Bayesian Neural Network for Rock Drill Diagnostics

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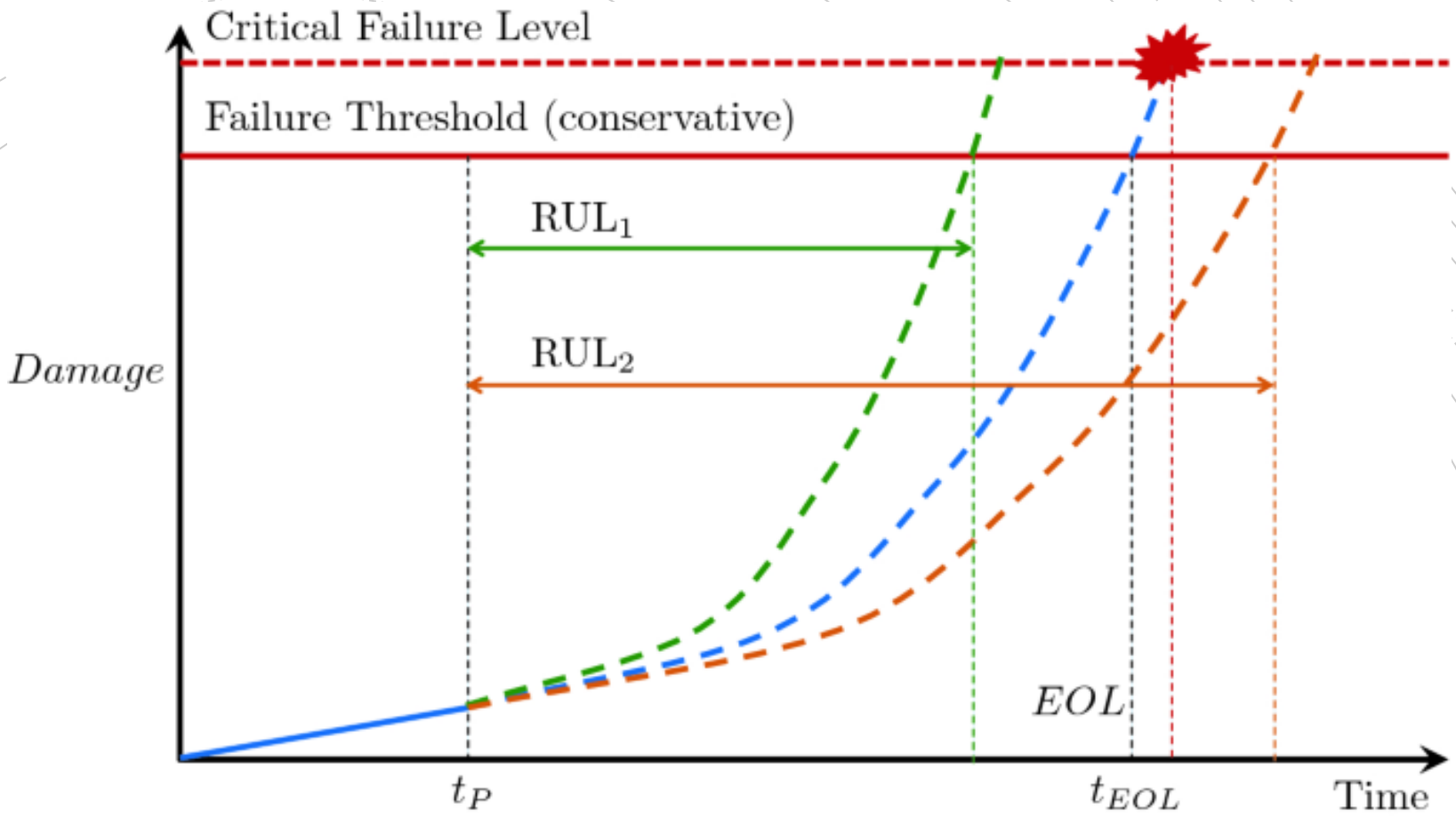
What is Prognostics?

Failure

- Detection
- Diagnosis
- Prediction

Charting Life of System



(1)

The data is collected from a carefully instrumented hydraulic rock drill, operating in a test cell while inducing a number of faults. Hydraulic pressures are measured at 50kHz at three different locations, resulting in a detailed pressure signature for each fault. Due to wave propagation phenomena, the system is sensitive to individual differences between different rock drills, drills rigs and configurations. Such differences are introduced in the data by altering certain parameters in the test setup.(2)

11 Fault Classification Categories

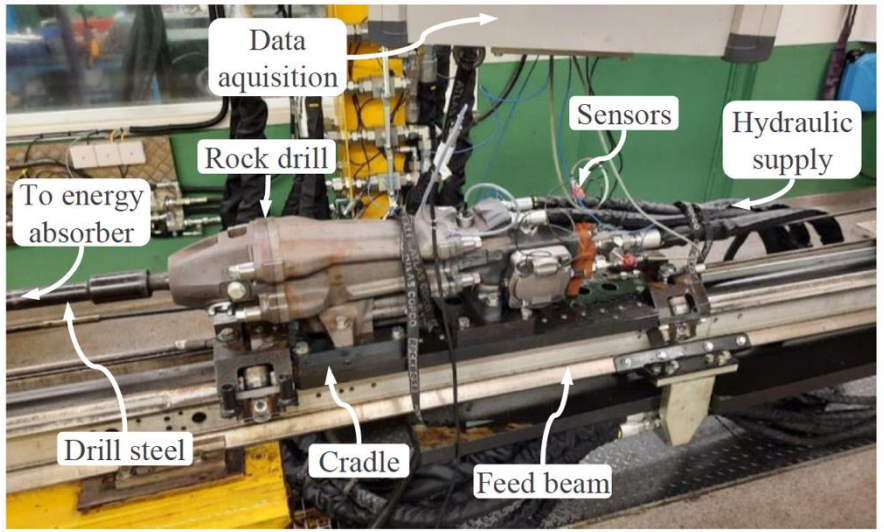
Rock Drill Degradation Data Set

- 10 Different Failure Modes
- 1 Healthy/No Fault Condition

Winners:

Team-Nuri with 100% accuracy

- Data driven approach
- Mathematical modeling created with deep learning



(2)

Data Details:

- Data is supplied in comma separated text files.
- Time series data from a certain sensor,
    - ~ stored together with labels in separate files
- Naming convention:
    - ~ data {signal} {individual number}.csv.
    - ~ accompanied by a number of reference samples from the No-fault class from the same individual.
        - + named according to reference {signal} {individual number}. csv.
- Each row contains one impact cycle.
    - ~ The first row in file data po1.csv is collected from the exact same cycle as the first row in data pin1.csv etc.
        - + Combining the three files from the same individual enables multivariate time series classification.

Data Details:

Files:

data_pdmp1, 2, 4, 5, and 6 contain: 7311, 7867, 7597, 7977, 3293 data points respectively.

data_pin1, 2, 4, 5, and 6 contain: 7311, 7867, 7597, 7977, 3293 data points respectively.

data_po1, 2, 4, 5, and 6 contain: 7311, 7867, 7597, 7977, 3293 data points respectively.

All ref_pdmp, ref_pin, and ref_po files contain: 20 data points each.

Label	Letter	Description
1	NF	No-fault
2	T	Thicker drill steel.
3	A	A-seal missing. Leakage from high pressure channel to control channel.
4	B	B-seal missing. Leakage from control channel to return channel.
5	R	Return accumulator, damaged.
6	S	Longer drill steel.
7	D	Damper orifice is larger than usual.
8	Q	Low flow to the damper circuit.
9	V	Valve damage. A small wear-flat on one of the valve lands.
10	O	Orifice on control line outlet larger than usual.
11	C	Charge level in high pressure accumulator is low.

Motivations

- Procedural Record
- Evaluating Usefulness in a Case Study
- Current Capacity in Research

Approach for Diagnosis

- Train Multilayer Perceptron
  - Bayesian Neural Network Parameters
  - Evaluate different network architectures
    - Number of nodes needed
- Record Predictions
  - Classify fault mode
- Evaluate Correctness

Questions?

Citations:

(Fig 1)
Bregon, A., Daigle, M.J. (2019). Fundamentals of Prognostics. In: Escobet, T., Bregon, A., Pulido, B., Puig, V. (eds) Fault Diagnosis of Dynamic Systems. Springer, Cham. https://doi.org/10.1007/978-3-030-17728-7_17

Jakobsson, E., Frisk, E., Krysander, M., & Pettersson, R. (2022). A Dataset for Fault Classification in Rock Drills, a Fast Oscillating Hydraulic System. *Annual Conference of the PHM Society*, *14*(1). https://doi.org/10.36001/phmconf.2022.v14i1.3144