PHM of Battery Flipped learning (Prognostics and Health Management: 건전성 예측 및 관리)

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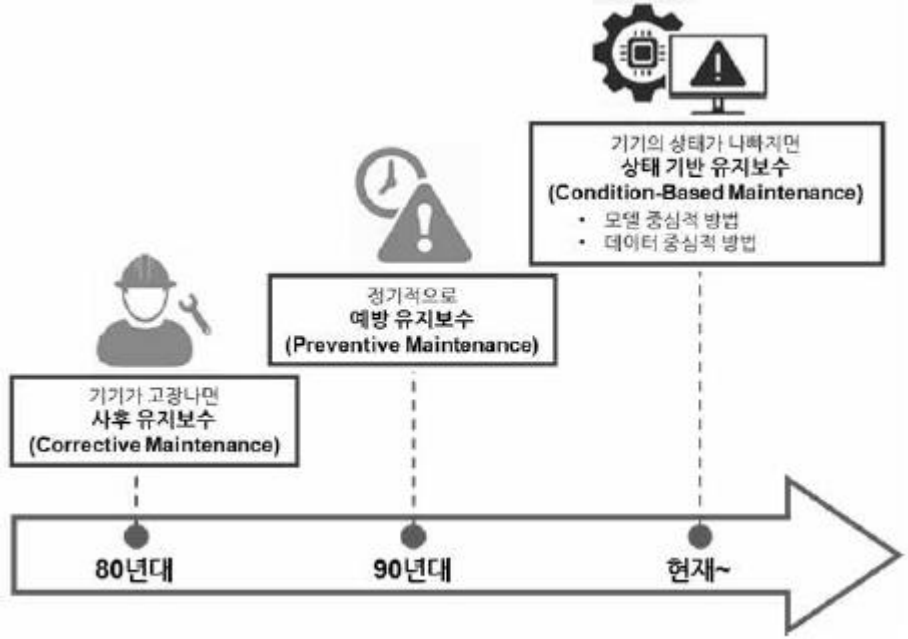
- PHM for Battery
  - What is PHM ?
  - Reason for choosing a topic
  - RUL(Remaining Useful Life) Prediction of Battery
- Reference

PHM Methods

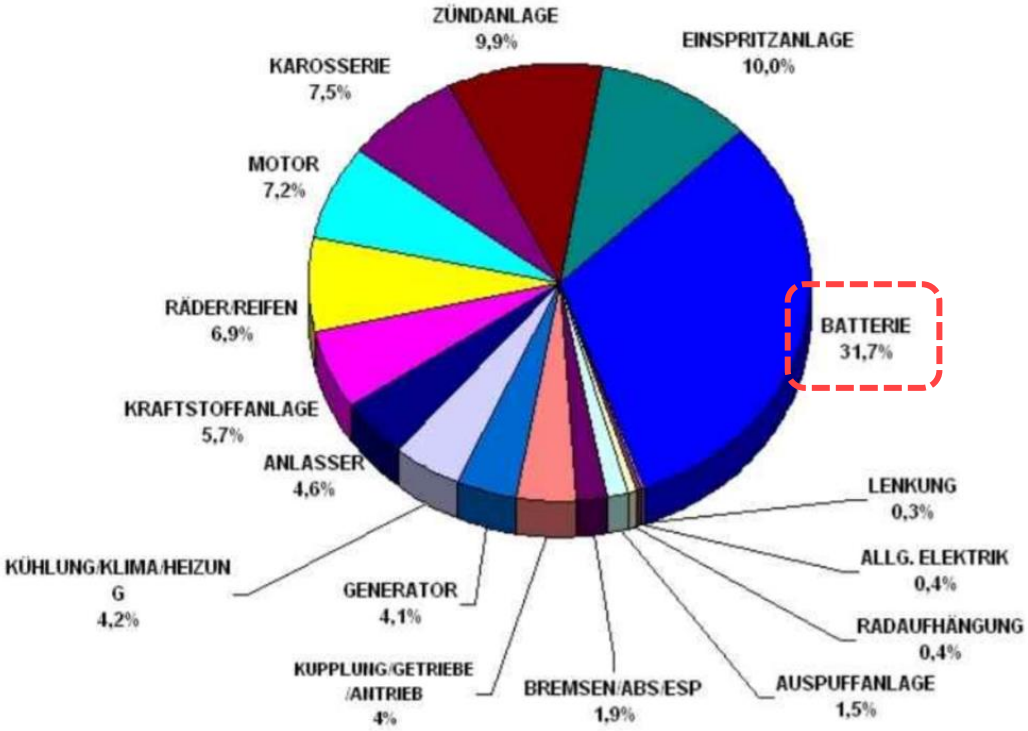
- PHM이란?
  - Prognostics and Health Management
  - 시스템의 건전성 관리를 위한 방법이다.
  - 사후 유지보수, 예방 유지보수, 그리고 상태기반 유지보수로 구분 가능하다.
  - 현재는 상태 기반(Data driven) 유지보수가 수행 되고 잇다.



Classification of Maintenance

Reason for choosing a topic (PHM of Battery)

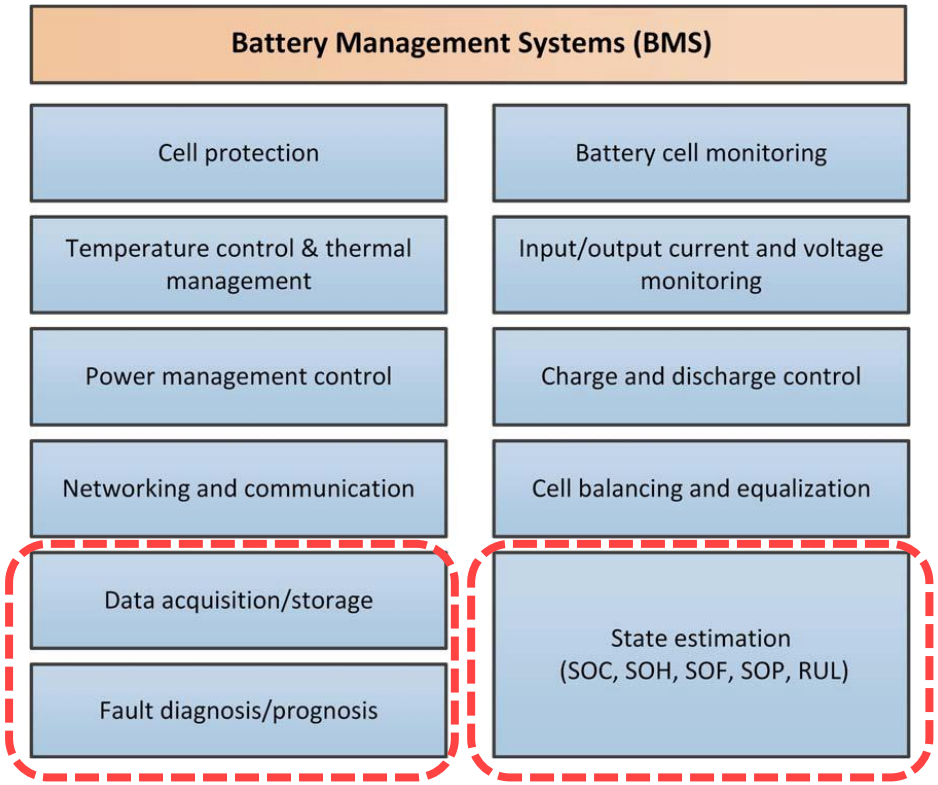
- 아래 그림은 자동차의 고장 원인을 나타낸다.
  - 배터리 문제가 자동차의 고장 원인 비율에서 높은 비중을 차지한다.
  - 따라서, 배터리의 신뢰성을 분석하고 고장을 예지하는 기술이 필요하다.



Causes of Car Breakdown

BMS (Battery Management System)

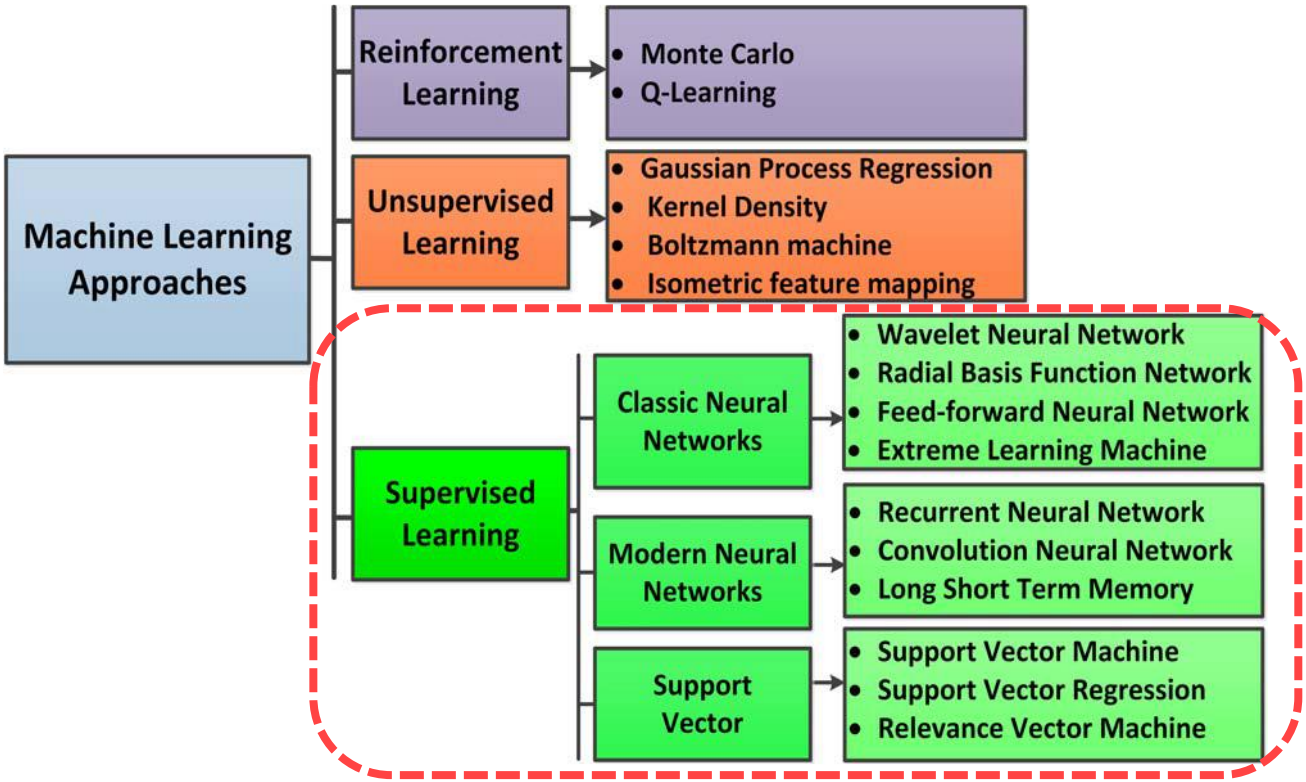
- Overview of BMS



Overview of battery management system

BMS (Battery Management System)

- Overview of Machine Learning Approaches in BMS



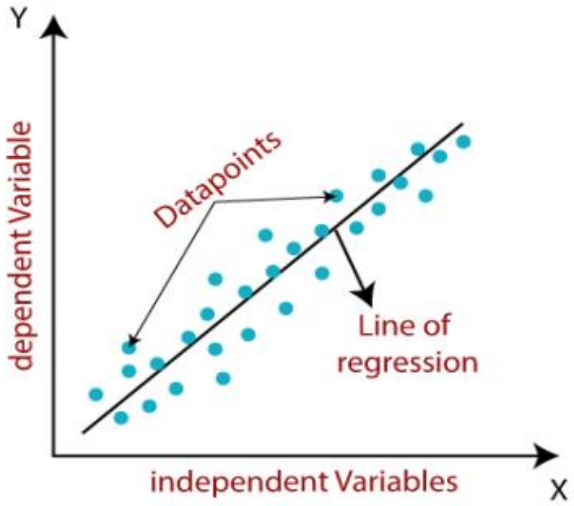
Machine Learning Approaches in BMS Applications

Machine Learning approaches in BMS

- Classification of Battery Management System
  - Fault Diagnosis and Prognosis
    - Critical faults in BMS invoked by such as, over/under voltage and current, irreversible chemical reaction, and low temperature
    - A lot of efforts have been done on the fault diagnosis
    - Methods : K-NN, ANN, SVM, LSTM
  - Remaining Useful Life Prediction
    - Such as, deposition of lithium, decomposition of electrolytes, and so on, lead to capacity degradation
    - Guarantee battery reliability
    - Methods : Linear Regression, ANN, RNN, SVM, LSTM, and so on

Methods of Remaining Useful Life Prediction

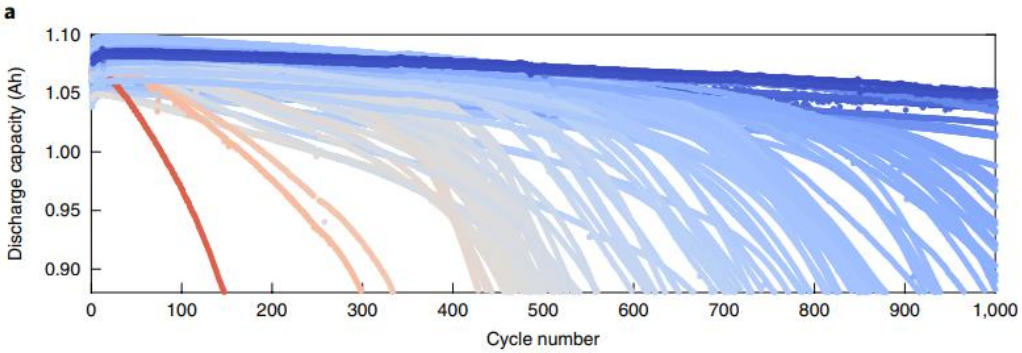
- Linear Regression
  - Useful when not much data
  - Prediction based on capacity data
  - Mathematically expressed Y = ax + b



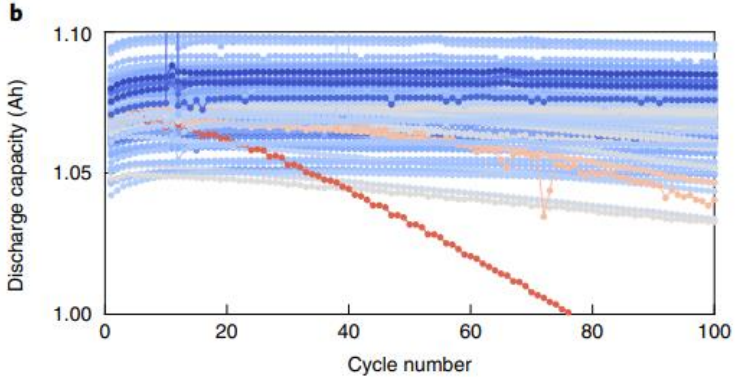
Linear Regression example

Methods of Remaining Useful Life Prediction

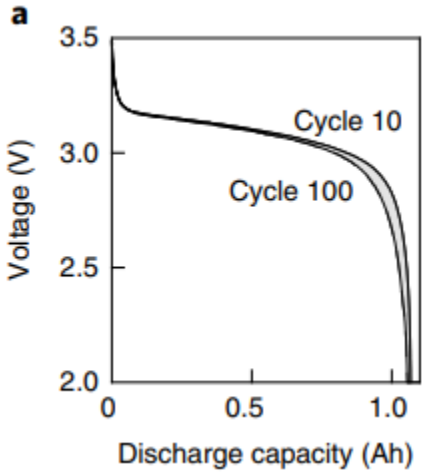
- Linear Regression



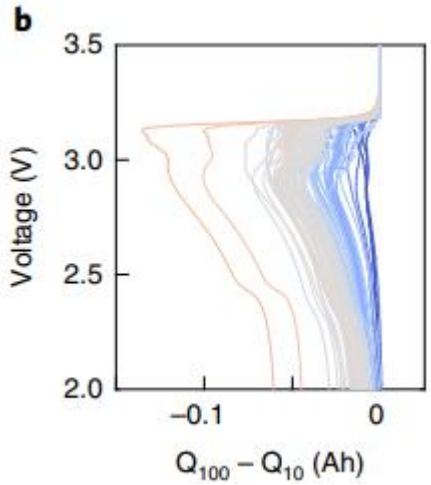
Discharge capacity for the first 1,000 cycles



Discharge capacity for the first 100 cycles



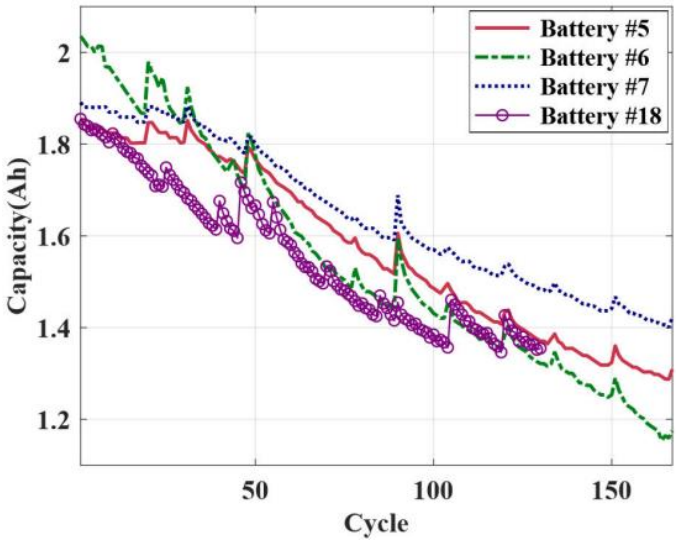
Discharge capacity curves for 100th and 10th cycles



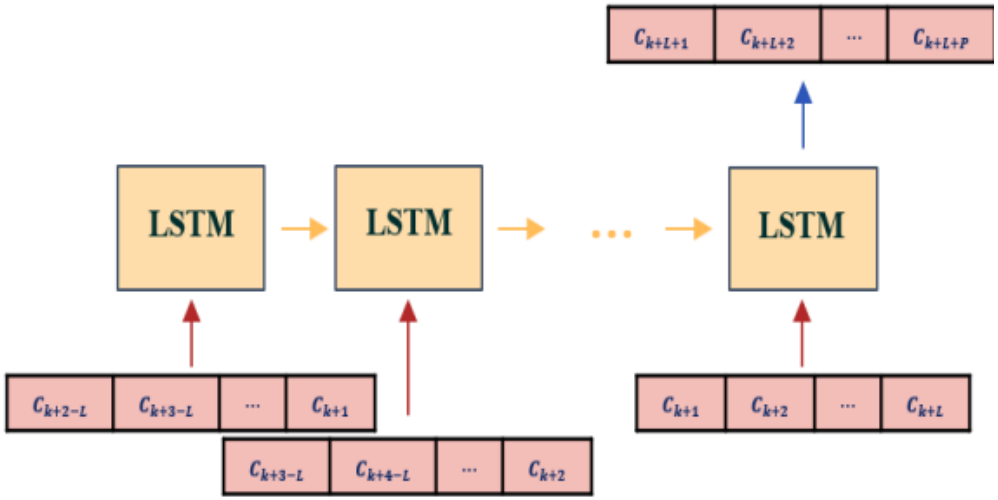
Difference of the discharge capacity curves as a function of voltage

Methods of Remaining Useful Life Prediction

- LSTM
  - Good for time series prediction
  - Widely used for RUL prediction
  - Time series capacity data based prediction



Capacity degradation over charging/discharging cycle



Input/Output format of LSTM base RUL prediction

Reference

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