Artificial Intelligence Application in Grid Edge Asset Health Monitoring

Presented by

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- **Introduction**
- Insights on Data Acquisition
  - Features
  - Sensor Saturation and Calibration
- Insights on Model Training
  - Overfitting
  - Model Elasticity (NN versus SVM)
- Deployment on an Embedded Platform
- Conclusion

Introduction

- Grid Edge Asset Health Monitoring

What is Grid Edge Asset Health Monitoring?

- Monitor and predict the potential malfunctioning of an edge device such as, for example, a switch.
- The health of the asset can be the life of any measurable components.

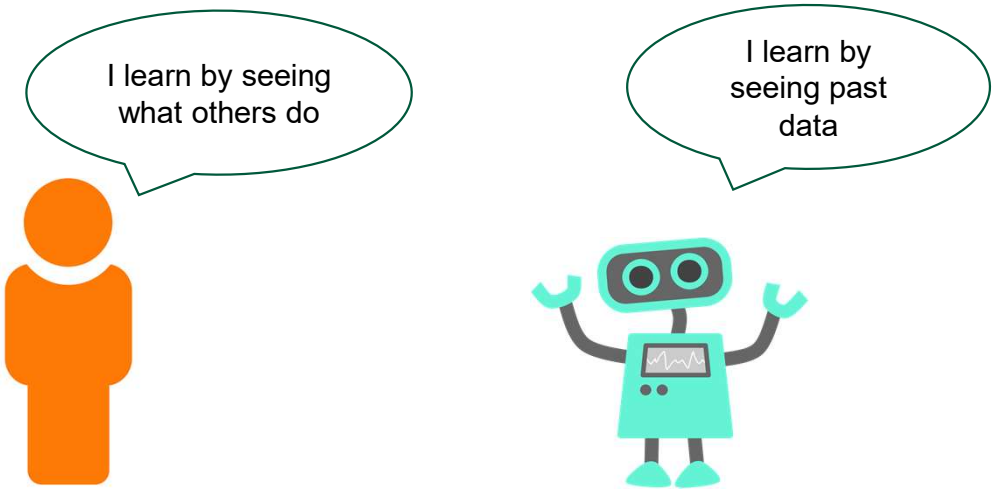
Why is it important?

O&M cost-saving strategy:

- Prevent finding malfunctions or breakdowns after it happened
- Predictive maintenance or planned maintenance instead of unnecessary outage or unplanned truck roll.
- Saving shipping costs the whole product to the factory for repair or troubleshooting

Introduction

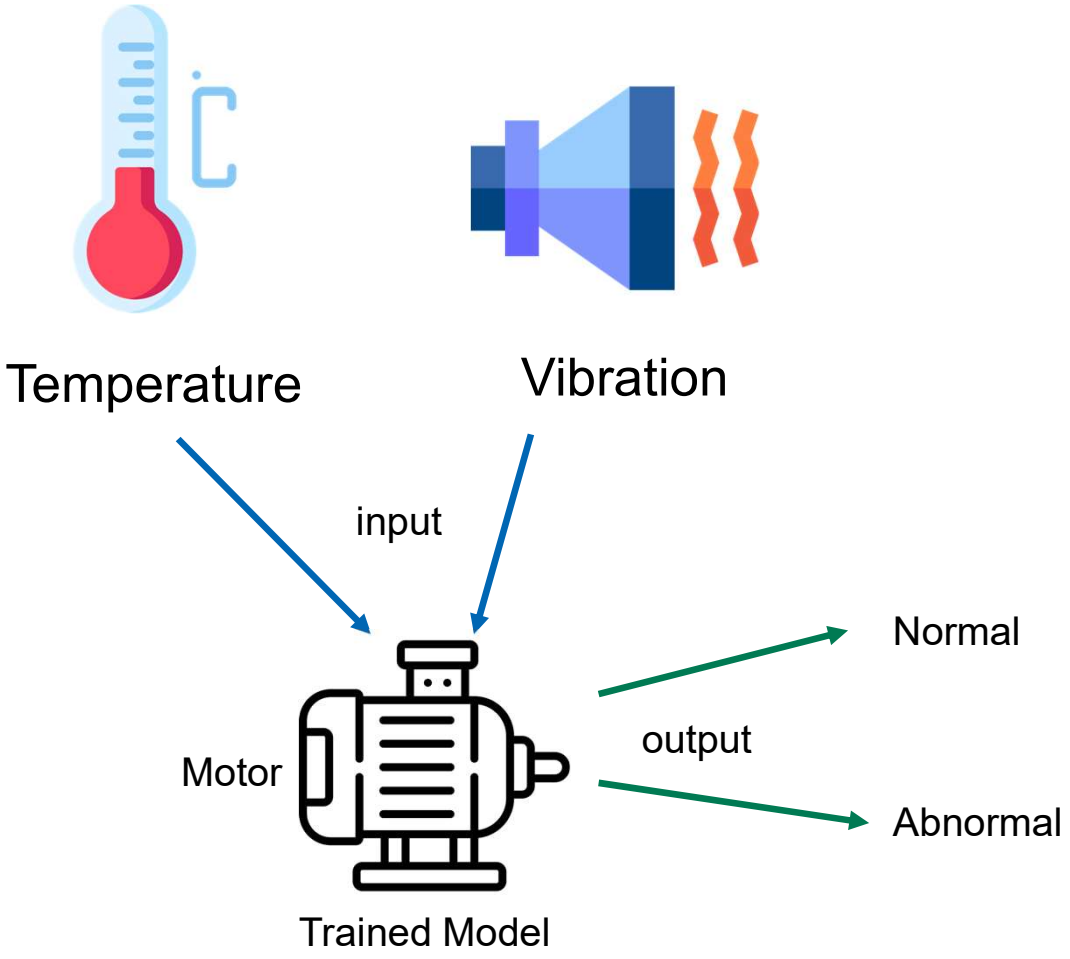
- What is machine learning?



Asset health monitoring can also use machine learning to make predictions on the asset health

Introduction

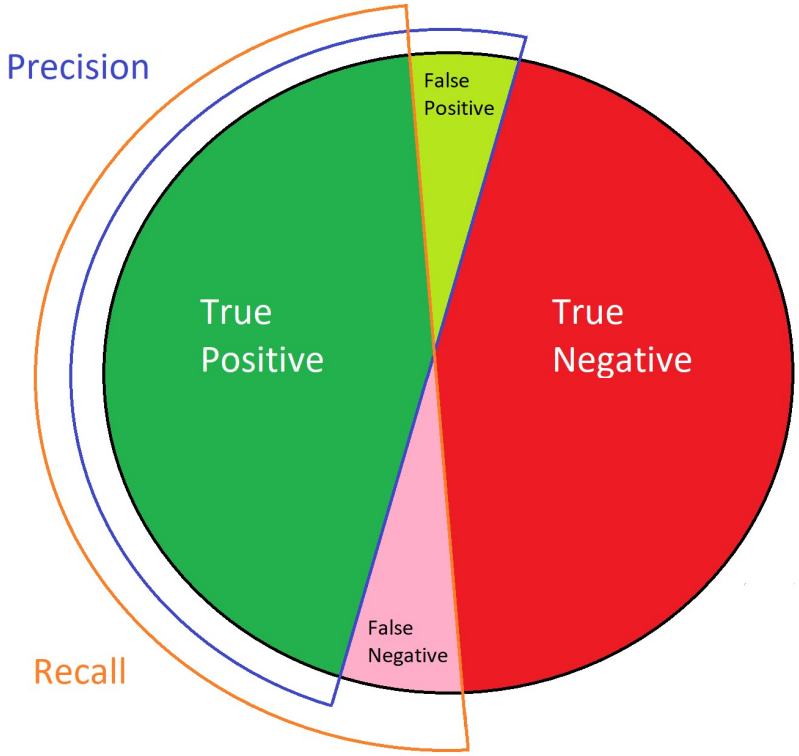
- Features



Introduction

- Models & Metrics

Neural Network (NN) and Support Vector Machine (SVM) are both machine learning algorithms where its objective is to draw a separation line where it can separate data into its respective classes.



Precision – % of positively classified which are true positive

Recall – % of positives which are detected as such

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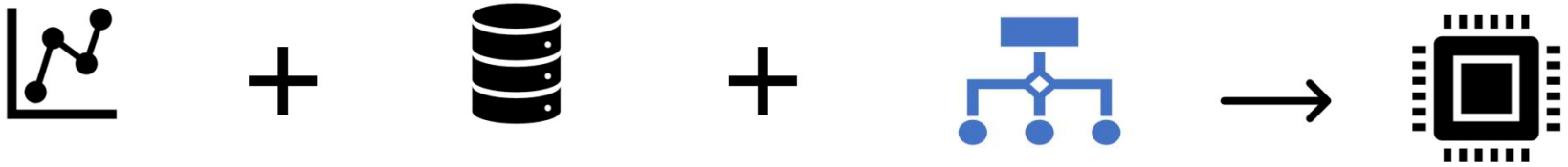
Data Acquisition

- Machine Learning Data Acquisition



Data Variety + Feature Engineering + Classes → Model

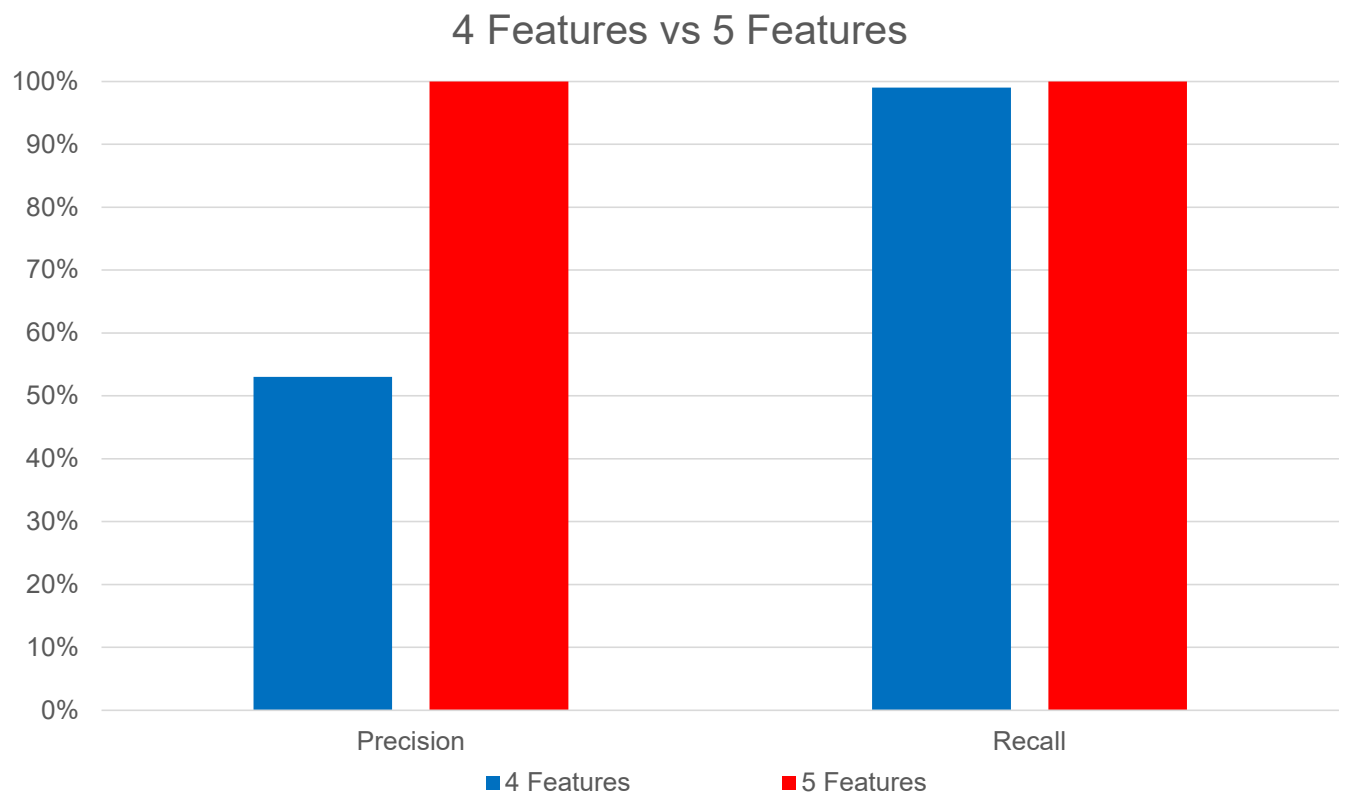
Examples:

Data Variety	Feature Engineering	Classes
Hot Day Cold Day	Temperature Vibration	Normal Malfunction Bearing issue

Data Acquisition

- Impact of features

More features

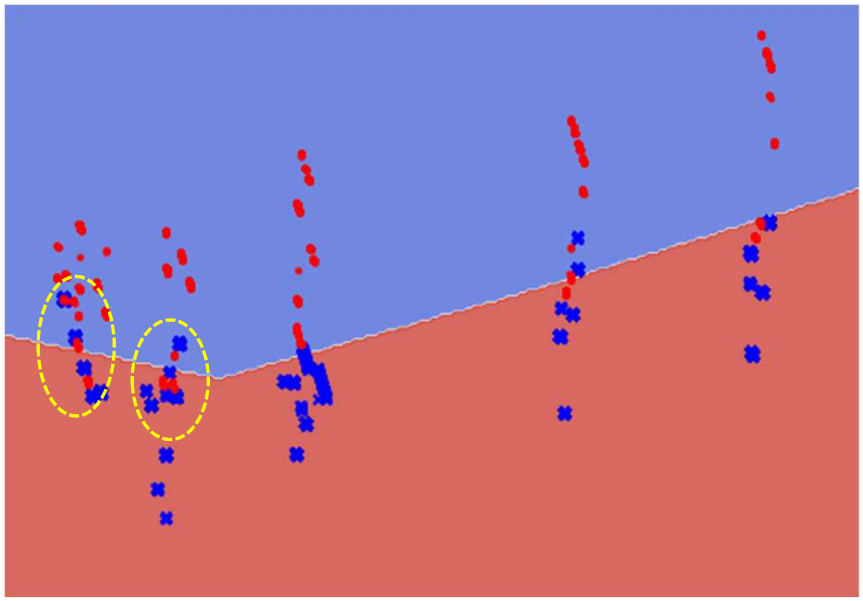


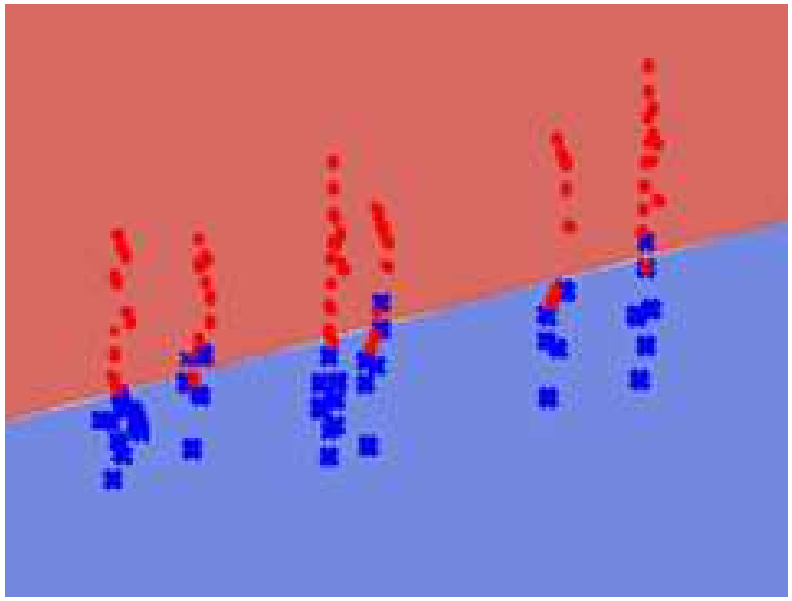
Data Acquisition

- Impact of Data Quality

Data Quality

Limitations on the sensor measurements



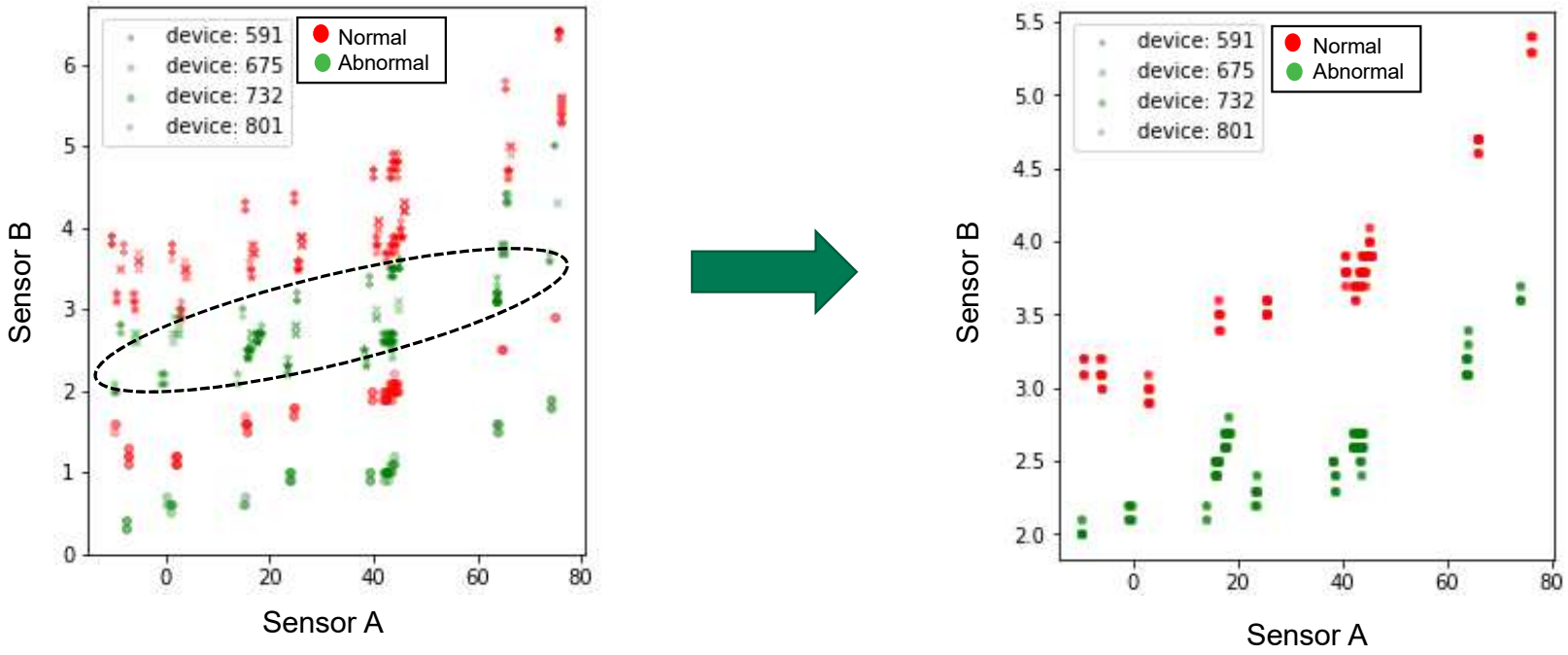


Data Acquisition

- Impact of Data Quality

Data Quality

Impact of small differences between the same sensors on different devices



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Model Training

- Example

Overfitting

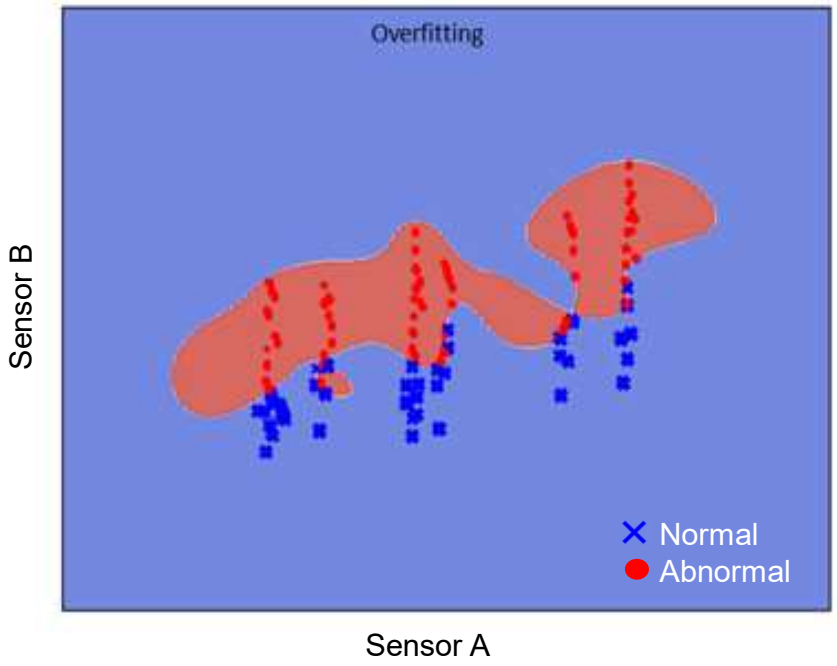


Figure A

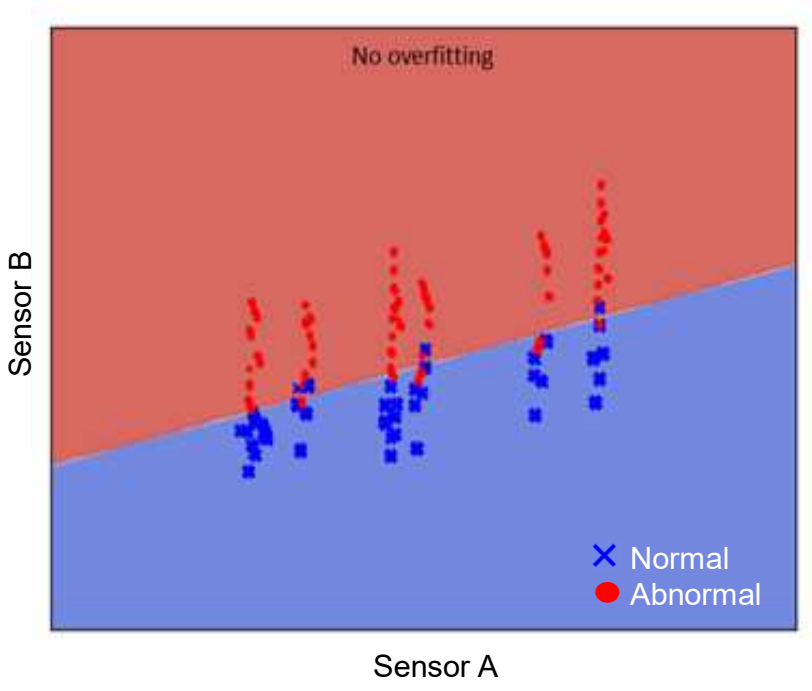


Figure B

Model Training

- Example

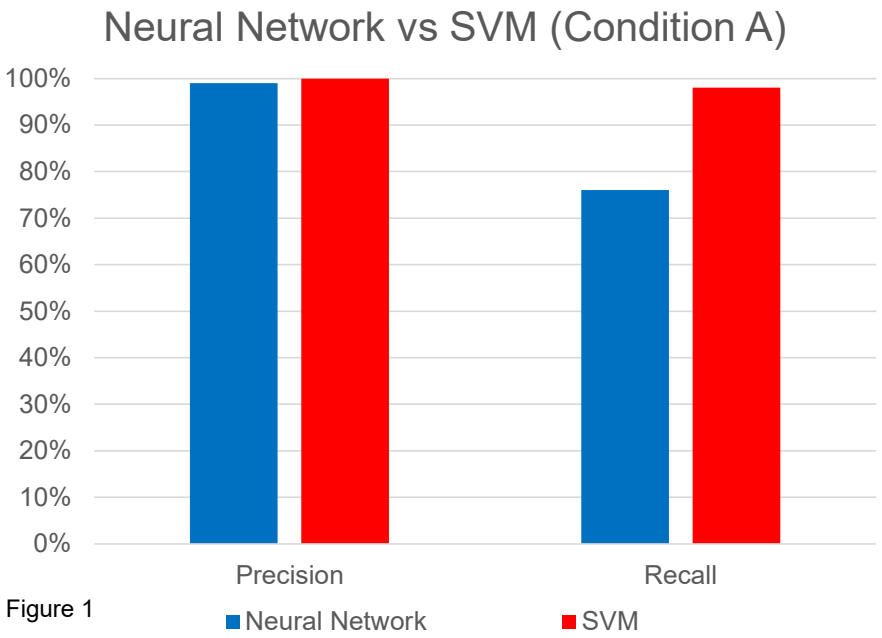


Figure 1

Model inferencing used a model trained with 26,000 samples

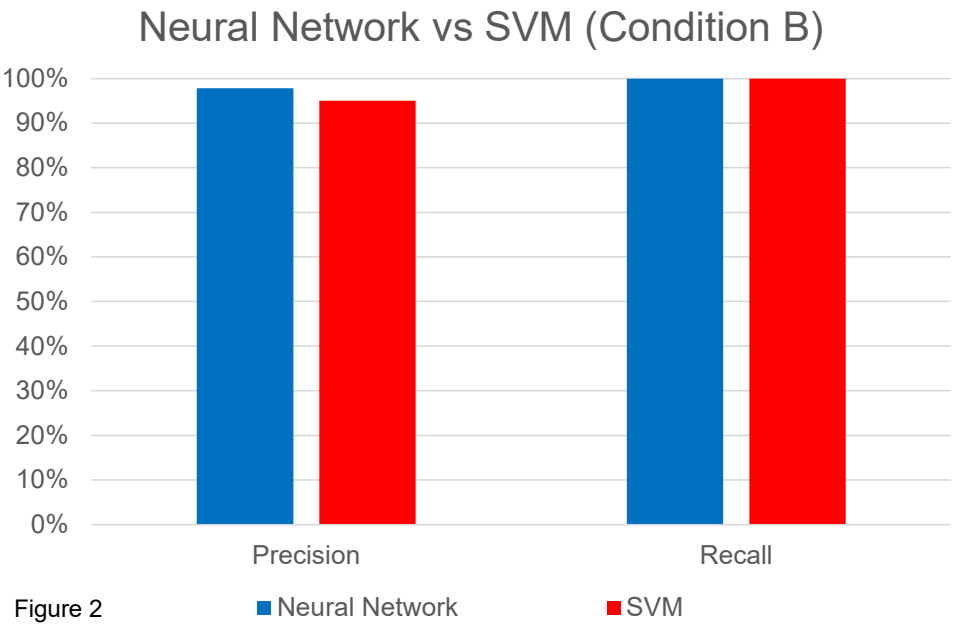
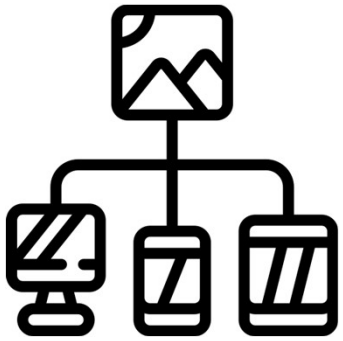


Figure 2

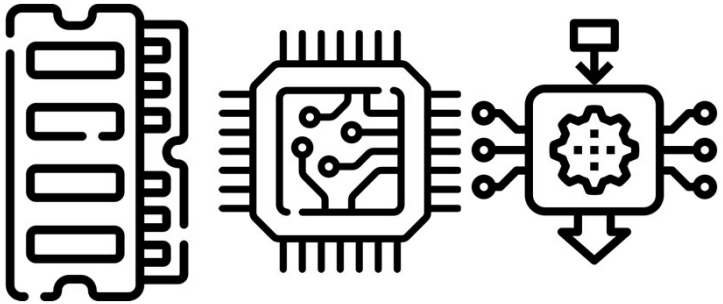
Model inferencing used a model trained with 500,000 samples

Inferencing

- Traditionally, machine learning requires sending data to the cloud where it will return the inferencing results but we have shown that this could be done on an edge device.



Deployment to the controller



Metrics on memory, CPU, & inferencing

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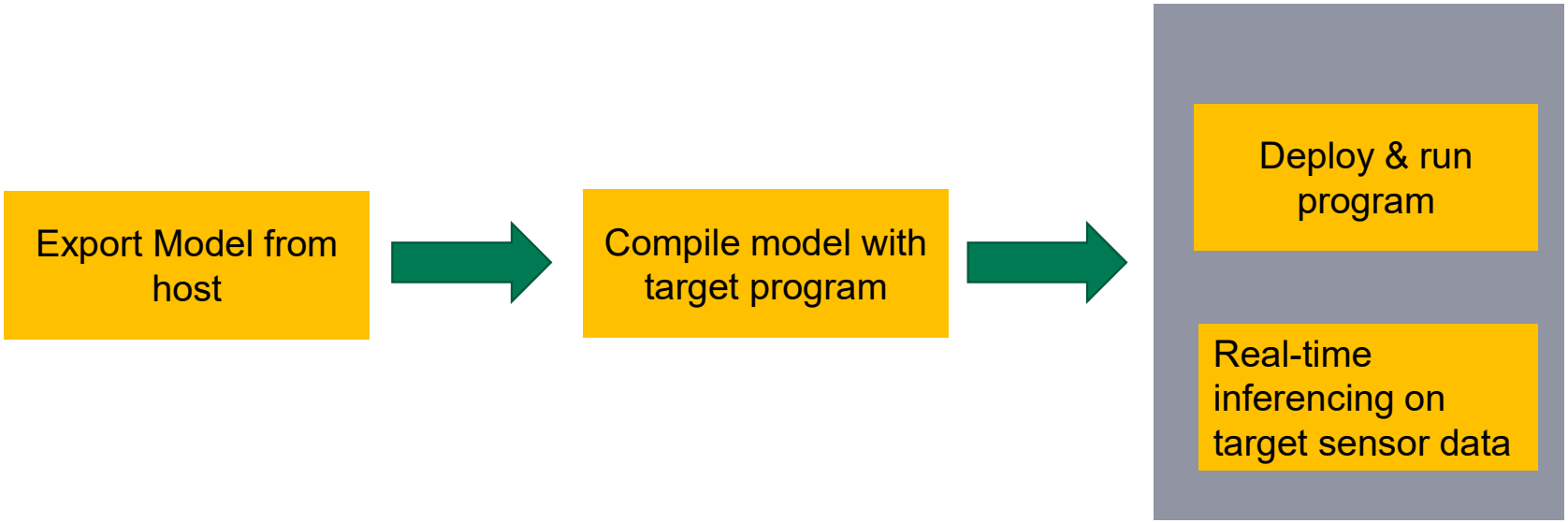
Inferencing

- Model Export and Inference

Model Export Deploy Inference Process



Inferencing

- CPU/Memory Metrics

NN and SVM running on Linux OS target

App	CPU	Memory	Inference Time
NN	0.7 %	3.4 M	45 µs
SVM	0.7 %	1.1 M	380 µs

Note: running on a quad core ARM 1 GHz processor

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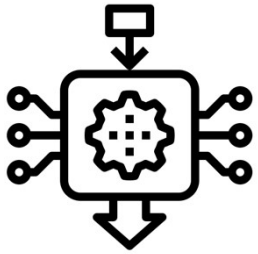
Conclusion



Artificial Intelligence

Data
Model Training
Inferencing

+

Constrained Edge Device
Health Monitoring

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