can be run again with identical results.
- Data lineage, reproducibility, and auditability are important to investigate potential bias in data and to ensure transparency.

Course use case

Workbook: AnyCompany use case

- Focused on many types of insurance
- Key challenge today is fraud
- Costing them millions of dollars per year
- Lots of historical data
- Wants to improve new claims fraud prediction
- Resolution needed by EOY

Knowledge check

Knowledge check 1

Which option uses deeply multilayered neural networks that perform tasks like speech and image recognition?

- A. Artificial intelligence
- B. Machine learning
- ✓ C. Deep learning
- D. Reinforcement learning

Knowledge check 2

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Which ML algorithm would you use for forecasting the demand for a product?

- A. Clustering
- B. Classification
- C. Regression
- D. Correct Action Rewarded

Module 2: Artificial Intelligence Services on AWS

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Module 2:

AI Services on AWS

- Overview of AWS ML/AI Portfolio
- Identify and describe key AWS AI services and Identify their use cases

Amazon Machine Learning stack

Our mission at AWS

Put machine learning in the hands of every developer

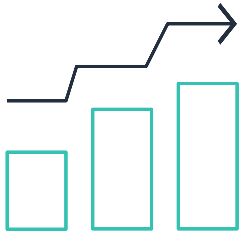
Why AWS for ML?

Broad and deep set of ML and AI services

200+ new features and services launched within the last year

Solutions for everyone from ML scientists to application developers

Support for all three major frameworks



Machine learning with Amazon SageMaker

Single integrated development environment (IDE) for the entire ML workflow

At least 54% lower total cost of ownership (TCO)

In the last 2 years, 10,000 customers have adopted Amazon SageMaker

Comprehensive cloud offerings

Highly secure, reliable, fully featured data store

Strong set of compute, storage, security, database, and analytics capabilities to build on

85% of TensorFlow in the cloud runs in the AWS Cloud

Amazon ML stack

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AI services

Vision | Speech | Text | Search | Chatbots | Personalize | Forecast | Fraud | Development | Contact Centers

ML services

Amazon SageMaker | Ground Truth | AWS Marketplace for ML | SageMaker Studio IDE | Neo | Augmented AI

ML frameworks and infrastructure

TensorFlow | MXNet | PyTorch | Gluon | Keras | DeepGraphLibrary | Deep Learning AMIs and Containers | GPUs and CPUs | Elastic Inference | Inferencia | FPGA

AI services

Amazon ML stack – AI services

AI services

Vision | Speech | Text | Search | Chatbots | Personalize | Forecast | Fraud | Development | Contact Centers

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Amazon Rekognition

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Amazon Rekognition

Function

Automate image and video analysis with machine learning

Use cases

- Media analysis
- Identity verification
- Content moderation

Key Features	
Labels	Custom labels
Content moderation	Text detection
Facial detection	Face search and verification
Celebrity recognition	Pathing

https://aws.amazon.com/rekognition

Highlighted customer

C-SPAN

Amazon Textract

Amazon Textract

Function

Extract any text and data from any document using machine learning and without manual effort

Use cases

- Create smart search indexes
- Build automated document processing workflows
- Maintain compliance in document archives

Benefits
Extract structured and unstructured data
Go beyond simple optical character recognition (OCR)
Security and compliance
Implement human reviews

https://aws.amazon.com/textract/

Highlighted customer

Filevine

Amazon Comprehend

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Amazon Comprehend

Function

Discover insights and relationships in text

Use cases

- Call center analytics
- Index and search product reviews
- Personalize content on a website

Benefits
Get answers from text
Organize documents by topics
Train models on your own data
Support general and industry-specific text

https://aws.amazon.com/comprehend

Highlighted customer

FINRA

Amazon Personalize

Amazon Personalize

Function

Create real-time, personalized user experiences fast, at scale

Use cases

- Retail – Help customers discover products
- Media and entertainment – Recommend new content, based on preference

Benefits
Deliver recommendations in real time
Implement personalized recommendations, in days
Personalize touchpoints along the customer journey

https://aws.amazon.com/personalize

Highlighted customers

Retail – Subway

Media and Entertainment – Coursera

Amazon Kendra

Amazon Kendra

Function

Enterprise search service powered by machine learning

Use cases

- Improve access to internal knowledge
- Enhance sales and customer support services
- Help customers find information efficiently

Benefits
Ask natural-language questions, get immediate answers
Bring data together with a few clicks
Constantly improve search results

https://aws.amazon.com/kendra

Highlighted customers

CORD-19 Search

COVID-19 Open Research Dataset (CORD-19)

Amazon Forecast

Amazon Forecast

Function

Time-series forecasting service

Use cases

- Product demand planning
- Financial planning
- Resource planning

Benefits
Reduce forecasting time from months to hours
Create any time series forecast
Secure business data

https://aws.amazon.com/forecast

Highlighted customer

Puget Sound Energy

Amazon Fraud Detector

Amazon
Fraud Detector

Function

Detect more online fraud faster

Use cases

Detect common types of fraud:

- New account
- Online payment
- Guest checkout
- Online service and loyalty program abuse

Benefits
Prevent and detect online fraud
Fraud detection in minutes
Customized for your unique business needs

https://aws.amazon.com/fraud-detector

Highlighted customers

Customers

How you can help customers

- AWS AI services solve specific business problems.
- Customers can have little to no Amazon ML experience.
- Customers can use APIs to interact with AWS AI services.

Call to action

- Explore AI services in the AWS Management Console
- Complete tutorials

Course use case

Workbook 2.1

- Return to the AnyCompany use case.
- Can a single AI service be used to address the problem?
- Can any combination of AI services be used?

<u>3-minute individual exercise and 3-minute class discussion</u>

Knowledge check

Knowledge check

Which AWS AI service can be used to discover insights and relationships in text?

- Amazon Kendra
- Amazon Textract
- ✓ Amazon Comprehend
- Amazon Personalize

Knowledge check

Which AWS AI service can be used to extract any text and data from any document without manual effort?

- Amazon Kendra
- Amazon Comprehend
- Amazon Pinpoint
- ✓ Amazon Textract

Module 3: Machine Learning Process

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Module 3:

ML Process

- Identify phases in the machine learning process
- Explain Machine Learning Pipeline
- Walk through the feature design process, requirements, and data dependencies for implementing ML on AWS
- Determine if a business problem can be solved with machine learning
- Identify your role, including how you can help customers
- Discuss Insurance Fraud Use Case

Phases of Machine Learning & ML Pipeline

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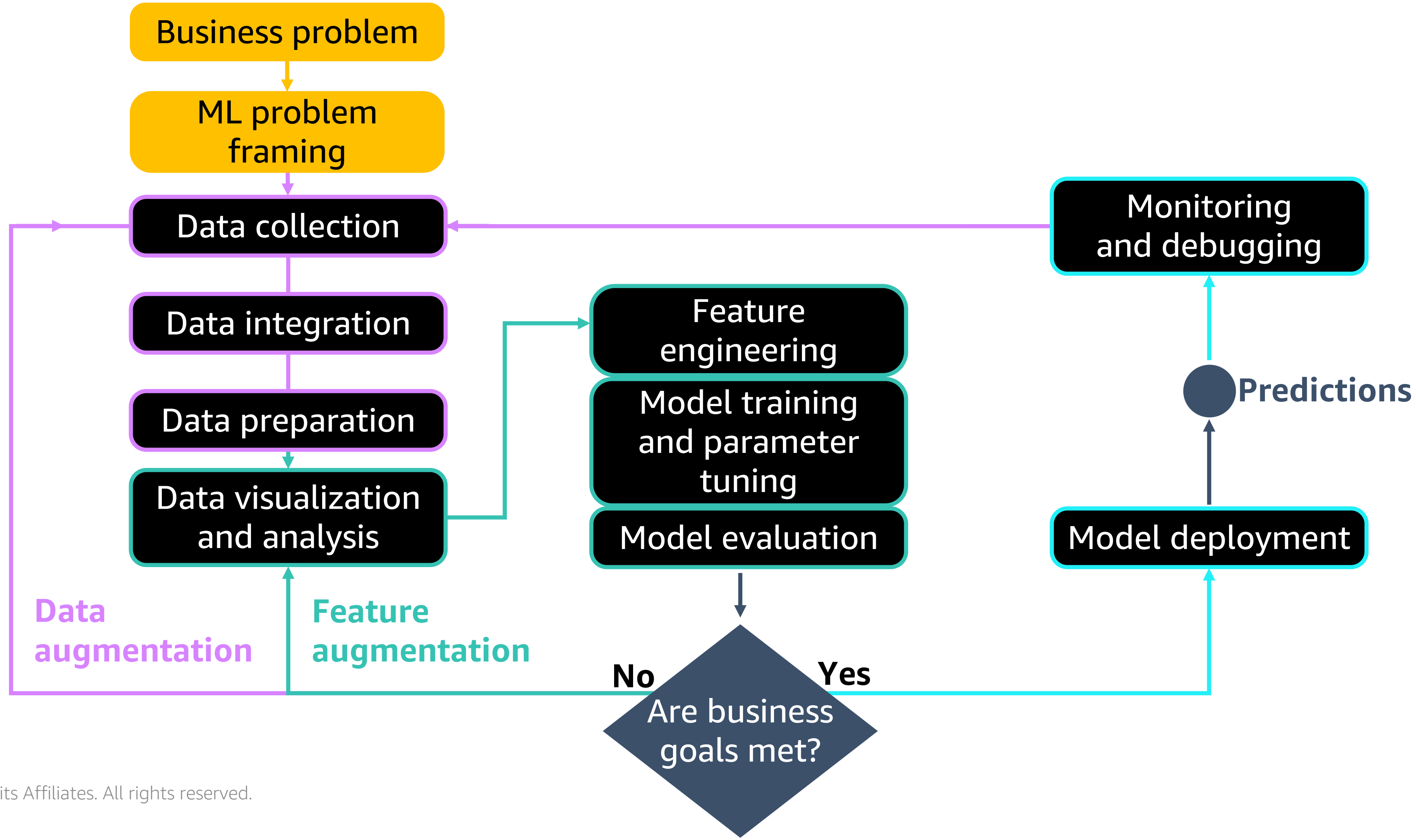
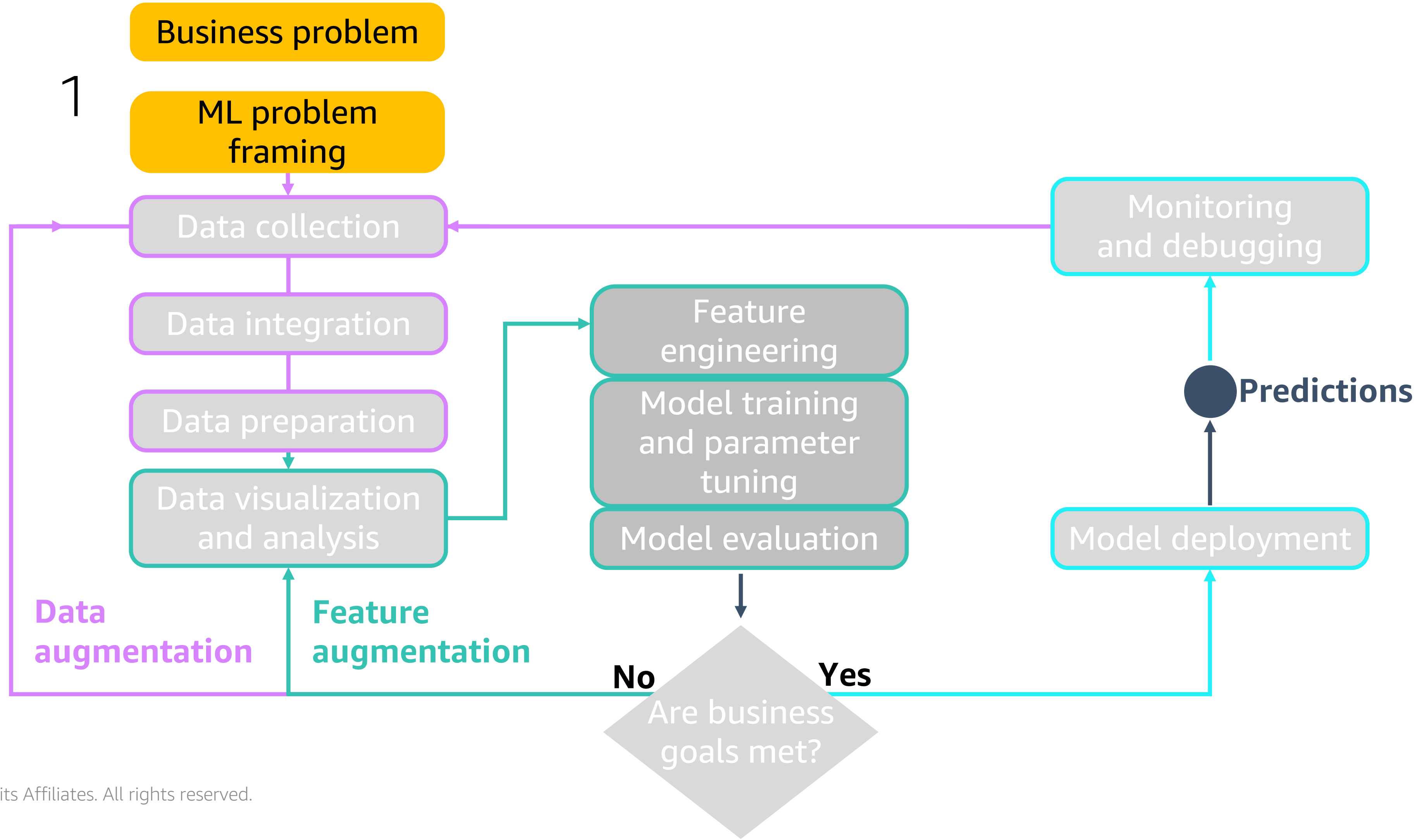
ML process overview



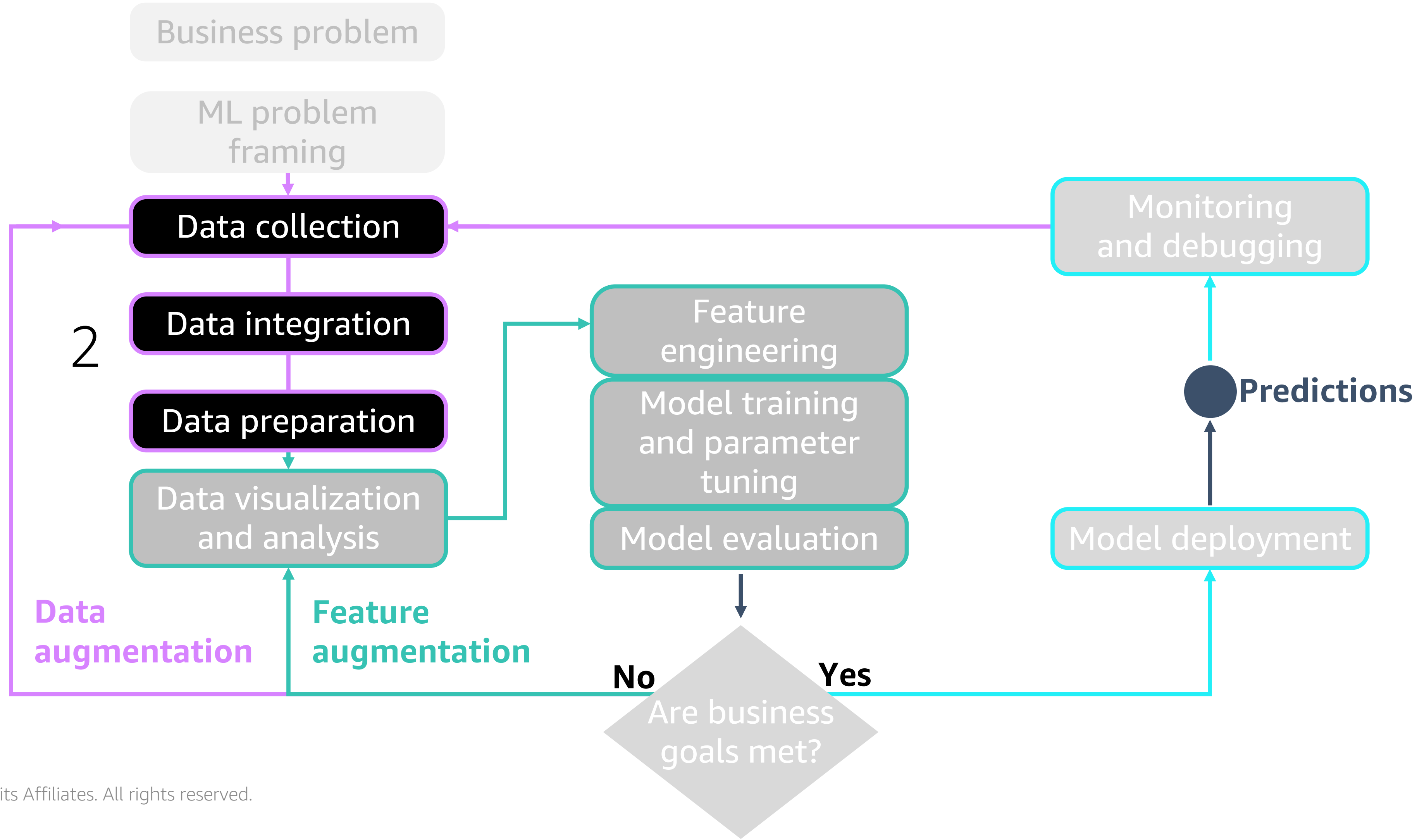
1. Business process: Framing a business problem

- Can the business problem be framed as a ML problem?



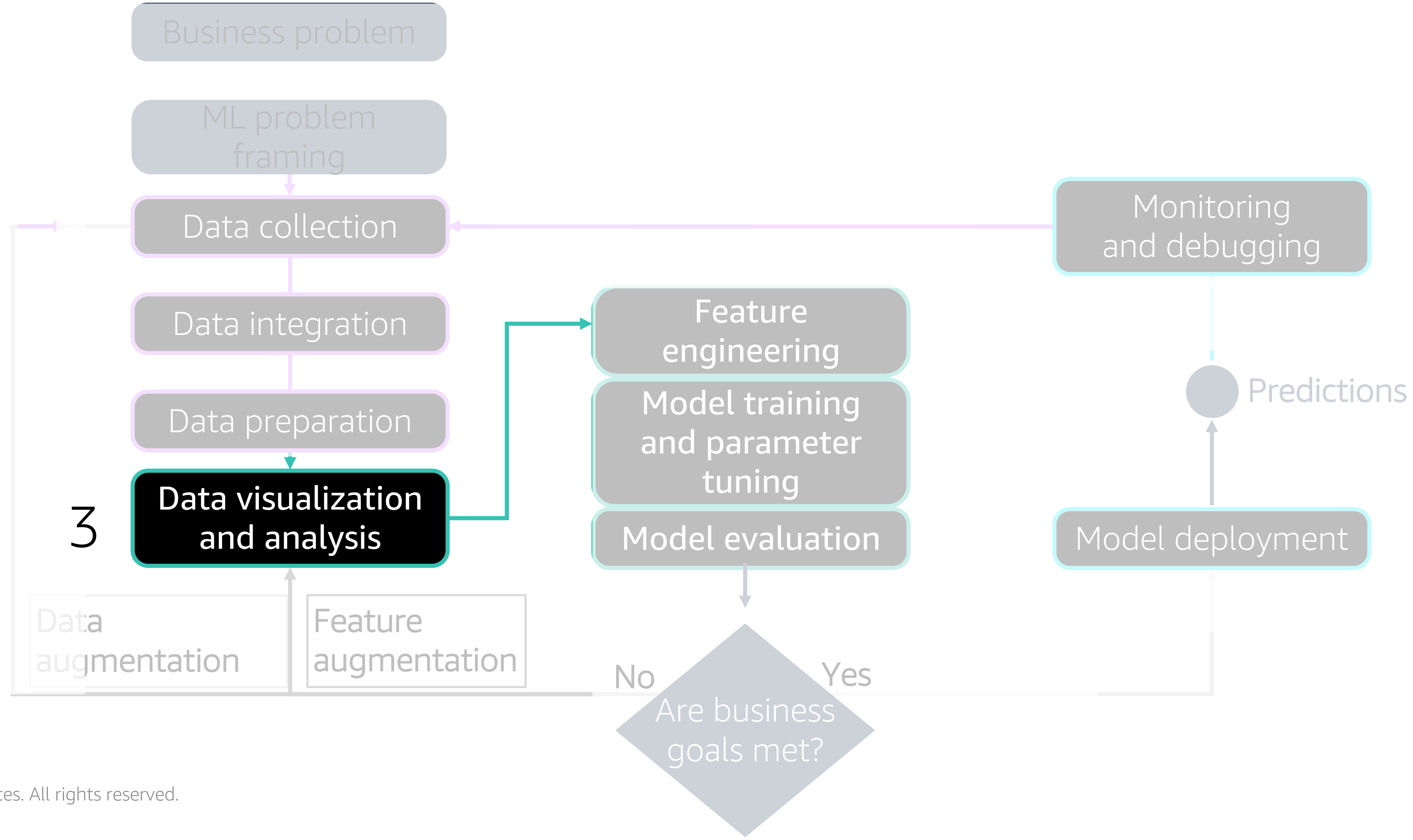
2. Data collection, integration, and preparation

- Set up Data Pipeline to
  - Collect data
  - Store data
- Cleanse, analyze and prepare data
- Use different tools for these tasks



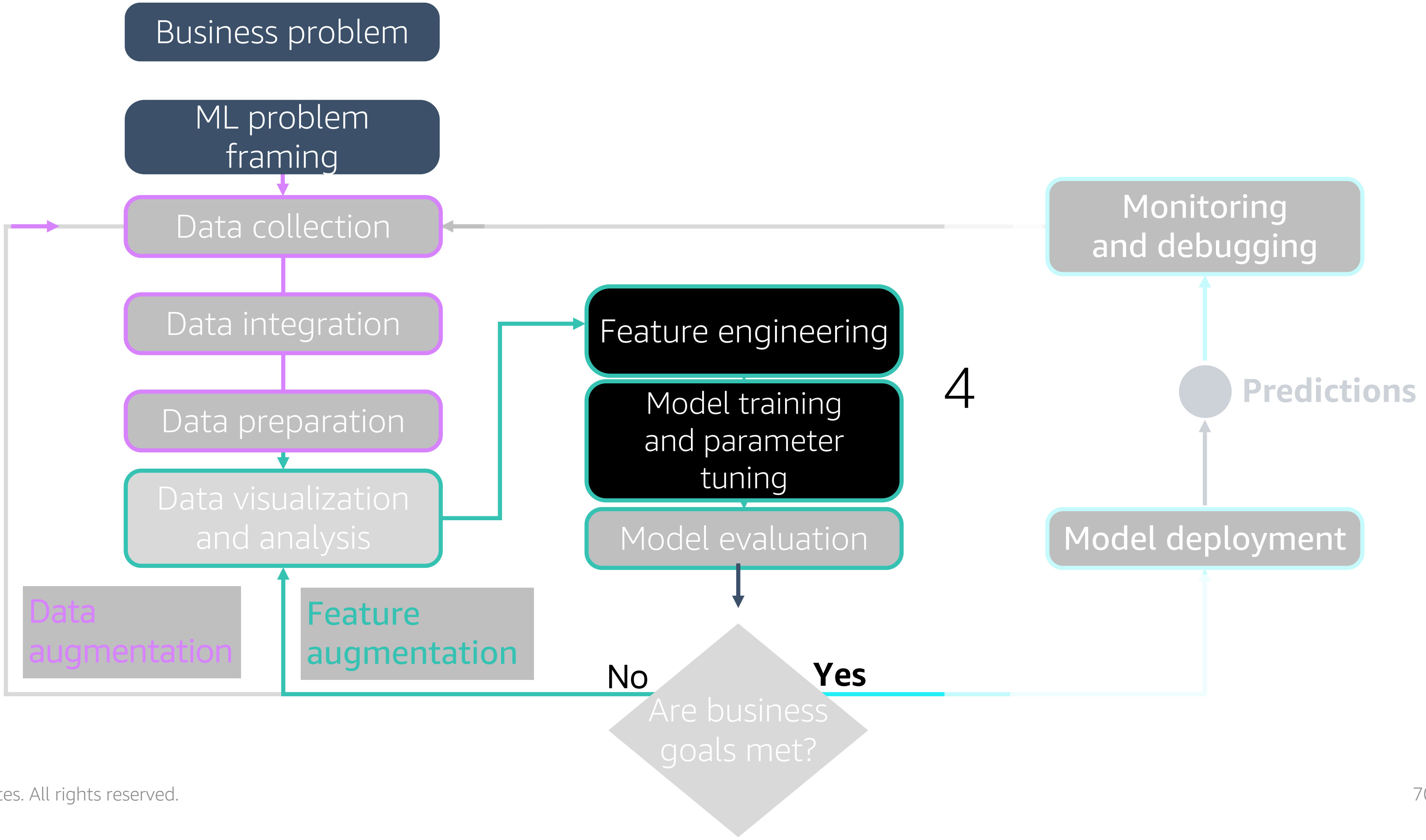
3. Data visualization

- Set up and manage
  - Notebook environments
- Use statistical tools to visualize and analyze data



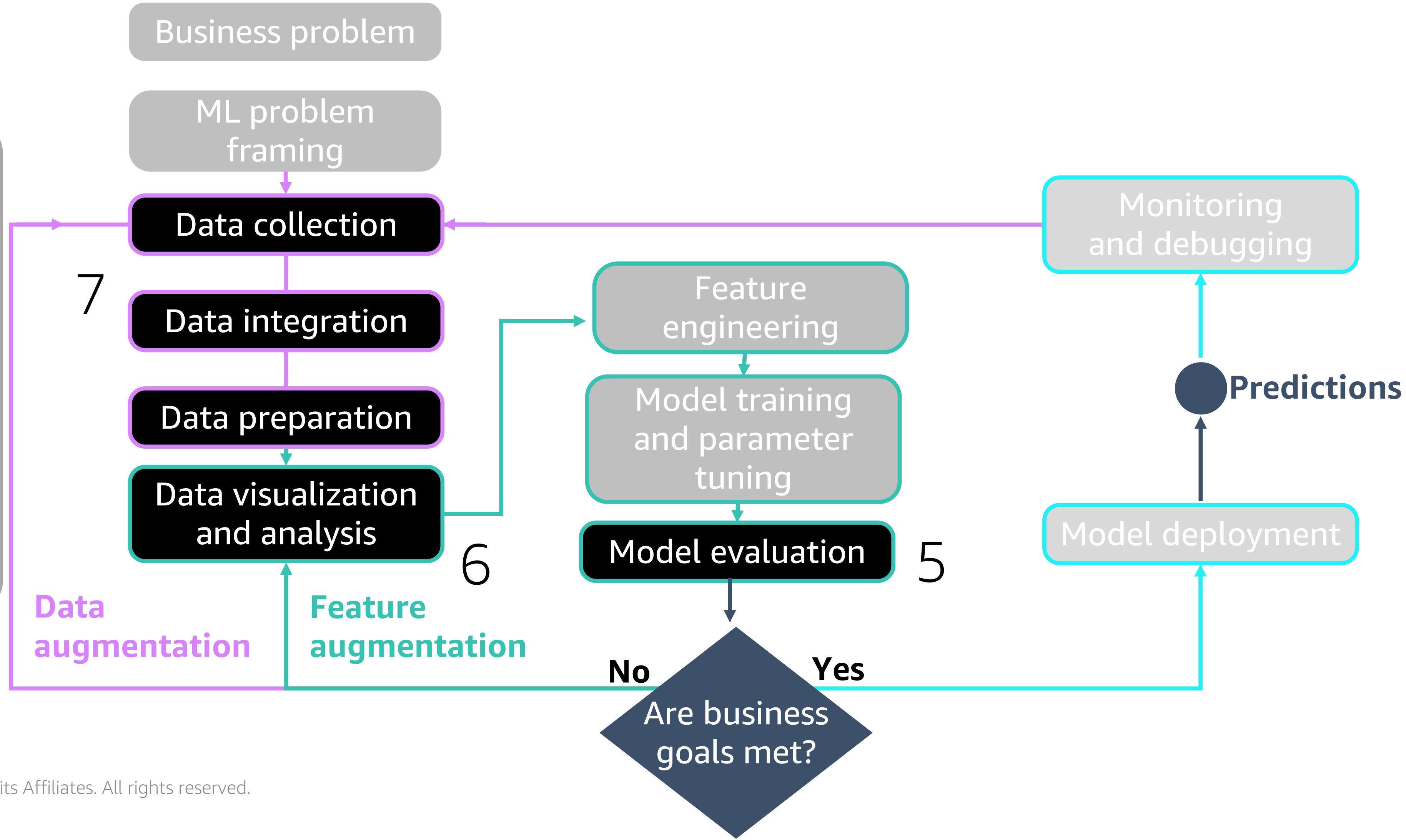
4. Feature engineering, model training, and parameter tuning

- Perform feature engineering
- Set up and manage inference clusters
- Manage and scale model inference APIs
- Train, monitor and debug model predictions
- Model versioning and performance tracking



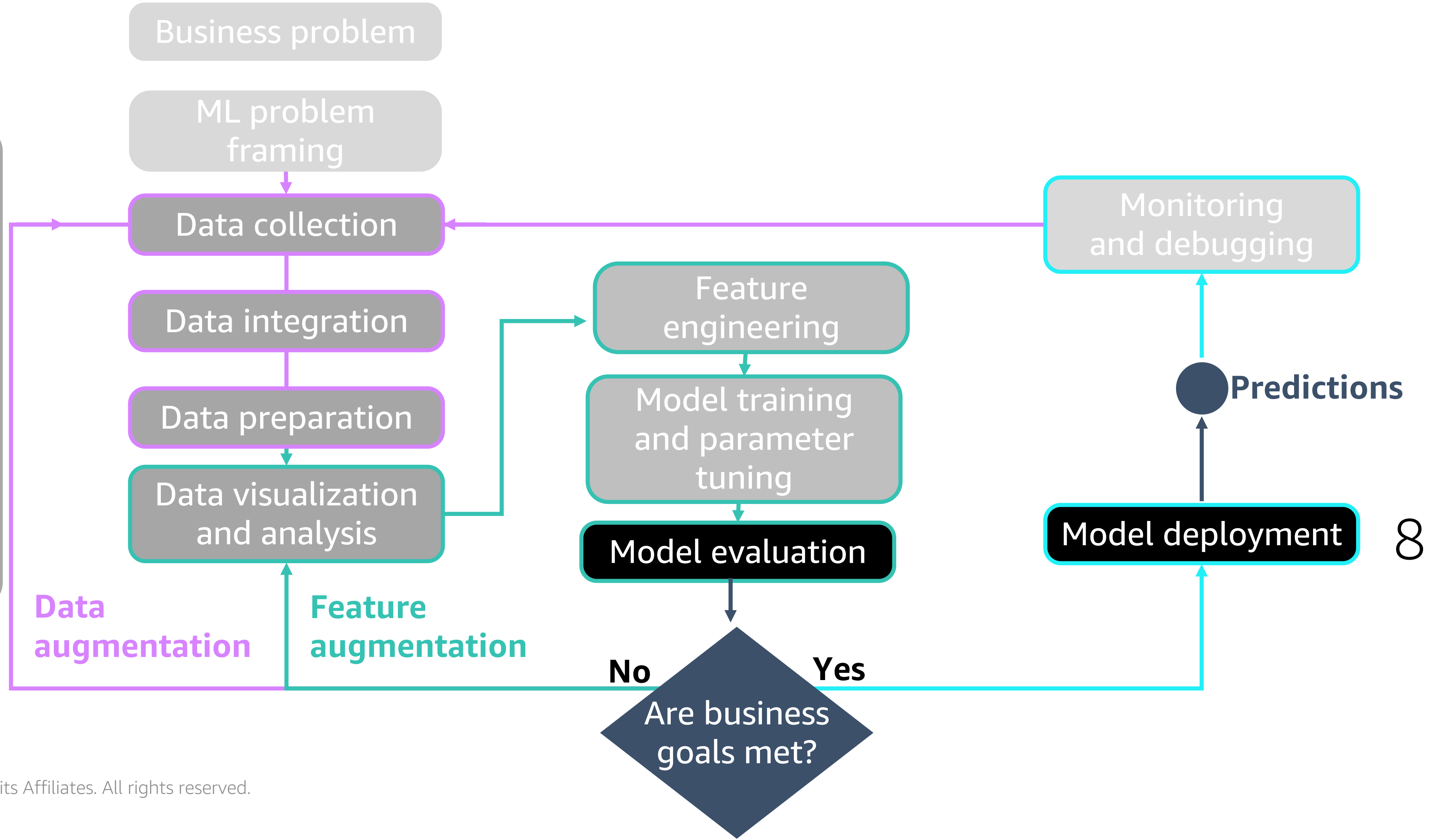
5, 6, 7 – Model evaluation, data and feature augmentations

- Evaluate if model performance meets business goals
- Will feature augmentations or data augmentations lead to improve model performance



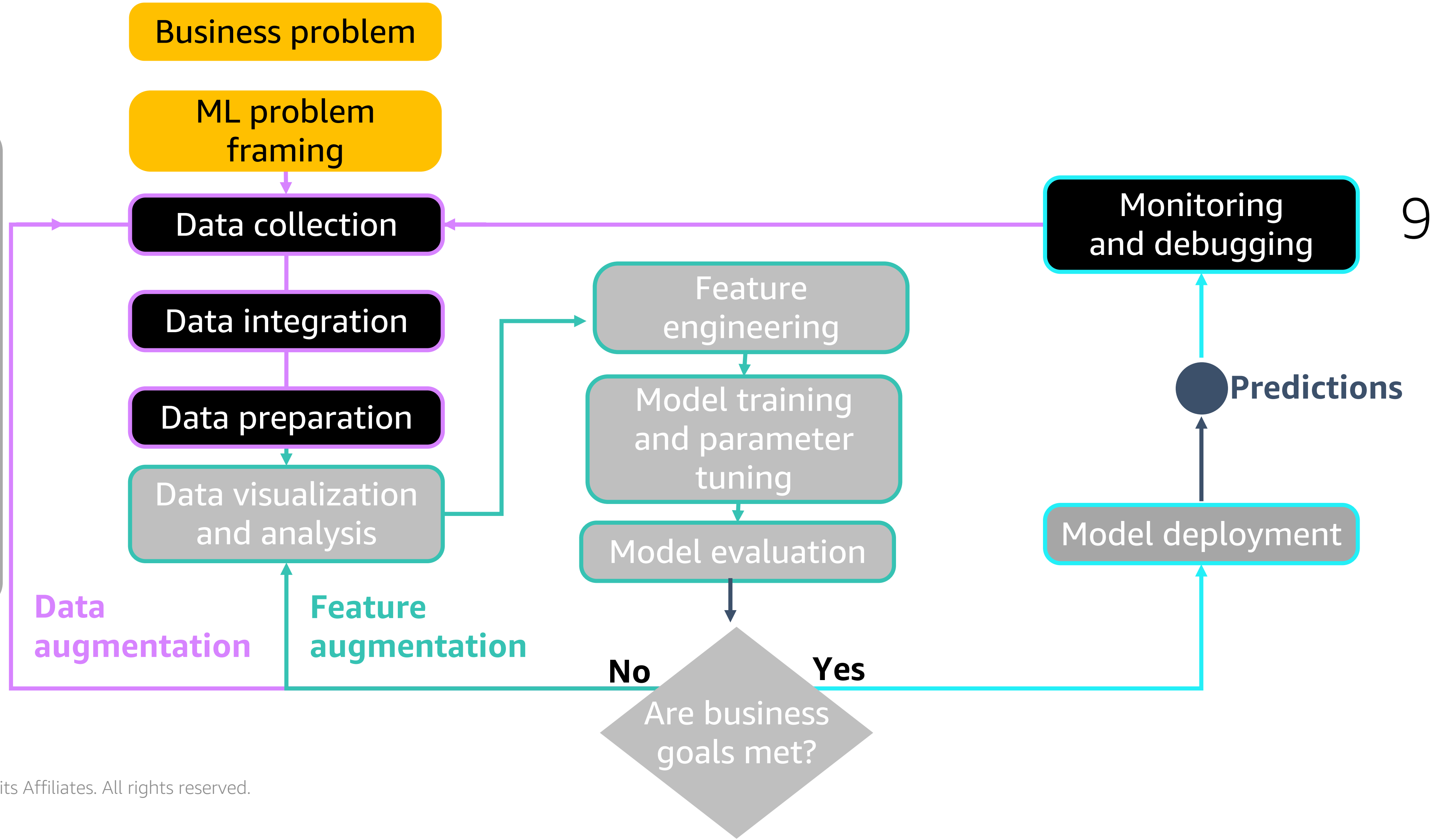
8. Model deployment

- If the model performance meets business goals
- Work with DevOps to deploy the ML model



9. Model monitoring and debugging

- Monitor for model performance and model drift
- To correct model drift, will need to go back to data collection and training phase



ML and the cloud journey

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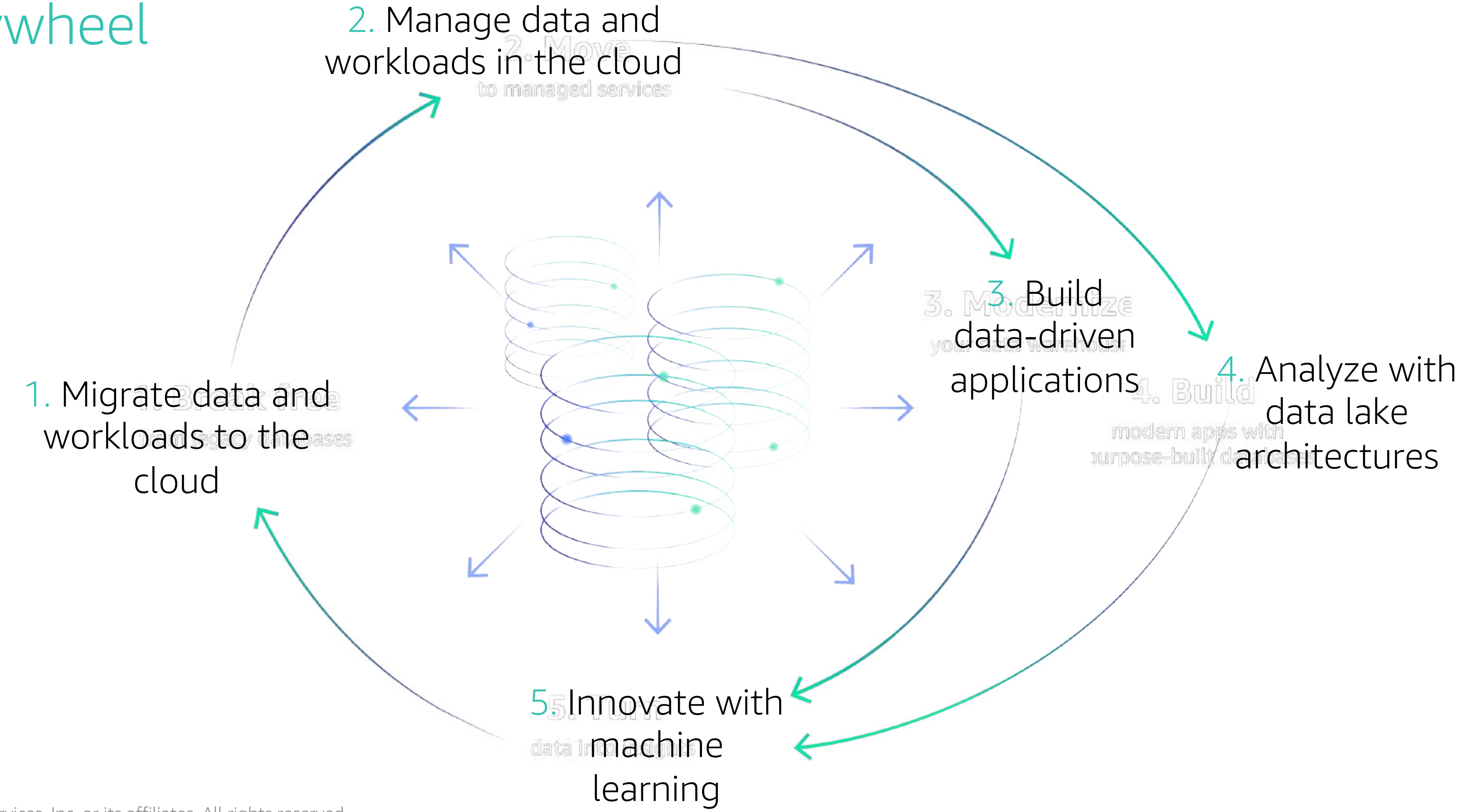
Data Flywheel

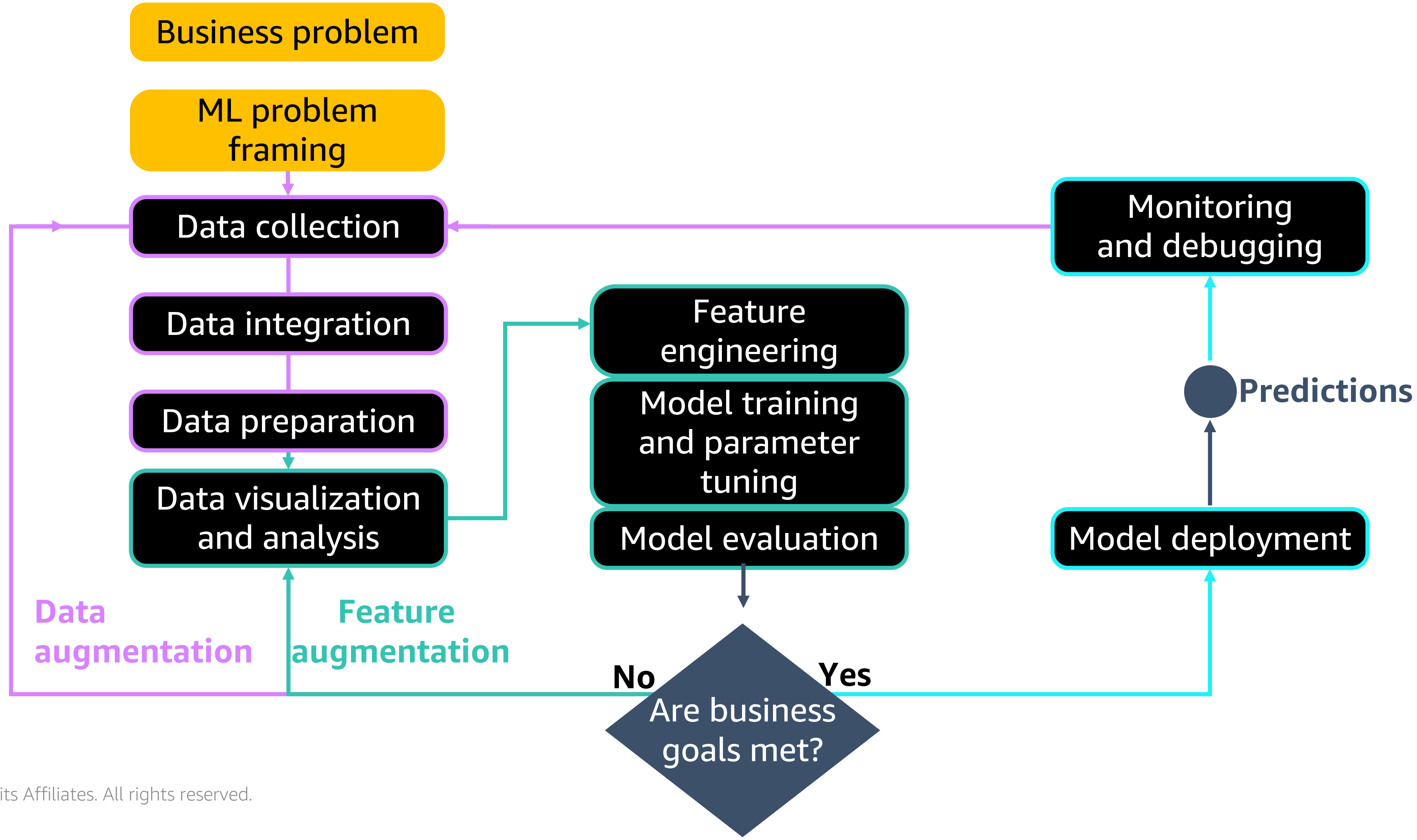


Workbook 3.0

- Revisit the persona you affiliated with at the beginning of the course
- With this persona in mind, identify portions of the machine learning process where you could add value, including what you could do and how you would do it during each phase

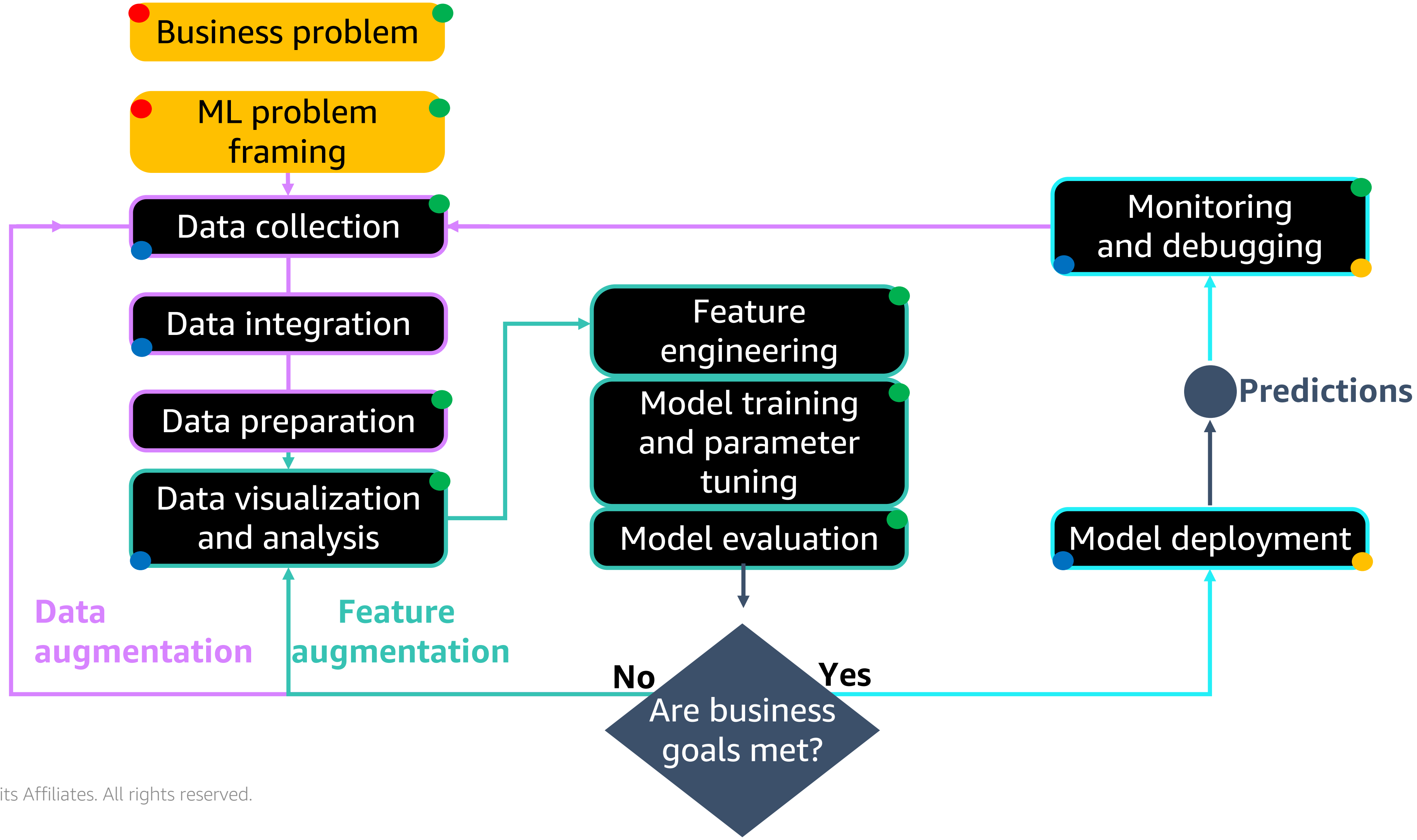
<u>3-minute individual exercise and 3-minute class discussion</u>

Workbook 3.1


Business problem
ML problem framing
Data collection
Data integration
Data preparation
Data visualization and analysis
Feature engineering
Model training and parameter tuning
Model evaluation
Are business goals met?
No
Yes
Model deployment
Predictions
Monitoring and debugging
Data augmentation
Feature augmentation

Workbook 3.1

- TAM
- Data Scientist
- Developer
- DevOps



How you can help customers

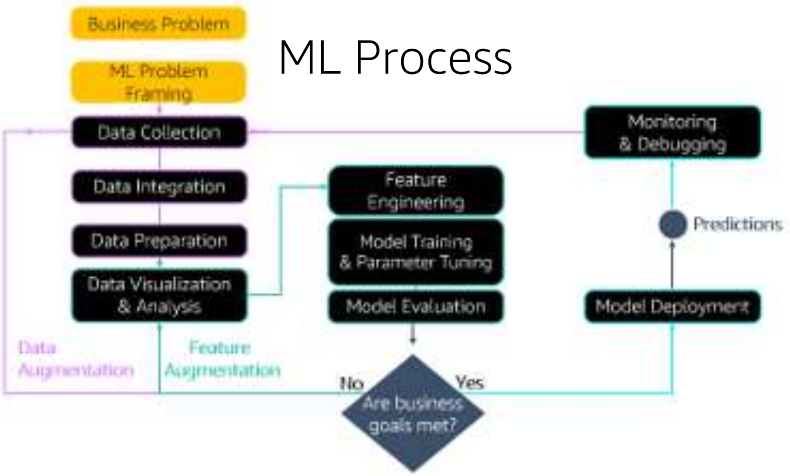
Customers

Just starting

Specific use case

Expert

Most business problems are not ML problems



ML Process

Amazon AI/ ML

Pricing

Course use case

Workbook 3.2: Use case

- Focused on many types of insurance
- Key challenge today is fraud
- Costing them millions of dollars per year
- Lots of historical data
- Wants to improve new claims fraud prediction
- Resolution needed by EOY

Workbook 3.2

	months_as_customer	age	policy_number	policy_bind_date	policy_state	policy_csl	policy_deductable	policy_annual_premium	umbrella_limit	insured_zip	police_report_available	total_claim_amount	injury_claim	property_claim	vehicle_claim	auto_make	auto_model	auto_year	fraud_reported
0	328	48	521585	2014-10-17	OH	250/500	1000	1406.91	0	466132	YES	71610	6510	13020	52080	Saab	92x	2004	Y
1	228	42	342868	2006-06-27	IN	250/500	2000	1197.22	5000000	468176	?	5070	780	780	3510	Mercedes	E400	2007	Y
2	134	29	687698	2000-09-06	OH	100/300	2000	1413.14	5000000	430632	NO	34650	7700	3850	23100	Dodge	RAM	2007	N
3	256	41	227811	1990-05-25	IL	250/500	2000	1415.74	6000000	608117	NO	63400	6340	6340	50720	Chevrolet	Tahoe	2014	Y
4	228	44	367455	2014-06-06	IL	500/1000	1000	1583.91	6000000	610706	NO	6500	1300	650	4550	Acura	RSX	2009	N

Knowledge check

Knowledge check

What is the most critical phase of the machine learning process?

- Data Collection, Integration, and Preparation phase
- Model Deployment phase
- Feature Engineering, Model Training, and Parameter Tuning phase
- ✓ Business Process phase

Knowledge check

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When does the ML process end?

- After model evaluation
- After model deployment
- After model monitoring and debugging
- ✓ The ML process never ends

Module 4: Data Collection, Integration, Preparation, Visualization, and Analysis

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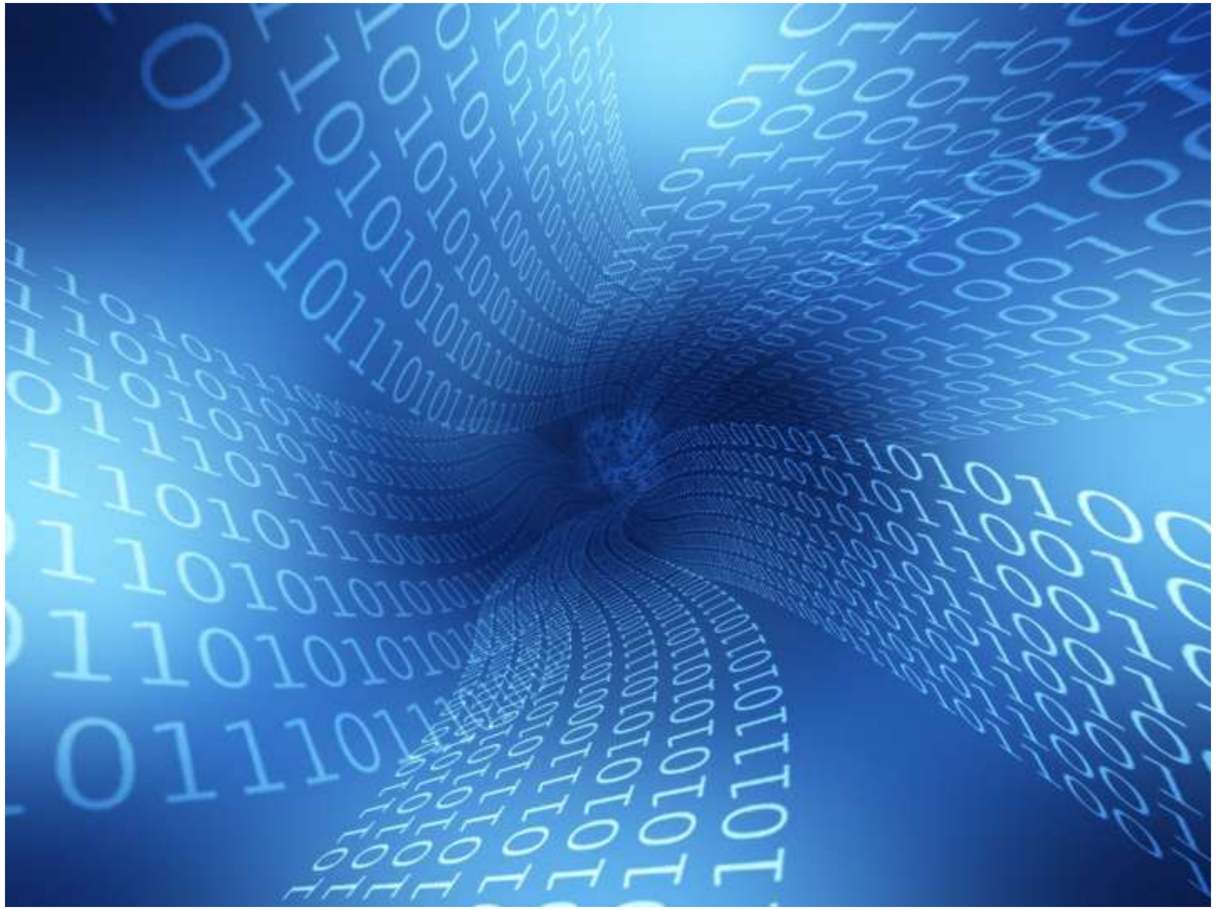
Module 4: Data Collection, Integration, Preparation, Visualization, and Analysis

- Explain why data is critical to machine learning problems
- Explain structured and unstructured data
- Explain the purpose of data phases in the ML process
- Identify AWS services that are used during data collection, integration, preparation, and visualization
- Explain Amazon SageMaker Data Wrangler
- Explain Amazon SageMaker Feature Store
- Explain the purpose of Amazon SageMaker Ground Truth and identify its use cases

Data challenges in ML projects



- ML project requires lots of data
- **ML requires clean data.**
- More than 50% of project time is spent gathering, cleansing, and visualizing data.
- 36% see dirty data as the #1 challenge.

Source Kaggle Machine Learning and Data Science Survey 2017:
https://www.kaggle.com/kaggle/kaggle-survey-2017

Structured versus unstructured data

Name	Color	Vegetable
Apple	Red	No
Broccoli	Green	Yes
Spinach	Green	Yes
Grape	Purple	No
Squash	Yellow	Yes

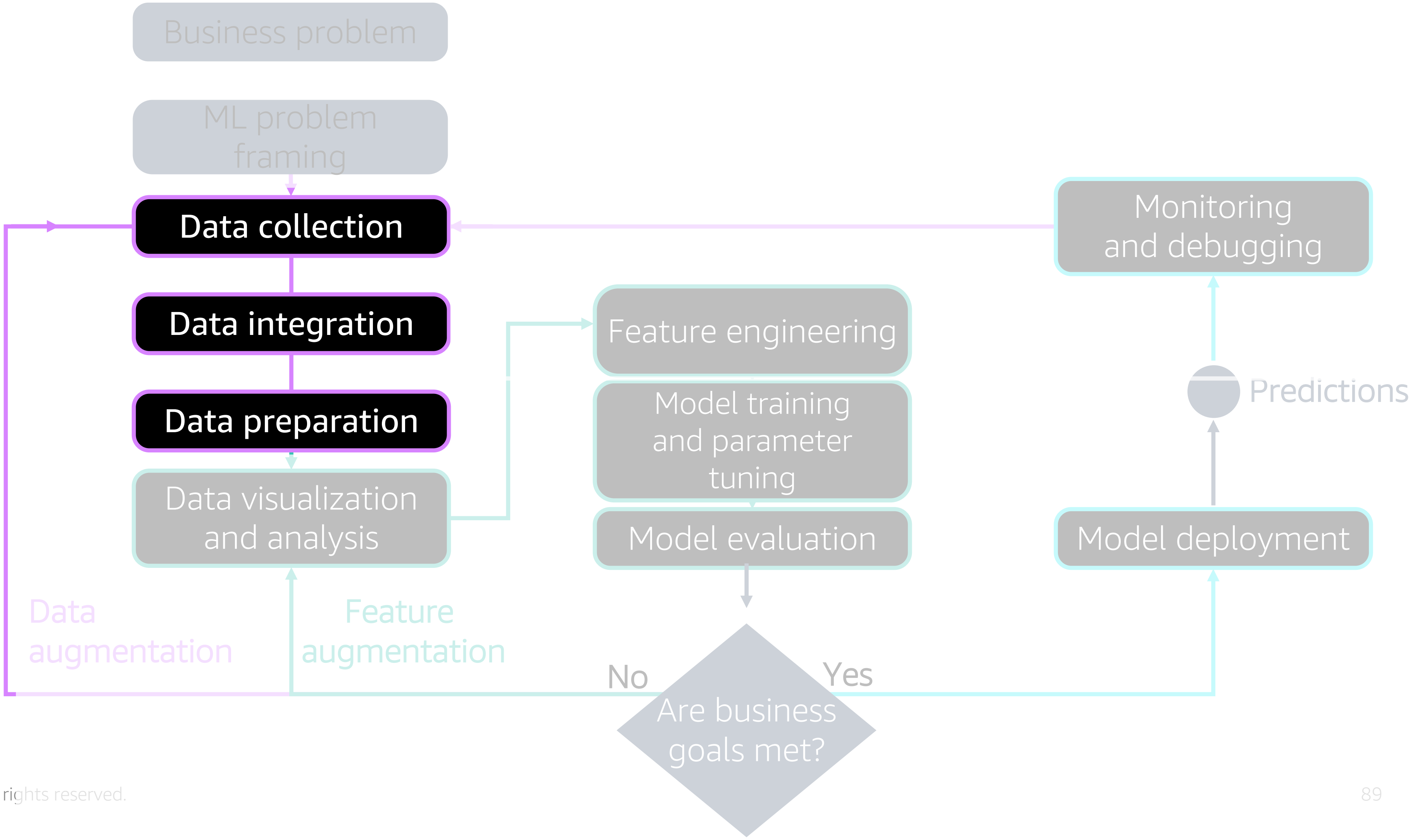
Structured
(relational databases, .csv files)

Unstructured
(documents,
audio, or video files)

ML process: Collection, Integration

Build the data platform:

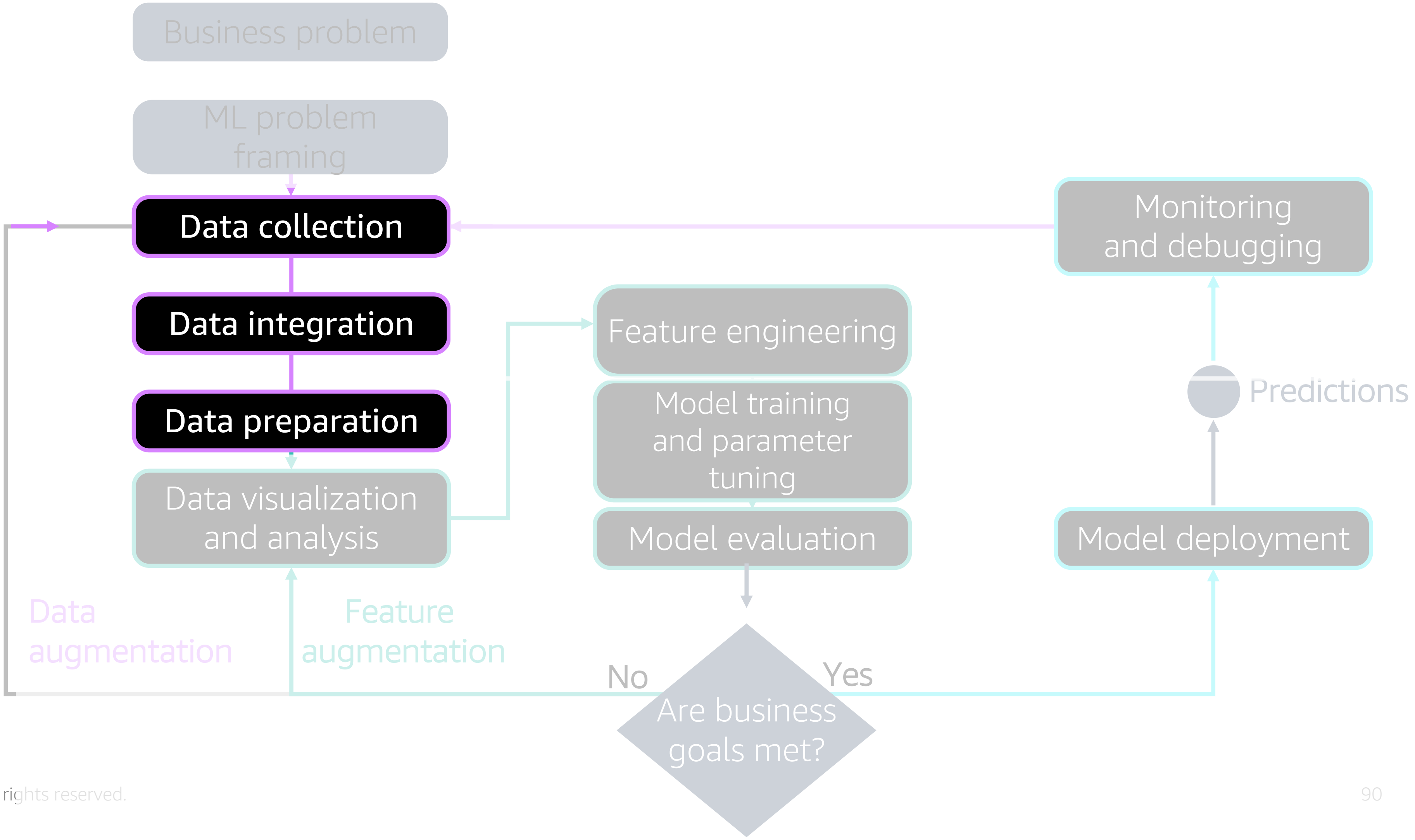
- Amazon Simple Storage Service (Amazon S3)
- Amazon Athena
- Amazon EMR
- AWS Glue
- Amazon QuickSight
- AWS Lake Formation
- Amazon Redshift



ML process: Preparation

Preparation steps:

- Data exploration and profiling
- Data formatting
- Data conversion
- Encoding
- Data cleaning
- Normalization
- Resampling (oversampling/ undersampling)



Amazon SageMaker Data Wrangler

aws training and certification

SageMaker Data Wrangler

The fastest and easiest way to prepare data for ML

With a **single click**

- Ingest data from various data sources
- Deploy data preparation workflows into production

Leverage **built-in feature** to

- Transform data with data transformations
- Data visually using visualization templates

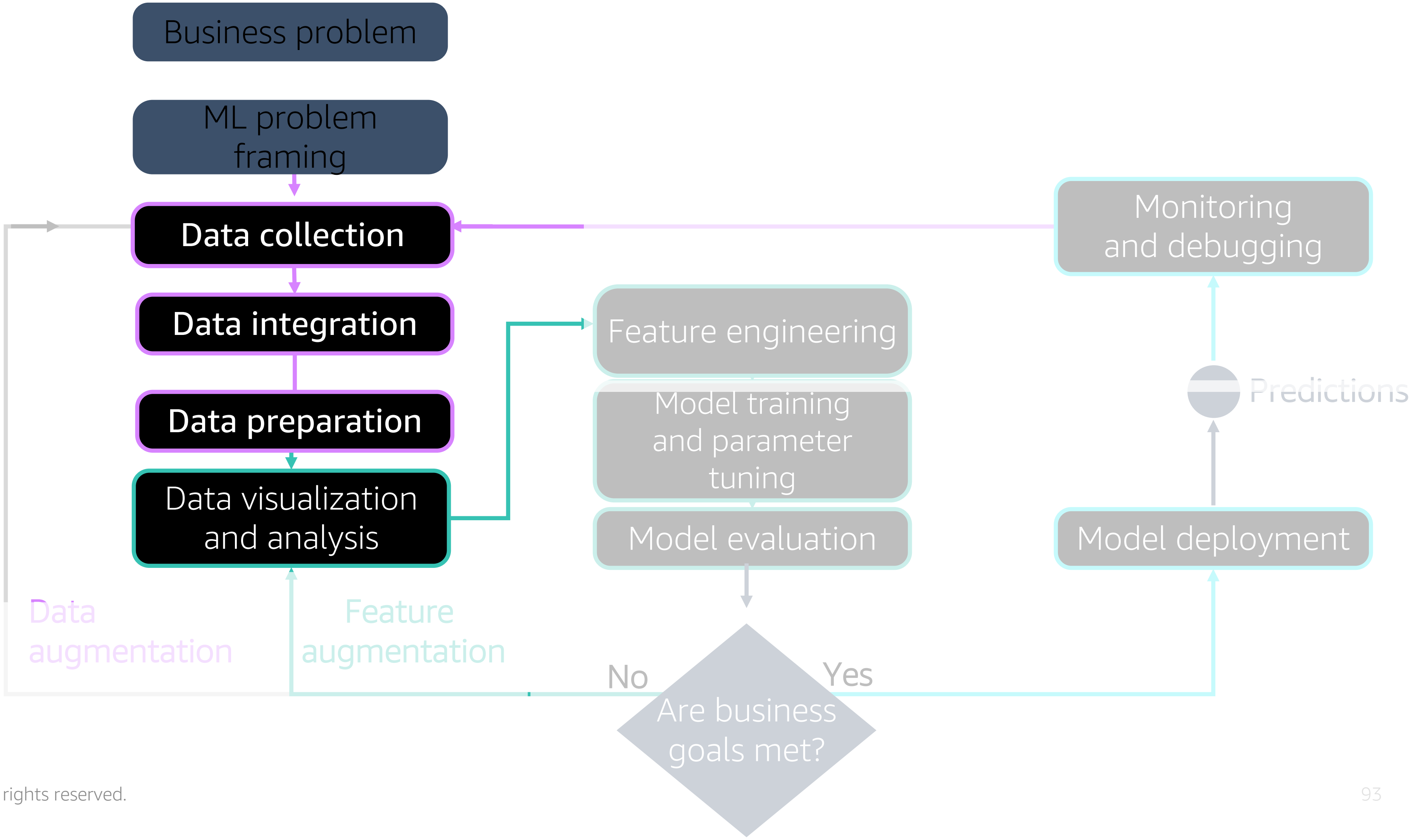
Ability to

- Bring your custom transformation
- Estimate ML model accuracy

Data collection, integration, preparation and visualization with Data Wrangler

Data Wrangler's

- Data Selection tool to import data in various formats from multiple sources
- Leverage 300+ data transformations to transform imported data
- Leverage pre-configured visualization template to visualize your data



Amazon SageMaker Feature Store

Challenges in Scaling ML Productivity

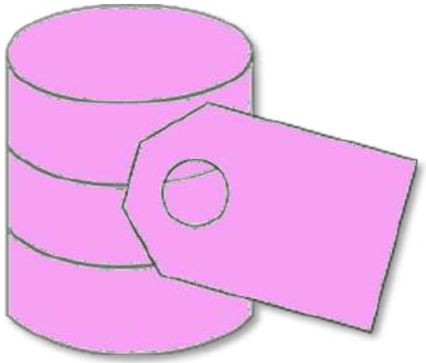
- Long and tedious feature engineering
- Redundant feature pipelines
- No sharing or discovery mechanism
- Troubleshooting overhead due to training inference skew

SageMaker Feature Store benefits

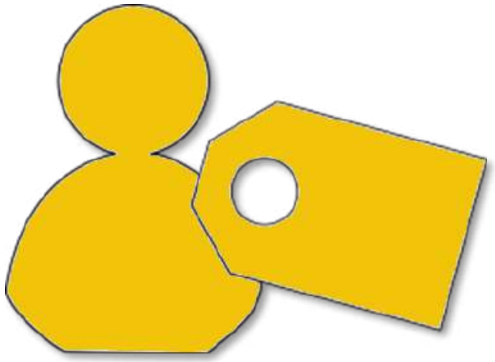
- Ingest features from many sources including Data Wrangler
- Search and discover features easily
- Ensure feature consistency for both training and for inferences
- Standardize with a single source of feature definition
- Integrate with SageMaker Pipeline

Amazon SageMaker Ground Truth

Amazon SageMaker Ground Truth Overview



Quickly label training data



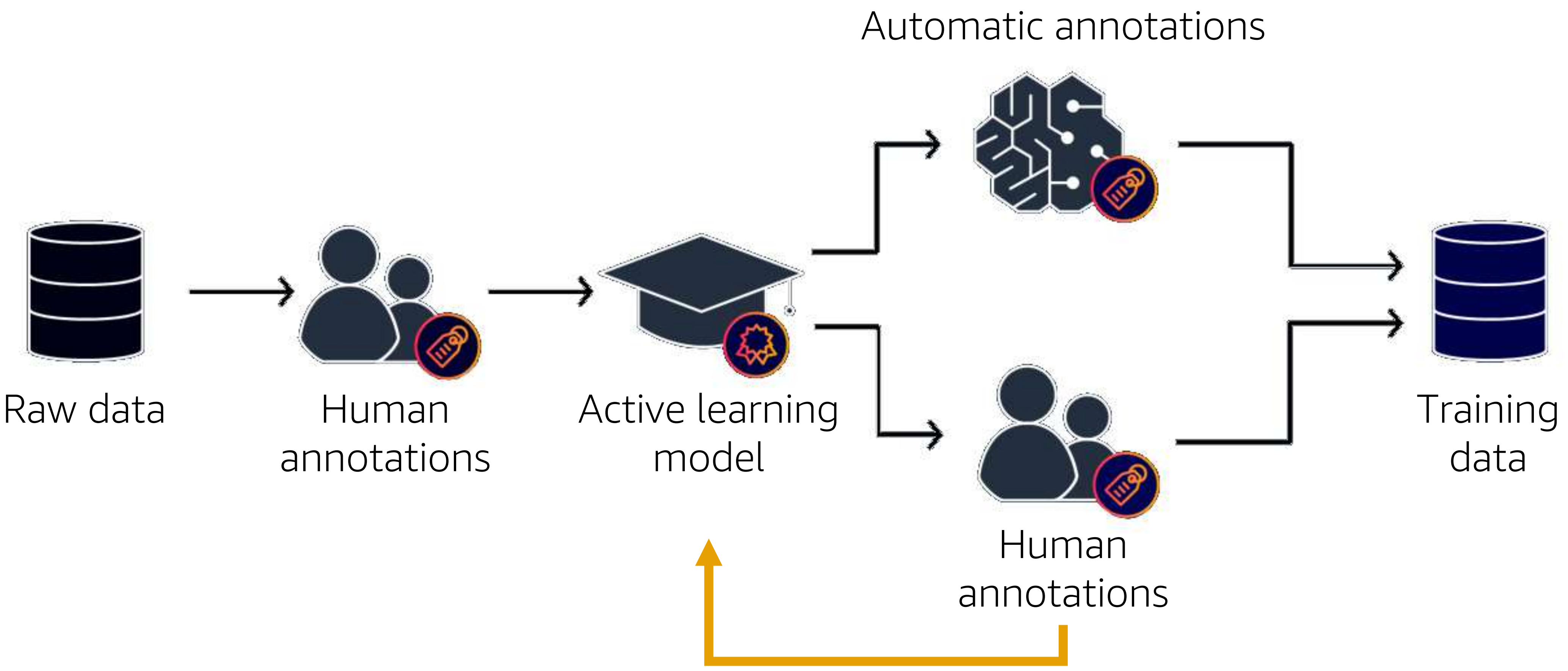
Easily integrate human labelers

Get accurate results

KEY FEATURES

- Automatic labeling by way of machine learning
- Ready-made and custom workflows for image bounding box, segmentation, and text
- Private and public human workforce
- Label management

SageMaker Ground Truth: How it works



How you can help customers

- Understand the data structure and its purpose
- Understand where data comes from and how it is used today
- Devise the appropriate data processing solution

Clean, prepare, and visualize data first, before using it for ML!

Course use case

Workbook 4.1

	months_as_customer	age	policy_number	policy_bind_date	policy_state	policy_csl	policy_deductable	policy_annual_premium	umbrella_limit	insured_zip	police_report_available	total_claim_amount	injury_claim	property_claim	vehicle_claim	auto_make	auto_model	auto_year	fraud_reported
0	328	48	521585	2014-10-17	OH	250/500	1000	1406.91	0	466132	YES	71610	6510	13020	52080	Saab	92x	2004	Y
1	228	42	342868	2006-06-27	IN	250/500	2000	1197.22	5000000	468176	?	5070	780	780	3510	Mercedes	E400	2007	Y
2	134	29	687698	2000-09-06	OH	100/300	2000	1413.14	5000000	430632	NO	34650	7700	3850	23100	Dodge	RAM	2007	N
3	256	41	227811	1990-05-25	IL	250/500	2000	1415.74	6000000	608117	NO	63400	6340	6340	50720	Chevrolet	Tahoe	2014	Y
4	228	44	367455	2014-06-06	IL	500/1000	1000	1583.91	6000000	610706	NO	6500	1300	650	4550	Acura	RSX	2009	N

Knowledge check

Knowledge check

Which of these are the two main challenges data engineers face after data collection and before the data can be used for training?

- Data integration and preparation
- Data variety - different data formats
- Data veracity - completeness, accuracy, or quality
- Structured and unstructured data

Knowledge check

What are the three key benefits of Amazon SageMaker Ground Truth?

- Speeds up model evaluation
- Quickly labels training data
- Easily integrates human labelers
- Gets accurate labeling results

Module 5: Deep Learning Amazon Machine Images

aws training and certification

Module 5: Deep Learning Amazon Machine Images

- Identify what deep learning AMIs are
- Identify the capabilities of AWS Deep Learning AMIs
- Identify use cases for AWS Deep Learning AMIs
- Explain when, how, and why to use AWS Deep Learning AMIs

ML infrastructure

Amazon ML stack

aws training and certification

AI services

Vision | Speech | Text | Search | Chatbots | Personalize | Forecast | Fraud | Development | Contact Centers

ML services

Amazon SageMaker | Ground Truth | AWS Marketplace for ML | SageMaker Studio IDE | Neo | Augmented AI

ML frameworks and infrastructure

TensorFlow | PyTorch | Gluon | Keras | DeepGraphLibrary | Deep Learning AMIs and Containers | GPUs and CPUs | Elastic Inference | Inferencia | FPGA

AWS Deep Learning AMIs: Two choices

- Pre-configured environments to quickly build deep learning applications for ML practitioners and researchers
- Quickly launch Amazon EC2 instances pre-installed with popular deep learning frameworks and interfaces

Conda AMI

- Pre-installed pip package for deep learning framework
- Available in Ubuntu, Amazon Linux, and Windows 2016 versions

Base AMI

- Clean slate to set up custom private deep learning engine repository with no frameworks installed; only NVIDIA CUDA and other dependencies
- Available in Ubuntu and Amazon Linux versions

Supported deep learning frameworks

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TensorFlow

PyTorch

mxnet

Chainer

theano

K

The Microsoft Cognitive Toolkit

GLUON

ML Infrastructure: AWS Deep Learning AMIs

aws training and certification

Provides access to the Amazon ML infrastructure

ML infrastructure

TensorFlow GLUON

MXNet Chainer

PyTorch Keras

P3 instance

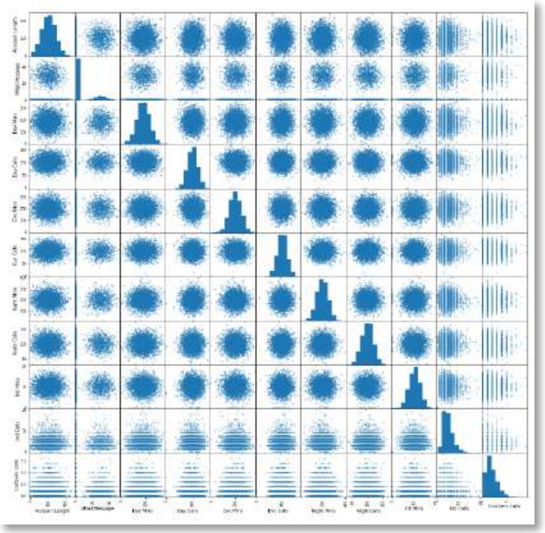
C5 instance

EC2 Inf1

Amazon Elastic Inference

Use cases: DLAMI

Learning and app development



Machine learning and data analytics

Research

Cost optimization

- AMIs are free. Customers pay only for AWS infrastructure.
- Benefits are gained from using powerful compute instances.
- P3 instances speed up training and reduce costs.
- Anaconda Data Science Platform simplifies package management and deployment (everything is ready for you to get started).
- Customers can containerize their code to realize economies of scale.

DLAMI customers

- Machine learning experts
- Build custom algorithms
- Need more flexibility
- Building internal data science teams

Course use case

Workbook 5.1

- Return to the AnyCompany use case.
- Could a DLAMI be used to predict future insurance claim fraud?
- Provide information to support your answer.

<u>3-minute individual exercise and 3-minute class discussion</u>

Knowledge check

Knowledge check

Conda-based AWS Deep Learning AMIs come installed with Jupyter Notebook loaded with which of the following kernels? (Select TWO)

- Scikit-learn
- SparkML
- ✓ TensorFlow
- ✓ Apache MXNet

Module 6: Amazon SageMaker Concepts

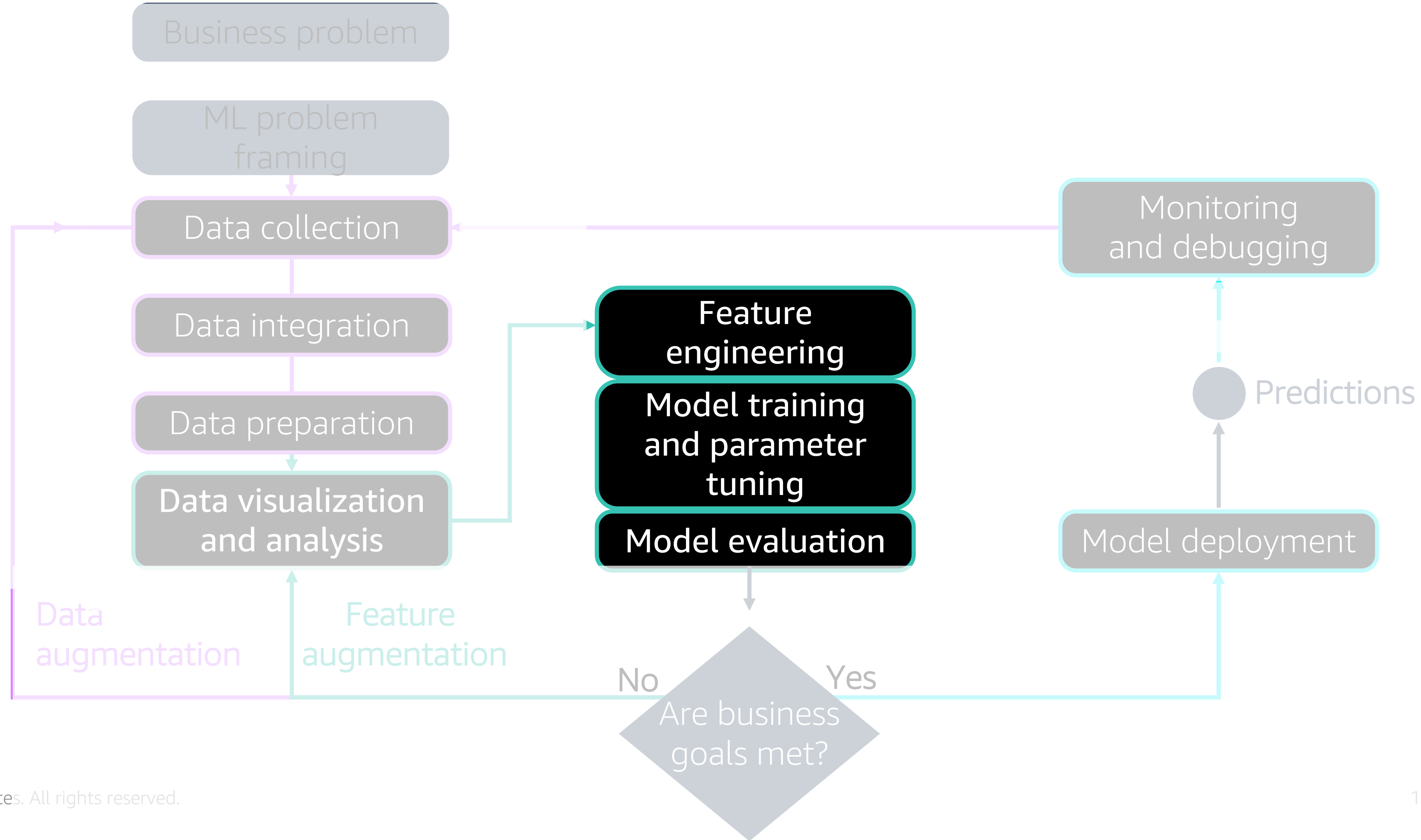
aws training and certification

Module 6: Amazon Sagemaker Concepts

- Review a typical machine learning workflow using the AWS Deep Learning AMIs
- Identify what Amazon SageMaker is and explain how it works
- Identify the key components and features of Amazon SageMaker
- Discuss Amazon SageMaker Studio
- Identify use cases for Amazon SageMaker
- Identify the advantages of using Amazon SageMaker
- Summary of latest SageMaker services

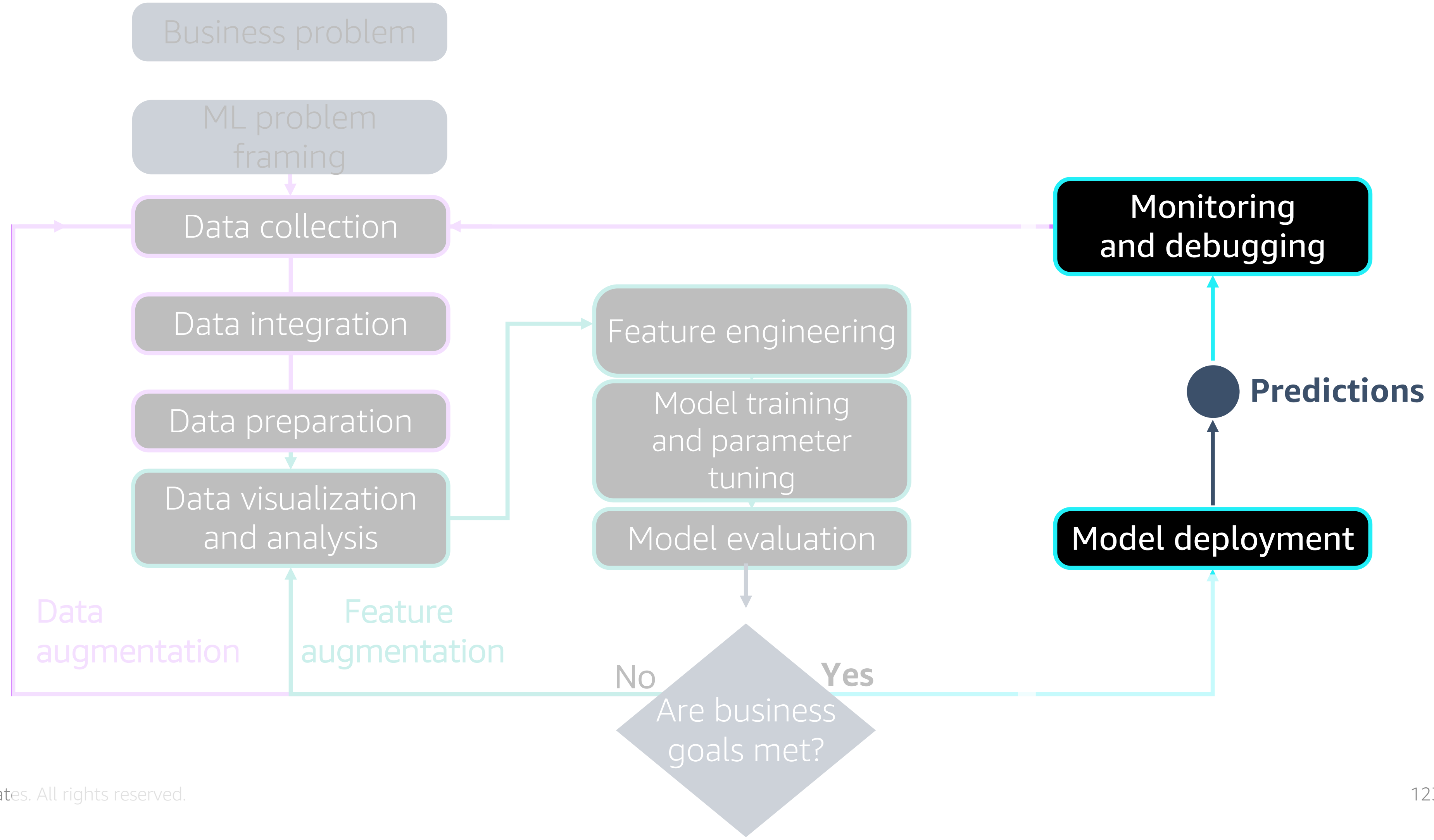
ML process: Model training

- Set up and manage
  - Notebook environments
  - Training clusters
- Write data connectors
- Scale ML algorithms to large datasets
- Distribute ML training algorithm to multiple machines
- Secure model artifacts



ML process: DevOps

- Set up and manage inference clusters
- Manage and scale model inference APIs
- Monitor and debug model predictions
- Model versioning and performance tracking
- Automate new model version promotion to production (A/B testing)



Challenges building and deploying an ML model

- ML development can be complex, cumbersome, time consuming, error prone, expensive, and a very iterative process.
- Different personas often use different tools in different phases of ML development, which can make collaboration and sharing work a challenge, affecting productivity.
- ML development lacked a robust integrated development environment (IDE) for the entire ML workflow until Amazon introduced Amazon SageMaker.

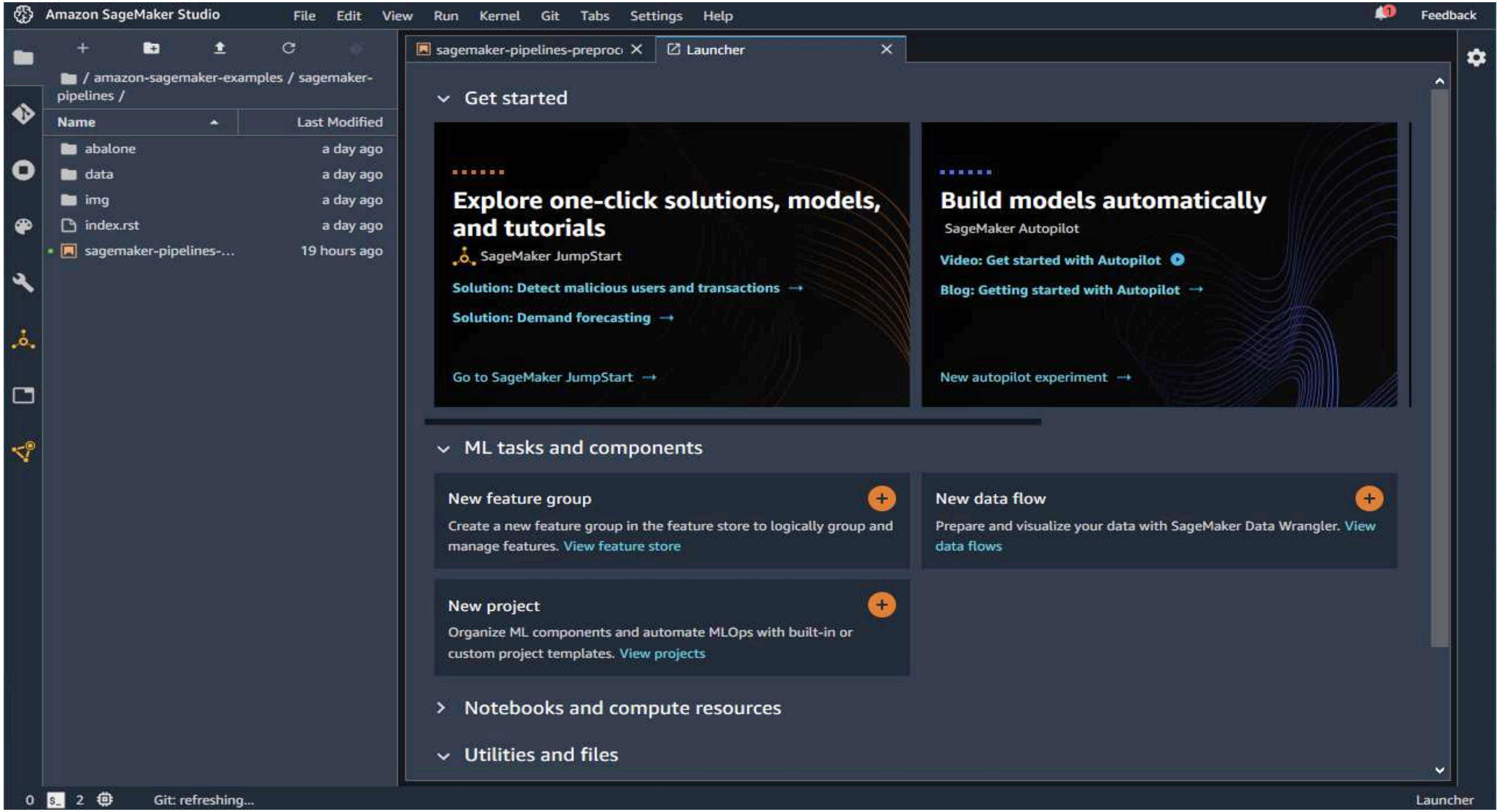
Amazon SageMaker

Amazon SageMaker Overview

Prepare	Build	Train & tune	Deploy & manage
SageMaker Ground Truth	SageMaker Studio Notebook	One-click Training	One-click Deployment
SageMaker Data Wrangler	Built-in and Bring-your-own Algorithms	SageMaker Experiments	Kubernetes & Kubeflow integration
SageMaker Processing	Local Mode	SageMaker Automatic Model Tuning	Multi-Model Endpoints
SageMaker Feature Store	SageMaker Autopilot	**SageMaker Distributed Training**	SageMaker Model Monitor
SageMaker Clarify	**SageMaker JumpStart**	SageMaker Debugger	SageMaker Edge Manager
		Managed Spot Training	**SageMaker Pipeline**

Amazon SageMaker Studio IDE

Fully integrated development environment (IDE) for Machine Learning



Amazon SageMaker Studio

Prepare	Build	Train & tune	Deploy & manage
SageMaker Ground Truth	SageMaker Studio Notebook	One-click Training	One-click Deployment
SageMaker Data Wrangler	Built-in and Bring-your-own Algorithms	SageMaker Experiments	Kubernetes & Kubeflow integration
SageMaker Processing	Local Mode	SageMaker Automatic Model Tuning	Multi-Model Endpoints
SageMaker Feature Store	SageMaker Autopilot	SageMaker Distributed Training	SageMaker Model Monitor
SageMaker Clarify	SageMaker JumpStart	SageMaker Debugger	SageMaker Edge Manager
		Managed Spot Training	SageMaker Pipeline

SageMaker Studio – Fully Integrated development environment (IDE) for ML

Summary of new SageMaker services

SageMaker Jumpstart	SageMaker Clarify	Deep Profiling for SageMaker Debugger	SageMaker Distributed Training
Set of solutions for common ML use cases with one click deployable ML models and algorithms	Brings transparency to your models by detecting bias across the ML workflow and explaining model behaviors.	Optimizes ML models with real-time monitoring of training metrics and system resources	You can train large deep learning models faster by automatically partitioning your model and training data with distributed training.

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

Knowledge check

Knowledge check

Which Amazon SageMaker service enables ML Practitioners to build, train, tune and deploy ML model from a single interface?

- Amazon SageMaker Experiments
- ✓ Amazon SageMaker Studio
- Amazon SageMaker Debugger
- Amazon SageMaker Model Monitor

Knowledge check

Which Amazon SageMaker service enables one click hyperparameter tuning?

- Amazon SageMaker Debugger
- Amazon SageMaker Automatic Model Tuning
- Amazon SageMaker Model Monitor
- Amazon SageMaker Experiments

Module 7: Amazon SageMaker Notebooks

aws training and certification

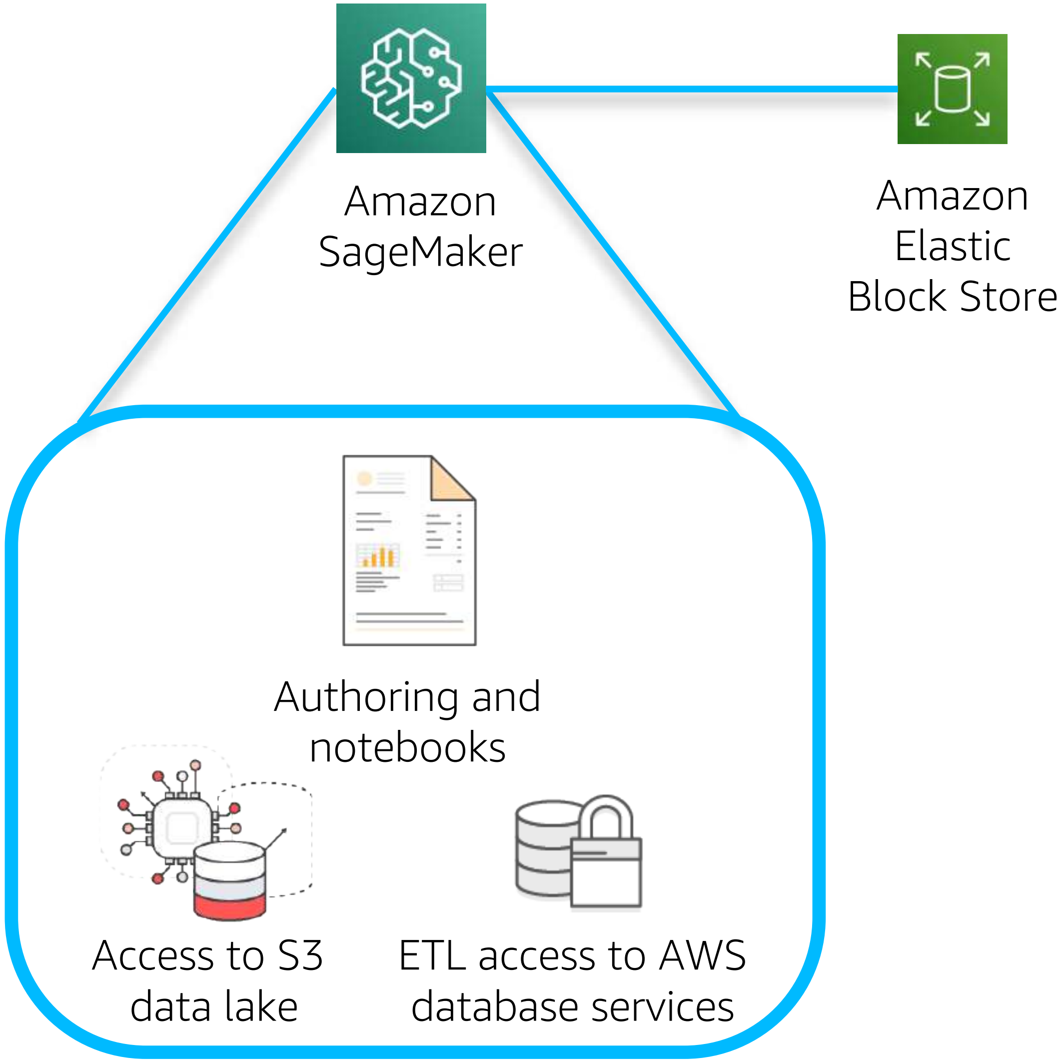
Module 7: Amazon SageMaker Notebooks

- Introduction to Jupyter Notebook and how Amazon SageMaker uses it
- Demo SageMaker notebooks - Create a notebook instance and explain how this is accomplished using Amazon SageMaker

Amazon SageMaker Notebooks

- **Single Sign-On (SSO)** - Access your notebooks in seconds
- **Access controls** - Administrators manage access and permissions
- **Fully managed** - Use your notebooks without manually spinning up or configuring compute resources
- **Collaboration** - Share notebooks with a single click
- **Scalability** - Scale up or down compute resources as needed

Notebook instances



- Recommendations/personalization
- Fraud detection
- Forecasting
- Image classification
- Churn prediction
- Marketing email/campaign targeting
- Log processing and anomaly detection
- Speech to text
- More…

Amazon SageMaker Notebooks demonstration

T2

```
# BUILD
algorithm = get_image_uri(...)
model = Estimator(algorithm,role,instance_type)
model.set_hyperparameters(...)

# TRAIN
model.fit(train_data)

# DEPLOY
endpoint = model.deploy(instance_type)
endpoint.predict(test_data)
```

C5

M5

Knowledge check

Knowledge check

To avoid unnecessary charges, your customer should always shut down unused processes in a Jupyter Notebook instance. To do this, they select the Running tab, and click the shut down button for the active process.

- True
- False

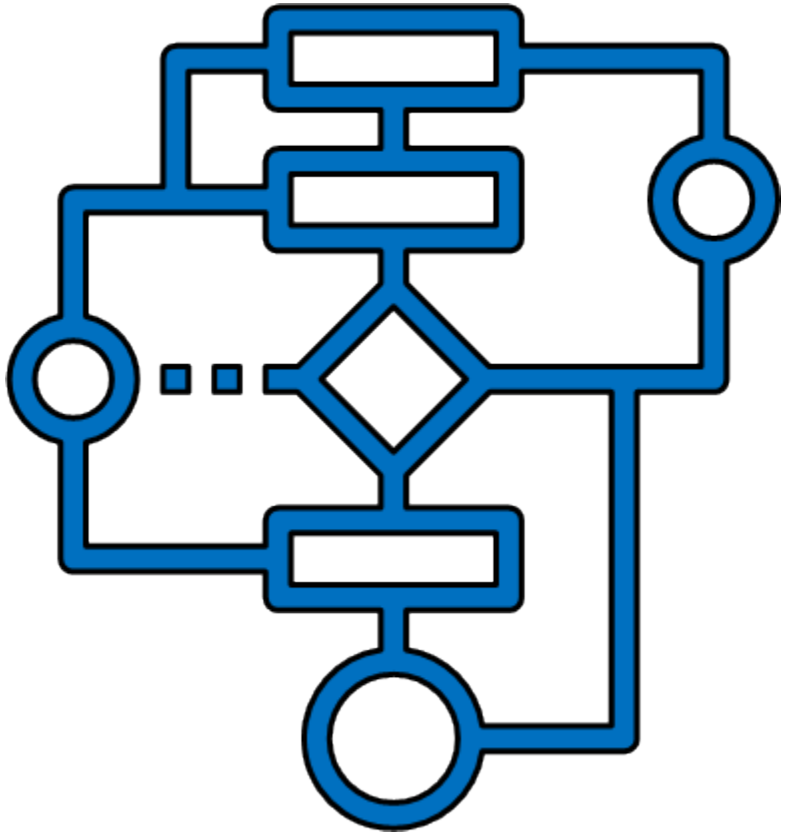
Module 8: Amazon SageMaker Built-In Algorithms

Module 8: SageMaker Built-In Algorithms

- Identify and explain the purpose of the Amazon SageMaker built-in algorithms
- Locate Amazon SageMaker algorithm examples in the console
- Select the appropriate algorithm for a business problem and data
- Configure and initiate a training job
- Associate a training job with an appropriate Amazon Simple Storage Service (Amazon S3) bucket
- Use queries with a model

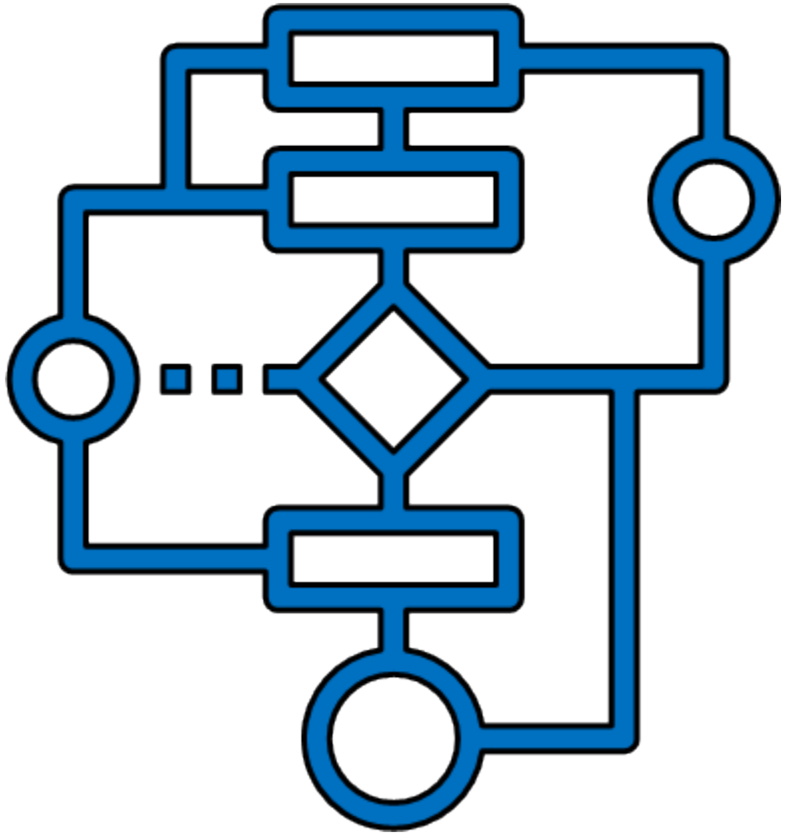
Algorithms

aws training and certification



- *Algorithms* are standardized methods used to train models.
- A *model* is a function that maps inputs to a set of predicted outcomes using algorithms.
- The exact definition of a model is unknown.
- Existing data is used to build a function, using rules, and this is called *training.*
- Algorithms define model rules.

Types of algorithms



- Linear regression
- Logistic regression
- Clustering
- Vectorization
- Image classification
- Encoding and decoding
- Language processing

Amazon SageMaker Built-in Algorithms

aws training and certification

General purpose

Numerical regression or classification

- Linear Learner
- XGBoost
- K-Nearest Neighbors (K-NN)

Recommendation

Factorization Machines

Group entities based on data

K-Means

Detect anomalies in time series data

Random Cut Forest (RCF)

Specific use cases

Classify images or find objects in images

- Image Classification
- Object Detection
- Semantic Segmentation

Classify, encode, and transform text data

- Sequence to Sequence (seq2seq)
- Neural Topic Model (NTM)
- Blazing Text
- Object2Vec

Predict future trends based on past history (time series)

DeepAR Forecasting

Reduce dimensions in datasets with high numbers of attributes

Principle Component Analysis (PCA)

Find usage patterns in network access logs

IP Insights

Algorithms

Game Show

Mary

John

Algorithms

Game Show

- **Five** scenarios relating to Amazon SageMaker algorithms
- **Four** options
- **One** option addresses the scenario

Algorithms

Game Show

Scenario 1

- Real estate company
- Predict price of newly listed home
- Dataset has 100,000 records of selling prices of house in the area
- Dataset has 12 features

Question 1

Which Amazon SageMaker algorithm would be most appropriate to use?

DeepAR Forecasting	Linear Learner algorithm
Random Cut Forest algorithm	Factorization Machines

Algorithms

Game Show

Scenario 1

- Real estate company
- Predict price of newly listed home
- Dataset has 100,000 records of selling prices of house in the area
- Dataset has 12 features

Question 1

Which Amazon SageMaker algorithm would be most appropriate to use?

DeepAR Forecasting	Linear Learner algorithm
Random Cut Forest algorithm	Factorization Machines

Algorithms

Game Show

Scenario 2

- Home insurance company
- Estimating rebuild cost has been manual
- Goal is to automate this process using historical data
- Many features and some are more important than others

Question 2

Which Amazon SageMaker algorithm should you use?

Random Cut Forest algorithm	Linear Learner algorithm
XGBoost algorithm	K-Nearest Neighbors (k-NN) algorithm

Algorithms

Game Show

Scenario 2

- Home insurance company
- Estimating rebuild cost has been manual
- Goal is to automate this process using historical data
- Many features and some are more important than others

Question 2

Which Amazon SageMaker algorithm should you use?

Random Cut Forest algorithm	Linear Learner algorithm
XGBoost algorithm	K-Nearest Neighbors (k-NN) algorithm

Algorithms

Game Show

Scenario 3

- National bank
- Risk scoring clients based on parameters
- Current algorithm based on hand-coded business rules and 50 parameters
- Need to classify based on similarity of parameters

Question 3

Which Amazon SageMaker algorithm should you use?

Factorization Machines	K-Nearest Neighbors (k-NN) algorithm
K-Means algorithm	Random Cut Forest algorithm

Algorithms

Game Show

Scenario 3

- National bank
- Risk scoring clients based on parameters
- Current algorithm based on hand-coded business rules and 50 parameters
- Need to classify based on similarity of parameters

Question 3

Which Amazon SageMaker algorithm should you use?

Factorization Machines	K-Nearest Neighbors (k-NN) algorithm
K-Means algorithm	Random Cut Forest algorithm

Algorithms

Game Show

Scenario 4

- Credit union
- Basing lending decisions on credit score
- They have data on members and want to group based on low, medium, and high risk
- Want to predict which group a potential borrower fits into

Question 4

Which Amazon SageMaker algorithm should you use?

Linear Learner algorithm	K-Nearest Neighbors (k-NN) algorithm
K-Means algorithm	XGBoost algorithm

Algorithms

Game Show

Scenario 4

- Credit union
- Basing lending decisions on credit score
- They have data on members and want to group based on low, medium, and high risk
- Want to predict which group a potential borrower fits into

Question 4

Which Amazon SageMaker algorithm should you use?

Linear Learner algorithm	$\boxed{\text{K-Nearest Neighbors (k-NN) algorithm}}$
K-Means algorithm	XGBoost algorithm

Algorithms

Game Show

Scenario 5

- Manufacturing company, making 10 valves
- Products built in random order, need to be classified for labeling and packaging
- Need to automate classification robotics
- Using AWS IoT

Question 5

Which Amazon SageMaker algorithm should you use?

Object2Vec	Object Detection algorithm
Image Classification algorithm	K-Means algorithm

Algorithms

Game Show

Scenario 5

- Manufacturing company, making 10 valves
- Products built in random order, need to be classified for labeling and packaging
- Need to automate classification robotics
- Using AWS IoT

Question 5

Which Amazon SageMaker algorithm should you use?

Object2Vec	Object Detection algorithm
Image Classification algorithm	K-Means algorithm

Course use case

Workbook 8.1

	months_as_customer	age	policy_number	policy_bind_date	policy_state	policy_csl	policy_deductable	policy_annual_premium	umbrella_limit	insured_zip	police_report_available	total_claim_amount	injury_claim	property_claim	vehicle_claim	auto_make	auto_model	auto_year	fraud_reported
0	328	48	521585	2014-10-17	OH	250/500	1000	1406.91	0	466132	YES	71610	6510	13020	52080	Saab	92x	2004	Y
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4	228	44	367455	2014-06-06	IL	500/1000	1000	1583.91	6000000	610706	NO	6500	1300	650	4550	Acura	RSX	2009	N

How you can help customers

- Understand the data structure and the data's purpose
- Determine which algorithm to use based on an ML problem and data
- Use the *Amazon SageMaker Developer Guide*
- Experiment with algorithms to find the optimal algorithm to solve an ML problem

Insurance Fraud Notebook Demo 1: Scikit-learn

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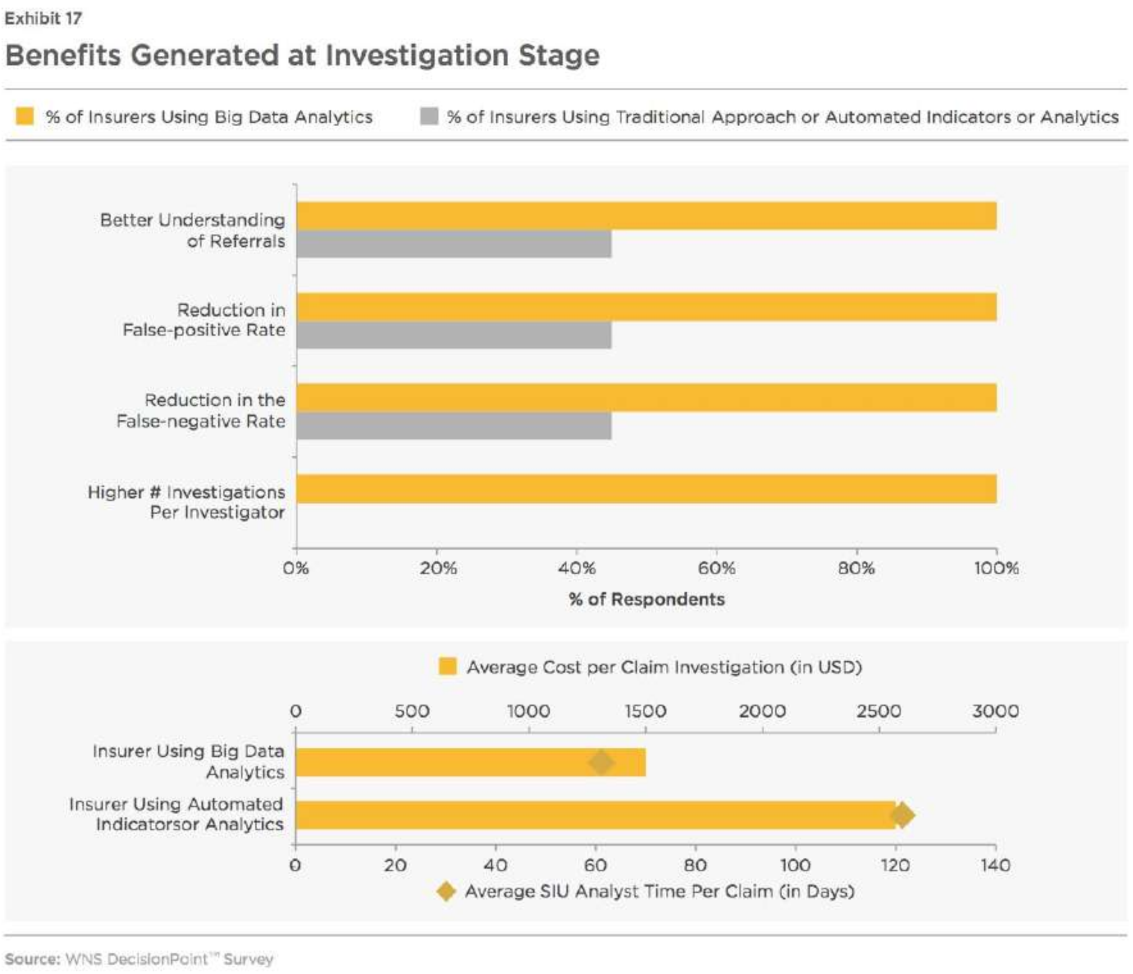
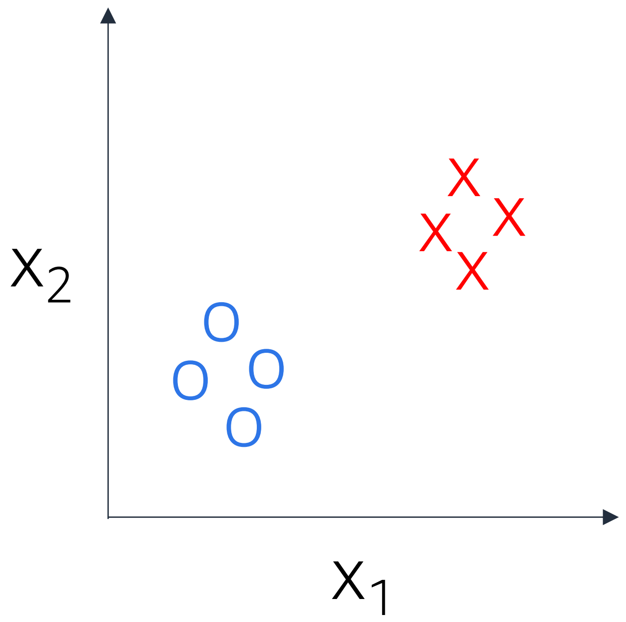
Myth: Fraud is a victimless crime



- Insurance fraud costs $80 billion per year.
- Detecting fraud uses significant resources and manpower.
- Insurers use big data to address fraud.
- ML helps insurers with fraud prediction accuracy.
- ML improves pricing accuracy, loss prevention, and customer relationships.

How ML can help



- Insurance fraud is a binary classification problem.
- The demonstration attempts to solve the problem.
- The dataset has 1,000 observations and 39 features.
- The goals are to train the classifier and predict whether claims are fraudulent.
- You can access the dataset here.

Demo 1 – Outcomes

- Discover the ML problem data using scikit-learn
- Focus on collection, integration, visualization, and analysis locally
- Determine optimal algorithm in scikit-learn to address the problem
- Understand using scikit-learn saves customers money during the discovery phase

T3

```
# BUILD
model1 = linear_model.LogisticRegression(hyperparams)
model2 = DecisionTreeClassifier(hyperparams)

# TRAIN
model1.fit(train_data)
model2.fit(train_data)

# TEST
model1.predict(test_data)
model2.predict(test_data)
```

Insurance Fraud Notebook Demo 2: Data preparation and model training in Amazon SageMaker

Demo 2 – Outcomes

- Use Amazon SageMaker for heavy lifting after data discovery
- Configure the Amazon S3 bucket
- Ensure that cleaning and preparation steps occur in Amazon SageMaker
- Obtain container image for linear-learner algorithm
- Create a training job
- Set hyperparameters
- Monitor training job status

Built-in algorithm mode – Python SDK

```
client = boto3.client('sagemaker')
runtime = boto3.client('sagemaker-runtime')

# BUILD
algorithm = get_image_uri(...)
hyperparams = …

# TRAIN
client.create_training_job(
     algorithm, hyperparams, role, train_data, instance_type)

# DEPLOY
client.create_model(model_name, model_url, container)
client.create_endpoint_config(config_name, instance_type)
client.create_endpoint(config_name)
predictions = runtime.invoke_endpoint(test_data)
```

T3

M4

T2

Many ways to train and deploy a model in SageMaker…

- Jupyter Notebook
  - Any platform: ScikitLearn, …
  - `from sklearn import linear_model`
- Built-in Algorithms
  - SageMaker API: `import sagemaker`
  - AWS SDK: `import boto3`
- Script mode
  managed Docker container
  - 6 supported platforms: TensorFlow, Mxnet, PyTorch, Chainer, Spark, ScikitLearn.
  - `from sagemaker.tensorflow import TensorFlow`
- Docker container
  unmanaged Docker container
- Marketplace
  - Model or Algorithm

Module 9: Amazon SageMaker Training, Debugging and Monitoring

Module 9: Training, Debugging and Monitoring

- Explain how SageMaker AutoPilot, Experiments Debugger improve ML productivity
- Explain deployment option hosting service, or batch transform
- Identify what to do once a model is trained, specifically the steps required to use inference
- Demo Use case - How to Manage endpoints through the Amazon SageMaker console
- Explain Model Performance with Confusion Matrix
- Identify how to use a production variant for traffic weighting
- Explain how to monitor and log Amazon SageMaker events with Amazon CloudWatch

SageMaker Services

Amazon SageMaker Experiments

Organize, track, and compare training experiments:

Tracking at scale

Track parameters and metrics across experiments and users

Custom organization

Organize experiments by teams, goals, and hypotheses

Visualization

Easily visualize experiments and compare

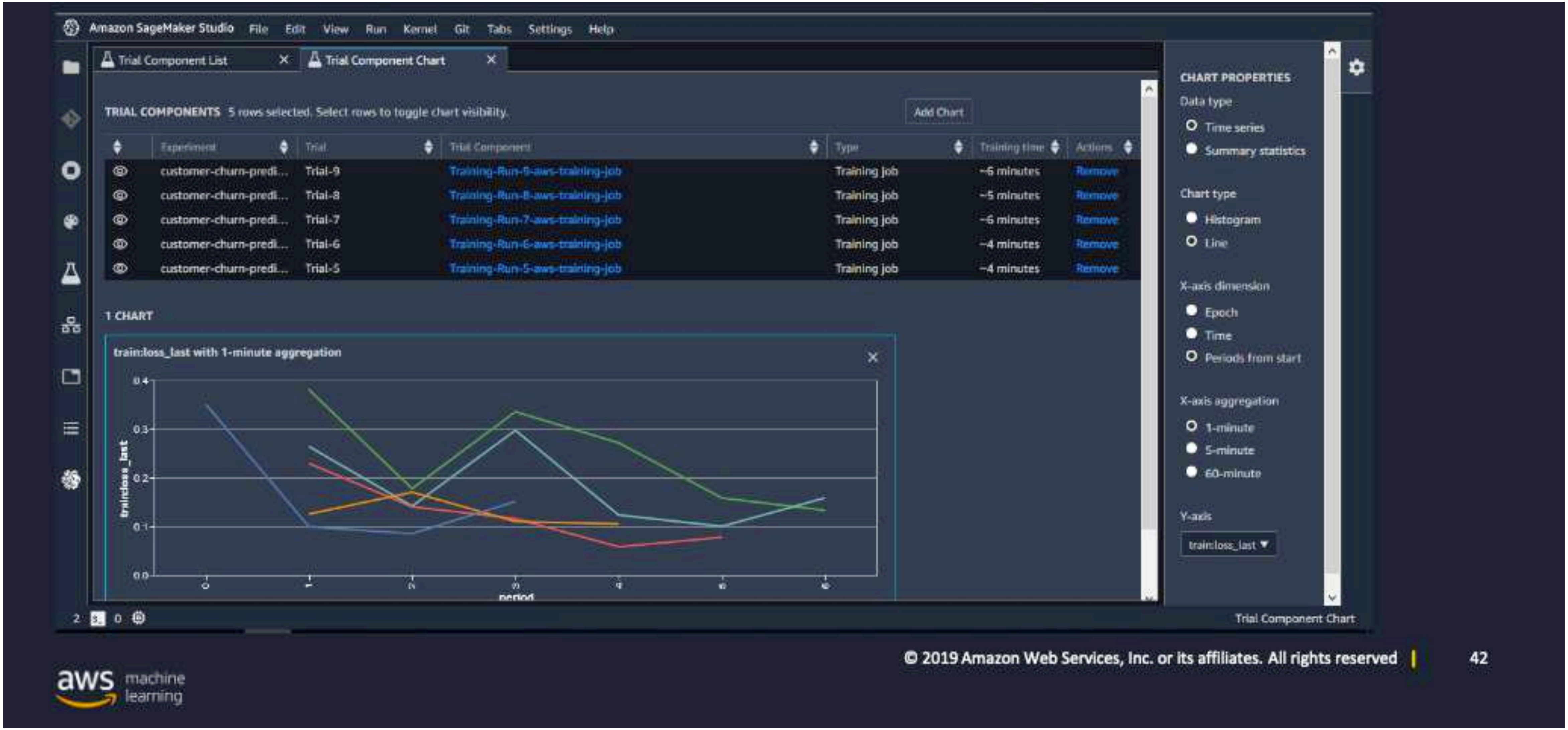
Metrics and logging

Log custom metrics using the Python SDK and APIs

Fast iteration

Quickly go back and forth and maintain high quality

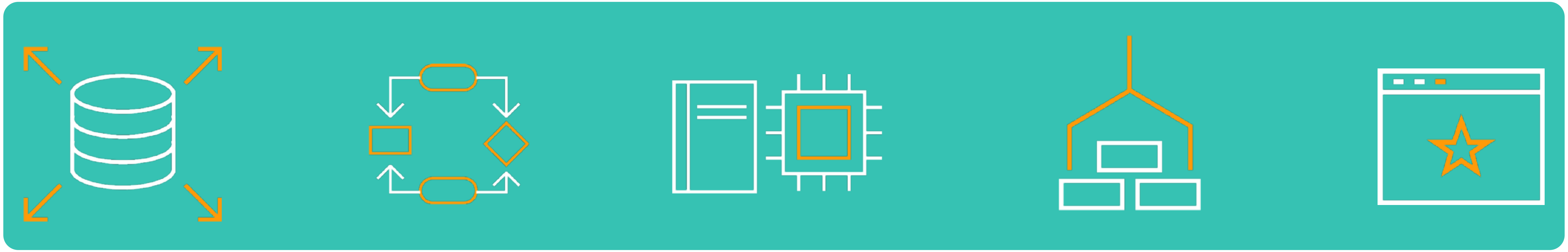
Amazon SageMaker Experiments



Amazon SageMaker Debugger

aws training and certification

- Analysis and debugging, explainability, and alert generation



Relevant data capture

Data is automatically captured for analysis

Data analysis and debugging

Analyze and debug data with no code changes

Automatic error detection

Errors are automatically detected based on rules

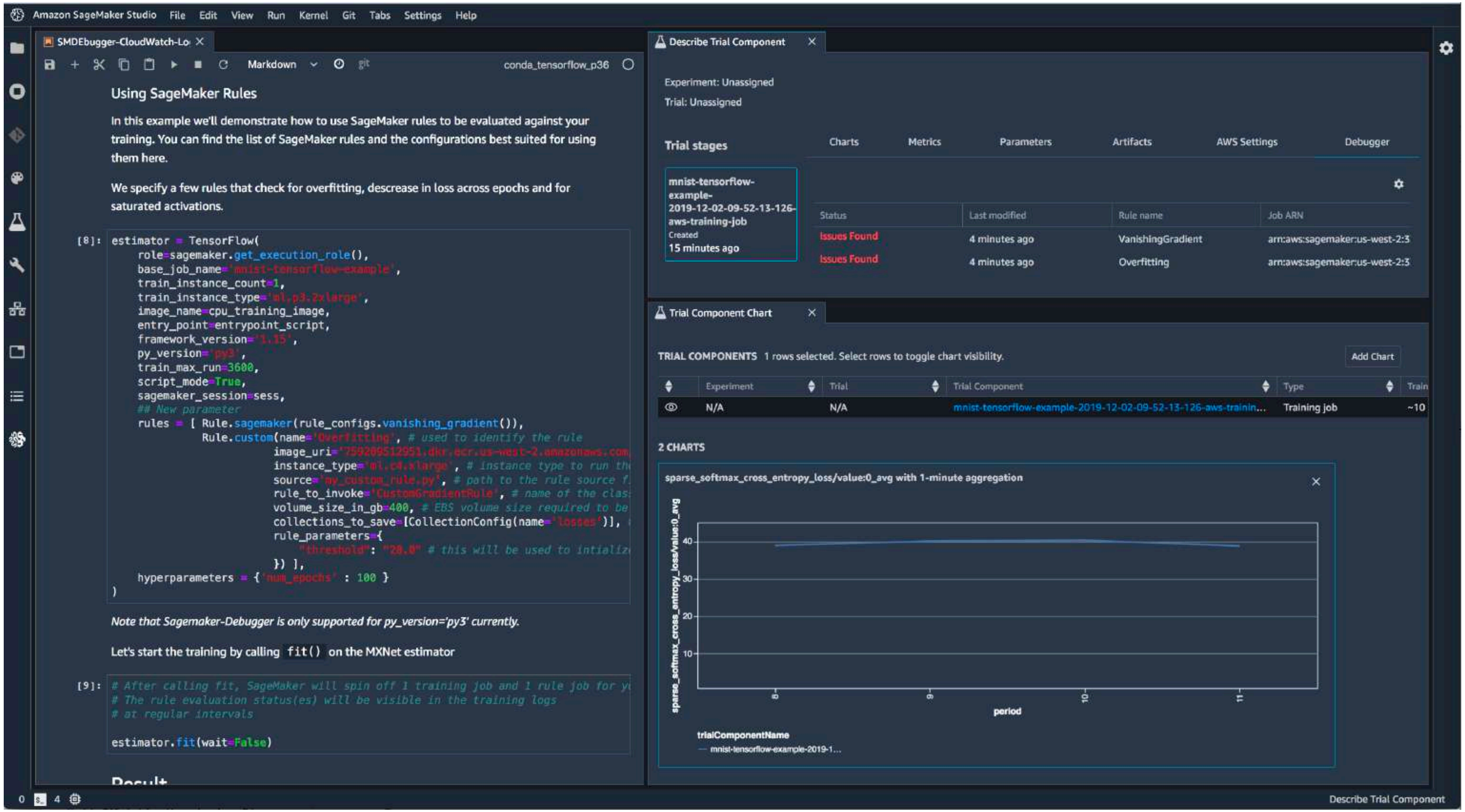
Improved productivity with alerts

Take corrective action based on alerts

Visual analysis and debugging

Visually analyze and debug from Amazon SageMaker Studio

Amazon SageMaker Debugger



Hyperparameter model tuning

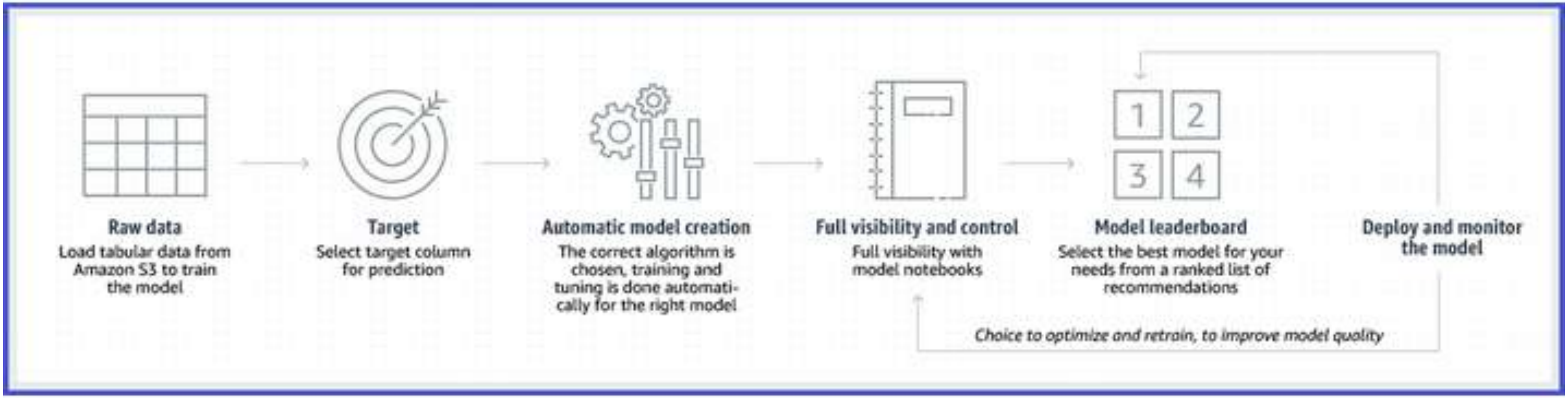
Hyperparameters are properties that **control the behavior** of a training algorithm. They are configured before training a model.

Choosing the right hyperparameters has a **significant impact** on model performance.

Amazon SageMaker automatic model tuning

- Adjusts various combinations of algorithm parameters
- Finds the best parameters automatically
- Speeds up processes
- Eliminates tedious manual work

Amazon SageMaker Autopilot – automates ML process



Deployment Options

aws training and certification

Deployment options

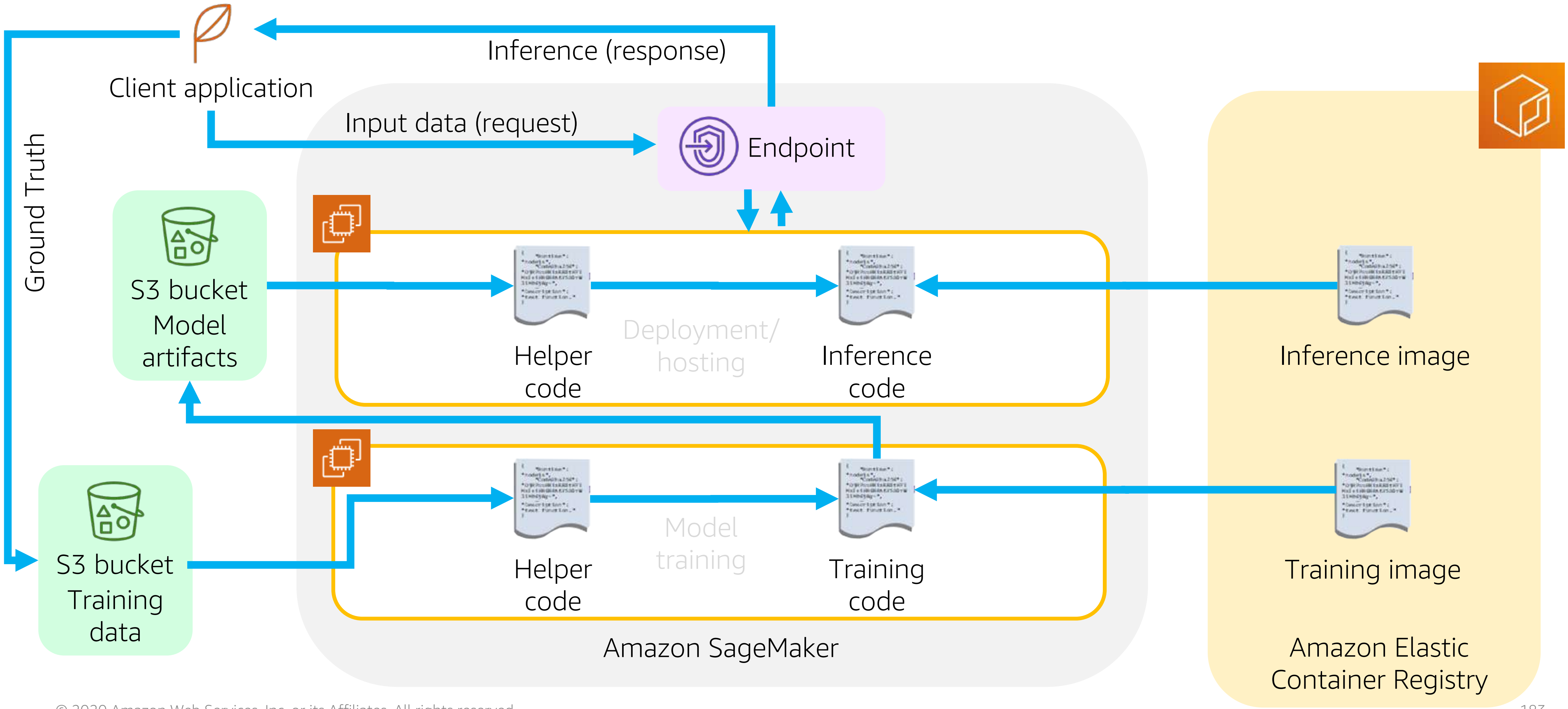
aws training and certification

Amazon SageMaker

Amazon SageMaker Hosting Services	Amazon SageMaker Batch Transform
Persistent endpoint	Predictions for an entire dataset
One prediction at a time	One after another

https://docs.aws.amazon.com/sagemaker/latest/dg/how-it-works-deployment.html

Amazon SageMaker hosting services

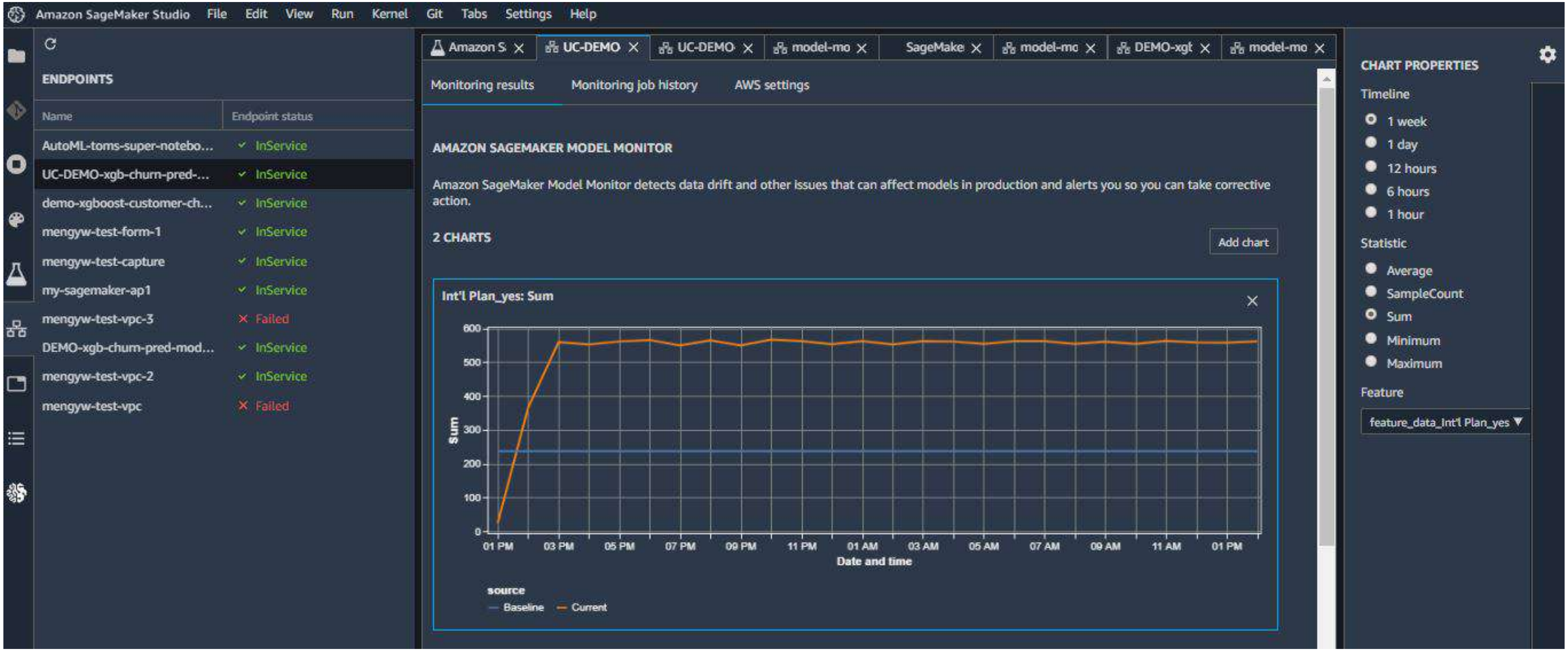


Amazon SageMaker Model Monitor

Continuous monitoring of models in production

Automatic data collection	Continuous monitoring	Flexibility with rules	Visual data analysis	Integration with Amazon CloudWatch
Data is automatically collected from your endpoints	Define a monitoring schedule, and detect changes in quality against a predefined baseline	Use built-in rules to detect data drift, or write your own rules for custom analysis	See monitoring results, data statistics, and violation reports in Amazon SageMaker Studio	Automate corrective actions based on CloudWatch alerts

Amazon SageMaker Model Monitor



Model performance and Confusion Matrix

Confusion matrix

Actual	Predicted Negative	Predicted Positive
Negative	True Negative	False Positive
Positive	False Negative	True Positive

Validating model with confusion matrix

aws training and certification

Actual	Predicted Negative	Predicted Positive
Negative	True Negative	False Positive
Positive	False Negative	True Positive

$$\text{Precision} = \frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}}$$

$$\text{Recall} = \frac{\text{True Positive}}{\text{True Positive} + \text{False Negative}}$$

$$\text{F1} = 2 \times \frac{\text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}}$$

Precision: Spam filtering with 1000 emails

aws training and certification

Mail we want: Send to inbox
[True Positive] = 650

Failed to predict spam as spam
[False Negative] = 75

Spam: Send to junk
[True Negative] = 250

Wrongly predicted as spam but it's mail we want
[False Positive] = 25

Precision = 650/[650 + 25] = 0.96

Recall = 650/[650 + 75] = 0.89

F1 Score = 2 *[0.96 * 0.89]/[0.96+0.89] = 0.94

Recall : COVID analysis of 1000 patients

Correct Healthy Predictions
[True Positive] = 500

Predicted a sick patient is healthy
[False Negative]

Correct sick predictions
[True Negative] = 400

Incorrectly Predicted a healthy patient is sick
[False Positive] = 70

Precision = 500/[500 + 70] = 0.87

Recall = 500/[500 + 30] = 0.94

F1 Score = 2 *[0.87 * 0.94]/[0.87+0.94] = 0.90

Insurance Fraud Notebook Demo 3: Deployment and endpoint management

Demo 3 – Outcomes

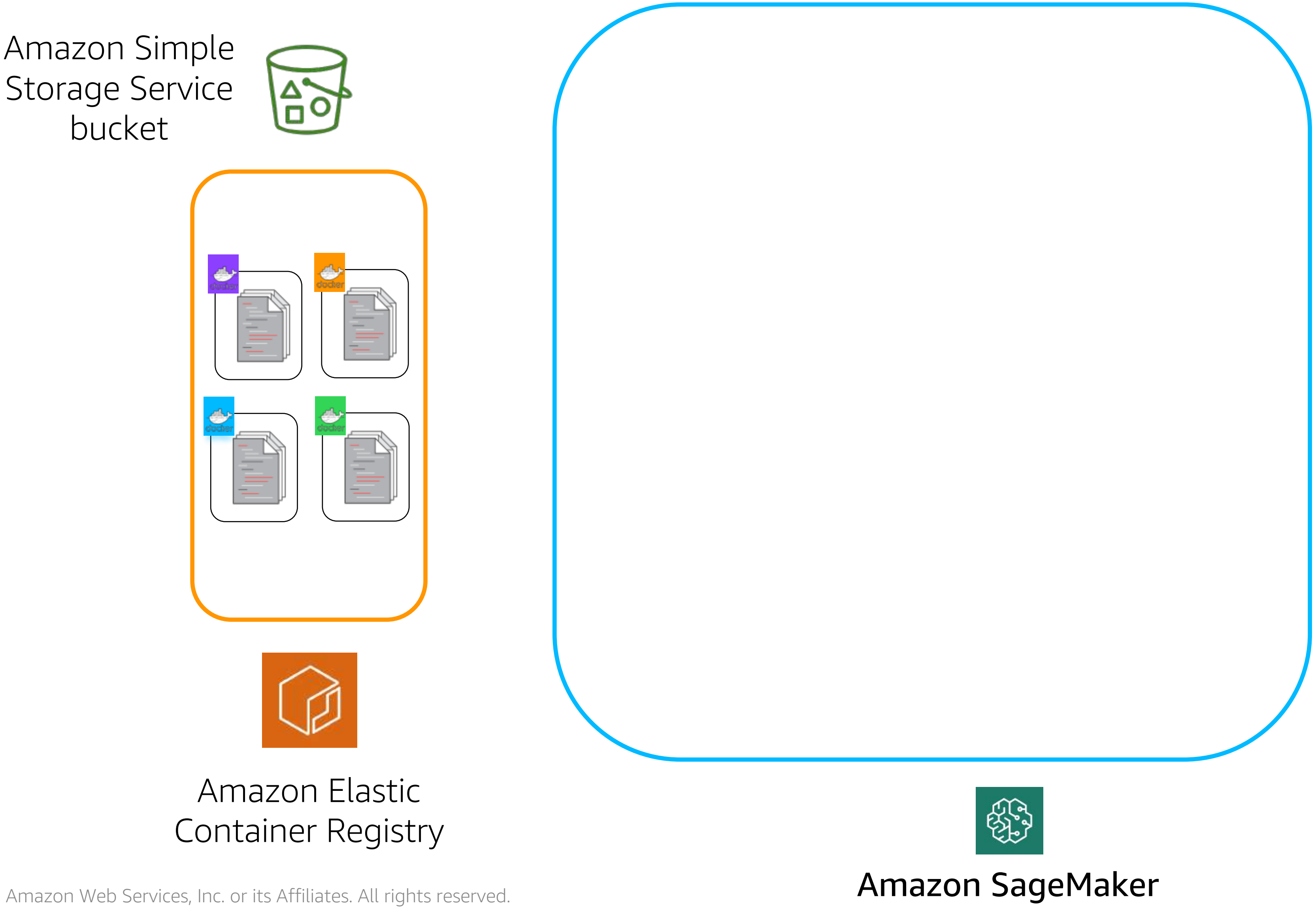
- Create a model definition
- Create an endpoint configuration
- Examine how a production variant can be used for distributing traffic (traffic weighting) to multiple models
- Create an endpoint
- Locate and manage endpoints in the console

Demo 3 – Outcomes

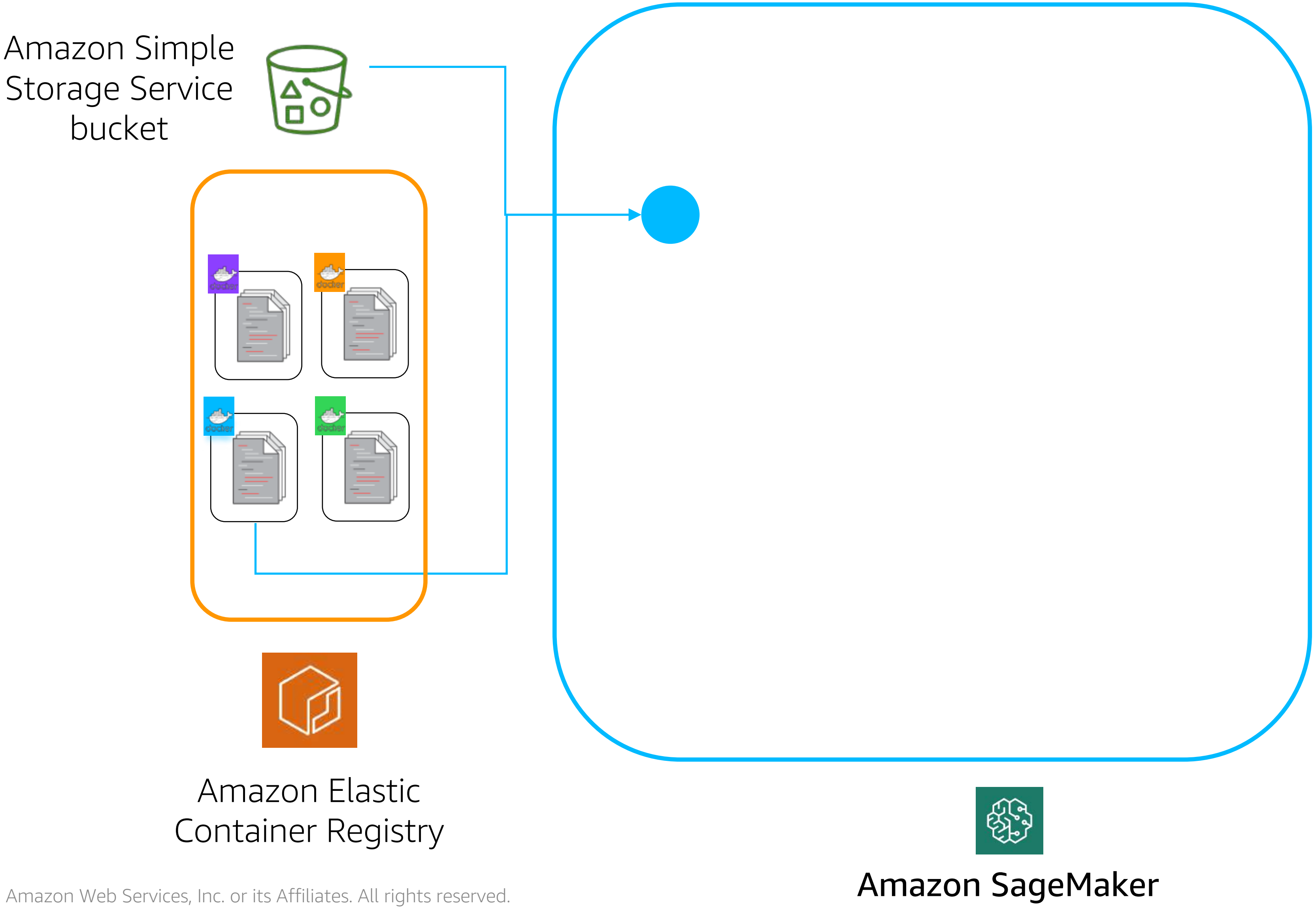
- Explain how to monitor and log events with Amazon CloudWatch
- Test the model with validation data

Production variants (traffic weighting)

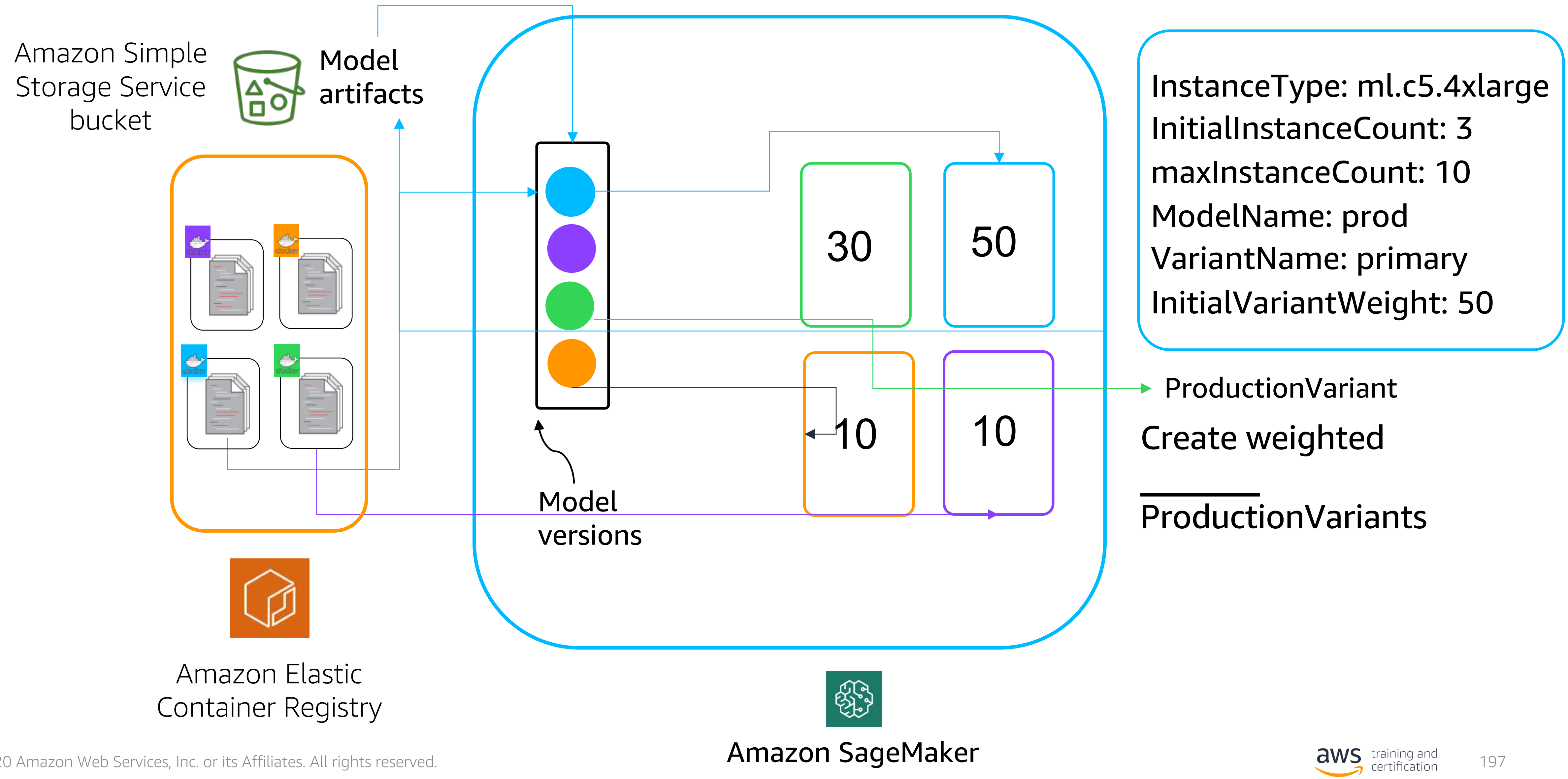
Model deployment to Amazon SageMaker



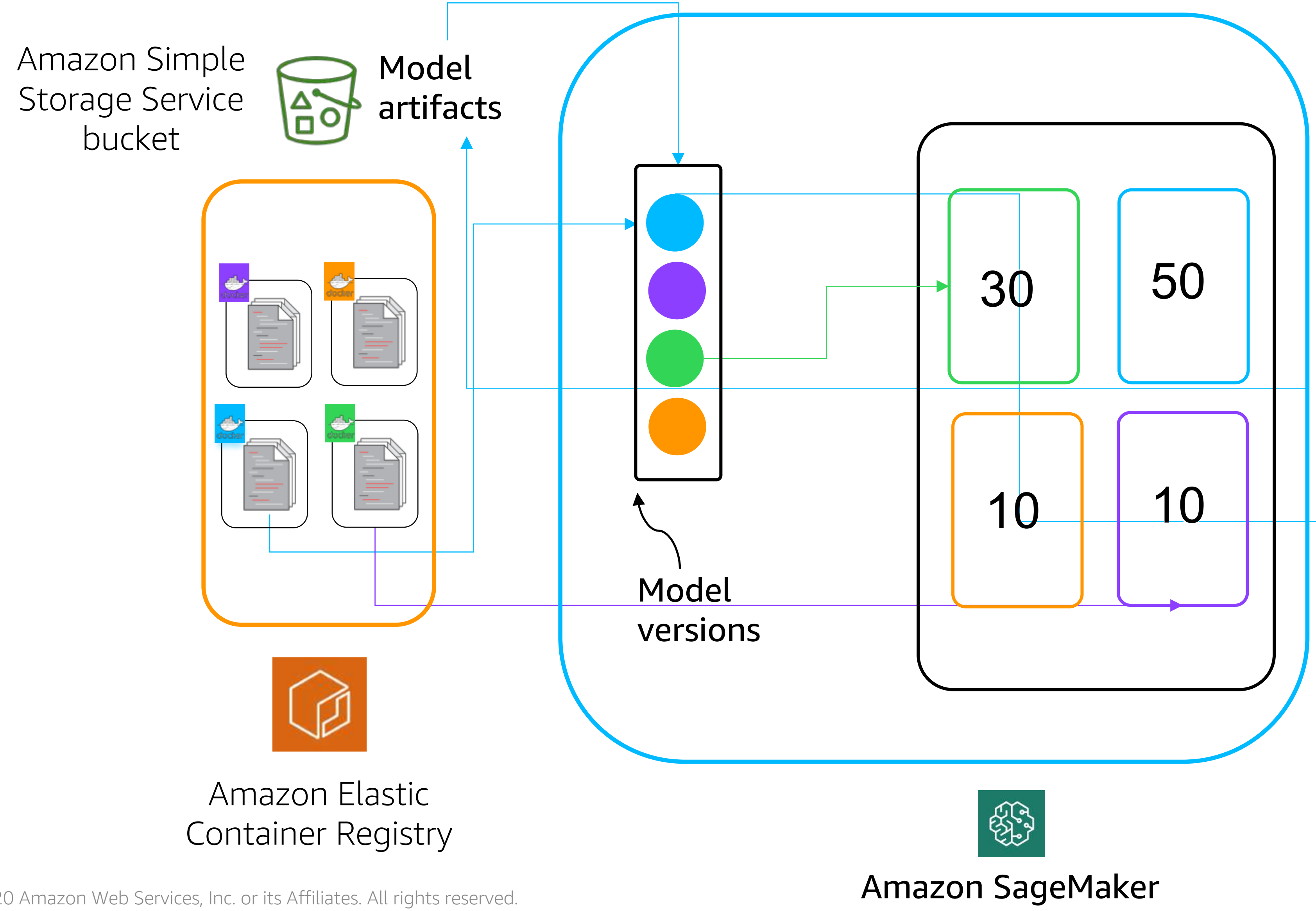
Model deployment to Amazon SageMaker



Model deployment to Amazon SageMaker



Model deployment to Amazon SageMaker

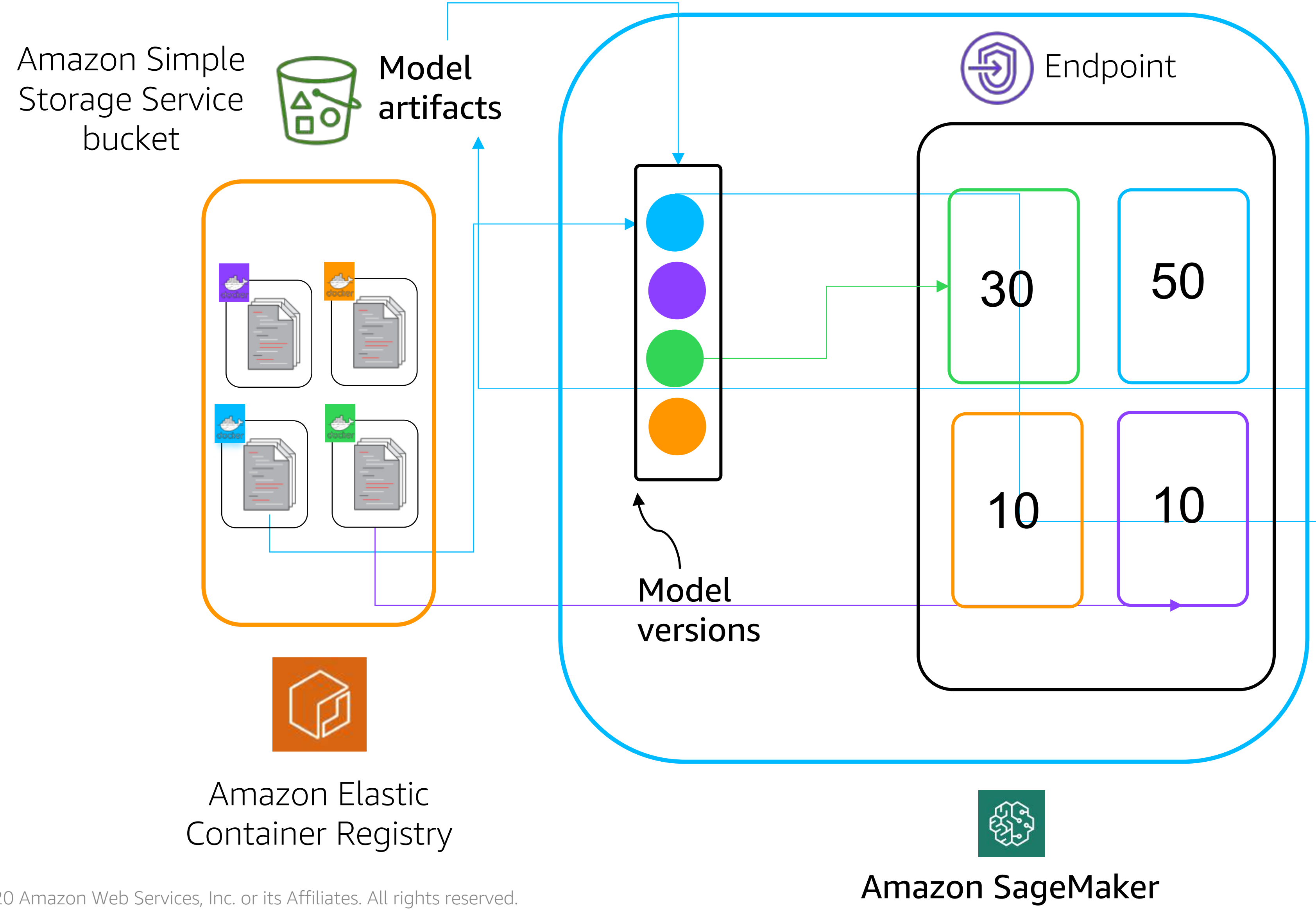


InstanceType: ml.c5.4xlarge
InitialInstanceCount: 3
maxInstanceCount: 10
ModelName: prod
VariantName: primary
InitialVariantWeight: 50

ProductionVariant

A/B testing models create an EndpointConfiguration from one or many ProductionVariant(s)

Model deployment to Amazon SageMaker



InstanceType: ml.c5.4xlarge
InitialInstanceCount: 3
maxInstanceCount: 10
ModelName: prod
VariantName: primary
InitialVariantWeight: 50

ProductionVariant

One Click!

TensorFlow
MXNet
PyTorch
Amazon provided algorithms

Production variant defined

```
# Get the current endpoint configuration
endpoint = sage_client.describe_endpoint(EndpointName=xgb_predictor.endpoint)
endpoint_config = sage_client.describe_endpoint_config(
    EndpointConfigName=endpoint['EndpointConfigName'])

# Change the current deployment weight to 0.5 (we'll move 50% of the traffic to
current_model_config = endpoint_config['ProductionVariants'][0]
current_model_config['InitialVariantWeight'] = 0.5
current_model_config['VariantName'] = 'XGBoost'
Variant = 'TunedXGBoost'

tuned_model_config = {'ModelName': model_name,
                      'InitialInstanceCount': 1,
                      'InstanceType': 'ml.m4.xlarge',
                      'VariantName': Variant,
                      'InitialVariantWeight': 0.5}
```

Production variant defined

```
# Create the new endpoint configuration
sage_client.create_endpoint_config(
    EndpointConfigName='AB-Config',
    ProductionVariants=[current_model_config,
                        tuned_model_config])

# Update the endpoint
sage_client.update_endpoint(
    EndpointName=endpoint['EndpointConfigName'],
    EndpointConfigName='AB-Config'
)
result = sess.wait_for_endpoint(endpoint['EndpointConfigName'])
```

Model deployment features of Amazon SageMaker

- ✓ Auto Scaling Inference APIs
- ✓ A/B testing
- ✓ Low latency and high throughput
- ✓ Bring Your Own Model
- ✓ Python SDK

Knowledge check

Knowledge check

Pick an Amazon SageMaker service that automates ML process by preparing data for training, trains and tunes the models and selects best candidate mode for deployment?

- Amazon SageMaker Experiments
- Amazon SageMaker Model Monitor
- Amazon SageMaker Automatic Model Tuning
- Amazon SageMaker Autopilot

Module 10: Introduction to MLOps

aws training and certification

Module 10: Introduction to MLOps

- DevOps and CI/CD pipelines
- Difference between MLOps and DevOps
- MLOps challenges
- MLOps process
- SageMaker Pipeline and other orchestration options
- Governance for ML on AWS

DevOps – CI/CD Pipeline

DevOps and Release Process

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Source

- Check-in source code such as .java files
- Peer review new code

Build

- Compile
- Unit tests
- Style checkers
- Create container images and function deployment

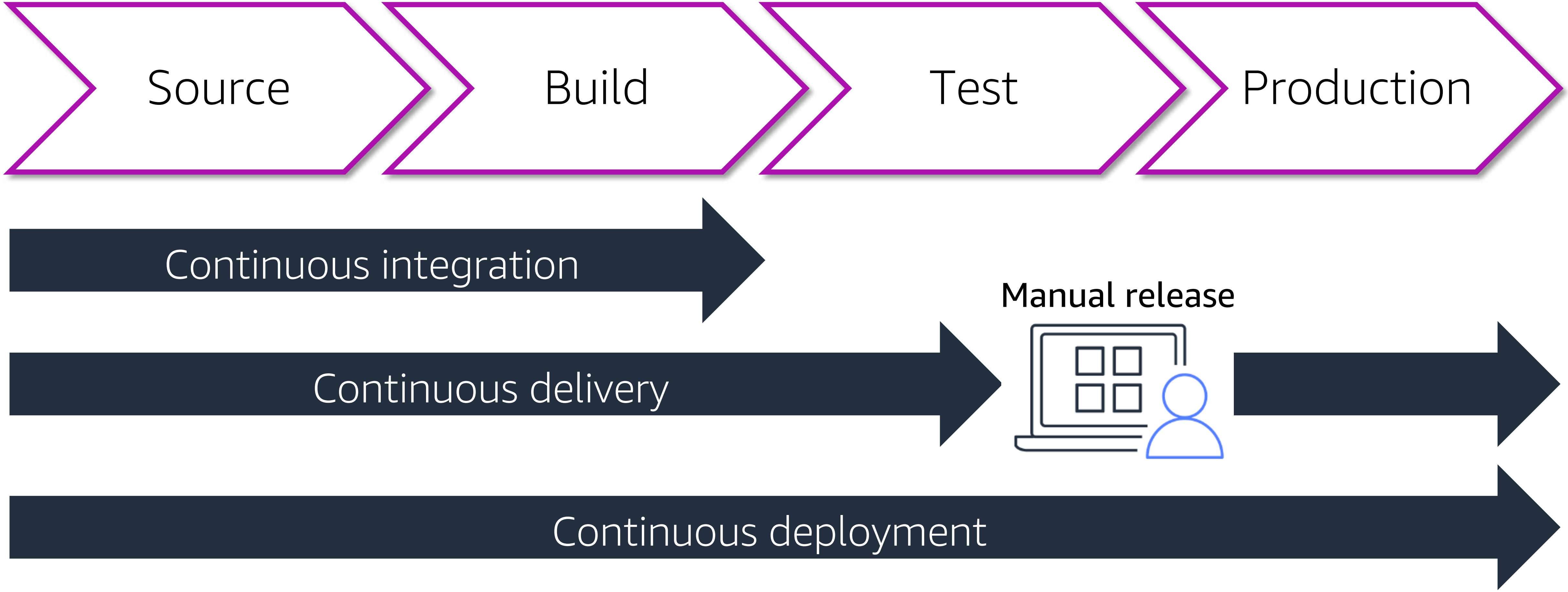
Test

- Integration testing with other systems
- Load testing
- UI testing
- Security testing
- Functional testing
- API testing

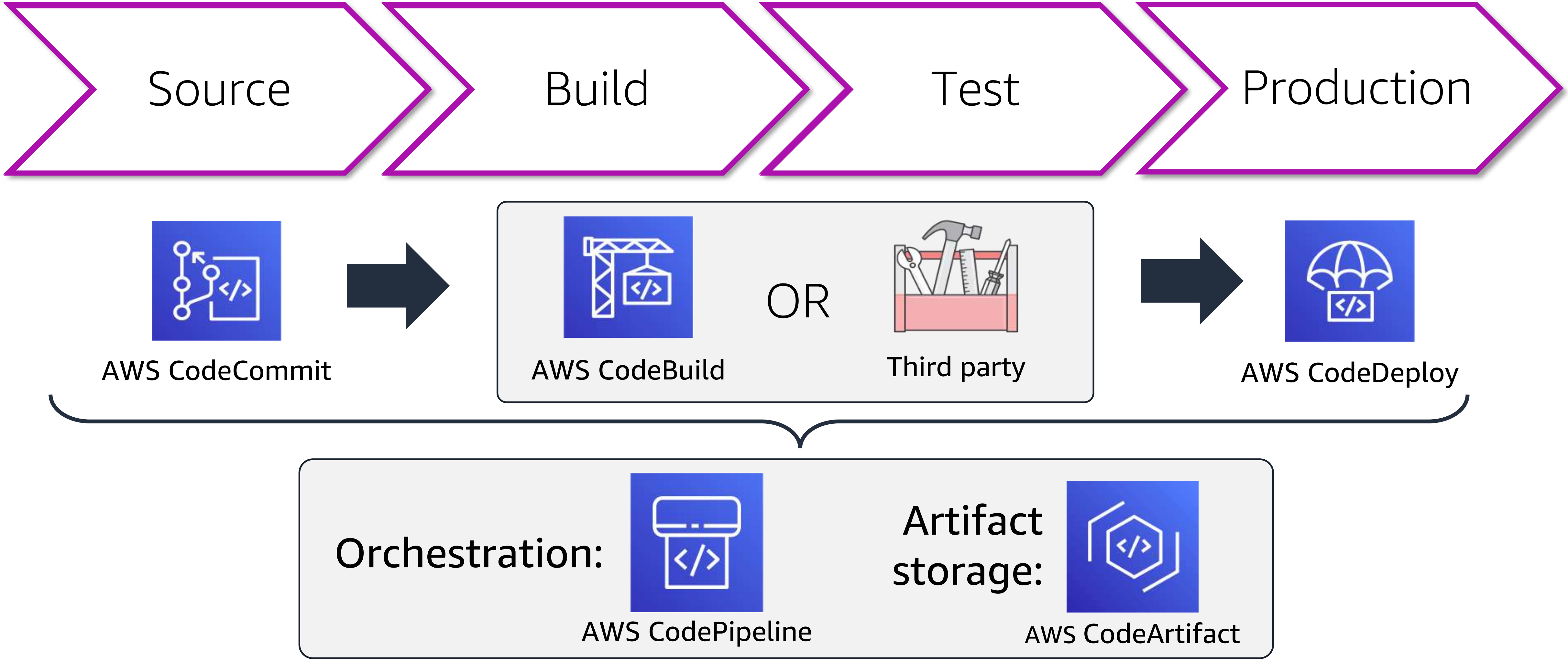
Production

- Deployment to production environments
- Monitor in production to quickly detect any issues

Automated CI/CD release process

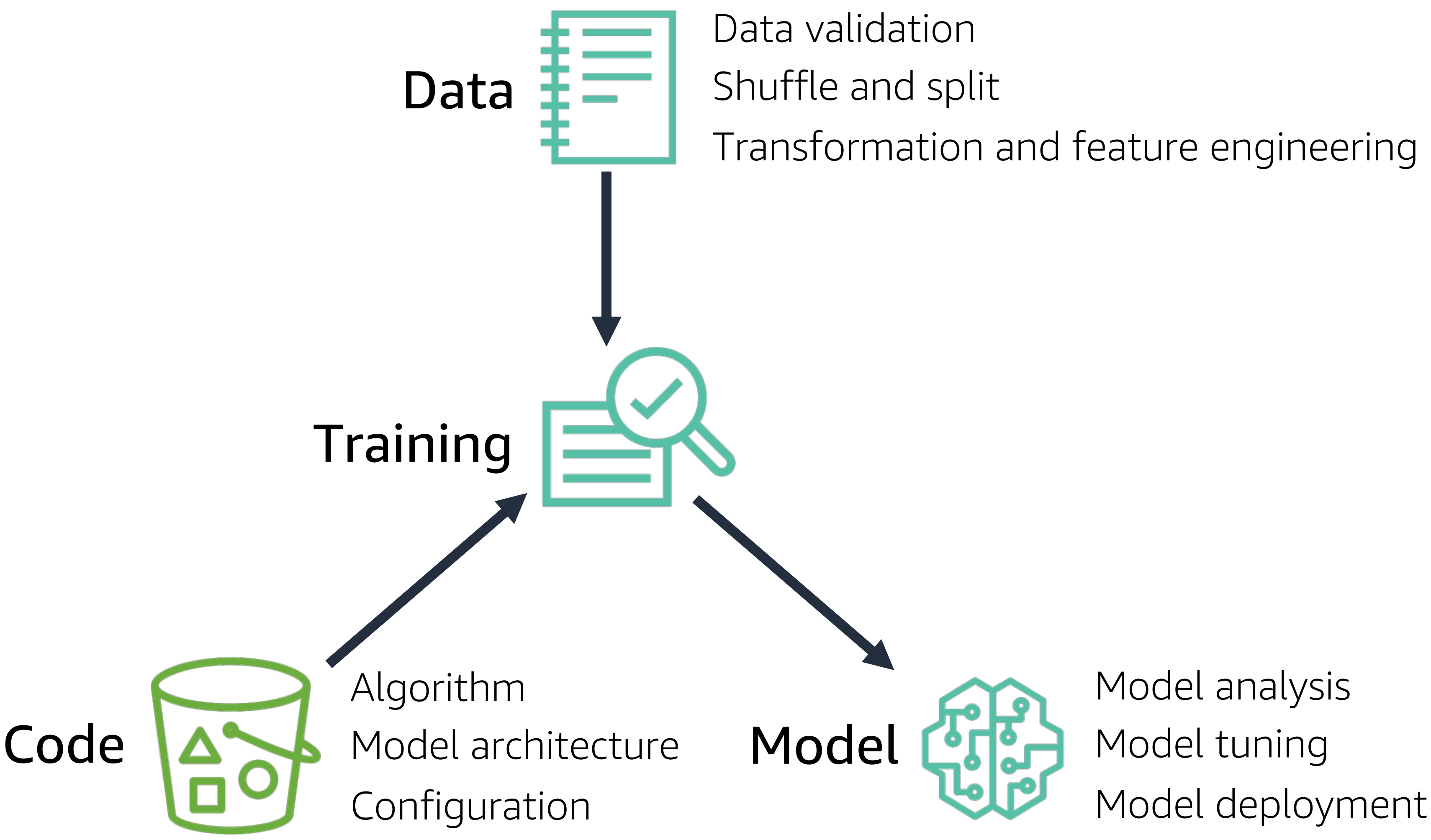


Software release steps

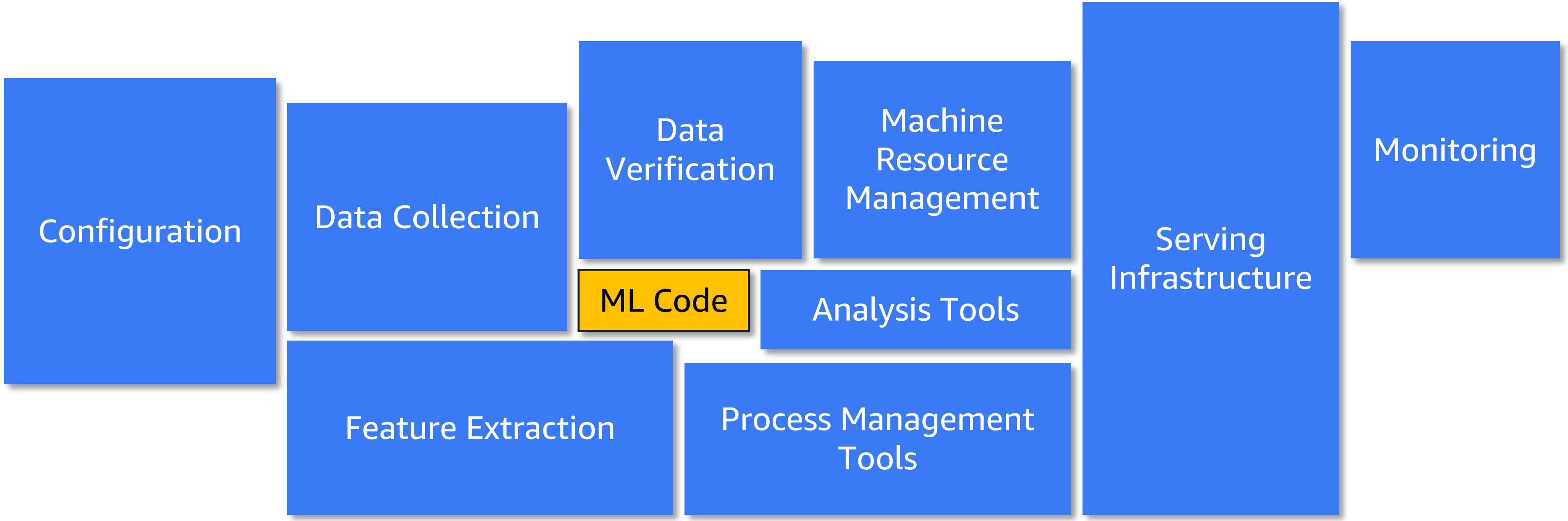


ML is different

ML code and data are independent

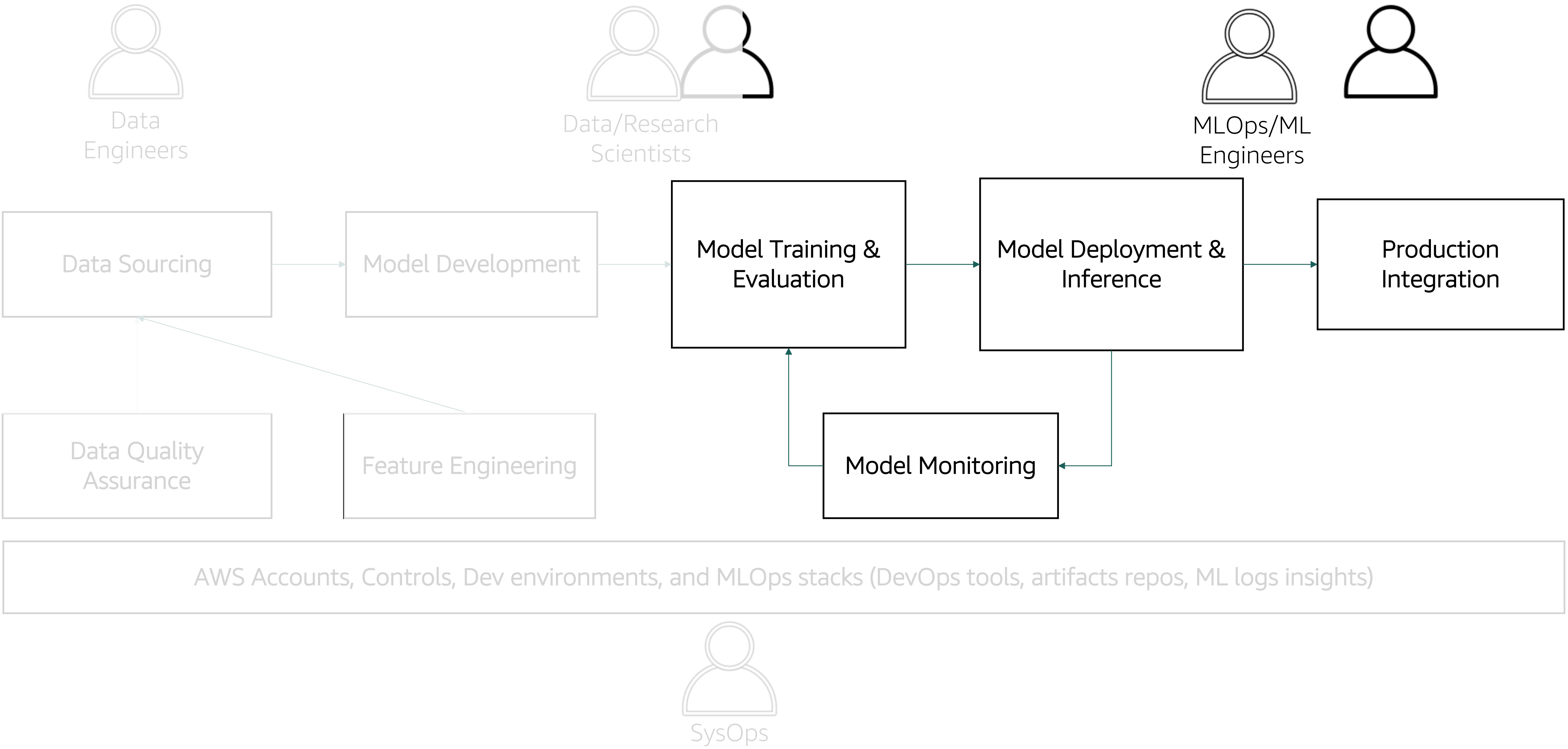


ML code is one small part of the solution



"Hidden Technical Debt in Machine Learning Systems" — Sculley et al.

Different teams might own part of process



ML has additional requirements

- Consistency: Minimal variance between environments (i.e. using containers)
- Flexibility: Can accommodate most frameworks
- Reproducibility: Can recreate past experiments/training
- Reusability: Components are reusable across projects
- Scalability: Able to scale resources to efficiently meet demand
- Auditability: Logs, versions, and dependencies of artifacts are available
- Explainability: Decision transparency

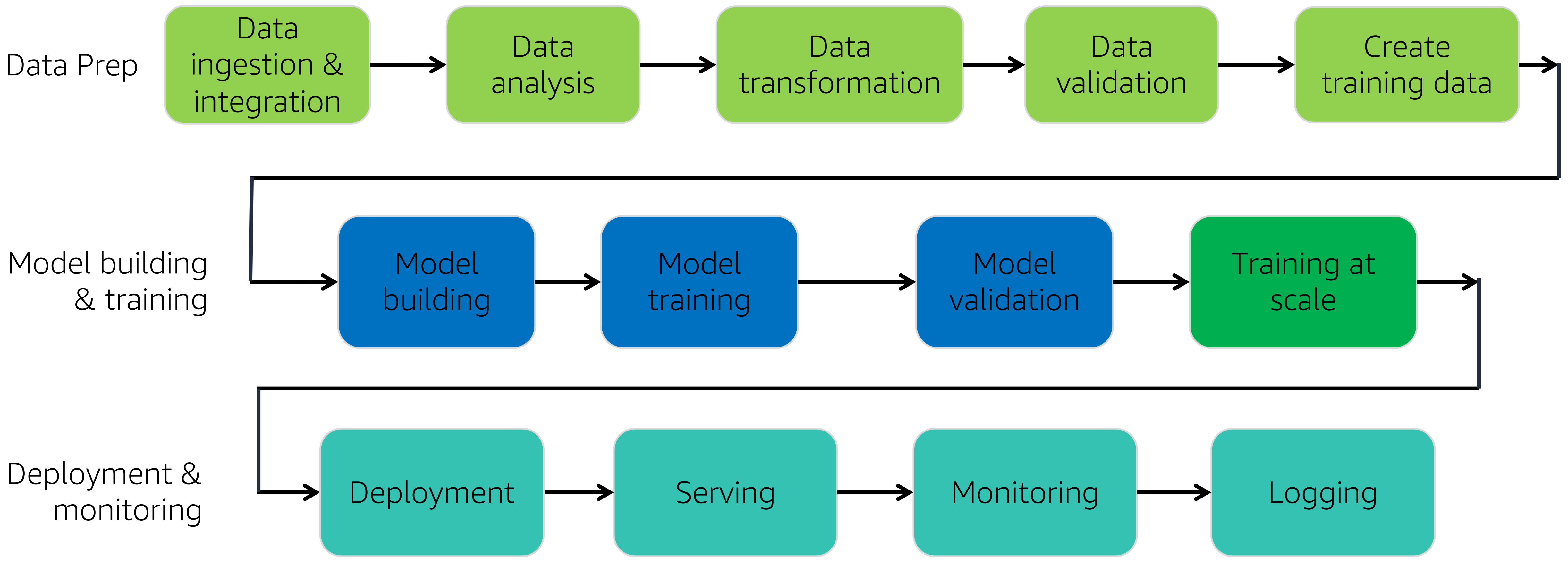
MLOps = DevOps for ML

	DevOps	DevOps for ML
Code versioning	☑	☑
Compute environment	☑	☑
Continuous integration/delivery	☑	☑
Monitoring in production	☑	☑
Data provenance		☑
Datasets		☑
Models		☑
Hyperparameters		☑
Metrics		☑
Workflows		☑

https://medium.com/analytics-vidhya/mlops-the-epoch-of-productionizing-ml-models-4eec06d93623

ML pipeline is more complex

Phases:



ML Pipeline Orchestration

training and certification

ML pipeline orchestration options

- Amazon SageMaker Pipeline
- AWS Step Functions and AWS CodePipeline
- Kubeflow: ML toolkit for Kubernetes
- Apache Airflow: Platform to author, schedule, and monitor workflows
- MLflow: Platform to manage the ML lifecycle

Automate ML workflows with Amazon SageMaker Pipeline

Amazon SageMaker Pipelines

aws training and certification

- Orchestrating workflows across each step of the ML process can take months of coding.
- SageMaker Pipeline - purpose-built CI/CD service for machine learning
- With SageMaker Pipelines you
  - Can use Python interface for creating pipelines to automate different steps of the ML workflow, including data loading, data transformation, training and tuning, and deployment.
  - Can build dozens of ML models a week, manage massive volumes of data, thousands of training experiments, and hundreds of different model versions.
  - Can share and re-use workflows to recreate or optimize models, helping you scale ML throughout your organization
  - Can manage dependencies, build correct sequences and automate steps without coding

Amazon SageMaker Pipeline benefits

- Compose and manage ML workflows
- Track model lineage for governance and audits
- Replay and re-run workflows
- Visually compare, select, and deploy models
- Access a central registry of trained models
- Fully managed ML Ops with built-in CI/CD support

Automate ML workflows with AWS Step Function and AWS CodePipeline

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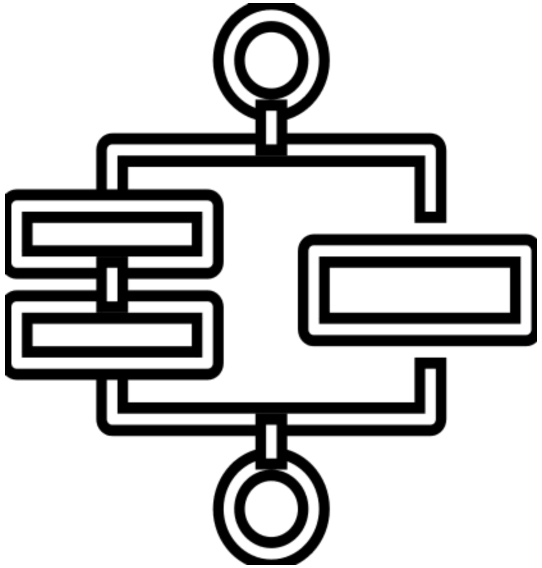
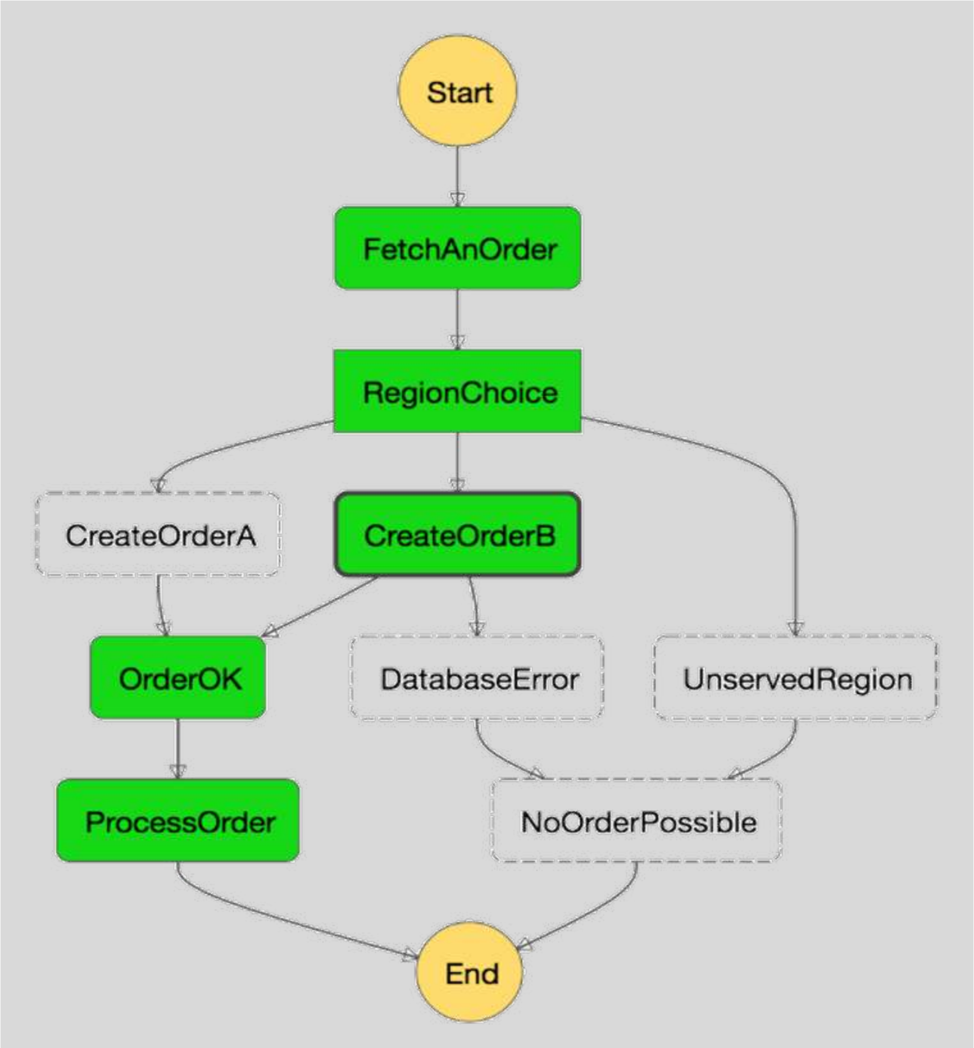
AWS Step Functions

- Resilient serverless workflows orchestration service
- Build visual workflows: Less code to write and maintain
- Can be used to:
  - Author and visualize your ML pipeline using Python and your Jupyter notebook
  - Leverage AWS CodePipeline for CI/CD



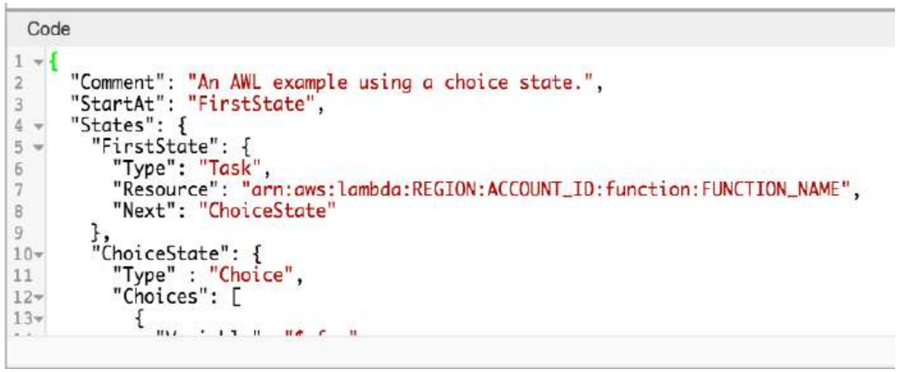
Easy to create workflow with Step Functions



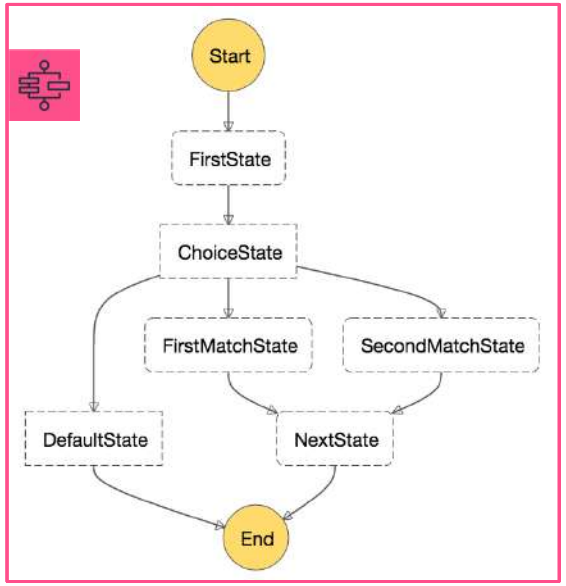
AWS Step Functions: Visual workflows

aws training and certification

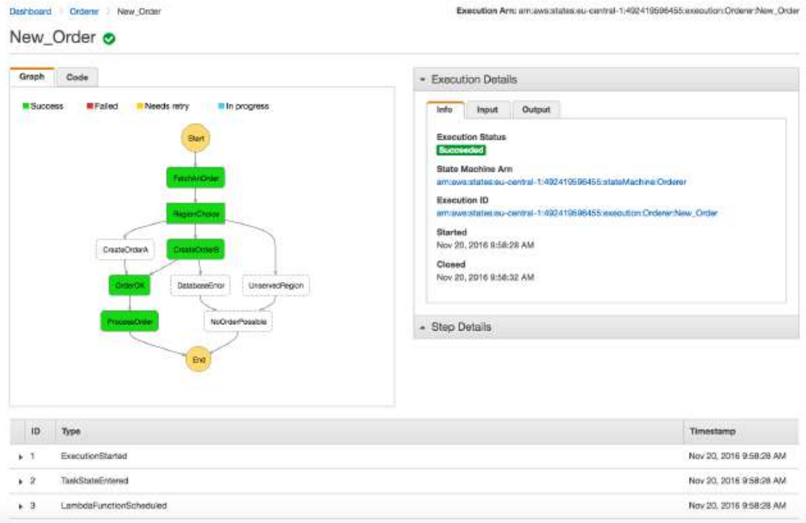
Define in JSON



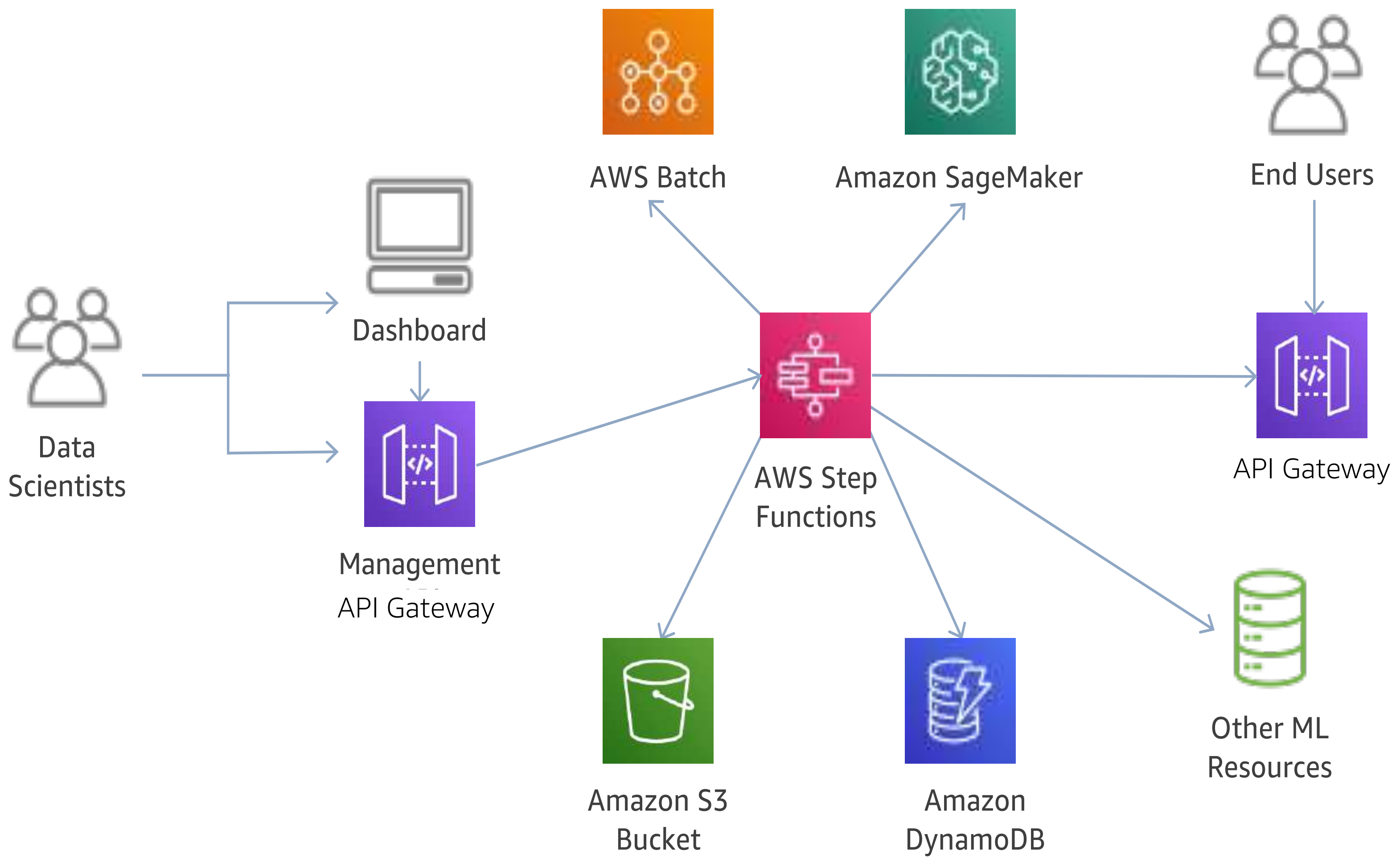
Visualize in the Console



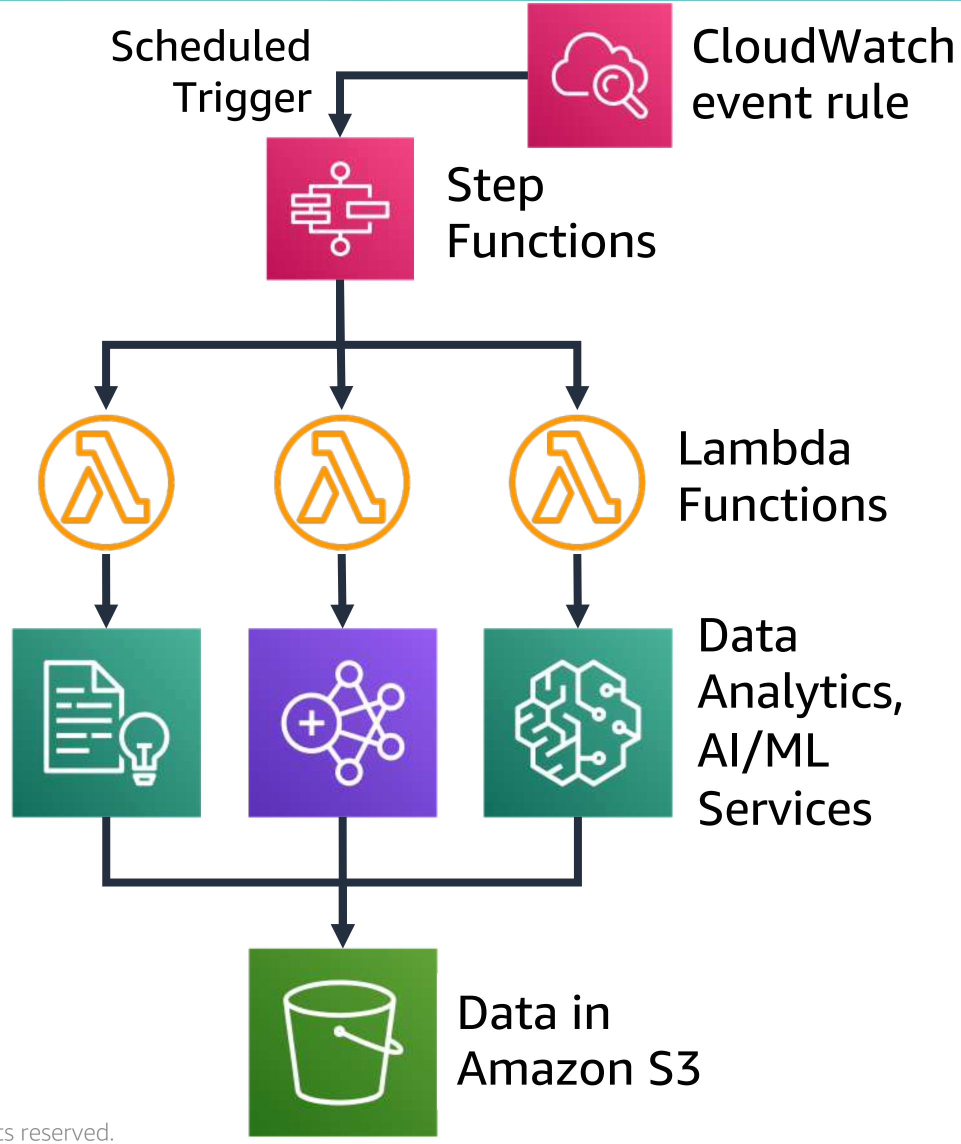
Monitor Run-time



AWS Step Functions: Build flexible and repeatable ML workflows



AWS Step Functions: Build flexible and repeatable ML workflows



Enable auditability, reproducibility, traceability, and verifiability

aws training and certification

Code Repo

Versioned Code: Amazon SageMaker

Experiments
- Python notebooks
- Python code

ML Training
- Python code
- Docker files
- BuildSpec Files
- CF Templates/CDK

ML Deployment
- Python code
- Docker files
- BuildSpec files
- CF templates/CDK

Data Repo

Versioned Data: Amazon S3

Data Files
- Raw data
- Processed data
- Labelled data
- Training data
- Validation data
- Inference data (batch)
- Inference feedback

Model Registry

Versioned Containers: Amazon ECR

Docker Images
- Data processing
- Model training
- Model deployment

Uniquely IDed Models: Amazon S3

Model Binaries
- model.tar.gz

Versioned Manifests: Amazon SageMaker

Release
- Container IDs
- Model name
- Model binary path
- Instance type
- Instance count
- Monitoring config
- Data feedback

Build
- Container IDs
- Input data
- Data processing
- Compute
- Training data
- Artefact registry
- Run-time outputs

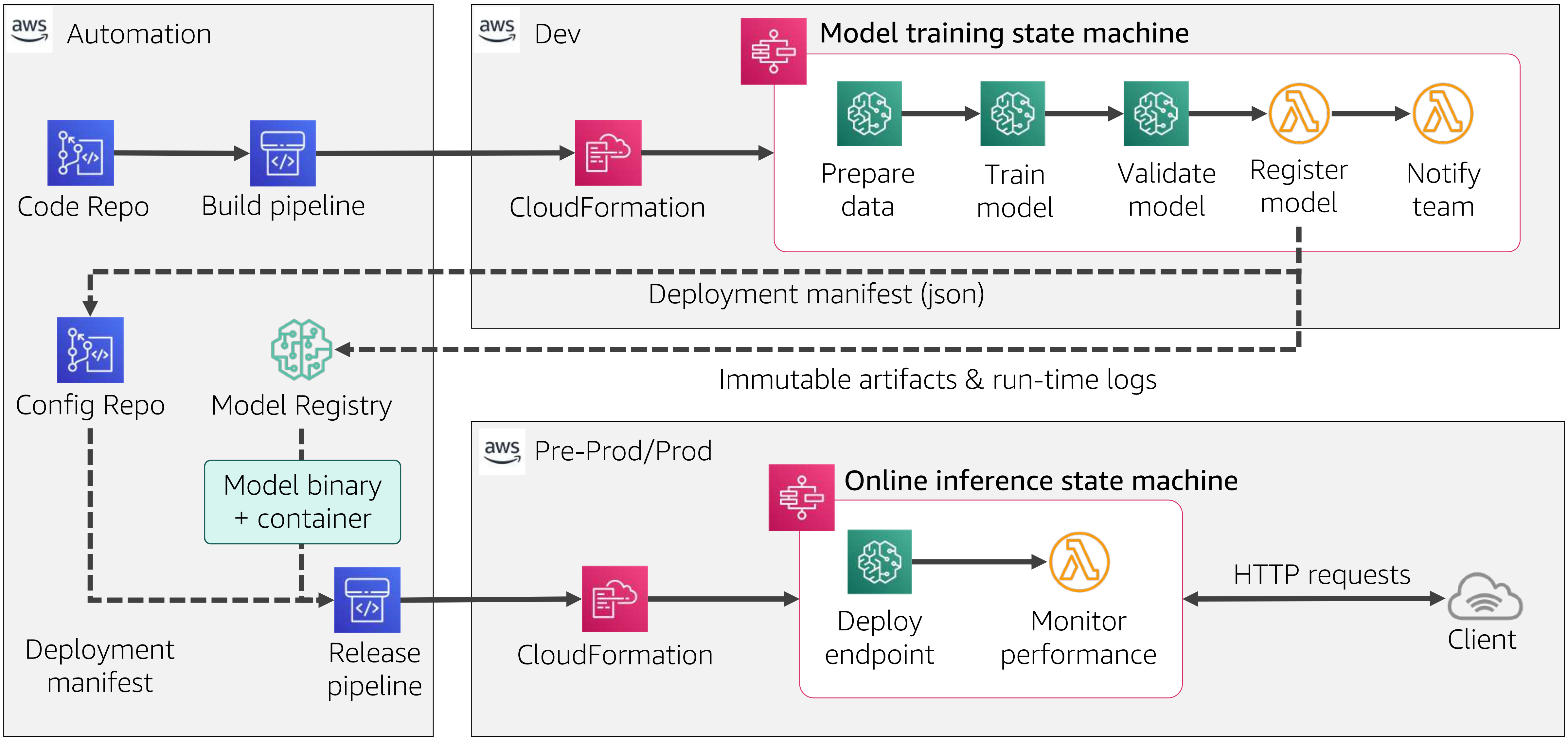
ML Logs Insights

ML Process Logs: Amazon CloudWatch

Logs Store
- Step Functions logs
- Data processing
- Training
- Validation
- Model fingerprint
- Deployment
- Monitoring

Logs Dashboard
- Project dashboard

MLOps pipeline orchestration for automated deployments



Automate ML workflows with Kubeflow

Kubeflow: ML Toolkit for Kubernetes

Kubeflow

Notebook

Pipeline

Training

Serving

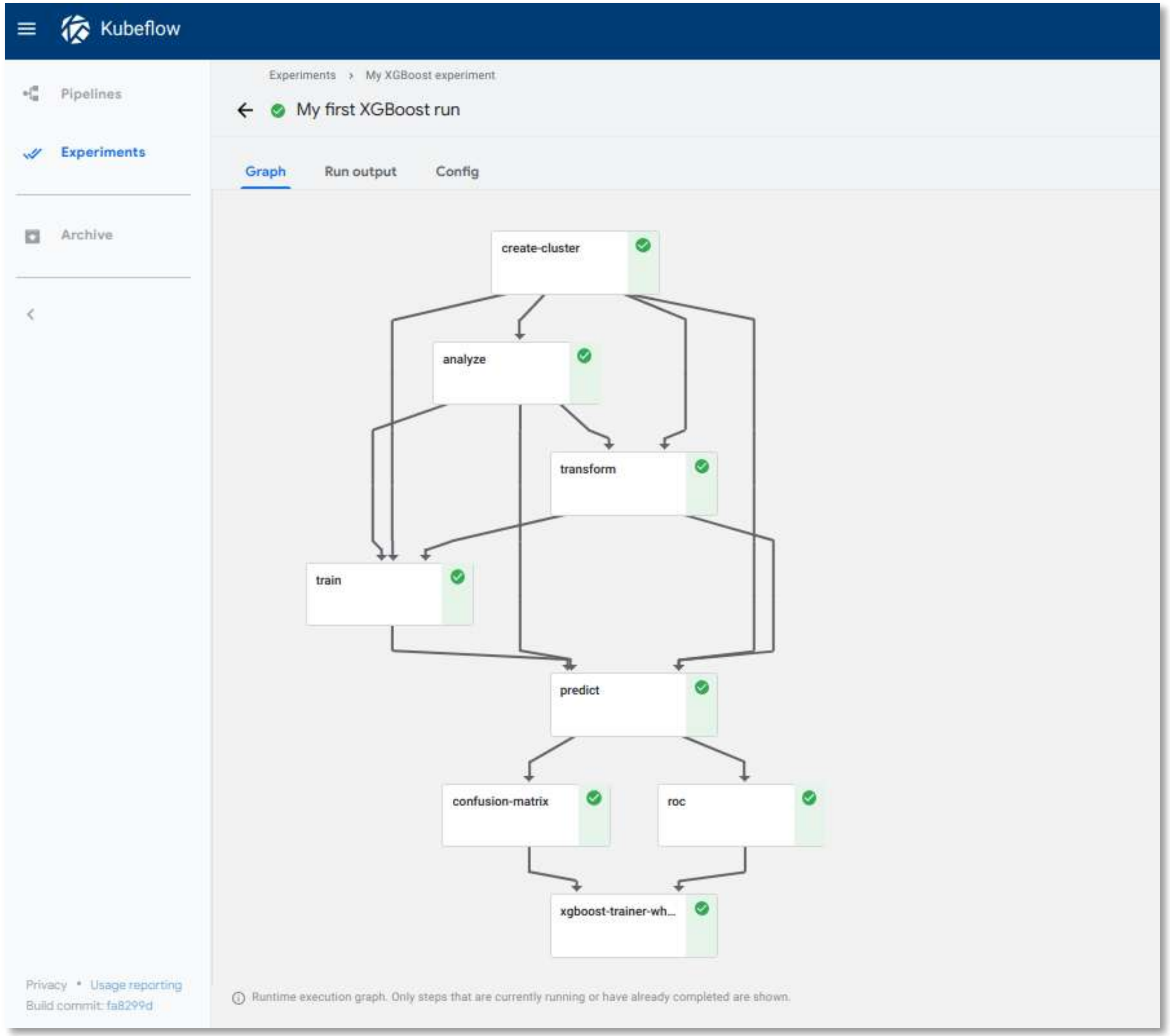
Kubeflow Pipelines

You can use Kubeflow Pipelines platform to compose, deploy, and manage end-to-end Kubernetes ML workflows

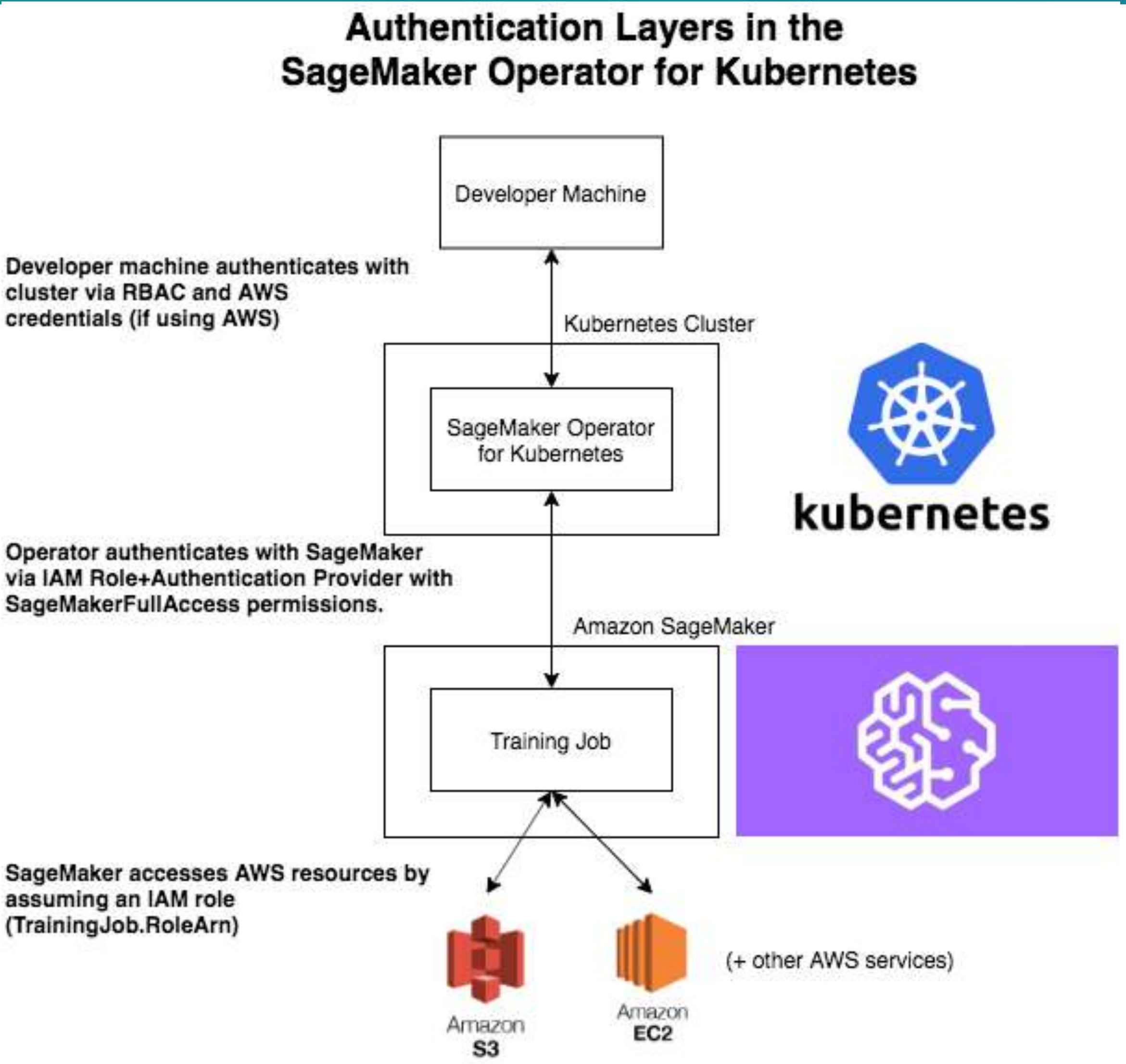
Leverage Kubeflow Pipelines SDK

- `kfp.compiler`, `kfp.components`, `kfp.Client`

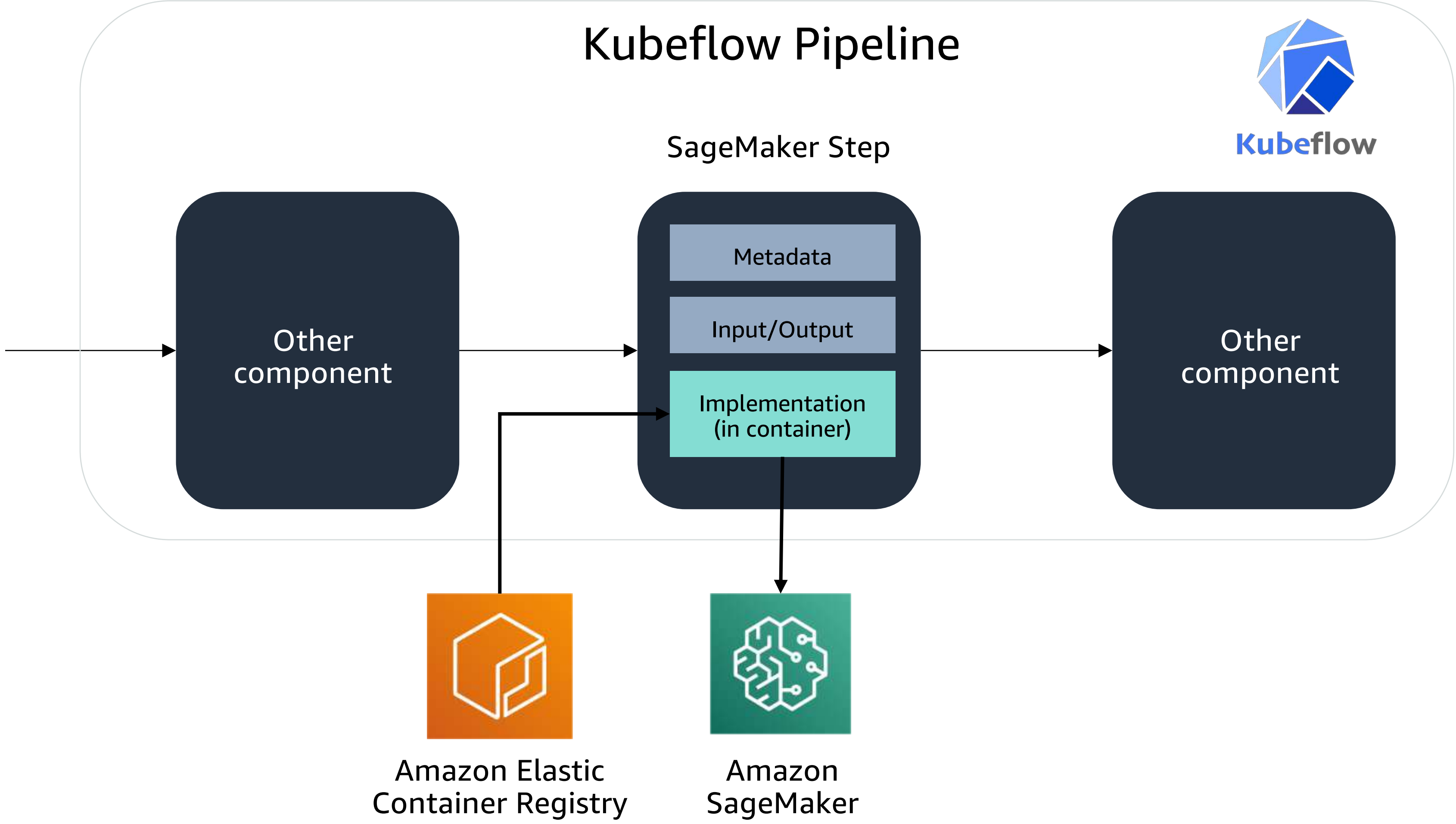
Uses Argo under the hood to orchestrate resources



Amazon SageMaker Operators for Kubernetes



Running SageMaker – pipeline components



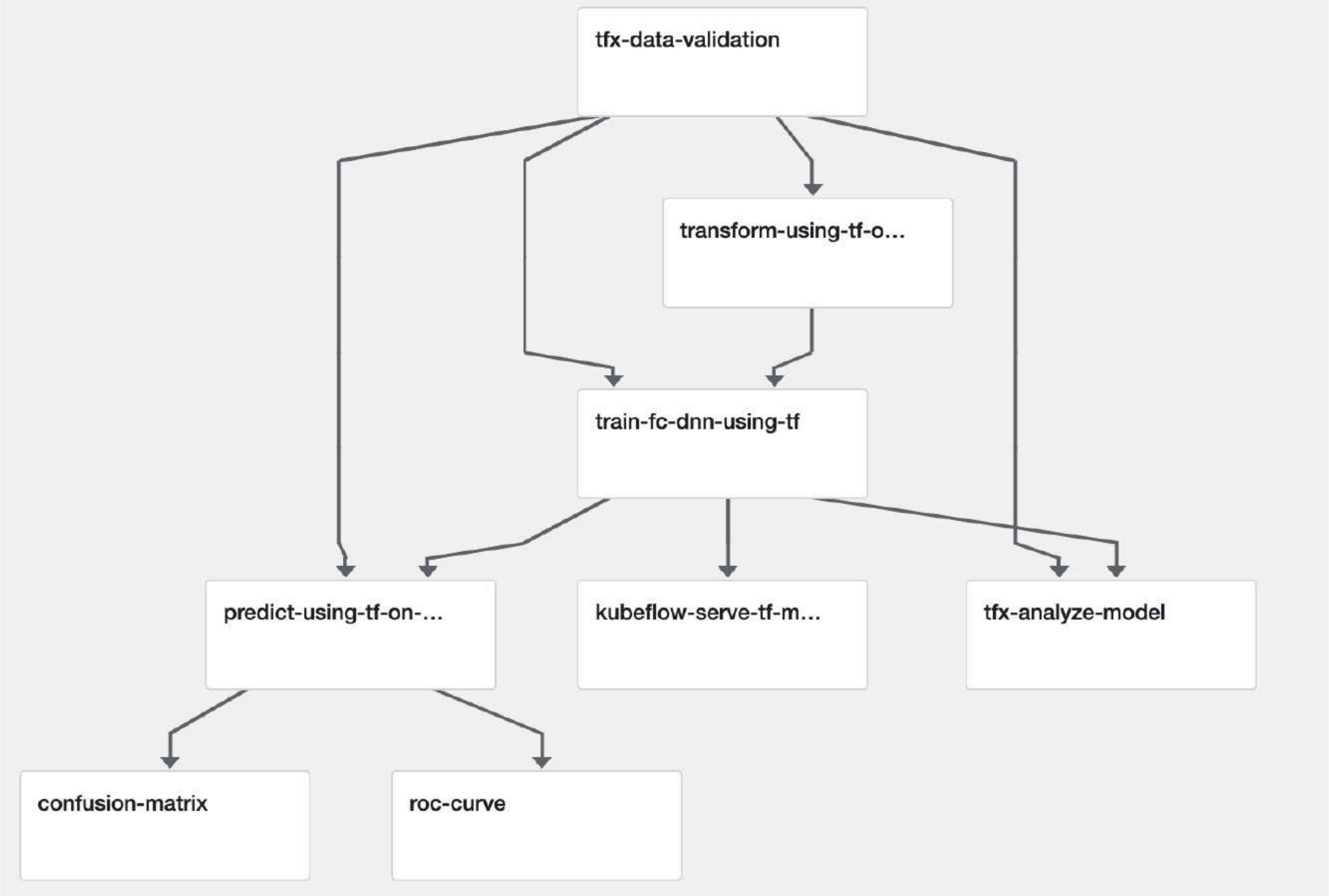
Supported components

- Training
- Model generation
- Hyperparameter tuning
- Model deployment
- Batch transform

https://github.com/kubeflow/pipelines/tree/master/components/aws/sagemaker

Kubeflow ML pipeline orchestration

Taxi Tip Prediction Model trainer using TF DNN

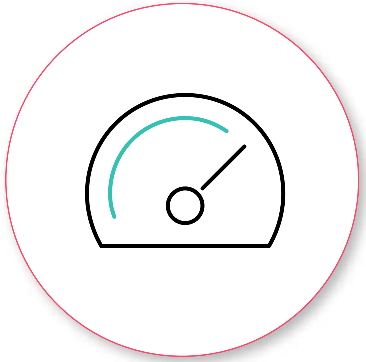


Governance at Scale for ML on AWS

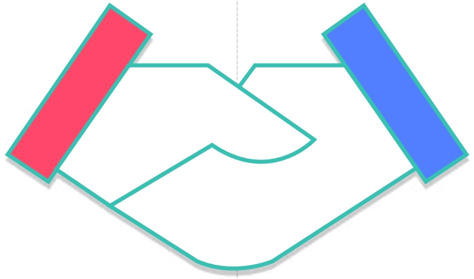
Enable self-service, governed ML development environments

Balancing the needs of ML builders and central cloud IT

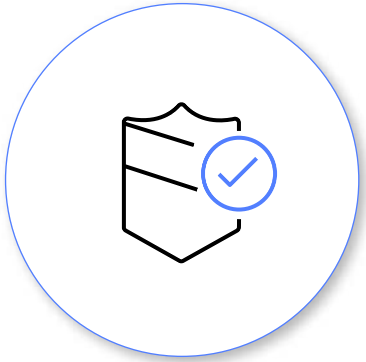
ML Builders
Stay agile



Innovate with the speed and agility of AWS
Self-service access
Experiment fast
Respond quickly to change



Cloud IT
Establish governance



Govern at scale with central controls
Security
Compliance
Operations
Spend management

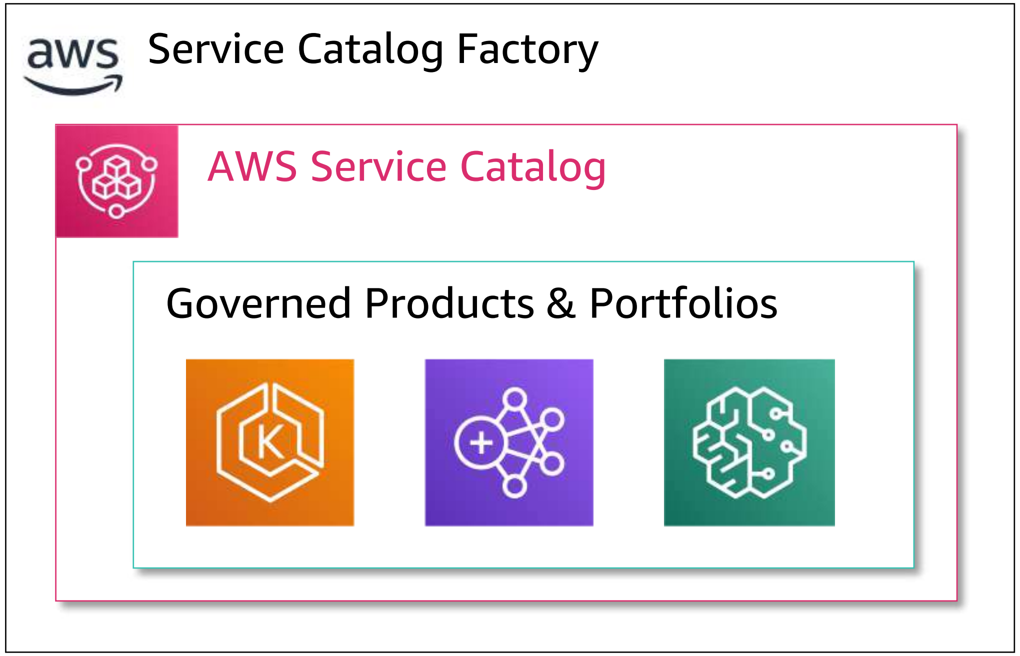
Enable MLOps/development teams to innovate at speed while ensuring governance

aws training and certification

MLOps team

Discover products

Launch governed resources



AWS Service Catalog Administrator

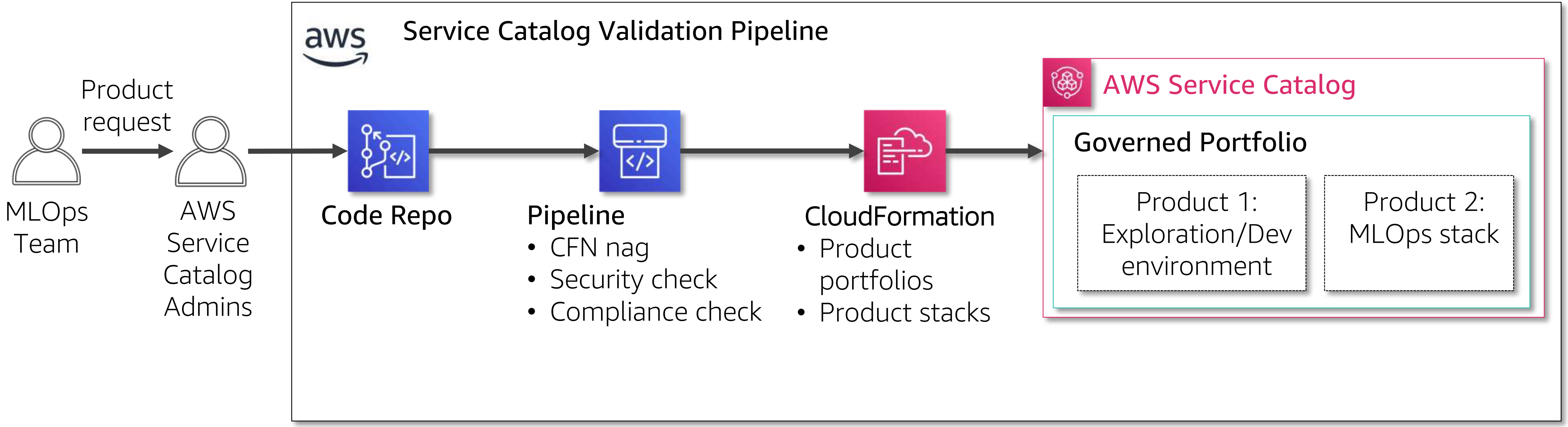
Author templates

Create portfolios/products

Constraints - Security controls - Tags

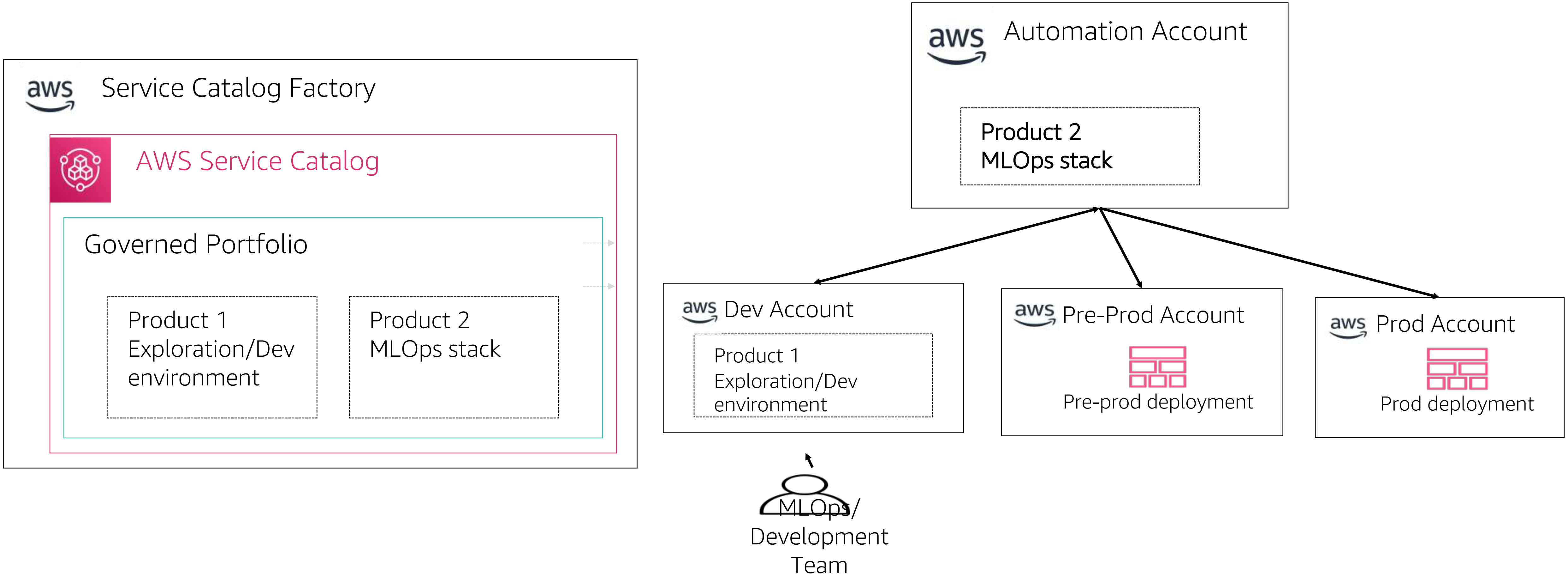
Ensure governance

Create governed environments with AWS Service Catalog



Launch governed ML environments in a few clicks

aws training and certification



Knowledge Check

Knowledge check

Select two ways we identified that MLOps is different from traditional DevOps:

- ✓ In ML, code and data are independent
- In ML, the code is what usually requires the most work
- ✓ ML code is only a small part of the ML solution
- MLOps doesn't use CI/CD pipelines

Knowledge check

Pick two AWS services that can be used together to orchestrate an MLOps pipeline:

- [x] AWS CodePipeline
- [ ] AWS AppSync
- [x] AWS Step Functions
- [ ] Amazon AppFlow

Module 11: Next Steps and Additional Learning

aws training and certification

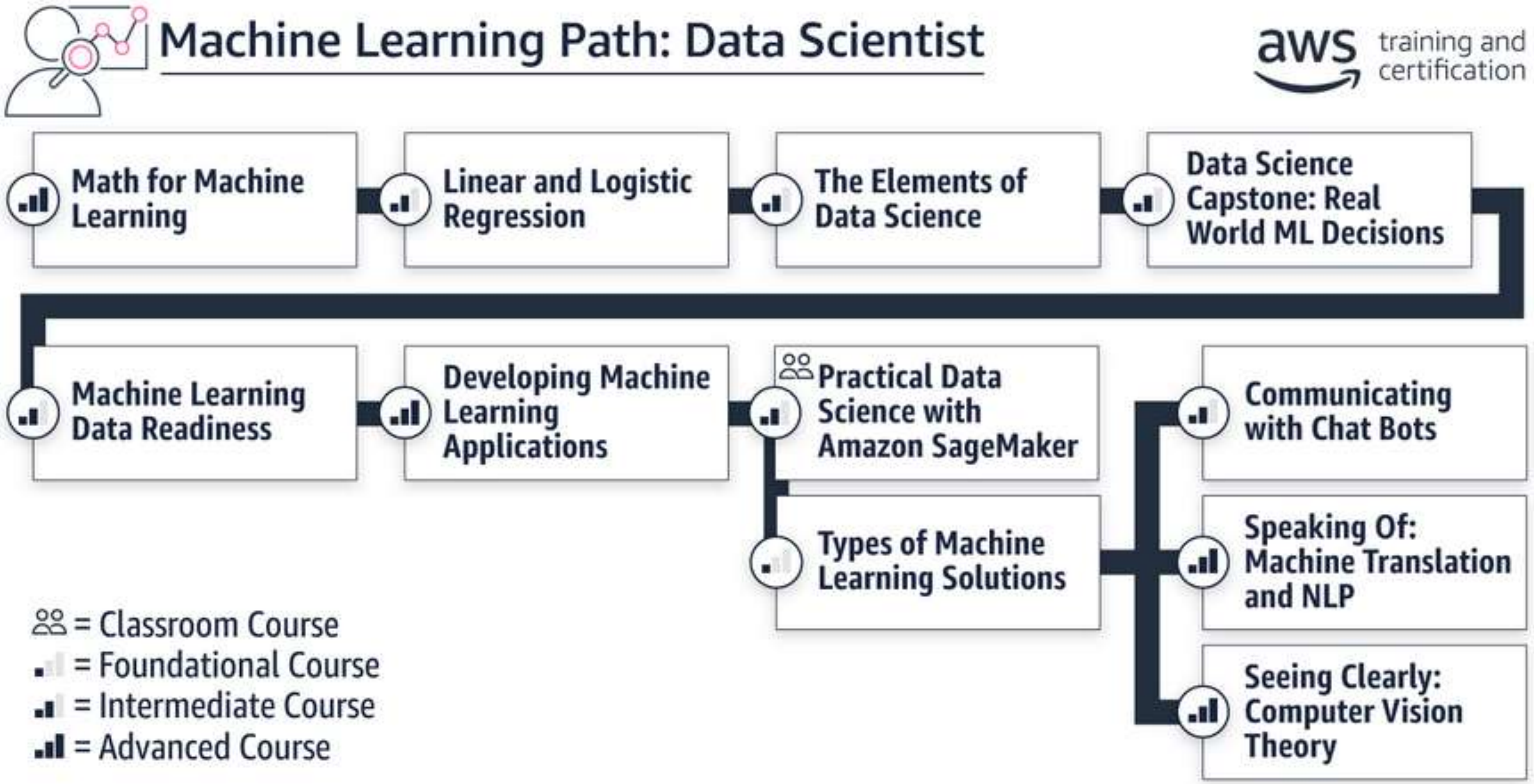
Module 11: Next Steps and Additional Learning

- Identify and describe the AWS Machine Learning Competency Program
- Explain how the AWS Machine Learning Competency Program impacts independent software vendors (ISVs) and consulting partners
- Locate resources for additional learning on ML topics

ML learning paths

https://pages.awscloud.com/AWS-Partner-Learning-Path-Tool.html

Learning path: ML for data scientists



https://aws.amazon.com/training/learning-paths/machine-learning

Machine Learning Certification

https://aws.amazon.com/certification/certified-machine-learning-specialty/

AWS ML Community

AWS ML Community

Learn from the ML Community

Whether you're just getting started with ML, already an expert, or something in between there is always something to learn. Choose from community created and ML focused blogs, videos, eLearning guides and much more.

VIDEO	BLOG	BOOK	TUTORIAL
How I started a career inmachine learning – no PhD required	How to win at at the AWS Deep Racer Leage (code and model included)?	AWS Machine Learning inMotion (gated content)	Learn how to find relevance from 1,000 wine descriptors using Amazon SageMaker
Alex Schultz	Vaibhav Malpani	Kesha Williams	Roald Schuring
Level 100	*Level 200*	*Level 300*	*Level 300*

https://aws.amazon.com/machine-learning/ml-community

AWS lofts

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aws loft NEW YORK CITY

aws loft SAN FRANCISCO

aws pop-up loft JAKARTA

aws | FLOOR28 TEL-AVIV

aws loft TOKYO

AWS Pop-up Loft Munich

https://aws.amazon.com/start-ups/loft

https://aws.amazon.com/start-ups/loft/faq

AWS Machine Learning Competency

https://aws.amazon.com/blogs/apn/new-look-aws-competency-validation-checklists-for-apn-technology-partners/

AWS Competency benefits

aws training and certification

AWS Competency Partner Benefits

In addition to the benefits you receive as an APN member, partners that qualify for AWS Competencies will receive a number of valuable benefits, which may include:

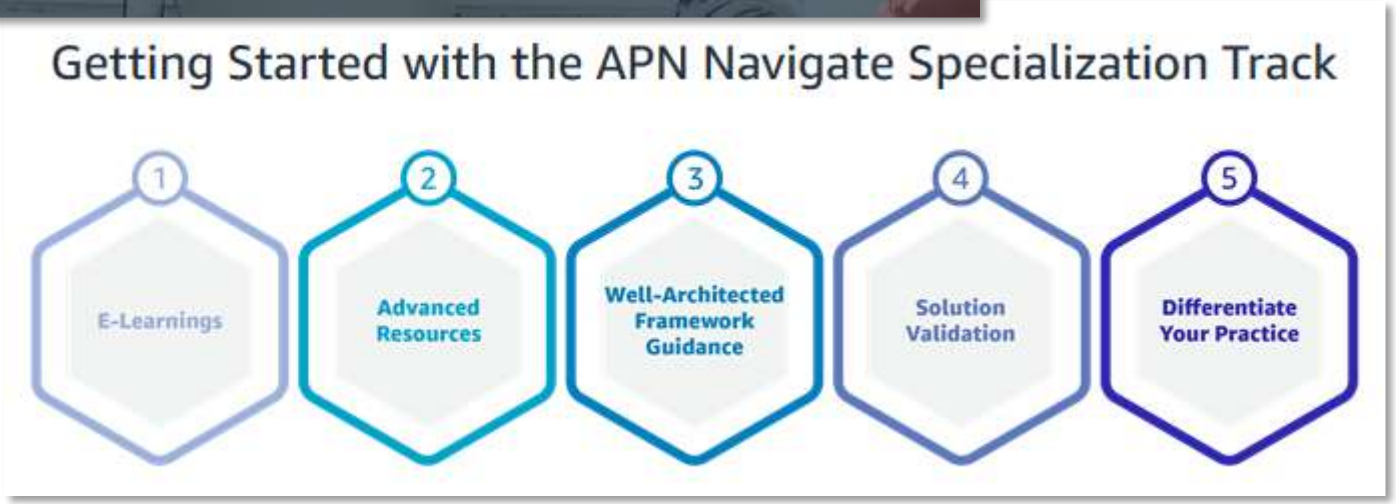
Special Access Benefits | Go-To-Market Benefits | Selective Eligibility | Event Specific Benefits

- Increased discount through the AWS Solution Provider Program
- Shared customer opportunities
- Preferred access to Market Development Funds
- Direct and prioritized access to AWS Partner Network reference team
- AWS Competency spotlight guest series on the APN Blog
- APN Partner spotlight opportunities
- AWS Sales enablement
- Preferred Partner recommendations

Special Access Benefits

https://aws.amazon.com/partners/competencies/#AWS_Competency_Partner_Benefits

APN Navigate

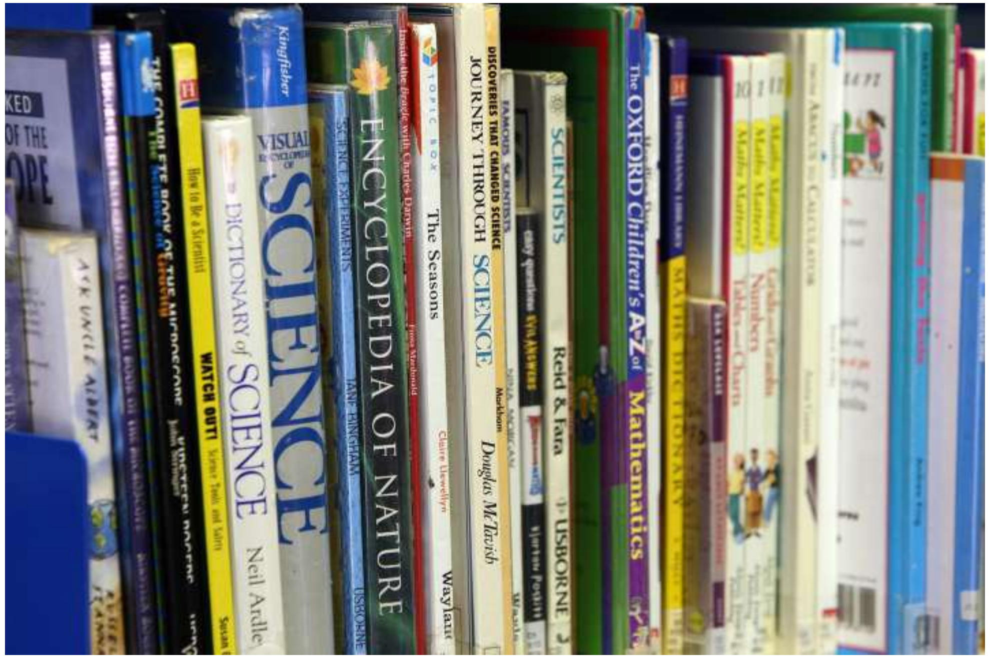


https://aws.amazon.com/partners/navigate/

APN Navigate for Machine Learning

https://aws.amazon.com/partners/navigate/machine-learning/

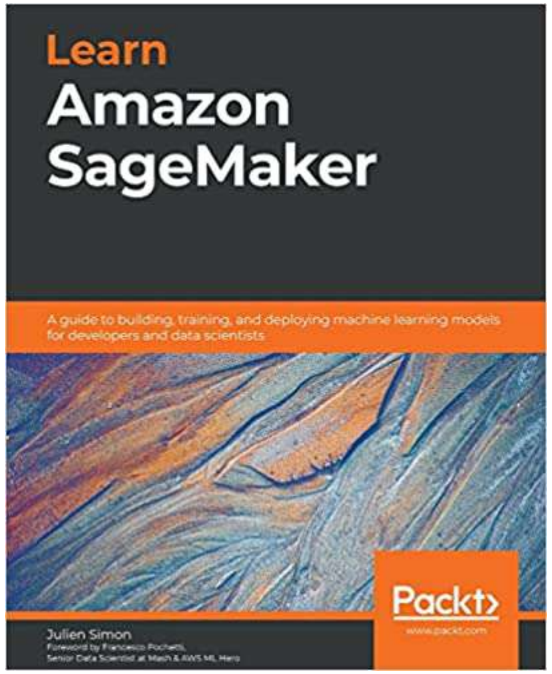
Resources and references



- Located in your participant guide
- Websites and references
- Please review
- Subject to change

Book - *Learn Amazon SageMaker*

A guide to building, training, and deploying machine learning models for developers and data scientists



September 2020

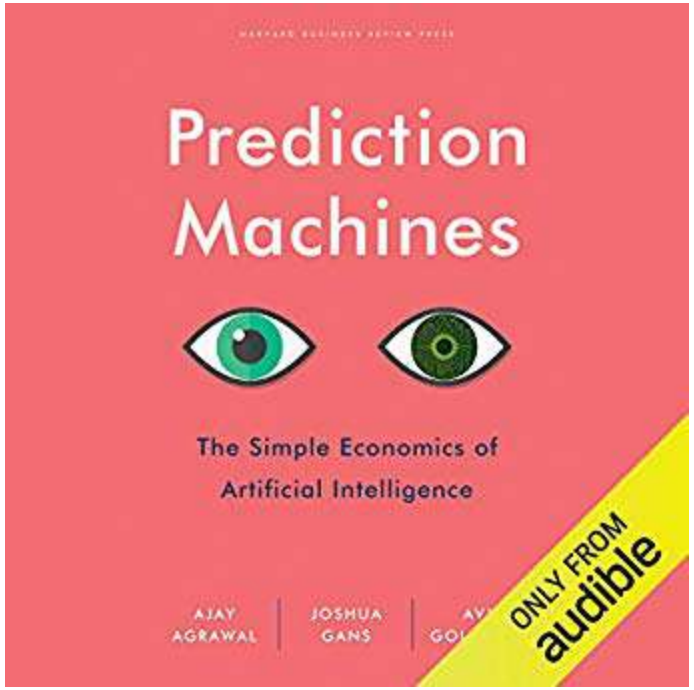
Julien Simon

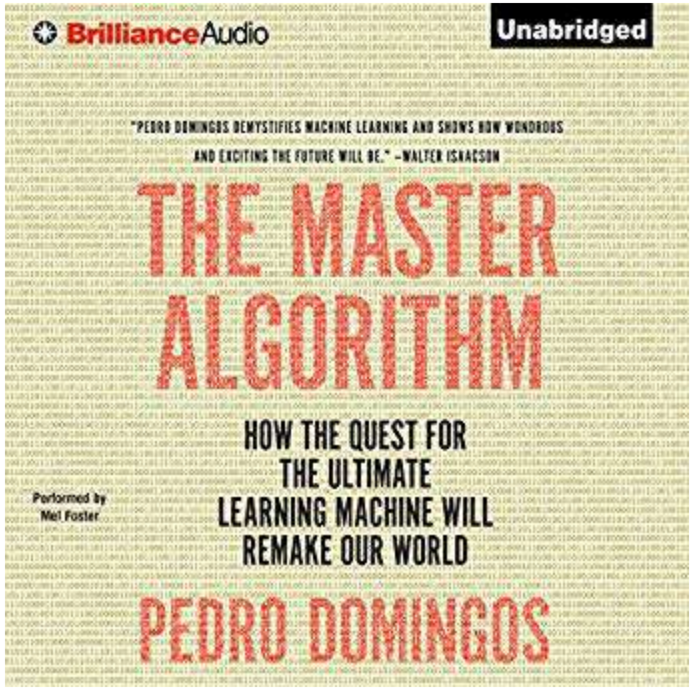
Principal Advocate, ML/AI

1. Getting Started with Amazon SageMaker
2. Handling Data Preparation Techniques
3. AutoML with Amazon SageMaker AutoPilot
4. Training Machine Learning Models
5. Training Computer Vision Models
6. Training Natural Language Processing Models
7. Extending Machine Learning Services Using Built-In Frameworks
8. Using Your Algorithms and Code
9. Scaling Your Training Jobs
10. Advanced Training Techniques
11. Deploying Machine Learning Models
12. Automating Machine Learning Workflows
13. Optimizing Prediction Cost and Performance

https://www.amazon.XX/Learn-Amazon-SageMaker-developers-scientists/dp/180020891X

Further learning

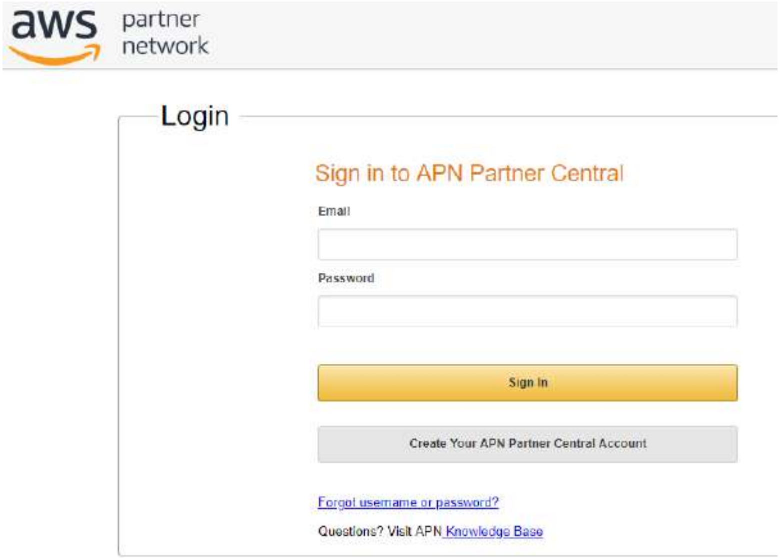




End of class

training and certification

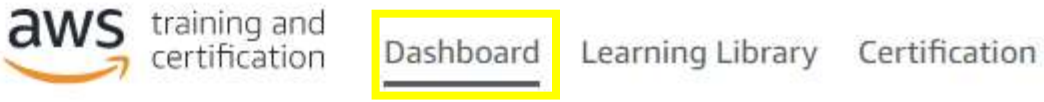
Assessment and course evaluation



1. https://partnercentral.awspartner.com

2. Click the Training tab.

3. Click the learn more link.



4. Click the Dashboard tab.

5. Solutions Training for Partners: Introduction to Machine Learning on AWS – Technical will be in progress.

Select the resume button, locate the assessment and click launch.

Thank You

aws training and certification