Machine Learning on AWS - Technical

AWS Solutions Training for Partners

Vijay
AWS Partner Trainer

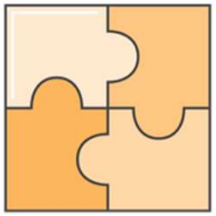
Machine Learning

aws training and certification

Prediction is the process of filling in missing information; it uses data you have to generate data you don't have.

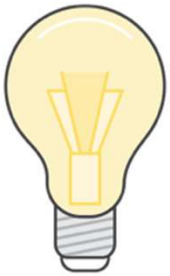
Learning

Language



Perception

Problem Solving



Insight

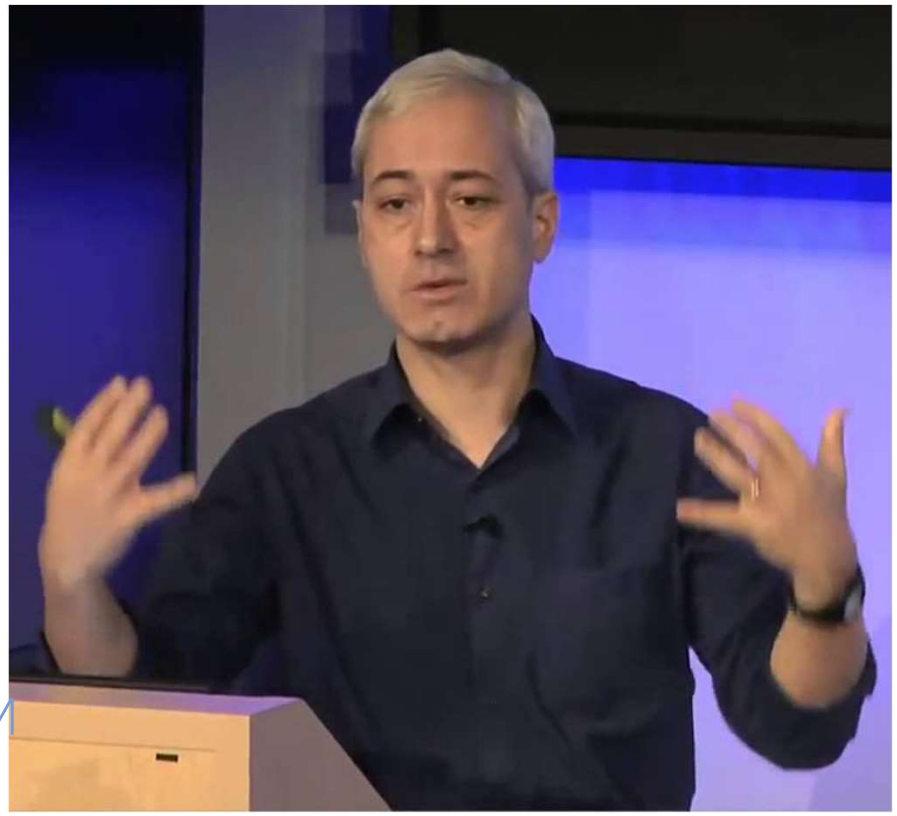
The Artificial Intelligence Landscape

Five Tribes / Two Breakthroughs

aws training and certification

Tribe	Origins	Algorithm
Bayesians	Statistics	Probabilistic
Analogizers	Psychology	Kernel
Symbolists	Logic	Inverse Deduction
Evolutionaries	Biology	Genetic
Connectionists	Neuroscience	Back Propagation

- Computer Vision : CNNs
  - Static / Unstructured
- Natural Language Processing : RNNs / LSTM
  - Sequential / Structured



aws training and certification

AWS Mission

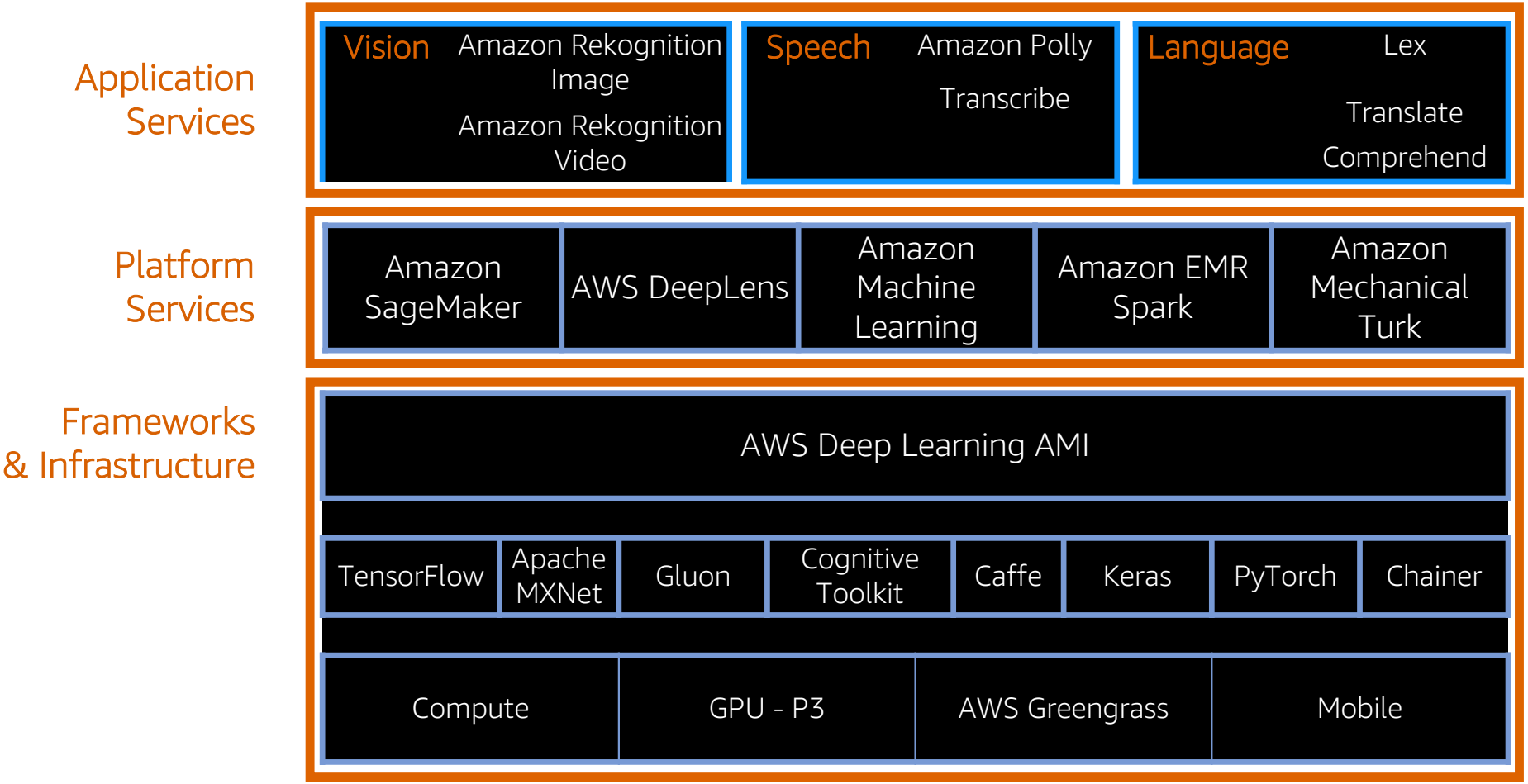
Put machine learning in the hands of every developer, data scientist and architect

Customers Running ML on AWS

aws training and certification

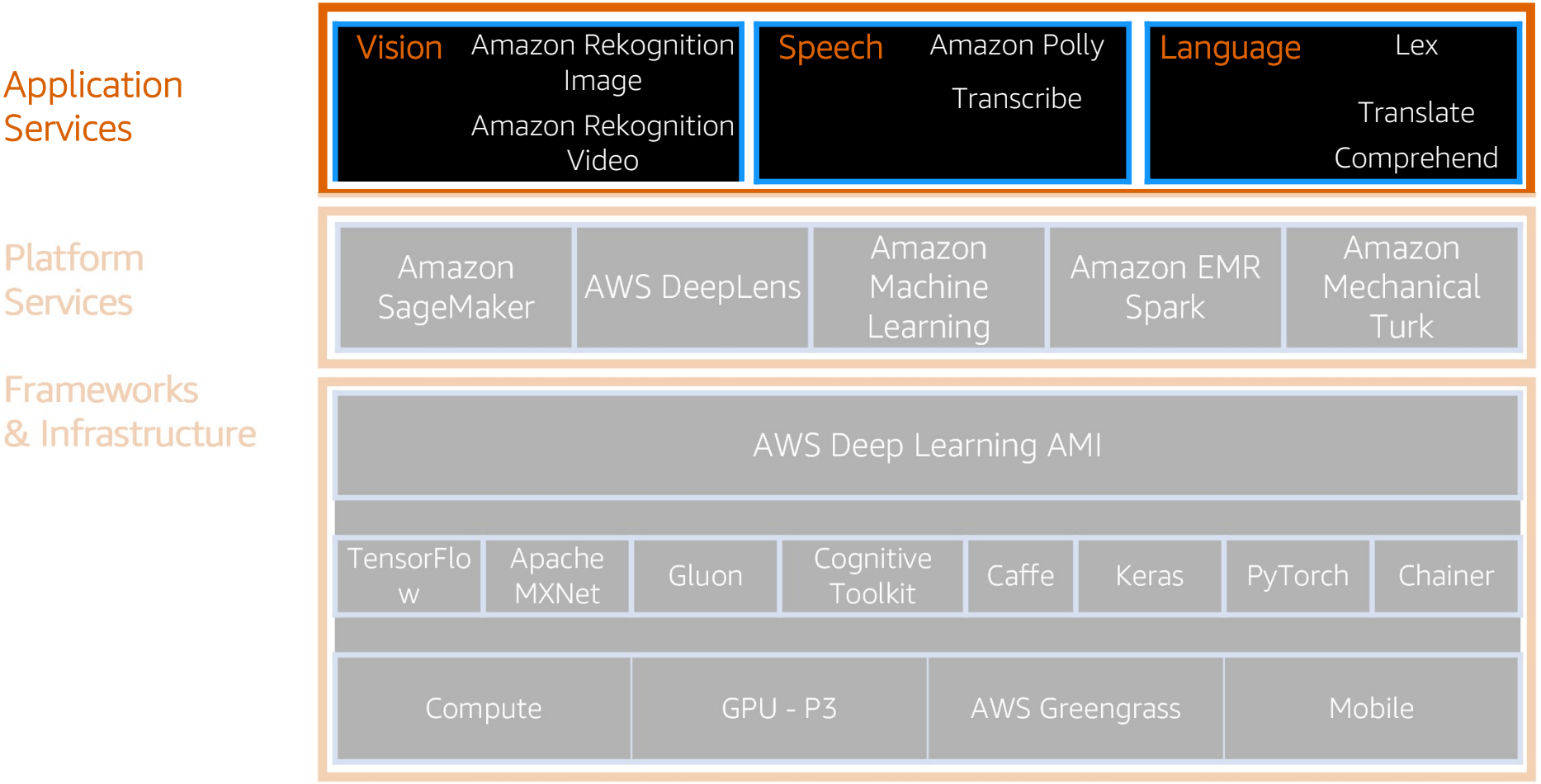
The AWS Machine Learning Stack

aws training and certification



The AWS Machine Learning Stack

aws training and certification

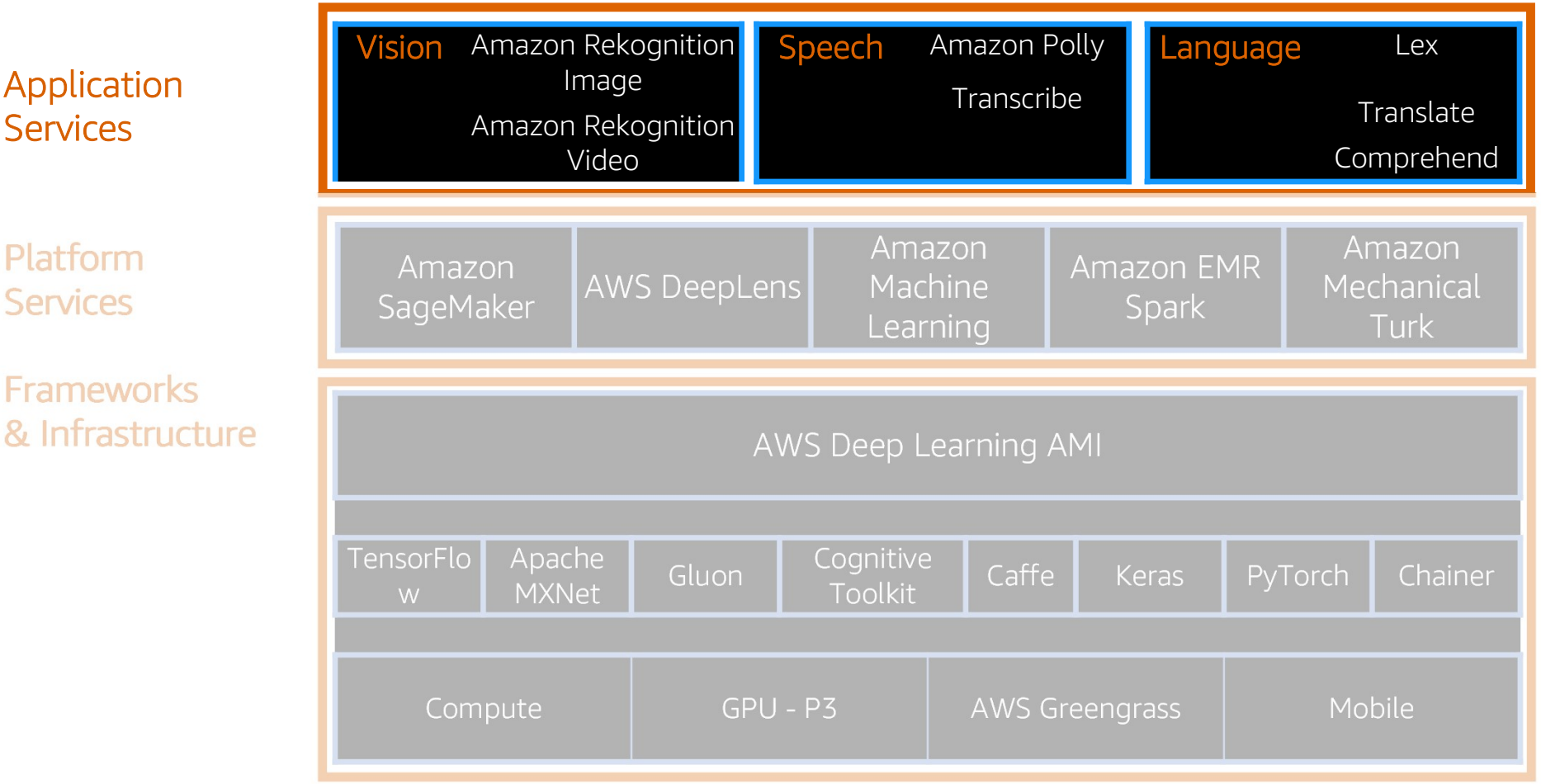


aws training and certification

Demo 1: Vision Services

The AWS Machine Learning Stack

aws training and certification

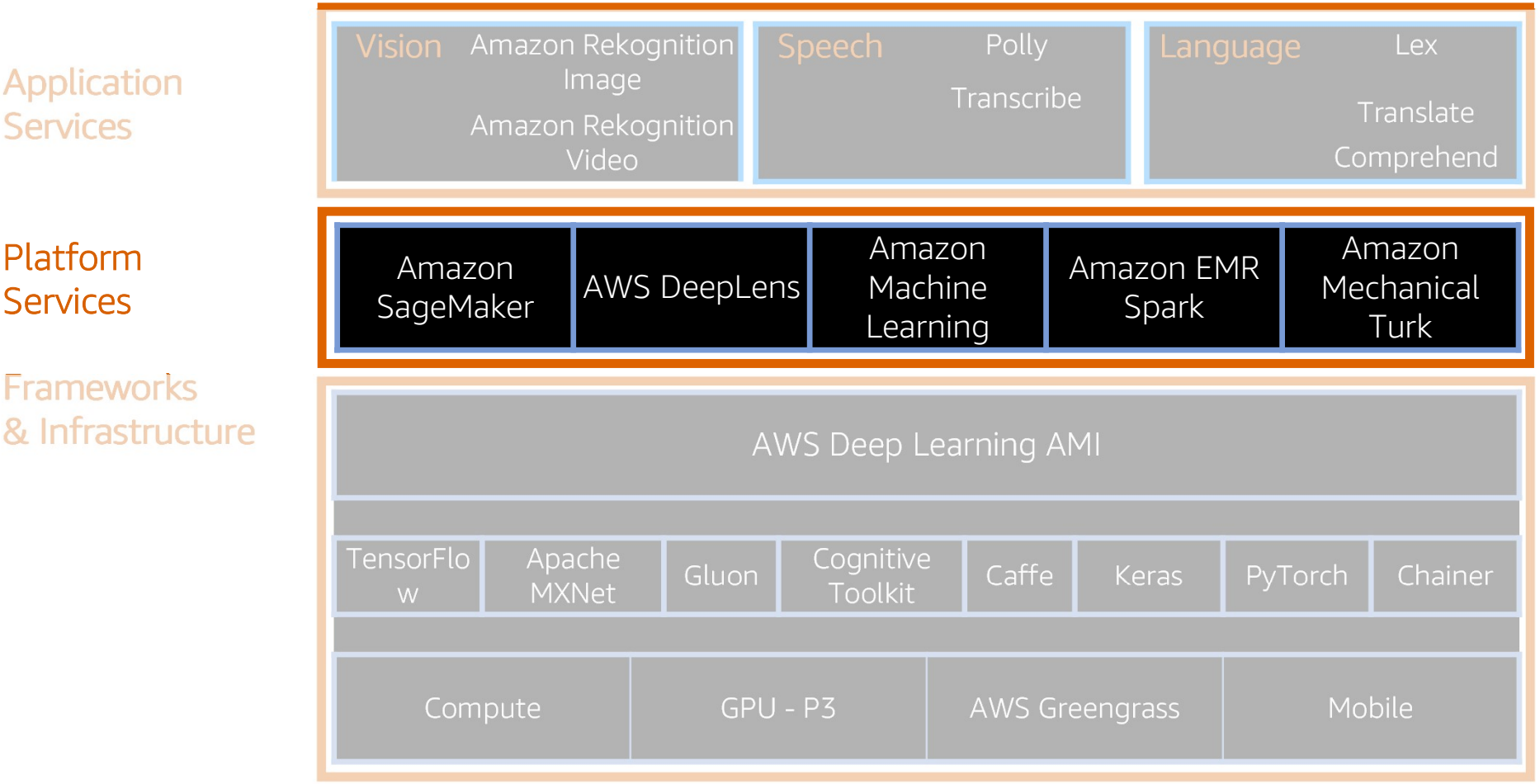


aws training and certification

Demo 2: Language Services

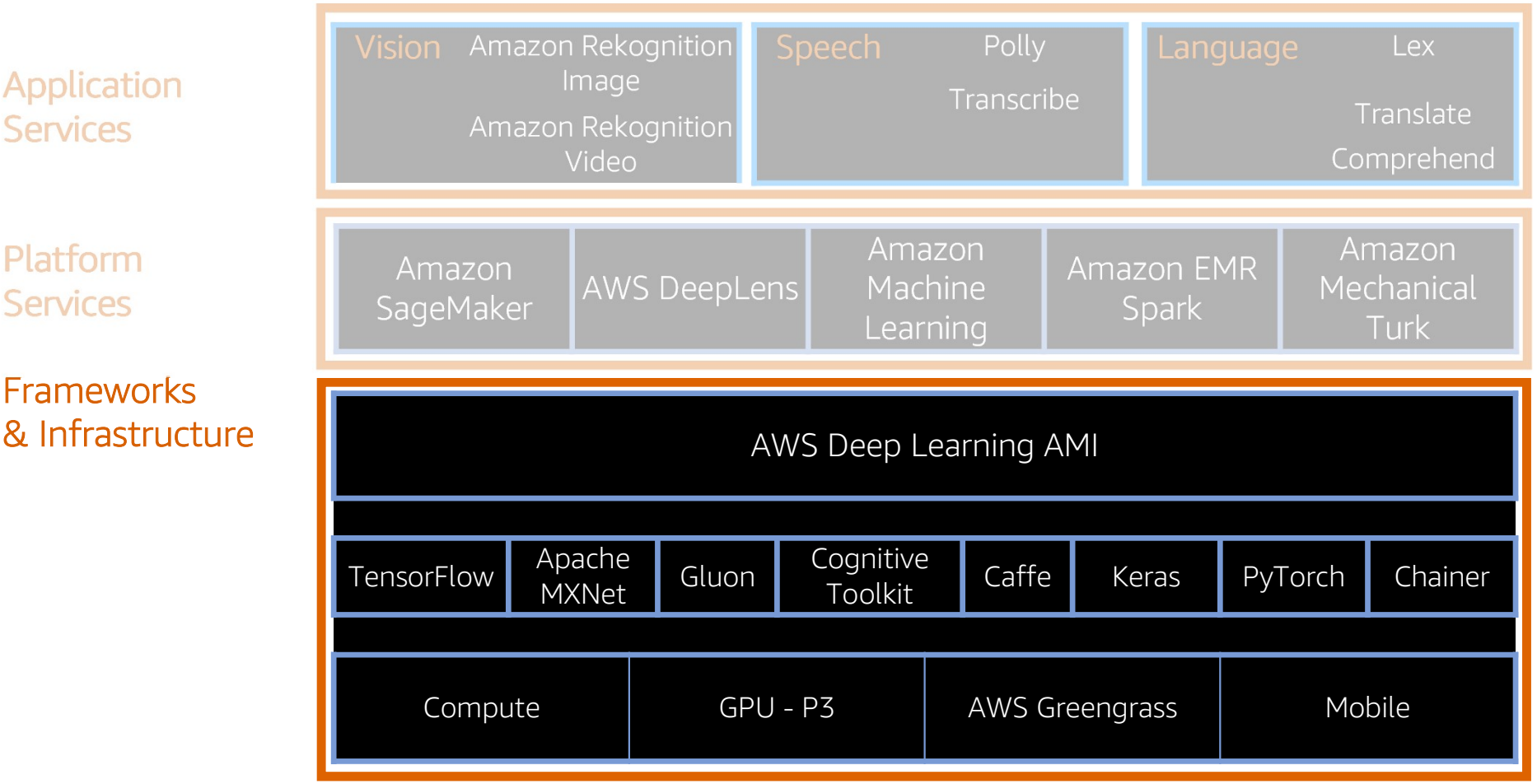
The AWS Machine Learning Stack

aws training and certification



The AWS Machine Learning Stack

aws training and certification

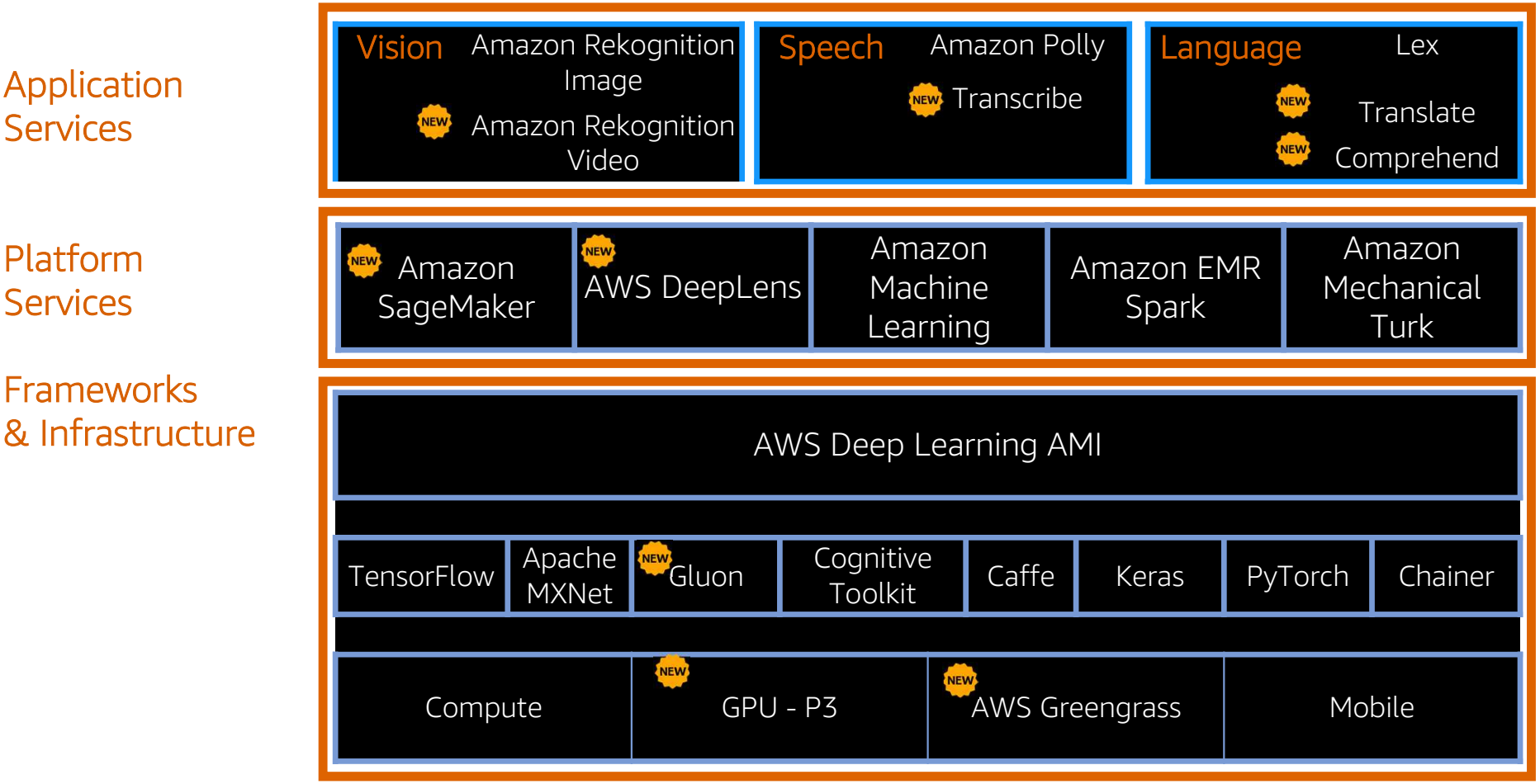


aws training and certification

Demo 3: Deep Learning AMI

The AWS Machine Learning Stack

aws training and certification



Amazon EC2 P3 Instances

aws training and certification

The fastest, most powerful GPU instances in the cloud

- Up to 8 NVIDIA Tesla V100 GPUs
  - 16GB GPU memory with 900 GB/sec peak bandwidth
- 1 PetaFLOPs of computational performance
  - 14x better than P2
- 300 GB/s GPU-to-GPU communication (NVLink)
  - 9X better than P2

Airbnb

Toyota Research Institute

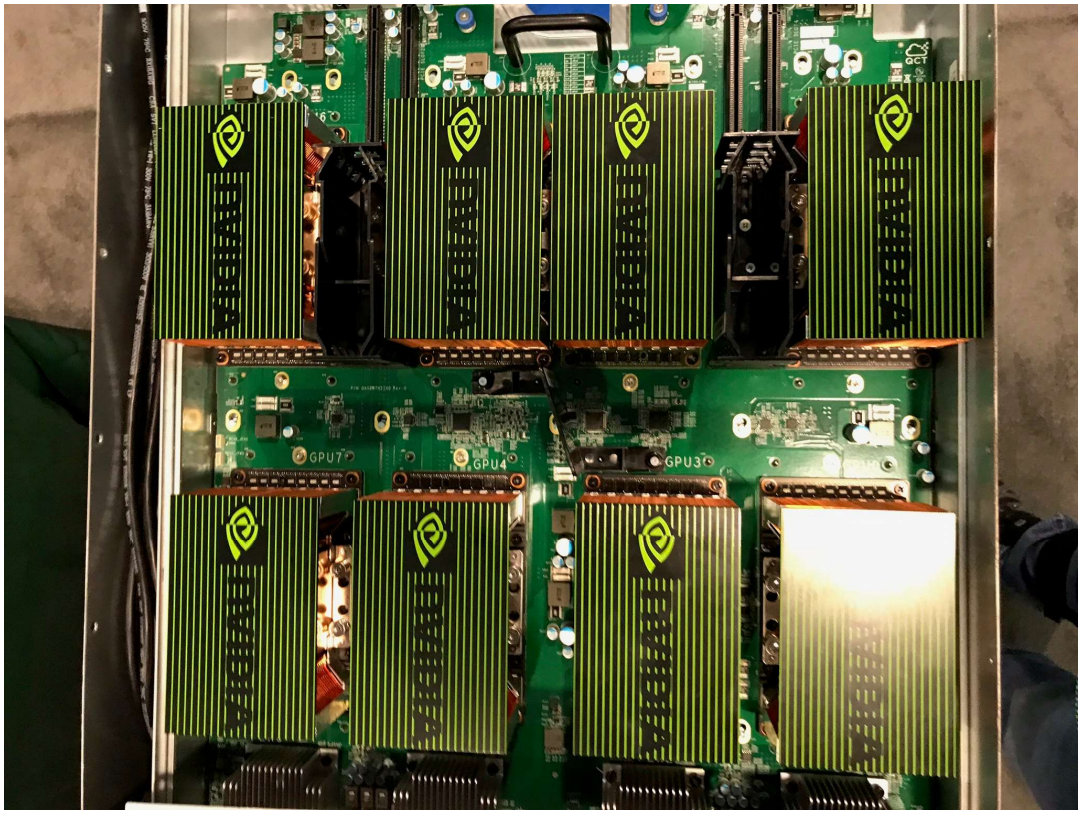
OpenAI

Amazon EC2 P3 Instances

aws training and certification

Amazon EC2 P3 Instances

aws training and certification



AWS Deep Learning Amazon Machine Image (AMI)

aws training and certification

- Get started quickly with easy-to-launch tutorials
- Hassle-free setup and configuration
- Pay only for what you use – no additional charge for the AMI
- Accelerate your model training and deployment
- Support for popular deep learning frameworks

TensorFlow, MXNet, Gluon, Keras, Caffe2, PyTorch, Zendesk, Matric Analytics, SCDM, etc.

Amazon ML Solutions Lab

aws training and certification

Lots of companies doing Machine Learning

Lack ML expertise

Unable to unlock business potential

Amazon ML Solutions Lab

aws training and certification

Lots of companies doing Machine Learning

Lack ML expertise

Unable to unlock business potential

Amazon ML Solutions Lab provides the missing ML expertise

Brainstorming

Modeling

Education

Amazon ML Lab Customers

aws training and certification

Johnson & Johnson

Toyota Research Institute

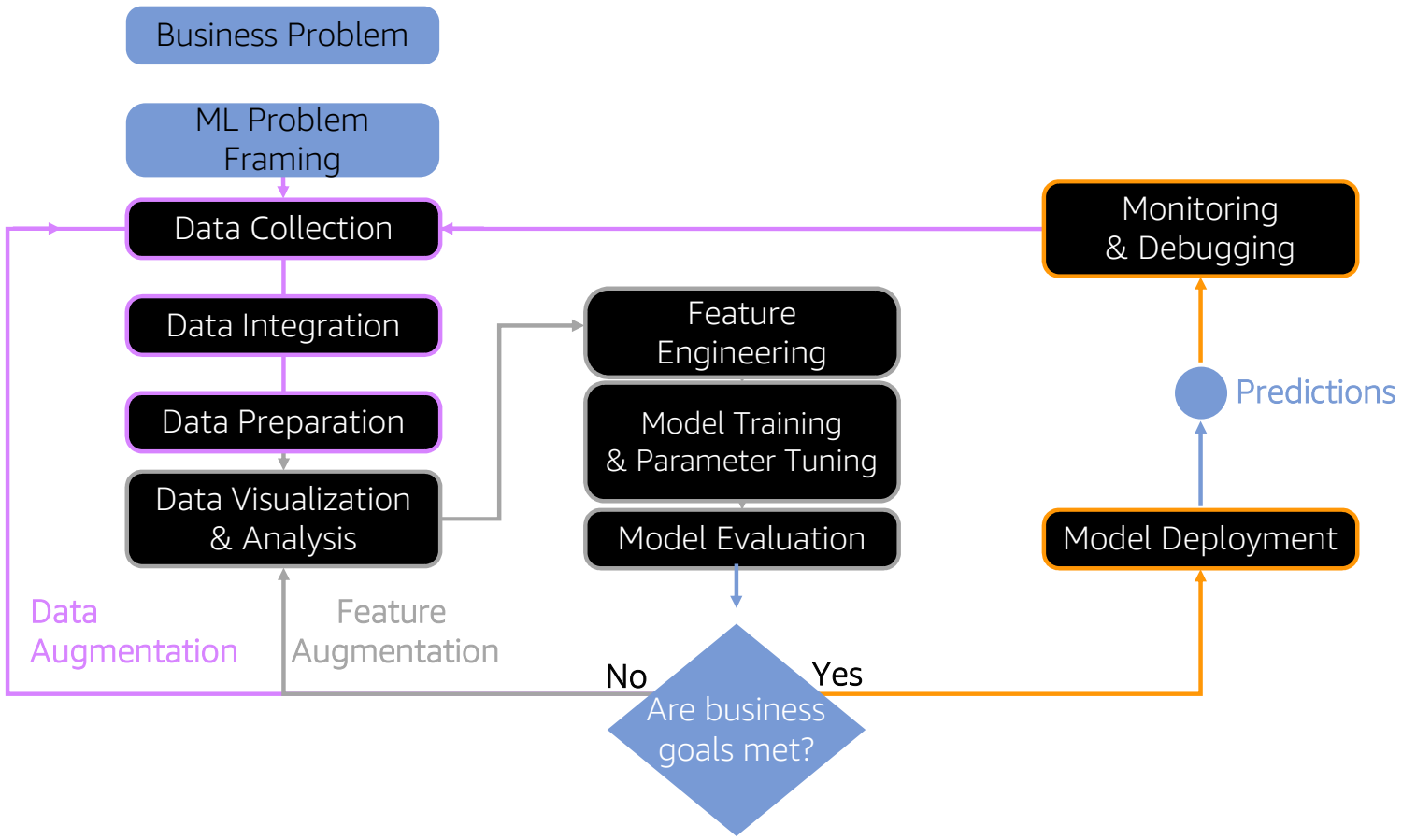
Washington Post

aws training and certification

The Machine Learning Process

The Machine Learning Process

aws training and certification



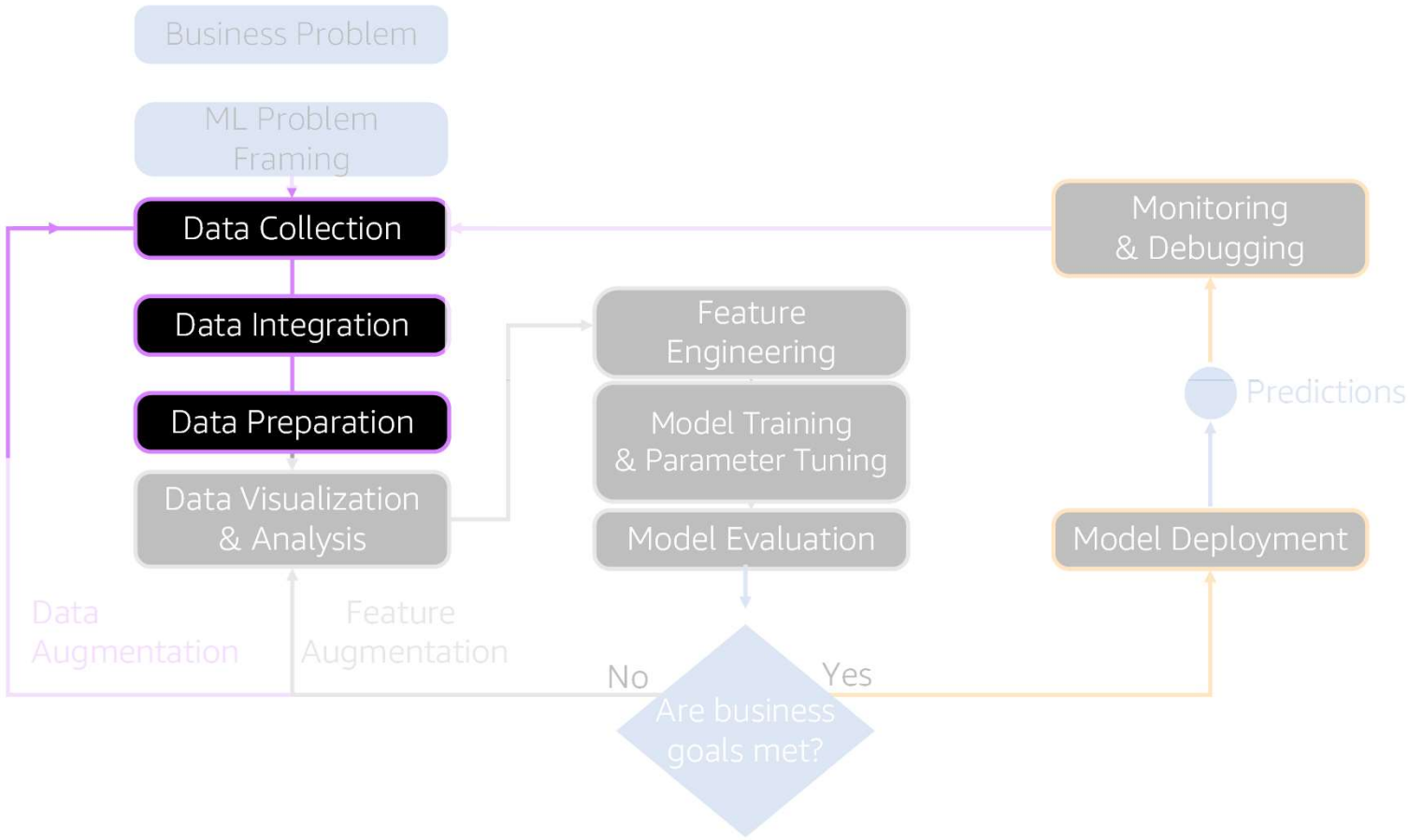
The ML Process

Integration: The Data Architecture

aws training and certification

Build the data platform:

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

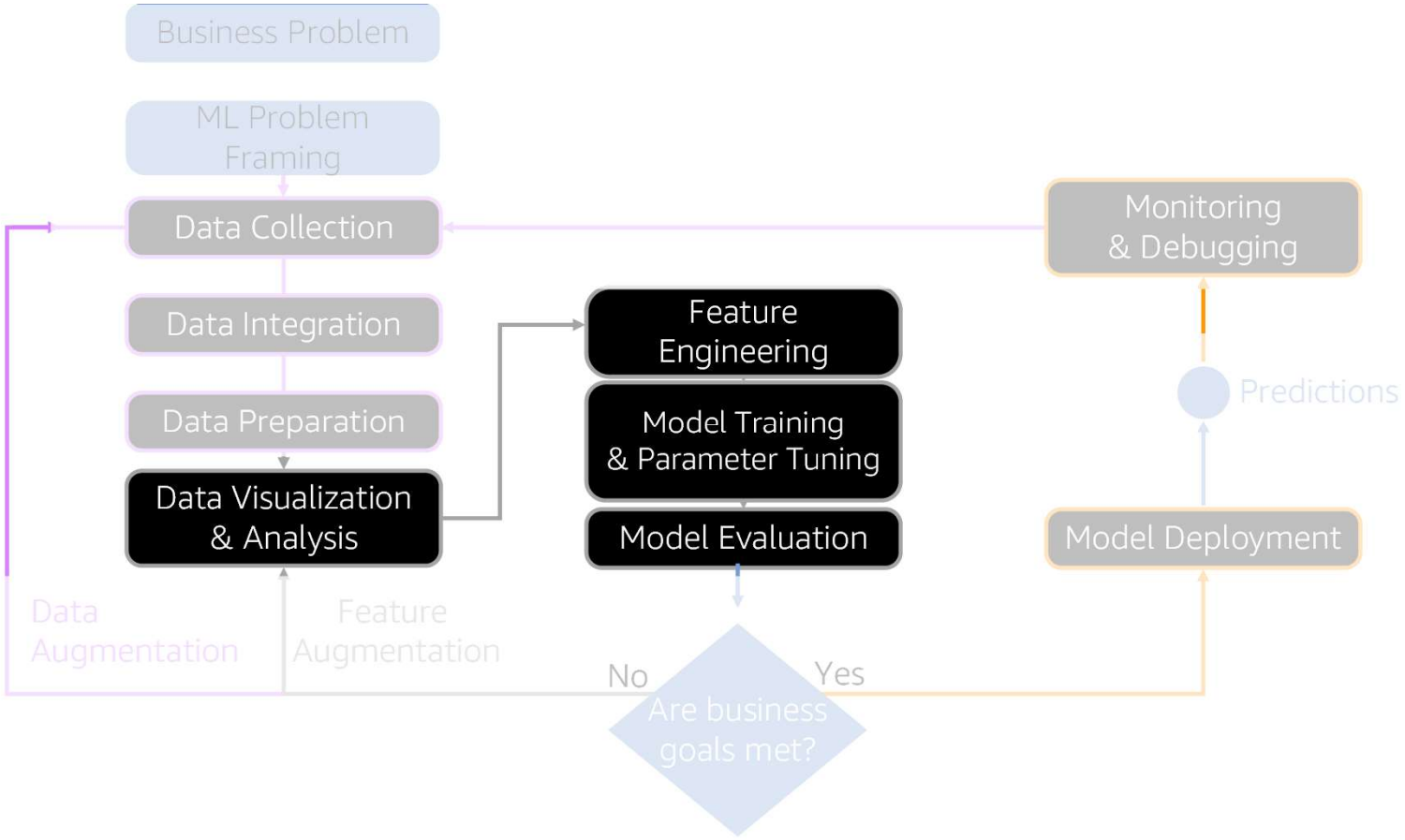


The ML Process

The Model Training: Undifferentiated Heavy Lifting

aws training and certification

- Setup 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

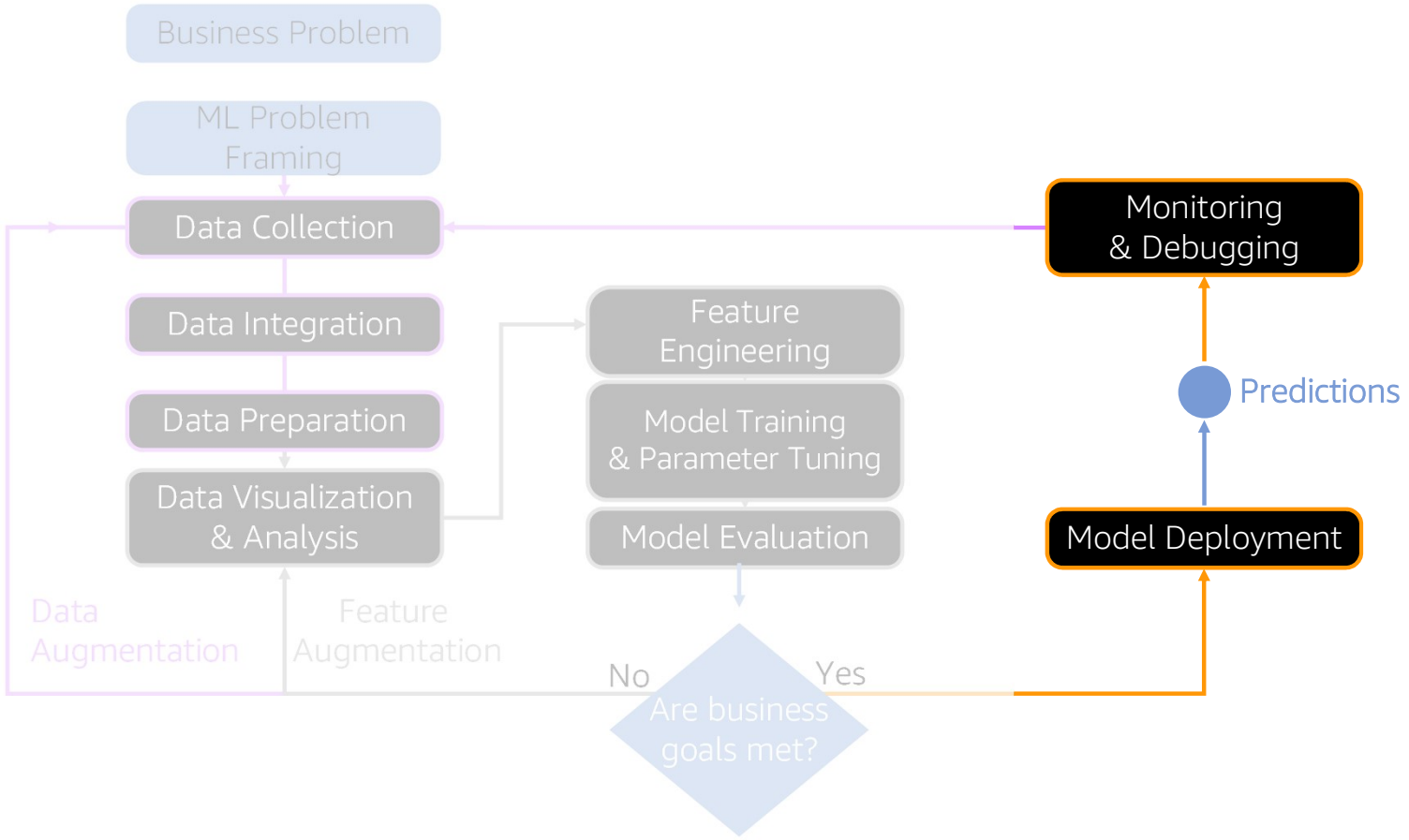


The ML Process

DevOps: Undifferentiated Heavy Lifting

aws training and certification

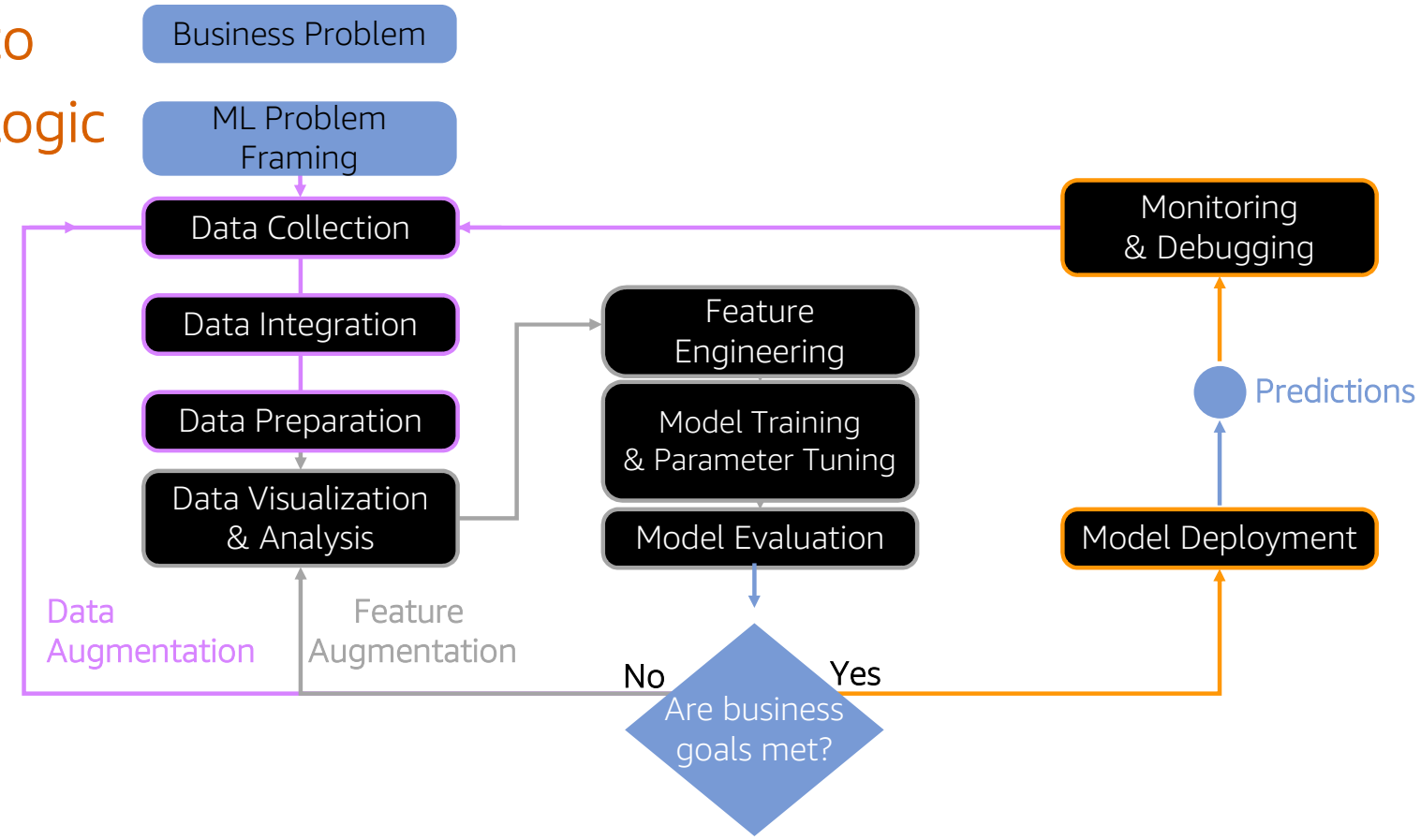
- Setup and Manage Inference Clusters
- Manage and Scale Model Inference APIs
- Monitor and Debug Model Predictions
- Models versioning and performance tracking
- Automate New Model version promotion to production (A/B testing)



Why Amazon SageMaker?

aws training and certification

You Only Have to Write Business Logic



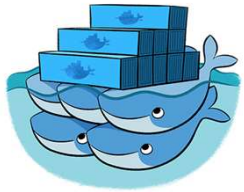
aws training and certification

Amazon SageMaker

A Fully-Dockerized Lifecycle

From Discovery to Development and Deployment

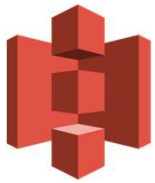
aws training and certification



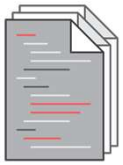
Data Scientists

Amazon SageMaker

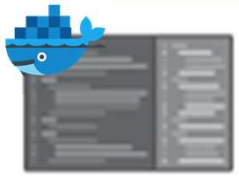
Model Artifacts



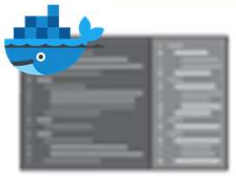
Amazon S3



Training Data



Training Algorithm



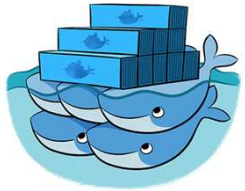
Inference Engine

Amazon Elastic Container Registry

A Fully-Dockerized Lifecycle

From discovery to development and deployment

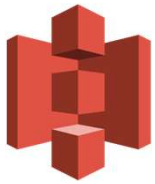
aws training and certification



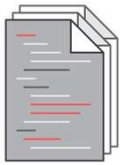
Developers and Operations

Amazon SageMaker

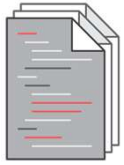
EndPoint



Amazon S3



Training Data



Model Artifacts

Training Algorithm

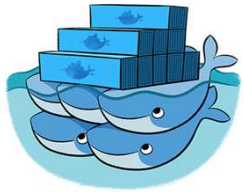
Inference Engine

Amazon Elastic Container Registry

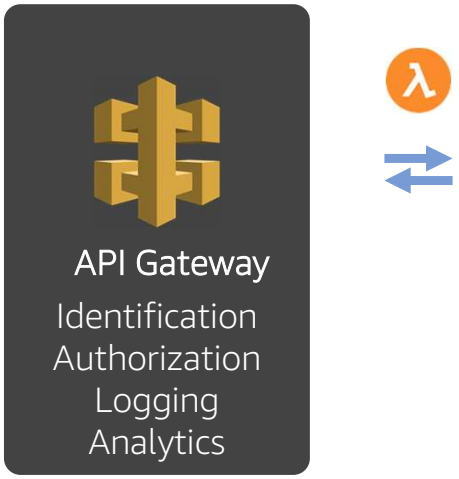
A Fully-Dockerized Lifecycle

From discovery to development and deployment

aws training and certification



Delighted Customers



Amazon SageMaker

Launch Customers

aws training and certification

Intuit

Digital Globe

ZipRecruiter

Hotels.com

Thomson Reuters

Customer Example: Intuit

aws training and certification

INTUIT

"With Amazon SageMaker, we can accelerate our Artificial Intelligence initiatives at scale by building and deploying our algorithms on the platform. We will create novel large-scale machine learning and AI algorithms and deploy them on this platform to solve complex problems that can power prosperity for our customers."

Ashok Srivastava, Chief Data Officer, Intuit

Key Benefits of Amazon SageMaker at Intuit

aws training and certification

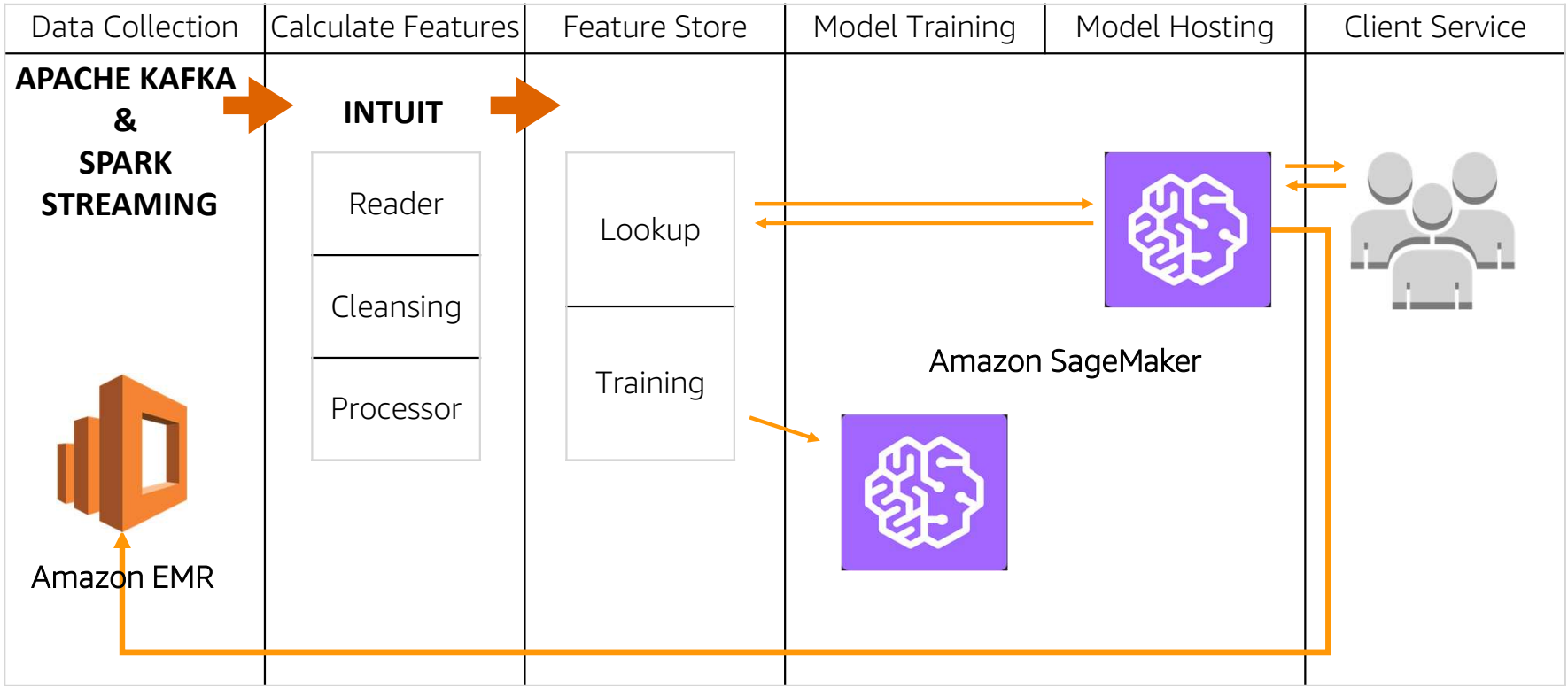
From

- Ad-hoc setup and management of notebook environments
- Limited choices for model deployment
- Competing for compute resources across teams

To

Fraud Detection using SageMaker

aws training and certification



Customer Example: DigitalGlobe

aws training and certification

DigitalGlobe

"As the world's leading provider of high-resolution Earth imagery, data and analysis, DigitalGlobe works with enormous amounts of data every day. DigitalGlobe is making it easier for people to find, access, and run compute against our entire 100PB image library, which is stored in AWS's cloud, to apply deep learning to satellite imagery. We plan to use Amazon SageMaker to train models against petabytes of Earth observation imagery datasets using hosted Jupyter notebooks, so DigitalGlobe's Geospatial Big Data Platform (GBDX) users can just push a button, create a model, and deploy it all within one scalable distributed environment at scale."

Dr. Walter Scott, CTO of Maxar Technologies and founder of DigitalGlobe

Customer Example: ZipRecruiter

aws training and certification

ZipRecruiter

"We're focused on making it faster and easier than ever to hire and get hired, training our machine learning algorithms against hundreds of millions of historical transactional activities in order to deliver highly relevant job matches as quickly as possible. Amazon SageMaker provided us with an answer to problems we had with ML workflow management, allowing us to train, evaluate and deploy models in a flexible way. In addition, Amazon SageMaker's modularity provides the ability to build and create models independently, which is a compelling feature for ZipRecruiter."

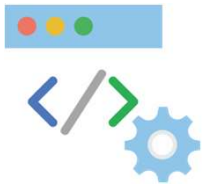
Avi Golan, VP of Engineering, ZipRecruiter

Amazon SageMaker's Components

aws training and certification

Amazon SageMaker

1

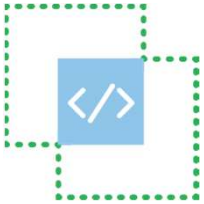


Notebook Instances

2

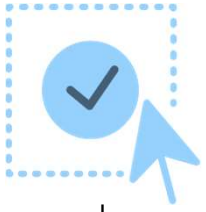
Algorithms

3



ML Training Service

4

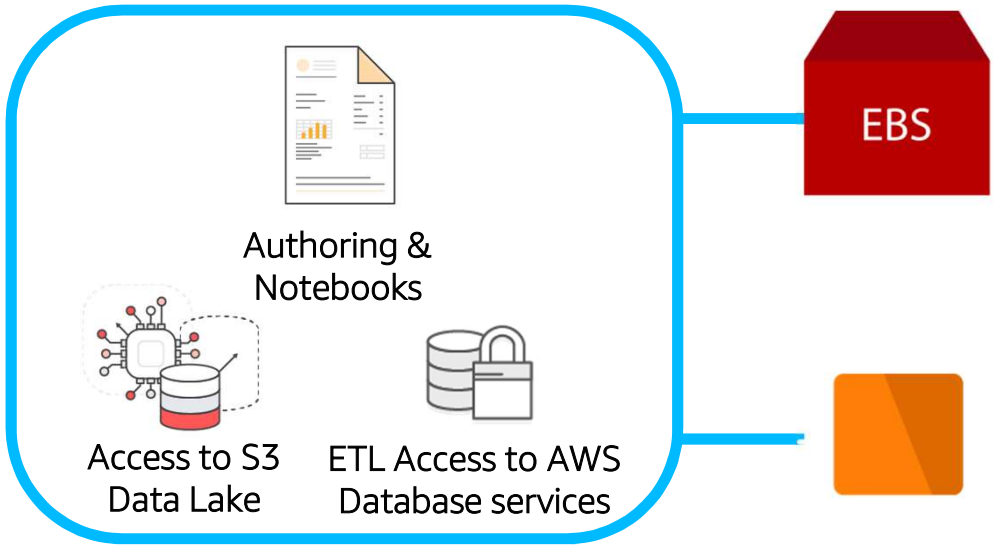


ML Hosting Service

SageMaker Notebook Instances

Zero Setup for Exploratory Data Analysis

aws training and certification



Just add data!

- Recommendations/Personalization
- Fraud Detection
- Forecasting
- Image Classification
- Churn Prediction
- Marketing Email/Campaign Targeting
- Log processing and anomaly detection
- Speech to Text
- More…

aws training and certification

Demo 4: A simple Jupyter Notebook

Pythagorean Theorem

aws training and certification

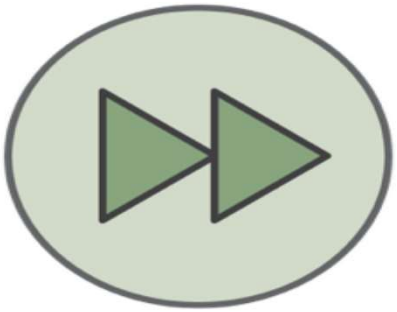
Demo 5: Predicting AWS Spot Pricing

SageMaker Built-in Algorithms

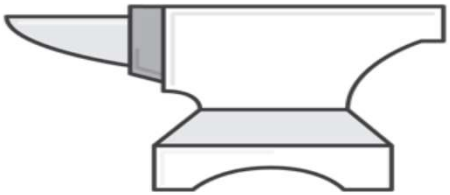
10x Faster

aws training and certification

Streaming datasets, for cheaper training



Train faster, in a single pass



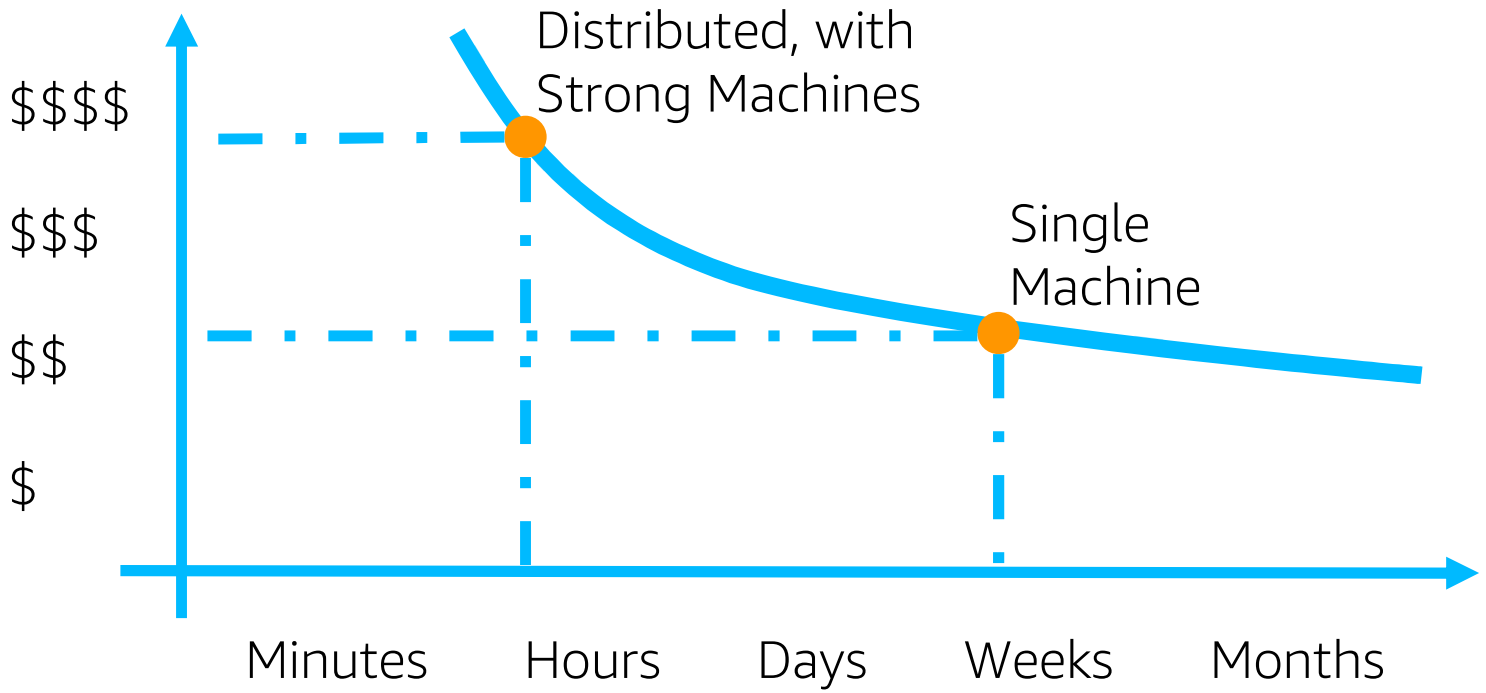
Greater reliability on extremely large datasets

Choice of several ML algorithms

SageMaker Built-in Algorithms

Time vs. Money

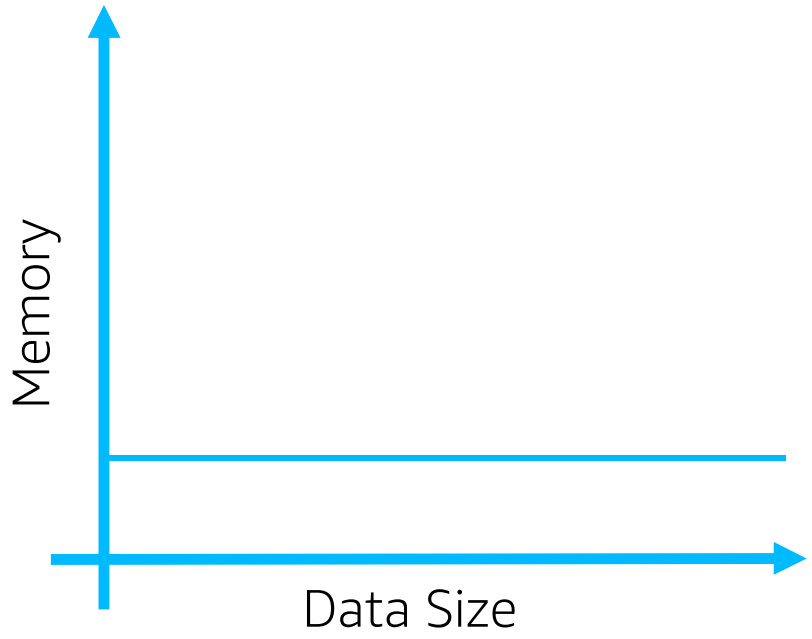
aws training and certification

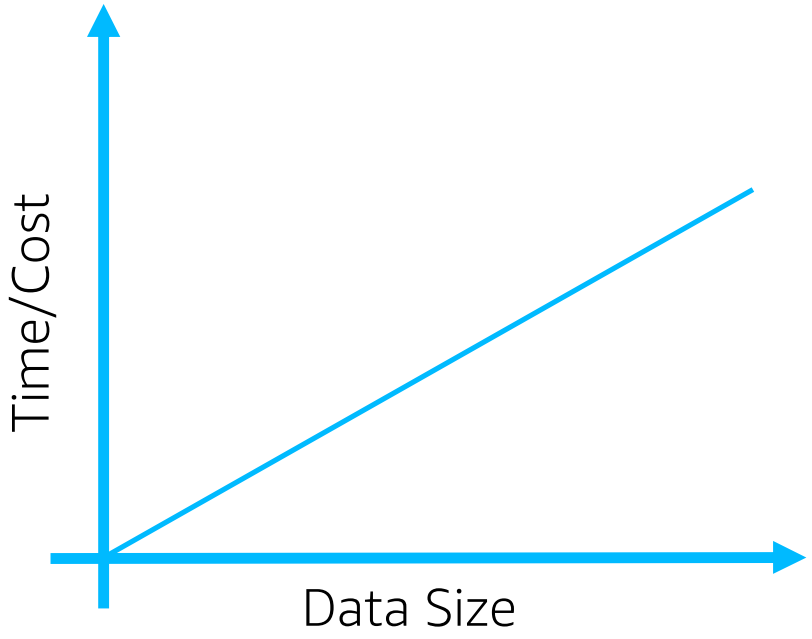


SageMaker Built-in Algorithms

Streaming

aws training and certification

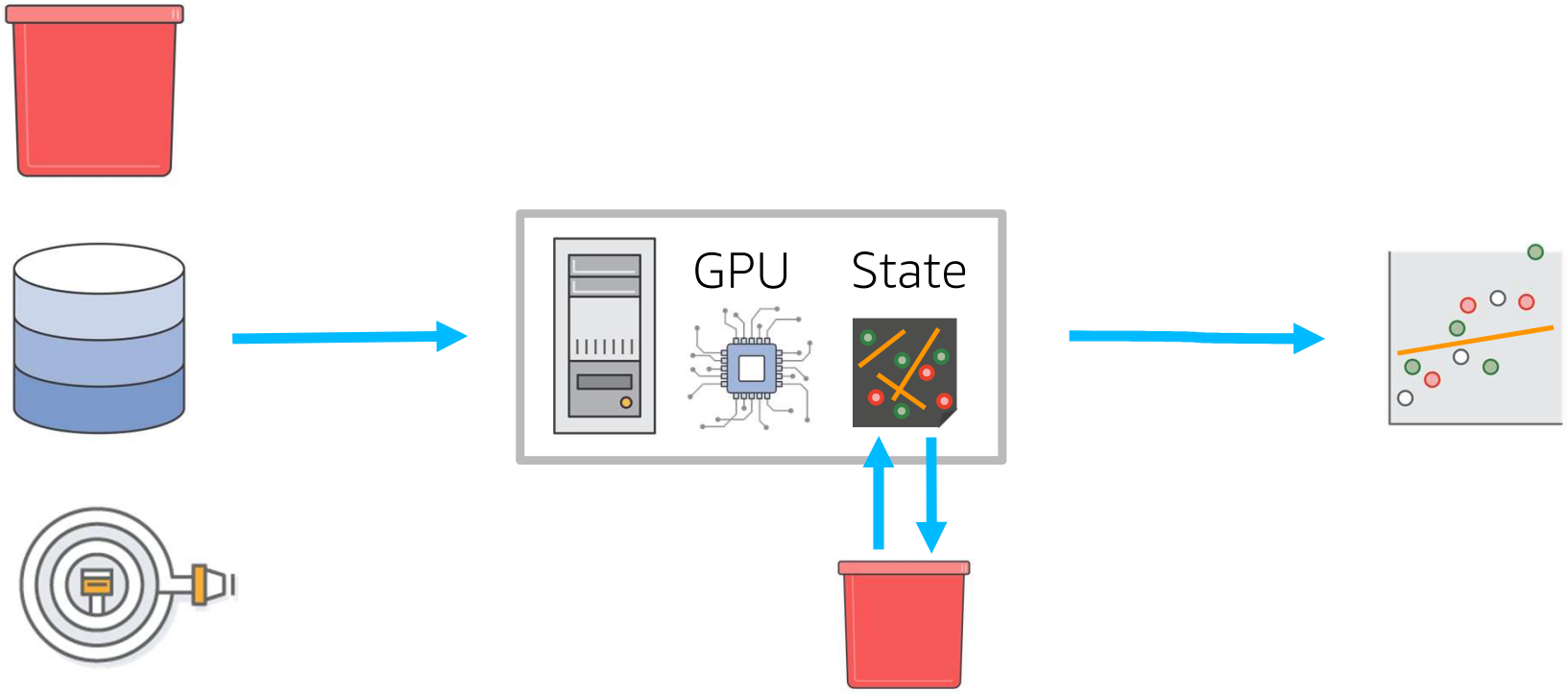




SageMaker Built-in Algorithms

Streaming

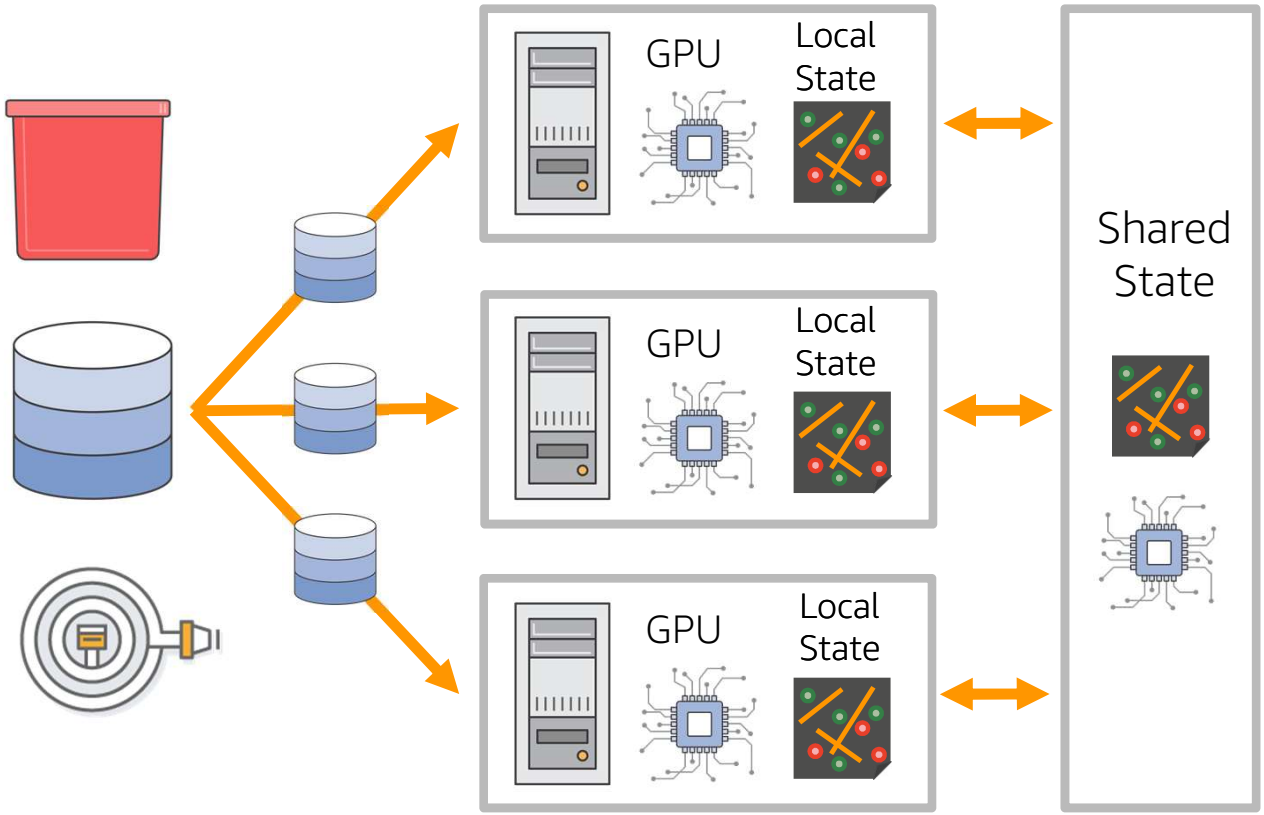
aws training and certification



SageMaker Built-In Algorithms

Distributed Shared State

aws training and certification



SageMaker Built-in Algorithms

Cost vs. Time

aws training and certification

aws training and certification

Infinitely Scalable ML Algorithms

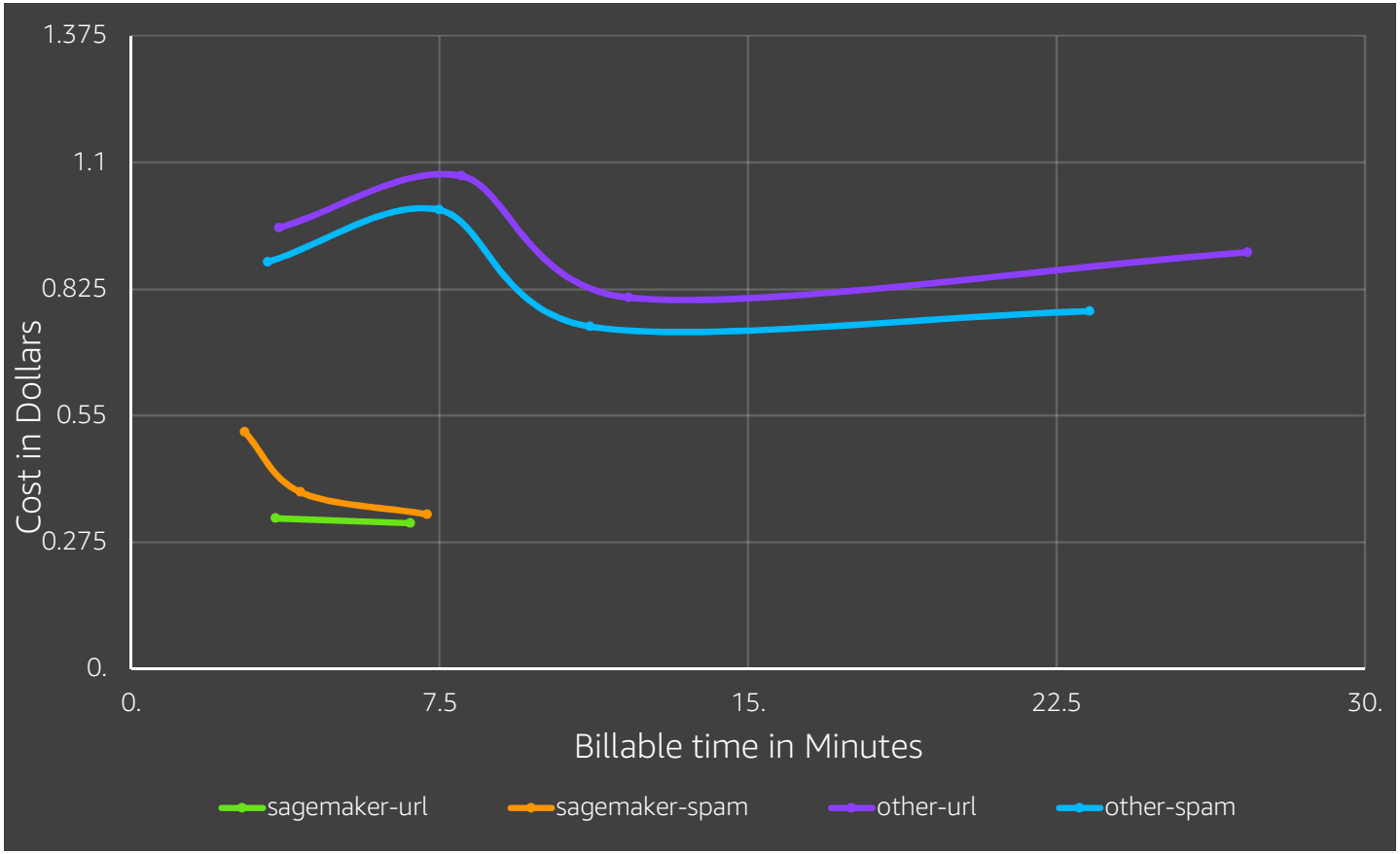
Linear Learner

aws training and certification

Regression (mean squared error)	
SageMaker	Other
1.02	1.06
1.09	1.02
0.332	0.183
0.086	0.129
83.3	84.5

Classification (F1 Score)	
SageMaker	Other
0.980	0.981
0.870	0.930
0.997	0.997
0.978	0.964
0.914	0.859
0.470	0.472
0.903	0.908
0.508	0.508

30 GB datasets for web-spam and web-url classification



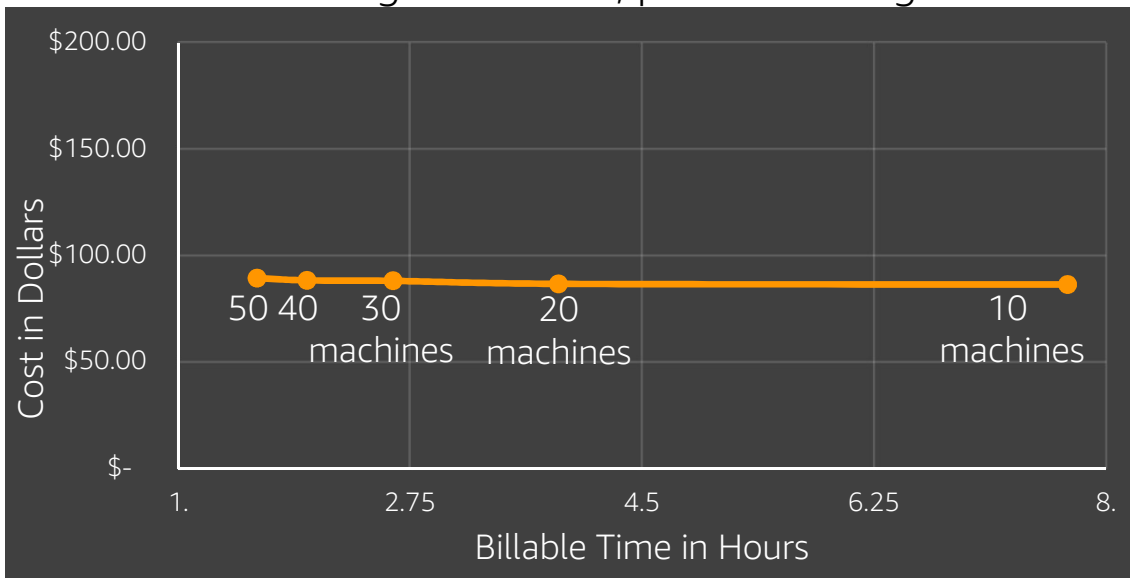
Factorization Machines

aws training and certification

$$\tilde{y} = w_0 + \langle w_1, x \rangle + \sum_{i,j>i} x_i x_j \cdot \langle v_i, v_j \rangle$$

	Log_loss	F1 Score	Seconds
SageMaker	0.494	0.277	820
Other (10 Iter)	0.516	0.190	650
Other (20 Iter)	0.507	0.254	1300
Other (50 Iter)	0.481	0.313	3250

Click Prediction 1 TB advertising dataset, m4.4xlarge machines, perfect scaling.



K-Means Clustering

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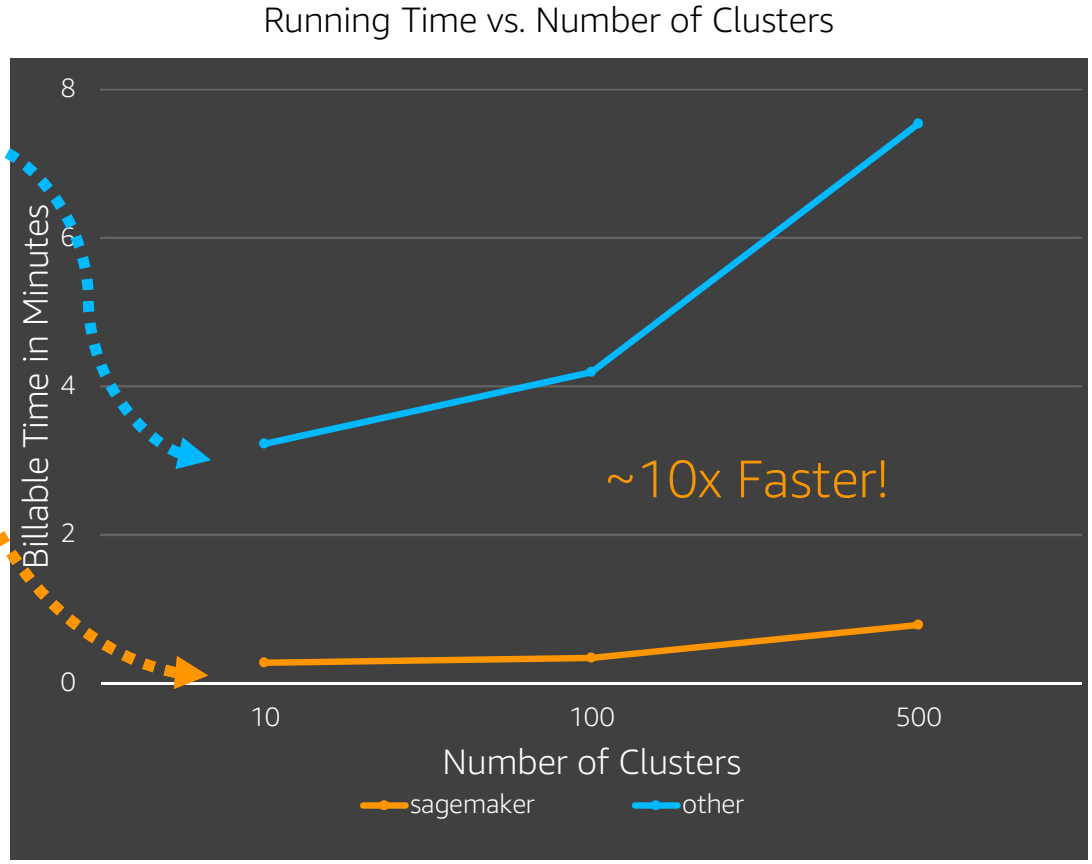
	k	SageMaker	Other
Text 1.2GB	10	1.18E3	1.18E3
	100	1.00E3	9.77E2
	500	9.18.E2	9.03E2
Images 9GB	10	3.29E2	3.28E2
	100	2.72E2	2.71E2
	500	2.17E2	Failed
Videos 27GB	10	2.19E2	2.18E2
	100	2.03E2	2.02E2
	500	1.86E2	1.85E2
Advertising 127GB	10	1.72E7	Failed
	100	1.30E7	Failed
	500	1.03E7	Failed
Synthetic 1100GB	10	3.81E7	Failed
	100	3.51E7	Failed
	500	2.81E7	Failed



Principal Component Analysis (PCA)

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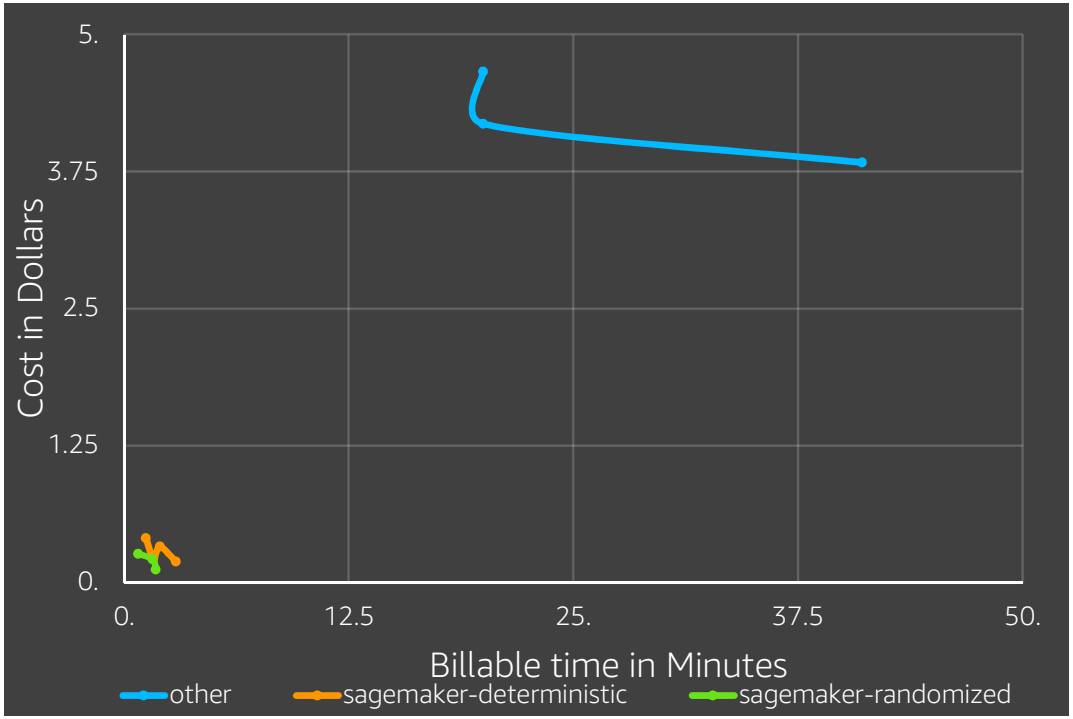
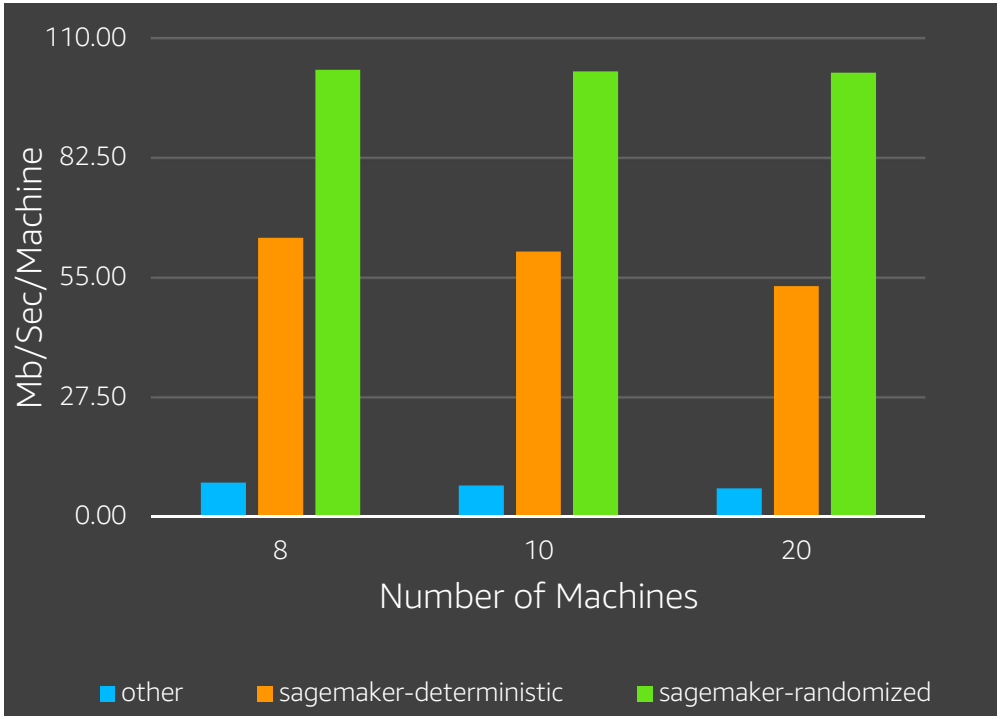
Cost vs. Time



Throughput and Scalability



Neural Topic Modeling

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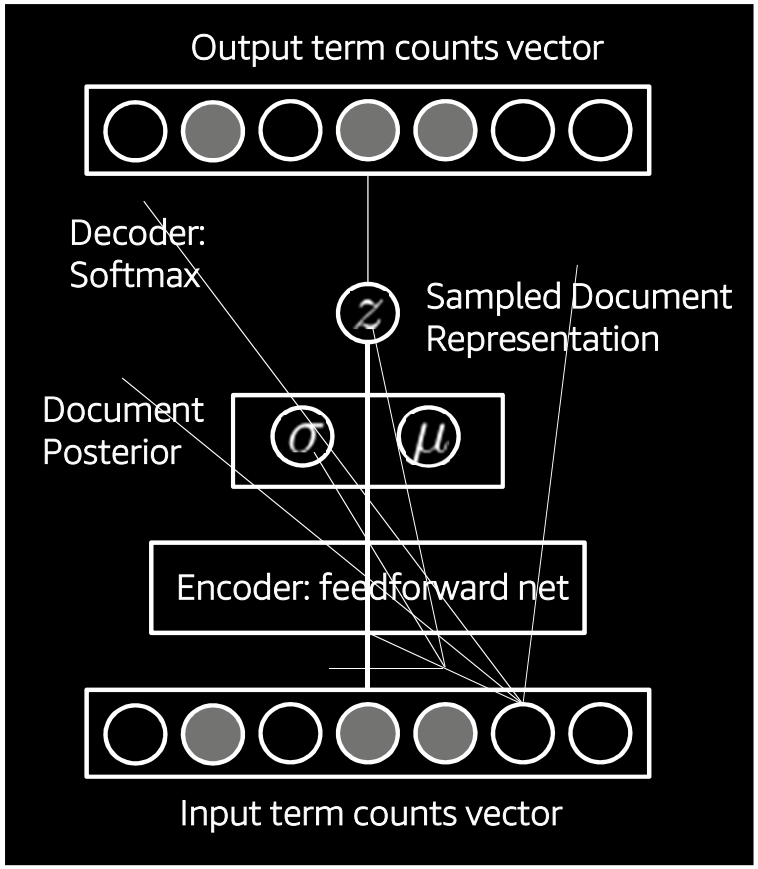
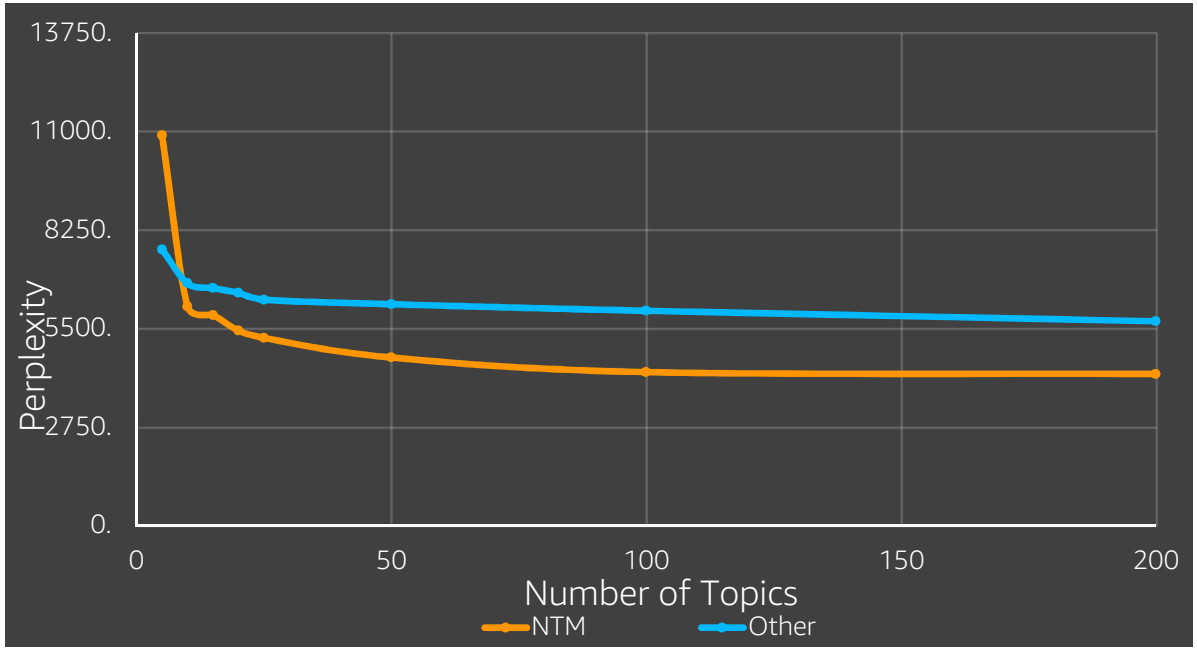
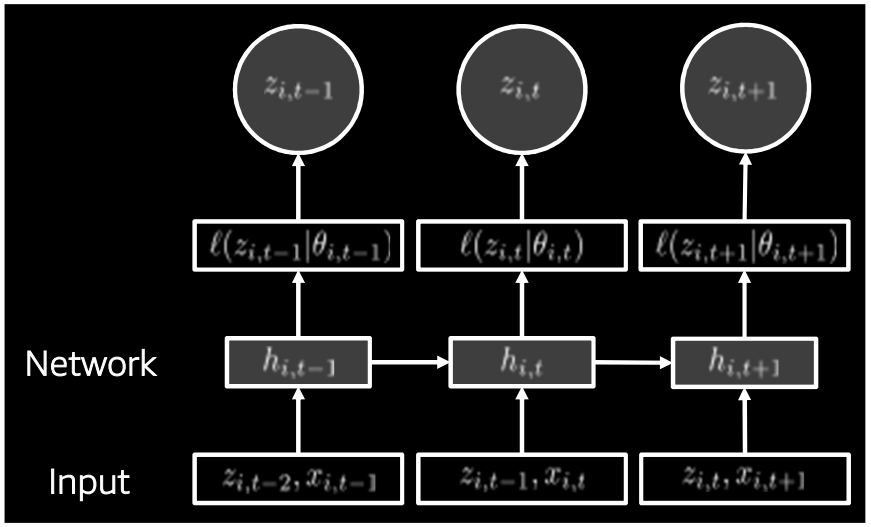


Perplexity vs. Number of Topic

(~200K documents, ~100K vocabulary)



DeepAR



		Mean absolute percentage error		P90 Loss	
		DeepAR	R	DeepAR	R
Traffic Hourly occupancy rate of 963 bay area freeways		0.14	0.27	0.13	0.24
Electricity Electricity use of 370 homes over time		0.07	0.11	0.08	0.09
Page views Page view hits of websites	10k	0.32	0.32	0.44	0.31
	180k	0.32	0.34	0.29	NA

One hour on p2.xlarge, $1

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More Great ML Algorithms

Spectral LDA

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The New York Times

U.S.

High-Tech Industry, Long Shy of Politics, Is Now Belle of Ball

By LIZETTE ALVAREZ DEC. 26, 1999

Correction Appended

At a time when Congress is bitterly divided and unable to reach consensus on issues like gun control and health care, Democrats and Republicans are happily reaching across party lines to pass legislation backed by high-tech companies.

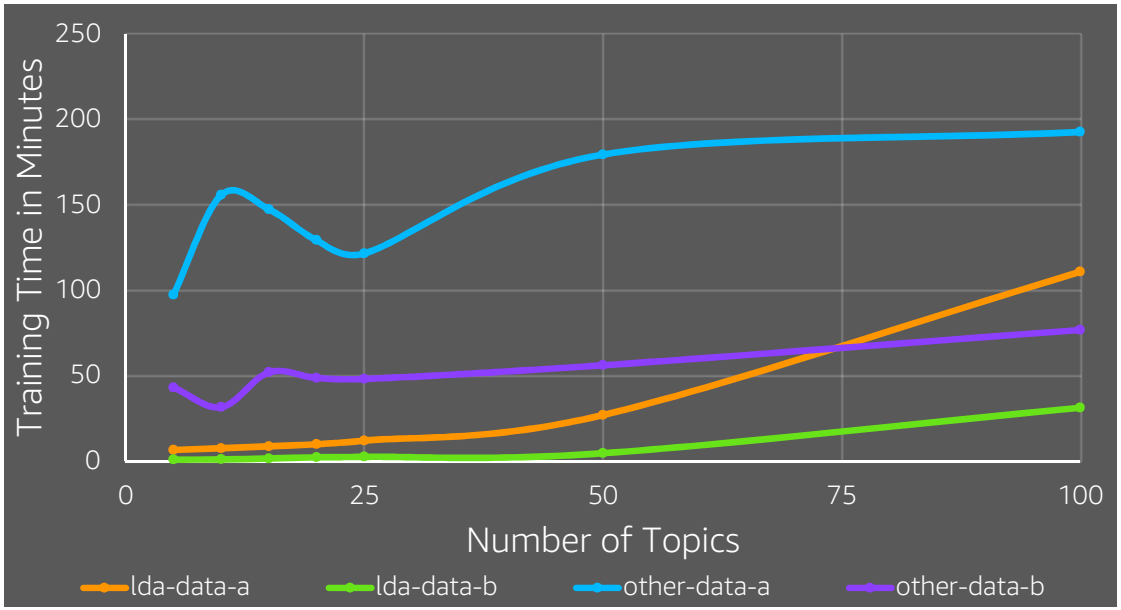
The high-tech industry, at the same moment, is lavishing new attention on Washington and changing its once-aloof posture toward the federal government.

Republicans and Democrats are both eager to win the loyalties of high-tech companies and executives, knowing that they represent untold jobs, wealth and ultimately votes and campaign contributions.

For its part, the industry has realized that the federal government can do its members as much harm as good. Microsoft, and its battle with the Justice Department, along with a spate of other threatened legal problems, drilled this point home.

"Microsoft was a poster child for our industry," said Connie Correll, director of communications for the Information Technology Industry Council, a trade organization that represents America Online, Dell and I.B.M., among others.

Training Time vs. Number of Topics



Boosted Decision Trees

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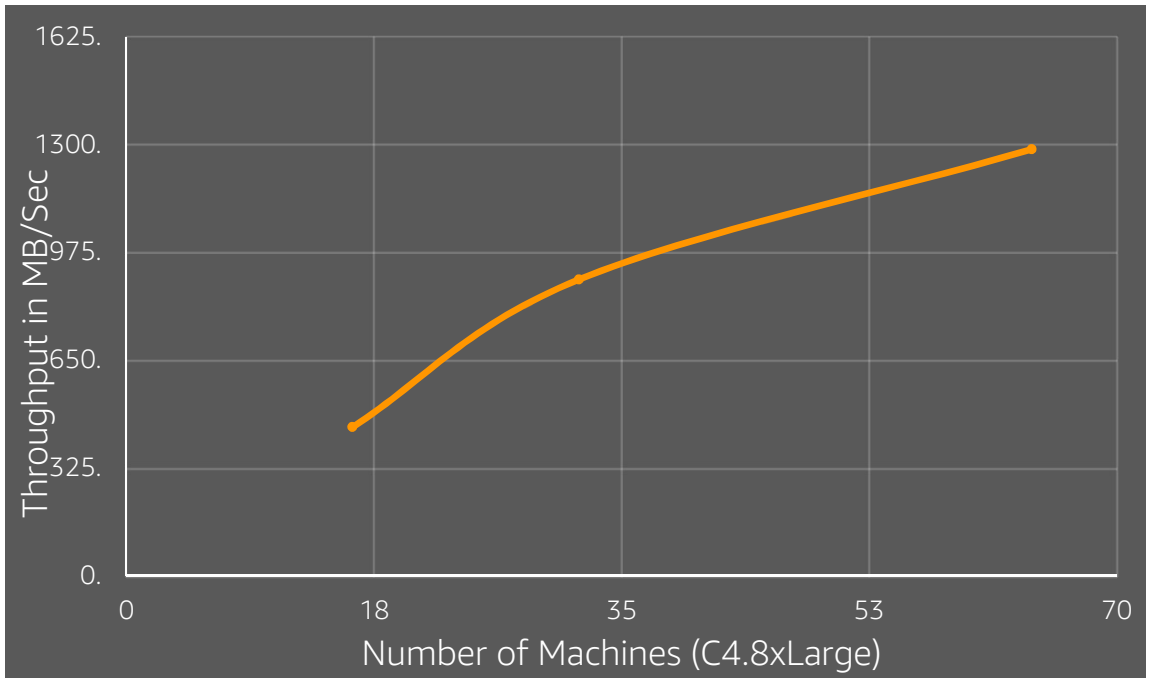
XGBoost is one of the most commonly used implementations of boosted decision trees in the world.

It is now available in Amazon SageMaker!

XGBoost

Throughput vs. Number of Machines



Sequence to Sequence

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Based on Sockeye and Apache incubated MxNet, Multi-GPU, and can be used for Neural Machine Translation.

Supports both RNN/CNN as encoder/decoder

English-German Translation

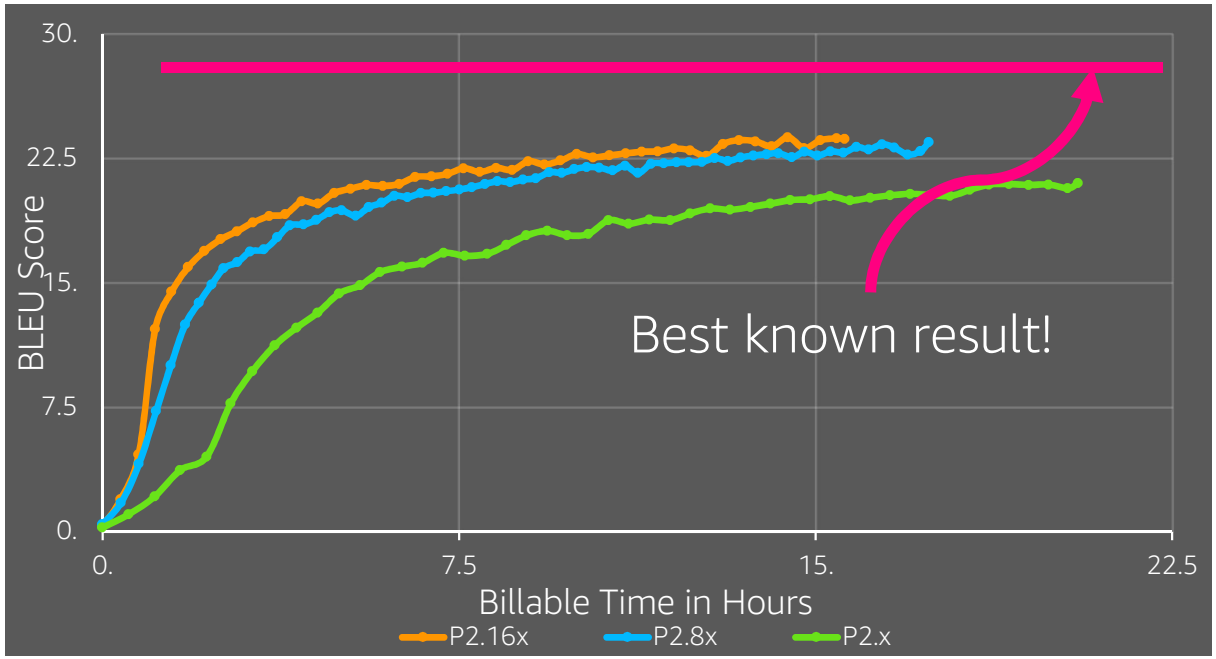

Image Classification

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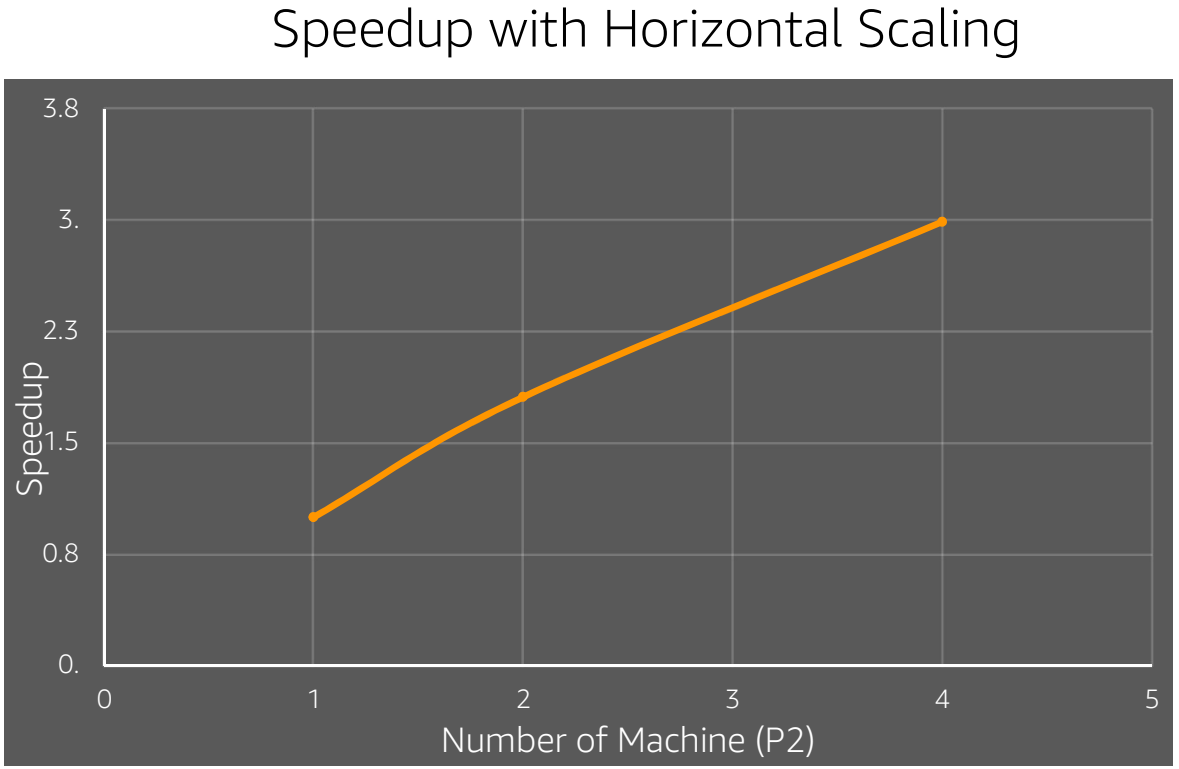
Implementation in MxNet of ResNet.
Other networks such as DenseNet and Inception will be added in the future.

Transfer learning: begin with a model already trained on ImageNet!



Amazon SageMaker Built-In Algorithms 10x Better

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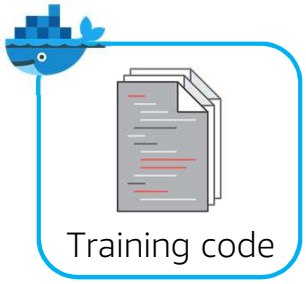


Training code

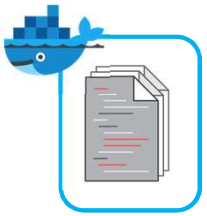
- Matrix Factorization
- Regression
- Principal Component Analysis
- K-Means Clustering
- Gradient Boosted Trees
- And More!

Amazon-Provided Algorithms

MxNet
TensorFlow

Bring Your Own Script
(Amazon SageMaker builds the Container)

Apache Spark Amazon SageMaker Estimators in Apache Spark



Bring Your Own Algorithm
(You build the Container)

Amazon SageMaker Built-In Algorithms

Managed Distributed Training with Flexibility

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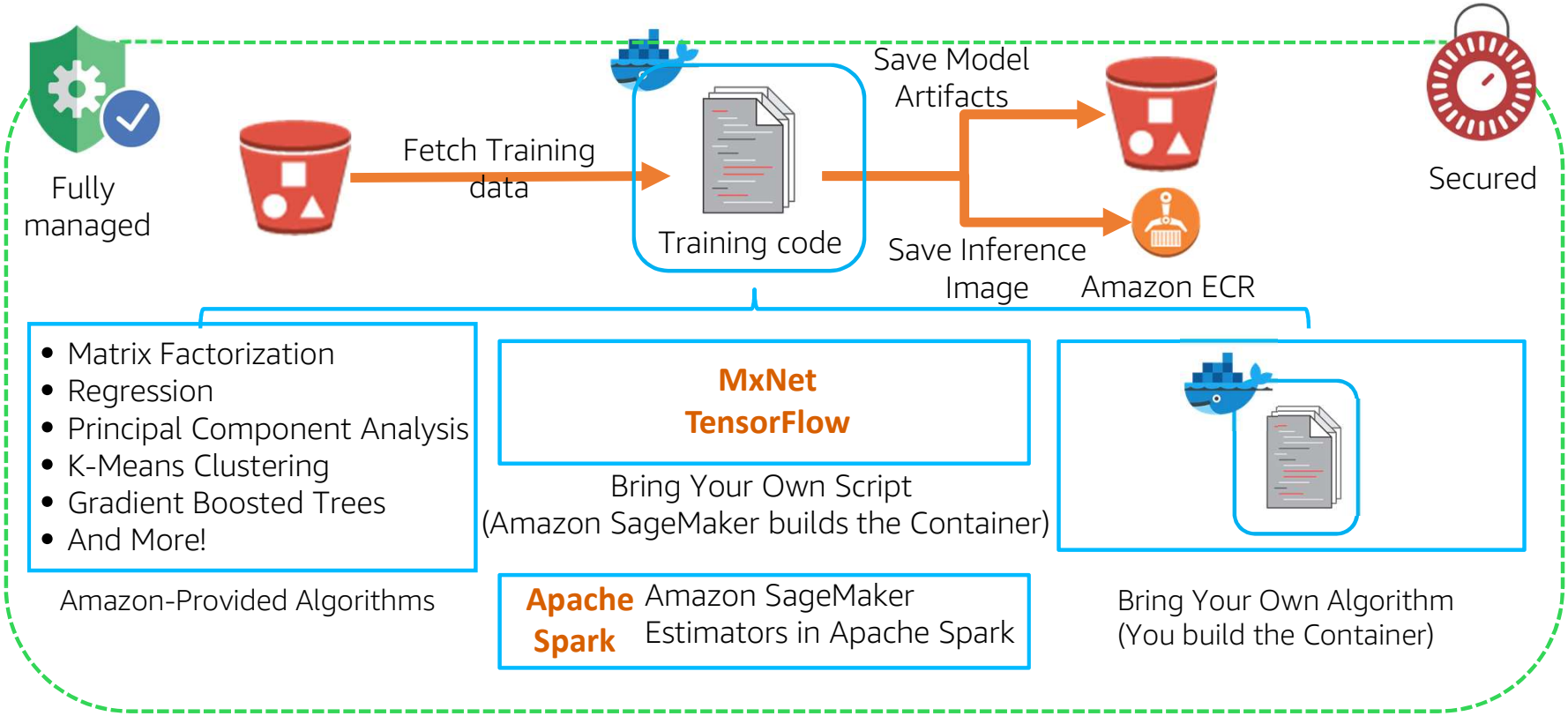

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Demo 6: Using Amazon SageMaker Built-in Algorithms

Amazon SageMaker Hosting Service

Easy Model Deployment to Amazon SageMaker

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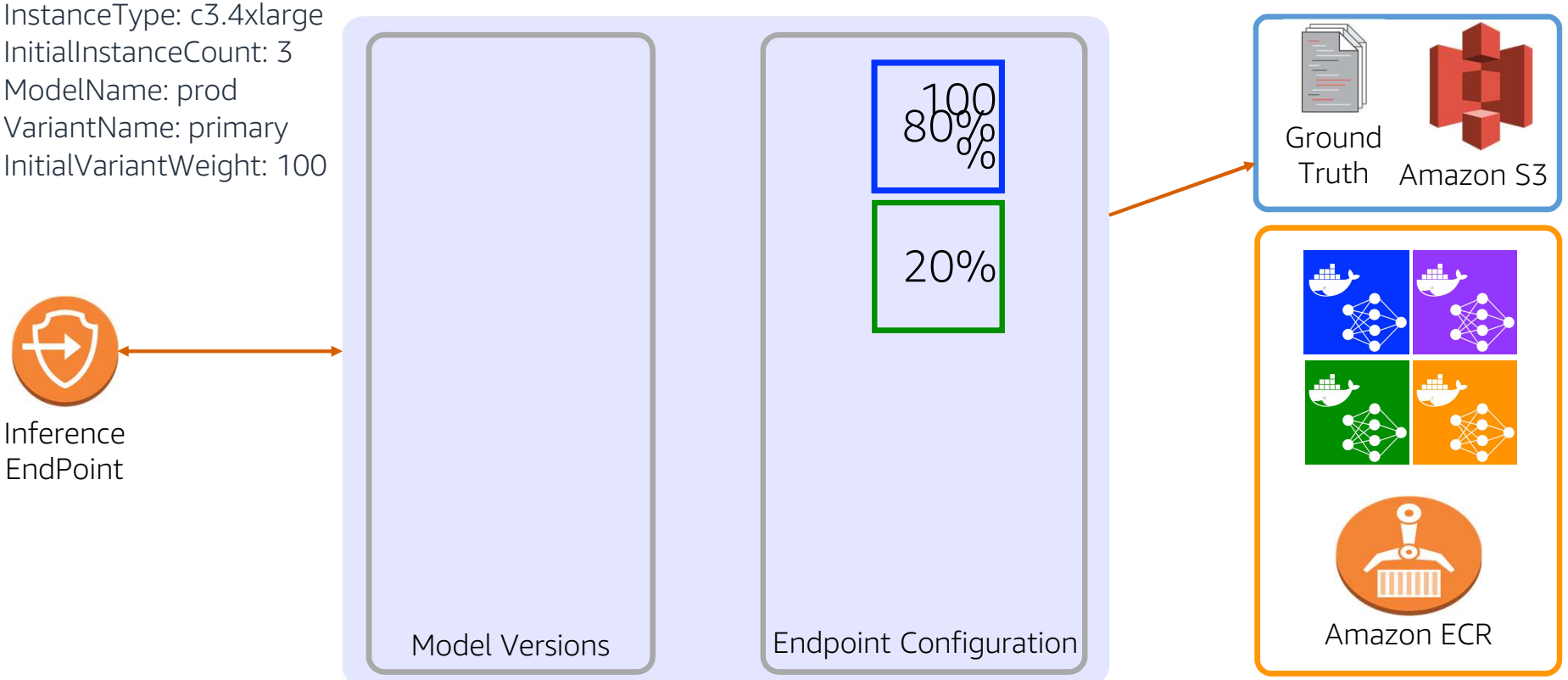
- InstanceType: c3.4xlarge
- InitialInstanceCount: 3
- ModelName: prod
- VariantName: primary
- InitialVariantWeight: 100



SageMaker Hosting Service

Easy Model Deployment to Amazon SageMaker

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- Auto-Scaling Inference APIs
- A/B Testing (more to come)
- Low Latency & High Throughput
- Bring Your Own Model
- Python SDK

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Demo 7: Analyzing Breast Cancer Datasets

aws training and certification

Demo 8: Using Containers with Amazon SageMaker

Amazon SageMaker
Reference Architecture

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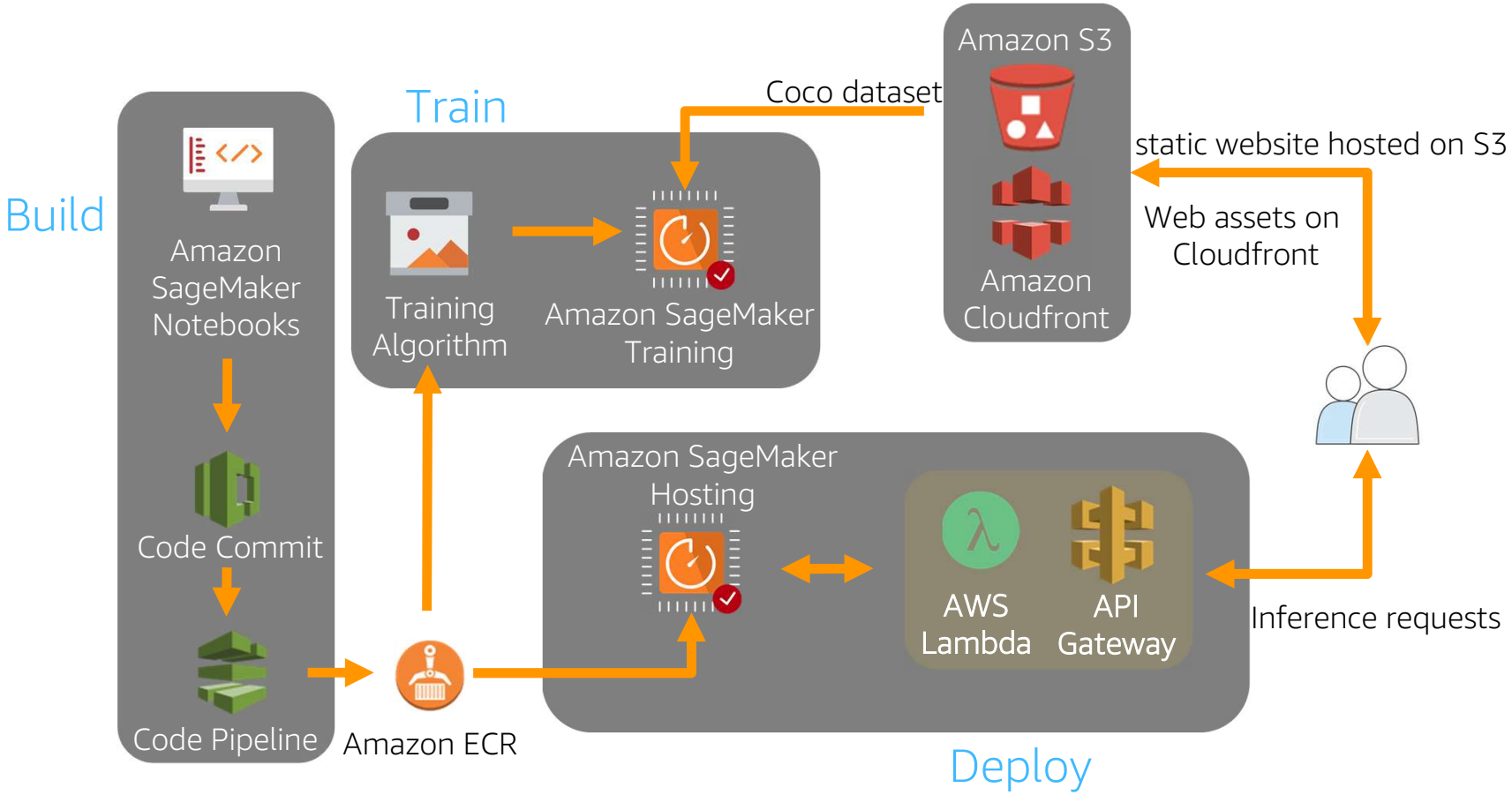

Amazon SageMaker

Technology Competency Partners

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Data Services	Platform Solutions		SaaS and API Solutions	
Alteryx	Bonsai	DataRobot	Anodot	SigOpt
CrowdFlower	C3 IoT	DOMINO DATA LAB	Luminoso	Veritone
Paxata	Databricks	H2O.ai	Narrative Science	x.ai
TRIFACTA	Data Iku			

Call To Action

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- Getting started with Amazon SageMaker: https://aws.amazon.com/sagemaker/
- Use the Amazon SageMaker SDK:
  - For Python: https://github.com/aws/sagemaker-python-sdk
  - For Spark: https://github.com/aws/sagemaker-spark
- SageMaker Examples: https://github.com/awslabs/amazon-sagemaker-examples

Thank You

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