ML Immersion Day

Mat Rowlands, Solutions Architect, AWS

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Today's Agenda

09.00 – 09.30	Welcome & Registration
09.30 – 10.00	Intro to AI / ML on AWS
10.00 – 11.15	Hands on with AI services
11.15 – 11.30	Coffee Break
11.30 – 12.00	Intro to Amazon SageMaker
12.00 – 13.00	Lunch
13.00 – 14.00	Predictions with SageMaker workshop
14.00 – 15.00	Image recognition on SageMaker workshop
15.00 – 15.15	Tea Break!
15.15 – 16.15	TensorFlow on SageMaer workshop
16.15 – 16.30	Wrap Up, Q&A and survey

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aws

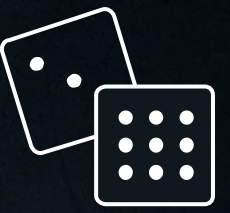
Centerpiece for digital transformation

Customer experience

Business operations

Decision making

Innovation



Competitive advantage

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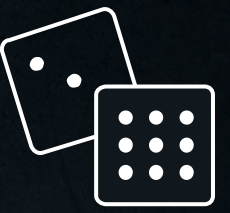

Competitive advantage

40% of digital transformation initiatives supported by AI in 2019 *- IDC 2018*

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Our mission at AWS

Put machine learning in the hands
of every developer

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More machine learning happens on AWS than anywhere else

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Why AWS for AI?

Broadest and deepest set of AI and ML services

200 new features & services launched this last year alone

Unmatched flexibility

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Why AWS for AI?

Broadest and deepest set of AI and ML services

Accelerate your adoption of ML with SageMaker

200 new features & services launched this last year alone

Unmatched flexibility

70% cost reduction in data-labeling

10x faster performance

75% lower inference cost

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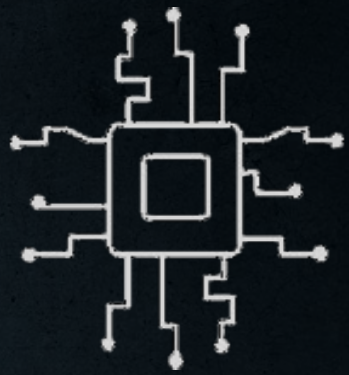

Built on the most comprehensive cloud platform optimized for ML

AWS holds the top spots on Stanford's benchmark, for fastest training time, lowest cost, lowest inference latency

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The Amazon ML stack: Broadest & deepest set of capabilities

AI SERVICES

Vision


REKOGNITION IMAGE


REKOGNITION VIDEO

Speech


TEXTRACT


POLLY


TRANSCRIBE

Language


TRANSLATE


COMPREHEND

Chatbots


LEX

Forecasting


FORECAST

Recommendations


PERSONALIZE

ML SERVICES


AMAZON SAGEMAKER

BUILD

Pre-built algorithms & notebooks

Data labelling (GROUND TRUTH)

Algorithms & models (AWS MARKETPLACE FOR MACHINE LEARNING)

TRAIN

One-click model training & tuning

Optimization (NEO)

Reinforcement learning

DEPLOY

One-click deployment & hosting

ML FRAMEWORKS & INFRASTRUCTURE

Frameworks

TensorFlow

mxnet

PYTORCH

Interfaces

GLUON

Keras

Infrastructure


EC2 P3 & P3N


EC2 C5


FPGAs


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Vision | Speech | Language | Chatbots | Forecasting | Recommendations


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So, what's in it for me?

	Data Scientist	Data Engineer	Developer	Decision Maker
AI SERVICES	Rapid Prototype Feature testing Focus on more complex tasks No infrastructure No deployment	Quickly iterate on data format and features Focus on more complex tasks No infrastructure No deployment	Quick integration Self serve No Data Science background No infrastructure No deployment	Solve business problems and add rich features quickly No Data Science background No infrastructure No deployment
ML SERVICES	Optimized Frameworks Unified environment Jupyter notebooks Full control Modular architecture	Unified deployment Integrates with IAM, VPC Elastic scaling Labeling Performance optimized	Easy integration Example notebooks A/B testing models	Optimize for a domain specific problem Optimize for performance
ML FRAMEWORKS & INFRASTRUCTURE	Choose optimal hardware Target IoT devices Full control	Choose optimal hardware	Endpoint data structures	Solving business differentiating problems

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AI Services

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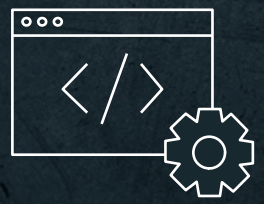
Pre-trained AI services that require no ML skills or training



Easily add intelligence to your existing apps and workflows

Quality and accuracy from continuously-learning APIs

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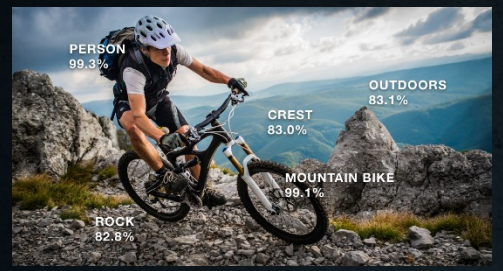
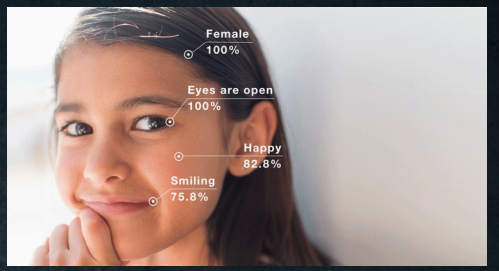
Amazon Rekognition

Deep learning-based image and video analysis



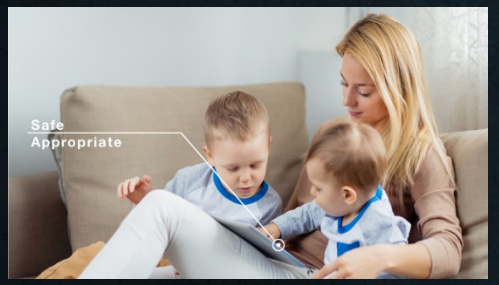
Object, Scene & Activity Recognition

Facial Recognition

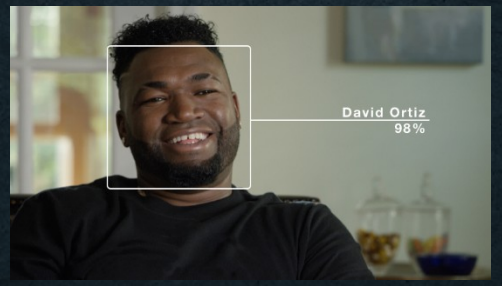


Facial Analysis

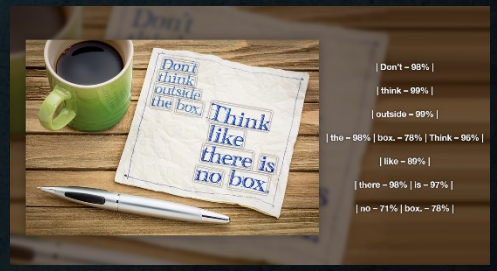
Person Tracking



Unsafe Content Detection



Celebrity Recognition



Text in Images

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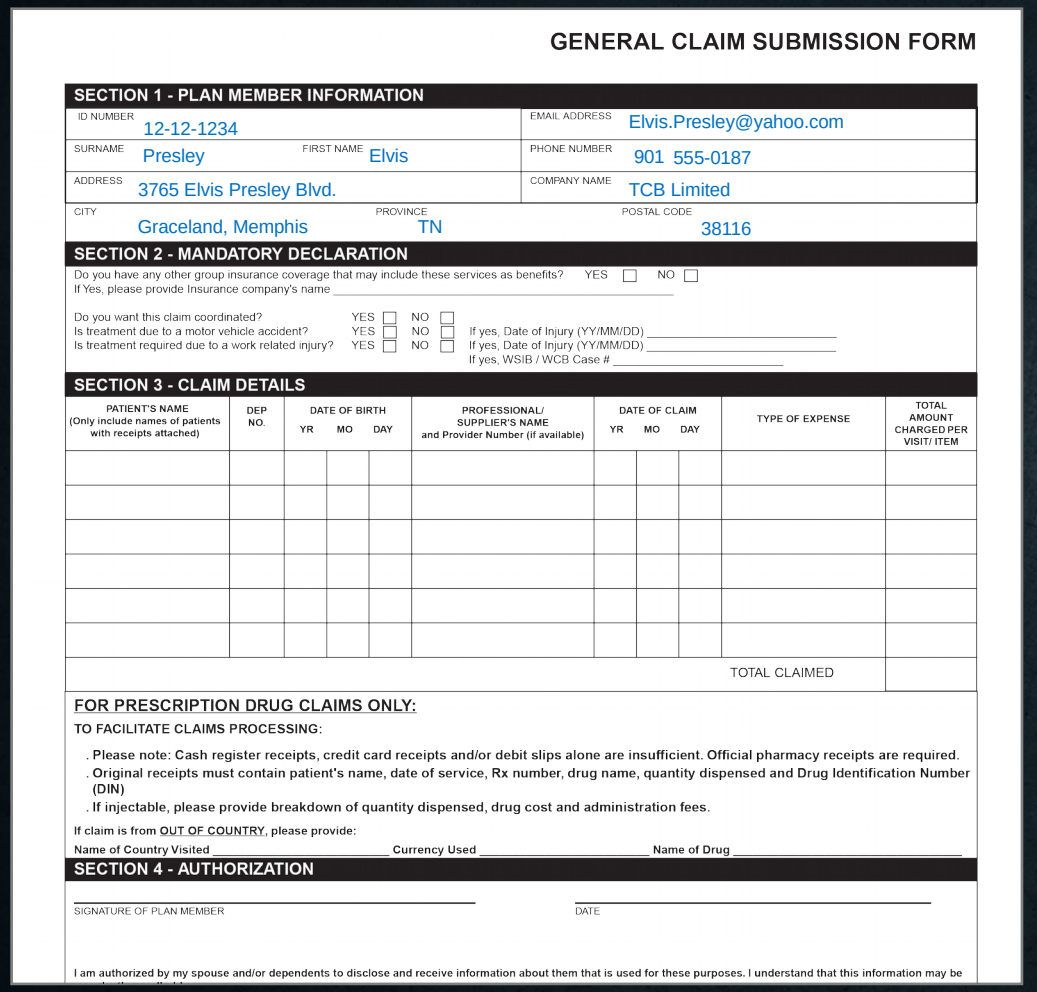
Amazon Textract

Automatic document processing without data entry, or writing rules



GENERAL CLAIM SUBMISSION FORM

SECTION 1 - PLAN MEMBER INFORMATION

ID NUMBER	12-12-1234	EMAIL ADDRESS	Elvis.Presley@yahoo.com
SURNAME	Presley	FIRST NAME Elvis	PHONE NUMBER 901 555-0187
ADDRESS	3765 Elvis Presley Blvd.		COMPANY NAME TCB Limited
CITY	Graceland, Memphis	PROVINCE TN	POSTAL CODE 38116

SECTION 2 - MANDATORY DECLARATION

Do you have any other group insurance coverage that may include these services as benefits? YES ☐ NO ☐
If Yes, please provide Insurance company's name _____

Do you want this claim coordinated? YES ☐ NO ☐
Is treatment due to a motor vehicle accident? YES ☐ NO ☐ If yes, Date of Injury (YY/MM/DD) _____
Is treatment required due to a work related injury? YES ☐ NO ☐ If yes, Date of Injury (YY/MM/DD) _____
If yes, WSIB / WCB Case # _____

SECTION 3 - CLAIM DETAILS

PATIENT'S NAME (Only include names of patients with receipts attached)	DEP NO.	DATE OF BIRTH YR	MO	DAY	PROFESSIONAL/ SUPPLIER'S NAME and Provider Number (if available)	DATE OF CLAIM YR	MO	DAY	TYPE OF EXPENSE	TOTAL AMOUNT CHARGED PER VISIT/ ITEM
									TOTAL CLAIMED	

FOR PRESCRIPTION DRUG CLAIMS ONLY:

TO FACILITATE CLAIMS PROCESSING:

. Please note: Cash register receipts, credit card receipts and/or debit slips alone are insufficient. Official pharmacy receipts are required.
. Original receipts must contain patient's name, date of service, Rx number, drug name, quantity dispensed and Drug Identification Number (DIN)
. If injectable, please provide breakdown of quantity dispensed, drug cost and administration fees.

If claim is from OUT OF COUNTRY, please provide:
Name of Country Visited _____ Currency Used _____ Name of Drug _____

SECTION 4 - AUTHORIZATION

_____ SIGNATURE OF PLAN MEMBER

_____ DATE

I am authorized by my spouse and/or dependents to disclose and receive information about them that is used for these purposes. I understand that this information may be

OCR++

Name	Presley, Elvis Aaron
Address	Graceland, Memphis, TN
Id	12-12-1234
Company	TCB Limited

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Amazon Polly

Turn text into lifelike speech using deep learning

Wide Selection of Voices and Languages

Synchronize Speech

Fine-grained Control

Unlimited Replay

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Amazon Transcribe

Automatic conversion of speech into accurate, grammatically correct text

Multiple languages

Intelligent punctuation and formatting

Timestamp generation

Support for telephony audio

Recognize multiple speakers

Custom vocabulary

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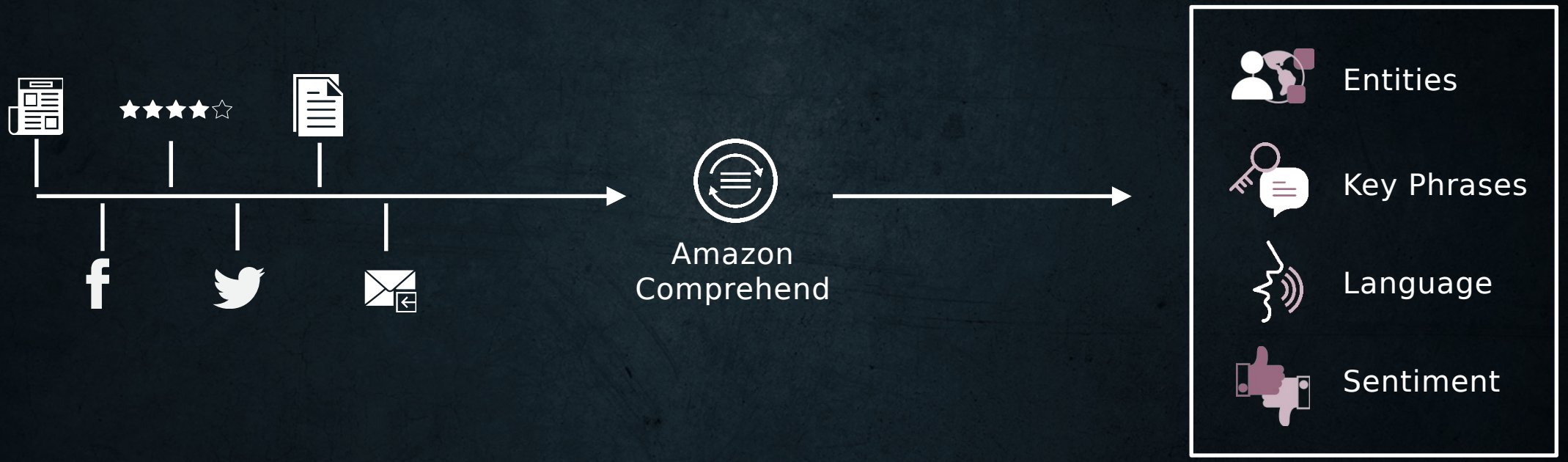
Amazon Comprehend

Discover insights and relationships in text



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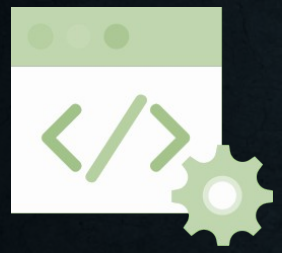
Amazon Lex

Conversational interfaces for your applications powered by the same deep learning technologies as Alexa

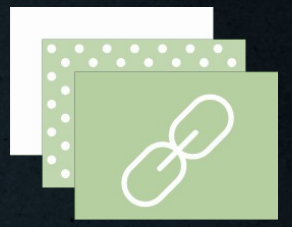


Integrated development in the AWS console

Trigger Lambda functions

Multi-step conversations

One-click deployment



Enterprise connectors

Fully managed

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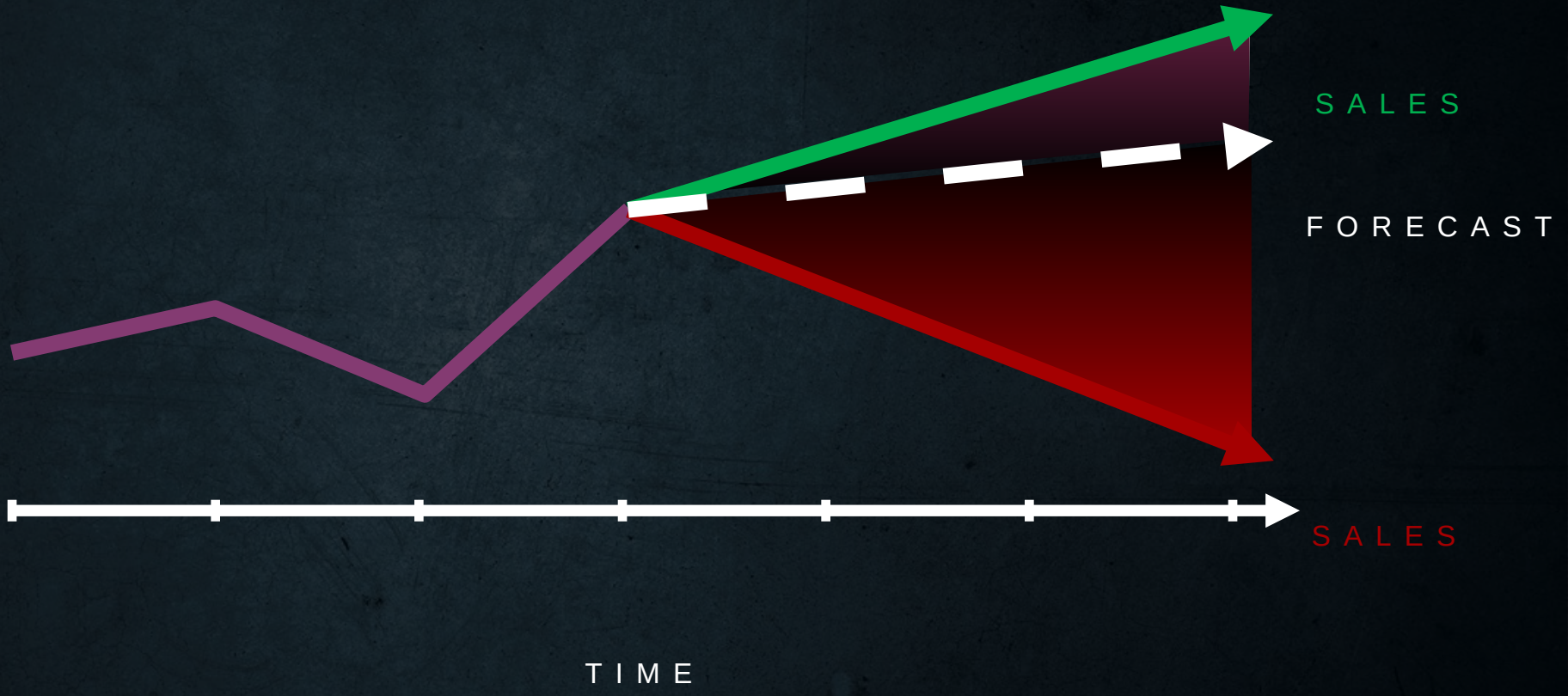
The perils of poor predictions in forecasting



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Amazon Forecast

Accurate time-series forecasting service, based on the same technology used at Amazon.com

Any historical time-series

Integrates with SAP and Oracle Supply Chain

Integrates with Amazon Timestream

Custom forecasts with 3 clicks

50% more accurate

1/10th the cost

Generate forecasts for:

Retail demand	Travel demand	AWS usage
Revenue forecasts	Web traffic	Advertising demand

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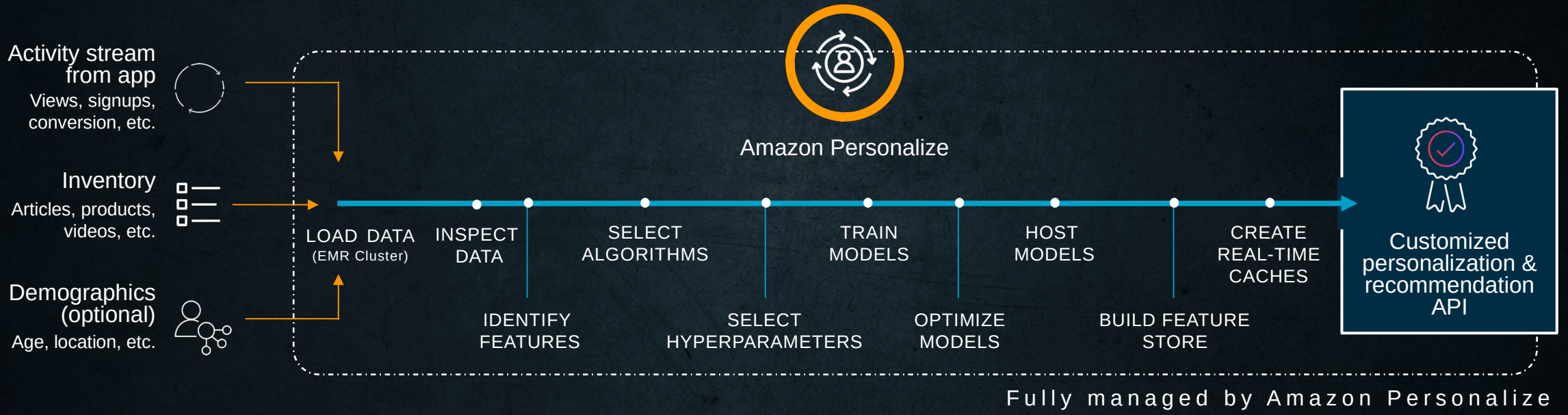
Amazon Personalize

Real-time personalization and recommendation service, based on the same technology used at Amazon.com



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Enough of me chatting!

Let’s build a chat bot
https://bit.ly/30rxCeN

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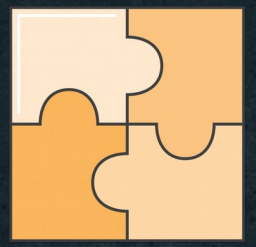
Solving Some Of The Hardest Problems In Computer Science

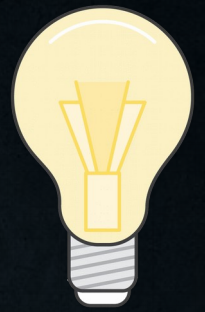
Learning

Language



Perception

Problem Solving



Reasoning

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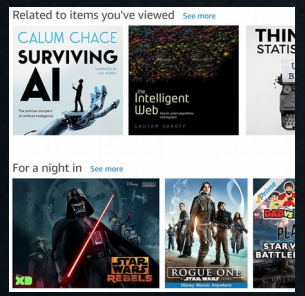
Machine Learning at Amazon: A long heritage

Personalized Recommendations



Fulfillment automation & Inventory Management

Drones

Voice driven Interactions

Inventing entirely new Customer experiences

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ML Services

Amazon SageMaker

1 BUILD

- Fast & accurate data labelling
- Built-in, high performance algorithms & notebooks

2 TRAIN

- One-click training and tuning
- Model optimization

3 DEPLOY

- One-click deployment
- Fully managed hosting with auto-scaling and elastic inference

TensorFlow · mxnet · PYTORCH · Chainer · HOROVOD · GLUON · Keras

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ML Services

Amazon SageMaker

1

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Fast & accurate data labelling

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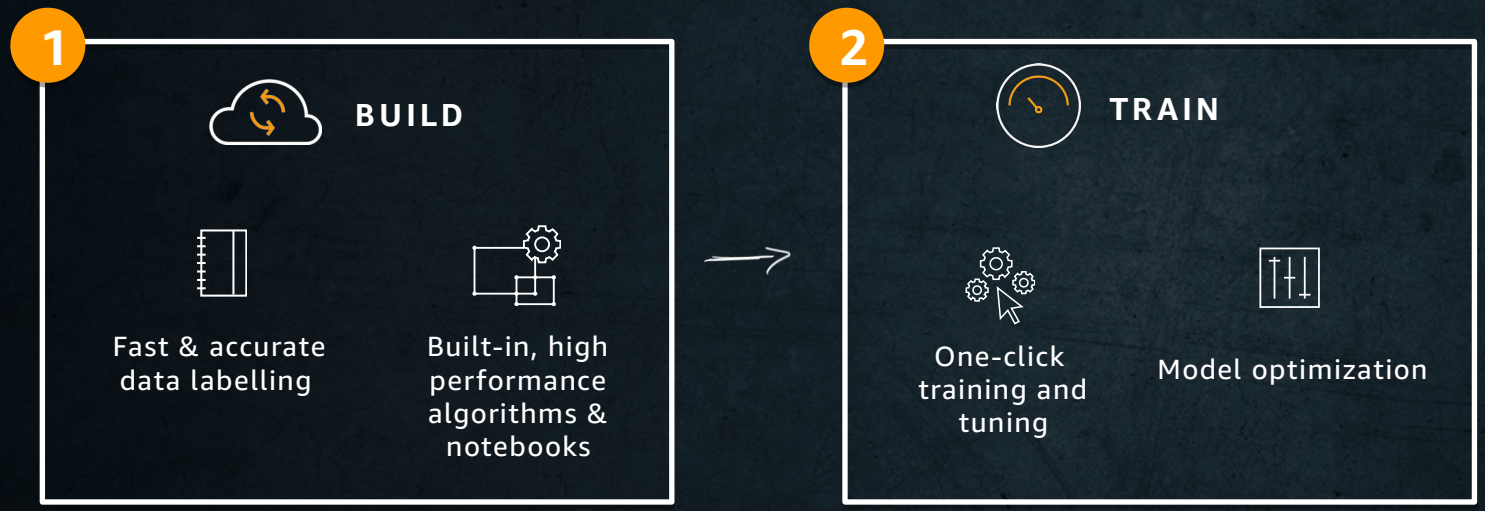

TensorFlow mxnet PYTORCH Chainer HOROVOD GLUON Keras

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Amazon SageMaker: Customer Story

"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

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Key benefits of SageMaker at Intuit

From	To
Ad-hoc setup and management of notebook environments	Easy data exploration in SageMaker notebooks
Limited choices for model deployment	Building around virtualization for flexibility
Competing for compute resources across teams	Auto-scalable model hosting environment

intuit

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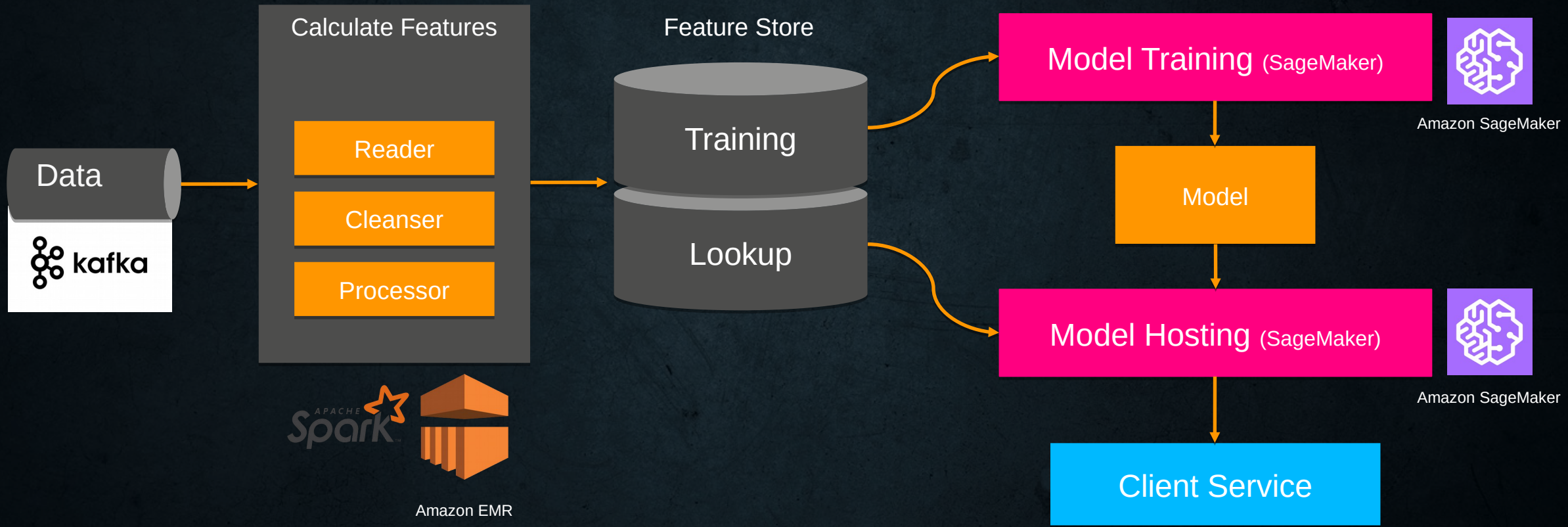
Near real-time fraud detection in AWS using SageMaker



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How do you teach machine learning models to make decisions when there is no training data?

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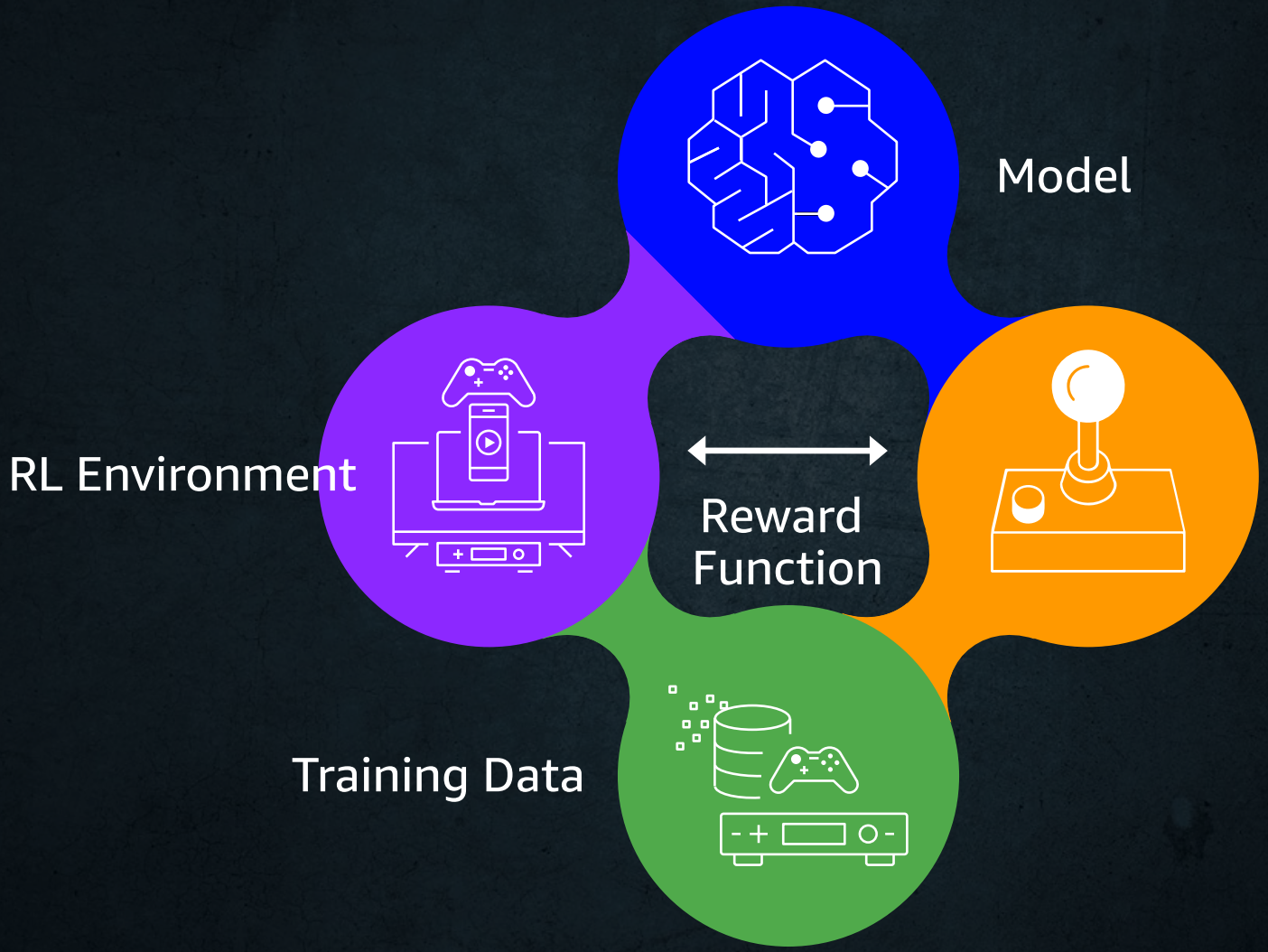
Reinforcement learning at work



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Reinforcement Learning

Learn by interacting with the real world

Model the real-world problem as a simulation environment

Trial and error

Observe results

Optimize learning strategy to maximize long-term reward

Model learns how to make complex decisions

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What is an RL environment?

Representation of the real world

Programmed to represent real-world conditions

Enables interaction with user or a computer program

Dynamic and updates itself based on the interactions and programmed behaviour

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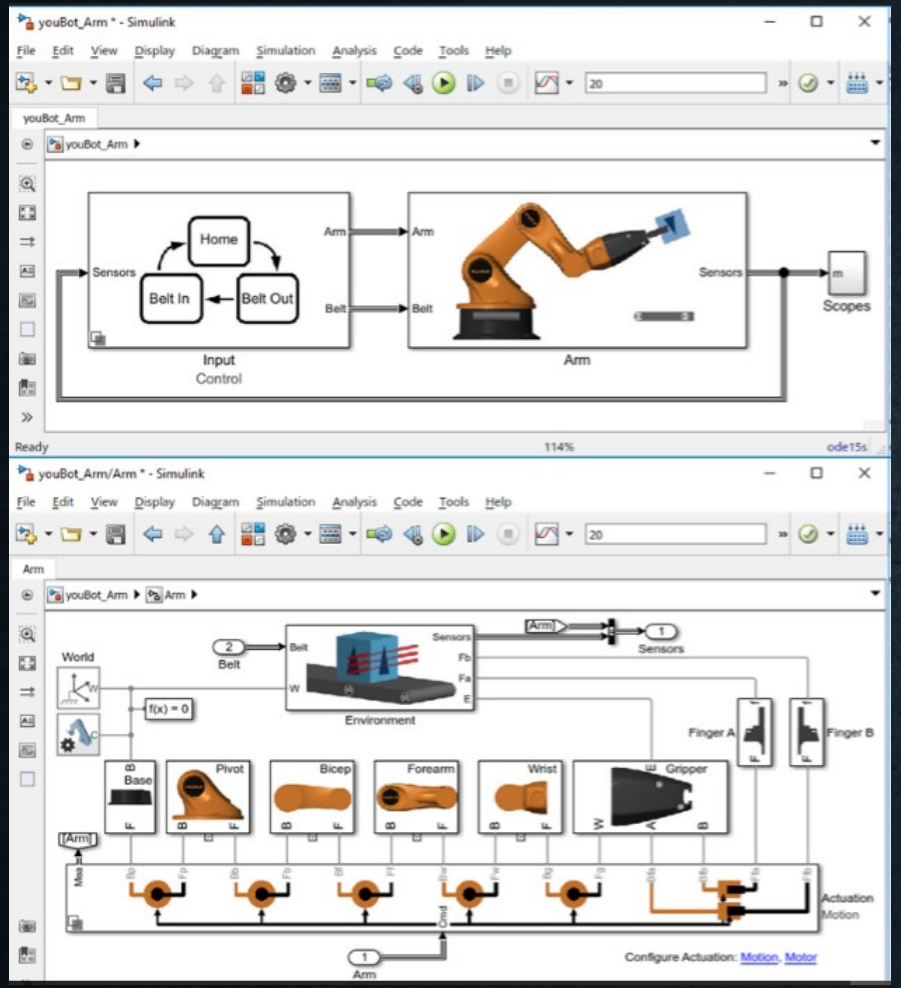
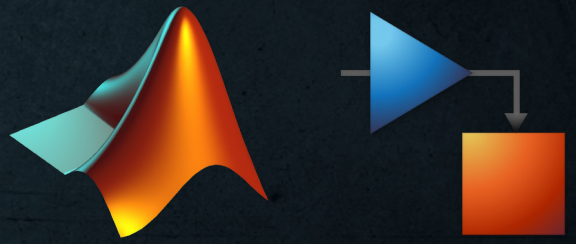
Environments can be sophisticated



MATLAB and Simulink for modeling and simulation



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aws

Or you can write your own RL environment

```
import gym
from gym.spaces import Discrete, Box

def __init__():
    #Initialize the RL environment

def reset(self):
    #Reset the RL environment

def step(self, action):
    #Take an action in the RL environment
    #Return the observation
    #return reward (positive or negative)

def render():
    #Render the RL environment
```

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This makes RL applicable in many domains and not just gaming

Robotics

Industrial control

HVAC

Autonomous vehicles

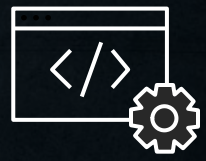
Advertising

NLP

Operations

Finance

Resource allocation



Online content delivery

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ML Workshop featuring Amazon SageMaker

End-to-End Managed ML Platform

https://bit.ly/2VCfBqq

Module 1 – Predicting the future

- Launching Amazon SageMaker
- Binding to a Git repository
- Working with Jupyter Notebooks
- Using built in XG-Boost algorithm
- Training a model
- Deploying an endpoint
- Getting predictions

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Amazon SageMaker

1

Notebook Instances

2

Algorithms

3

ML Training Service

4

ML Hosting Service

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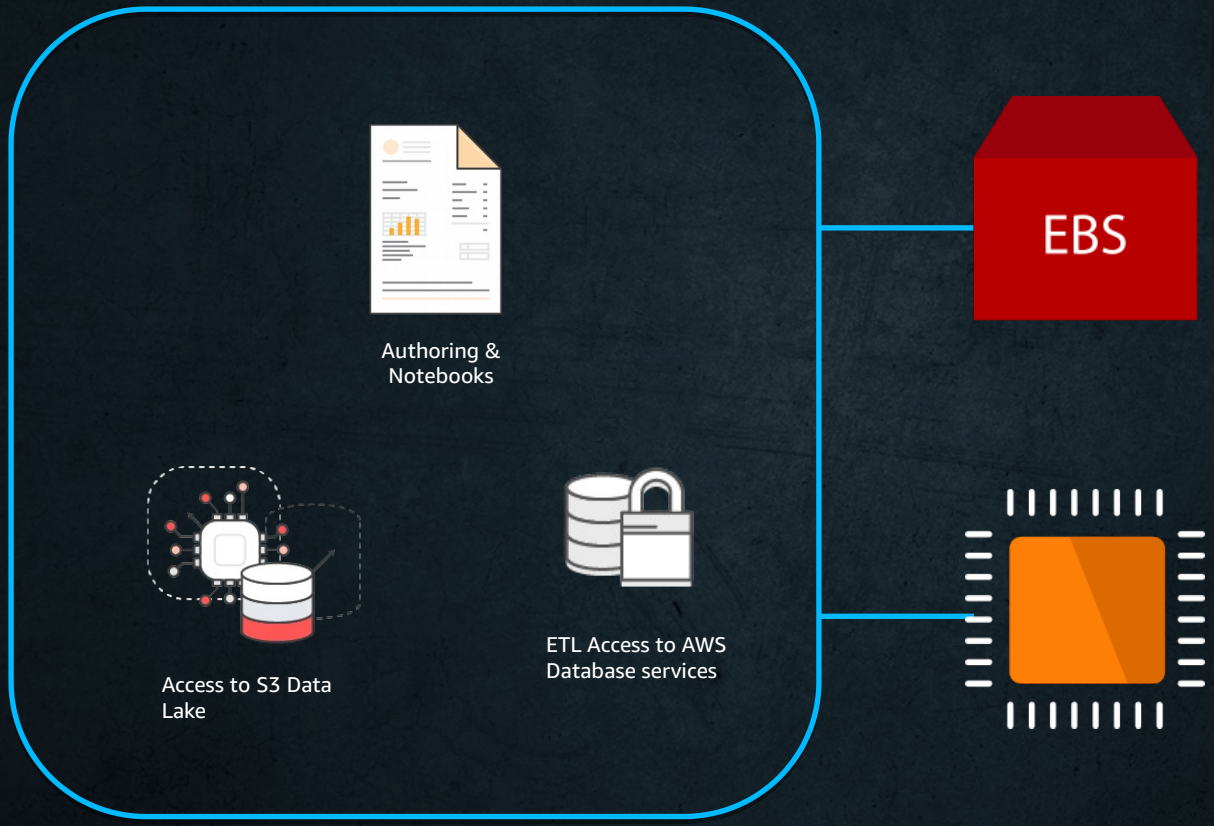
aws

1

Zero Setup For Exploratory Data Analysis

Notebook Instances



"Just add data"

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

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2

Amazon SageMaker: 10x better algorithms

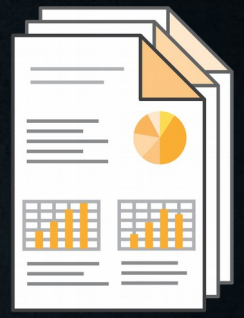
I

Algorithms

Streaming datasets, for cheaper training

Train faster, in a single pass

Greater reliability on extremely large datasets



Choice of several ML algorithms

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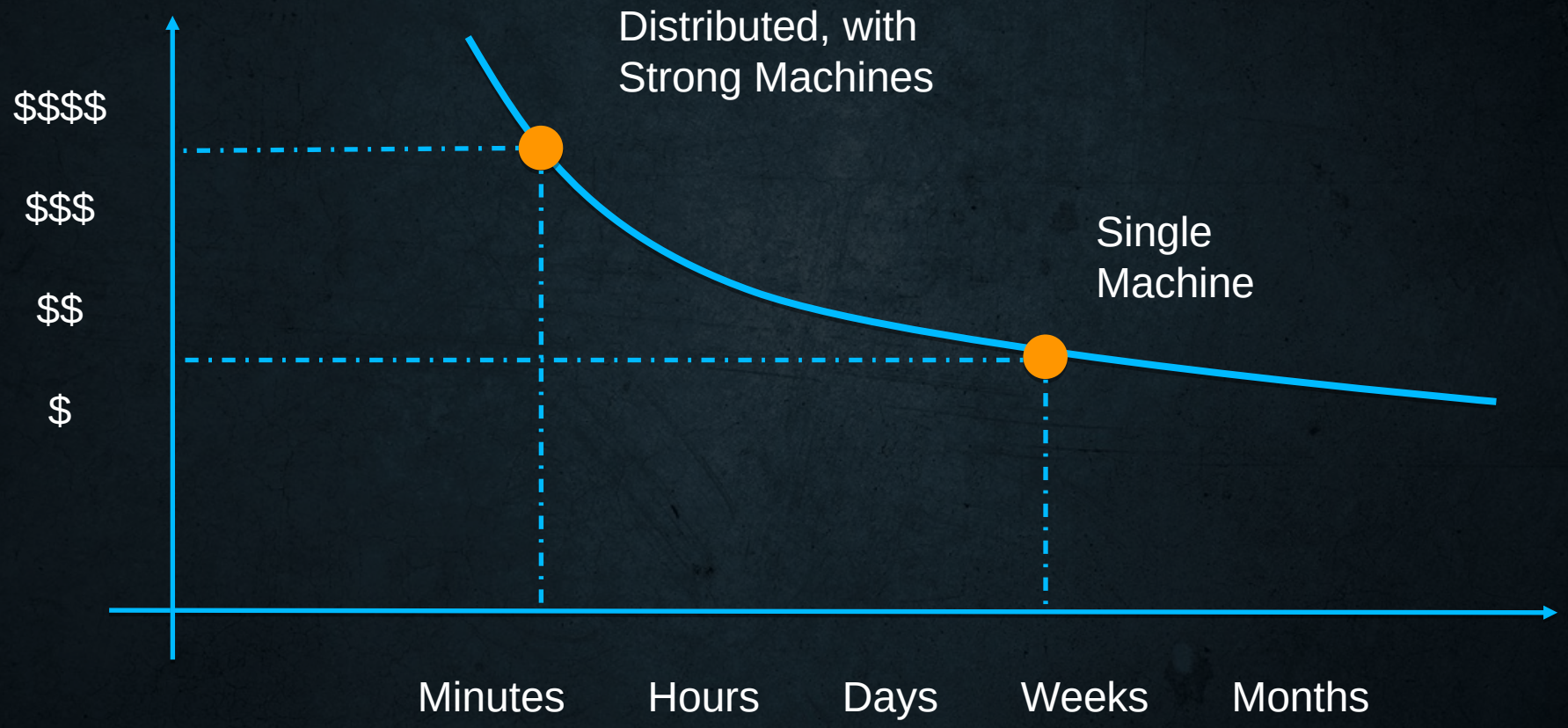
Cost vs. Time



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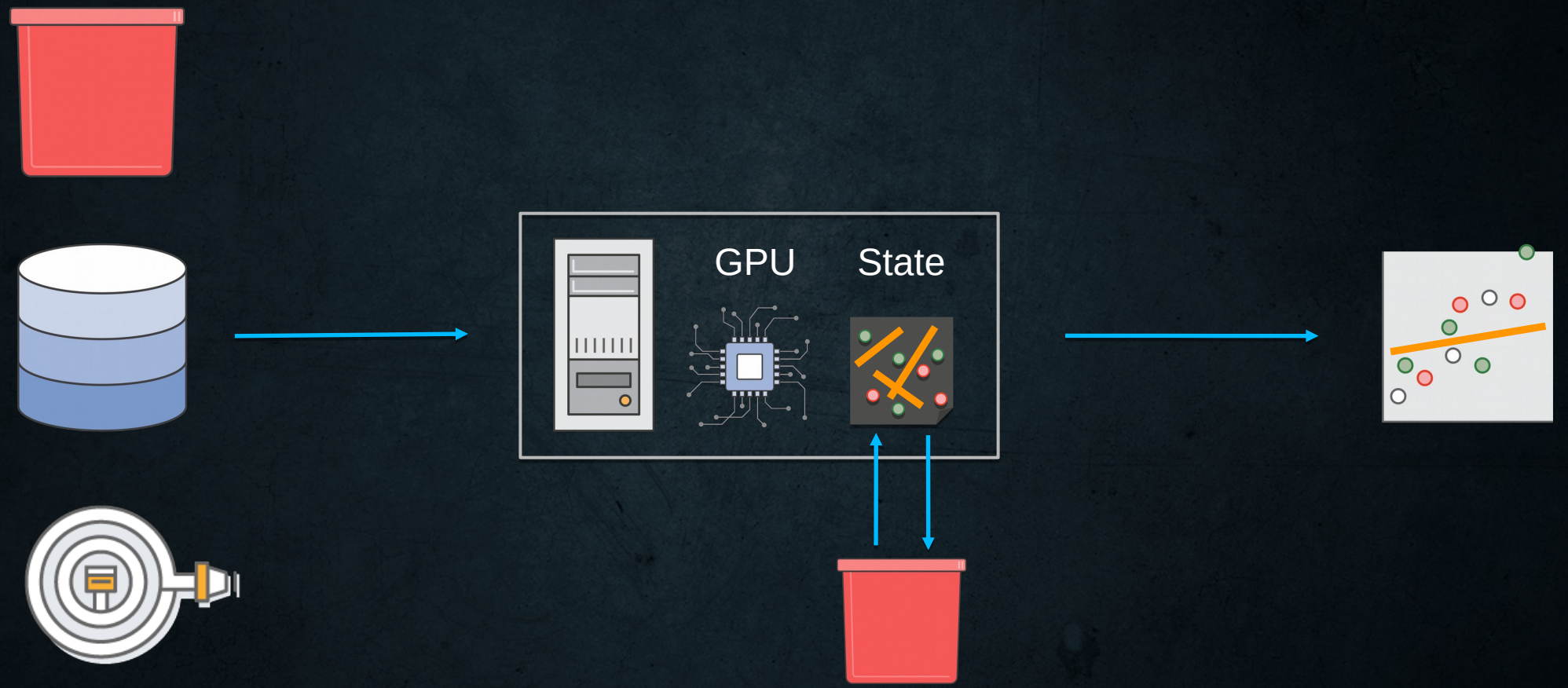
Streaming



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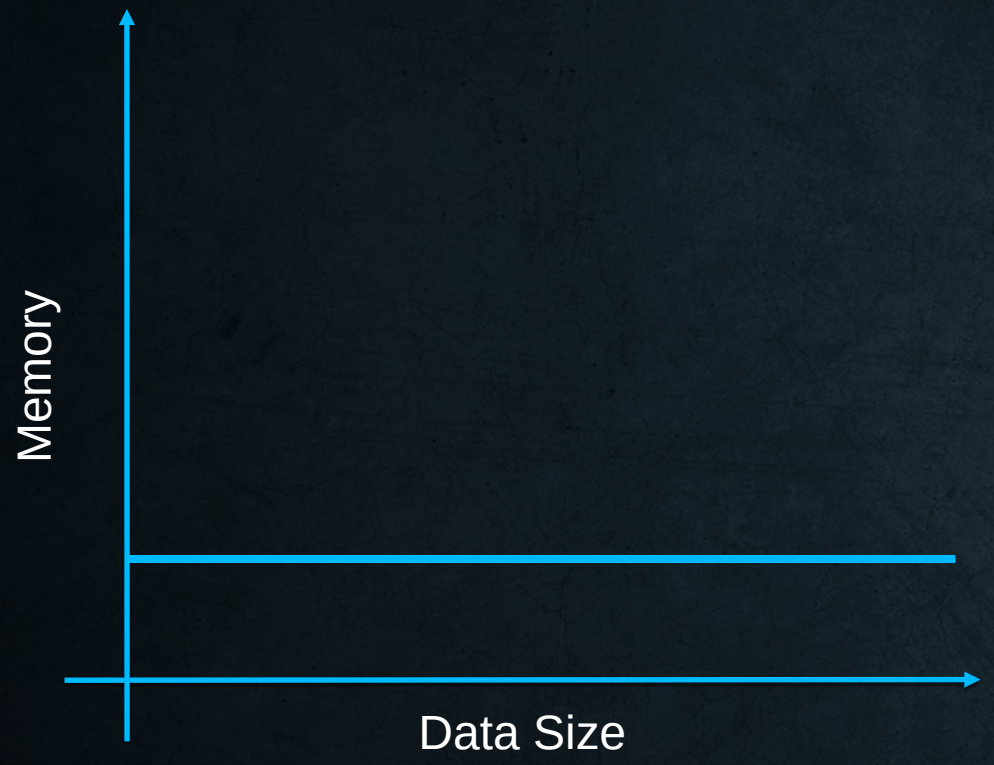
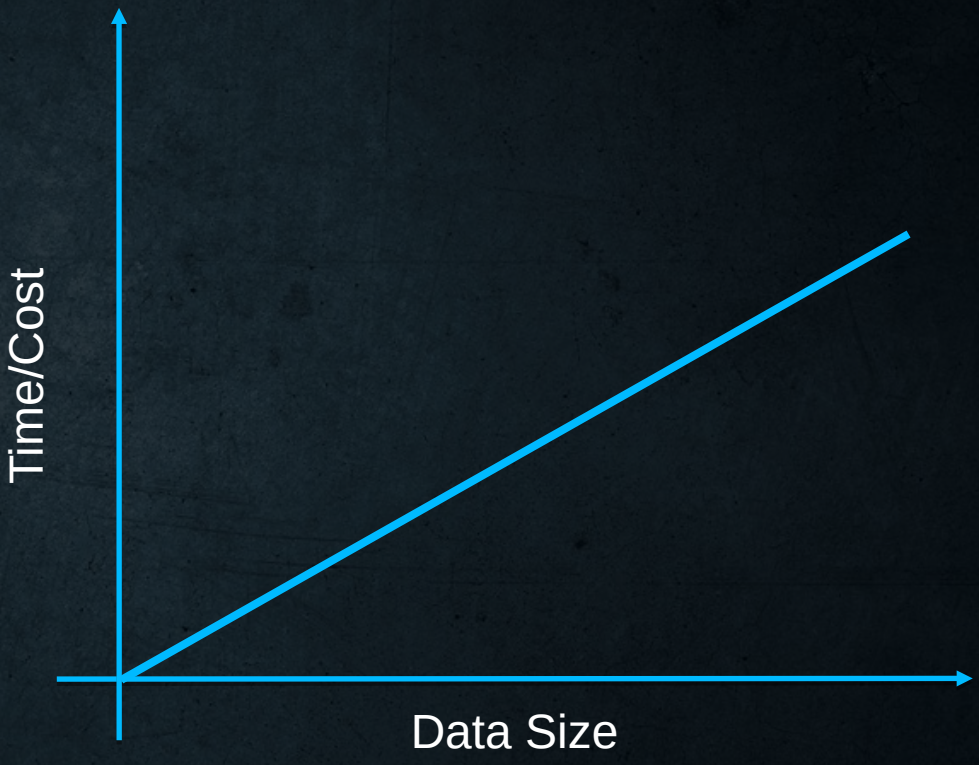
Streaming





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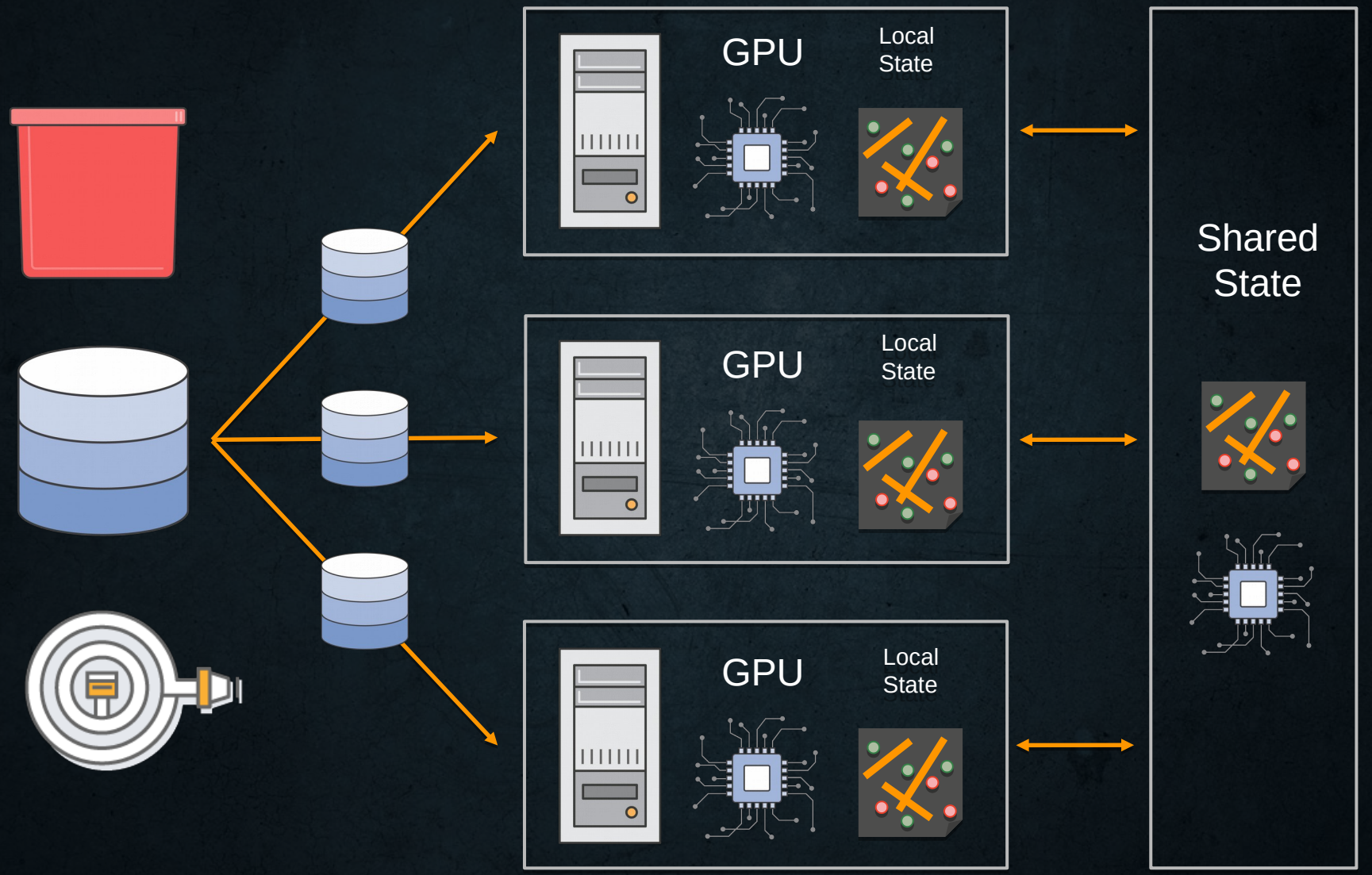
Shared State



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Pipe Mode

- Data flows on-the-fly during training
- Shorter startup times
- Higher I/O throughput with optimized agent
- No dataset size limits
- Requires protobuf recordIO format
- Available algorithms:
  - Principal Component Analysis (PCA)
  - K-Means Clustering
  - Factorization Machines
  - Latent Dirichlet Allocation (LDA)
  - Linear Learner (Classification and Regression)
  - Neural Topic Modelling
  - Random Cut Forest
- Or use it with your own algorithms!

PCA + K-Means on NY Taxi Dataset

Pipe

File

https://aws.amazon.com/blogs/machine-learning/using-pipe-input-mode-for-amazon-sagemaker-algorithms/

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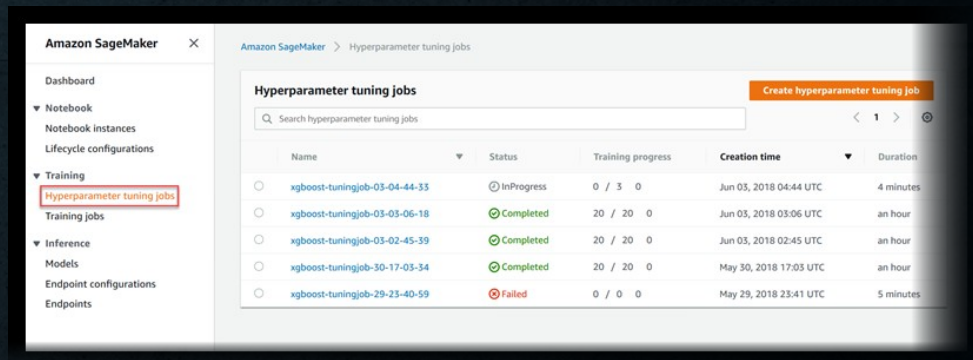
Automatic Model Tuning

1. Define objective metrics
   (Not needed for built-in)
2. Define hyper-parameter ranges
3. Let automatic tuning do the job!

- Based on Bayesian optimization
- Intelligently navigates parameter space to find optimal parameters
- Tries to balance explore/exploit trade-off

```
"ParameterRanges": {
      "CategoricalParameterRanges": [
        {
          "Name": "tree_method",
          "Values": ["auto", "exact", "approx", "hist"]
      ],
      "ContinuousParameterRanges": [
        {
          "Name": "eta",
          "MaxValue" : "0.5",
          "MinValue": "0"
        }
      ],
      "IntegerParameterRanges": [
        {
          "Name": "max_depth",
          "MaxValue": "10",
          "MinValue": "1",
        }
      ]
    }
```



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3

Managed Distributed Training with Flexibility

ML Training Service

Secured

Fetch Training data

Training code

Save Model Artifacts

Save Inference Image

Amazon ECR

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

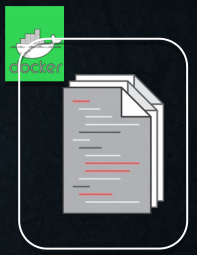
Amazon provided Algorithms

mxnet TensorFlow™ CHAINER

Bring Your Own Script
(SageMaker builds the Container)

APACHE Spark

SageMaker Estimators in Apache Spark



Bring Your Own Algorithm (You build the Container)

CPU GPU

HPO

Fully managed

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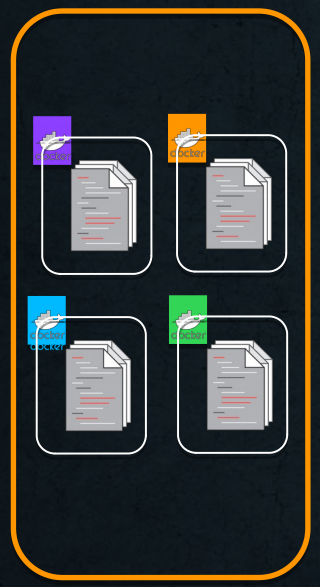
4

Easy Model Deployment to Amazon SageMaker

ML Hosting Service



Versions of the same inference code saved in inference containers. Prod is the primary one, 50% of the traffic must be served there!

Amazon ECR

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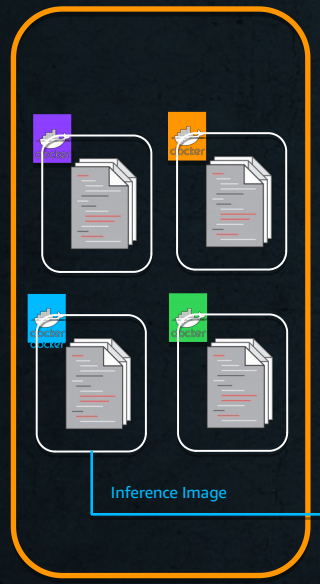
4

Easy Model Deployment to Amazon SageMaker

ML Hosting Service

Model Artifacts



Inference Image

Amazon ECR

ModelName: prod

Create a Model

Versions of the same inference code saved in inference containers. Prod is the primary one, 50% of the traffic must be served there!

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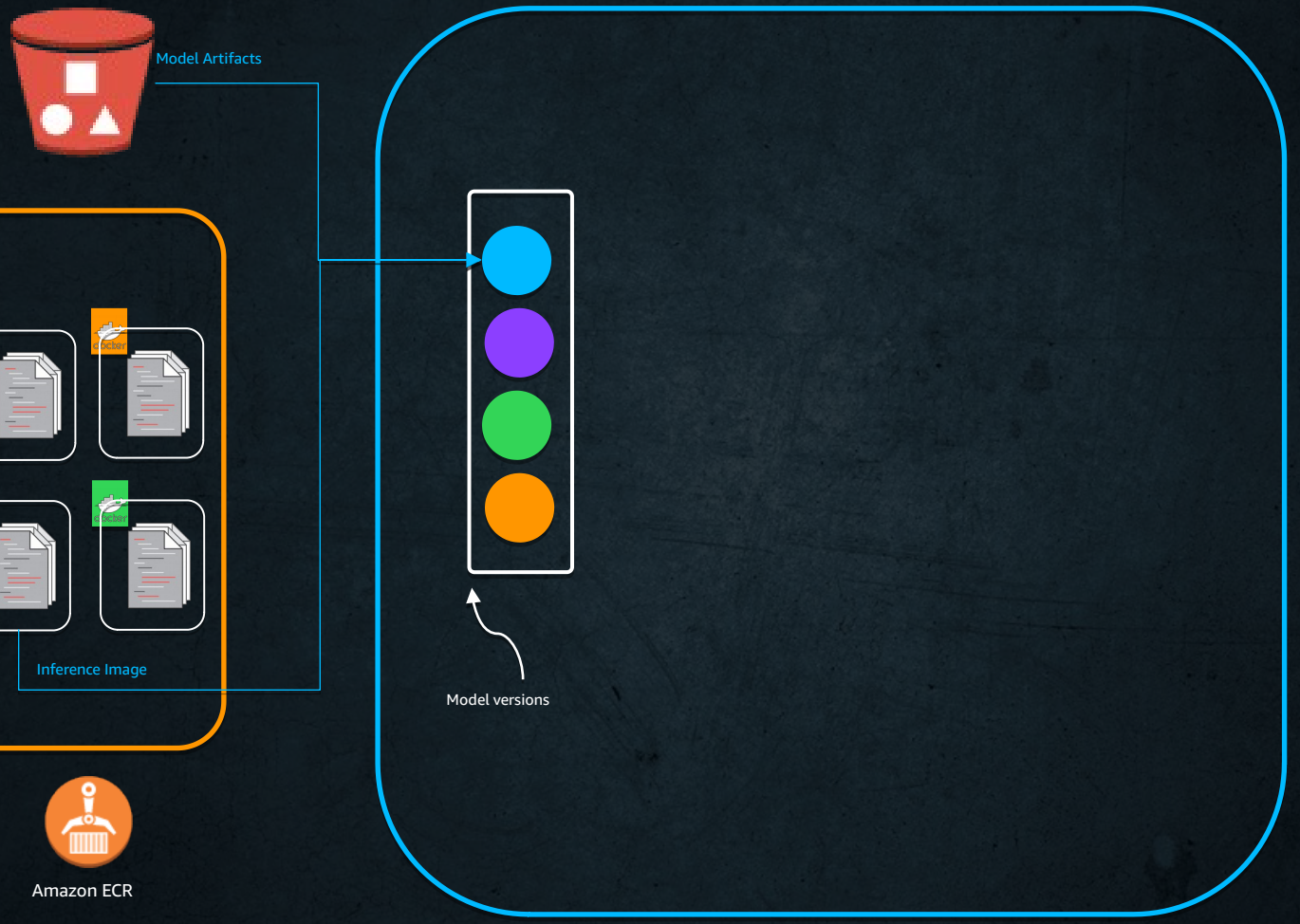
Easy Model Deployment to Amazon SageMaker

ML Hosting Service

Versions of the same inference code saved in inference containers. Prod is the primary one, 50% of the traffic must be served there!



Create versions of a Model

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Easy Model Deployment to Amazon SageMaker

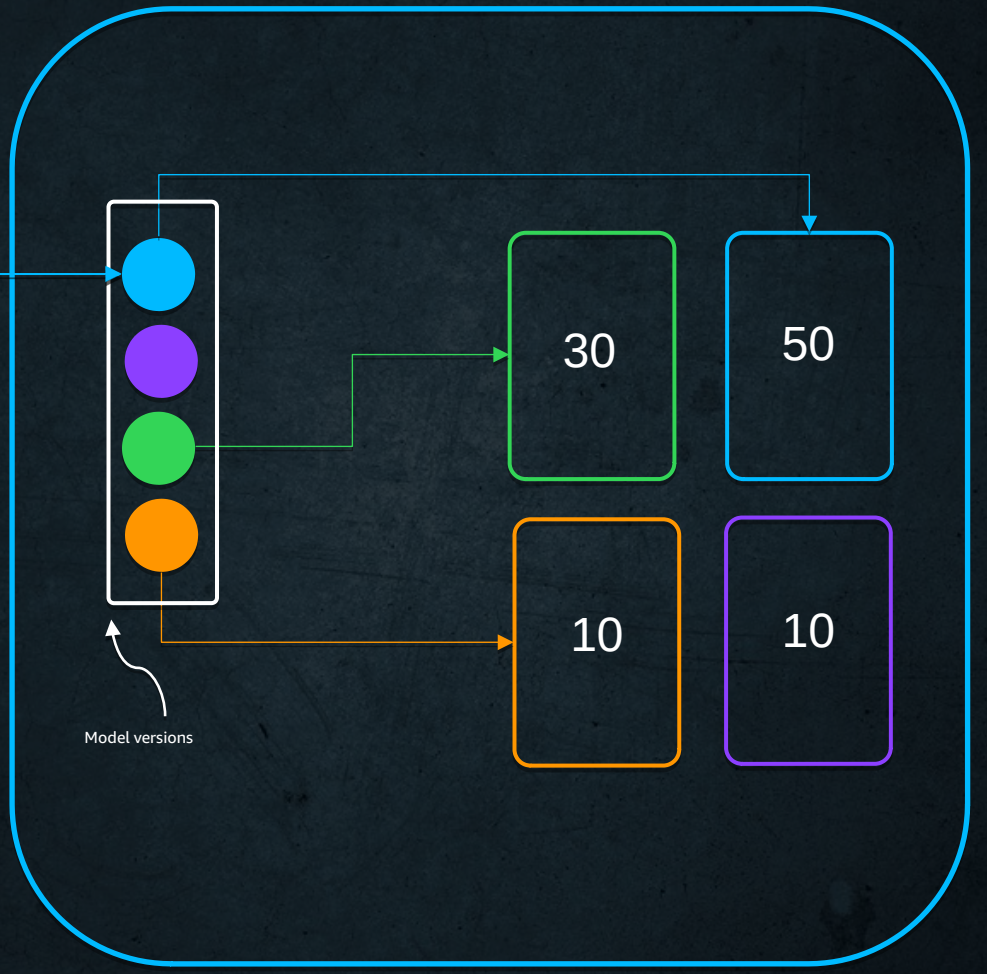
ML Hosting Service

Versions of the same inference code saved in inference containers. Prod is the primary one, 50% of the traffic must be served there!

Model Artifacts

Inference Image

Amazon ECR



InstanceType: c3.4xlarge

InitialInstanceCount: 3

ModelName: prod

VariantName: primary

InitialVariantWeight: 50

ProductionVariant

Create weighted ProductionVariants

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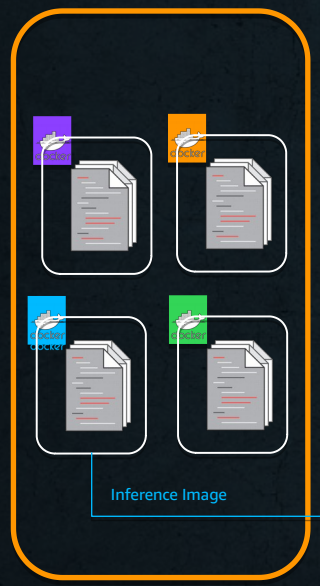
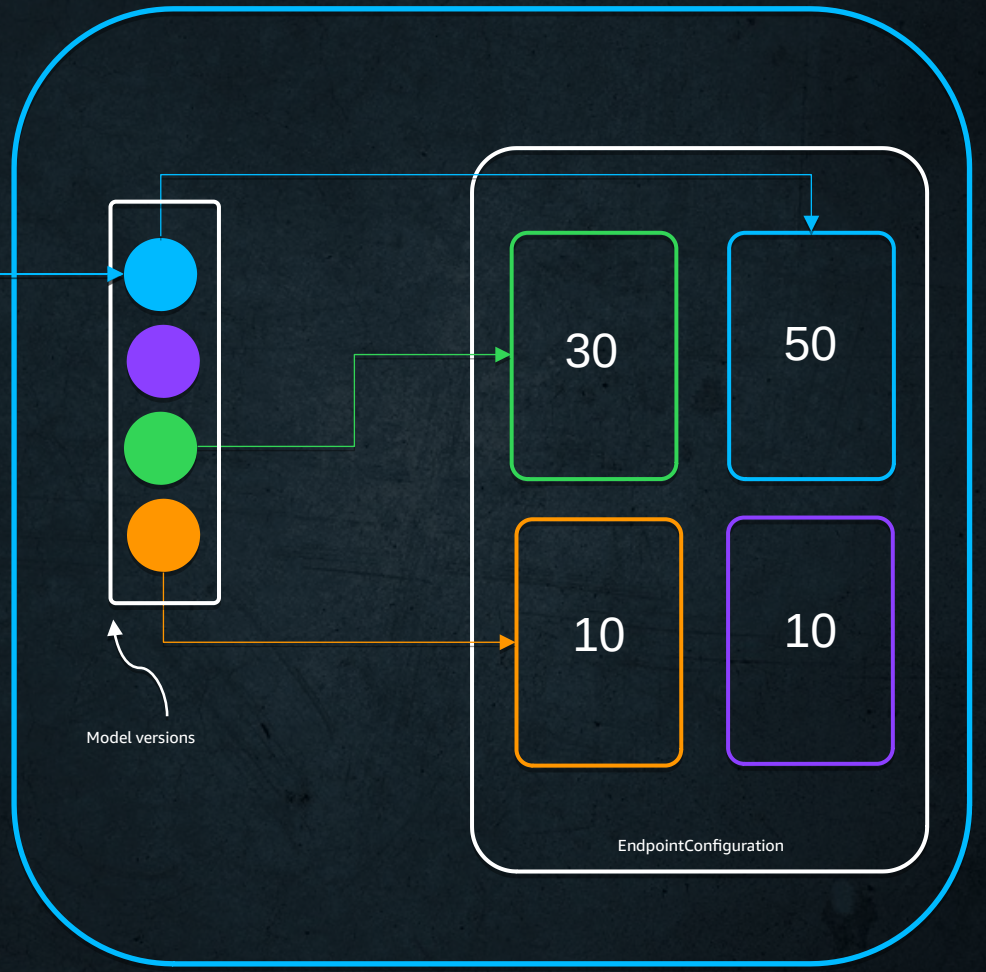
Easy Model Deployment to Amazon SageMaker

ML Hosting Service

Versions of the same inference code saved in inference containers. Prod is the primary one, 50% of the traffic must be served there!





InstanceType: c3.4xlarge

InitialInstanceCount: 3

ModelName: prod

VariantName: primary

InitialVariantWeight: 50

ProductionVariant

Create an EndpointConfiguration from one or many ProductionVariant(s)

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Easy Model Deployment to Amazon SageMaker

ML Hosting Service

- ✓ Auto-Scaling Inference APIs
- ✓ A/B Testing
- ✓ Low Latency & High Throughput
- ✓ Bring Your Own Model
- ✓ Python SDK

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Amazon SageMaker workflows

Experiment Management

Organize, track, and evaluate model training experiments with SageMaker search

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Amazon SageMaker workflows

Experiment Management

Organize, track, and evaluate model training experiments with SageMaker search

Collaboration

Link GitHub, AWS CodeCommit, and self-hosted Git repositories to notebooks

Clone public and private repositories

Secure information with AWS Identity and Access Management (IAM), LDAP, and AWS Secrets Manager

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Amazon SageMaker workflows

Experiment Management

Organize, track, and evaluate model training experiments with SageMaker search

Collaboration

Link GitHub, AWS CodeCommit, and self-hosted Git repositories to notebooks

Clone public and private repositories

Secure information with AWS Identity and Access Management (IAM), LDAP, and AWS Secrets Manager

Automation

Use AWS Step Functions to automate end-to-end workflows

Integrate with Apache Airflow

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The Amazon ML stack: Broadest & deepest set of capabilities

AI SERVICES

Vision


REKOGNITION IMAGE


REKOGNITION VIDEO

Speech


TEXTRACT


POLLY


TRANSCRIBE

Language


TRANSLATE


COMPREHEND

Chatbots


LEX

Forecasting


FORECAST

Recommendations


PERSONALIZE

ML SERVICES


AMAZON SAGEMAKER

BUILD

Pre-built algorithms & notebooks

Data labelling (GROUND TRUTH)

Algorithms & models (AWS MARKETPLACE FOR MACHINE LEARNING)

TRAIN

One-click model training & tuning

Optimization (NEO)

Reinforcement learning

DEPLOY

One-click deployment & hosting

ML FRAMEWORKS & INFRASTRUCTURE

Frameworks

TensorFlow

mxnet

PYTORCH

Interfaces

GLUON

Keras

Infrastructure


EC2 P3 & P3N


EC2 C5


FPGAs


GREENGRASS


ELASTIC INFERENCE

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Highest-performing infrastructure for your business

ML FRAMEWORKS & INFRASTRUCTURE

Frameworks

TensorFlow

mxnet

PYTORCH

Interfaces

GLUON

Keras

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EC2 P3 & P3N

EC2 C5

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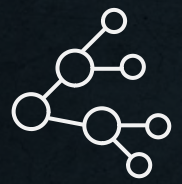

Build custom algorithms using the ML frameworks

Fastest and lowest-cost compute options for ML workloads

Elastic compute to provision just-right compute for your ML workloads

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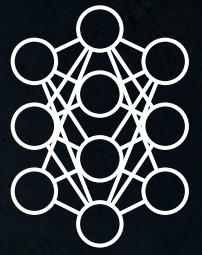
Amazon EC2 P3dn instance

The largest P3 instance, optimized for distributed training

Reduce machine learning training time

Better GPU utilization



Support larger, more complex models

KEY FEATURES

100Gbps of networking bandwidth

8 NVIDIA Tesla V100 GPUs

32GB of memory per GPU (2x more P3)

96 Intel Skylake vCPUs (50% more than P3) with AVX-512

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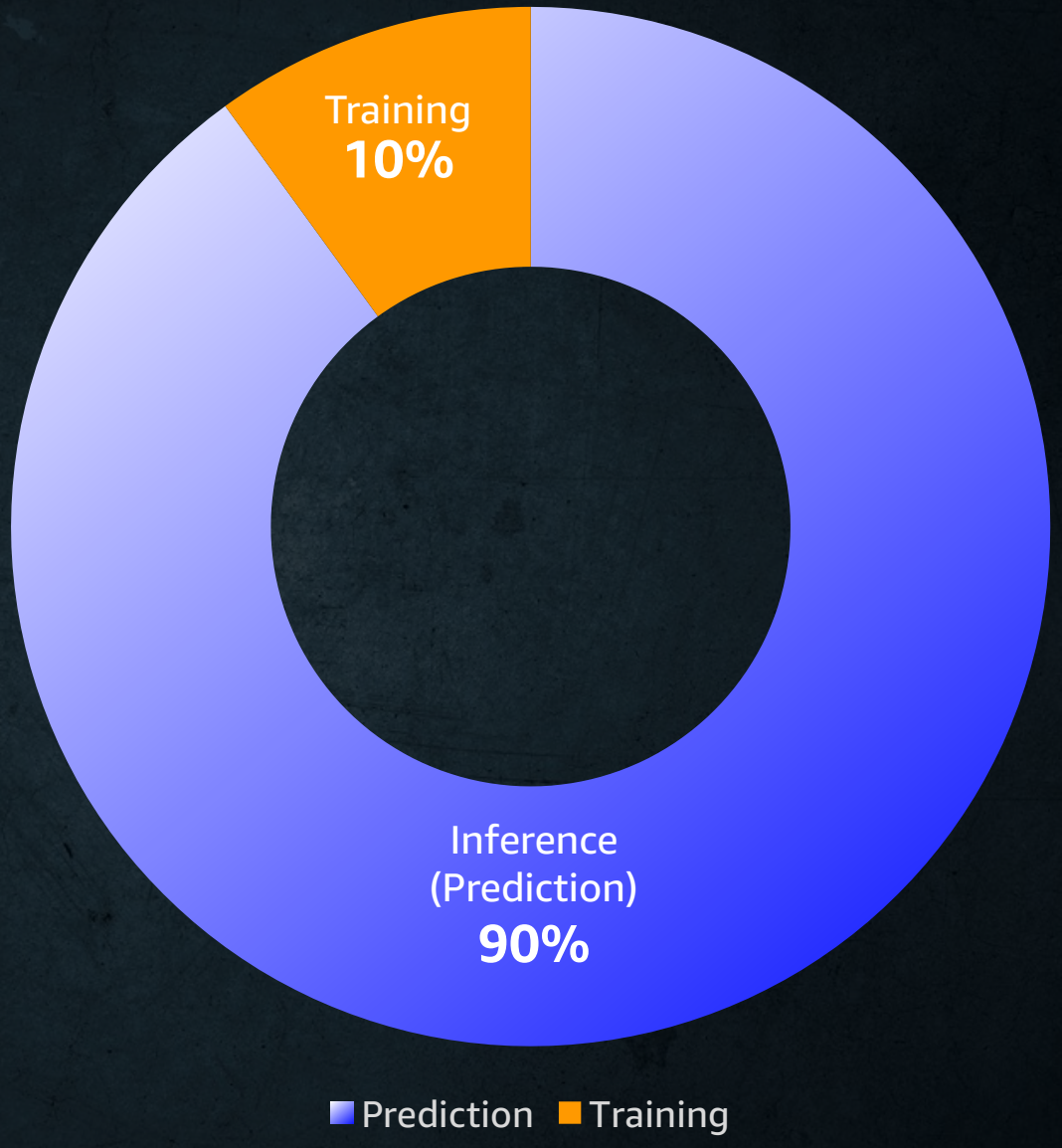
Predictions drive complexity and cost in production



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Amazon Elastic Inference

Add GPU acceleration to any Amazon EC2 instance for faster inference at much lower cost (up to 75% savings)

Provision Elastic Inference capacity inside VPC

Starting at 1 TFLOPS	Up to 32 TFLOPS
Simple speech and language models	Recommendation engines or fraud detection models

Any instance family

mxnet

TensorFlow

PYTORCH

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Lowering inference costs with Amazon Elastic Inference

ResNet-50
Computer vision
deep learning model

360,000
images per hour,
inference

$0.22
per hour
on medium EI accelerator

LOWEST COST AVAILABLE

75%
lower cost

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ML Workshop featuring Amazon SageMaker

End-to-End Managed ML Platform

https://bit.ly/2VCfBqq

Module 2 – Image recognition

- Using built in Image Classification algorithm
- Training a model with Transfer Learning
- Using Elastic Inference
- Using Automatic Tuning
- Deploying an endpoint
- Getting predictions

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AWS is framework agnostic

Choose from popular frameworks

TensorFlow mxnet PYTORCH Chainer Caffe2 ONNX Keras GLUON

Run them fully managed

Or run them yourself

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AWS: The platform of choice to run TensorFlow

85% of all TensorFlow workloads in the cloud runs on AWS

Source: Nucleus Research, November 2018

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aws

The best place to run TensorFlow

Stock
TensorFlow

65%

scaling efficiency
with 256 GPUs

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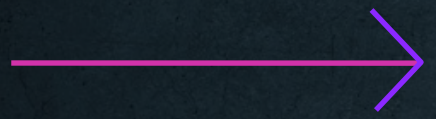
The best place to run TensorFlow

Stock TensorFlow

65%

scaling efficiency with 256 GPUs



NEW

AWS-Optimized TensorFlow

90%

scaling efficiency with 256 GPUs

Available with Amazon SageMaker and the AWS Deep Learning AMIs

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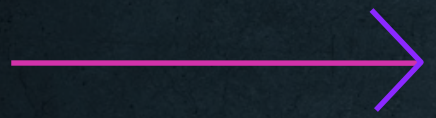
The best place to run TensorFlow

NEW

Stock TensorFlow

65%

scaling efficiency with 256 GPUs



AWS-Optimized TensorFlow

90%

scaling efficiency with 256 GPUs

Available with Amazon SageMaker and the AWS Deep Learning AMIs

30m

training time

14m

training time

Fastest time for TensorFlow

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AWS is the best platform for TensorFlow

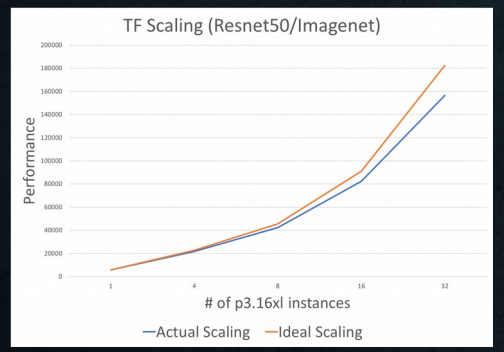
Fast

Versatile

Scalable

Time-to-train (CNN, ResNet50)

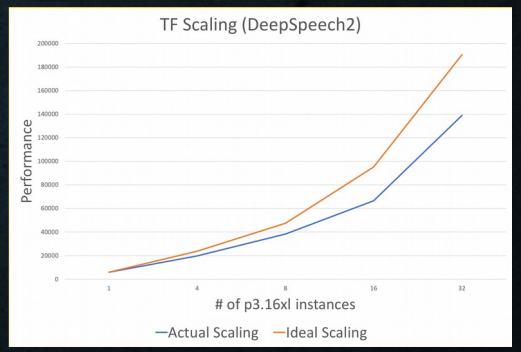
7h → 14m with 256 GPUs



Within 90% of ideal scaling

Time-to-train (LSTM, DeepSpeech2)

6d → 3.5h with 256 GPUs



Within 73% of ideal scaling

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ML Workshop featuring Amazon SageMaker

End-to-End Managed ML Platform

https://bit.ly/2VCfBqq

Module 3 – Tensor Flow

- Bring your own training script for Tensor Flow
- Training locally
- Using Batch Transform for bulk predictions
- Making your own container
- Deploying an endpoint
- Getting predictions

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The Amazon ML stack: Broadest & deepest set of capabilities

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EC2 P3 & P3N


EC2 C5


FPGAs


GREENGRASS


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More machine learning happens on AWS than anywhere else

10,000+

customers have used machine learning on AWS

81% of deep learning in the cloud runs on AWS

85% of TensorFlow projects in the cloud run on AWS

AWS holds the top spots on Stanford's deep learning benchmark, DAWN, for fastest training time, lowest cost, lowest inference latency

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aws

Thank you.

And please fill out the survey

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