

# Applying AI Model Management on the CSC's AIoT Platform

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# OUTLINE

□ **Introduction** – Importance of managing AI models

□ **Methods** – The design of AI model operations

□ **Results** – An AI model for predicting soaking time

□ **Discussion** – Improvements & Feedback

□ **Summary** – Operationalizing more AI models



An illustration of two hands, one at the top and one at the bottom, holding a large white scroll. The hands are rendered in a simple, stylized manner with orange and tan colors. The scroll is unrolled, revealing the text in the center. The background is a light blue gradient with faint white lines.

# 1. Introduction

**Importance of managing AI models**

# Efforts on Creating AI Models

- The **foundation** of smart manufacturing solutions for solving specific production problems
- Require **significant efforts** for developing intelligent applications (Hechler, Oberhofer, & Schaeck, 2020)
  - Well-preserved data
  - Resource-intensive tasks
- Next, **deploy** the created AI models and **manage** real-time inference requests

# Data / AI Model Drift

- However, **data/AI model drift** inevitably occurs along with the changes in production
- **Affect performance** over time
  - Accuracy
  - Reliability
- **Proper maintenance helps the online AI models**
  - **Function normally** and contribute to effective production processes
  - **Without deteriorating** by accumulated biases

# The Practice of CSC

- Construct the CSC's **AIoT platform**
  - Hyper-converged infrastructure (HCI)
  - The central hub of intelligent manufacturing solutions
- **Apply AI model management**
  - **Quality monitoring mechanism**
    - Beneficial to form the foundation of trustworthy AI with open data, processes, and algorithms (Janssen, Brous, Estevez, Barbosa, & Janowski, 2020)
  - **Suitable management approach** for the increasing intelligent applications (Gartner, 2021)
    - such as XOps (DataOps, MLOps, ModelOps, etc.)

An illustration of a hand holding a scroll. The hand is light orange with a darker orange shadow. The scroll is white with a blue ribbon running through it. The background is a light blue gradient with white lines.

## 2. Methods

**The design of AI model operations**



# The CSC's Procedure for Developing Intelligent Applications

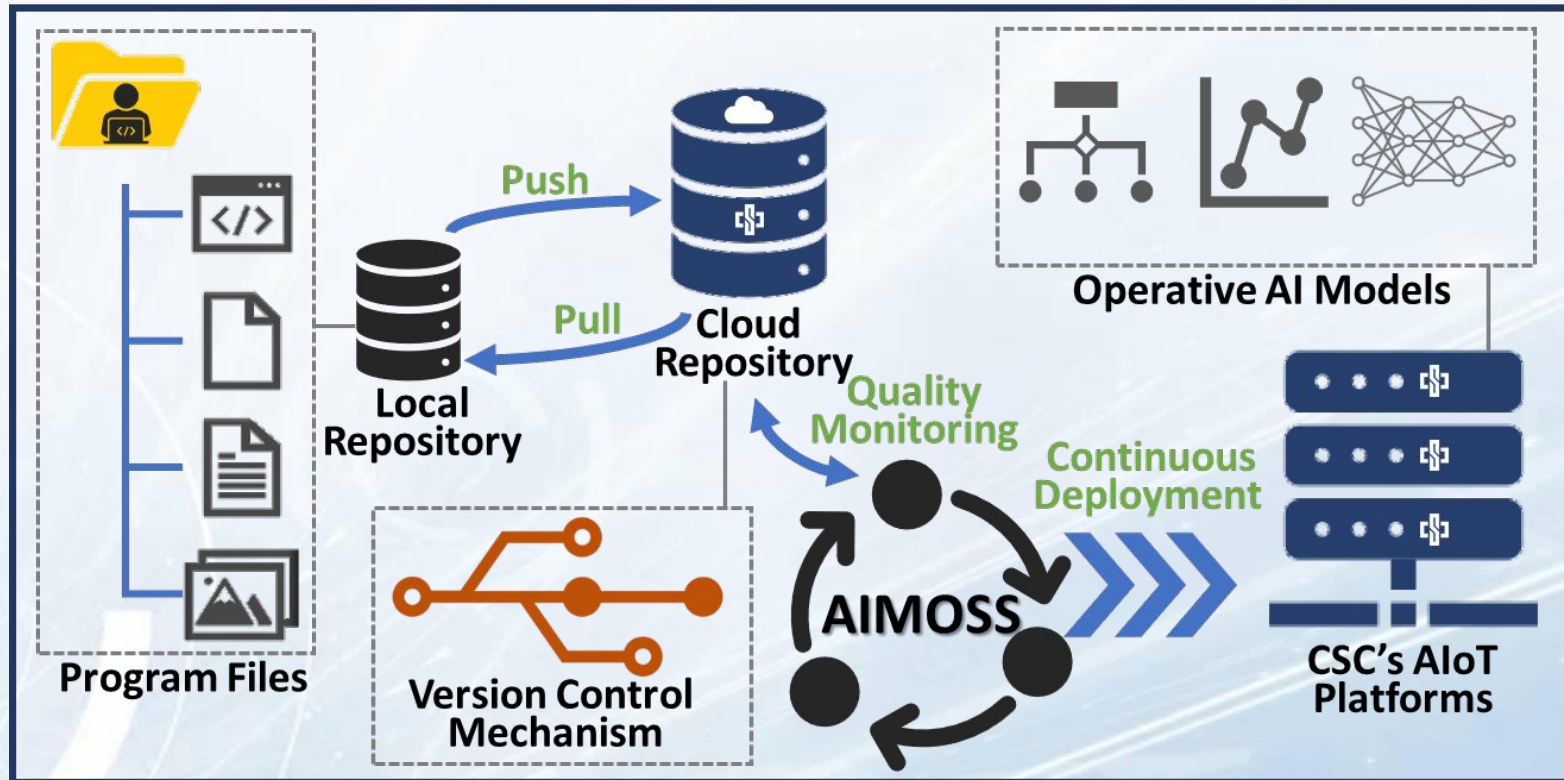


- Learns from the experience and defines the five steps
- Focuses on **the last two steps** for **ModelOps**



# AIMOSS

## AI Model Operationalization Support System



- Operationalizing AI models on the **CSC's AIoT platform** is based on **continuous deployment** and **model management**
- Specifically designed and implemented to meet CSC's demands

# Continuous Deployment

- How to manage various intelligent applications in a production field?
  - Especially when operation engineers take over the upcoming deployable AI models
- **Source code management (SCM) mechanism**
  - **Easily switch** in between different versions of a deployed AI model
  - **Automatically switching** without being intervened by operation engineers

# The Configuration and Versions of an AI Model Operation

```

image: $CI_REGISTRY/docker:19.03.12
services:
  - name: $CI_REGISTRY/docker:19.03.12-dind
    alias: docker
stages:
  - build
  - prod-deploy

variables:
  W2_HUB: "w2-hub:5000"
  W3_HUB: "w3-hub:5000"
  Y4_HUB: "y4-hub:5000"
  Y5_HUB: "y5-hub:5000"
  PUSH_REGISTRY: "${Y5_HUB}"
  # PUSH_REGISTRY: "${CI_REGISTRY}"

IMAGE_TAG="${PUSH_REGISTRY}/${CI_PROJECT_PATH}:${CI_COMMIT_REF_SLUG}"
CONTAINER_RELEASE_IMAGE: "${PUSH_REGISTRY}/${CI_PROJECT_PATH}:latest"

before_script:
  - echo CI_COMMIT_SLUG="${CI_COMMIT_REF_SLUG}"
  - echo CI_COMMIT_TAG="${CI_COMMIT_TAG}"
  - echo CI_COMMIT_SHA="${CI_COMMIT_SHA}"
  - if [ "${CI_COMMIT_TAG}" != "null" ]; then
    tag="${CI_COMMIT_TAG}"
  fi
  - IMAGE_TAG="${PUSH_REGISTRY}/${CI_PROJECT_PATH}:${tag}"
  - echo IMAGE_TAG=${IMAGE_TAG}

build:
  stage: build
  script:
    - docker build -t $IMAGE_TAG .
    - docker push $IMAGE_TAG

prod-deploy:
  stage: prod-deploy
  script:
    - docker tag $IMAGE_TAG $CONTAINER_RELEASE_IMAGE
    - docker push $CONTAINER_RELEASE_IMAGE
  when: manual

workflow:
  rules:
    - if: '$CI_PIPELINE_SOURCE == "push"'
      when: never # Prevent pipeline run for push event
    - when: always # Run pipeline for all other cases
  
```

**Configurations**

Home / y6p4/baf\_hd

### Tags

Repository  
Y5 glai-hub:5000 with http:y6p4/baf\_hd

Id	Tag	Created	Layers	Size	Delete
f4a639bd71e	latest	1 day ago	29	1.2 GB	Delete
f4a639bd71e	V1.0.19	1 day ago	29	1.2 GB	Delete
9041fe50247	V1.0.18	5 days ago	29	1.2 GB	Delete
cf9a1711636	V1.0.17	5 days ago	29	1.2 GB	Delete

**Versions**

y6p4 > BAF\_HD

**B** BAF\_HD   
Project ID: S

<- 31 Commits 1 Branch 18 Tags 266 KB Files 678 KB Storage

DEMO BAF\_HD

main baf\_hd / +

Switch branch/tag

Search branches and tags

Branches

- main

Tags

Tag	Last update
V1.0.19	1 day ago
V1.0.18	1 month ago
V1.0.17	1 month ago
V1.0.16	1 month ago

Dockerfile DEMO 3 weeks ago

README.md Initial commit 1 month ago

requirements.txt TEST CI& CD 1 month ago

**Source Code Management**

# Model Management

- How to manage outdated AI model and replace it?
  - With another retrained AI model when operation engineers maintain the existing online AI models
- Monitors the quality and performance of AI models

Component	Description
1. Predicting	Services for providing prediction results of the online AI models
2. Validating	Quality monitoring by automatically validating the online AI models
3. Retraining	Model drift correction by automatically retraining the online AI models



# 3. Results

**An AI model for predicting soaking time**

# A Pilot Case

- To **evaluate** the effectiveness of the AIMOSS
- The selected AI model was designed to provide **predictions of soaking time** in a batch annealing furnace (BAF)
  - A heat treatment for cold-rolled steel coils to **relieve mechanical stress** and **achieve specific mechanical properties**
  - Production engineers **adjust production parameters** for meeting customers' requirements

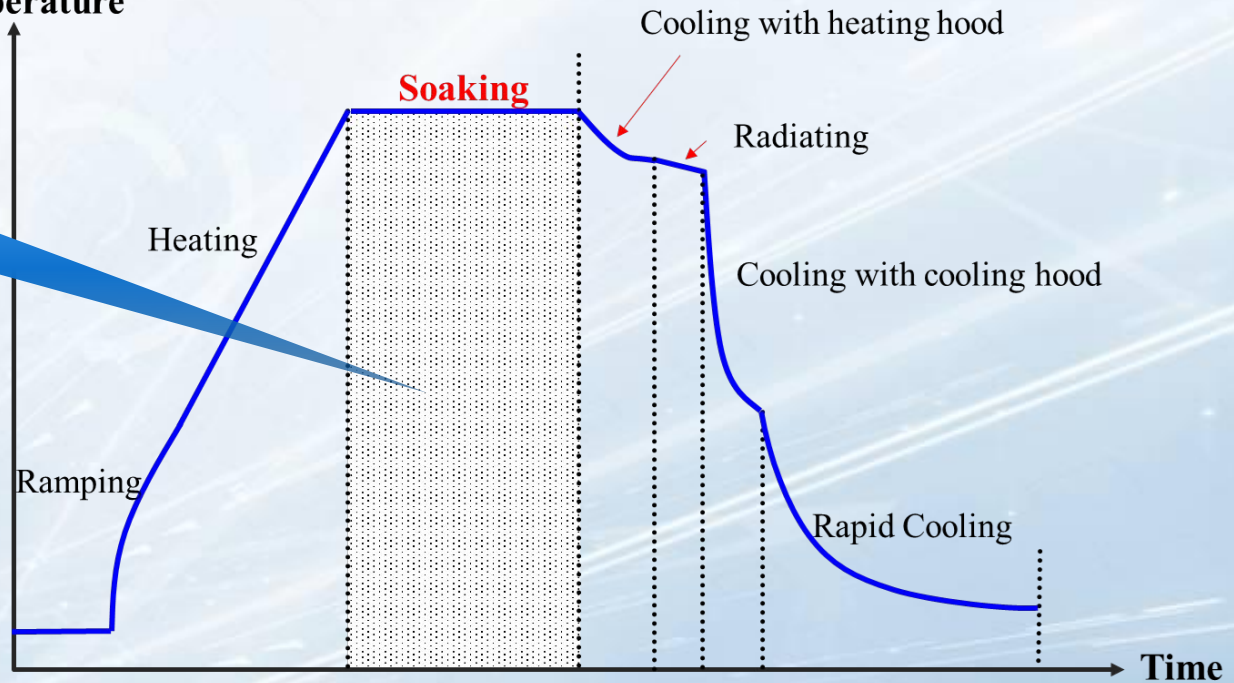


# Predictions of soaking time in a batch annealing furnace



Furnace  
Temperature

Predictions



# AI model operationalization

# Build Pipelines

## ● Input data

- IoT devices
- Databases across various production fields

## ● Target mechanical properties

- Hardness
- Yield Strength

## ● The AIMOSS automatically

- Prepares the corresponding **runtime environment image**
- Creates a **container** on the CSC's AIoT platform

The screenshot displays a web interface for managing pipelines. At the top, there are tabs for 'All' (28), 'Finished', 'Branches', and 'Tags'. A search bar labeled 'Filter pipelines' is present. Below this is a table with columns for 'Status', 'Pipeline', 'Trigger', and 'Stages'. The table lists several pipelines, each with a 'passed' status, a name (e.g., '#update'), a version (e.g., 'v1.0.20'), and a commit hash (e.g., '0bf2b8ce'). The most recent pipeline is highlighted with a green 'latest' badge. The interface also shows a 'Clear runner caches' button and a 'Run pipeline' button.

Status	Pipeline	Trigger	Stages
passed	#update		
00:01:15	#278 v1.0.20		
3 weeks ago	latest		
passed	Update		
00:01:23	#143 v1.0.19		
1 month ago	latest		

# AI model operationalization

# Predicting

Logs: predict-test Connected

*ProTip: Hold the Control key when opening logs to launch a new window.*

```
2022/6/27 上午9:40:22 Download File Success!
2022/6/27 上午9:40:22 *get* '220-FileZilla Server 1.3.0\n'
2022/6/27 上午9:40:22 *get* '220 Please visit https://filezilla-project.org/\n'
2022/6/27 上午9:40:22 *resp* '220-FileZilla Server 1.3.0\n220 Please visit https://filezilla-project.org/'
2022/6/27 上午9:40:22 *cmd* 'USER icsc'
2022/6/27 上午9:40:22 *put* 'USER icsc\r\n'
2022/6/27 上午9:40:22 *get* '331 Please, specify the password.\n'
2022/6/27 上午9:40:22 *resp* '331 Please, specify the password.'
2022/6/27 上午9:40:22 *cmd* 'PASS ****'
2022/6/27 上午9:40:22 *put* 'PASS ****\r\n'
2022/6/27 上午9:40:22 *get* '230 Login successful.\n'
2022/6/27 上午9:40:22 *resp* '230 Login successful.'
2022/6/27 上午9:40:22 *cmd* 'CMD BA_System/'
2022/6/27 上午9:40:22 *put* 'CMD BA_System\r\n'
2022/6/27 上午9:40:22 *get* '250 CMD command successful\n'
2022/6/27 上午9:40:22 *resp* '250 CMD command successful'
2022/6/27 上午9:40:22 *cmd* 'TYPE I'
2022/6/27 上午9:40:22 *put* 'TYPE I\r\n'
2022/6/27 上午9:40:22 *get* '200 Type set to I\n'
2022/6/27 上午9:40:22 *resp* '200 Type set to I'
2022/6/27 上午9:40:22 *cmd* 'PASV'
2022/6/27 上午9:40:22 *put* 'PASV\r\n'
2022/6/27 上午9:40:22 *get* '227 Entering Passive Mode (172,24,26,13,254,221)\n'
2022/6/27 上午9:40:22 *resp* '227 Entering Passive Mode (172,24,26,13,254,221)'
2022/6/27 上午9:40:22 *cmd* 'STOR Prediction.csv'
2022/6/27 上午9:40:22 *put* 'STOR Prediction.csv\r\n'
2022/6/27 上午9:40:22 *get* '150 Starting data transfer.\n'
2022/6/27 上午9:40:22 *resp* '150 Starting data transfer.'
2022/6/27 上午9:40:22 *get* '226 Operation successful\n'
2022/6/27 上午9:40:22 *resp* '226 Operation successful'
Upload File Success!
2022/6/27 上午9:40:22 {"coilID":{"0":5052415,"1":5055858,"2":5056726},"c":{"0":0.04,"1":0.05,"2":0.09},"si":{"0":0.01,"1":0.0,"2":0.01},"mn":{"0":0.25,"1":0.22,"2":0.4},"p":{"0":0.017,"1":0.009,"2":0.018},"s":{"0
2022/6/27 上午9:40:22 [27/Jun/2022 09:40:22] "POST /bda/predict/ HTTP/1.1" 200 1139
```

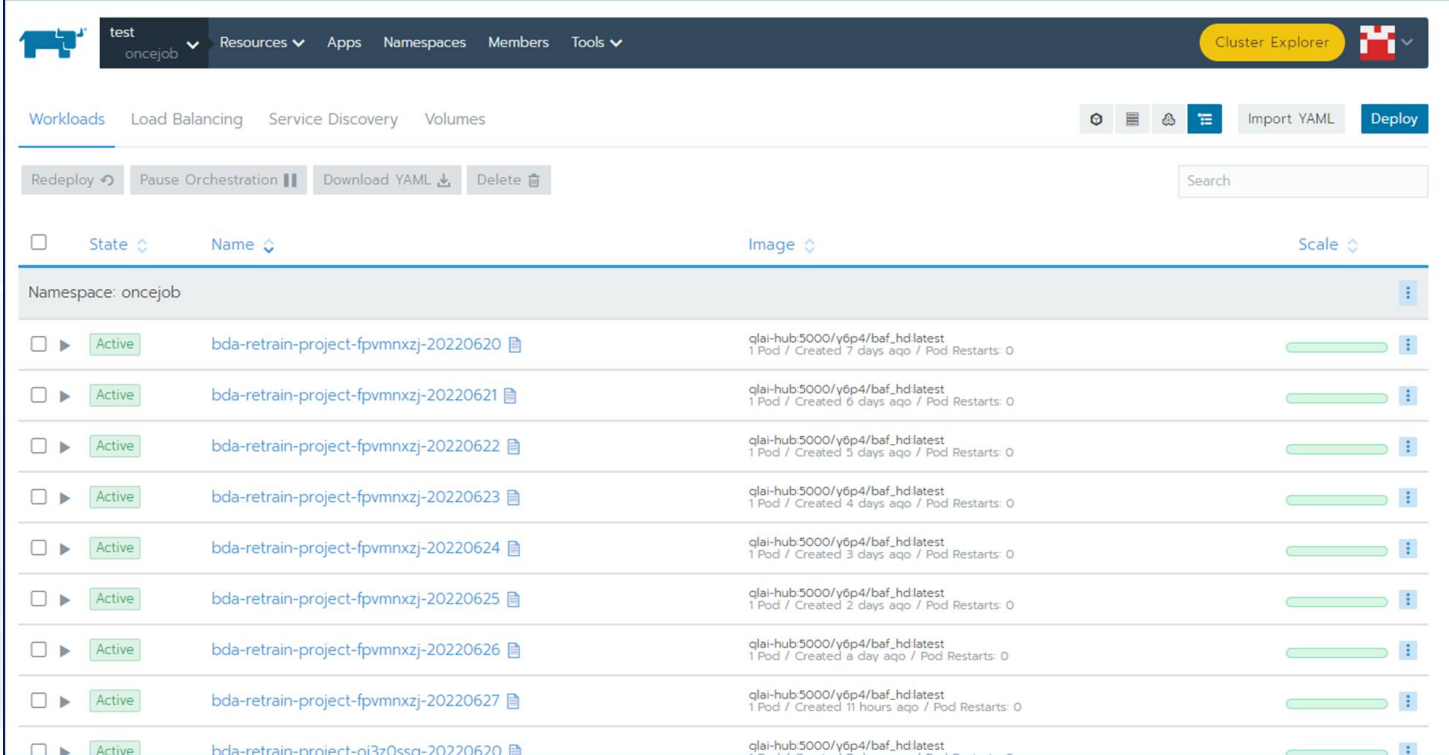
Wrap lines  
 Previous Container

[Scroll to Top](#) [Scroll to Bottom](#) [Download Logs](#) [Clear Screen](#) [Close](#)

- Prediction results can be presented in real-time execution logs with the web-based command line interface

# AI model operationalization

# Validating & Retraining

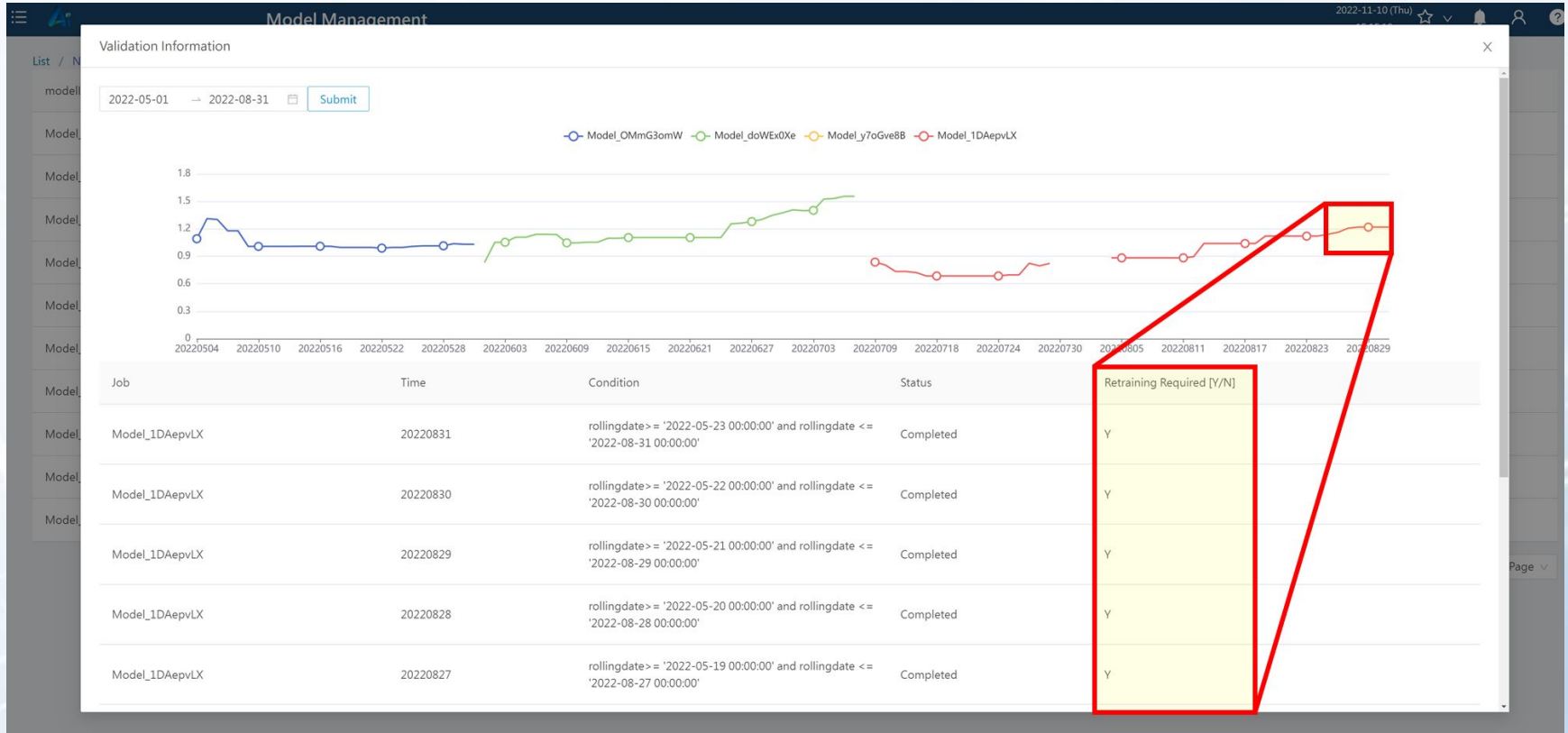


State	Name	Image	Scale
Active	bda-retrain-project-fpvmnxzj-20220620	qlai-hub-5000/y6p4/baf_hd latest 1 Pod / Created 7 days ago / Pod Restarts: 0	1
Active	bda-retrain-project-fpvmnxzj-20220621	qlai-hub-5000/y6p4/baf_hd latest 1 Pod / Created 6 days ago / Pod Restarts: 0	1
Active	bda-retrain-project-fpvmnxzj-20220622	qlai-hub-5000/y6p4/baf_hd latest 1 Pod / Created 5 days ago / Pod Restarts: 0	1
Active	bda-retrain-project-fpvmnxzj-20220623	qlai-hub-5000/y6p4/baf_hd latest 1 Pod / Created 4 days ago / Pod Restarts: 0	1
Active	bda-retrain-project-fpvmnxzj-20220624	qlai-hub-5000/y6p4/baf_hd latest 1 Pod / Created 3 days ago / Pod Restarts: 0	1
Active	bda-retrain-project-fpvmnxzj-20220625	qlai-hub-5000/y6p4/baf_hd latest 1 Pod / Created 2 days ago / Pod Restarts: 0	1
Active	bda-retrain-project-fpvmnxzj-20220626	qlai-hub-5000/y6p4/baf_hd latest 1 Pod / Created a day ago / Pod Restarts: 0	1
Active	bda-retrain-project-fpvmnxzj-20220627	qlai-hub-5000/y6p4/baf_hd latest 1 Pod / Created 11 hours ago / Pod Restarts: 0	1
Active	bda-retrain-project-qi3z0ssq-20220620	qlai-hub-5000/y6p4/baf_hd latest	1

- According to the pre-determined AI model operation parameters
  - training dataset, the validation dataset, validation rules, and notification settings

# AI model operationalization

# Quality Monitoring



- Monitor the quality of online AI models
- **Automatically** retrain the unqualified models with the latest dataset



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# 4. Discussion

## Improvements & Feedback



# Before

## Applying Model Management

- The online AI models were deployed on workstations of different IT facilities of production fields
- **Limited** computation resource of workstations
- **Requiring** operation engineers
  - To **monitor** the online AI models
  - To **conduct** a retraining process
  - To **deploy** revised AI models to the platform

# After

## Applying Model Management

- The **CSC's AIoT platform** serves as a **central hub** of intelligent manufacturing solutions
- More **powerful** and **flexible** computation resources
- The AIMOSS can **automatically**
  - **Find** out outdated AI models
  - **Retrain** AI models with the latest training datasets
  - **Create** proper runtime environments for AI models
  - **Deploy** AI models to the CSC's AIoT platform

# Benefits

## of The AIMOSS

### BEFORE

- IT facilities for AI models located in **different** production fields
- Retraining process usually takes up to **1 hr**
- Various **manual** operations for manage the online AI models

### AFTER

- The AIoT platform as the **central hub** for the online AI models
- Retraining process shorten to about **10 min**
- **Automatic** operations for manage the online AI models

# Feedback

## of Operation Engineers

- **Technical specifications of the AIMOSS**
  - Delineate in **more detail** for operation engineers
  - E.g., Container running options
    - Prediction frequency of AI models
- **Interactive web-based command line interface**
  - **Execute** more management commands
  - **Increase** efficiency and flexibility of debugging

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# 5. Summary

**Operationalizing more AI models**

# Operationalizing more AI models on the CSC's AIoT platform

- Present the practice and progress of developing and deploying AI applications
- The upcoming challenges
  - **More** intelligent applications
  - **More** loads of daily operations
- By utilizing **AIMOSS**, the CSC's AIoT platform becomes more capable of operationalizing more intelligent applications



# *Thank You*

