Electric Vehicle (EV) Charging Operations

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Introduction

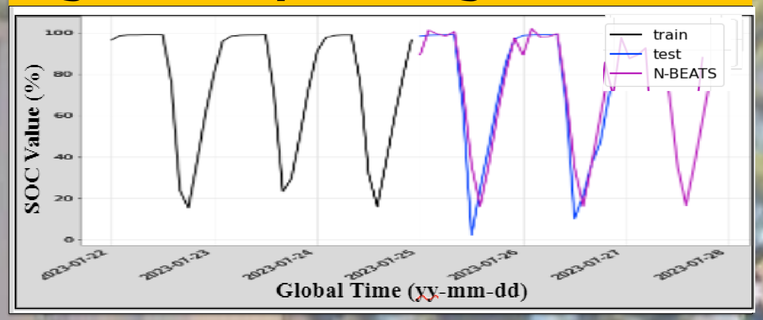
About CAT Digital:

- CAT Digital is the digital and technology business unit within Caterpillar Inc. focused on data technology, AI capabilities, and advanced analytics
- CAT is expanding on electric products to support customers' needs towards a lower-carbon future
- Currently facing new challenges such as charging resources and equipment management to sustain the new business

Project Objective:

- To build an app that can direct operators and fleet managers to receive push notifications to alert battery charging state, nearest available chargers, estimated arrival & charge time and total cost.

Figure 1: Deep Learning Predictive AI



Deep Learning Predictive AI

Objective: Use AI to predict SoC (state of charge) from data generated by CAT electric machine prototypes

- Tested various machine learning models (NBEATS, Naive Seasonal, LSTM)
  - NBEATS (Neural Basis Expansion Analysis) (Figure 1)
  - Naïve Seasonal Model (Regression Model)
  - LSTM (Long Short-Term Memory)
- Calculated error statistics to compare model predictions

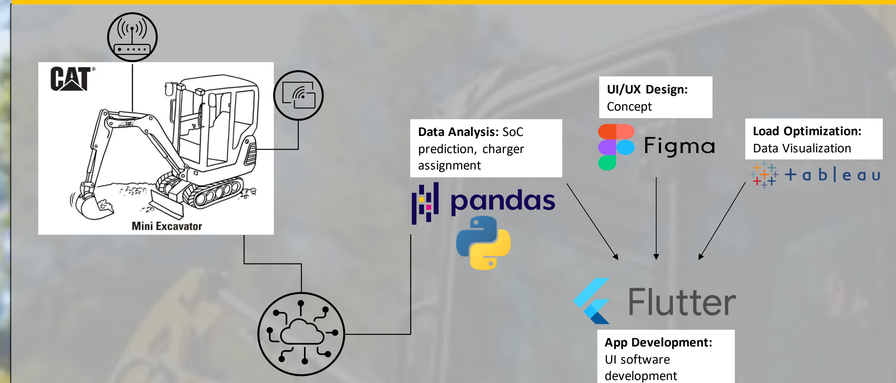
Future Goal: Evaluate how each model works against real-world data (3 different models based on machine performance)

- Utilize predictions to send notification via the application

References

- https://towardsdatascience.com/n-beats-unleashed-deep-forecasting-using-neural-basis-expansion-analysis-in-python-343dd6307010
- https://www.cat.com/en_US/by-industry/construction/electric-products.html
- https://arxiv.org/pdf/1905.10437.pdf

Data Workflow



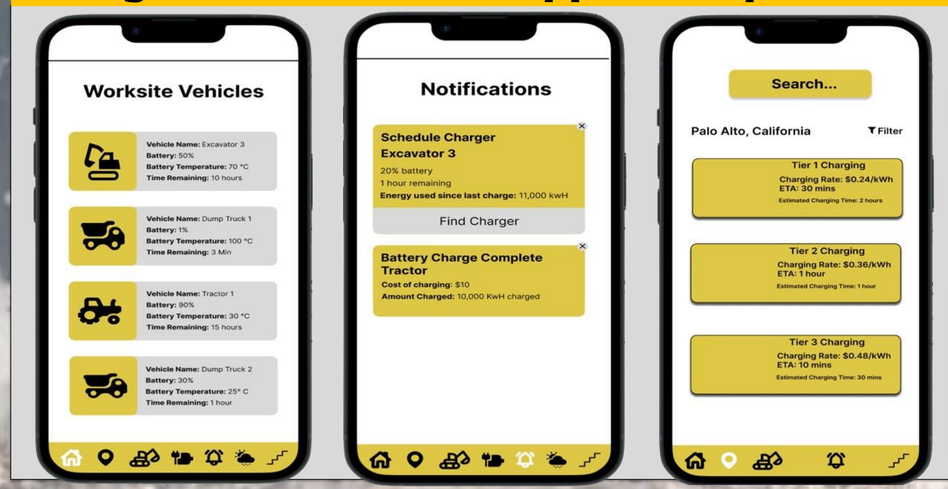
Full Stack – App Features

Objective: Support productivity and efficiency in Caterpillar Electric machine operations by providing real-time insights into battery status.

App features:

- Allows the fleet managers to monitor and manage their worksite vehicles
- Predicts charging times using time-series forecasting and notifies users about remaining time before the machine runs out of power
- Notifies the user when the battery hits extreme temperature levels
- Allows the user to select various chargers to charge their machines
- Displays various data on available chargers, such as charging rates and the estimated time before the charger arrives at the worksite

Figure 2: Full Stack – App Development

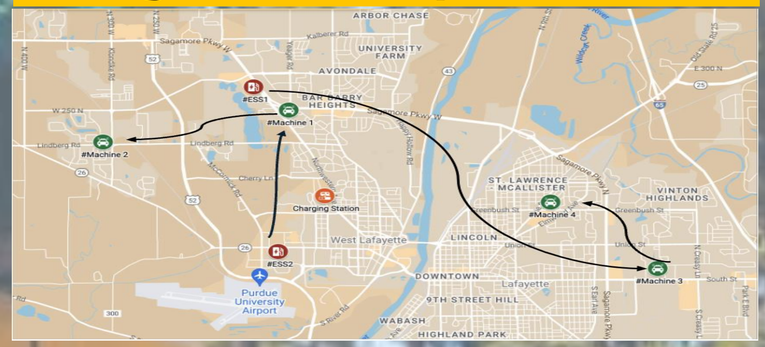


Load Optimization

Objective: Implement charge scheduling recommendations for on-site mobile chargers.

- Using EV charging station data as a mock-up for solving the fleet manager's problem.
- Visualized data using Tableau to better understand charging patterns (Figure 3)
- Created a sequence and the fundamental guidelines for optimizing efficiency and reducing the wait time between the machines and the mobile charger.

Figure 3: Load Optimization



Conclusions & Future Goals

Conclusions:

- Forecasting SoC and charge scheduling are very complex problems that demand a multi-faceted approach
- We have made significant progress towards charging solutions for the construction industry by developing an app for fleet managers

Future Goals:

- Predictive AI: Evaluate how each model works against real-world data (3 different models based on machine performance)
- App Development: Integration with SoC forecasting and charge scheduling
- Load Optimization: To integrate industry standard for electric fleet management into the app.

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