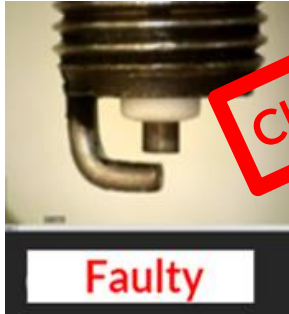


Fault Diagnosis and Detection of ICE Spark Plugs using Extended Multi-Scale Principal Component Analysis (EMSPCA)

Prepared by **Essam Seddik**

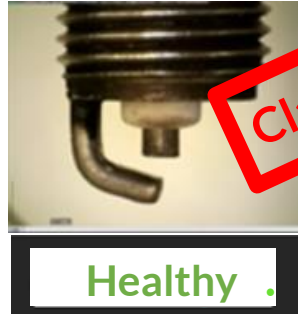
Problem Statement

Smaller Gap



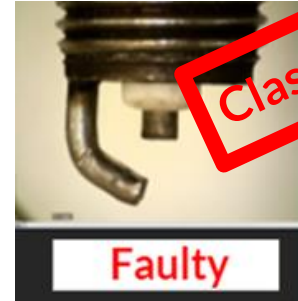
- Short Spark
- Early & weak ignition
- Low engine performance
- Low efficiency
- High Fuel Consumption
- Piston damage

OEM Gap



- Design Spark
- Design ignition
- Design performance
- Design efficiency
- Design Fuel Consumption

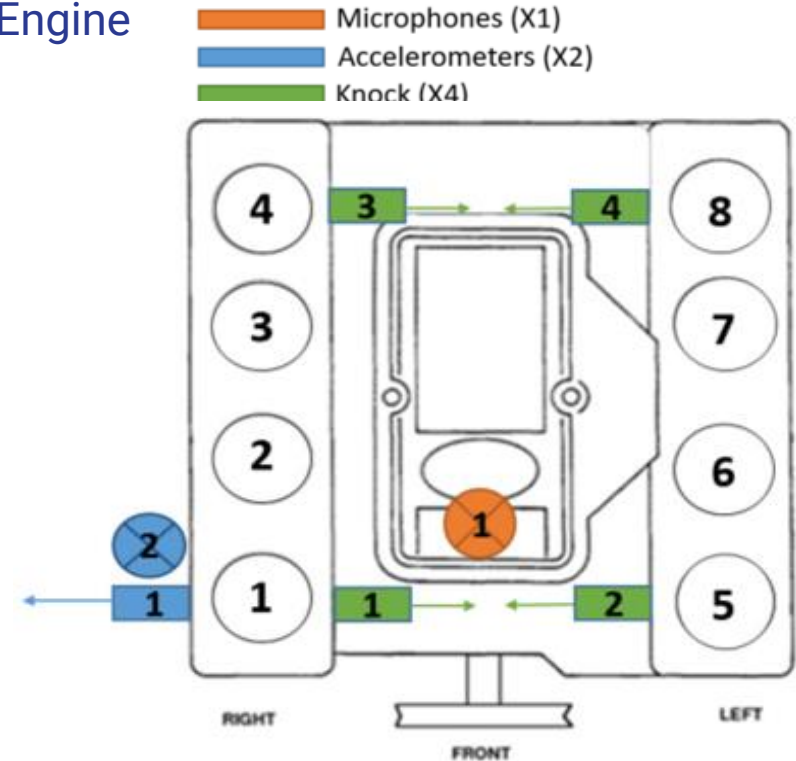
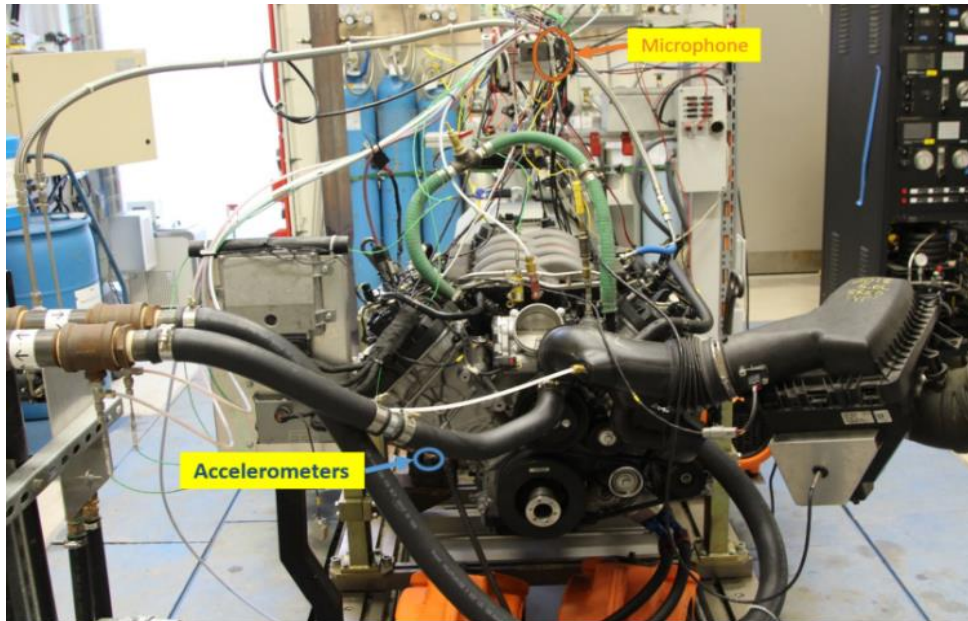
Larger Gap



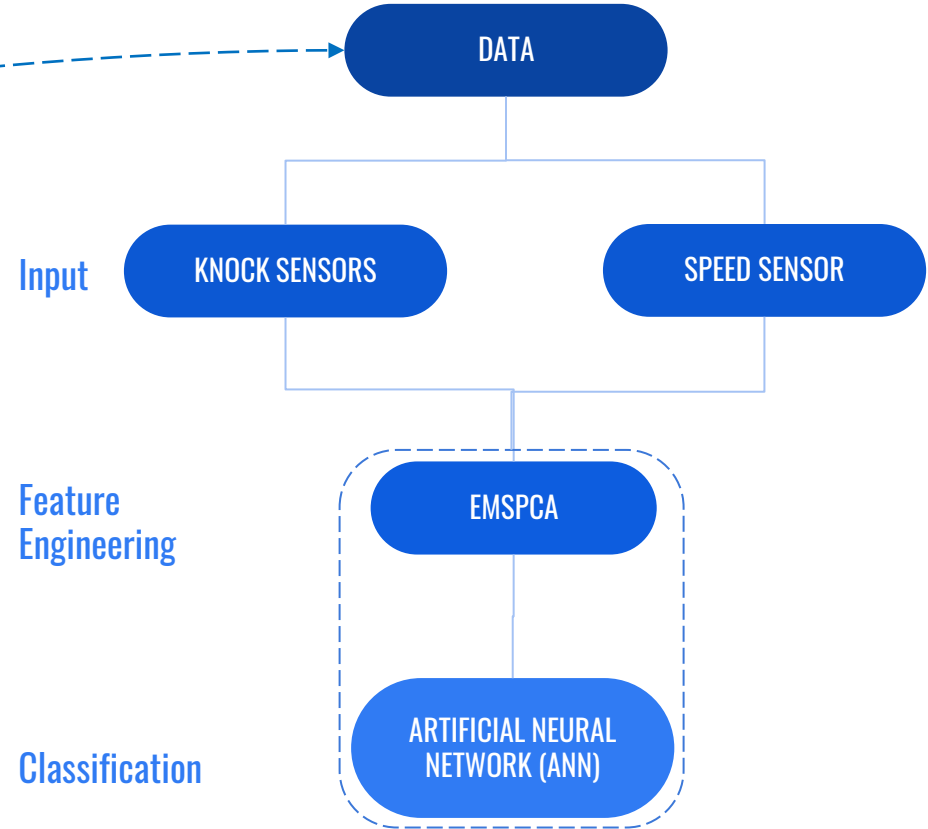
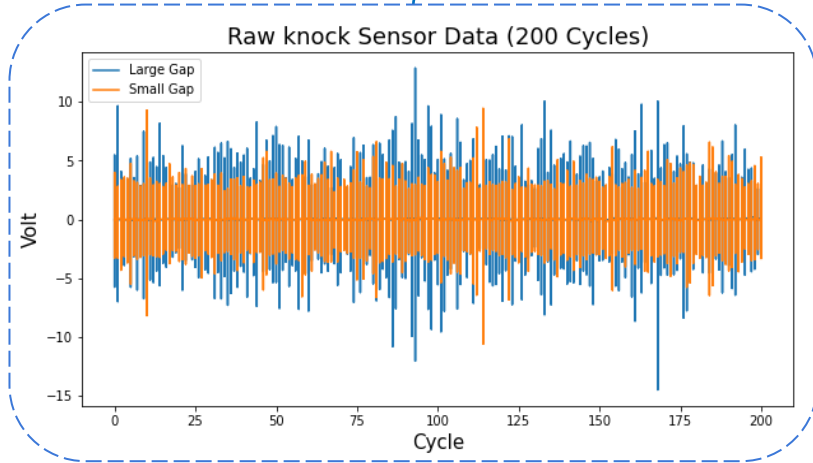
- Wide Spark
- Late ignition (or None)
- Low engine performance
- Low efficiency
- High Fuel Consumption
- Piston damage

Data Acquisition

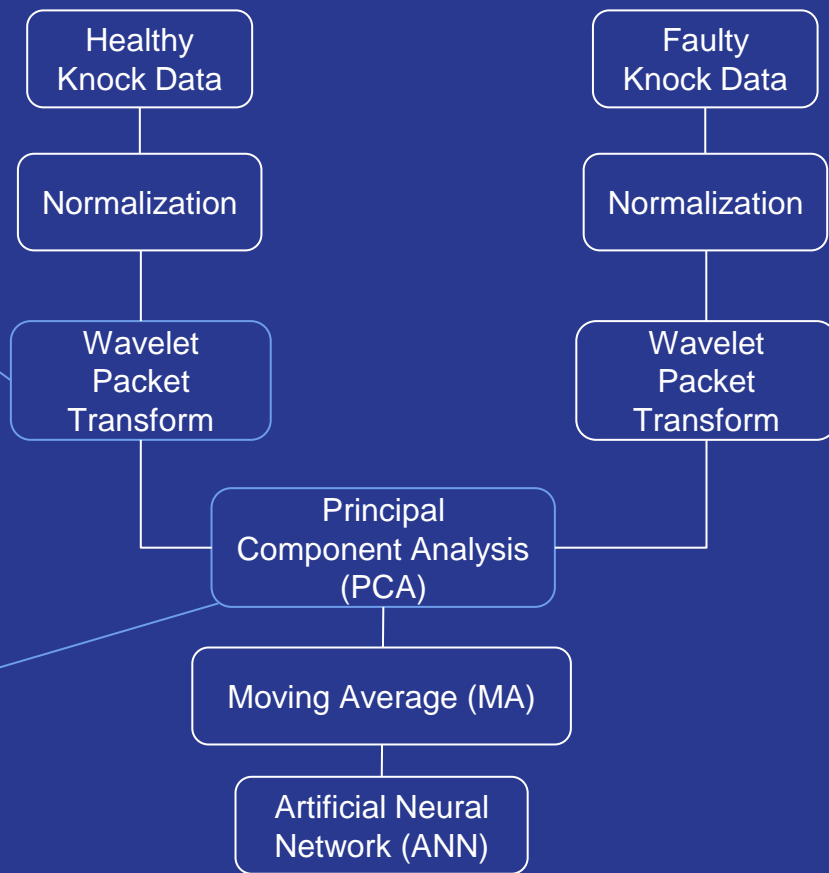
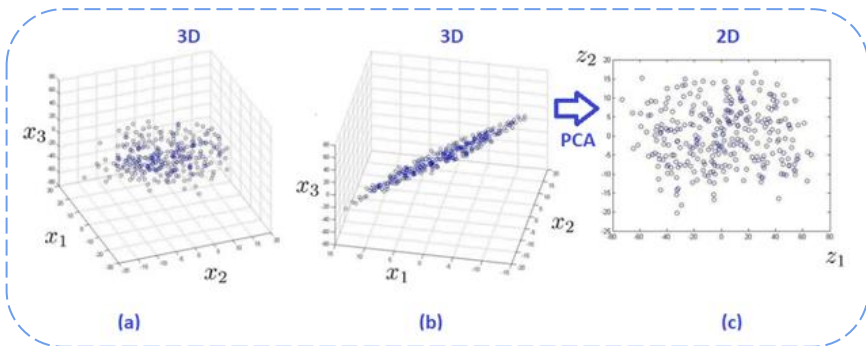
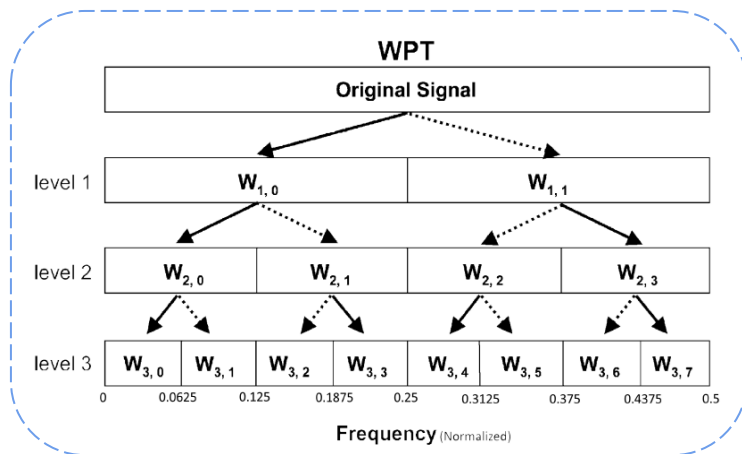
Data was collected through a V8 5.0L Ford Coyote Engine Test Center: [CMHT's dynamometer]



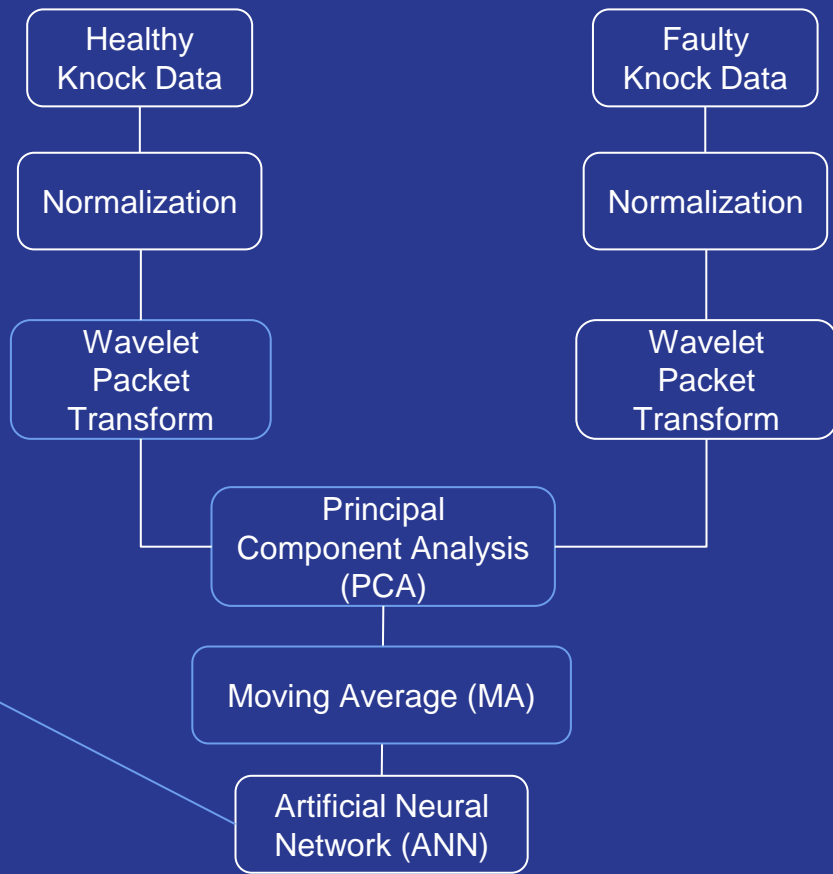
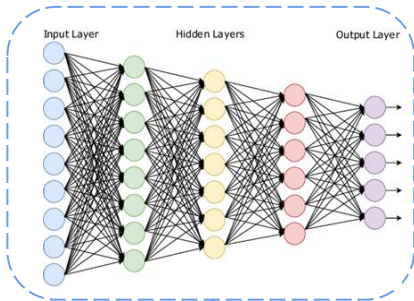
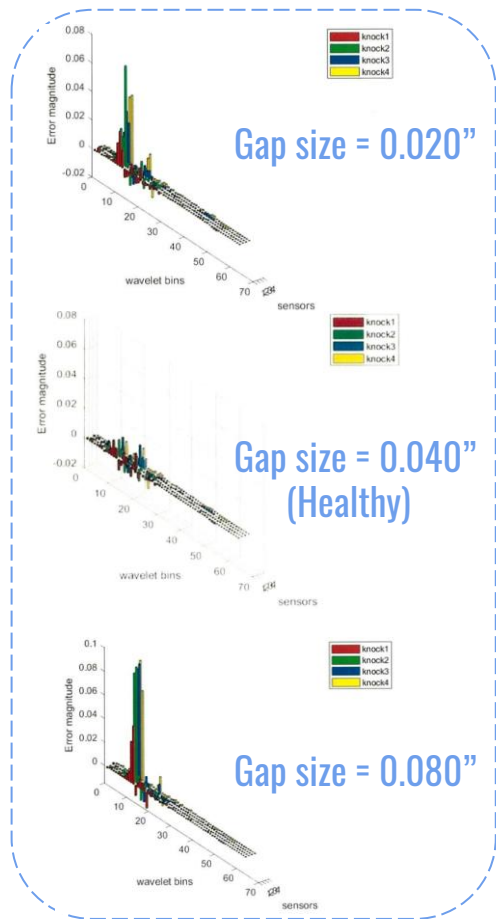
Extended Multiscale Principal Component Analysis (EMSPCA)



Extended Multi-Scale Principal Component Analysis (EMSPCA)



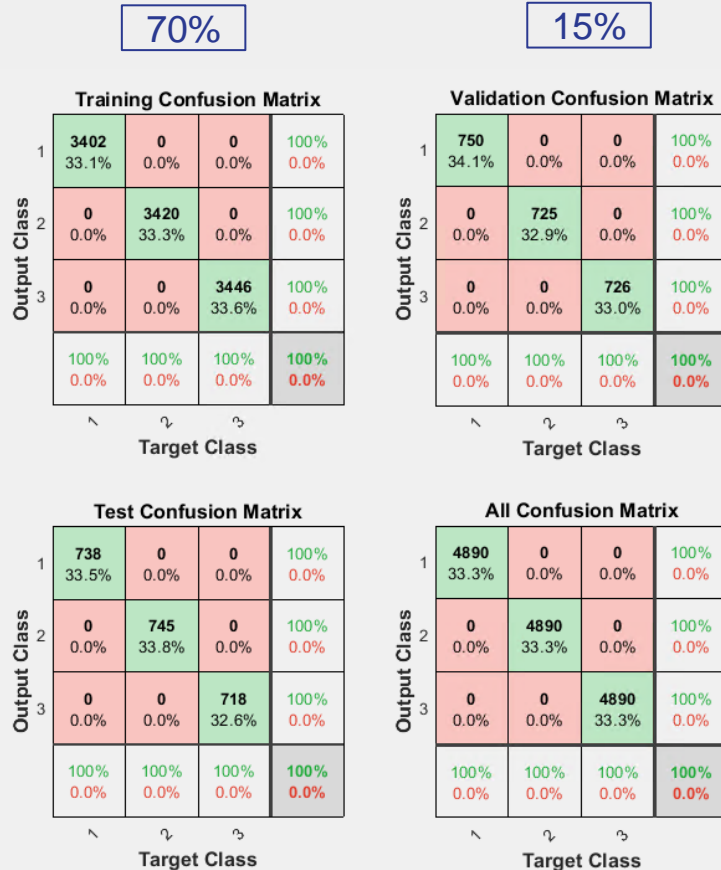
Extended Multi-Scale Principal Component Analysis (EMSPCA)



EMSPCA Results

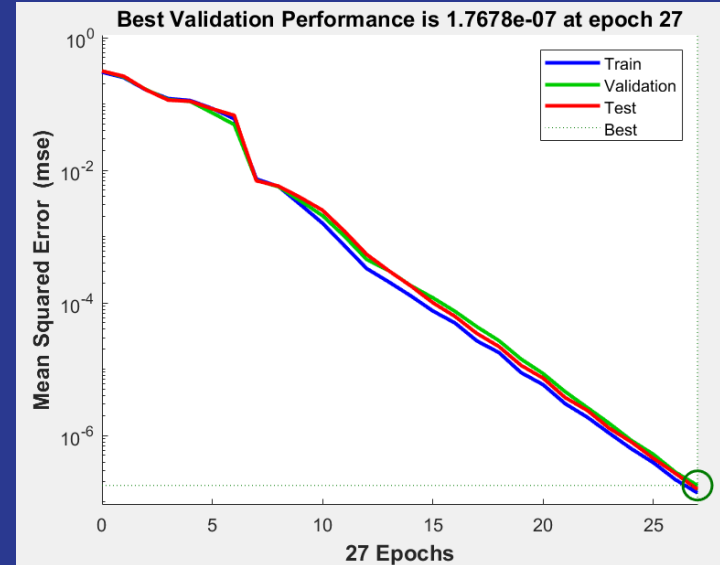
Classifier = prtClassNet
Processing Time = 15 hrs

NN = PRT toolbox
Epochs = 27



15%

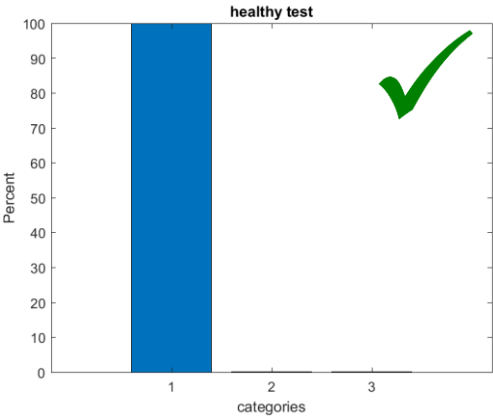
100%



Results

Validation Accuracy = 98.2%

Results



Verification Test Confusion Matrix

	Predicted Labels				
Actual Labels		Healthy	0.02"	0.08"	
	Healthy	3	0	0	100%
	0.02"	0	2	0	100%
	0.08"	0	0	2	100%
	Total = 7 Samples				100%

Actual Labels	Predicted Labels
0.04" (Healthy)	<p>A bar chart titled "Sample A test". The y-axis is labeled "Percent" and ranges from 0 to 100 in increments of 10. The x-axis is labeled "categories" and has three categories: 1, 2, and 3. Category 1 has a blue bar reaching 100%. A large green checkmark is positioned to the right of the chart.</p>
0.02"	<p>A bar chart titled "Sample C test". The y-axis is labeled "Percent" and ranges from 0 to 100 in increments of 10. The x-axis is labeled "categories" and has three categories: 1, 2, and 3. Category 2 has a blue bar reaching 100%. A large green checkmark is positioned to the right of the chart.</p>
0.08"	<p>A bar chart titled "Sample E test". The y-axis is labeled "Percent" and ranges from 0 to 100 in increments of 10. The x-axis is labeled "categories" and has three categories: 1, 2, and 3. Category 3 has a blue bar reaching 100%. A large green checkmark is positioned to the right of the chart.</p>