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Numerical Methods

Statistical methods in machine learning

Motivation:

Equipment failure disrupts operations in industries ranging from design to manufacturing. It's crucial to ensure reliability and minimize downtime for efficient production. The digital twin, a virtual replica of a physical system, has emerged as a powerful approach for predictive maintenance. For this project, we aim to develop a digital twin model for NASA's Turbofan Jet Engine CMaps dataset, found here:
https://www.kaggle.com/code/wassimderbel/nasa-predictive-maintenance-rul/notebook

Methods:

We will simulate a mechanical jet engine system using numerical methods. Sensor data will be provided by the dataset from Kaggle. We will implement networks like SVMs, Random Forests, and MLPs to predict component failures.

We will explore gradient descent optimization using various optimization methods such as AdamW, RMSProp, and other optimizers found here:
https://pytorch.org/docs/stable/optim.html

We will also employ the use of quantization, a technique used to discretize weights down from larger (say, 32 or 64 bit floating point) representations to smaller (say, 8 bit integer) representations. We will analyze the memory savings as well as the error of the system and accuracy of the system due to the discretization methods.

The numerical accuracy and computational efficiency of the different models will be assessed, providing insights into the feasibility of deploying such systems in real-world engineering applications. This study will highlight how numerical methods and other machine learning methods enhance predictive capabilities, and reduce costs through proactive maintenance.