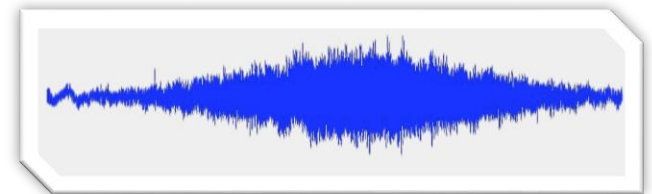


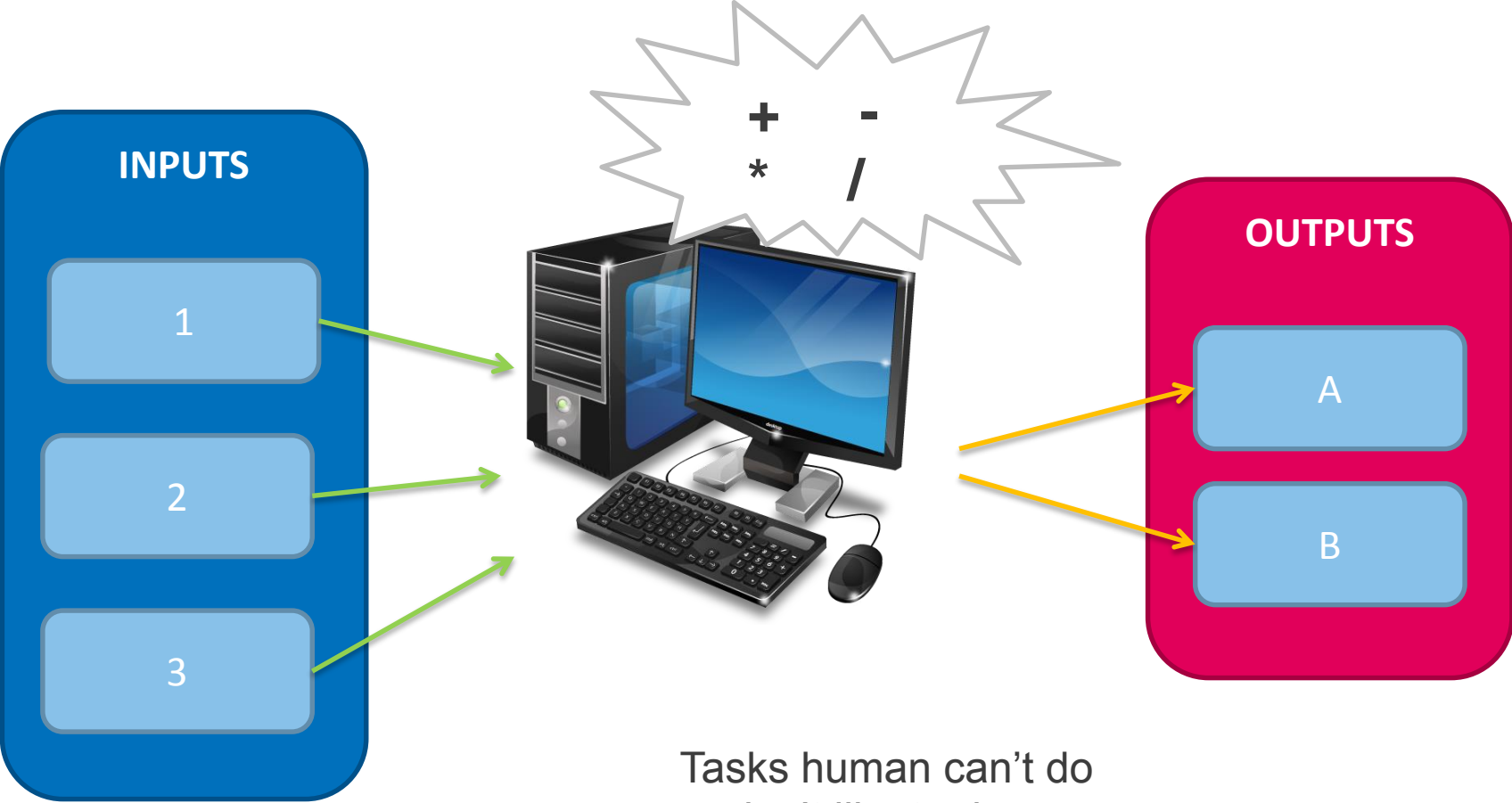
Industrial Approach: Automated Fault Detection with 1-Dimensional Sensory Signals for Quality Inspection

Philipp Schmid

04.02.2016

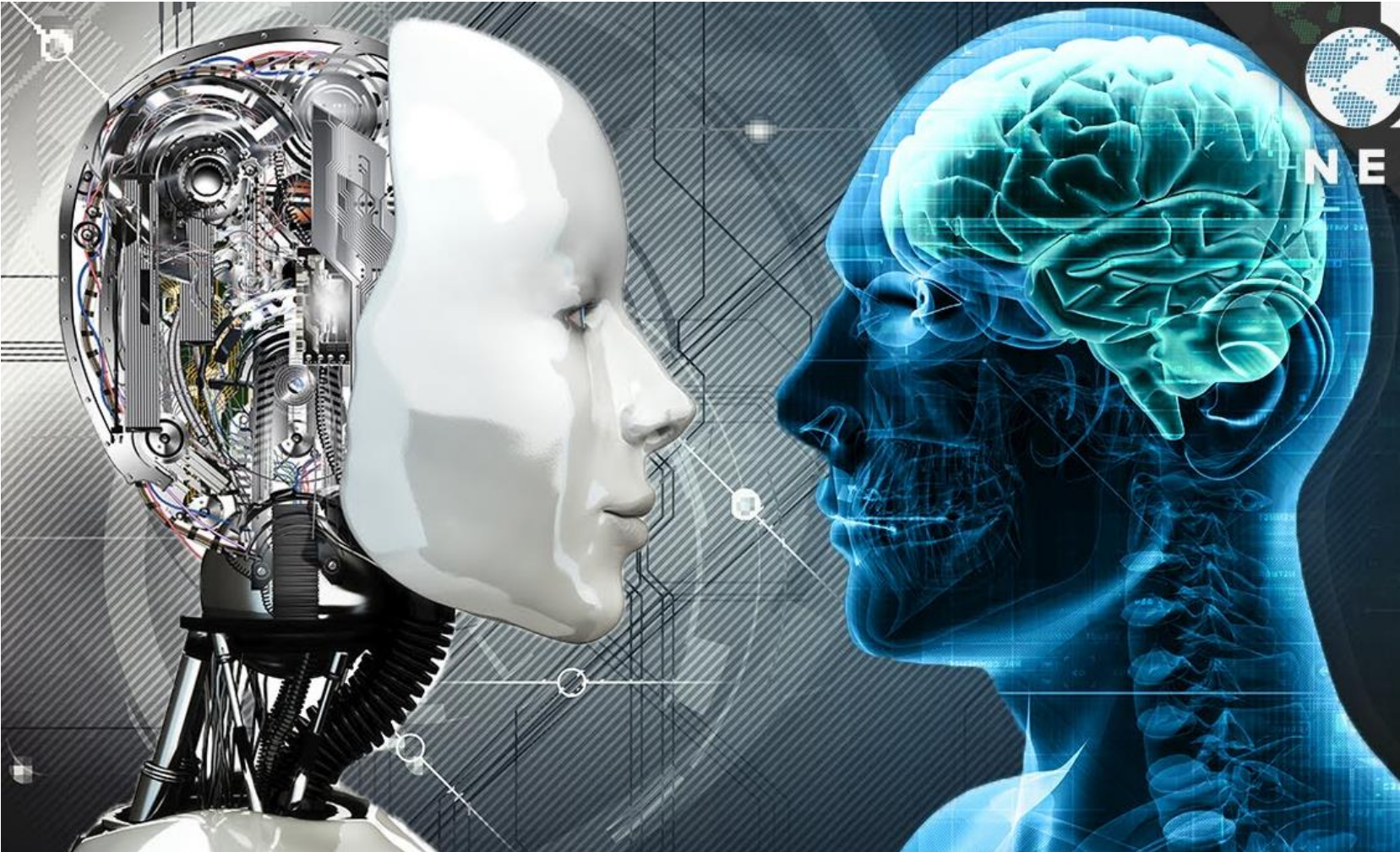


Smart Computers?



Tasks human can't do
or don't like to do

Machine Learning!



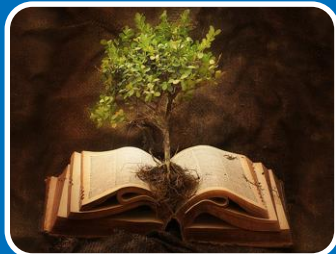
Learning Categories



Supervised Learning



Reinforcement Learning



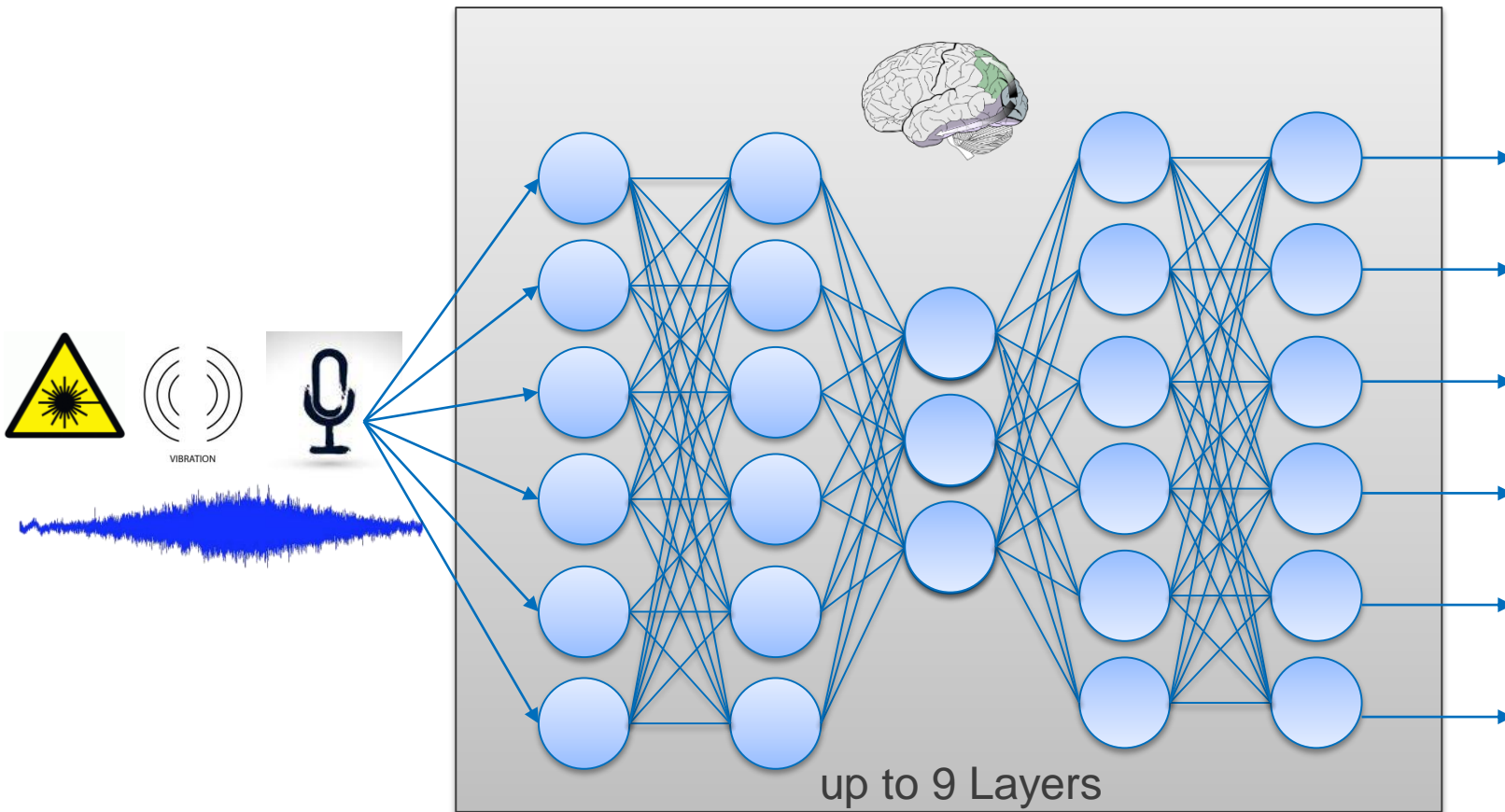
Unsupervised Learning

How works our Brain?



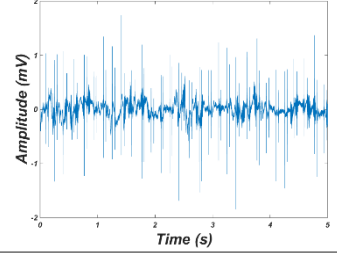


How to model the human Brain?



Deep Belief Network

Applications

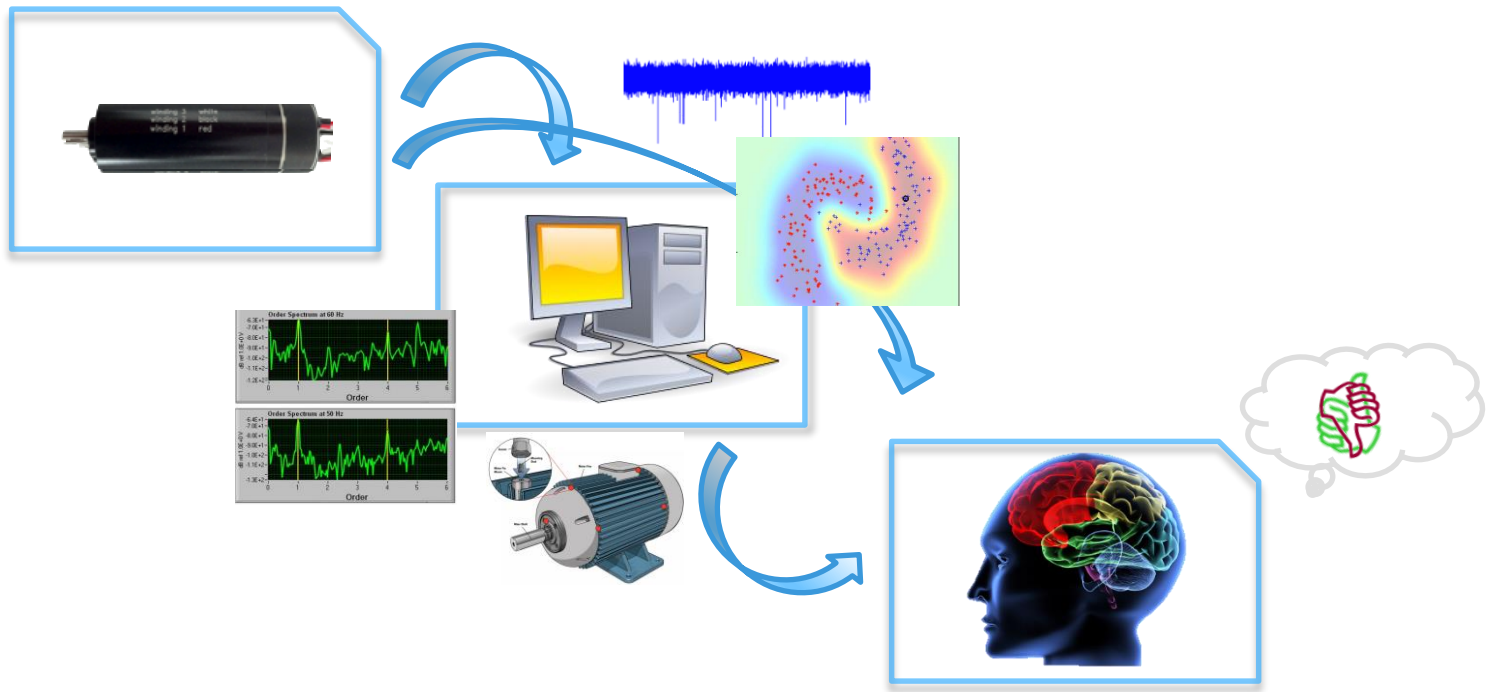


- 1-Dimensional sensory signal analysis and automated quality decision (Good/Bad)

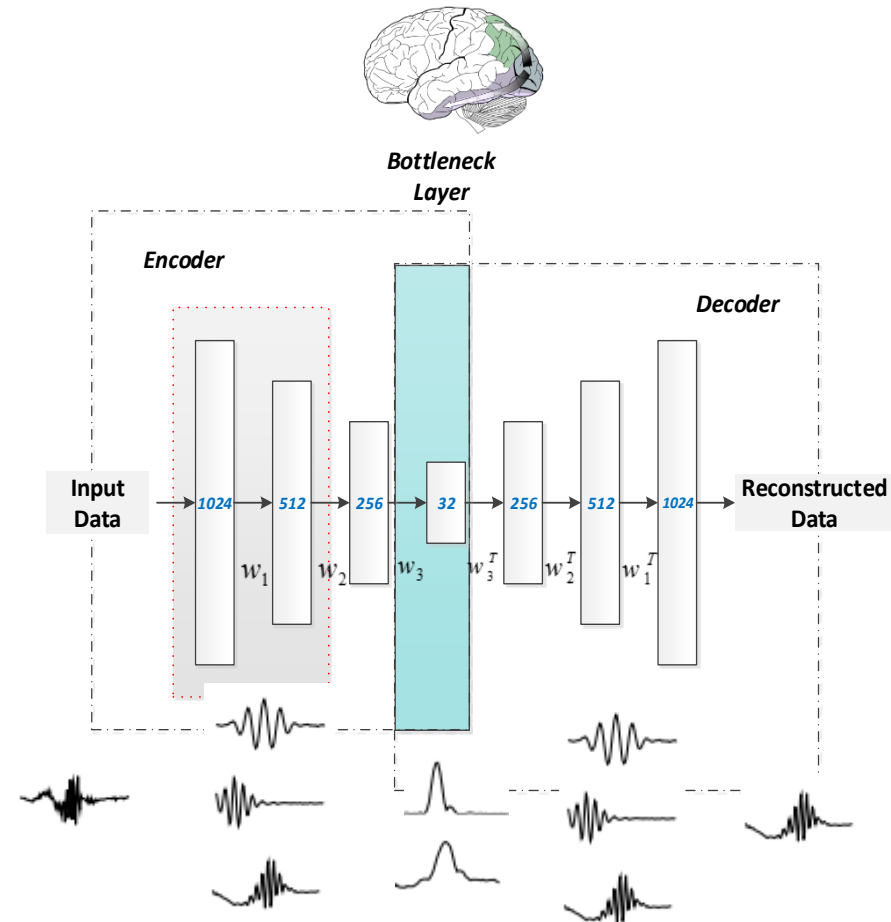
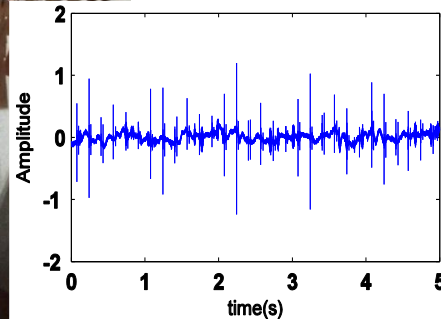
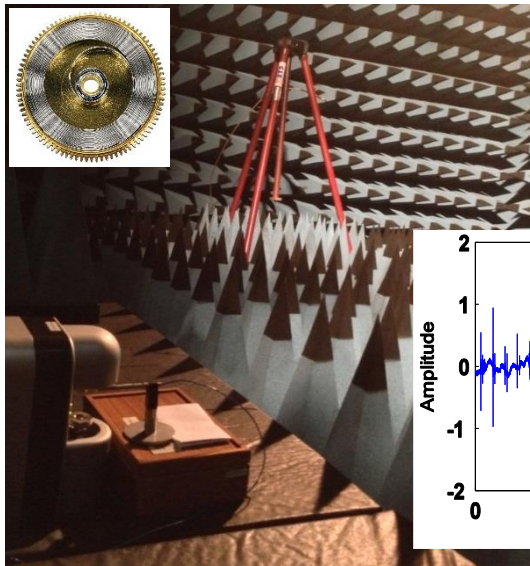
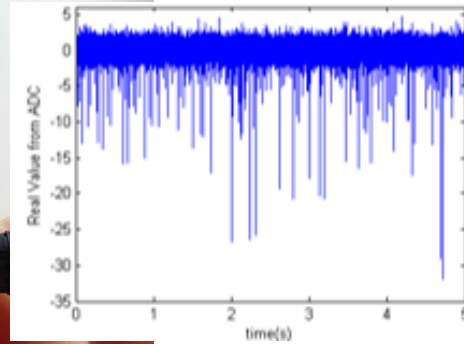
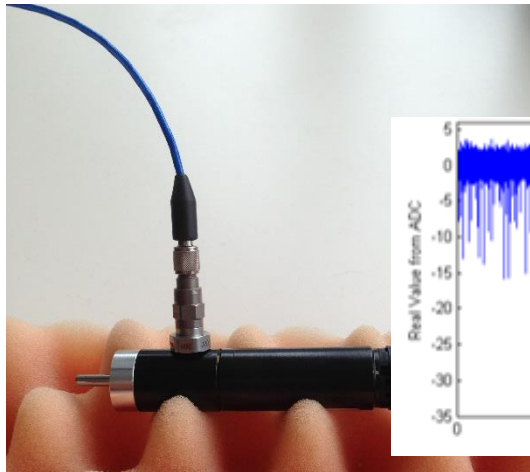




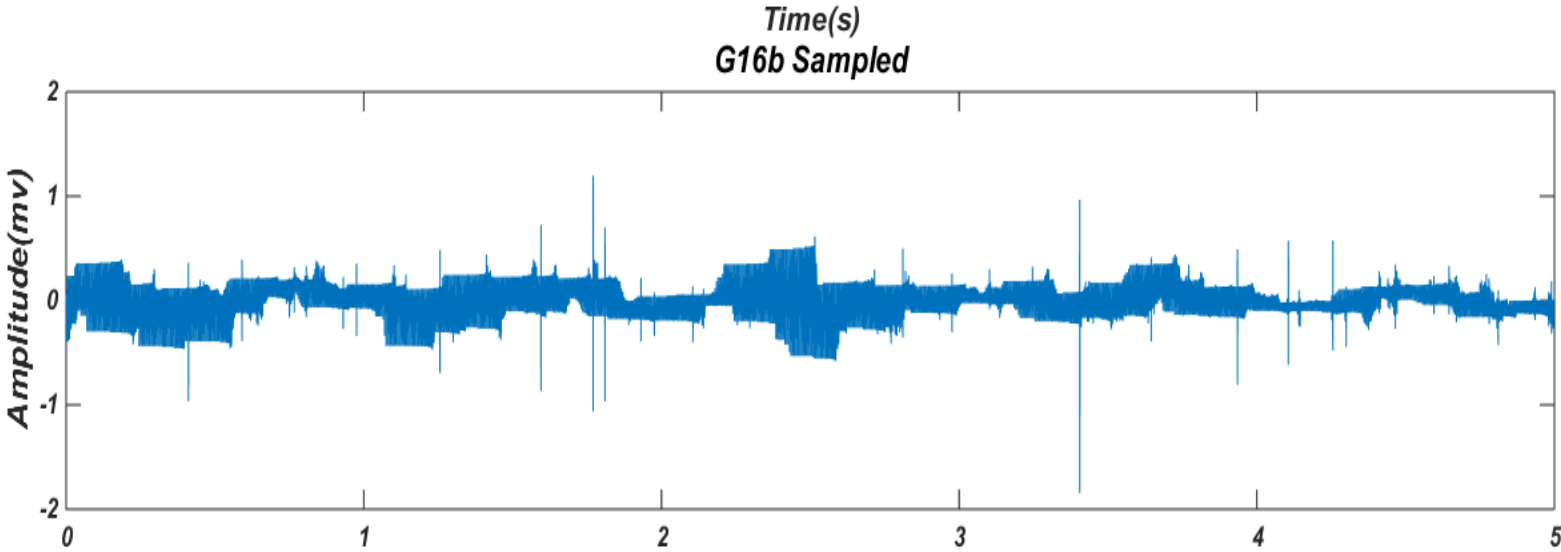
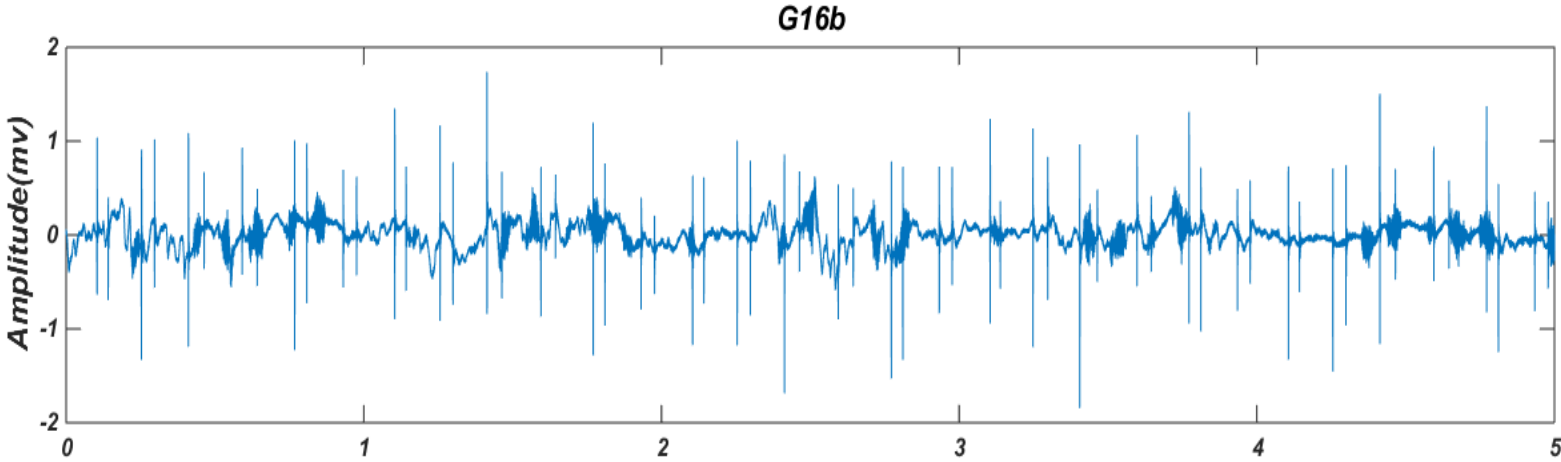
Industrial Acoustic Quality Check Today



How to Use Deep Belief Networks?

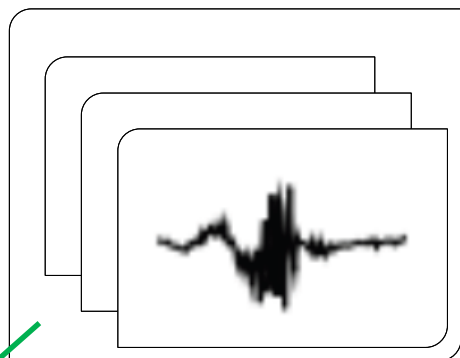


Acoustic Signal Sampling

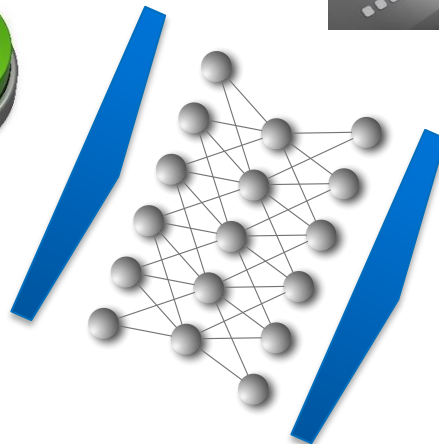
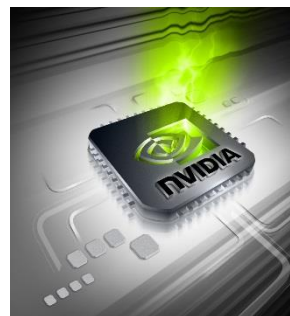




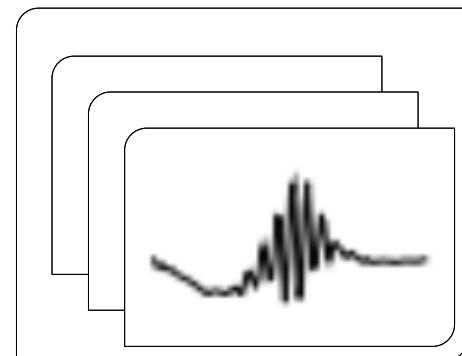
Train the Brain



Sensor signals
ONLY from **GOOD**
samples

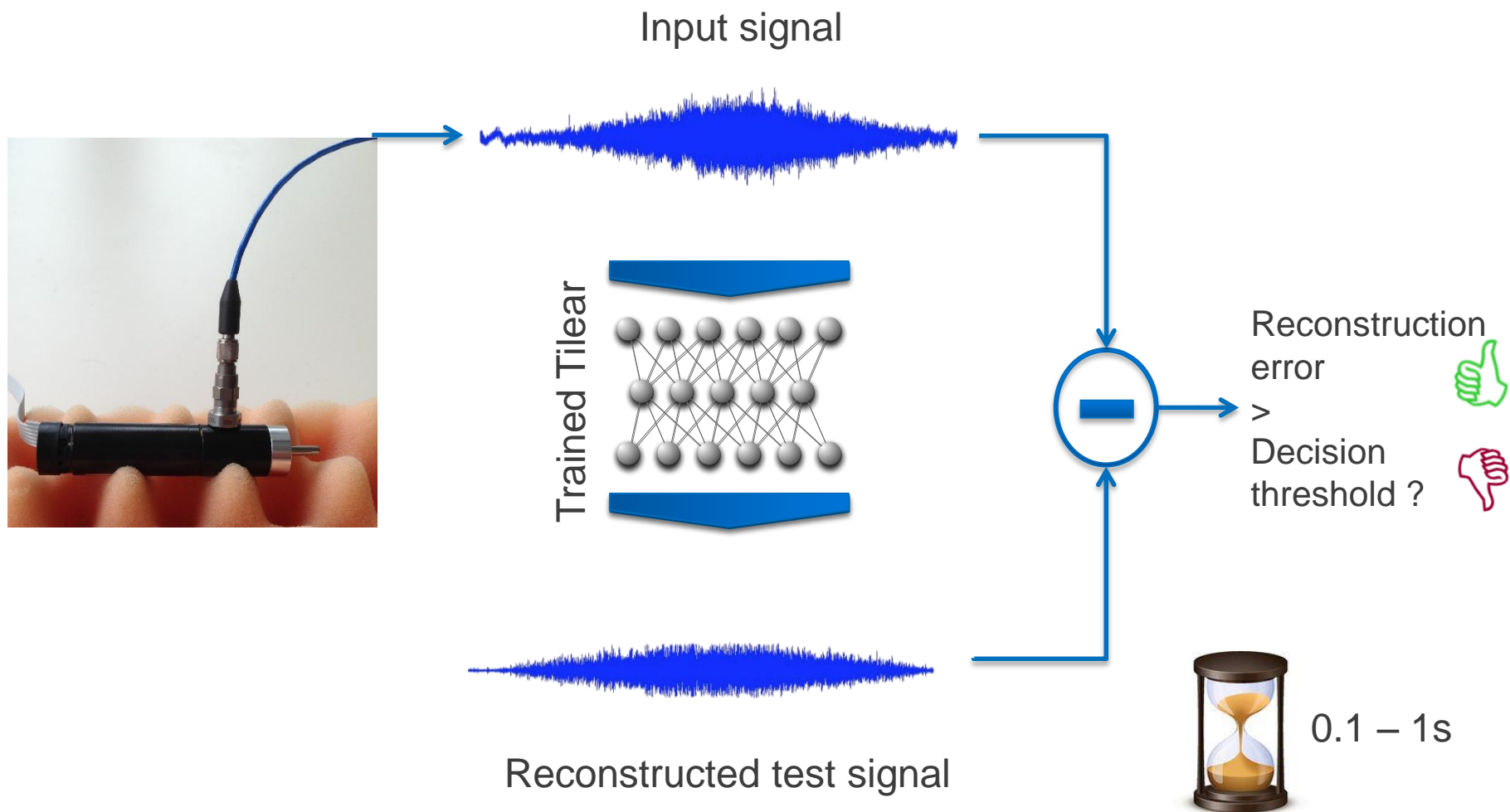


20-30min



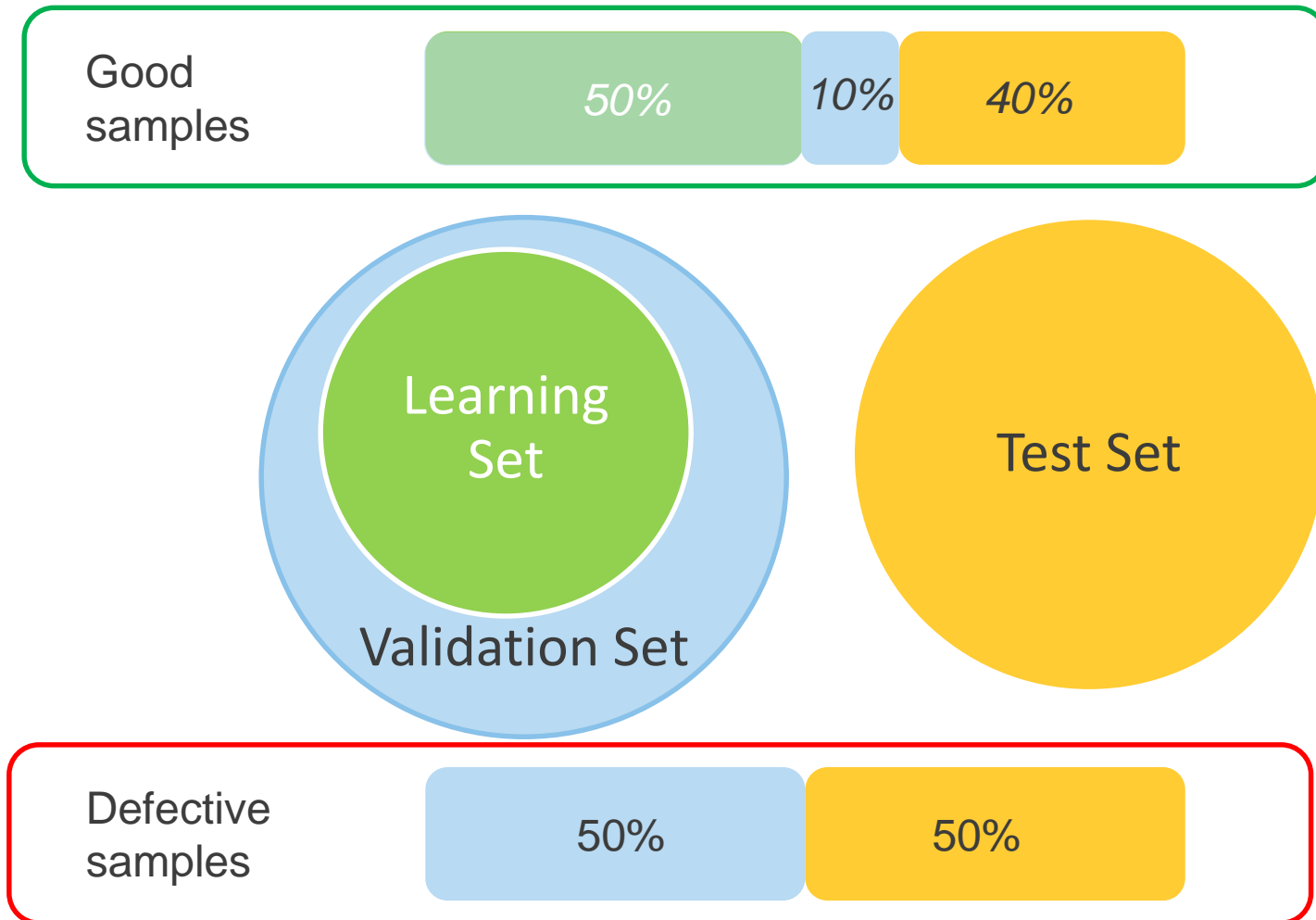


Use the Brain





Dataset Split

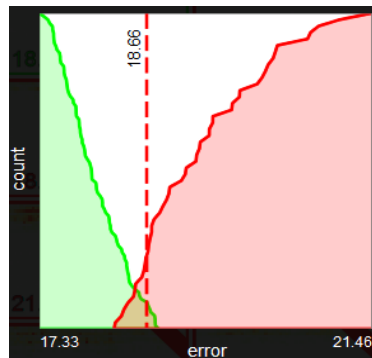


Experiment Results: Electromotors

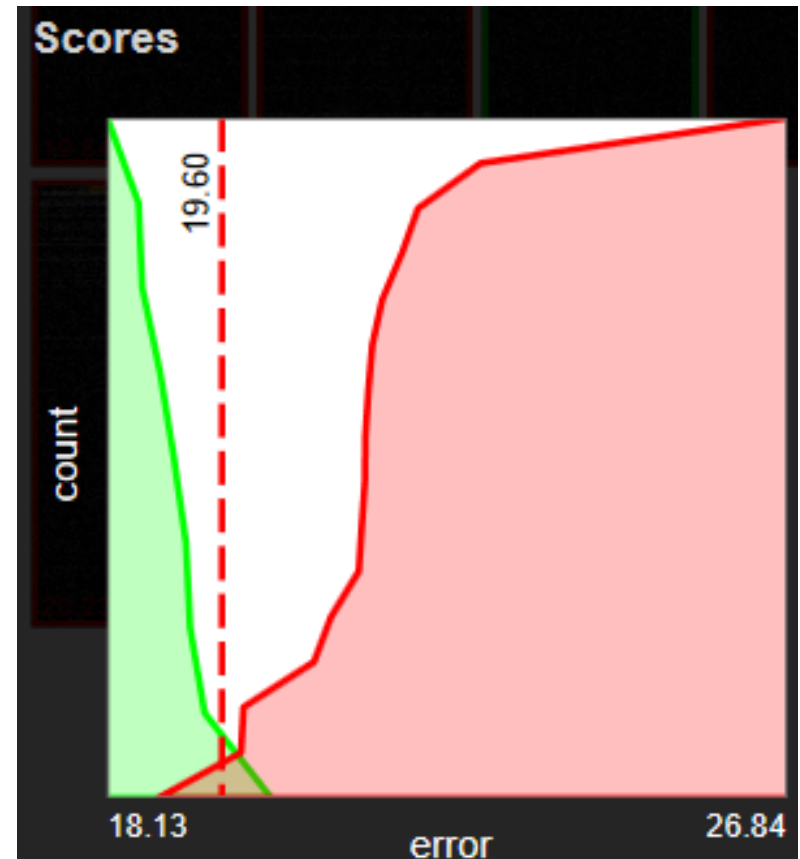
- Cumulative Distribution of Reconstruction Errors
 - Red part: defective samples
 - Green part: good samples
 - Red dash line: threshold value for Decision making



Validation set

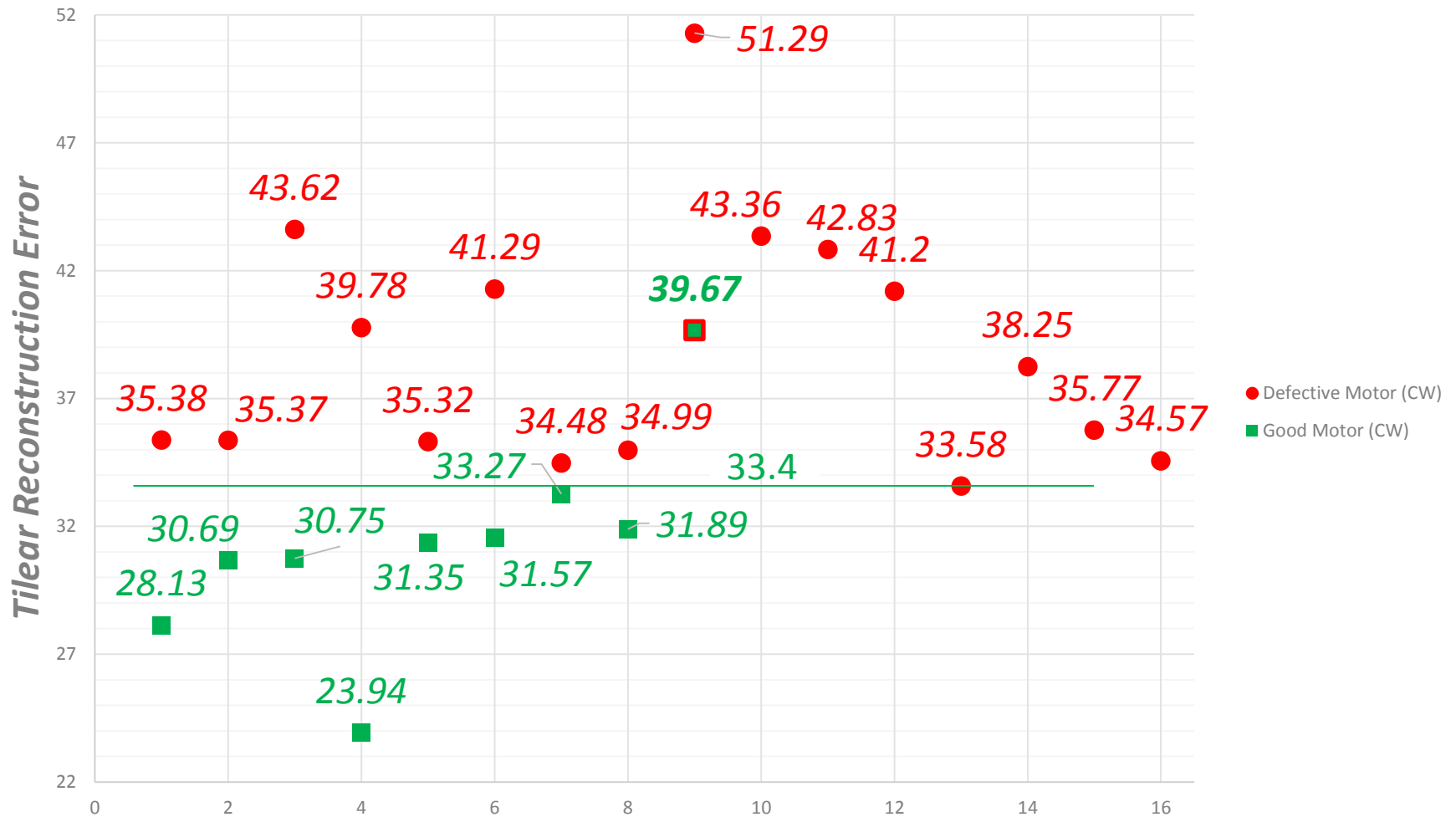


Test set



Experiment Results: Electromotors

Reconstruction Error Plot of Measurements at 85rpm (Raw Vibration Signal)



CSEM Tlear vs Industrial state of the Art*

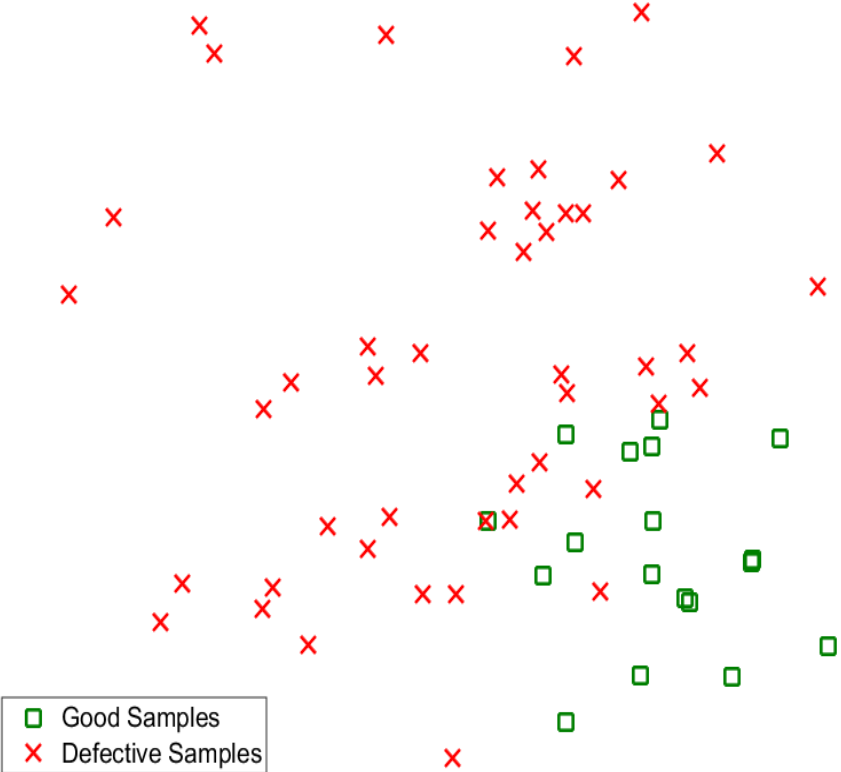
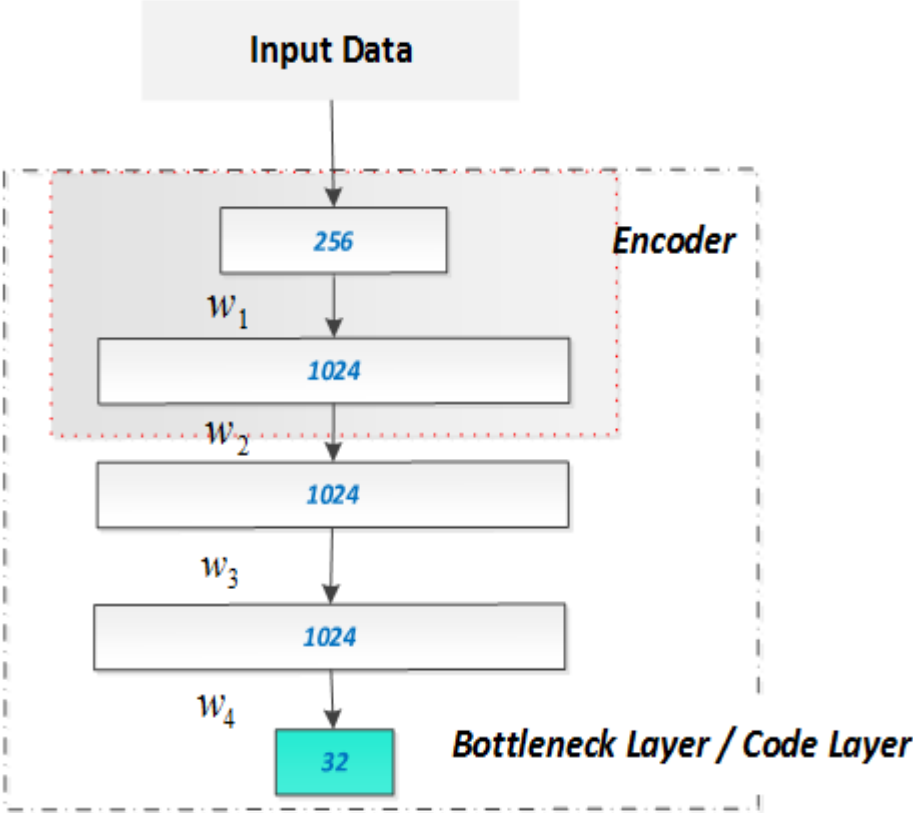


	State of the Art		CSEM Tlear	
True Positive	87	92%	90	95%
False Positive	8	8%	5	5%
False Negative	5	6%	2	2%
True Negative	78	94%	81	98%

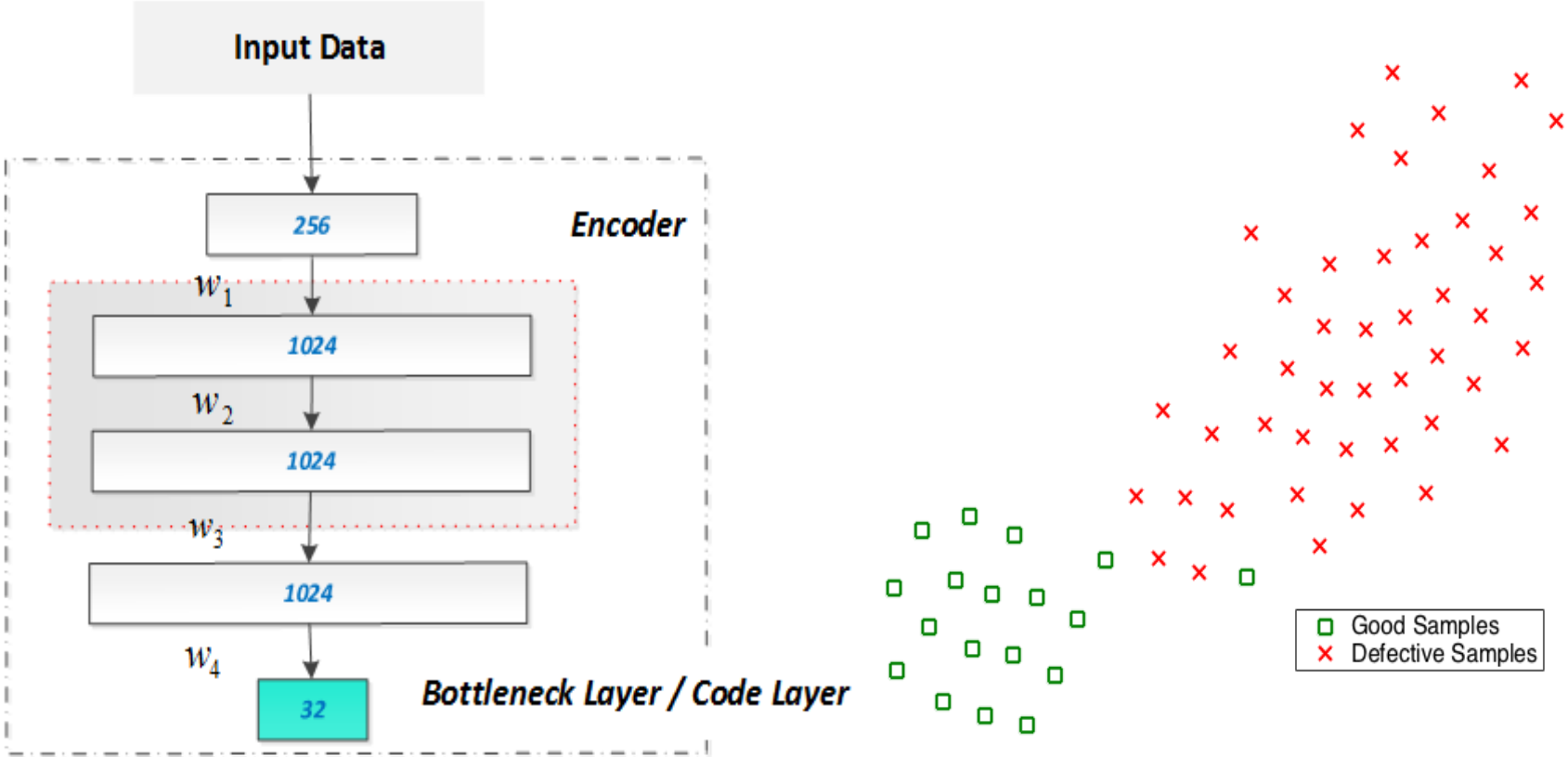


* RTE Akustik + Prüftechnik GmbH

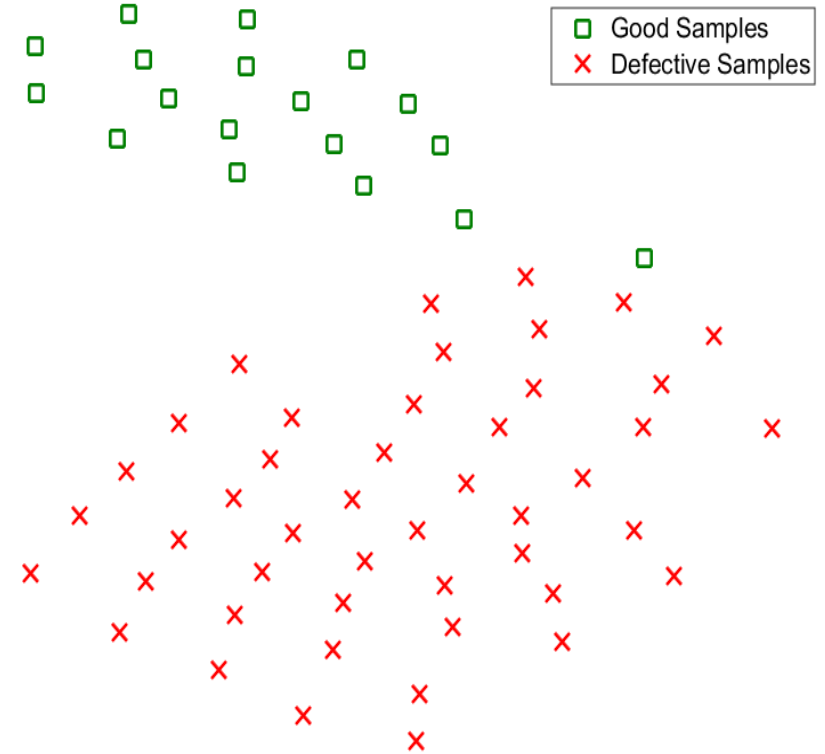
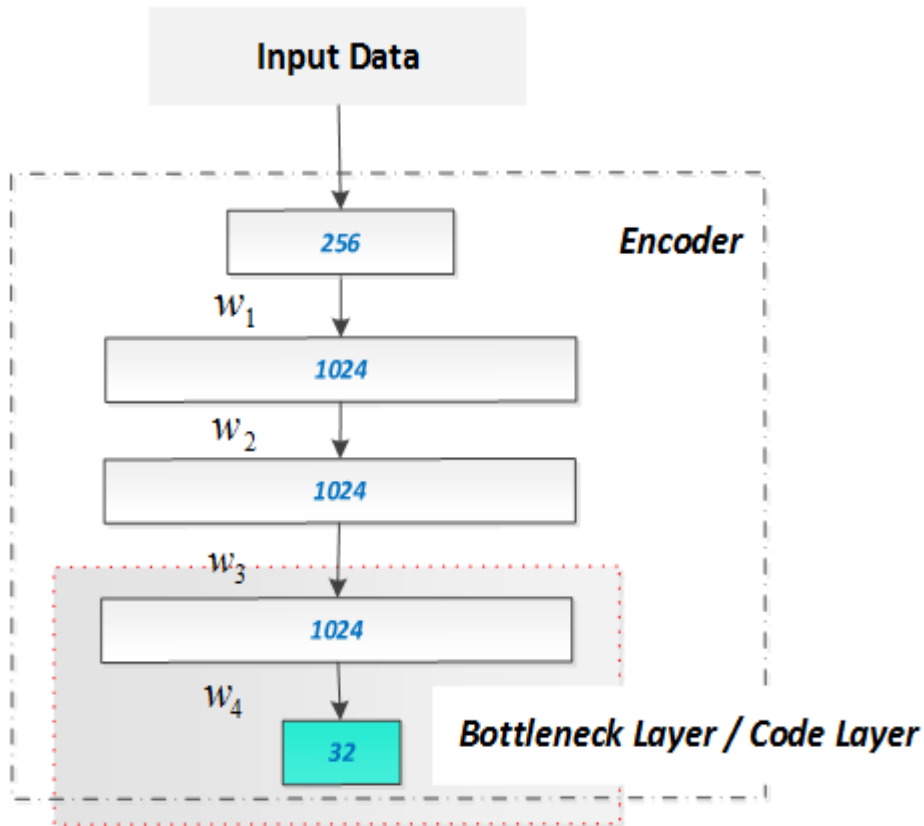
Visualization of Activity Patterns: 1st Hidden Layer



Visualization of Activity Patterns: 2nd Hidden Layer



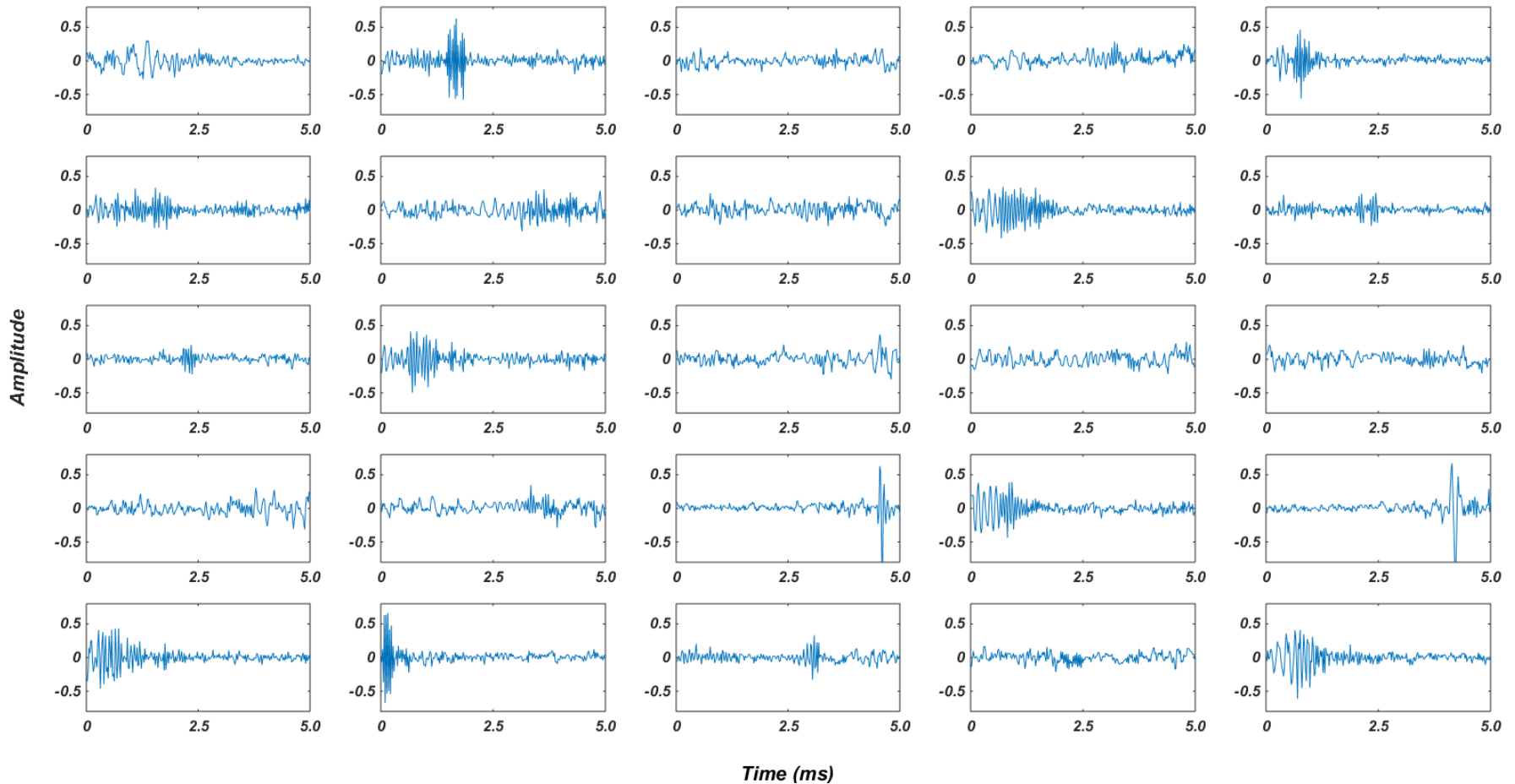
Visualization of Activity Patterns: 4th Hidden Layer



- **Conclusion: the features learned by the DBN based auto-encoder can be used to discriminate these classes.**

Features Selected from 1st Fine-Tuned Layer

Selected Learned Features from 1st Fine-Tuned Layer



- *Selected features learned by the 1st Layer in Tlear Auto-encoder*

Low input samples vs. overfitting

Motivation

- ❖ Minimum number of training samples



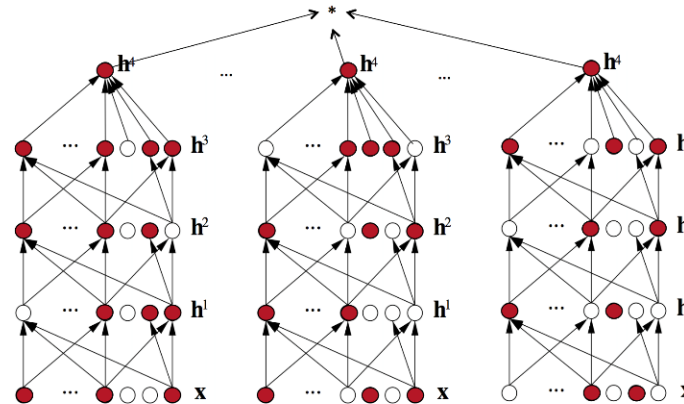
Problem

- ❖ Overfitting



Solution

- ❖ Dropout Technique



CSEM Industrial Integration

The screenshot displays the TiBox (x64) - v1.6.0.1 - Tilear application window. The interface is divided into several sections:

- Project:** A tree view on the left shows the project structure, including Image Analysis configurations, IA Config - Tilear, Camera Modules, Image Processor Modules, Image Analyser Modules, Coordinator Modules, and Logger Modules. A red "Project" label is overlaid on this section.
- Settings:** A detailed configuration panel on the left shows settings for the File Camera - Input Data module, including Advanced, Camera, Information, and Misc sections. A red "Settings" label is overlaid on this section.
- Camera Modules:** A window titled "...Input Data" displays a line graph of "The Value Range" over "frames". A red "Deep Belief Network" label is overlaid on this section.
- Image Processor Modules:** A window titled "...Preprocessor" displays a line graph of "The Value Range" over "frames".
- Image Analyser Modules:** A window titled "...Tilear" shows "Image information" and a "Score" graph. A red "Deep Belief Network" label is overlaid on this section.
- Coordinator Modules:** A window titled "...Result" shows a "TRG" status with radio buttons for "Pass", "Fail", and "Random (20-80)". A red "Result" label is overlaid on this section.
- Logger Modules:** A window titled "...Logger" shows a "Start Logging" button and a file path "C:\Tilearlogs". A red "Logging" label is overlaid on this section.

Outlook: Predictive Maintenance

