CISCO Live!

ALL IN

#CiscoLive

Getting Started with MLOps & Kubeflow

Flo Pachinger, Developer Advocate
@flopachinger
DEVNET-1623

Cisco Webex App

Questions?
Use Cisco Webex App to chat
with the speaker after the session

How

1. Find this session in the Cisco Live Mobile App
2. Click "Join the Discussion"
3. Install the Webex App or go directly to the Webex space
4. Enter messages/questions in the Webex space

Webex spaces will be moderated
by the speaker until June 17, 2022.

https://ciscolive.ciscoevents.com/ciscolivebot/#DEVNET-1623

3
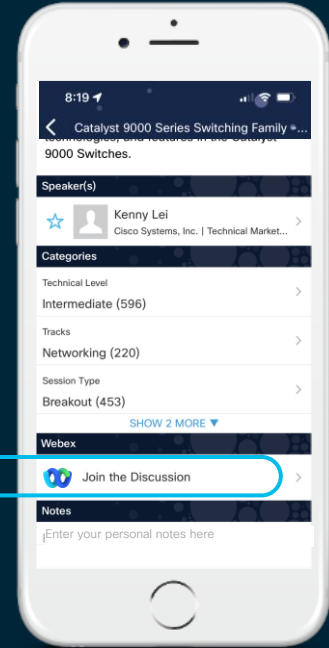
Slido

Agenda

- Machine Learning Nowadays
- How are these ML applications built?
- The Need for MLOps
- MLOps Ecosystem
- Kubeflow & Deployment with IKS
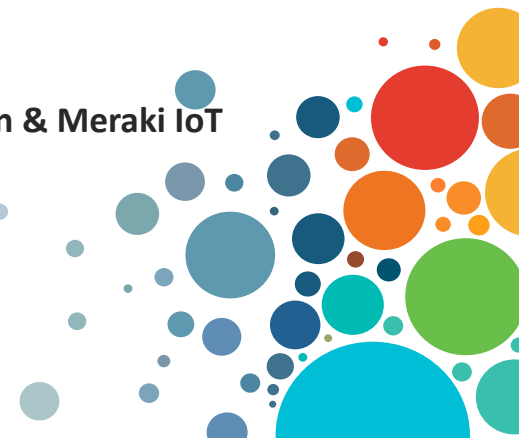- Conclusion

Flo Pachinger

Developer Advocate, Cisco Developer Relations

- Based in Vienna, Austria

- Software & Networking Background

- **DevNet Projects:**

  - **Smart Parking with LoRaWAN**

  - **Play Minecraft on Catalyst 9300 Switch**

  - **IT/OT Dashboard with Industrial Asset Vision & Meraki IoT**

  - **Creator of johann Network Monitoring Tool**

Machine Learning Nowadays

My Hamburgers

Cisco AI Network Analytics platform
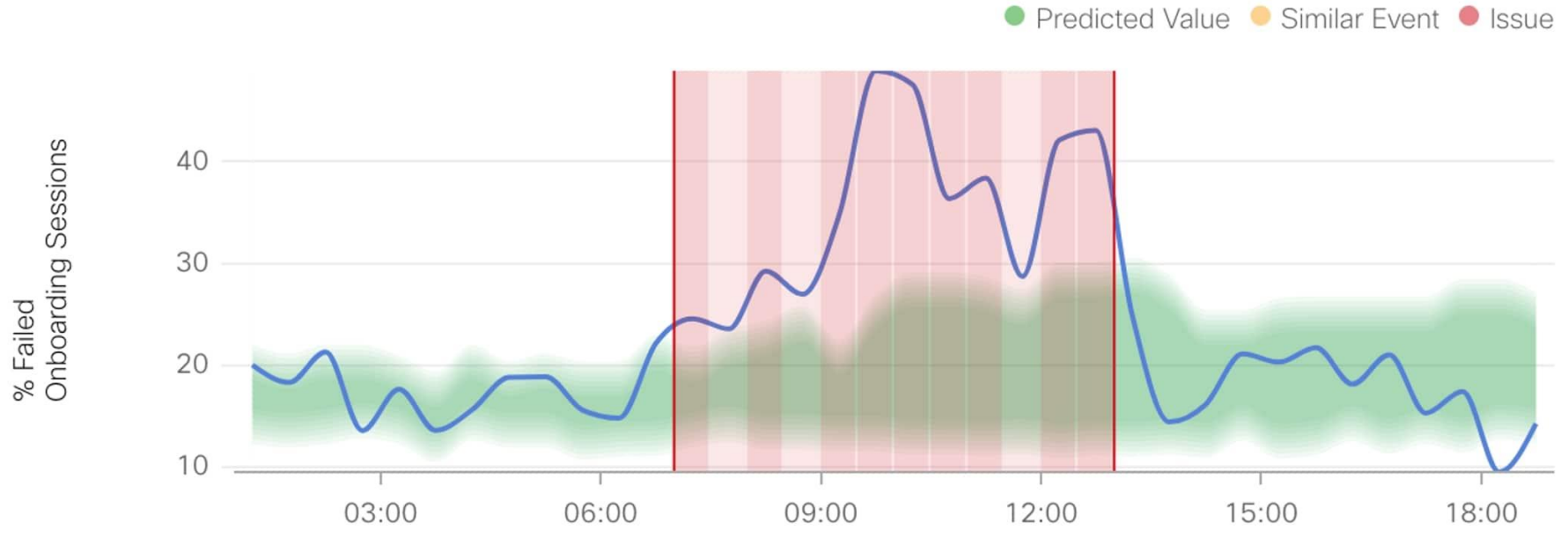
Webex Audio Intelligence

Webex Bots

Cisco Secure Network Analytics (Stealthwatch)

Figure 2. Anomaly detection using behavioral modeling

Collect and analyse telemetry

Comprehensive data set optimized to remove redundancies

Flows

Create a baseline of normal behavior

Security events to detect anomalies and known bad behavior

Security Observations		
Number of concurrent flows	New flows created	Number of SYNs received
Packet per second	Number of SYNs sent	Rate of connection resets
Bits per second	Time of day	Duration of the flow

Alarm on anomalies and behavioral changes

Alarm categories for high-risk, low-noise alerts for faster response

Anomaly detected in host behavior

Threshold

Exchange Servers

ML Model

ML Prep + Training

How are these ML applications built?

To understand MLOps, you need to understand how ML applications are built.

Example: Hand-written Digits Recognizer

- Detect hand-written digits

- Pre-existing Dataset - "Hello World" of Machine Learning

- Comparable with any other ML project
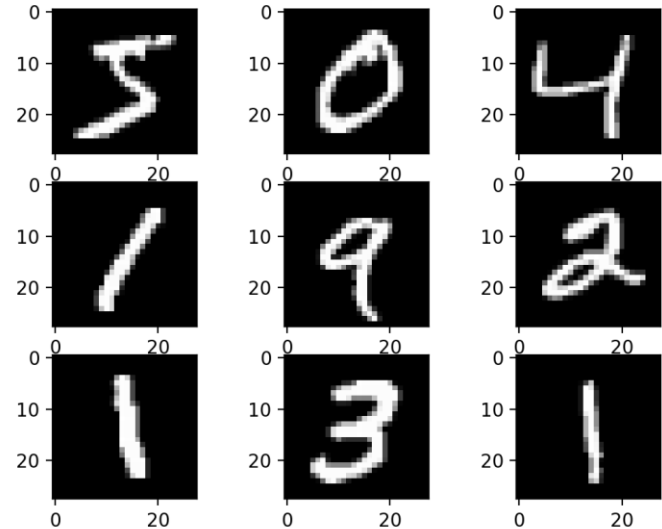
Image = Collection of Numbers
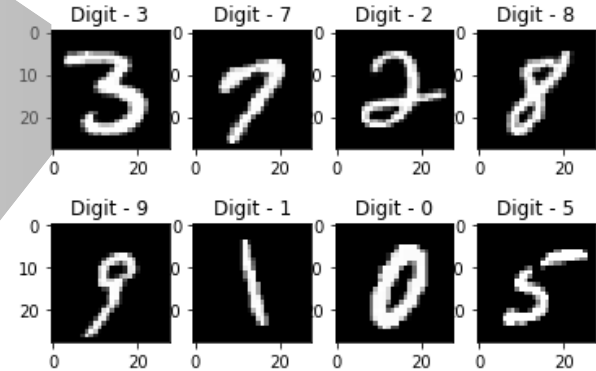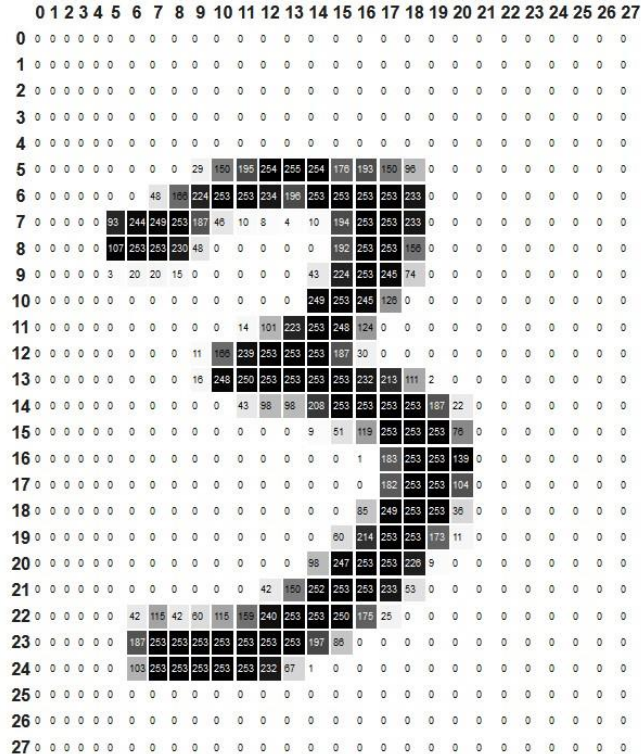
1. Data Sourcing

- Getting hand-written images

- Try out various data sources – be creative!

Data Sourcing

2. Data Management

- Pre-process images

- Label images

- Define features which are necessary

Data Management

That's a 0: That's 0: That's 0: ...

3. ML-Model Development

ML-Model Development

- What is the goal? Talk to domain-experts
- Select Algorithms
- Select ML Framework
- Select Hardware (GPUs) & Software components

Convolutional neural network

INPUT 32x32

C1: feature maps 6@28x28

C3: f. maps 16@10x10

S2: f. maps 6@14x14

S4: f. maps 16@5x5

C5: layer 120

F6: layer 84

OUTPUT 10

Convolutions   Subsampling   Convolutions   Subsampling   Full connection   Full connection   Gaussian connections
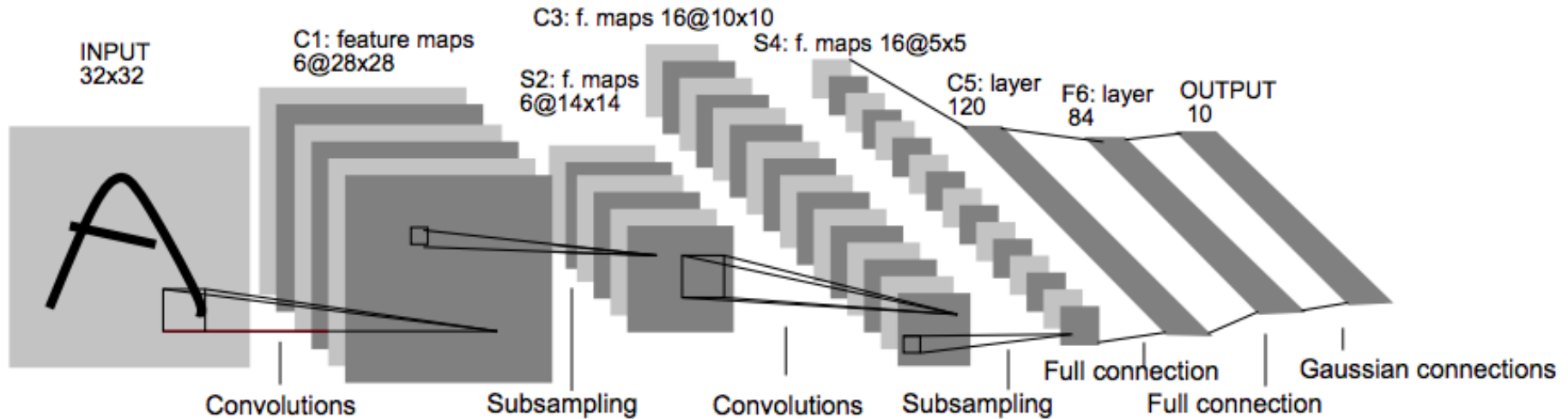
4. Application / Model Management

- Create the application or implement the feature
- Define model serving

Application

Application Overview
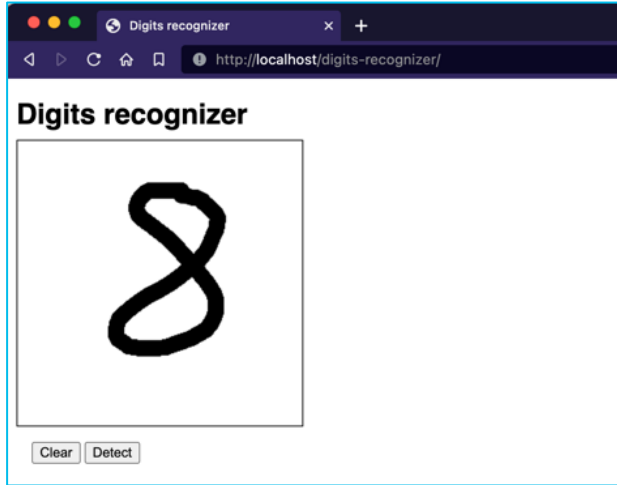
REST API

ML Model Inference Server

Model Training

Good, for testing. Would you want to push this to production?

The Need for MLOps

ML Lifecycle Components

Data Storage	Hardware & Workload Management	ML Framework	ML Workflow
Data Pipeline	Feature Engineering	ML Code	Model & Experiment Management
Data Verification	Configuration	Logging & Monitoring	Serving Infrastructure
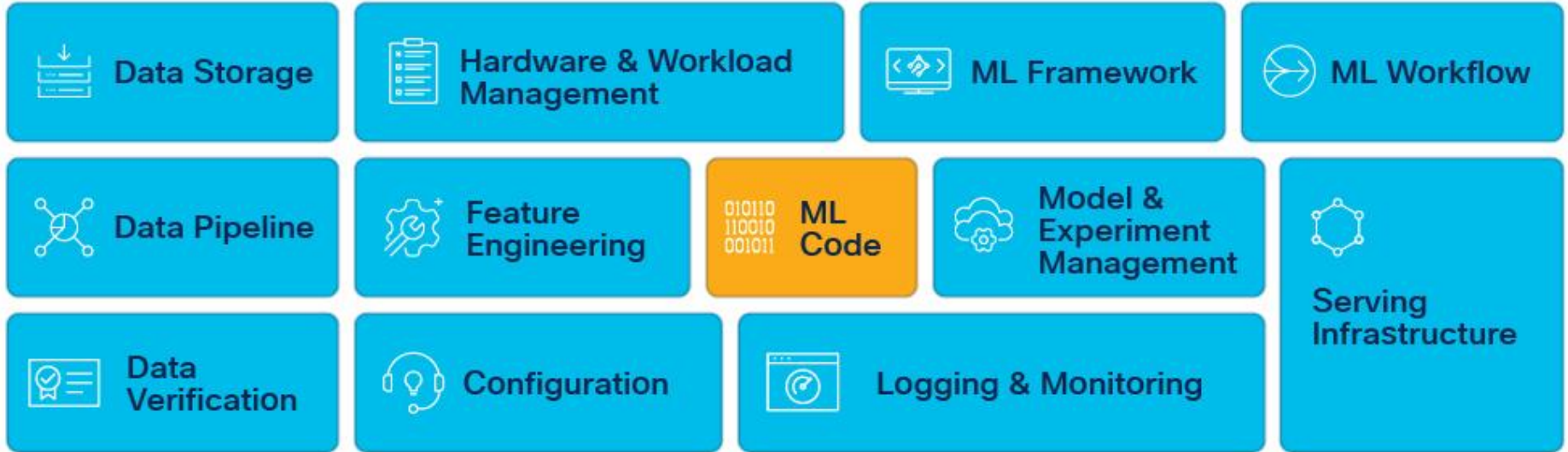
Data scientists spend around 45% of their time on data management tasks:

Pie chart:
- Data Loading — 19%
- Data Cleansing — 26%
- Data Visualization — 21%
- Model Selection — 11%
- Model Training and Scoring — 12%
- (red) — 11%
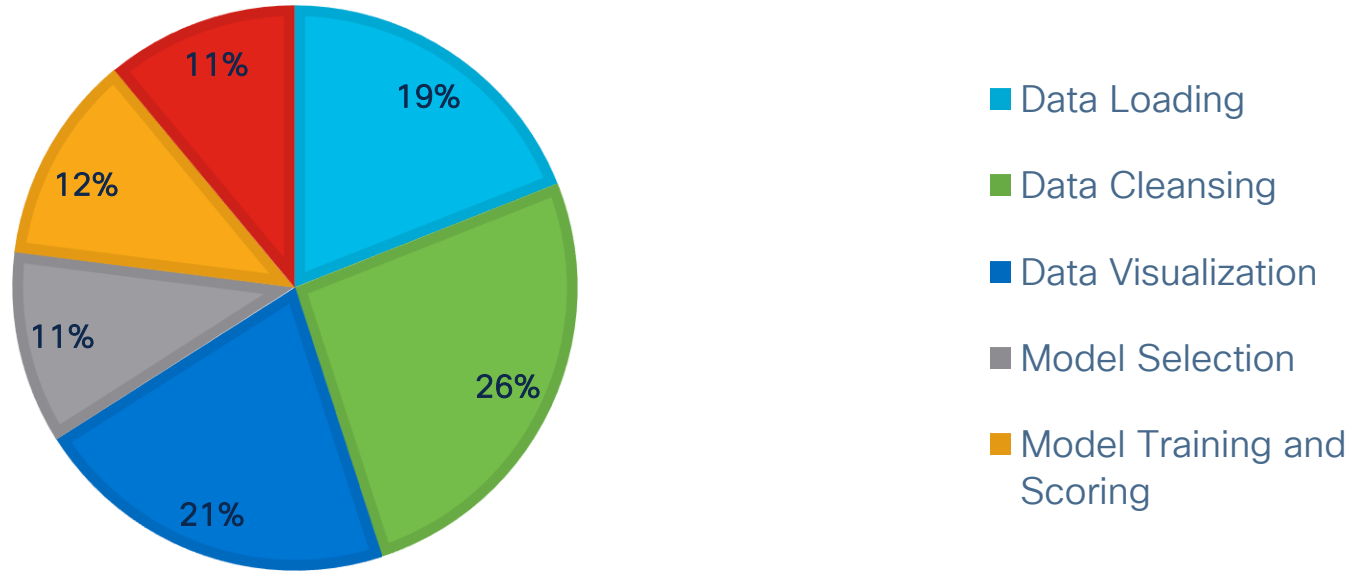
A lot of companies are stuck in the pilot stage:

"36% of respondents said that ML algorithms had been deployed beyond the pilot stage"[1]

1 Mckinsey Global Survey: https://www.mckinsey.com/business-functions/operations/our-insights/the-imperatives-for-automation-success

DevOps

DevOps is a set of practices that combines software development (Dev) and IT operations (Ops).

MLOps

MLOps is a set of practices that combines data and machine learning engineering (ML), IT operations (Ops) and Software Development.

How can we enhance our ML application using DevOps principles?

1. Data Sourcing

Data Sourcing

Streaming

Sourcing

Ingestion

- Automate data ingestion into a centralized database / object storage.

- Add a dataset versioning tool

- Check if there are 3rd party datasets out there

2. Data Management

Data Management
Validation
Analysis
Segmentation
Feature Engineering

- Provide a collaboration tool data scientists
- Set up a framework for out-of-the-box data analysis tools

- MNIST handwritten digits dataset:
  - training set: 60.000 images
  - test set: 10.000 images

3. ML-Model Development

ML-Model Development

Building

Training

Evaluation

Versioning + Metadata

- Standardize frameworks usage within the organization

- Add a model management solution for model versioning and performance measuring

- Be aware that data may change

- Scale out if ML training process requires it

4. Application / Model Management

Application
Model Deployment
Model Monitoring
Serving API/UI
Load Balancing

- Implement a CI/CD pipeline to automatically push the model from testing to production

- Implement model monitoring to check performance

- Add a load balancer

ML Lifecycle Process

feeding data

Data Sourcing
- Streaming
- Sourcing
- Ingestion

Data Management
- Validation
- Analysis
- Segmentation
- Feature Engineering

ML-Model Development
- Building
- Training
- Evaluation
- Versioning + Metadata

Application
- Model Deployment
- Model Monitoring
- Serving API/UI
- Load Balancing

feeding new data back

Infrastructure

| Configuration | Containerization | Logging + Monitoring | CI/CD pipelines | Authentication | Hardware/GPUs |

MLOps Ecosystem & Kubeflow

Linux Foundation AI & Data Landscape

1.0

See the interactive landscape at l.lfaidata.foundation

Greyed logos are not open source

MLOps Tools Examples

- Infrastructure: Kubernetes/Cisco IKS

- Data Streaming: Apache Kafka

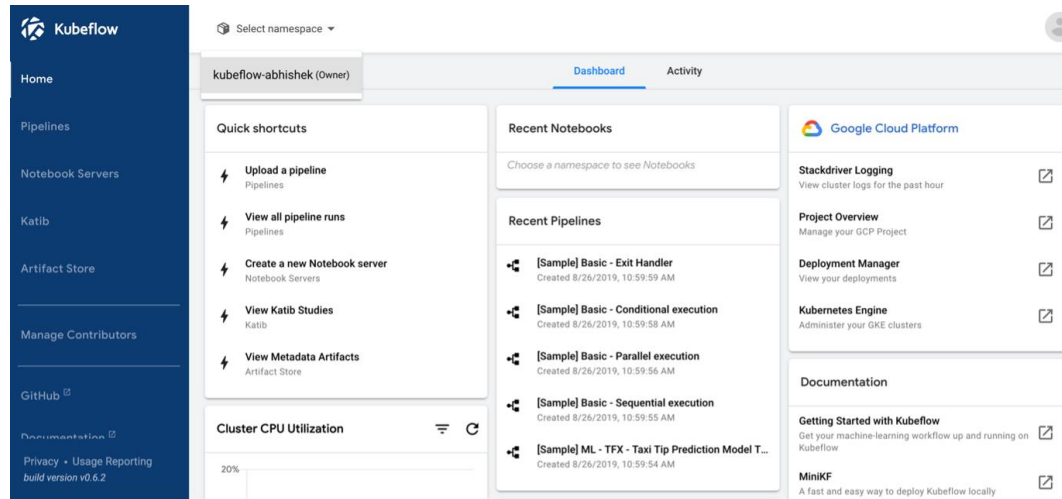- Data Version Control: Pachyderm

- ML Model Framework: Tensorflow, PyTorch

- Notebooks/Collab: Jupyter Notebooks

- Model Serving: Kserve

Kubeflow

- open source machine learning framework which orchestrates and automates machine learning workflows

- Runs on Kubernetes

Most Popular Kubeflow Components

- **Kubeflow Notebooks**: web-based development environments such as JupyterLab

- **Kubeflow Pipelines**: most-used component of Kubeflow. Create for every step or function in your ML project a reusable containerized pipeline components which can be chained together as a ML pipeline.

- **Katib**: This component is used for automated machine learning (AutoML)

- **Kserve** (previously KFServing): Kserve is used for model serving.

kubectl get pods –n kubeflow

```
kubeflow          admission-webhook-deployment-7df7558c67-d7mfm              1/1
kubeflow          cache-deployer-deployment-6f4bcc969-zh9vx                  2/2
kubeflow          cache-server-575d97c95-jc4nw                               2/2
kubeflow          centraldashboard-79f489b55-cr7hn                           2/2
kubeflow          jupyter-web-app-deployment-5886974887-m96wv                1/1
kubeflow          katib-controller-58ddb4b856-9zjtj                          1/1
kubeflow          katib-db-manager-d77c6757f-jt9b6                           1/1
kubeflow          katib-mysql-7894994f88-zzwrz                               1/1
kubeflow          katib-ui-f787b9d88-cwg9l                                   1/1
kubeflow          kfserving-controller-manager-0                             2/2
kubeflow          kfserving-models-web-app-7884f597cf-8vg4b                  2/2
kubeflow          kserve-models-web-app-5c64c8d8bb-sqtzs                     2/2
kubeflow          kubeflow-pipelines-profile-controller-84bcbdb899-rddgd     1/1
kubeflow          metacontroller-0                                           1/1
kubeflow          metadata-envoy-deployment-7b847ff6c5-cqvkw                 1/1
kubeflow          metadata-grpc-deployment-f8d68f687-kqlgq                   2/2
kubeflow          metadata-writer-78fc7d5bb8-t5xp7                           2/2
kubeflow          minio-5b65df66c9-sx8kb                                     2/2
kubeflow          ml-pipeline-7bb5966955-87jbv                               2/2
kubeflow          ml-pipeline-persistenceagent-87b6888c4-n9tgd               2/2
kubeflow          ml-pipeline-scheduledworkflow-665847bb9-2mpz6              2/2
kubeflow          ml-pipeline-ui-554ffbd6cd-8sswm                            2/2
kubeflow          ml-pipeline-viewer-crd-68777557fb-k65lr                    2/2
kubeflow          ml-pipeline-visualizationserver-66c54744c-cp2np            2/2
kubeflow          mysql-f7b9b7dd4-56gjd                                      2/2
kubeflow          notebook-controller-deployment-7474fbff66-26fzm            2/2
kubeflow          profiles-deployment-5cc86bc965-vjfv6                       3/3
kubeflow          tensorboard-controller-controller-manager-5cbddb7fb5-cglzr 3/3
kubeflow          tensorboards-web-app-deployment-7c5db448d7-84pjw           1/1
kubeflow          training-operator-6bfc7b8d86-l59l8                         1/1
kubeflow          volumes-web-app-deployment-87484c848-rl4rl                 1/1
kubeflow          workflow-controller-5cb67bb9db-7bfqc                       2/2
```
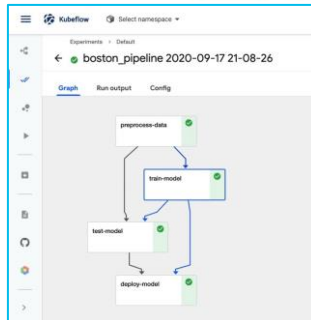
Data & Model Storage

Jupyter Notebooks

Kubeflow Pipelines
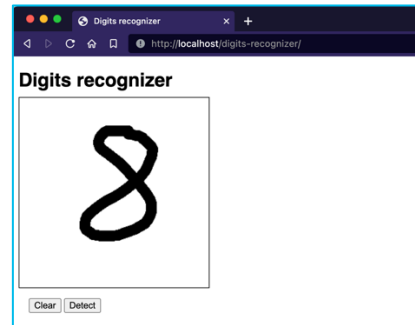
KServe

Model Inference

Cisco Intersight Kubernetes Cluster

When to not use Kubeflow?

- Target audience: ML teams who are building large-scale ML applications
  - How many users will be served? How large is the data input? How often new data will arrive and be added to the training set?

- Bring out your Kubernetes skills!

- Documentation can be better ☺

    48

Conclusion

- Don't focus ONLY on your ML model! There are many other components as well

- Have a framework ready and try to automate as much as possible

- Leverage on-prem and Cloud Workloads using Cisco Intersight Kubernetes Service

Technical Session Surveys

- Attendees who fill out a minimum of four session surveys and the overall event survey will get Cisco Live branded socks!

- Attendees will also earn 100 points in the Cisco Live Game for every survey completed.

- These points help you get on the leaderboard and increase your chances of winning daily and grand prizes.

Cisco Learning and Certifications

From technology training and team development to Cisco certifications and learning plans, let us help you empower your business and career. www.cisco.com/go/certs

Pay for Learning with Cisco Learning Credits

(CLCs) are prepaid training vouchers redeemed directly with Cisco.

Learn

Cisco U.
IT learning hub that guides teams and learners toward their goals

Cisco Digital Learning
Subscription-based product, technology, and certification training

Cisco Modeling Labs
Network simulation platform for design, testing, and troubleshooting

Cisco Learning Network
Resource community portal for certifications and learning

Train

Cisco Training Bootcamps
Intensive team & individual automation and technology training programs

Cisco Learning Partner Program
Authorized training partners supporting Cisco technology and career certifications

Cisco Instructor-led and Virtual Instructor-led training
Accelerated curriculum of product, technology, and certification courses

Certify

Cisco Certifications and Specialist Certifications
Award-winning certification program empowers students and IT Professionals to advance their technical careers

Cisco Guided Study Groups
180-day certification prep program with learning and support

Cisco Continuing Education Program
Recertification training options for Cisco certified individuals

Here at the event? Visit us at The Learning and Certifications lounge at the World of Solutions

Continue your education

- Visit the Cisco Showcase for related demos

- Book your one-on-one Meet the Engineer meeting

- Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs

- Visit the On-Demand Library for more sessions at www.CiscoLive.com/on-demand

CISCO Live!

CISCO Live!

ALL IN

#CiscoLive