AWS re:Invent

AIM326-R

Implementing ML workflows with Kubernetes and Amazon SageMaker

David Ping

Principal ML Solutions Architect

Amazon Web Services

Aditya Bindal

Senior Product Manager

Amazon Web Services

Suhas Guruprasad

ML Lead

Zalando

AWS re:Invent

aws

Agenda

- Machine learning is a hard problem
- Fully managed machine learning with Amazon SageMaker
- Kubernetes architecture
- Build ML workflows with Amazon SageMaker and Kubernetes
- Machine learning at Zalando
- Demo

Your organization has adopted ☸ to modernize technology

Need to transform business with machine learning

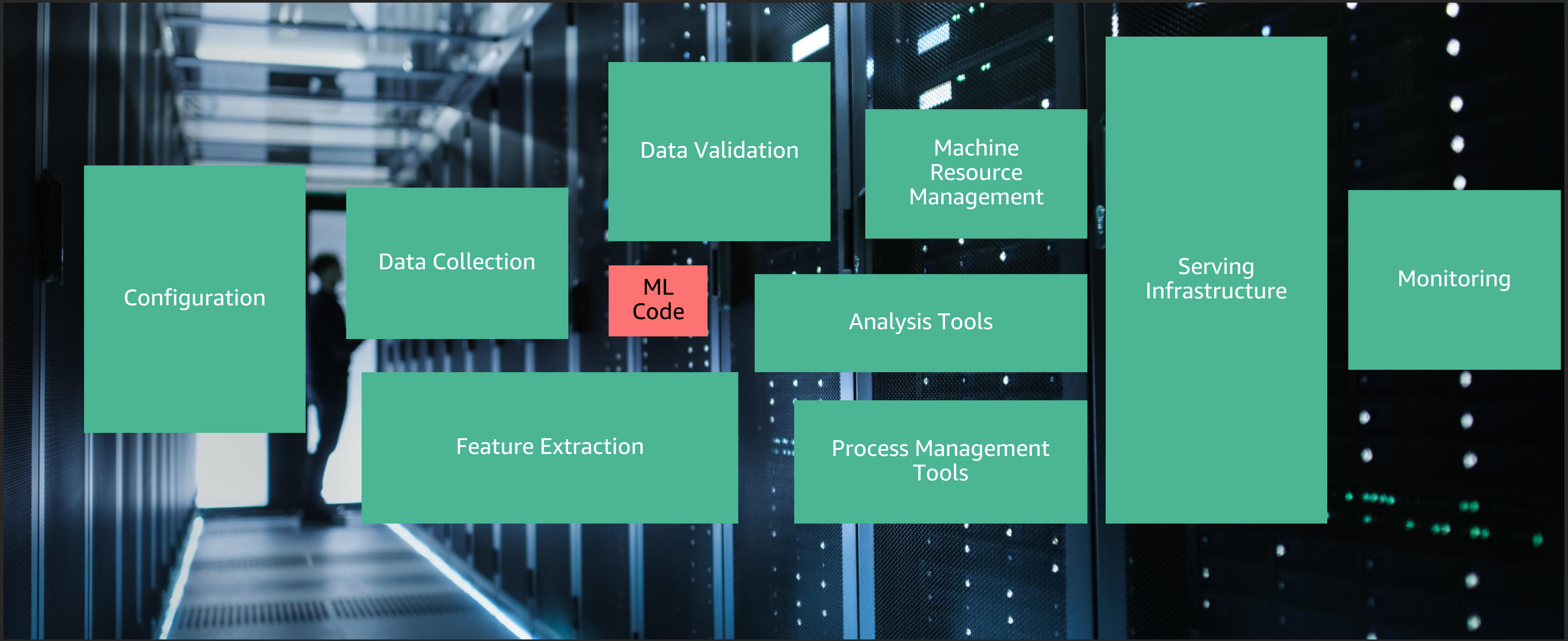
Data scientist

- Focuses on data science, business outcome and speed to market
- Wants minimum dependency on the DevOps team for experimentation and model development
- No or limited K8s and infrastructure knowledge

K8s DevOps engineer

- Wants to leverage existing K8s investment and best practices
- Wants to manage using familiar K8s construct and syntax
- Limited ML knowledge & engineering experience with ML workloads

Machine learning is hard



Source: Sculley et al: Hidden Technical Debt in Machine Learning Systems

Do-it-yourself

Opportunity for both?

Managed service

Fully managed machine learning with Amazon SageMaker

AWS re:Invent

aws

Amazon SageMaker is a fully managed service that covers the entire machine learning workflow

- Jupyter notebook instances
- High-performance algorithms
- Large-scale training
- Optimization
- One-click deployment
- Fully managed with auto-scaling

Built on modern application architecture

Containers

- Built-in algorithms for training and hosting
- Managed ML containers for training and hosting
- Bring-your-own containers for training and hosting

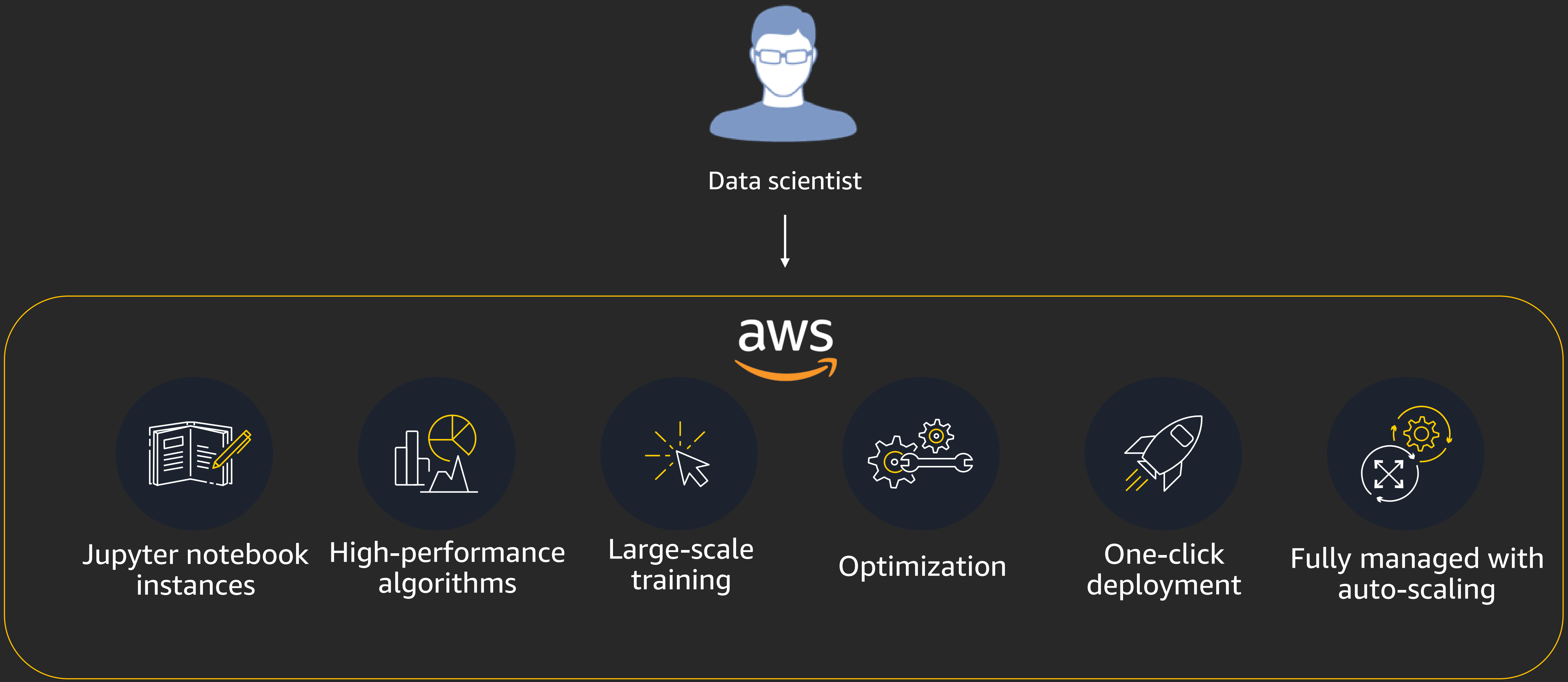
Serverless

- No server to manage
- API driven
- Pay by usage
- Built-in monitoring and logging

Cloud Native

- Multi-AZ deployment
- Scale with powerful compute resources
- IAM, VPC, Encryption
- Resource on-demand or SPOT, Amazon Elastic Inference, Multi-Model Endpoint

Minimized dependency on DevOps engineering



Data scientist

Jupyter notebook instances

High-performance algorithms

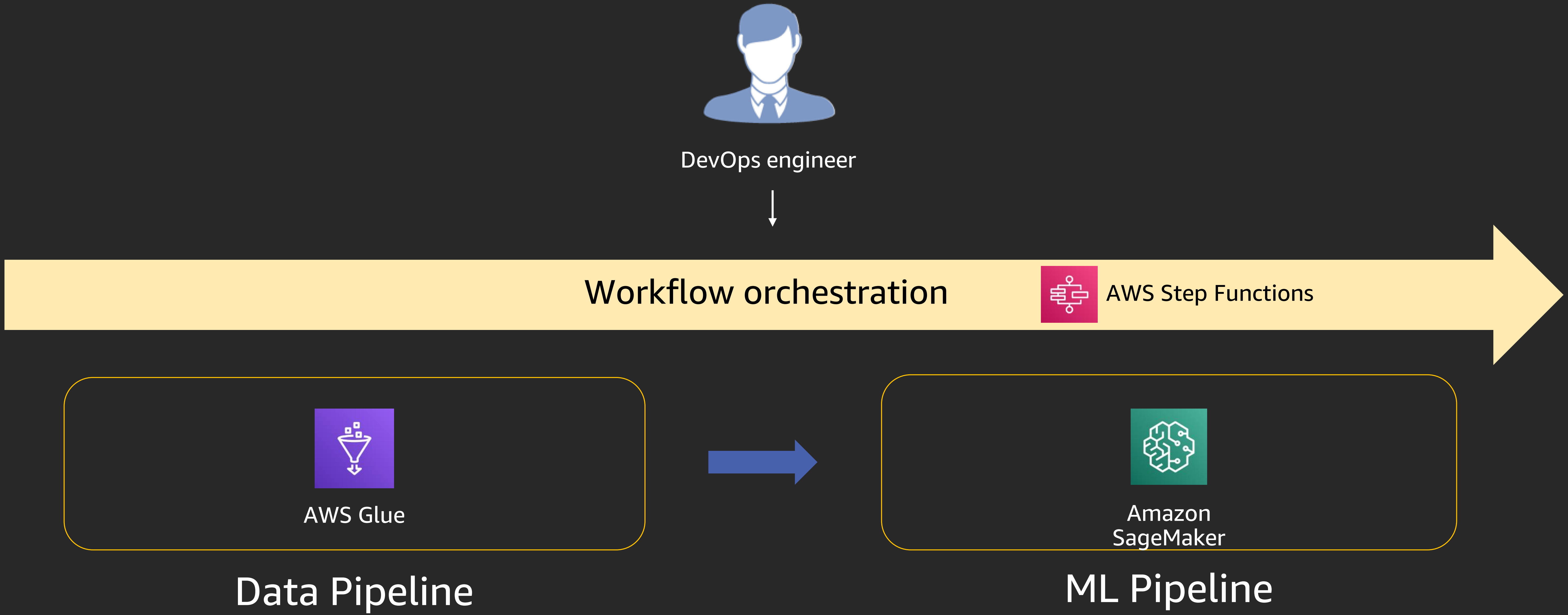
Large-scale training

Optimization

One-click deployment

Fully managed with auto-scaling

Run Amazon SageMaker in a pipeline



Kubernetes architecture

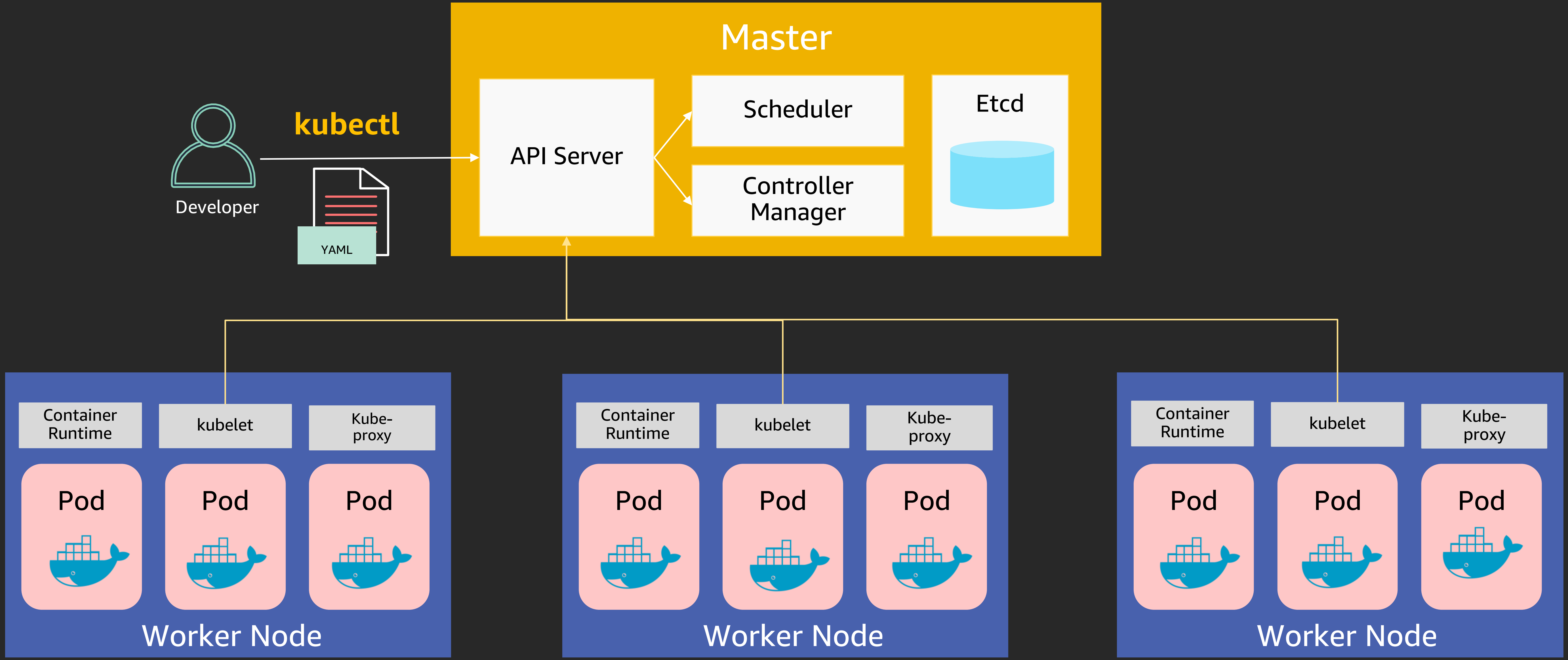
What is Kubernetes (aka K8s)?

Open-source container management platform

Helps you run containers at scale

Gives you primitives for building modern applications

Kubernetes architecture



Building ML workflows with Kubernetes and Amazon SageMaker

AWS re:Invent

aws

Using Kubernetes for ML is hard to manage and scale

Build and manage services within Kubernetes cluster for ML

+

Make disparate open-source libraries and frameworks work together in a secure and scalable way

+

Requires time and expertise from infrastructure, data science, and development teams

=

Need an easier way to use Kubernetes for ML

Introducing Amazon SageMaker Operators for Kubernetes

Kubernetes customers can now train, tune, and deploy models in Amazon SageMaker

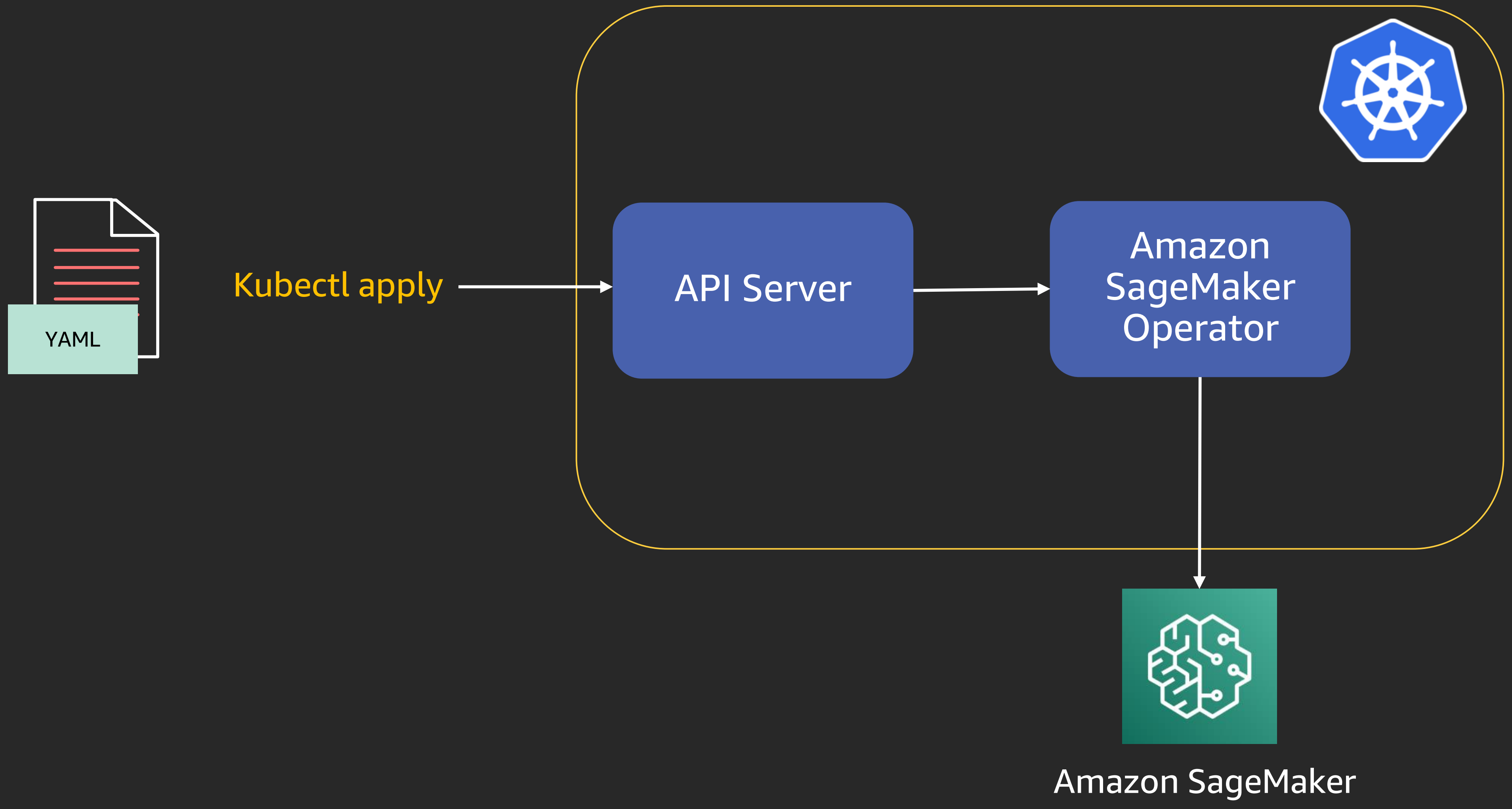
Train, tune, and deploy models in Amazon SageMaker

Orchestrate ML workloads from your Kubernetes environments

Create pipelines and workflows in Kubernetes

Fully managed infrastructure in Amazon SageMaker

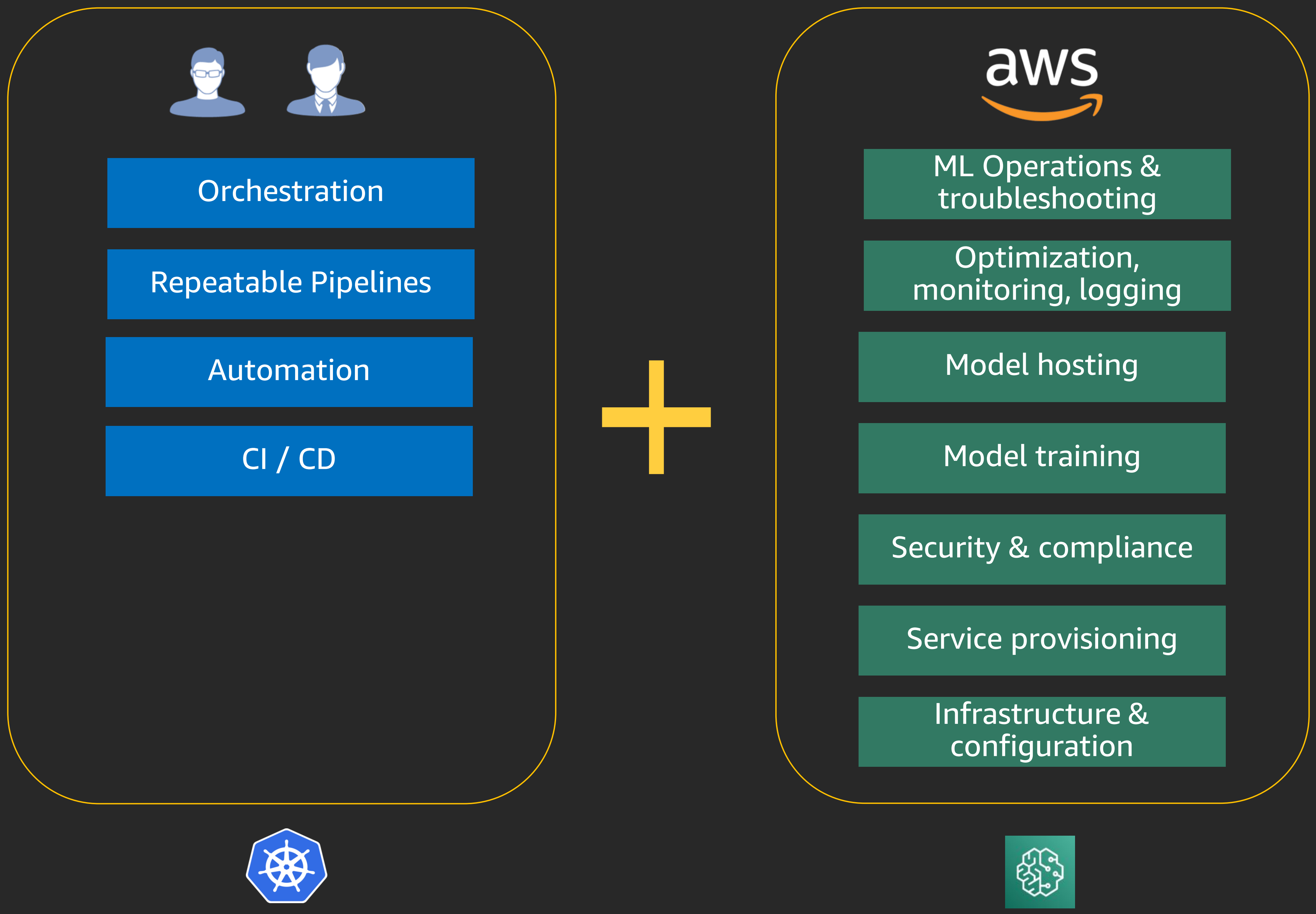
Under the hood – Amazon SageMaker and Kubernetes



Key Features

- Amazon SageMaker Operators for training, tuning, inference
- Natively interact with Amazon SageMaker jobs using K8s tools (e.g., get pods, describe)
- Stream and view logs from Amazon SageMaker in K8s
- Helm Charts to assist with setup and spec creation

Why together?



Orchestration

Repeatable Pipelines

Automation

CI / CD

aws

ML Operations & troubleshooting

Optimization, monitoring, logging

Model hosting

Model training

Security & compliance

Service provisioning

Infrastructure & configuration

Machine learning at Zalando

Zalando.

The starting point for fashion.

ZALANDO AT A GLANCE

~ 5.4 billion EUR revenue 2018

> 300 million visits per month

~ 14,000 employees in Europe

> 80% of visits via mobile devices

> 29 million active customers

> 450,000 product choices

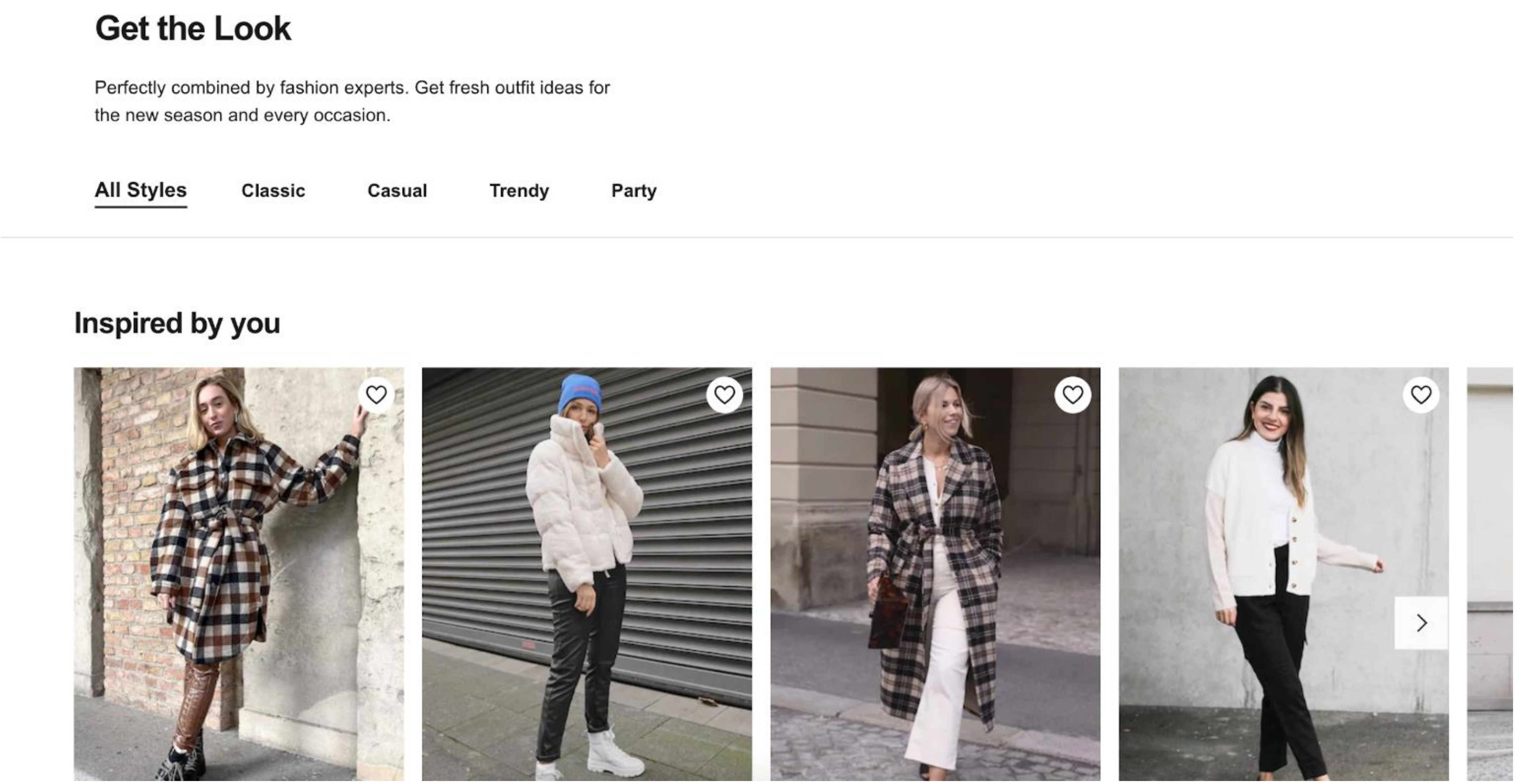
> 2,000 brands

17 countries

“A sustainable fashion platform with a net positive impact for people and planet”

We leverage Machine Learning across the platform to deliver a better customer experience.

MACHINE LEARNING AT ZALANDO

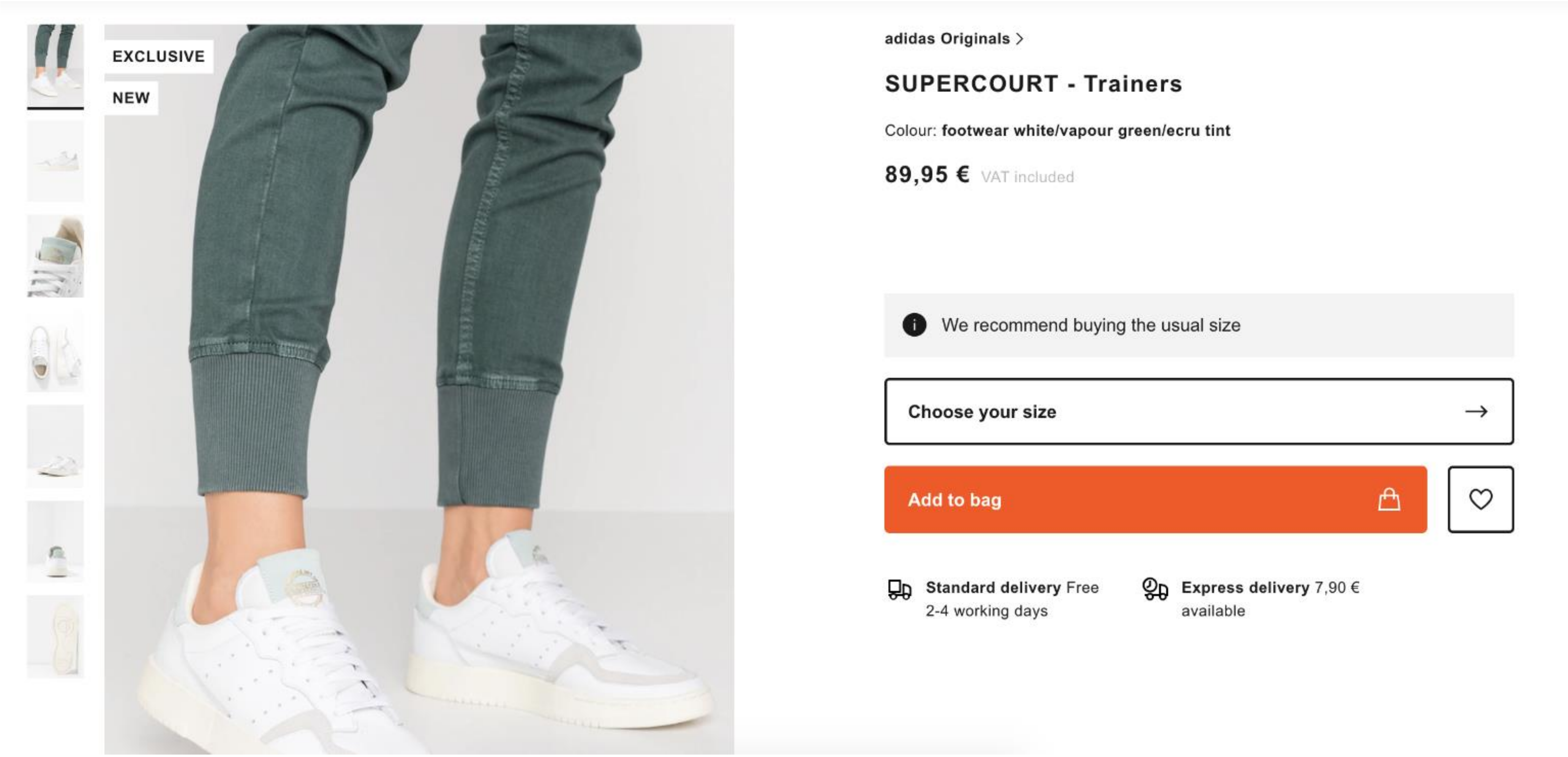


Get the Look

Perfectly combined by fashion experts. Get fresh outfit ideas for the new season and every occasion.

Inspired by you

MACHINE LEARNING AT ZALANDO



adidas Originals >

SUPERCOURT - Trainers

Colour: **footwear white/vapour green/ecru tint**

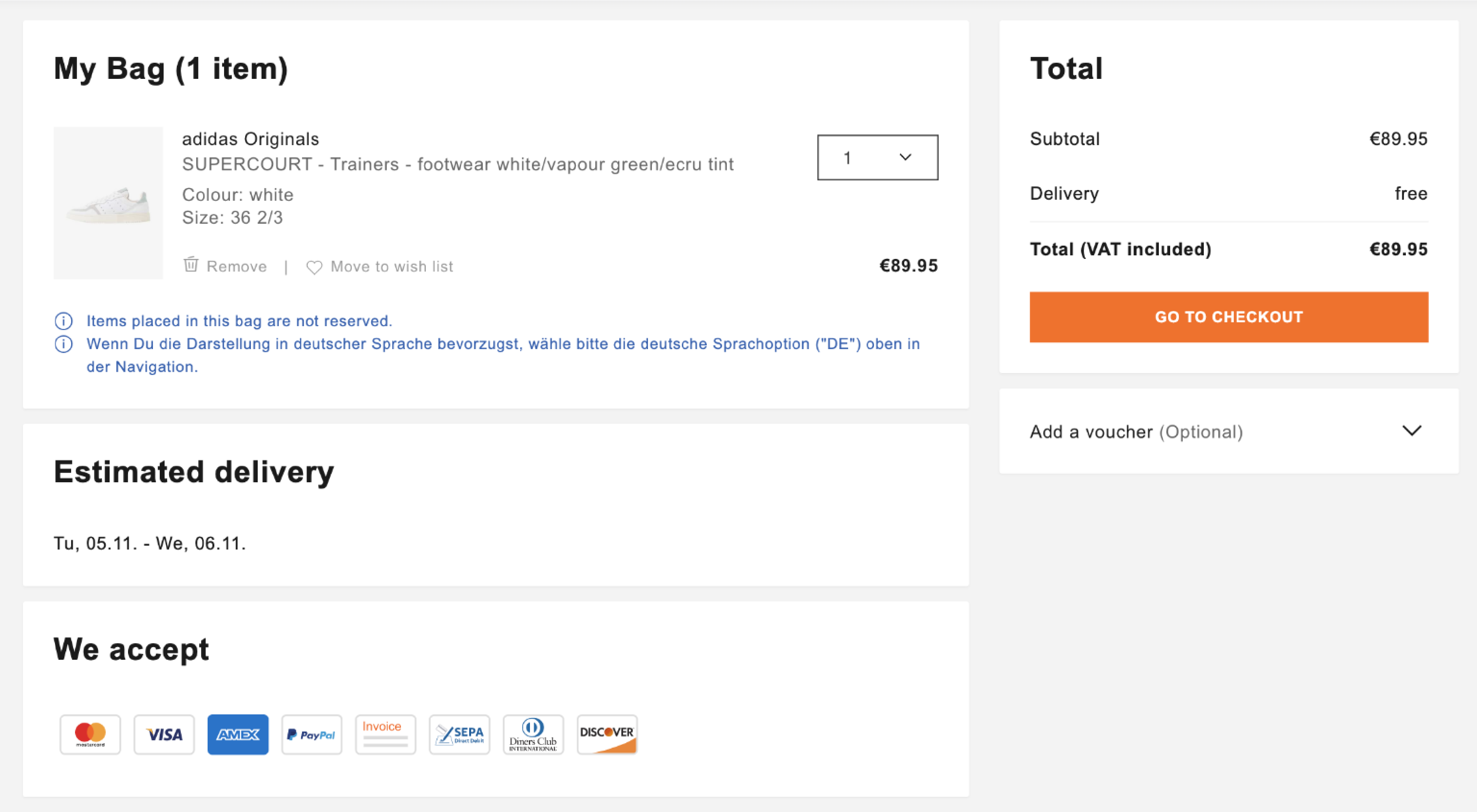
89,95 € VAT included

We recommend buying the usual size

Standard delivery Free
2-4 working days

Express delivery 7,90 €
available

MACHINE LEARNING AT ZALANDO



My Bag (1 item)

adidas Originals
SUPERCOURT - Trainers - footwear white/vapour green/ecru tint
Colour: white
Size: 36 2/3

€89.95

Items placed in this bag are not reserved.

Wenn Du die Darstellung in deutscher Sprache bevorzugst, wähle bitte die deutsche Sprachoption ("DE") oben in der Navigation.

Estimated delivery

Tu, 05.11. - We, 06.11.

We accept

Total

Subtotal	€89.95
Delivery	free
Total (VAT included)	**€89.95**

Add a voucher (Optional)

MACHINE LEARNING AT ZALANDO

But what constitutes an ML project and how is it different from traditional software?

MICROSERVICES AT ZALANDO

CODE

and commits to

GitHub

MICROSERVICES AT ZALANDO

CODE

and commits to GitHub

CONTINUOUS DEPLOYMENT

builds triggered by pull requests

MICROSERVICES AT ZALANDO

CODE

and commits to GitHub

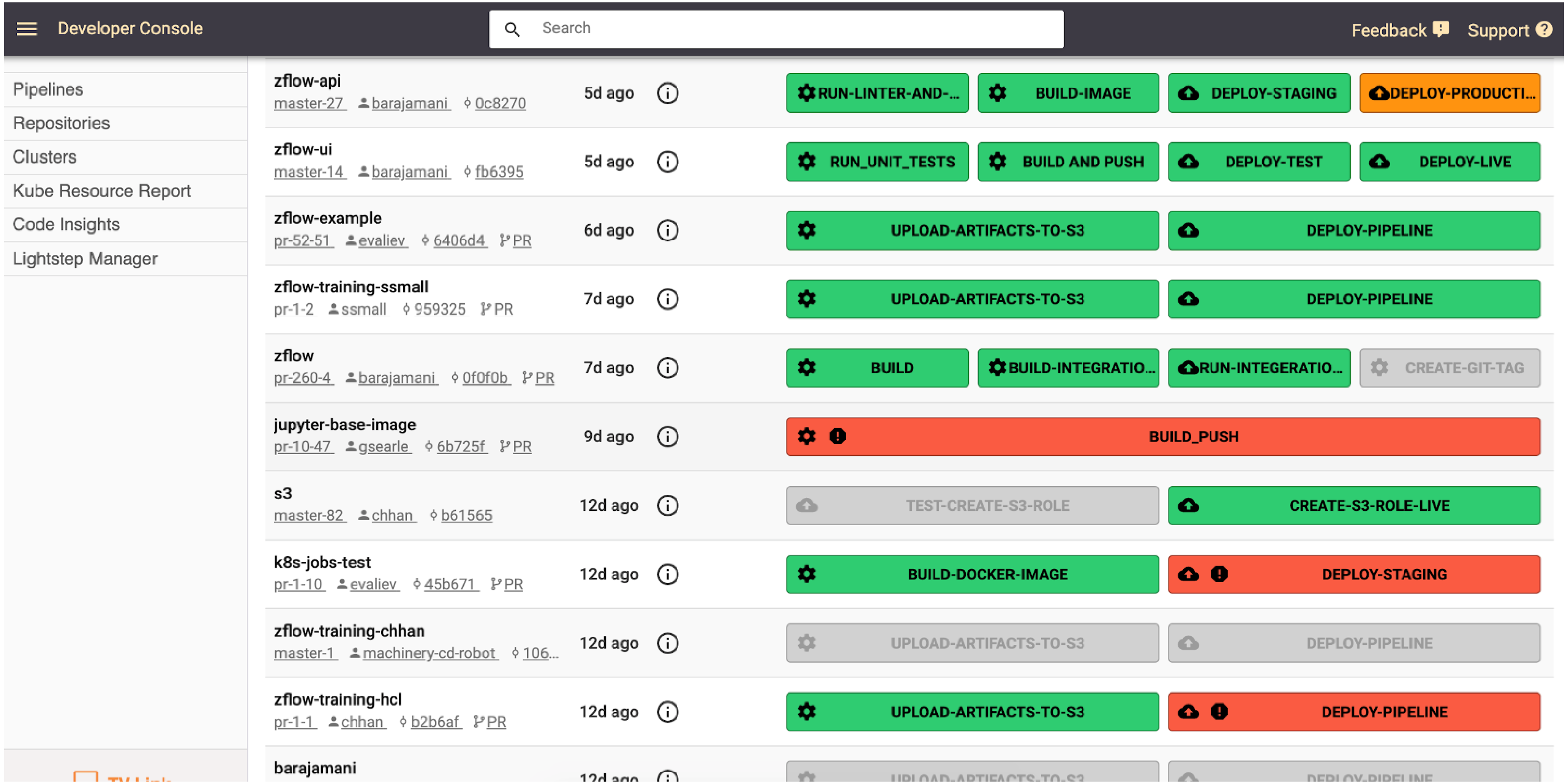
CONTINUOUS DEPLOYMENT

builds triggered by pull requests

KUBERNETES

Software runs on one of our >140 Kubernetes clusters on AWS

CONTINUOUS DEPLOYMENT



Developer Console

Search

Feedback Support

- Pipelines
- Repositories
- Clusters
- Kube Resource Report
- Code Insights
- Lightstep Manager

zflow-api master-27 barajamani 0c8270	5d ago	RUN-LINTER-AND-...	BUILD-IMAGE	DEPLOY-STAGING	DEPLOY-PRODUCTI...
zflow-ui master-14 barajamani fb6395	5d ago	RUN_UNIT_TESTS	BUILD AND PUSH	DEPLOY-TEST	DEPLOY-LIVE
zflow-example pr-52-51 evaliev 6406d4 PR	6d ago	UPLOAD-ARTIFACTS-TO-S3		DEPLOY-PIPELINE	
zflow-training-ssmall pr-1-2 ssmall 959325 PR	7d ago	UPLOAD-ARTIFACTS-TO-S3		DEPLOY-PIPELINE	
zflow pr-260-4 barajamani 0f0f0b PR	7d ago	BUILD	BUILD-INTEGRATIO...	RUN-INTEGERATIO...	CREATE-GIT-TAG
jupyter-base-image pr-10-47 gsearle 6b725f PR	9d ago	BUILD_PUSH			
s3 master-82 chhan b61565	12d ago	TEST-CREATE-S3-ROLE		CREATE-S3-ROLE-LIVE	
k8s-jobs-test pr-1-10 evaliev 45b671 PR	12d ago	BUILD-DOCKER-IMAGE		DEPLOY-STAGING	
zflow-training-chhan master-1 machinery-cd-robot 106...	12d ago	UPLOAD-ARTIFACTS-TO-S3		DEPLOY-PIPELINE	
zflow-training-hcl pr-1-1 chhan b2b6af PR	12d ago	UPLOAD-ARTIFACTS-TO-S3		DEPLOY-PIPELINE	
barajamani	12d ago	UPLOAD-ARTIFACTS-TO-S3		DEPLOY-PIPELINE	

zalando

THE MACHINE LEARNING JOURNEY

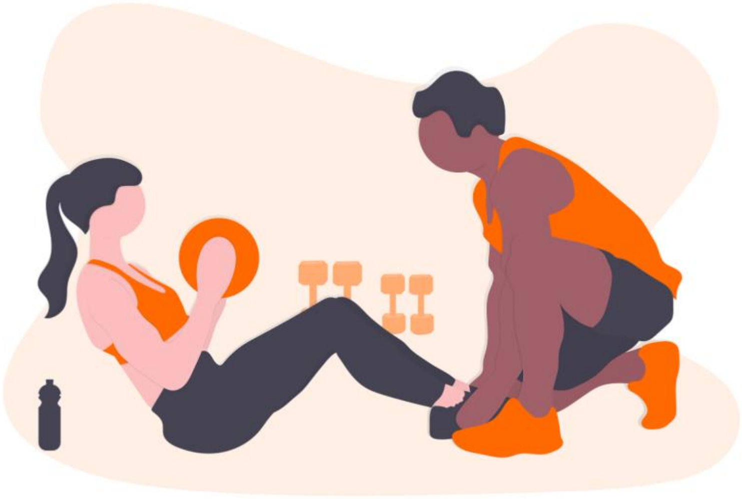
ANALYSIS

Exploratory Data Analysis

THE MACHINE LEARNING JOURNEY

ANALYSIS

Exploratory Data Analysis



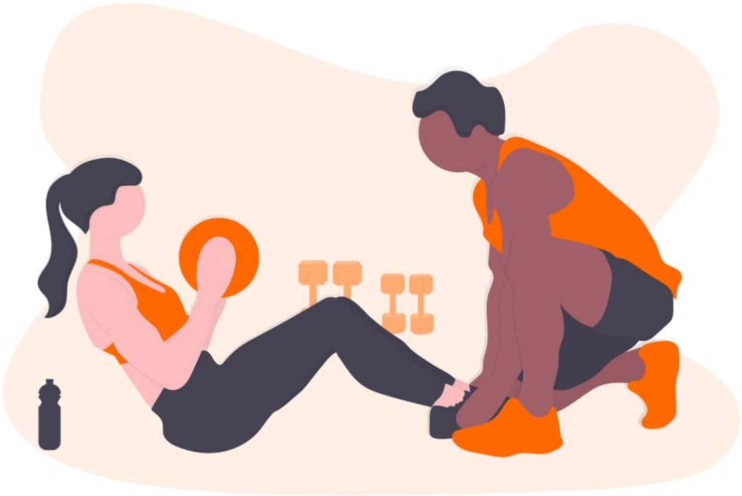
TRAINING

Features, Training & Evaluating models

THE MACHINE LEARNING JOURNEY

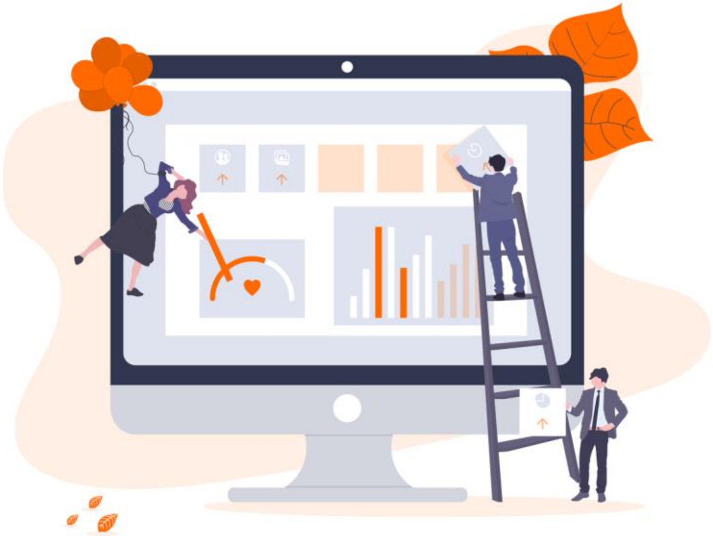
ANALYSIS

Exploratory Data Analysis



TRAINING

Features, Training & Evaluating models



OBSERVATIONS

Run A/B tests, see KPIs & adjust

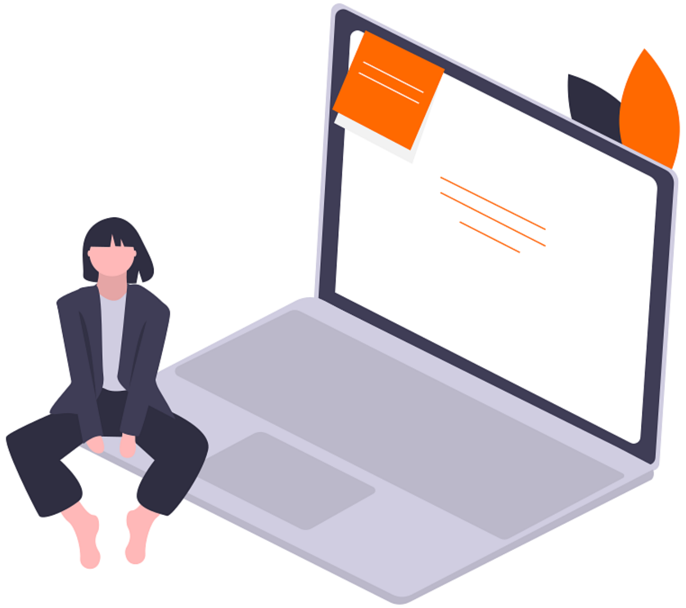
Building a central ML platform: What are the challenges?

CHALLENGES

SPEED

Research to production time

CHALLENGES



SPEED

Research to production time

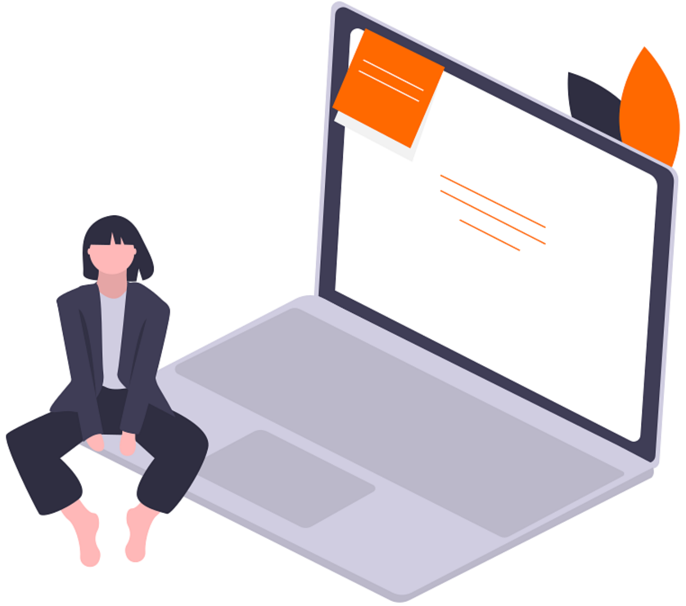
SAFETY

Understanding, testing, reproducibility, monitoring

CHALLENGES

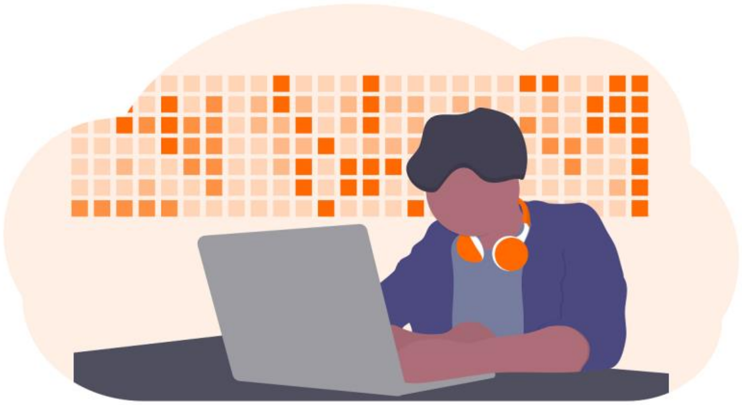
SPEED

Research to production time



SAFETY

Understanding, testing, reproducibility, monitoring



SCALE

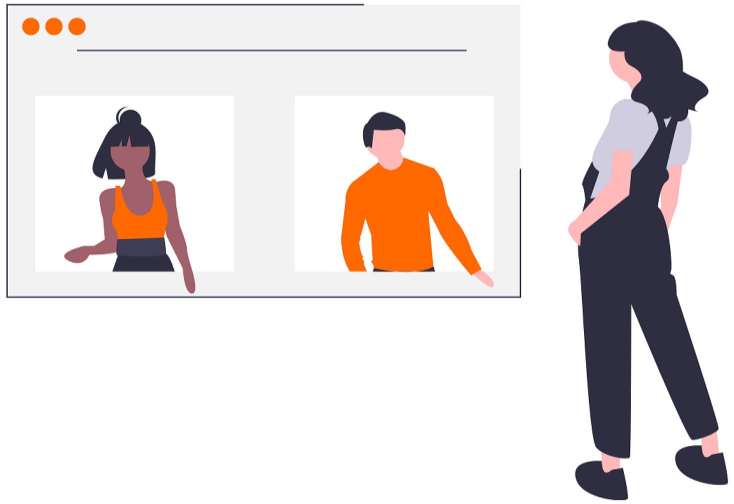
Run thousands of experiments

CHALLENGES

COST-EFFICIENCY

Experiments must be cheap at scale

CHALLENGES



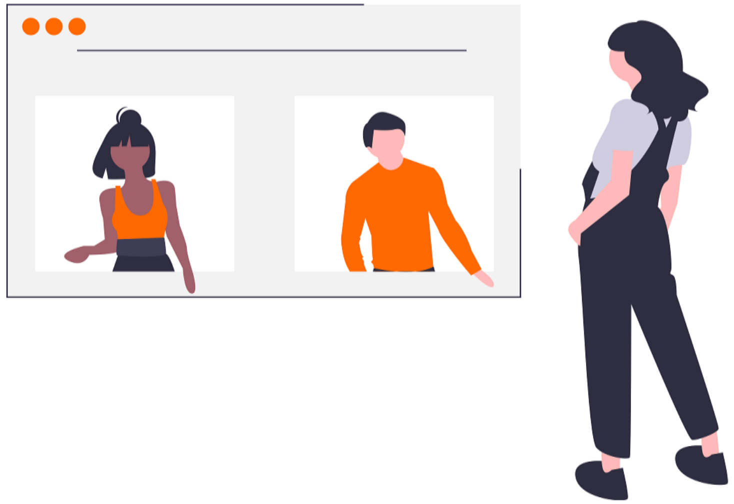
COST-EFFICIENCY

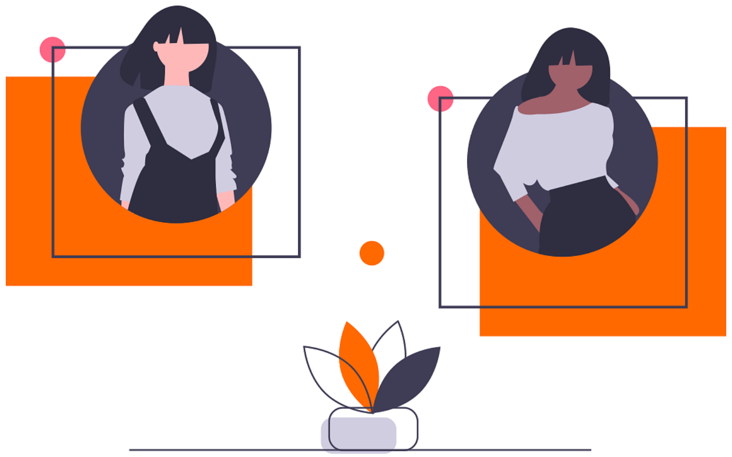
Experiments must be cheap at scale

COLLABORATION

Across multiple job families

CHALLENGES





COST-EFFICIENCY

Experiments must be cheap at scale

COLLABORATION

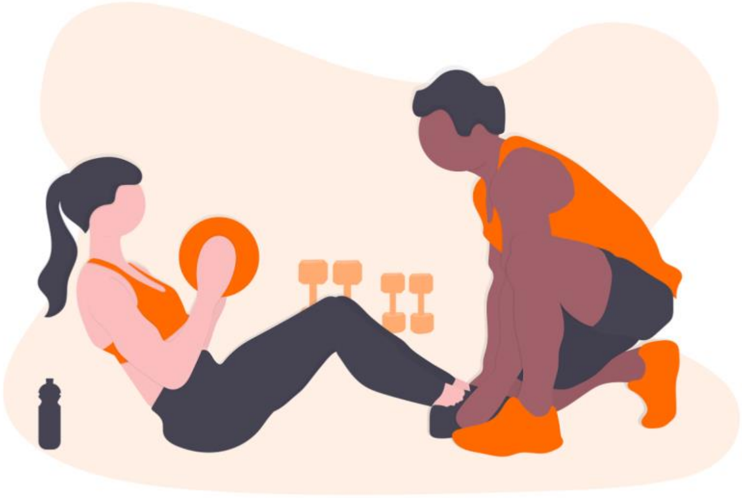
Across multiple job families

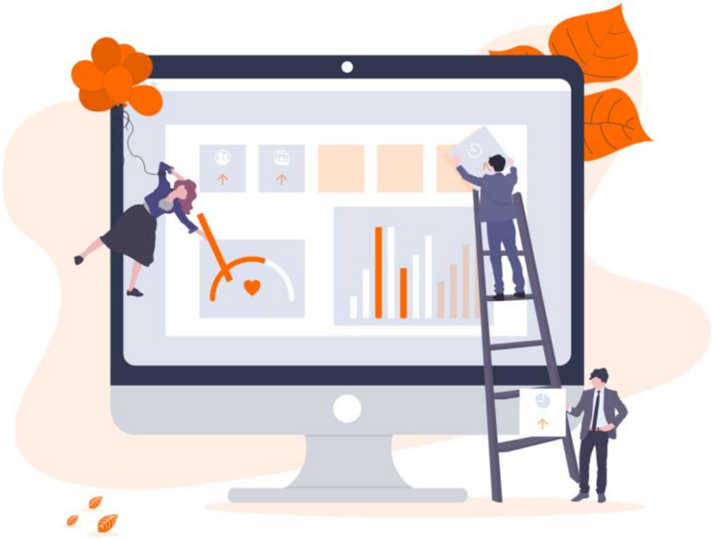
SATISFACTION

Job satisfaction and happiness

Relooking at the ML journey to define the ML pipeline for the ML platform

THE MACHINE LEARNING JOURNEY





ANALYSIS

Exploratory Data Analysis

TRAINING

Features, Training & Evaluating models

OBSERVATIONS

Run A/B tests, see KPIs & adjust

MACHINE LEARNING PIPELINES

FUNDAMENTAL

ML should be about pipelines,

not just data or models

Using Amazon SageMaker for ML pipelines at Zalando

WHY AMAZON SAGEMAKER AT ZALANDO

TRAINING JOBS

Training jobs repr.
core of a pipeline.

WHY AMAZON SAGEMAKER AT ZALANDO

TRAINING JOBS

Training jobs repr. core of a pipeline.

ALGORITHMS

Built-in and bring-your-own docker images.

WHY AMAZON SAGEMAKER AT ZALANDO

TRAINING JOBS

Training jobs repr. core of a pipeline.

ALGORITHMS

Built-in and bring-your-own docker images.

INTEGRATED

With AWS offerings.

WHY AMAZON SAGEMAKER AT ZALANDO

TRAINING JOBS

Training jobs repr. core of a pipeline.

ALGORITHMS

Built-in and bring-your-own docker images.

INTEGRATED

With AWS offerings.

“SERVERLESS”

Training instances are managed, jobs easy to distribute.

WHY AMAZON SAGEMAKER AT ZALANDO

TRAINING JOBS

Training jobs repr. core of a pipeline.

ALGORITHMS

Built-in and bring-your-own docker images.

INTEGRATED

With AWS offerings.

“SERVERLESS”

Training instances are managed, jobs easy to distribute.

BATCH & APIs

In the same package. Easy to reason and deploy.

WHY AMAZON SAGEMAKER AT ZALANDO

TRAINING JOBS

Training jobs repr. core of a pipeline.

ALGORITHMS

Built-in and bring-your-own Docker images.

INTEGRATED

With AWS offerings.

“SERVERLESS”

Training instances are managed, jobs are easy to distribute.

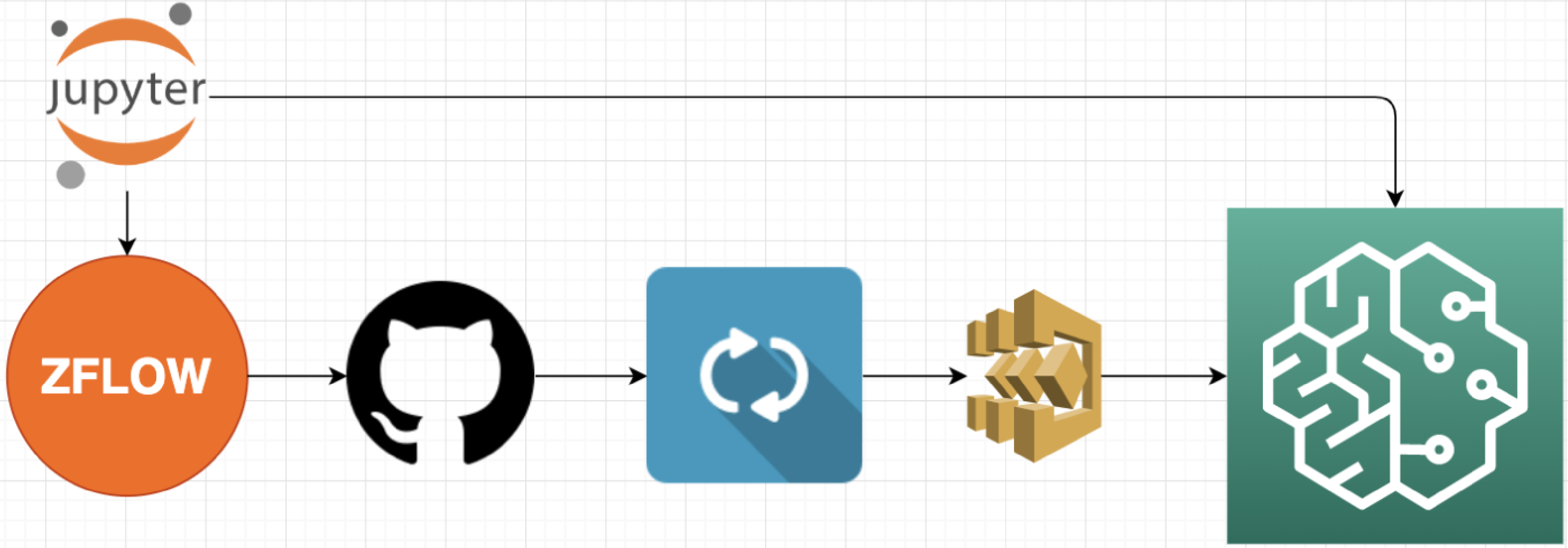
BATCH & APIs

In the same package. Easy to reason and deploy.

SCRIPT MODE

Easy to write quick TensorFlow scripts and tie in to pipelines

ZALANDO MACHINE LEARNING PLATFORM



ZFLOW

Zalando's pythonic interface to ML pipelines

STEP FUNCTIONS

To orchestrate pipelines

SAGEMAKER

The Core Engine

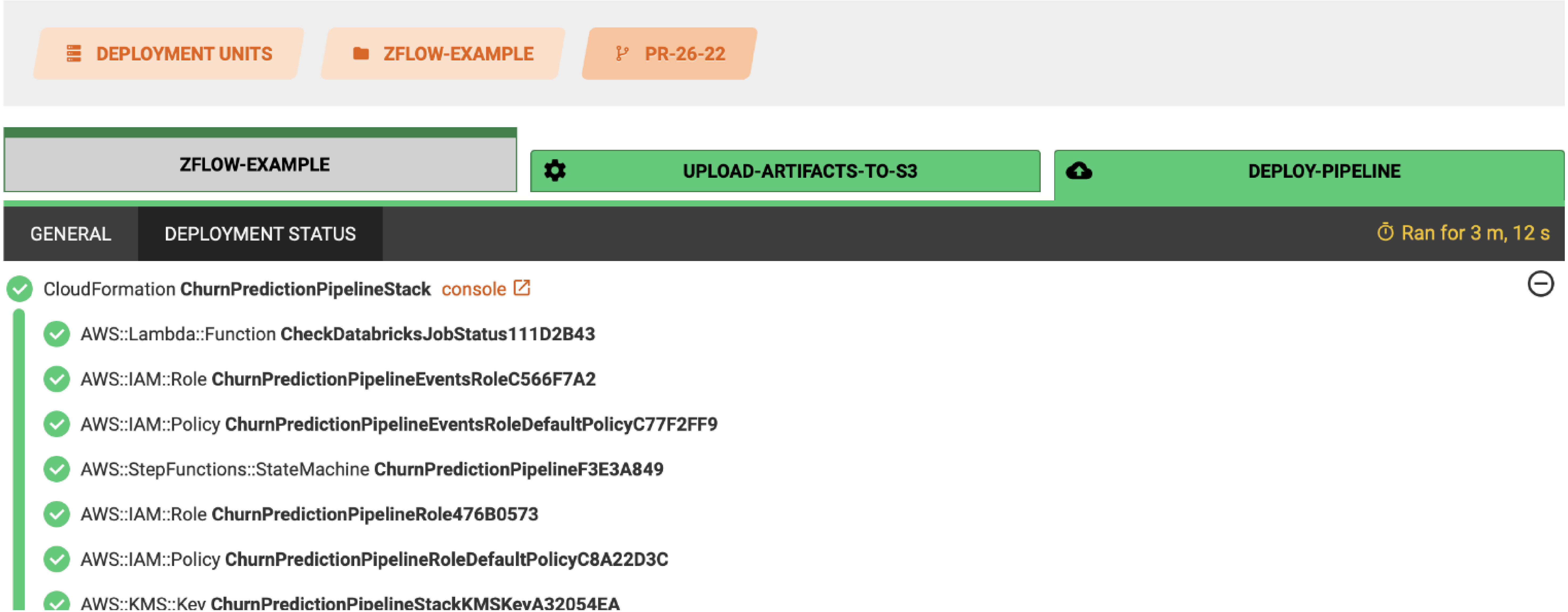
ZALANDO MACHINE LEARNING PLATFORM

```
training_stage = training_job(
    name=”...”,
    input_data_configs=”...”,
    hyperparameters=”...”
)

batch_transform_stage =
batch_transform_job(
    name=”...”,
    s3_input_path=”...”,
    s3_output_path=”...”
)
```

ZALANDO MACHINE LEARNING PLATFORM

```
pipeline = PipelineBuilder(“my_pipeline”)

pipeline
    .add_stage(data_processing_stage)
    .add_stage(training_stage)
    .add_stage(batch_transform_stage)
```

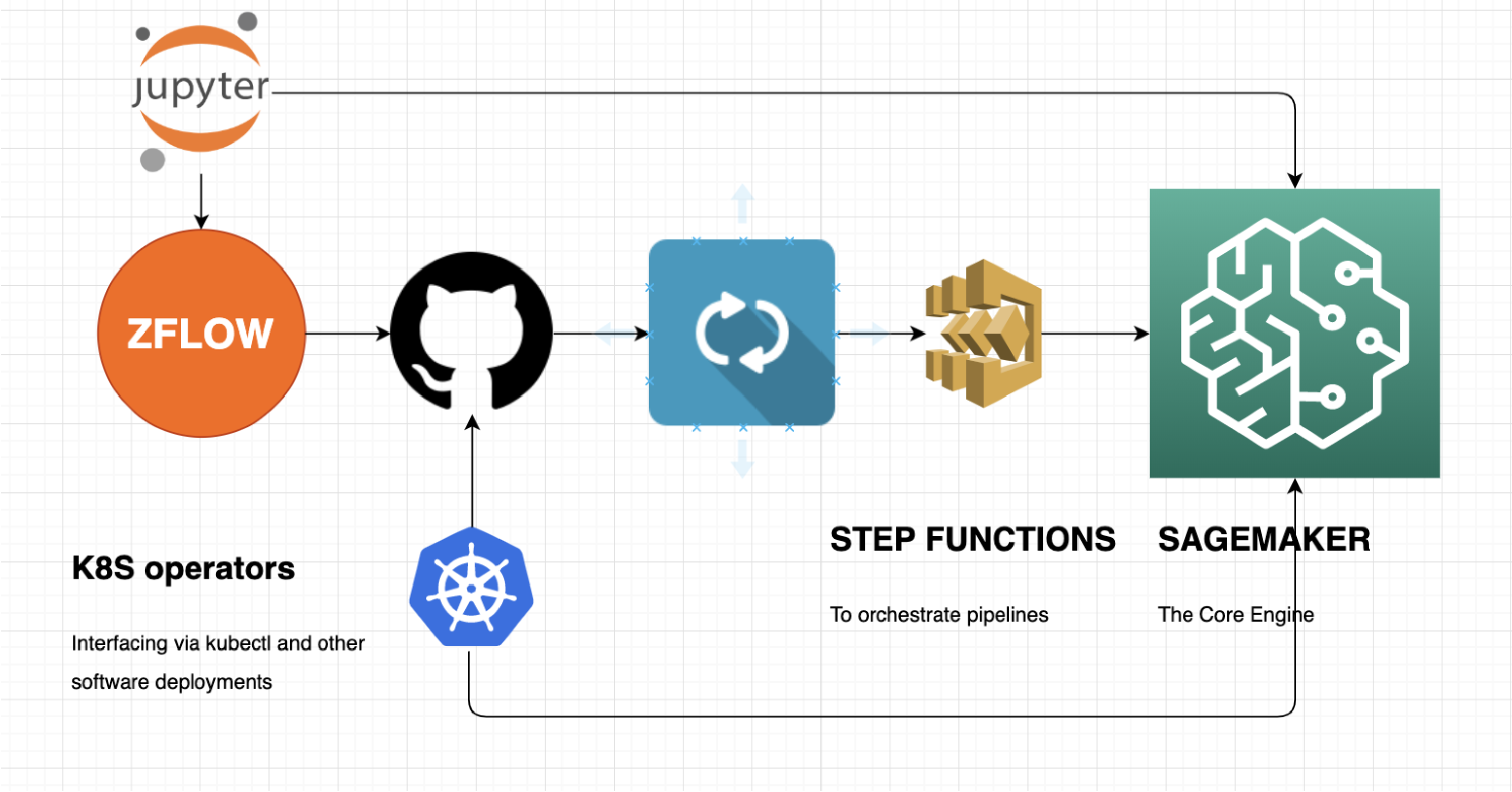
ZALANDO MACHINE LEARNING PLATFORM



✓ CloudFormation **ChurnPredictionPipelineStack** console

- ✓ AWS::Lambda::Function **CheckDatabricksJobStatus111D2B43**
- ✓ AWS::IAM::Role **ChurnPredictionPipelineEventsRoleC566F7A2**
- ✓ AWS::IAM::Policy **ChurnPredictionPipelineEventsRoleDefaultPolicyC77F2FF9**
- ✓ AWS::StepFunctions::StateMachine **ChurnPredictionPipelineF3E3A849**
- ✓ AWS::IAM::Role **ChurnPredictionPipelineRole476B0573**
- ✓ AWS::IAM::Policy **ChurnPredictionPipelineRoleDefaultPolicyC8A22D3C**
- ✓ AWS::KMS::Key **ChurnPredictionPipelineStackKMSKeyA32054EA**

UPCOMING



K8S operators

Interfacing via kubectl and other software deployments

STEP FUNCTIONS

To orchestrate pipelines

SAGEMAKER

The Core Engine

ZALANDO MACHINE LEARNING PLATFORM

```
apiVersion: sagemaker.aws.amazon.com/v1
kind: TrainingJob
metadata
    name: kmeans-mnist
spec
    algorithmSpecification
        trainingImage: .../kmeans:1
        trainingInputMode: File
        hyperParameters: ...
        inputDataConfig:
    resourceConfig
        instanceType: ml.c4.8xlarge
    ...
```

OVERCOMING THE CHALLENGES

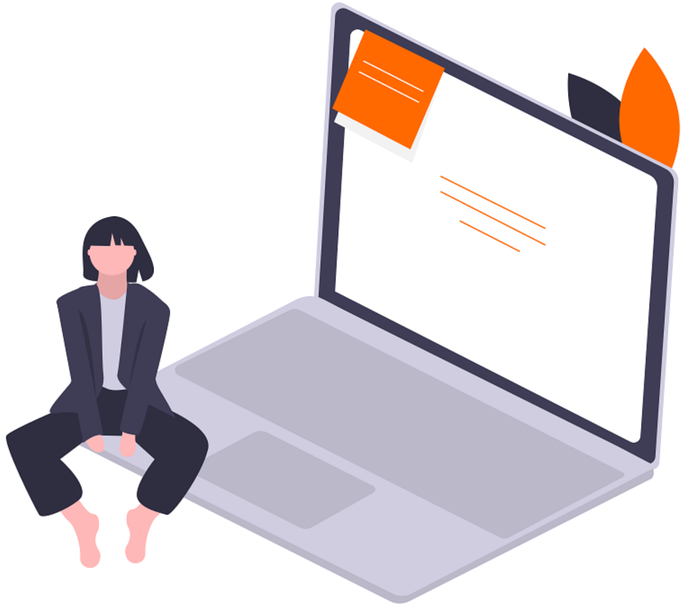
SPEED

Notebooks + consistent interfaces

OVERCOMING THE CHALLENGES

SPEED

Notebooks + consistent interfaces



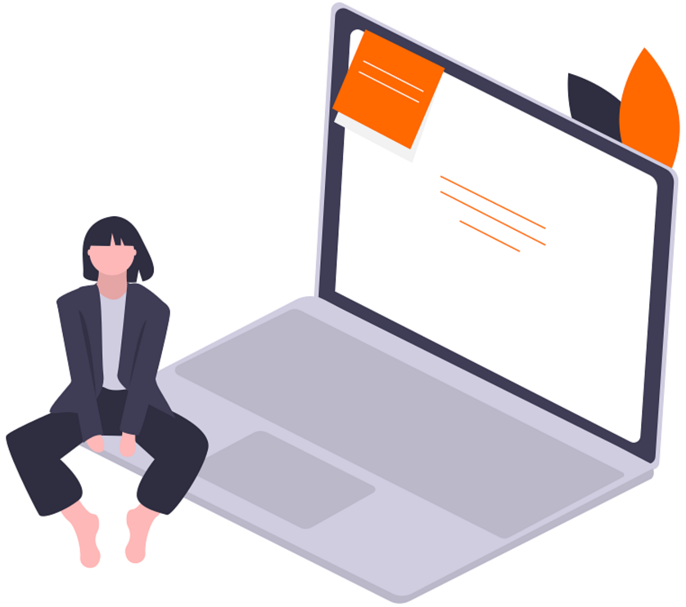
SAFETY

Amazon SageMaker training/scoring

OVERCOMING THE CHALLENGES

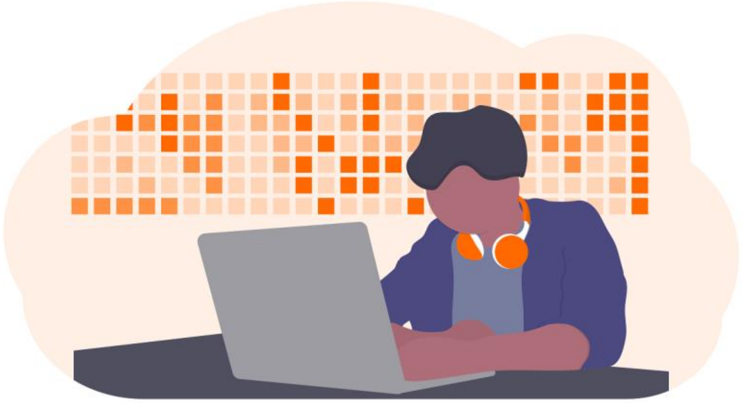
SPEED

Notebooks + consistent interfaces



SAFETY

Amazon SageMaker training/scoring



SCALE

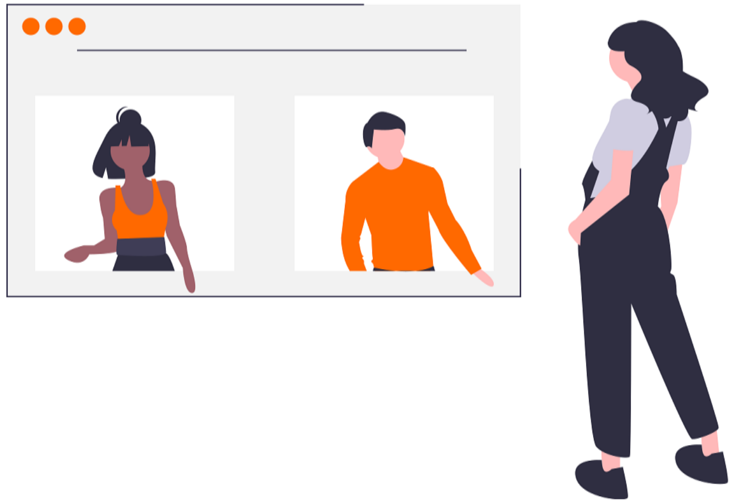
Amazon SageMaker training/scoring

OVERCOMING THE CHALLENGES

COST-EFFICIENCY

Amazon SageMaker training/scoring

OVERCOMING THE CHALLENGES



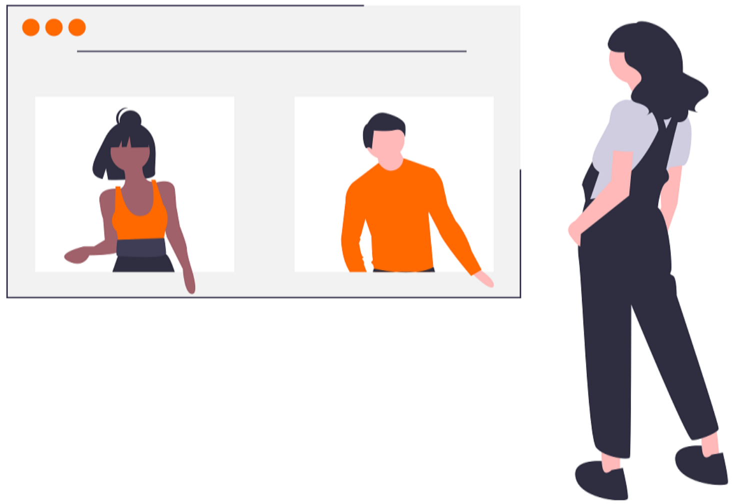
COST-EFFICIENCY
Amazon SageMaker
training/scoring

COLLABORATION
Consistent interfaces

OVERCOMING THE CHALLENGES

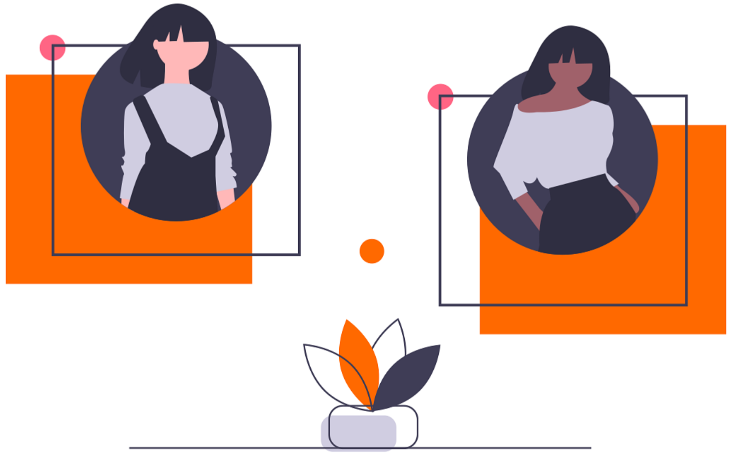
COST-EFFICIENCY

Amazon SageMaker training/scoring



COLLABORATION

Consistent interfaces



SATISFACTION

Central team support

Machine learning at scale offers exciting new opportunities for us to serve our customers better.

Demo

In summary

- Machine learning is a hard problem
- Amazon SageMaker simplifies ML with modern application architecture
- Kubernetes is great for large-scale container orchestration
- Amazon SageMaker and Kubernetes can provide greater benefits when combined

Thank you!

Please complete the session survey in the mobile app.

AWS re:Invent

aws