Fast Validation of Grid Energy Storage Solutions. Experiments and Machine Learning

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Significance and Impact

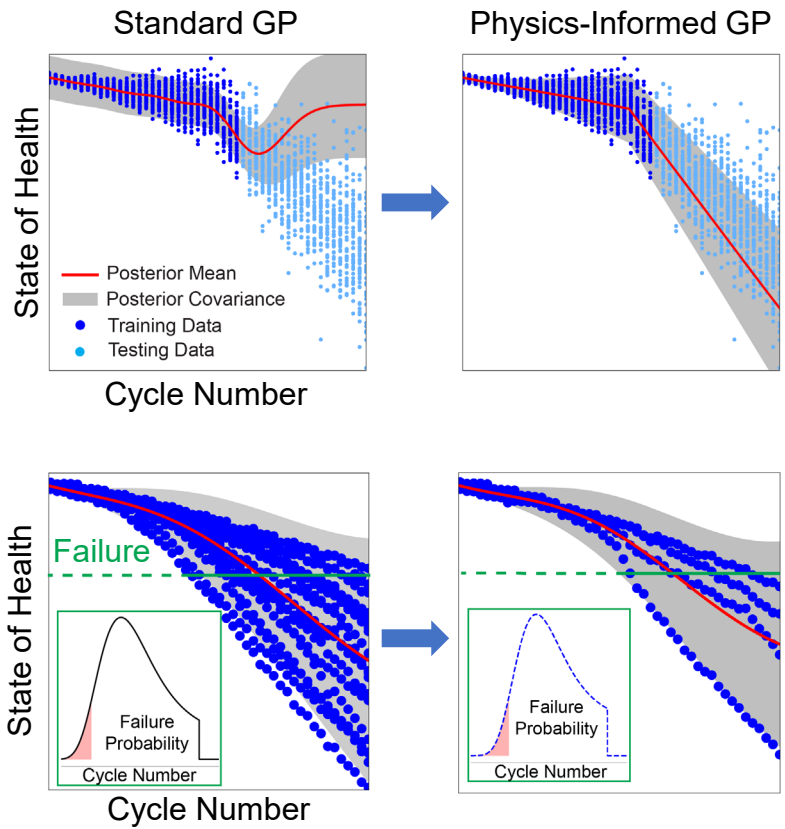
- OE says utilities require a warranty life of 15+ years
- Field focuses on predicting expected life
- Warranties depend on early failure outliers, not expected life
- Failure distribution is needed (1st life and 2nd life warranties)

Scientific Achievement

- Developed technology-agnostic framework for fast validation of energy storage systems
- Used physics-informed Gaussian processes (GP)
- Enabled accurate extrapolation and uncertainty quantification

Results

- Incorporated domain knowledge with machine learning
- Developed a stopping criterion for sequential battery testing
- Eliminated 70% of testing with < 7% error
- Estimated failure probabilities with minimum testing accurately



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Significance and Impact

- Durability depends on several parameters
  - E.g.: Temperature, max State of Charge, C-rate, Cycle #
- Variability is incorporated to estimate failure distributions

Scientific Achievement

- Developed an efficient technology-agnostic framework for high-dimensional parameter space exploration
- Used physics-informed GP and AI sequential sampling

Plans

- Lab cycling is not representative of real-life cycling
  - Cycles could be in minutes or hours
  - Depends on sun, wind, clouds
- Cycling may follow arbitrary path through the 4D space
- Use SOH gradient and history dependence to predict durability in real-life cycling