MATLAB EXPO

使用MATLAB进行DevOps: 流数据的预测性维护系统

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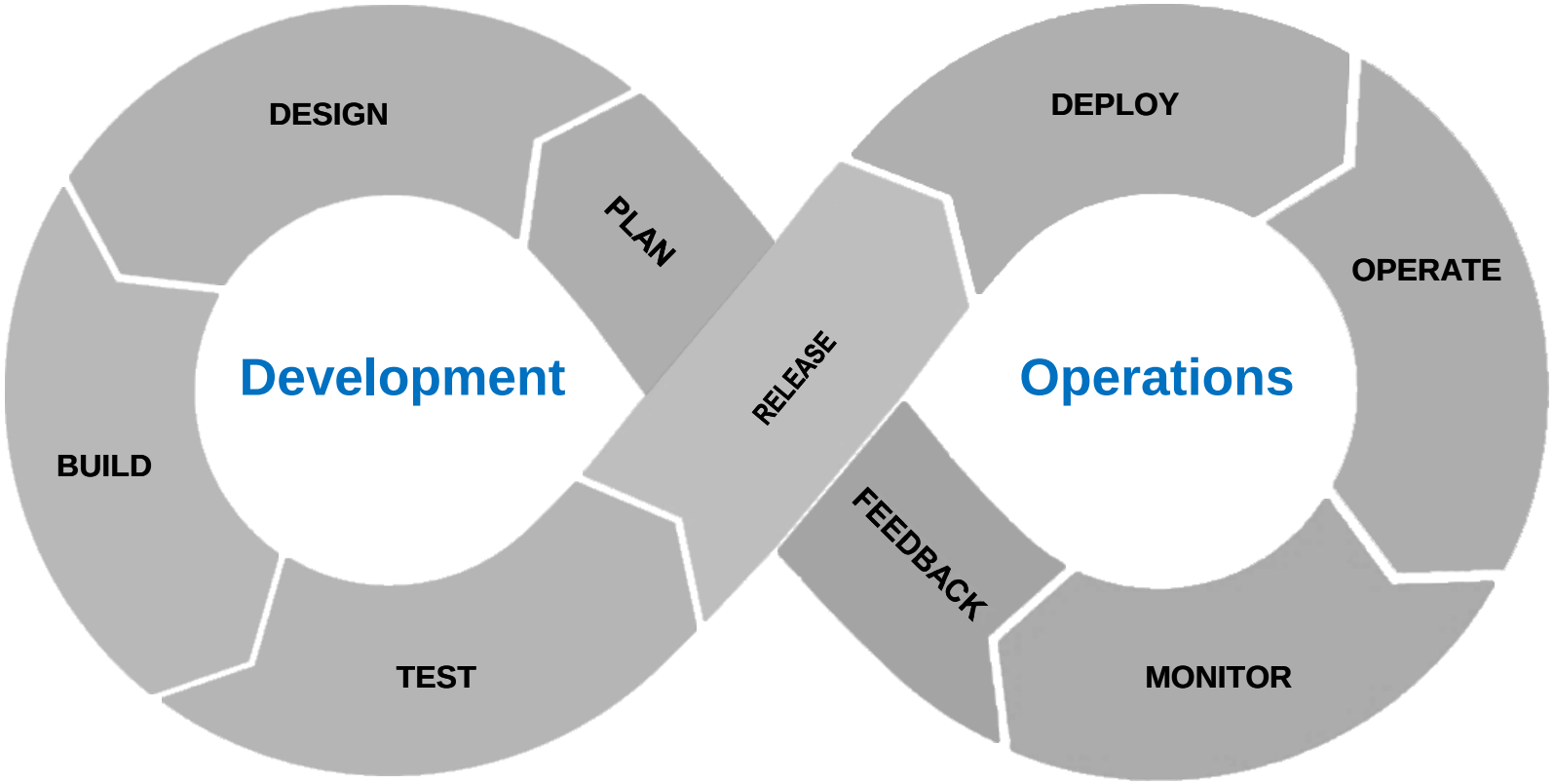
MathWorks中国

MathWorks

主要内容

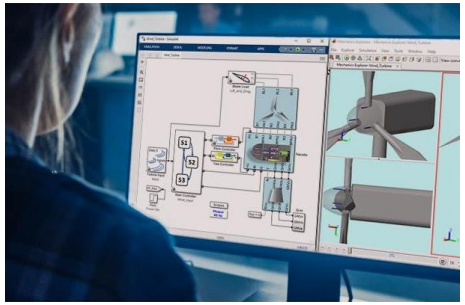
- **利用MATLAB已有的能力** 包括预测性维护和漂移检测
- **集成到生产系统** 例如数据源和仪表板，并将这些集成从桌面扩展到云端
- 结合CI/CD**自动化完成MATLAB代码和Simulink模型的build, test, package, deploy**

DevOps: 开发和运营生产软件



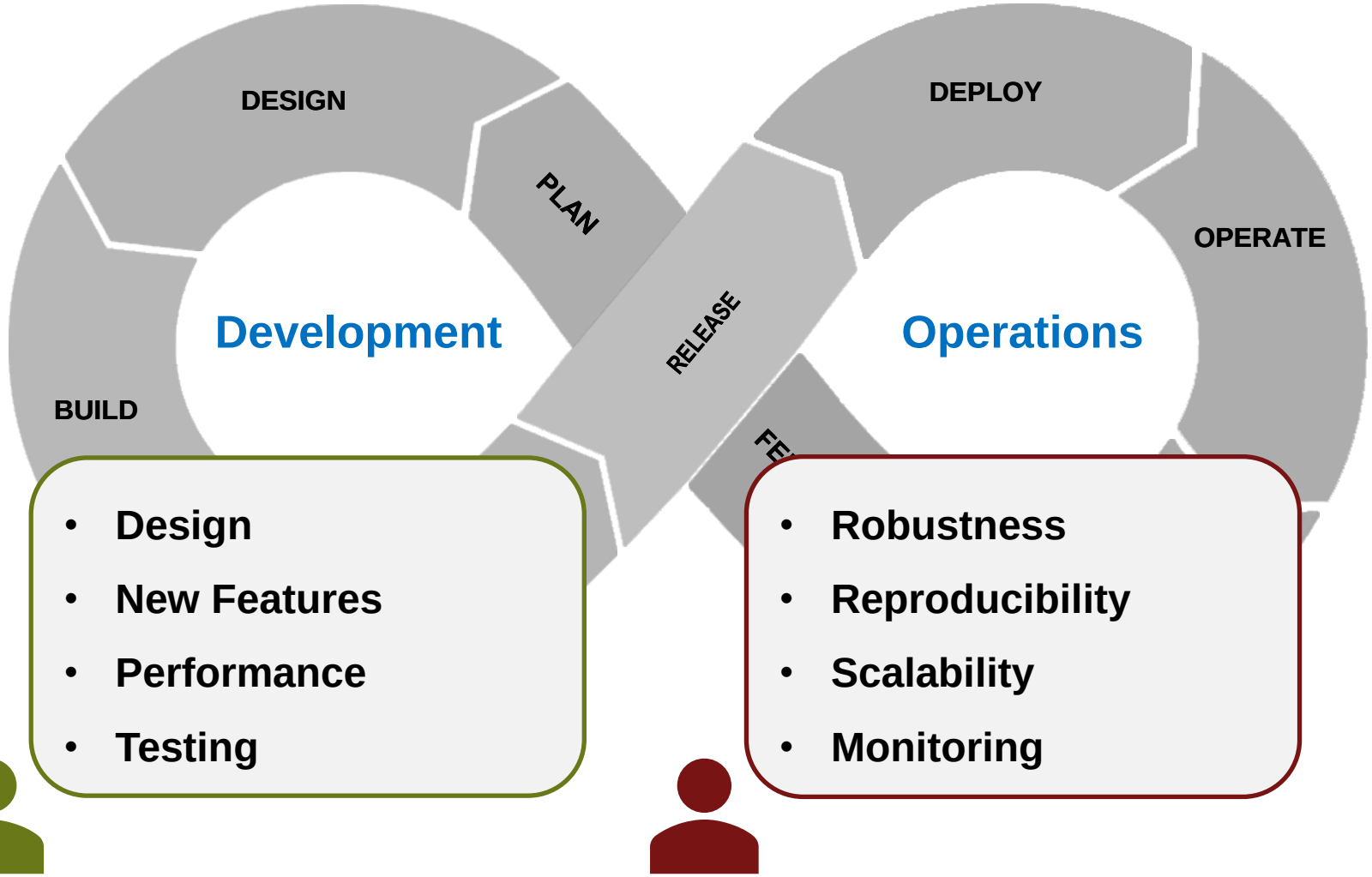
Predictive Maintenance

Financial Modeling

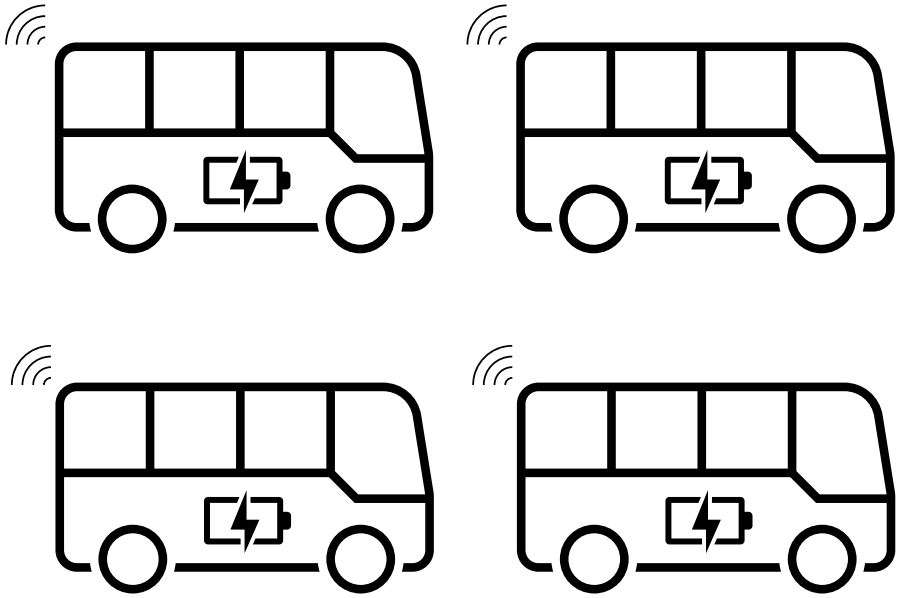


Embedded Controls

开发和运维和而不同：不同的关注点



示例:预测电池 State-of-Health



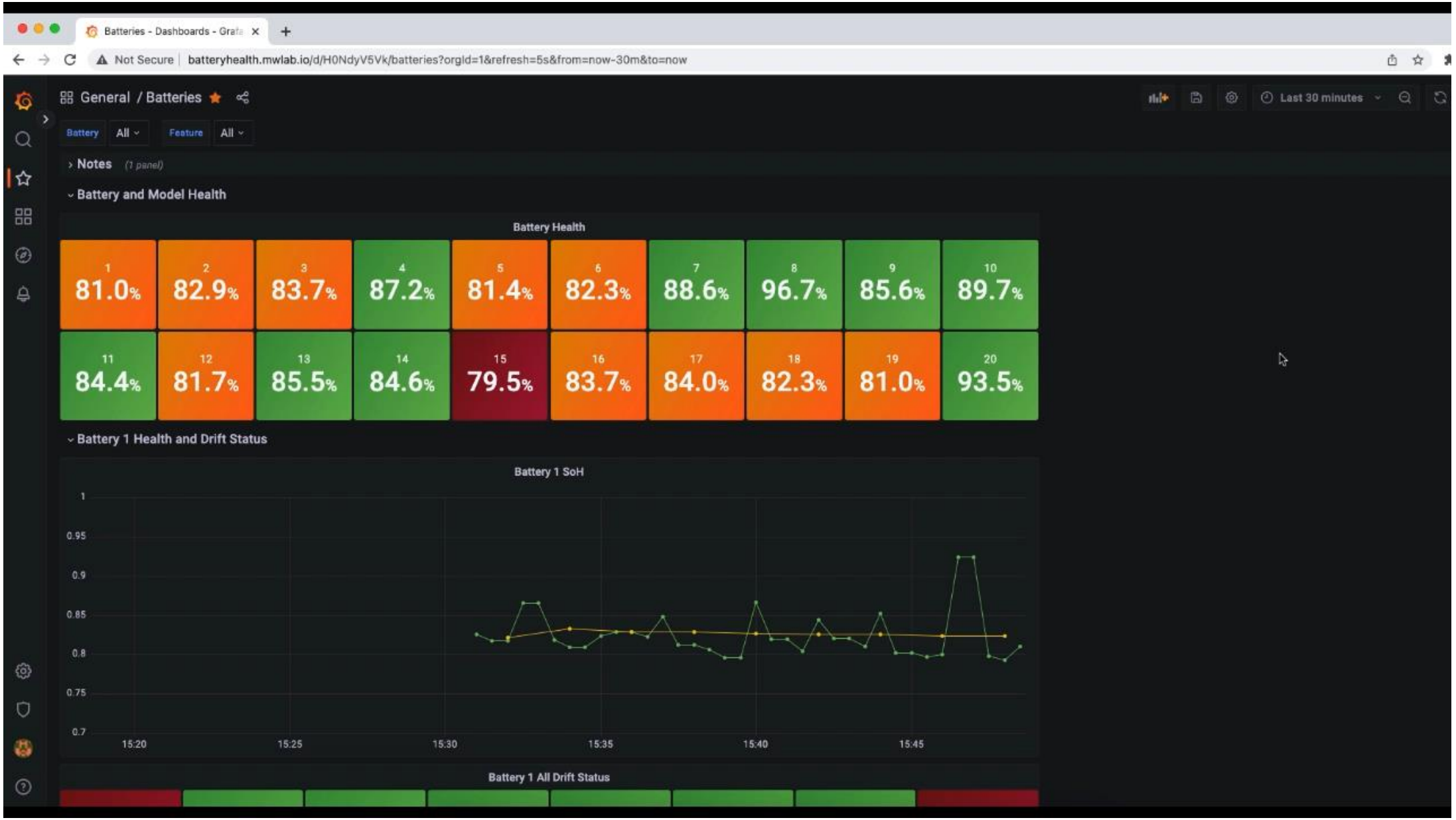
- 电动巴士车队
- 运维较昂贵：**是否可以预测什么时候电池需要更换了?**
- 开始收集电池的远程数据

Variables – observations

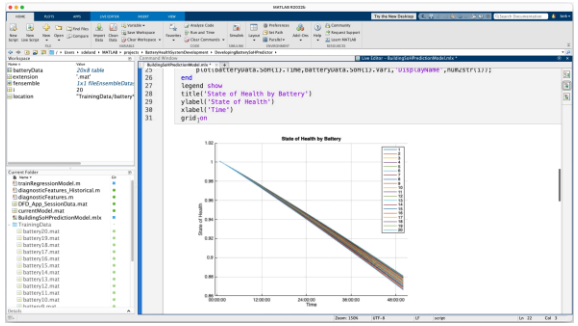
observations

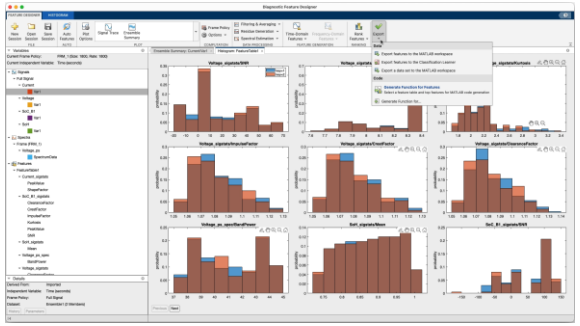
1800x7 timetable

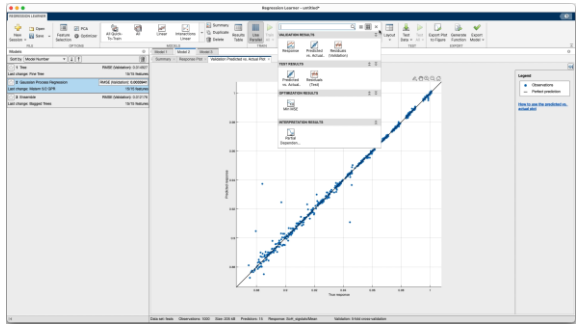
	timestamp	1 Current	2 Voltage	3 Temperature1	4 Temperature2	5 SoC_B1	6 SoC_B2	7 BatteryID
1	01-Nov-2021 00:...	2.6869	7.4436	333.1463	332.7619	0.4995	0.4995	1
2	01-Nov-2021 00:...	2.6872	7.4426	333.1317	332.3924	0.4990	0.4990	1
3	01-Nov-2021 00:...	2.6876	7.4417	333.1073	332.0405	0.4985	0.4985	1
4	01-Nov-2021 00:...	2.6879	7.4408	333.0740	331.7048	0.4980	0.4980	1
5	01-Nov-2021 00:...	2.6882	7.4399	333.0327	331.3844	0.4975	0.4975	1
6	01-Nov-2021 00:...	2.6885	7.4390	332.9843	331.0783	0.4970	0.4970	1
7	01-Nov-2021 00:...	2.6889	7.4381	332.9295	330.7857	0.4965	0.4965	1


Batteries - Dashboards - Grafa
Not Secure
batteryhealth.mwlab.io/d/H0NdyV5Vk/batteries?orgId=1&refresh=5s&from=now-30m&to=now
General / Batteries
Last 30 minutes
Battery
All
Feature
All
Notes (1 panel)
Battery and Model Health
Battery Health
1 81.0%
2 82.9%
3 83.7%
4 87.2%
5 81.4%
6 82.3%
7 88.6%
8 96.7%
9 85.6%
10 89.7%
11 84.4%
12 81.7%
13 85.5%
14 84.6%
15 79.5%
16 83.7%
17 84.0%
18 82.3%
19 81.0%
20 93.5%
Battery 1 Health and Drift Status
Battery 1 SoH
1
0.95
0.9
0.85
0.8
0.75
0.7
15:20
15:25
15:30
15:35
15:40
15:45
Battery 1 All Drift Status

使用领域相关的工具创建SoH预测功能，用于工程数据的预测性维护

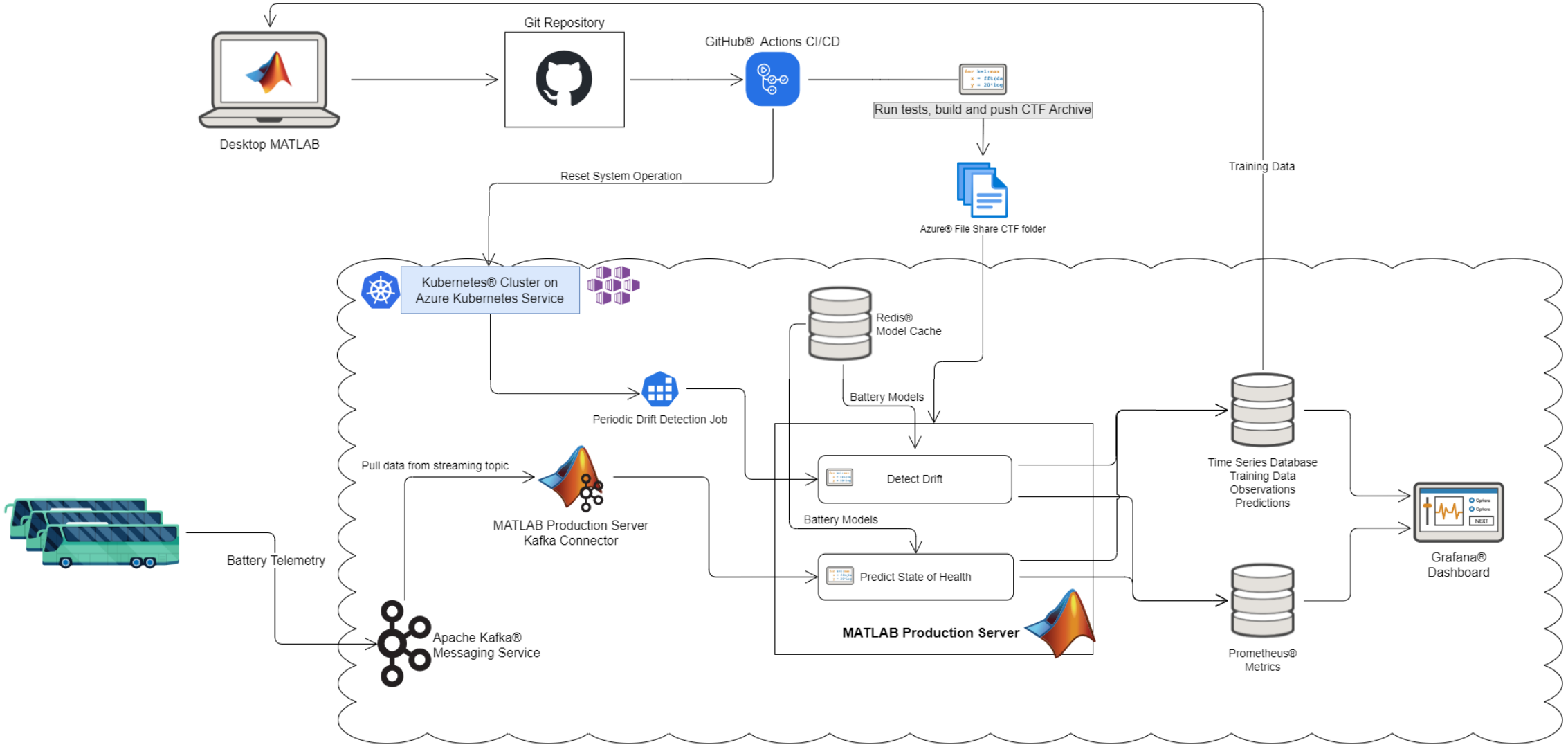






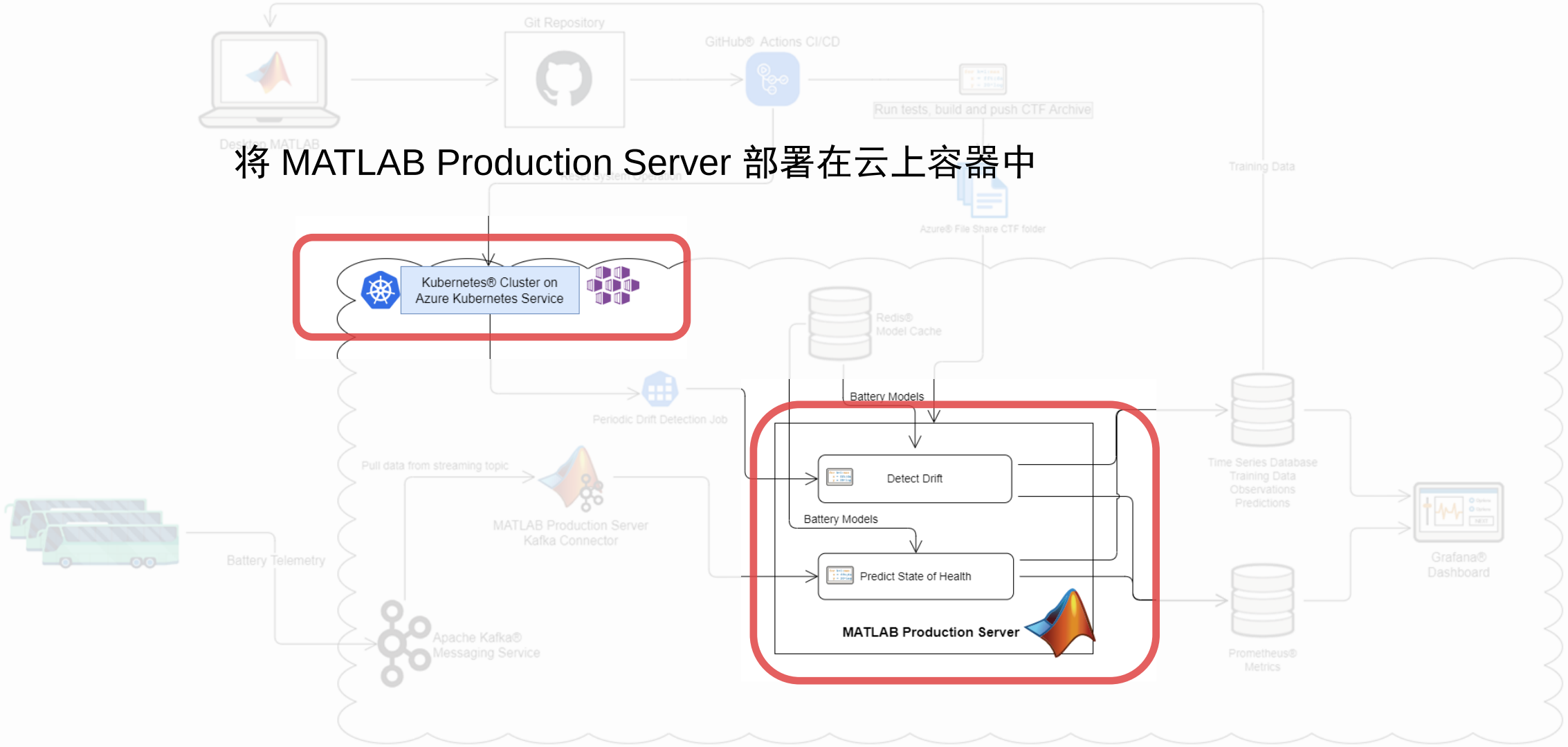
Data Exploration → Feature Extraction → Machine Learning

运行在云上的可扩展生产系统，使用行业标准工具



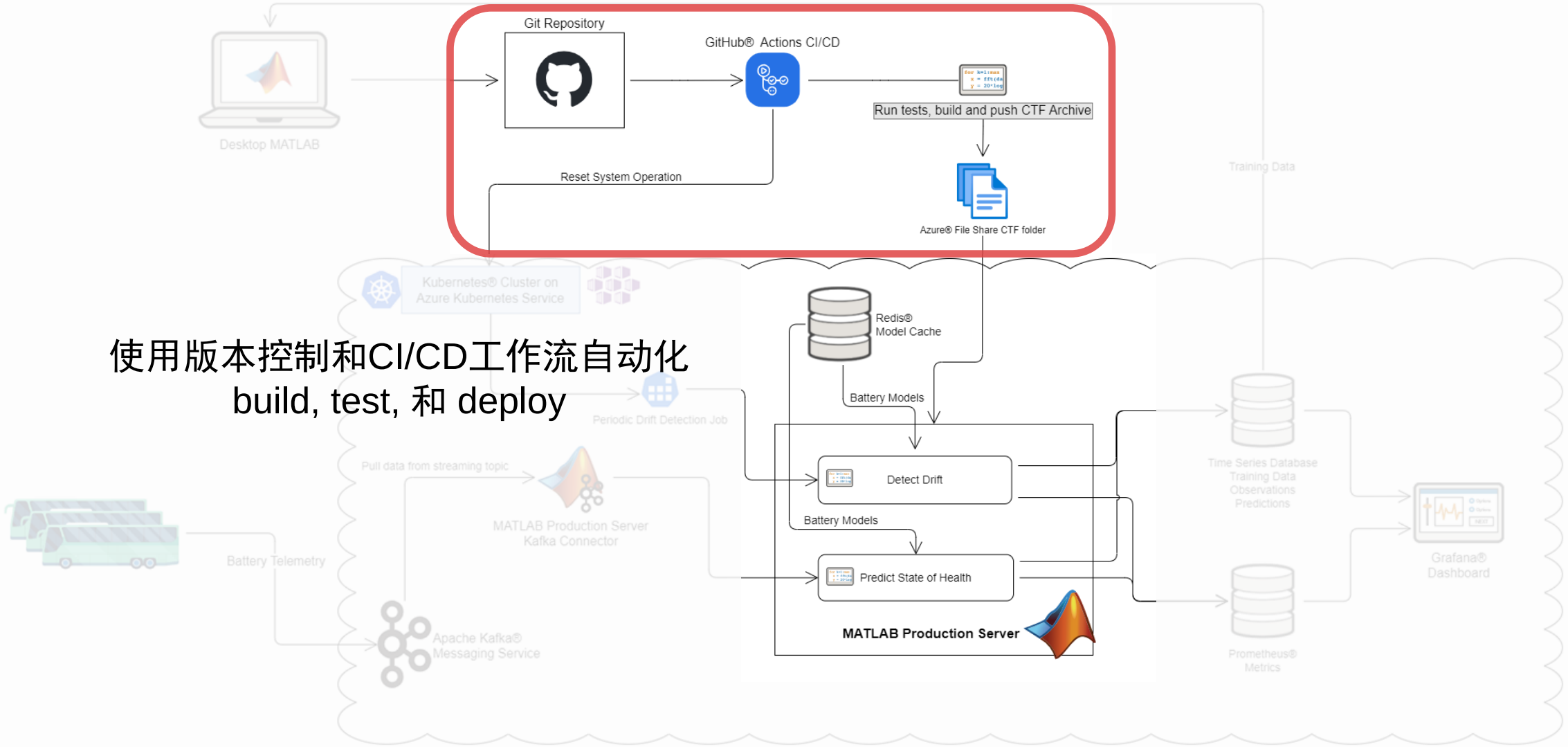
运行在云上的可扩展生产系统，使用行业标准工具

将 MATLAB Production Server 部署在云上容器中



运行在云上的可扩展生产系统，使用行业标准工具

使用版本控制和CI/CD工作流自动化
build, test, 和 deploy



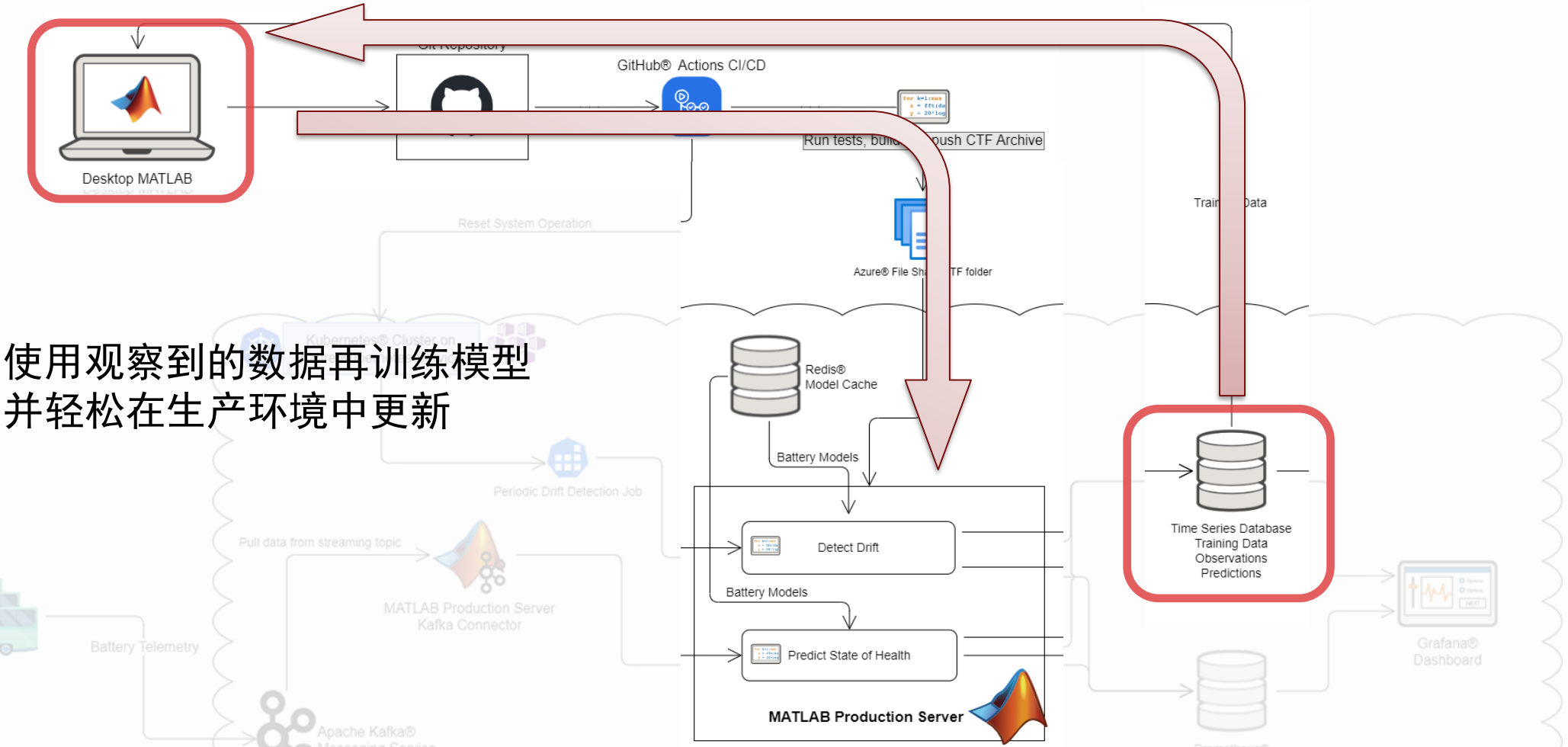
运行在云上的可扩展生产系统，使用行业标准工具

运行在云上的可扩展生产系统，使用行业标准工具

集成行业标准仪表板向业务相关的工程师展示有价值的指标

运行在云上的可扩展生产系统，使用行业标准工具

使用观察到的数据再训练模型
并轻松在生产环境中更新



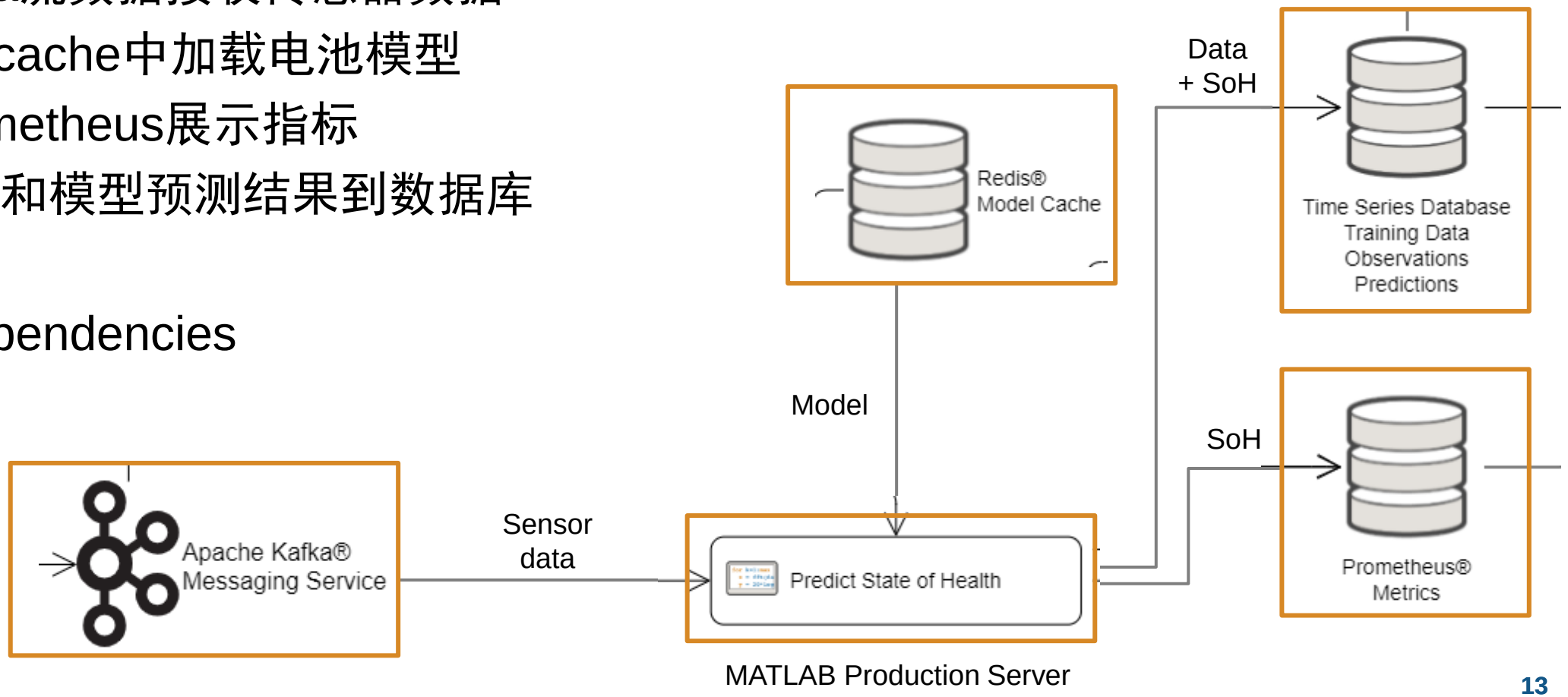
State of health算法运行在生产环境中

生产系统

- 通过kafka流数据接收传感器数据
- 从Redis cache中加载电池模型
- 使用Prometheus展示指标
- 保存数据和模型预测结果到数据库

本地测试

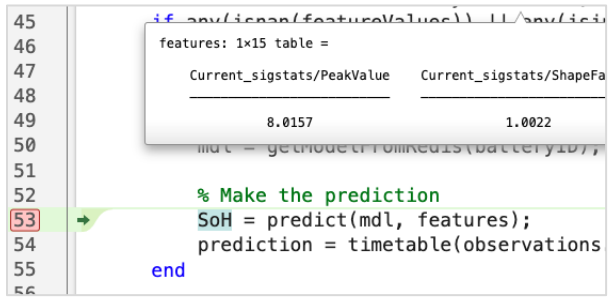
- Mock dependencies



编写SoH预测函数来使用kafka数据流

Simulate streams with
- `inMemoryStream`
- `testStream`

Use production Kafka streams with `kafkaStream`



MATLAB Desktop

f(x)

MATLAB Production Server

Debug locally, then deploy the same MATLAB code to production.

自动 build, test, package, 和部署 MATLAB 代码

esteinerMW / Battery-Health-Estimation-Streaming-Demo Private

forked from mathworks/Battery-Health-Estimation-Streaming-Demo

Watch 0 Fork 2 Star 1

Code Pull requests Actions Projects Wiki

Build and upload deployable archive (CTF) to MATLAB Production Server

update battery dashboard #19

Summary

Jobs

build

Reset Demo Operations

Run details

Usage

Workflow file

build

succeeded 12 hours ago in 3m

Set up job

Run actions/checkout@v3 3s

Setup MATLAB Support Packages 0s

Setup MATLAB

Run MATLAB buildtool

1 ▶ Run matlab-actions/run-build@v1

8 ▶ Generate script

10 ▶ Run command

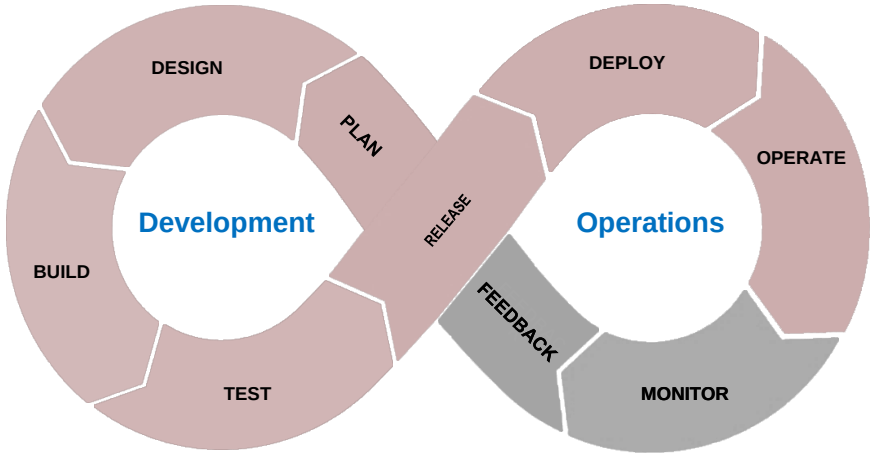
Azure login

Azure CLI script - upload CTF to az file-share

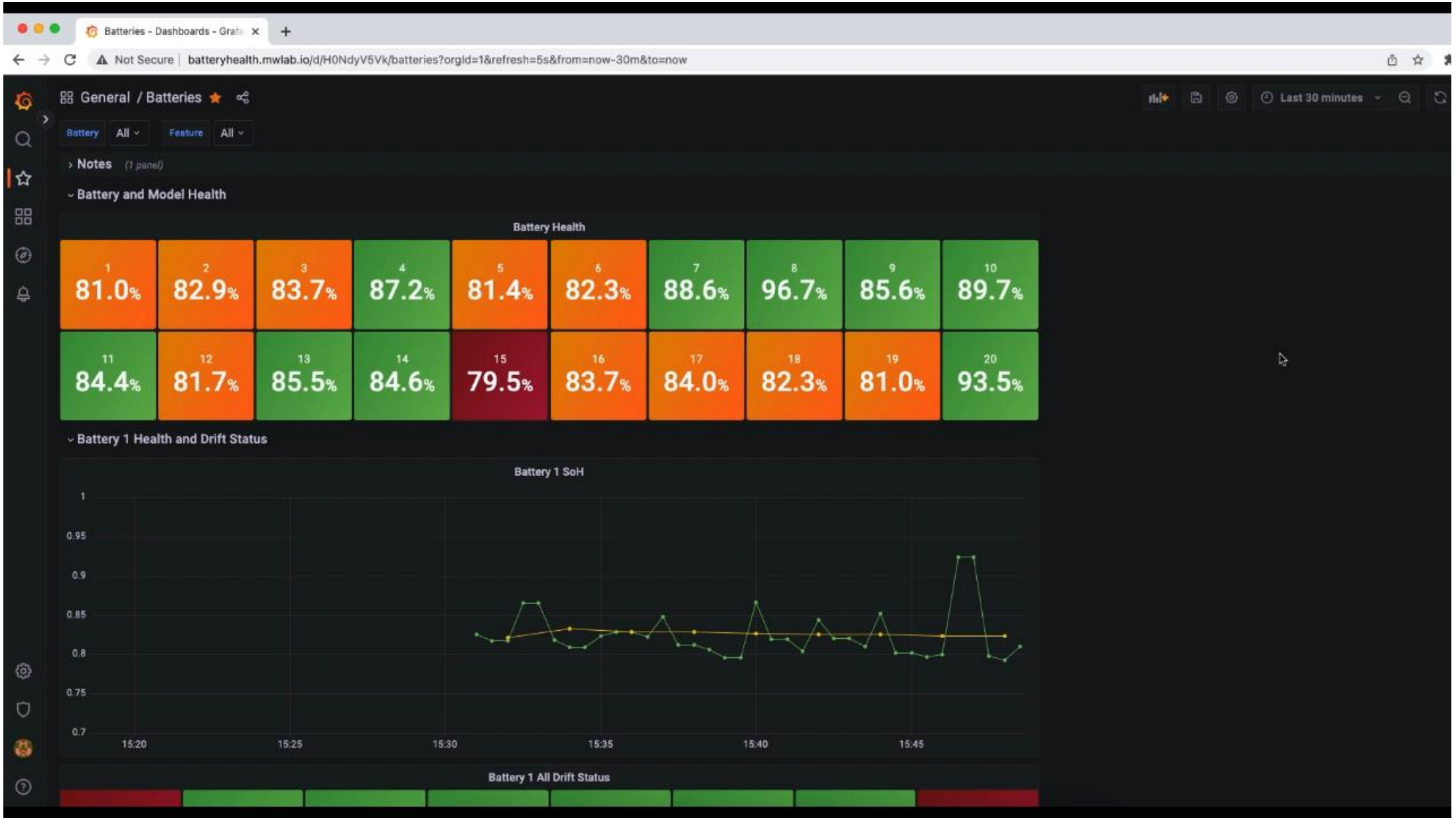
Post Run actions/checkout@v3

Complete job

```
- name: Run MATLAB buildtool
uses: matlab-actions/run-build@v1
with:
tasks: packageDriftDetection
packageSoHPrediction
```




```
function plan = buildfile
plan = buildplan(localfunctions);
plan("packageDriftDetection").Dependencies = "test";
plan("packageSoHPrediction").Dependencies = "test";
plan("test").Dependencies = "validate";
end
```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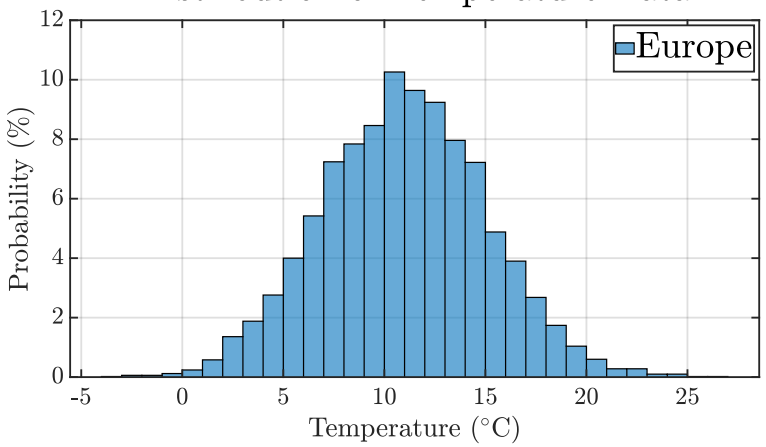
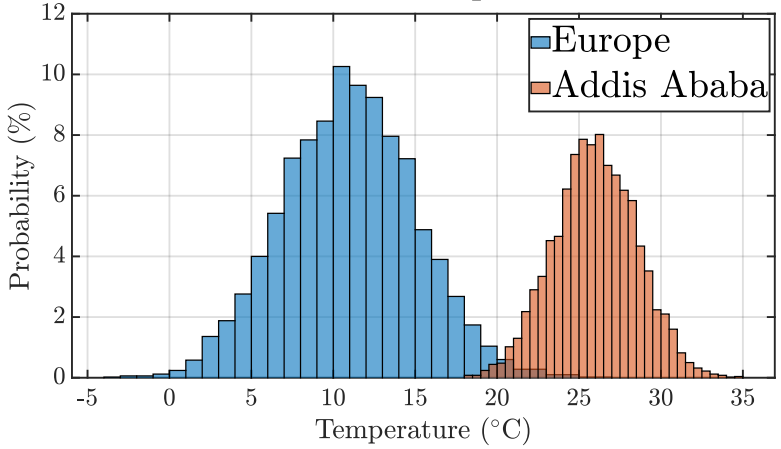
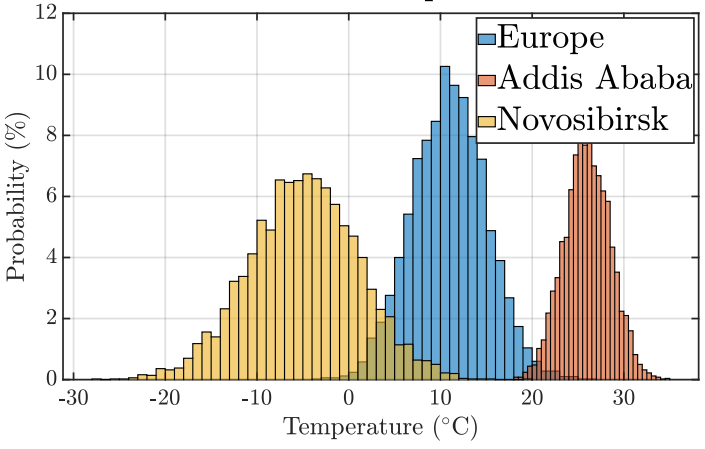
静态数据假设在现实世界中很少成立

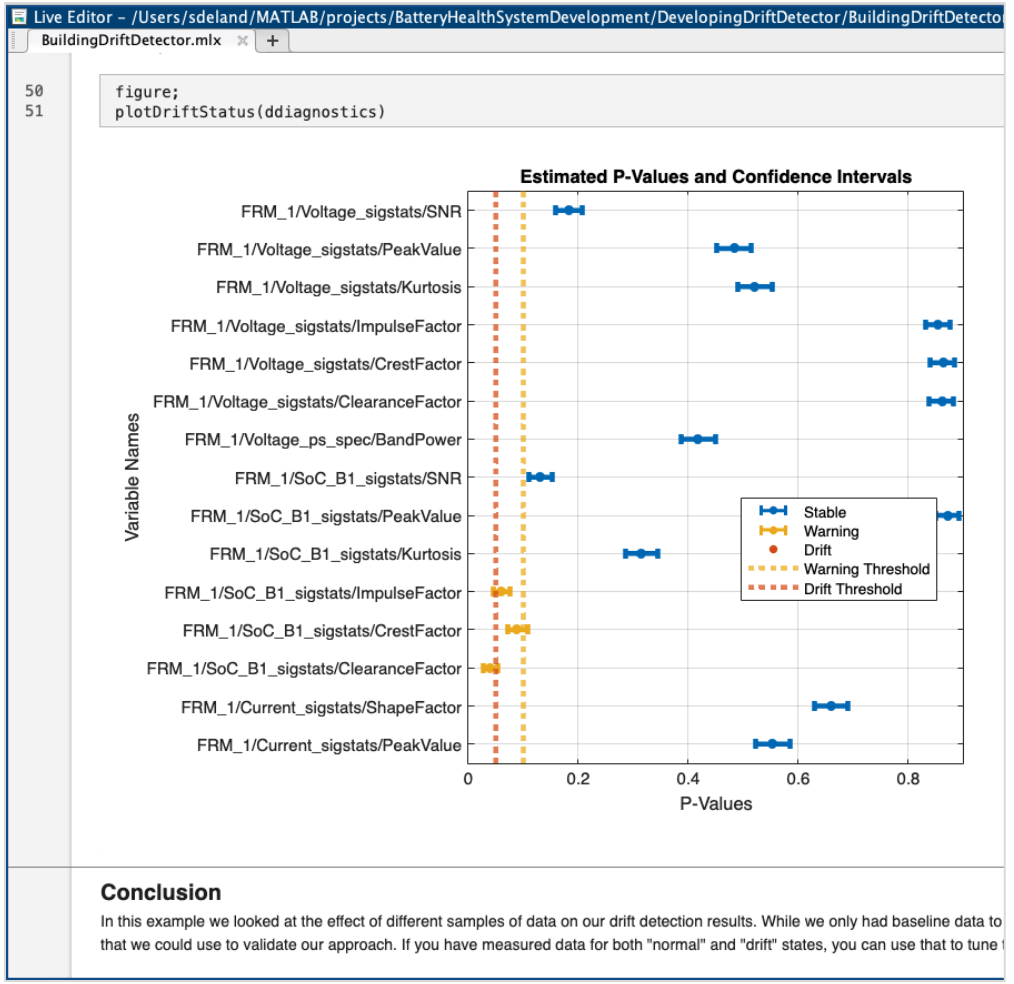






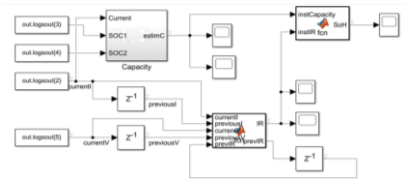
使用 detectdrift 开发漂移检测算法

- 使用历史数据 (训练数据) 来创建一个基准分布
- 生成合成数据来测试漂移
  - 生产环境中将使用真实流数据

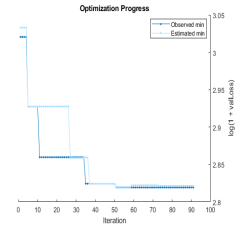


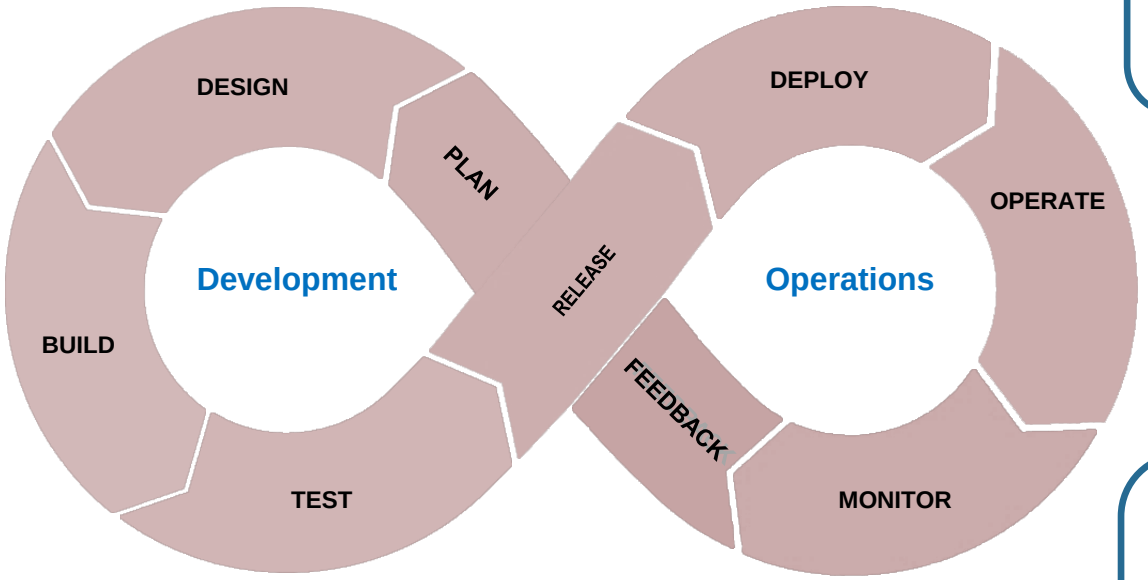
当检测到数据漂移之后就更新模型

Data labeling



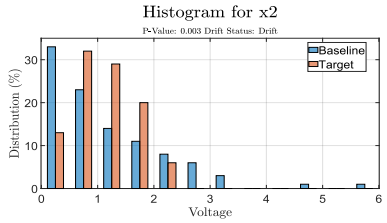
Retrain



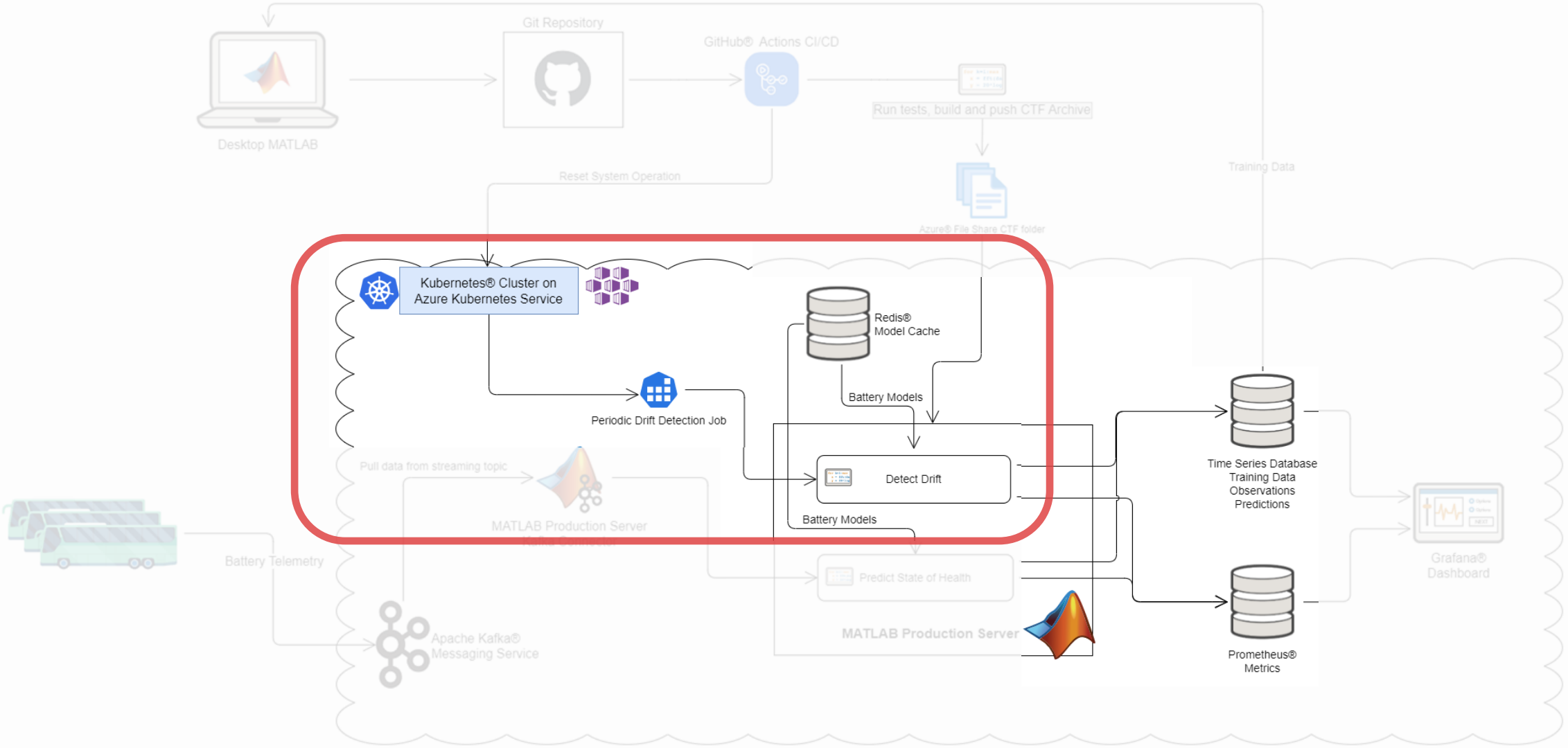


$\hat{f}_2(x)$

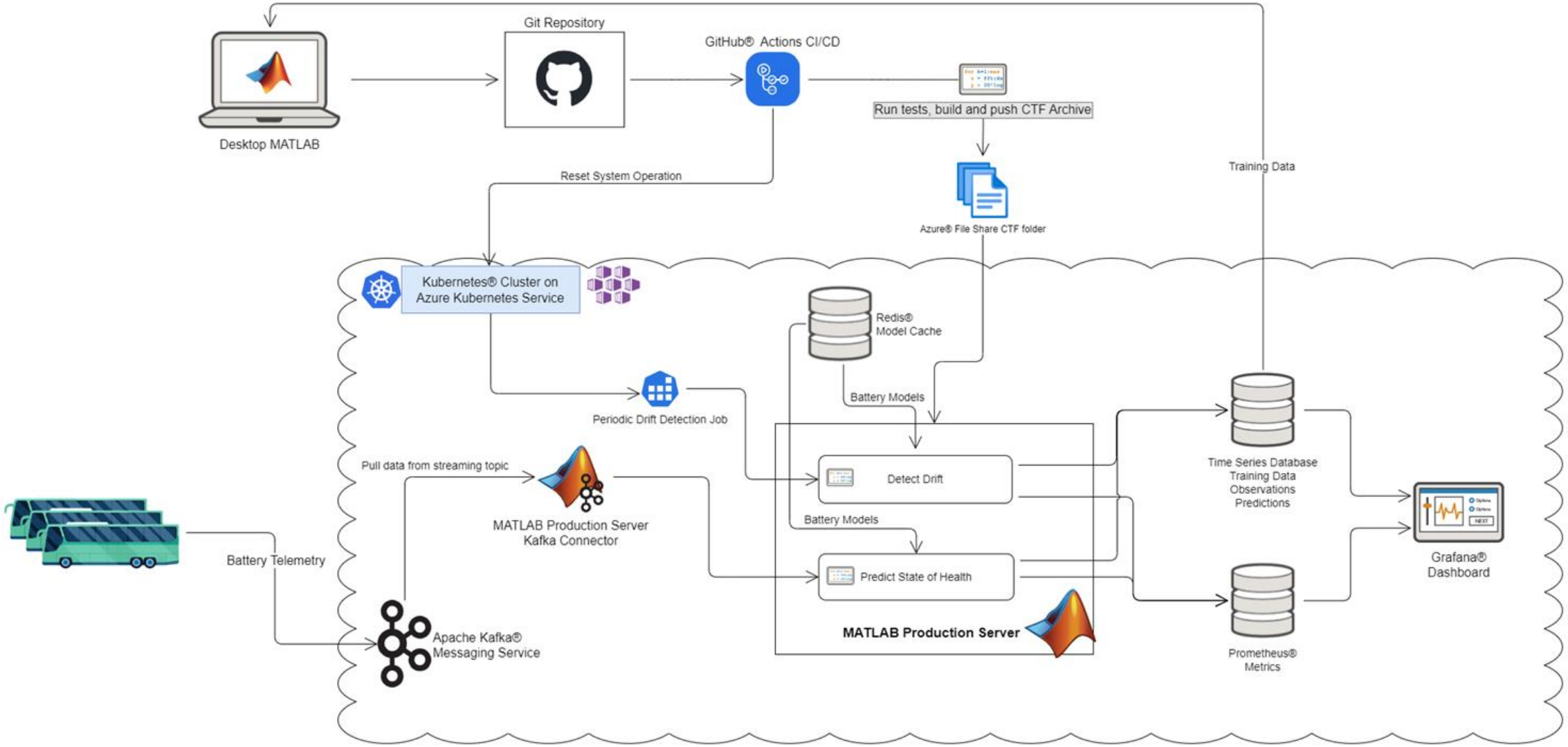
Drift Detection



更新基础架构来定期运行漂移检测功能



完整的系统


Git Repository
GitHub® Actions CI/CD
Desktop MATLAB
Run tests, build and push CTF Archive
Reset System Operation
Azure® File Share CTF folder
Training Data
Kubernetes® Cluster on
Azure Kubernetes Service
Redis®
Model Cache
Periodic Drift Detection Job
Battery Models
Pull data from streaming topic
MATLAB Production Server
Kafka Connector
Detect Drift
Time Series Database
Training Data
Observations
Predictions
Battery Models
Predict State of Health
Grafana®
Dashboard
Battery Telemetry
Apache Kafka®
Messaging Service
MATLAB Production Server
Prometheus®
Metrics

主要内容

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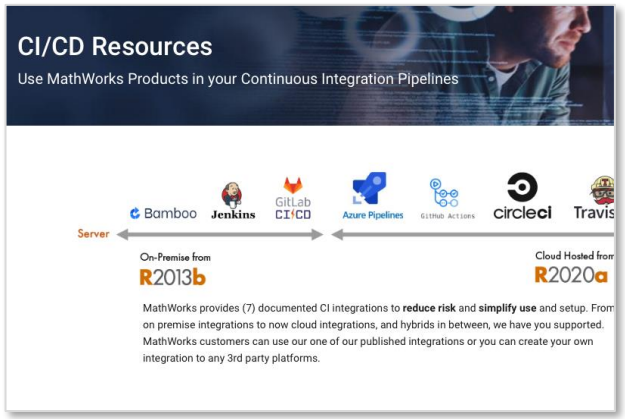
更多内容

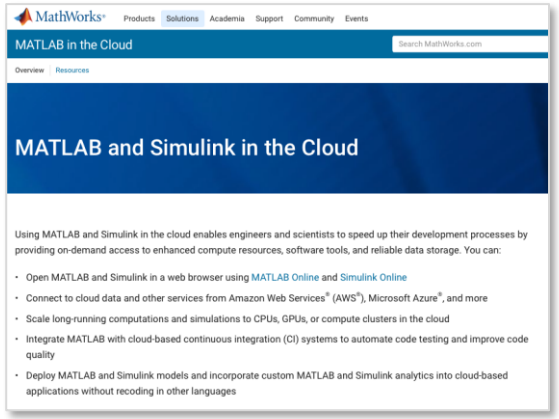
How MATLAB and Simulink are used with Enterprise IT

https://www.mathworks.com/solutions/enterprise-it-systems.html



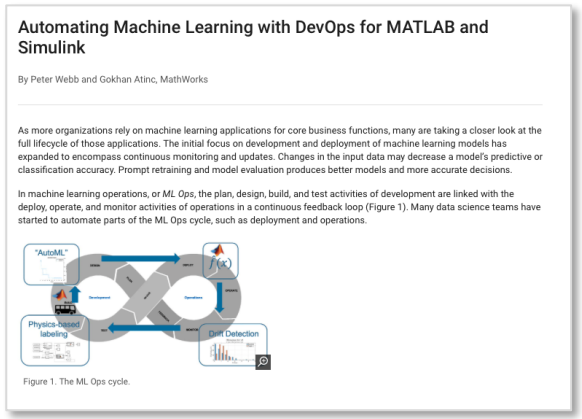
CI/CD Resources

https://www.mathworks.com/solutions/enterprise-it-systems/ci-cd.html



MATLAB and Simulink in the Cloud

https://www.mathworks.com/solutions/cloud.html



Automating Machine Learning with DevOps for MATLAB and Simulink

https://www.mathworks.com/company/newsletters/articles/automating-machine-learning-with-devops-for-matlab-and-simulink.html

Q&A

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