Predictive Maintenance with MATLAB & Simulink
A Model-Based Approach

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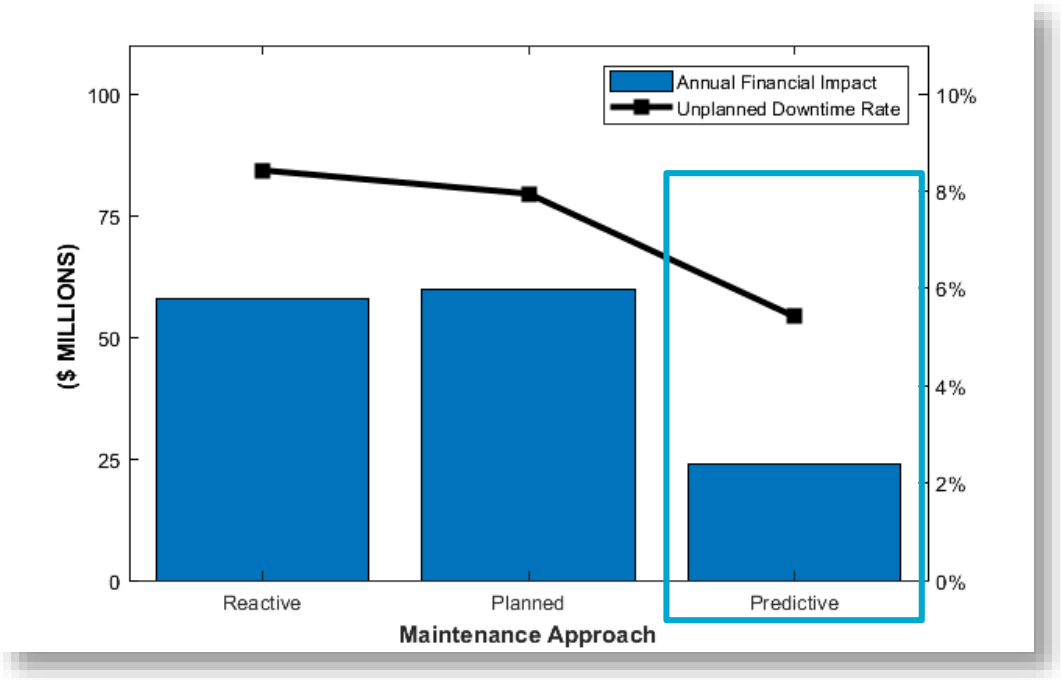
MathWorks Automotive Conference 2017, Seoul

Why is Predictive Maintenance Important?

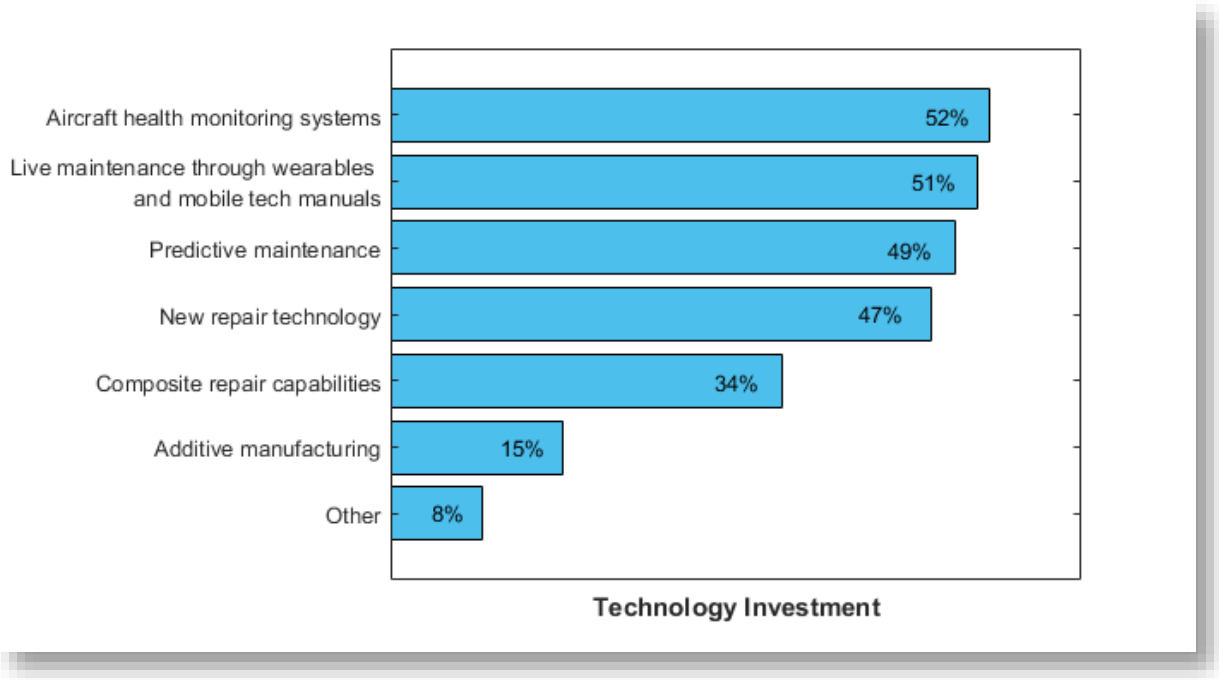
- Example: faulty braking system leads to wind turbine disaster
  - https://youtu.be/-YJuFvjtM0s?t=39s
- Wind turbines cost millions of dollars
- Failures can be dangerous
- Maintenance also very expensive and dangerous

Why is Predictive Maintenance Important?

- Improved operating efficiency
- New revenue streams
- Competitive differentiator



Source: GE Oil & Gas

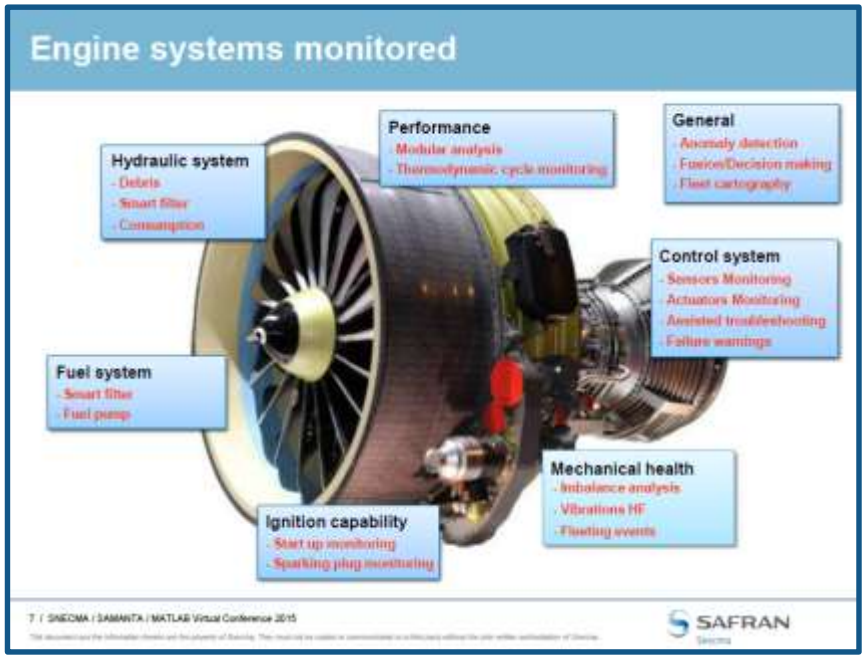


Source: Oliver Wyman 2015 MRO Survey

What Does Success Look Like?

Safran Engine Health Monitoring Solution

- Monitor Systems
  - Detect failure indicators
  - Predict time to maintenance
  - Identify components
- Improve Aircraft Availability
  - On time departures and arrivals
  - Plan and optimize maintenance
  - Reduce out-of-service time
- Reduce Maintenance Costs
  - Troubleshooting assistance
  - Limit secondary damage



Desktop

- Ad-hoc data analysis
- Analytics to predict failure

Compiled & Shared

- Suite of MATLAB Analytics
- Available to other teams
- Proof of readiness

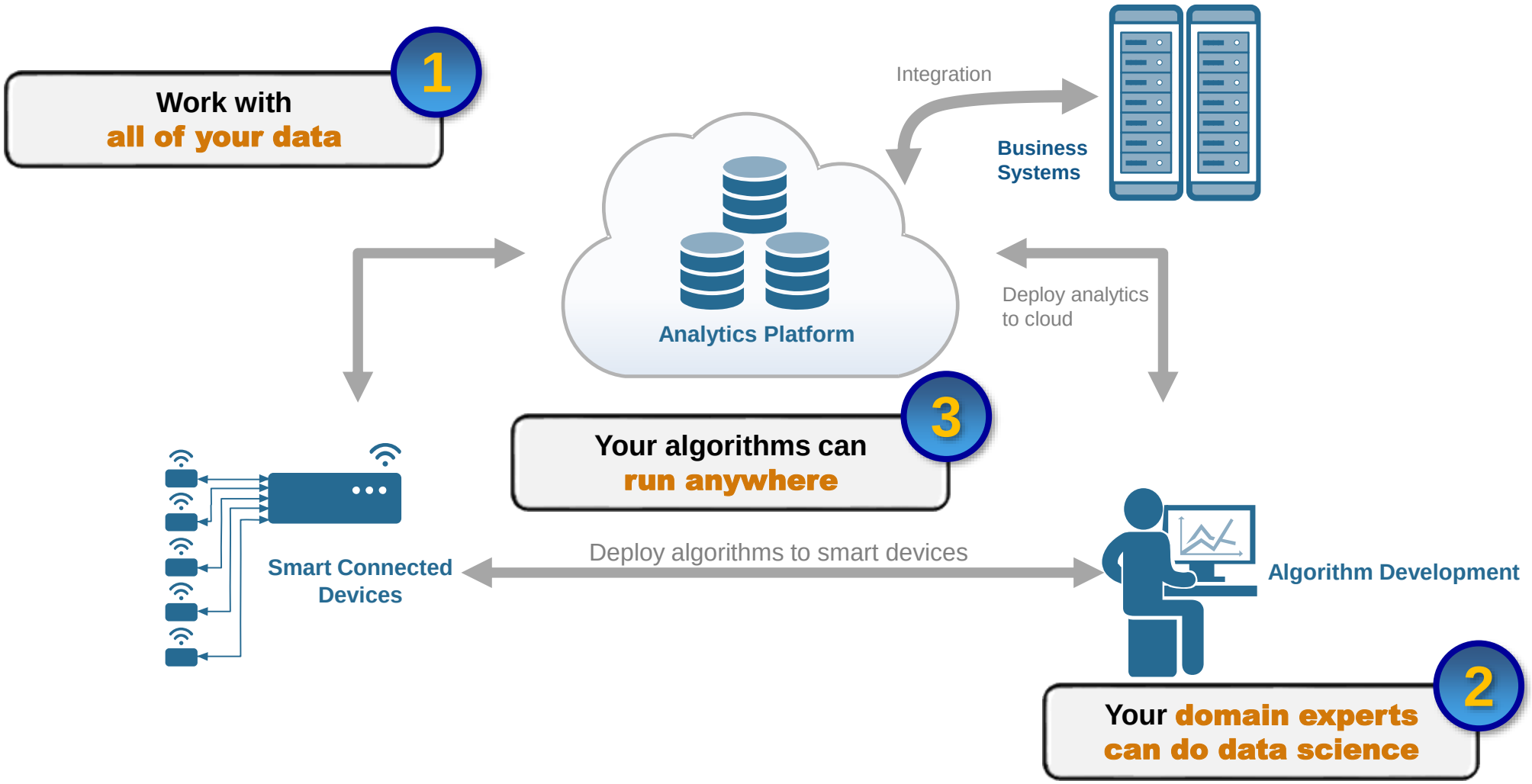
Enterprise Integration

- Real-time analytics
- Integrated with maintenance and service systems

MATLAB VIRTUAL CONFERENCE 2015

http://www.mathworks.com/company/events/conferences/matlab-virtual-conference/

Why MATLAB & Simulink?

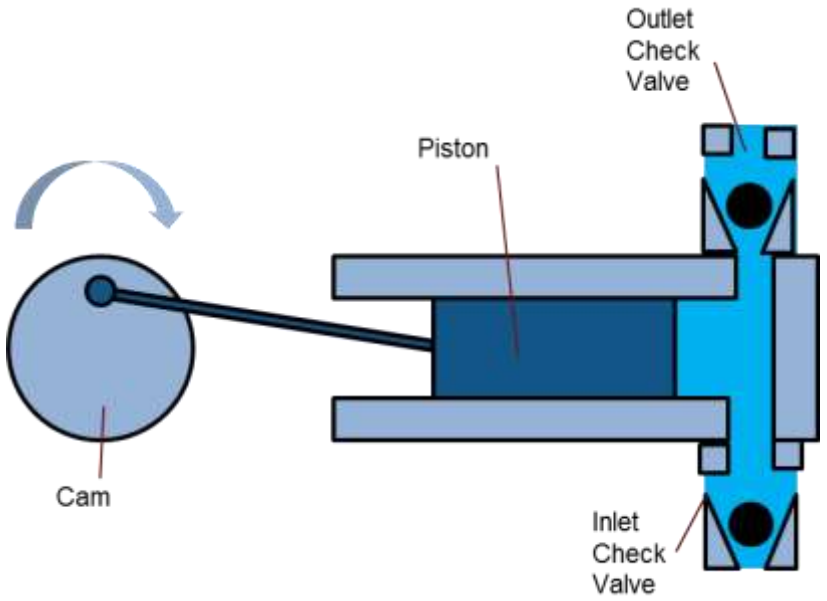


Why MATLAB & Simulink?

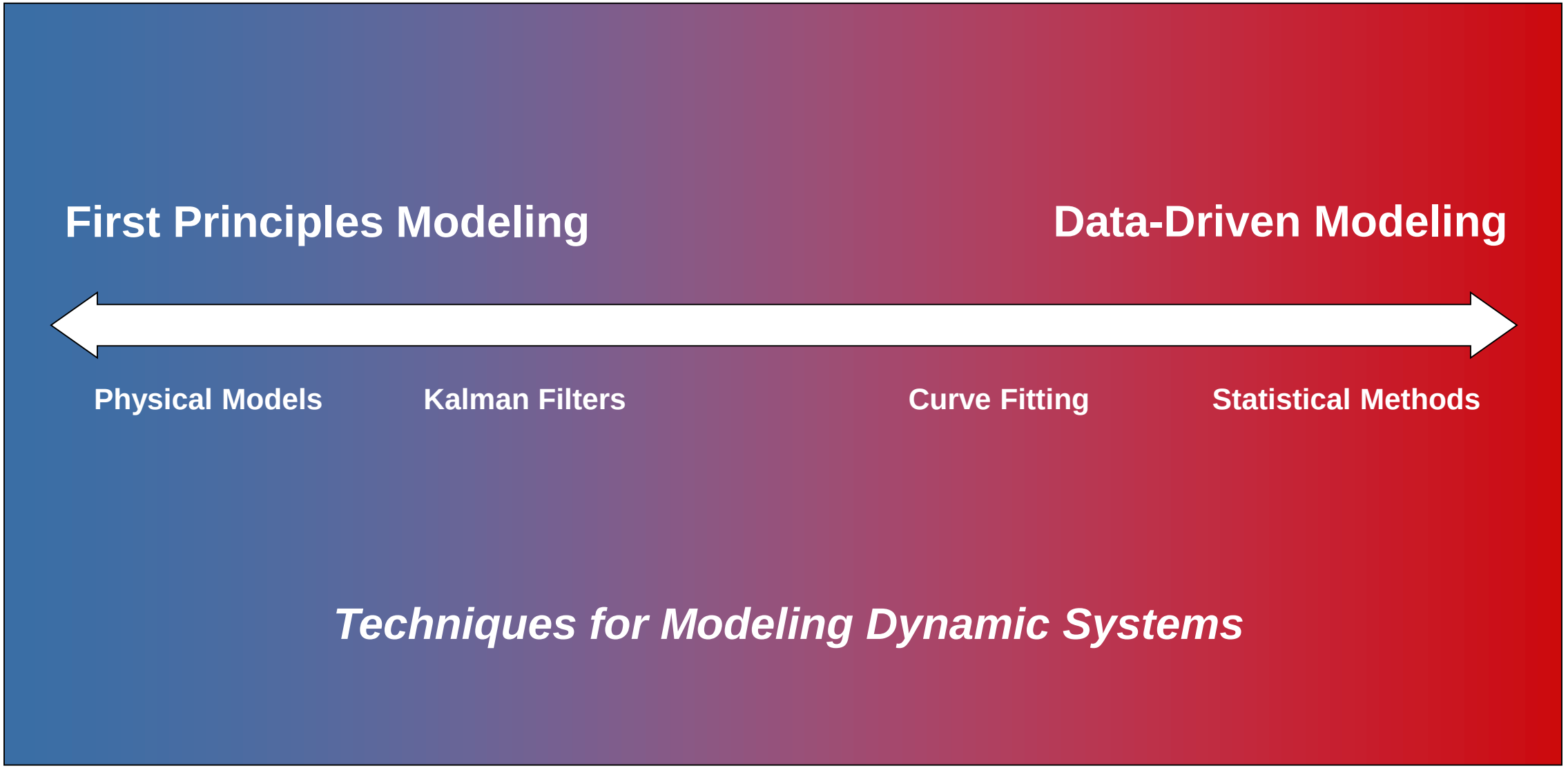
1. Work with **all of your data**
   - What if I have a lot of data?
   - What if I don't have failure data?
2. Your **domain experts can do data science**
   - How do I integrate my domain knowledge?
   - How can I identify the root cause of failure?
3. Your algorithms can **run anywhere**
   - What kind of data should I collect?
   - Where does my predictive model run?

Predictive Maintenance of a Reciprocating Pump

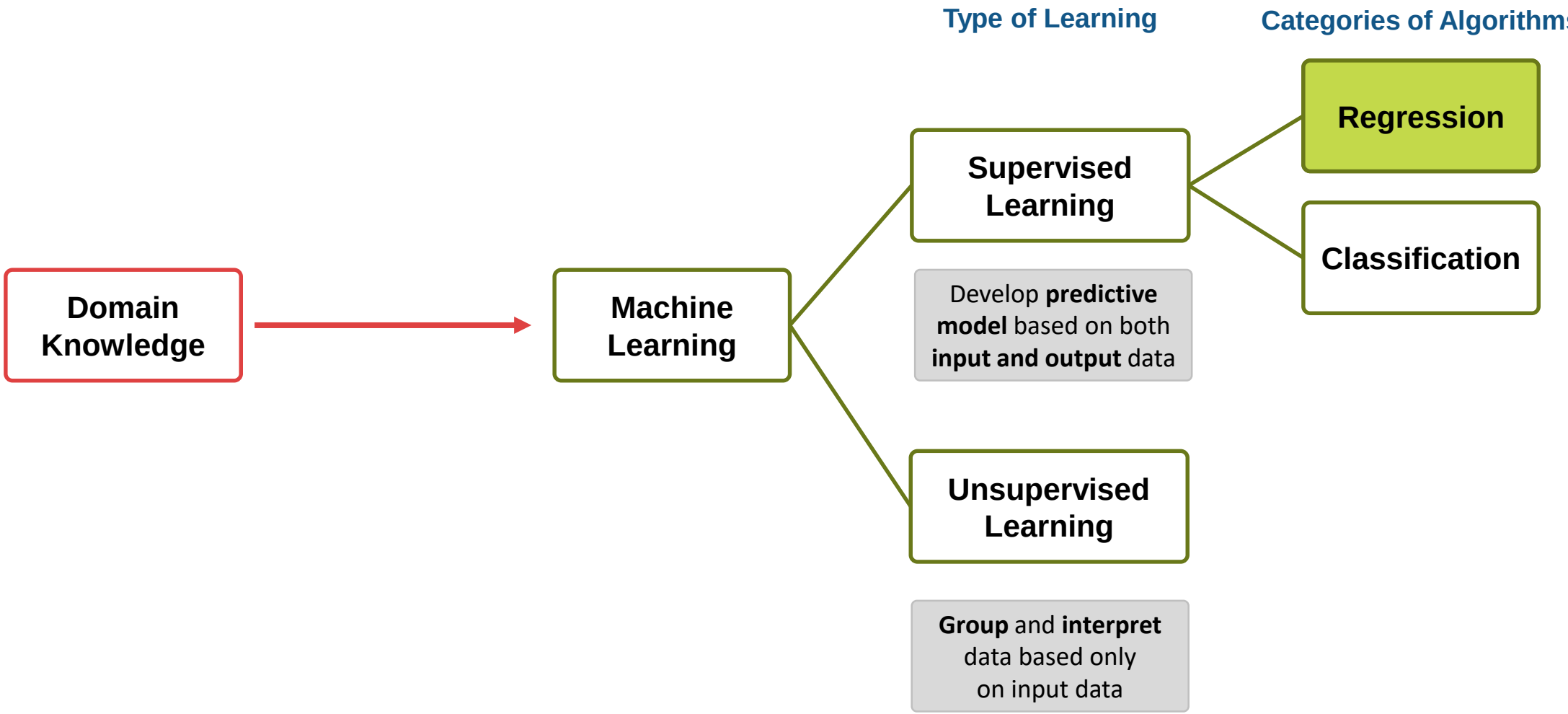
- Analyze sensor data corresponding to motor deterioration
- Estimate remaining useful life (RUL) of pump from data
- Deploy algorithm to run on live sensor data
- Predict pump failures in real-time



Integrate Domain Knowledge

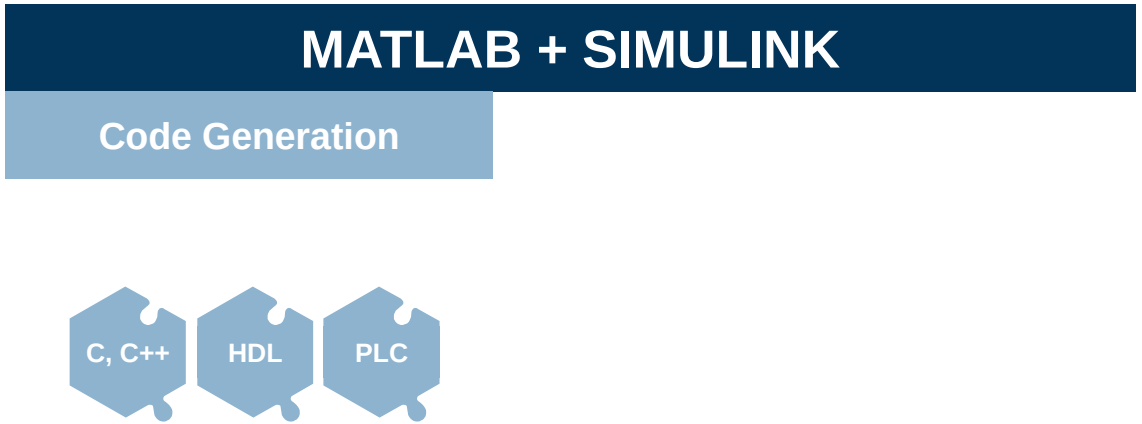


Integrate Domain Knowledge with Machine Learning



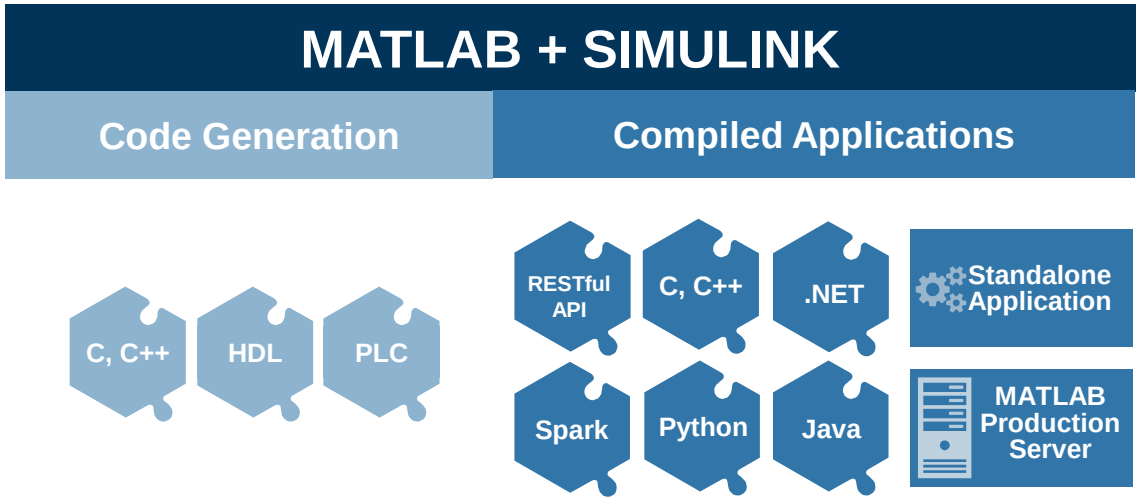
Gather the Right Data

- Preprocess data at the edge device using automatically generated code
- Extract features for use in predictive models
- Transmit the relevant data to conserve bandwidth

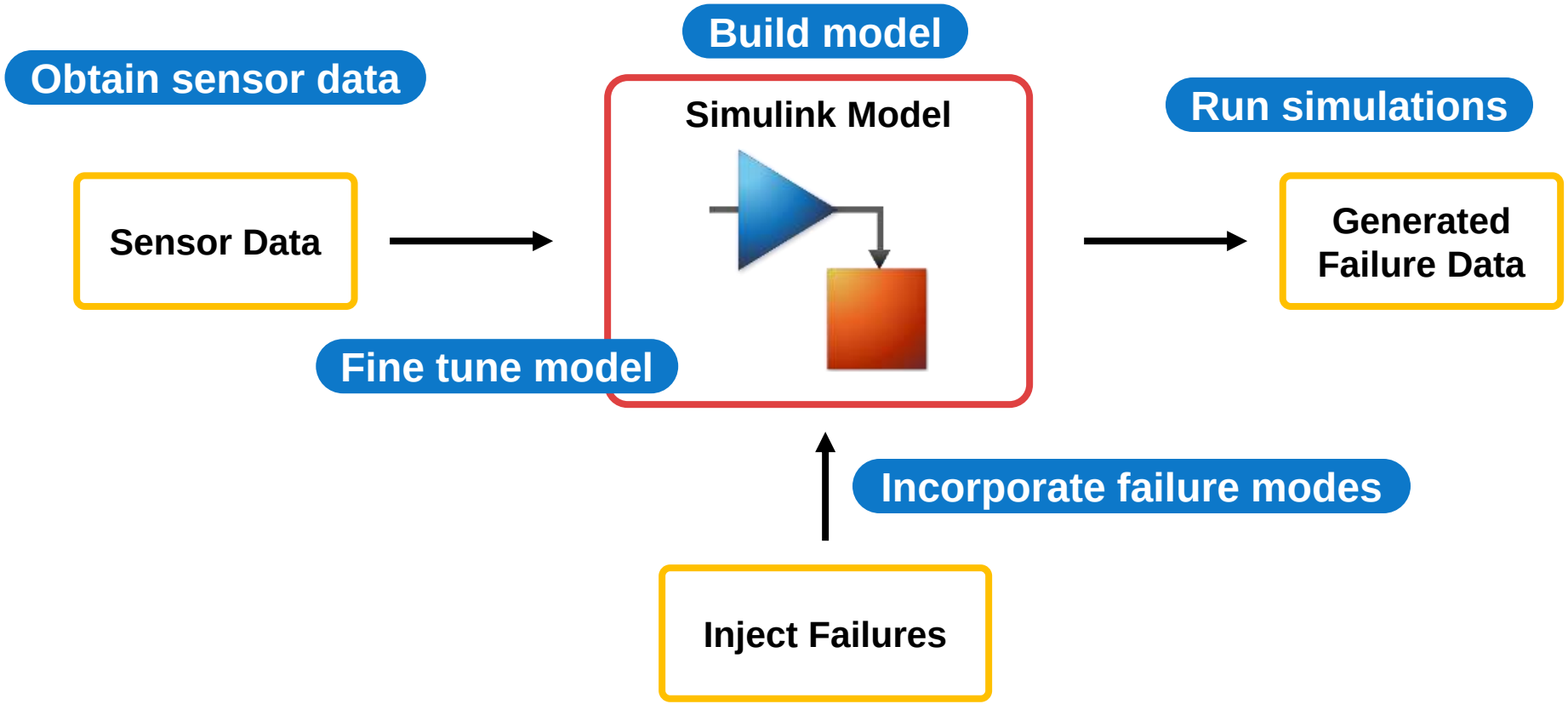


Deploy the Predictive Model

- Run your predictive model in the cloud or on embedded devices
- Scale to a production level environment
- Integrate with your enterprise systems and cloud platform



Generate Failure Data



Why MATLAB & Simulink?

- **What if I have a lot of data?**
  Use tall arrays and datastores
- **What if I don't have failure data?**
  Generate data from simulations

- **How do I integrate my domain knowledge?**
- **How can I identify the root cause of failure?**
  Use domain specific algorithms and techniques with machine learning capabilities

- **What kind of data should I collect?**
  Collect feature rich data from your machine
- **Where does my predictive model run?**
  Run it on the cloud, enterprise systems, or on local machines