

MathWorks®

Accelerating the pace of engineering and science

The leading developer of mathematical computing software
for engineers and scientists.

MATLAB® & SIMULINK®



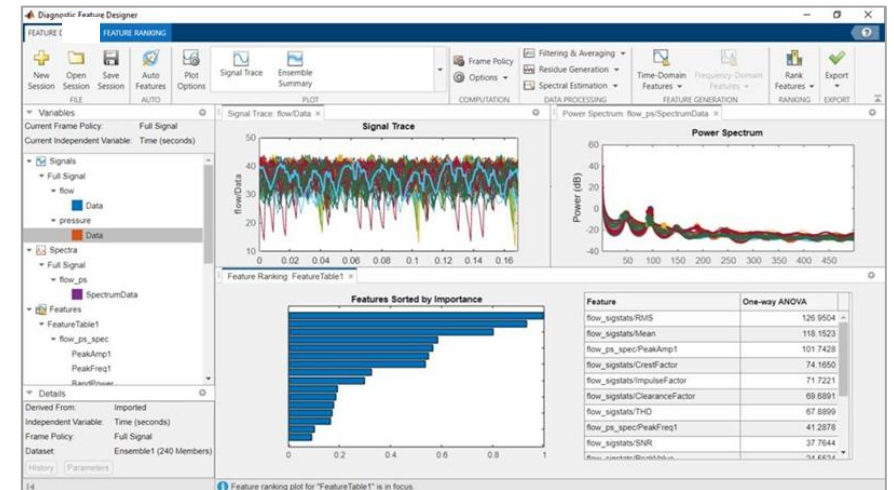
Our Products

MATLAB is a programming environment for algorithm development, data analysis, visualization, and numeric computation.

Simulink is a block diagram environment for designing, simulating, and testing systems.

More than 120 **add-on products** for specialized tasks.

Predictive Maintenance Toolbox



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United States

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Italy
Netherlands
Spain
Sweden
Switzerland
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Asia-Pacific

Australia
China
India
Japan
Korea

MathWorks Today



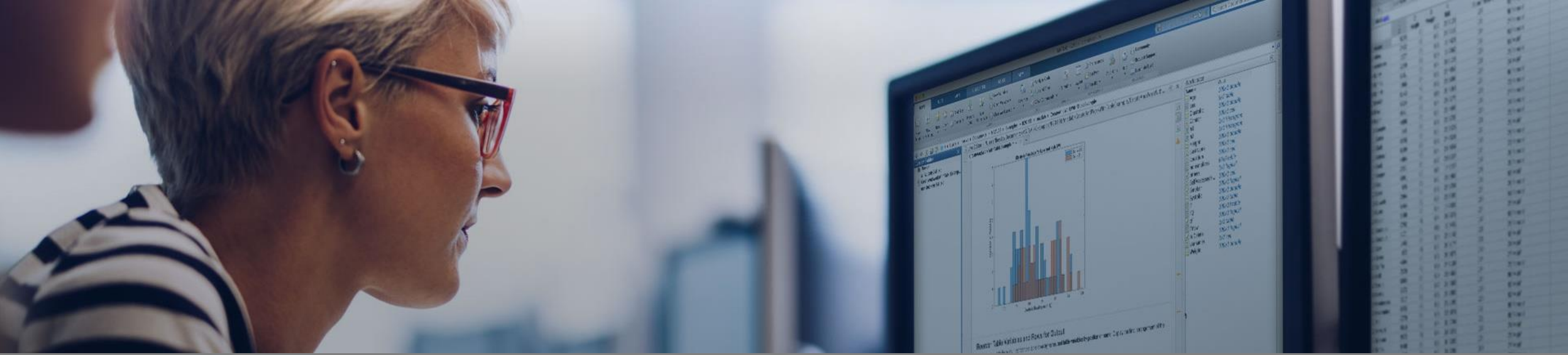
6000+ staff
in 34 offices around
the world



\$1.25+ billion
in revenue



Privately held
and profitable every year



Our Customers

Millions of engineers and scientists worldwide use MATLAB and Simulink.



5 million+

users in over 180 countries



100,000+

businesses, governments,
and universities



All the top 10
automotive and
aerospace companies

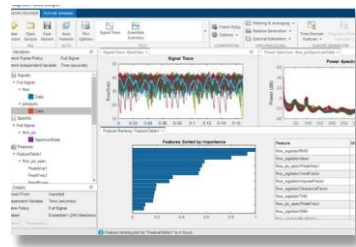
Fortune: 2021 Global 500 auto companies
FlightGlobal: 2020 Top 100 aero companies*

*Excluding companies that are subject to embargos, sanctions, or other controls

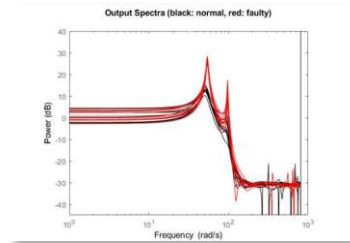


Predictive Maintenance Toolbox

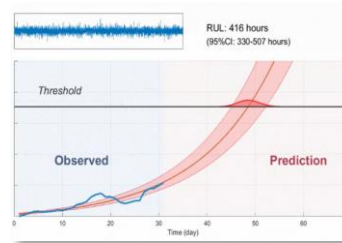
Design and test condition monitoring and predictive maintenance algorithms



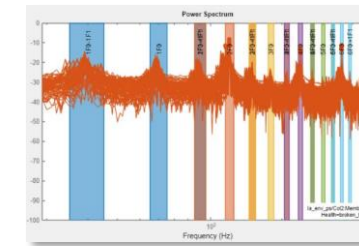
Feature Engineering



Fault and Anomaly Detection



RUL Estimation

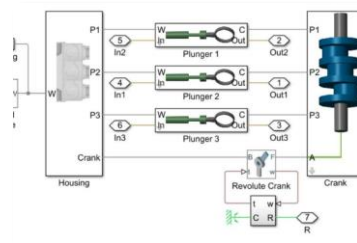


Application-Specific Algorithms

```
fileLocation = fullfile('.', 'RollingElementBearingFaultDiagnosis-0');
fileExtension = '.mat';
ensembleData = fileEnsembleDatastore(fileLocation, fileExtension);
ensembleData = initializeEnsemble(ensembleData);
ensembleDataTable = tall(ensembleData);

ensembleDataTable =
n=10 tall table
  Vibration_Data      sr      rate      load      BPFD      BPEI      FTF
  [1646884:1 double]  48828  25      0      81.125  118.88  14.838
  [1646884:1 double]  48828  25      50      81.125  118.88  14.838
  [1646884:1 double]  48828  25      100     81.125  118.88  14.838
  [1646884:1 double]  48828  25      150     81.125  118.88  14.838
  [1646884:1 double]  48828  25      200     81.125  118.88  14.838
  [1646884:1 double]  48828  25      270     81.125  118.88  14.838
  [1646884:1 double]  48828  25      270     81.125  118.88  14.838
  [1646884:1 double]  48828  25      25      81.125  118.88  14.838
```

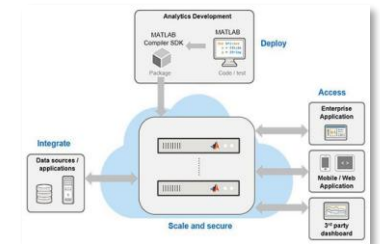
Data Management and Preprocessing



Synthetic Data Generation

```
RULPredict.m [10]
32 // Return type : void
33
34 void degradationRULPredict(const coder::b_table *dat
35     double c[3], Coder::tab
36 {
37     static const double dv[3](0.05, 0.5, 0.95);
38     cell wrap_29(2);
39     double pPFRM[400];
40     double pdfRMNormalized[400];
41     int i;
42     int idx;
43     // Load prepared model
44     // use input data for new prediction
45     [estRUL, estCI] = RULPredict(dv, dat, c);
46     idx = 1;
47     for (i=0; i<400; i++)
48         pPFRM[i] = 0.0;
49         pdfRMNormalized[i] = 0.0;
50         pPFRM[i] = 1.0;
51     }
52 }
```

Embedded Deployment

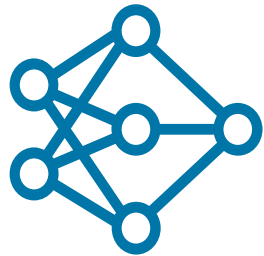


Cloud Deployment

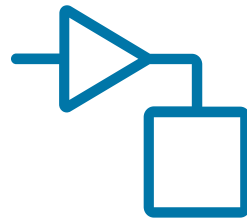
MATLAB and Simulink for Predictive Maintenance

Develop and deploy custom predictive maintenance algorithms

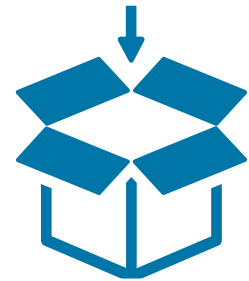
Get started



Design Predictive Algorithms

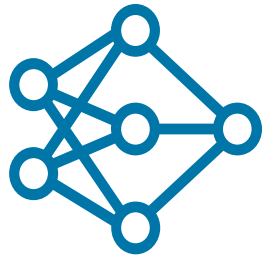


Model Components and Systems



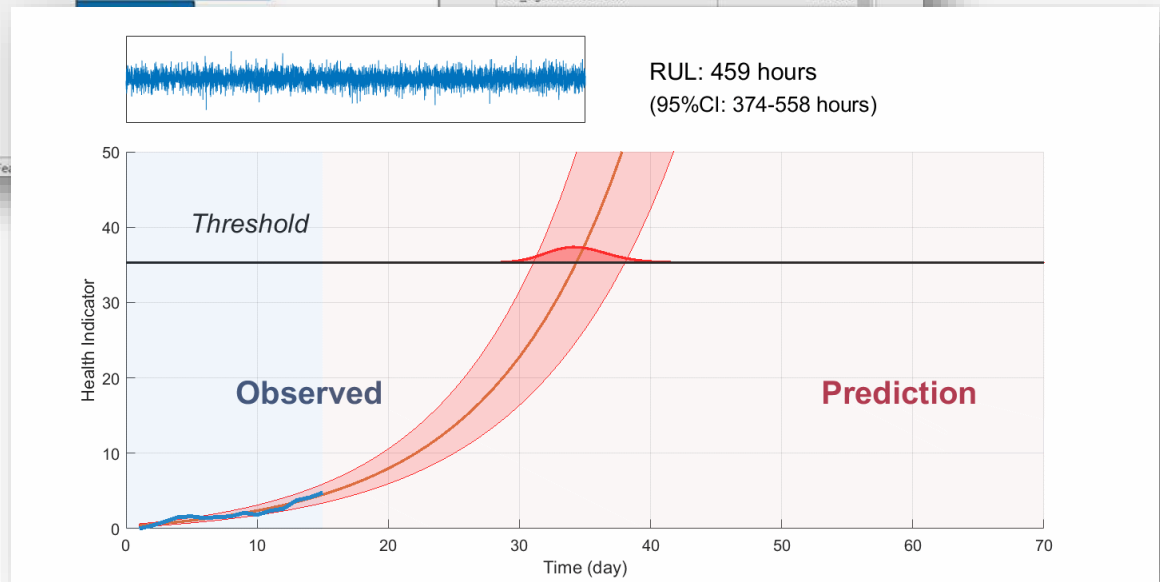
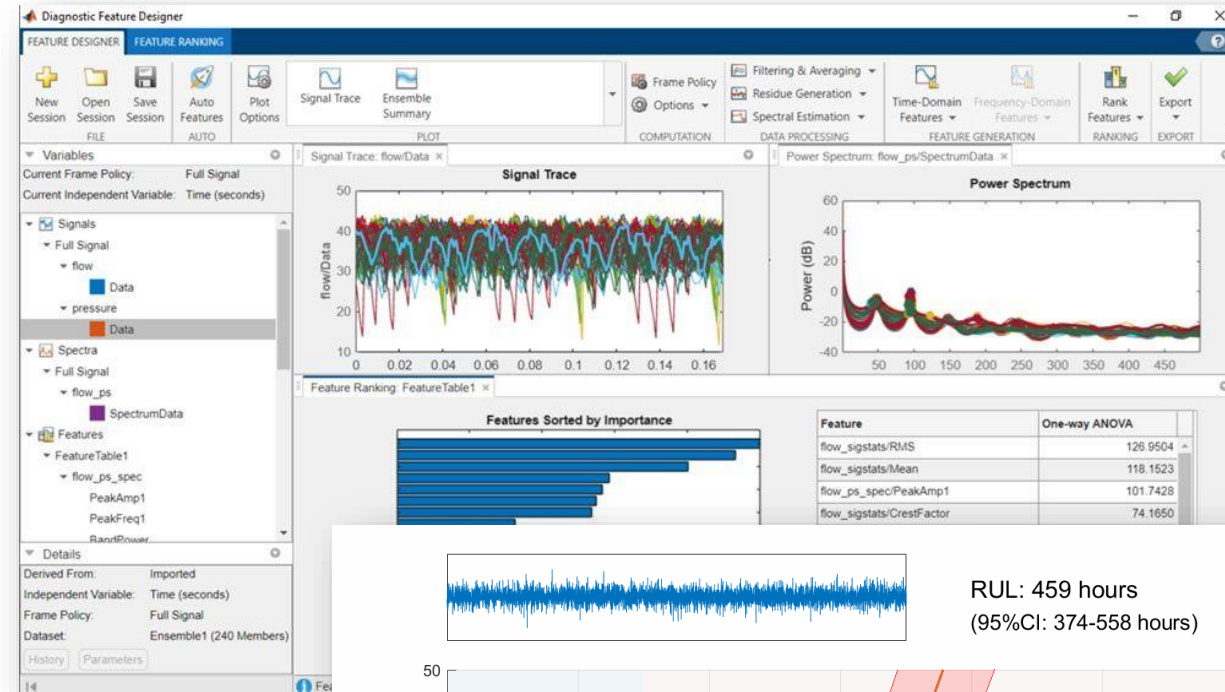
Deploy Anywhere

Apply your engineering expertise to design algorithms

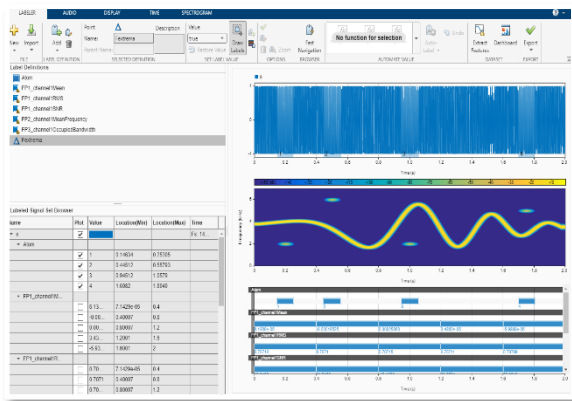


Design Predictive Algorithms

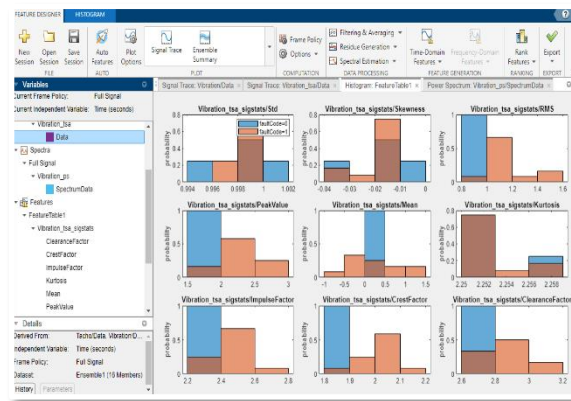
Detect anomalies, identify faults, and estimate remaining useful life with physics-based features and low-code AI



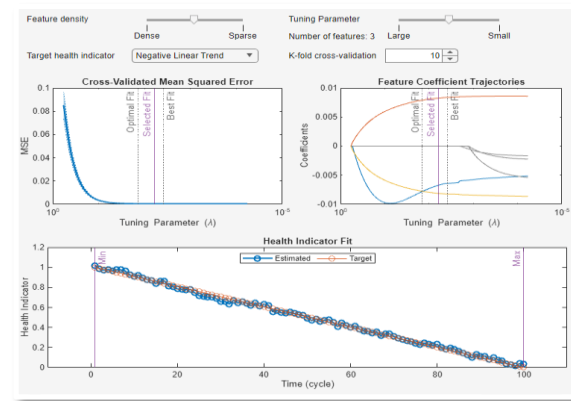
Interactive apps for predictive maintenance algorithm development



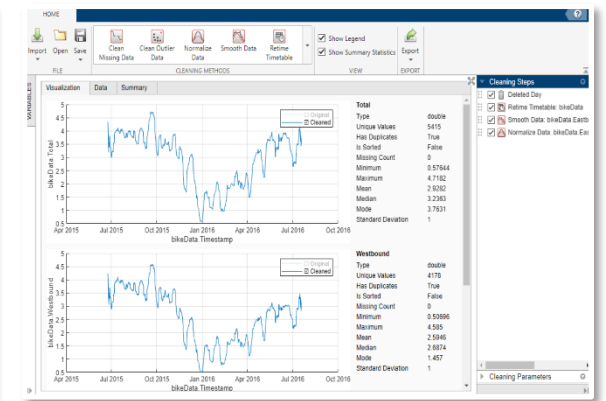
Signal Labeler



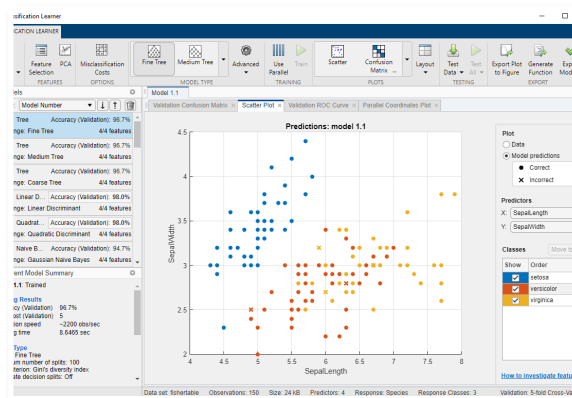
Diagnostic Feature Designer



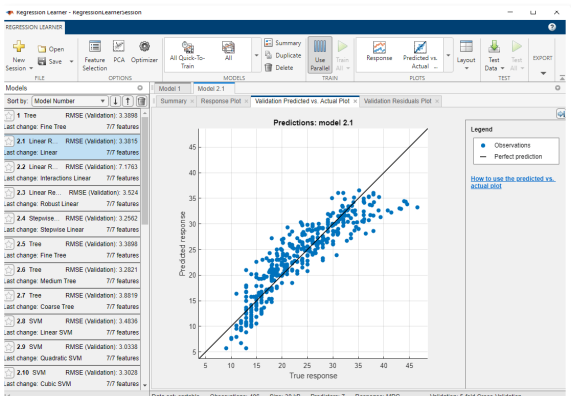
Health Indicator Designer



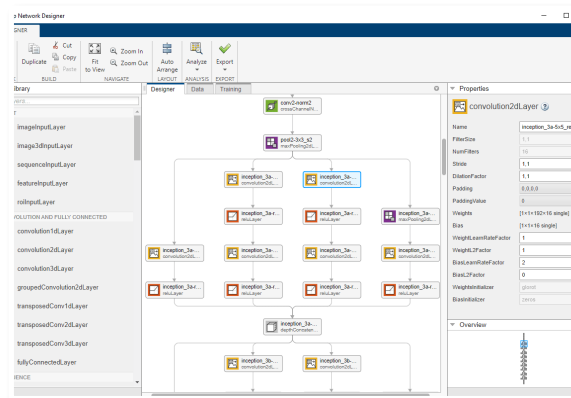
Data Cleaner



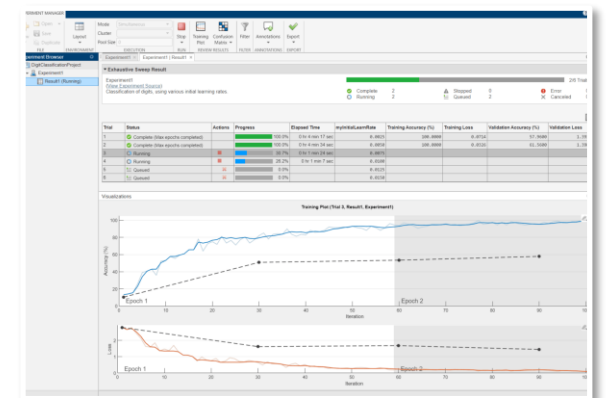
Classification Learner



Regression Learner

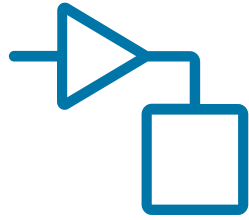


Deep Network Designer



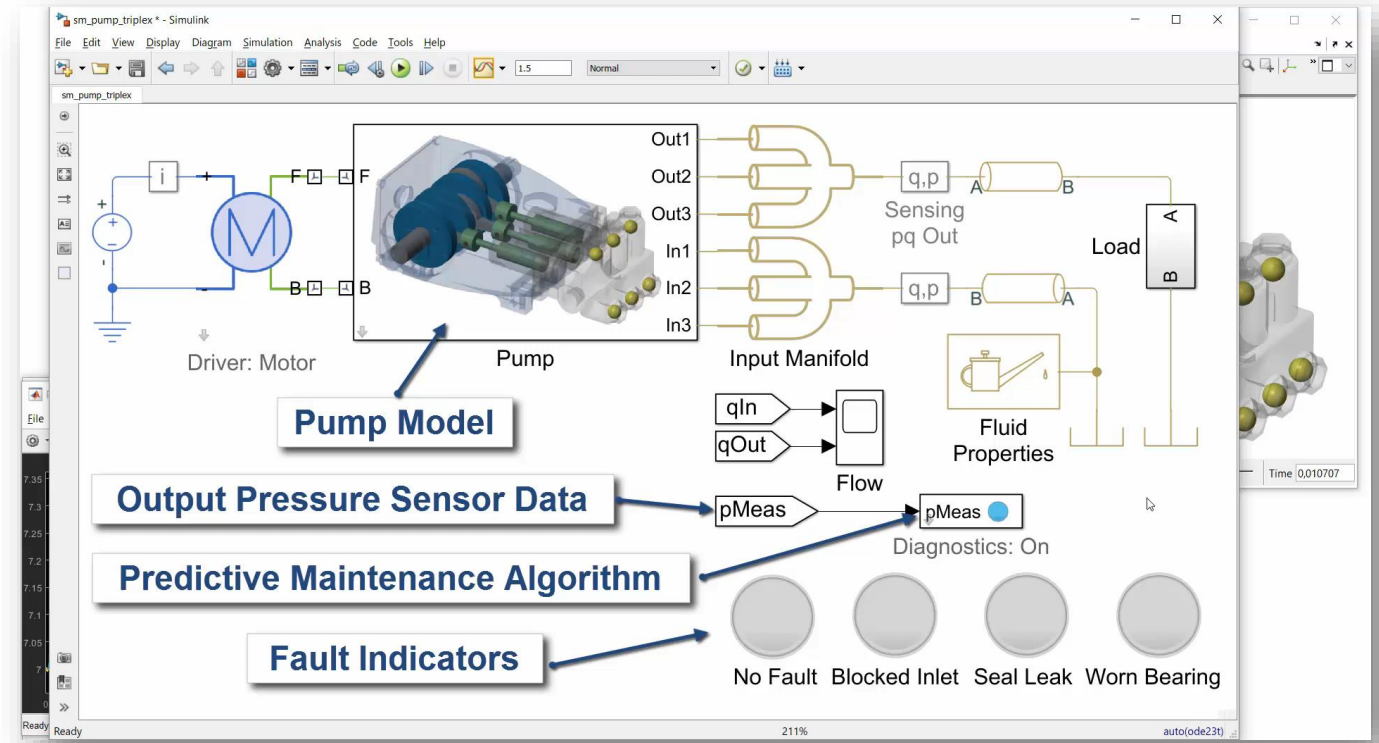
Experiment Manager

Generate synthetic data using **system and component models**

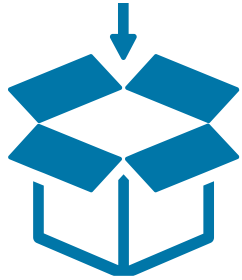


Model Components and Systems

Reuse models from design,
generate synthetic sensor data,
build and integrate digital twins

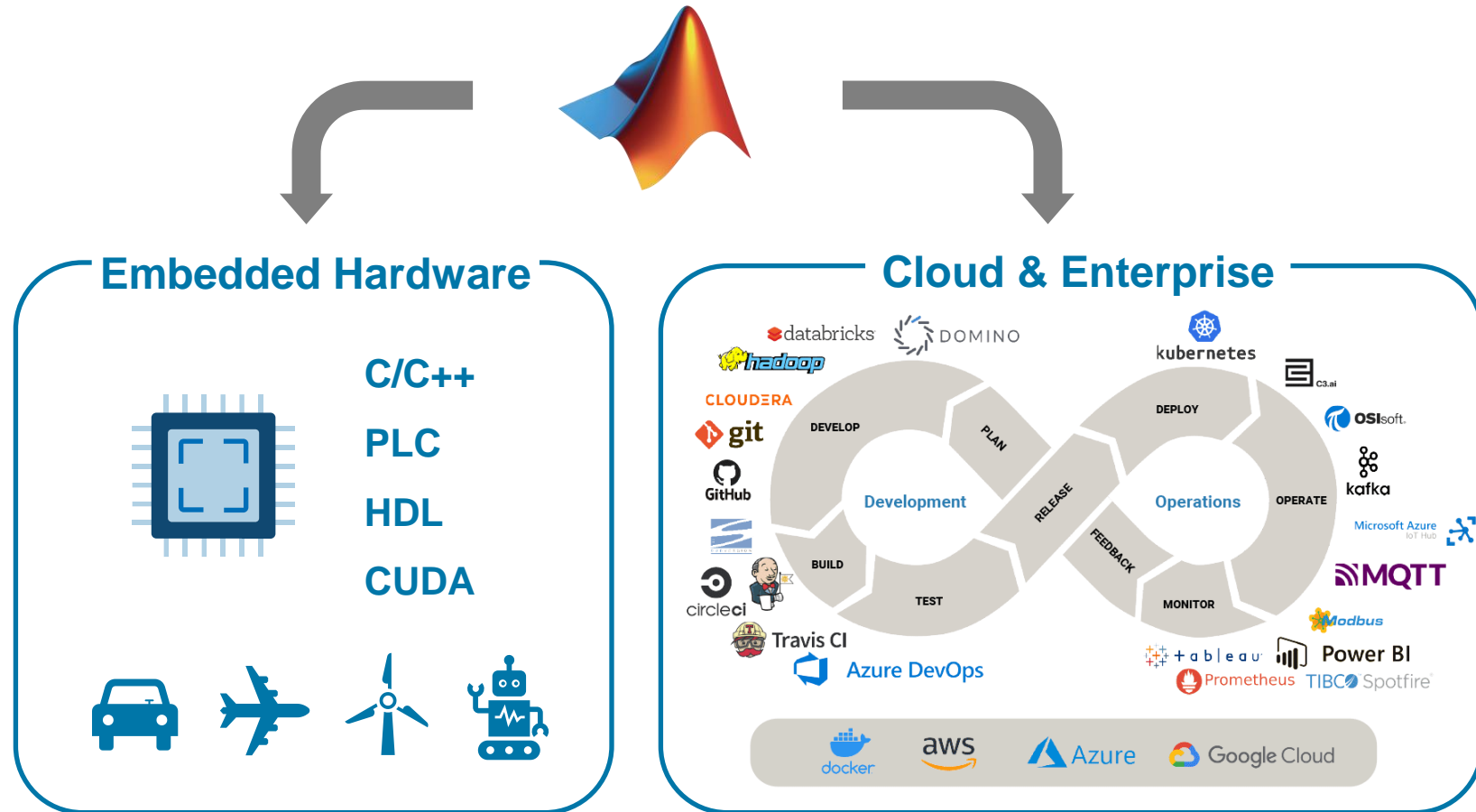


Deploy to **your choice** of embedded hardware, or integrate with a variety of platforms in the cloud



Deploy Anywhere

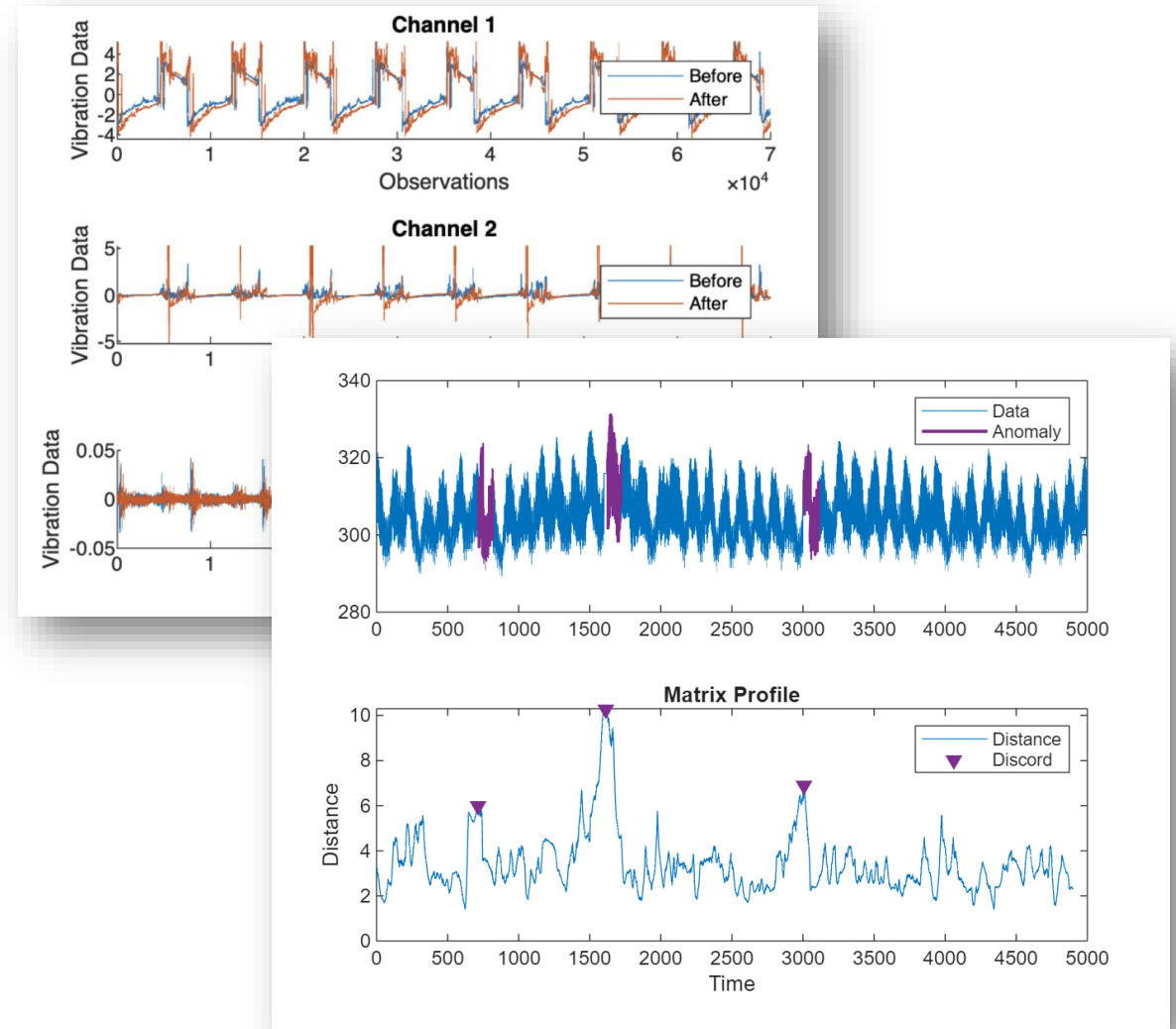
Integrate with IT/OT systems in the cloud, or generate C/C++ code for real-time processing



Tech Demo: *Time Series Anomaly Detection with MATLAB*

Tuesday 10:45 - 12:15

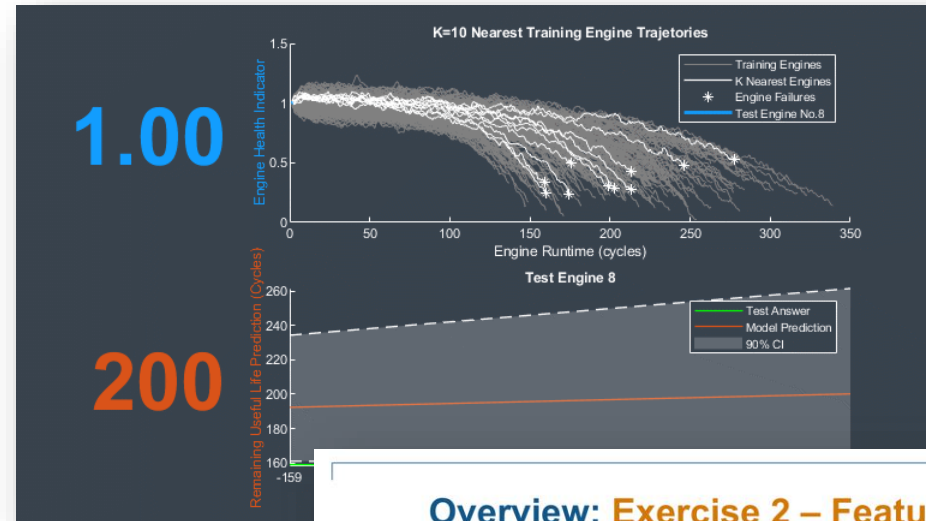
- **Overview** of new MATLAB capabilities for Predictive Maintenance and Anomaly Detection
- **Real world examples** for unsupervised anomaly detection on time series data
- **Interactive tools** like Diagnostic Feature Designer and Classification Learner
- Plenty of time for **Q&A** with MathWorks engineers



Hands-On Workshop: *Predictive Maintenance with MATLAB*

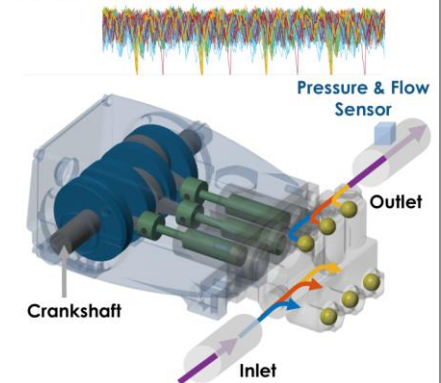
Thursday 9:30 - 11:00

- No need to install anything: explore examples using MATLAB Online in your browser
- All software licenses provided
- Just bring a fully charged laptop

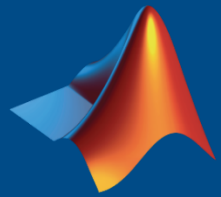


Overview: Exercise 2 – Feature Extraction

- Three-phase pump commonly used for drilling and servicing oil wells
- Detect combinations of faults:
 - Seal leak
 - Inlet blockage
 - Bearing degradation
 } 8 fault codes (1, 10, 111, etc.)
- **Goal:** Detect faults using only data from pressure and flow rate sensors



Spots are limited: Sign up at the MathWorks booth!



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**Visit our booth to learn more about
MATLAB and Simulink for
Predictive Maintenance**



Rachel Johnson
Principal Product Manager
Predictive Maintenance Toolbox



Bora Eryilmaz
Principal Software Engineer
Predictive Maintenance Toolbox



Sammit Jain
Senior Application Engineer
AI Products