Déploiement d’algorithmes de dérive de données et de modèles dans le cloud

Pierre Harouimi, MathWorks
“More than half of AI Models Never Make It To Production”
Source: Gartner 2021
How much longer can you drive before recharging?

State of Charge (SoC) cannot be directly measured  x
No observed data  x
Need to embed model for real-time data  x
How to handle data drifting from baseline  x

✓ Predict battery SoC using AI with MATLAB & python
✓ Generate realistic data with Simulink
✓ Convert python model into MATLAB to generate code
✓ Deploy MATLAB algos and Simulink model in the cloud
Battery State-of-Charge (SoC) estimation using AI

- Voltage
- Current
- Temperature

AI

SoC
AI-driven system design and collaboration

Data Preparation
- Data cleansing and preparation
- Human insight
- Simulation-generated data

AI Modeling
- Model design and tuning
- Hardware accelerated training
- Interoperability

System Design
- Integration with complex systems
- System simulation
- System verification and validation

Deployment
- Embedded devices
- Enterprise systems
- Edge, cloud, desktop
AI-driven system design and collaboration

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Predictive Maintenance and data drifting

From development to production

Testing and CI/CD deployment

How to use MATLAB® for predictive maintenance applications
A predictive maintenance solution is more than an algorithm
Many challenges

How do I build the best predictive algorithms?

How do I deploy and monitor my algorithms?

What if I don’t collect enough failure data?
MATLAB for Predictive Maintenance

- Use interactive apps to analyze time series
- Import, visualize, extract new features, and generate MATLAB code
- Detect data and concept drifting
Types of Maintenance

- **Reactive** – Do maintenance once there’s a problem
  - Problem: unexpected failures can be expensive and potentially dangerous

- **Scheduled** – Do maintenance at a regular rate
  - Problem: unnecessary maintenance can be wasteful; may not eliminate all failures

- **Predictive** – Forecast when problems will arise
  - Problem: difficult to make accurate forecasts for complex equipment
Why perform predictive maintenance?

**Increase**
- Service life of parts
- Equipment safety
- Overall profitability

**Reduce**
- Downtime
- Maintenance costs
- Equipment failures
What does a predictive maintenance algorithm do?

<table>
<thead>
<tr>
<th>Question</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is my machine operating normally?</td>
<td>Anomaly Detection</td>
</tr>
<tr>
<td>Why is my machine behaving abnormally?</td>
<td>Fault Detection (Diagnostics)</td>
</tr>
<tr>
<td>How much longer can I operate my machine?</td>
<td>Remaining Useful Life Estimation (Prognostics)</td>
</tr>
</tbody>
</table>

I need help.

One of my cylinders is blocked.

I will shut down your line in 15 hours.
What does a predictive maintenance algorithm do?

Is my machine operating normally?

Why is my machine behaving abnormally?

How much longer can I operate my machine?

Most organizations start here

Anomaly Detection

Fault Detection (Diagnostics)

Remaining Useful Life Estimation (Prognostics)

Increasing:
- Algorithm complexity
- Data requirements
- Business value

But ultimately want to get here
MATLAB apps to extract and generate new features
MATLAB for Predictive Maintenance

Data and concept drifting

Why data/concept drift? Because static data/model assumption rarely holds in the real world.
MATLAB for Predictive Maintenance
Data drifting: detect drift from baseline

Permutation Results for x1
P-Value: 0.285 Drift Status: Stable
Wasserstein Metric Threshold Value: 0.22381

Permutation Results for x2
P-Value: 0.003 Drift Status: Drift
Wasserstein Metric Threshold Value: 0.36879
“More than half of AI Models Never Make It To Production”
Source: Gartner 2021

From development to production

Predictive Maintenance and data drifting

How to deploy applications and integrate them in an IT ecosystem

Testing and CI/CD deployment
Other deployment - Code generation for Machine/Deep Learning

- Optimization library
- Optimization library
- Optimization library
- Library free source code
- Any CPU

- OneDNN Library
- ARM Compute Library
- TensorFlow Lite
- Plain C Code No Library Needed

Support for TFLite: R2022a
Integrate functions and applications in an IT ecosystem

- Ease-to-use functions and apps allow you to deploy applications without any IT skills.

- Integrate MATLAB & Simulink into your entreprise applications with an endpoint HTTPS and REST API.

- Many different ways to deploy your algorithms.
Generate web services and microservices

I need to put my MATLAB algo in production for streaming and asynchronous analysis

You can easily integrate your MATLAB functions in production, onprem or in the cloud
Models’ deployment for data drifting

- predictSOC.py
  - Predict battery state-of-charge

- detectDrift.m
  - Detect data drifting from baseline

- batteryModel.slx
  - Model-based labeling

MATLAB Production Server
Models' deployment for data drifting

New streaming data → MATLAB Production Server

Run one MATLAB instance → Detect data drifting from baseline

- drift
- no drift

Model-based labeling

Update model → pyrunfile newdata label

Update DL network → Predict battery state-of-charge
Models' deployment for data drifting
Deployment for streaming analysis
Models' deployment for data drifting

Case study: Step 6 – Integrate algorithms in Grafana
MBD meets AI

Predictive Maintenance and data drifting

From development to production

Testing and CI/CD deployment

How to integrate your whole workflow in a local testing and a CI/CD pipeline
• Elastic scaling
• Data sovereignty
• Automation
• Multiple uses
DevOps Lifecycle
DevOps Lifecycle
Simplifying Continuous Integration for MATLAB & Simulink users

- Enable users to model pipeline inside MATLAB
- Create single integration point for DevOps engineers
- Empower users to maintain and debug pipeline
Write and run your tests locally
1 – Write and manage test locally

- Enable coverage and view report
- Test suite being viewed
- Summary of tests and results
- Table of tests and results
- Results are persisted in project, can close/reopen Test Manager or MATLAB

Open project
Test selector with \textit{DependsOn}!
Coverage metrics: tells you what you have tested

MATLAB
Statement & Function Coverage

MATLAB Test
Decision Coverage
Condition Coverage
Modified Condition/Decision Coverage
Equivalence testing feature: Catch issues before leaving MATLAB

myFunction

Execute

out = myFunction(a, b);

Build

Artifact

myFunction

Verify

out == out
Version control
2 – Version your code locally and directly from MATLAB
Version control
What does a CI-based workflow look like?

Developers

Source Code Repository

Continuous Integration Platform

Build and Test Reports

Build Artifacts
Deploy – Create a Microservice in MATLAB

- Requirements:
  - Docker
  - MATLAB Compiler
  - MATLAB Compiler SDK
  - Simulink Compiler

- Code:

```matlab
mpsResults = compiler.build.productionServerArchive("myFunction.m");
compiler.package.microserviceDockerImage(mpsResults,...
    "ImageName","micro-myfunction");
```
Deploy – Integration with the DevOps Pipeline

- How to use it in pipeline
A predictive maintenance solution is more than an algorithm
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Not Me
Thank you!

Questions?