20SP SYS 6014 Project Proposal

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Motivation

- Patterns exist in time series.
- Forecasting and prediction can be achieved by several approaches.
- Problem: researches emphasize model evaluation, but rarely discuss decison making upon predicted data.
- Aim of this project: decision analysis based on prediction achieved by Long-short term memory (LSTM).

Predictivce Maintenance Decision analysis: Problem Formulation

- Predictive Maintenance:
  predict when an in-service machine will fail, so that maintenance can be planned in advance.
- Prediction component:
  Regression: Predict the Remaining Useful Life (RUL).
  Classification: Predict if an asset will fail within certain time frame (e.g. days).
- Optimization component:
  Statistical decision model.

Data set

- Training set
- Test set
- Ground Truth

Steps

- Step 1: Data preparation and feature engineering
- Step 2: Train and evaluate model
- Step 3: Decision analysis

Statistical Decision Model

Action set:

$$\mathbb{A} = \{A_s : stopEngine, A_c : continue\}$$

If the oepration state attribute can be treated as a random variable, then state space can be described as:

$$\mathbb{X} = \{X_n : Operational, X_f : failure\}$$

The actual data distribution will be updated based on data set. The predicted time series will be generated by LSTM.

Statistical Decision Model

Parameter Space:

$$\Theta = \mathbb{R} \times [argmin\{attributes\}, argmax\{attributes\})$$

for each of attributes of data set.
Prior Belief: the mean of cycles for each engine id.

Statistical Decision Model

Payoffs: It can be described as: the expected payoff can be described as the economic based on the decsions made by the given potential risk information. For example: if the decision maker choose to continue operating the engine in a window, then there will be a loss.

$$\mathbf{E}(A_s|X_n) < 0, \mathbf{E}(A_s|X_f) = 0, \mathbf{E}(A_c|X_n) = 0, \mathbf{E}(A_c|X_f) < 0$$

Objective: Minimise potential loss.