

Power optimization using energy disaggregation

Team name: Door Number - 311

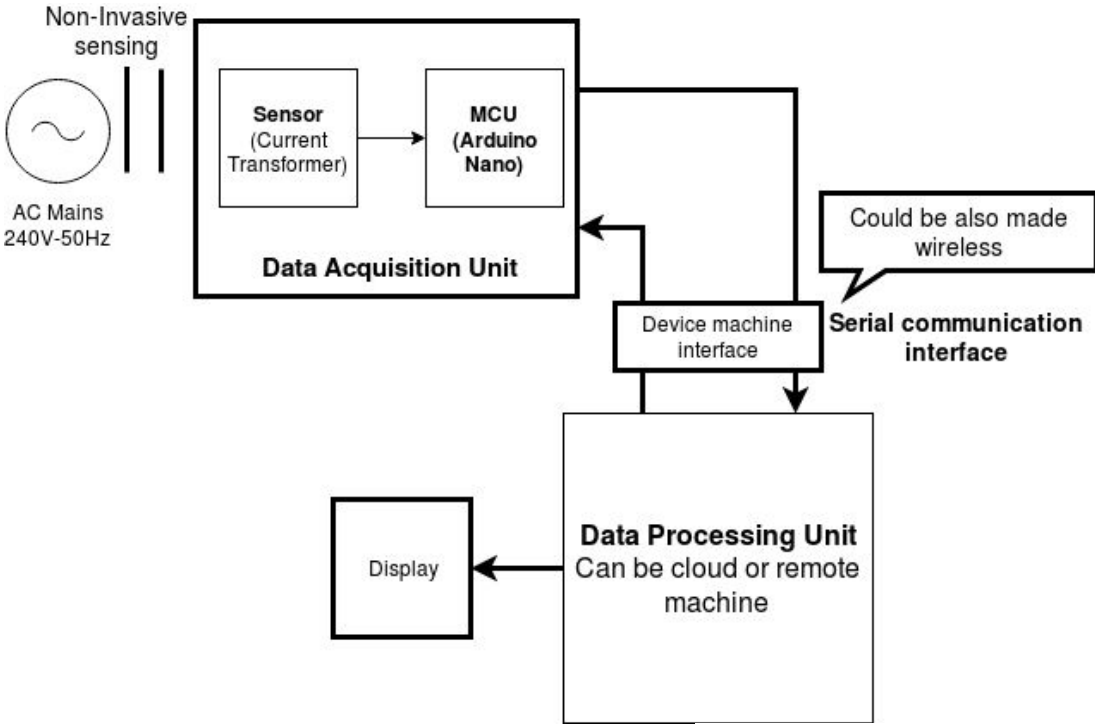
What's in the box?

- Majority of existing power optimization solutions are **invasive not scalable**.
- Studies have shown that energy breakdown and consumer **awareness can save 15% wastage** in energy all over the world*
- We are solving this problem by disaggregating energy of individual devices.
- Providing analytics as a service solution resulting in power optimization.

*Yiling Jia, Nipun Batra, Hongning Wang, and Kamin Whitehouse. 2019. A Tree-Structured Neural Network Model for Household Energy Breakdown. In Proceedings of the 2019 World Wide Web Conference (WWW '19), May 13-17, 2019, San Francisco, CA, USA. ACM, New York, NY, USA, 7 pages.
<https://doi.org/10.1145/3308558.3313405>

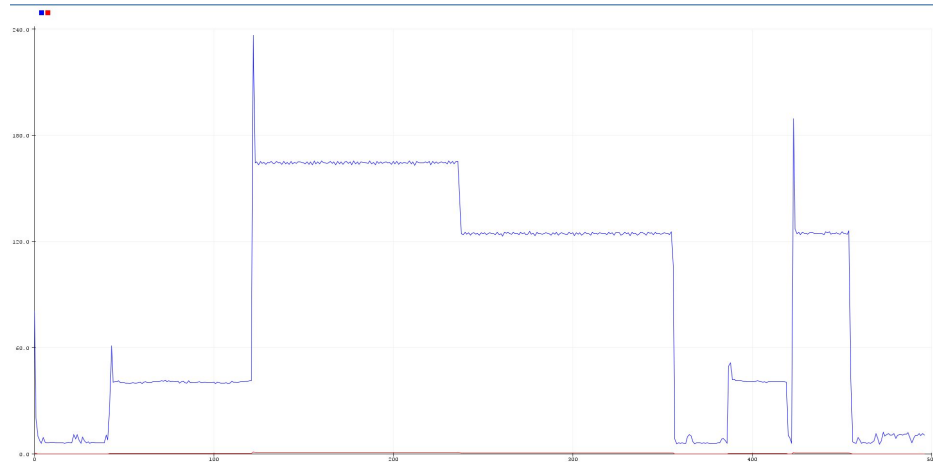


System diagram



Hackware Hardware

- Low-cost, small-form factor device which is installed in the residential buildings to capture apparent power.
- **Non - Invasive** solution.
- Using the module, we have acquired data for different combinations of appliances.



Data Acquisition of bulb and vacuum pump with multiple combinations.

Machines can learn - Device Classification

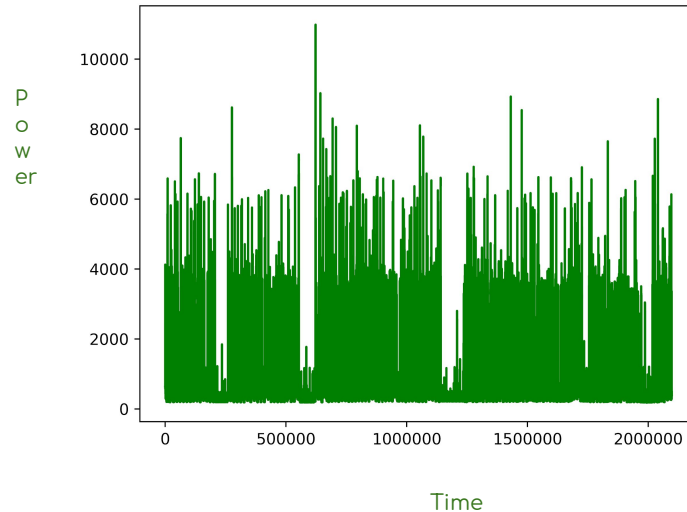
- Classification of individual devices using LSTM neural networks.
- A simple one-layer LSTM was used to classify three devices.
- Accuracy is around 74%.
- Training data size is 4045 and test data size is 1013.
- The model size is 32KB.

```
Epoch 82/100
- 6s - loss: 0.3297 - accuracy: 0.8088 - val_loss: 0.8386 - val_accuracy: 0.7655
Epoch 83/100
- 5s - loss: 0.3297 - accuracy: 0.8021 - val_loss: 0.9773 - val_accuracy: 0.7329
Epoch 84/100
- 6s - loss: 0.3264 - accuracy: 0.8085 - val_loss: 0.9943 - val_accuracy: 0.7177
Epoch 85/100
- 6s - loss: 0.3268 - accuracy: 0.8043 - val_loss: 1.0176 - val_accuracy: 0.7256
Epoch 86/100
- 5s - loss: 0.3240 - accuracy: 0.8056 - val_loss: 1.1623 - val_accuracy: 0.6584
Epoch 87/100
- 5s - loss: 0.3143 - accuracy: 0.8154 - val_loss: 1.1466 - val_accuracy: 0.6607
Epoch 88/100
- 6s - loss: 0.3246 - accuracy: 0.8094 - val_loss: 1.1378 - val_accuracy: 0.6607
Epoch 89/100
- 6s - loss: 0.3216 - accuracy: 0.8052 - val_loss: 0.9967 - val_accuracy: 0.7431
Epoch 90/100
- 5s - loss: 0.3270 - accuracy: 0.8056 - val_loss: 1.0165 - val_accuracy: 0.6868
Epoch 91/100
- 5s - loss: 0.3165 - accuracy: 0.8154 - val_loss: 1.2722 - val_accuracy: 0.6337
Epoch 92/100
- 6s - loss: 0.3166 - accuracy: 0.8106 - val_loss: 1.1915 - val_accuracy: 0.6528
Epoch 93/100
- 6s - loss: 0.3131 - accuracy: 0.8128 - val_loss: 1.4011 - val_accuracy: 0.6357
Epoch 94/100
- 6s - loss: 0.3283 - accuracy: 0.7998 - val_loss: 1.1699 - val_accuracy: 0.6558
Epoch 95/100
- 5s - loss: 0.3139 - accuracy: 0.8089 - val_loss: 0.9374 - val_accuracy: 0.7339
Epoch 96/100
- 5s - loss: 0.3223 - accuracy: 0.8082 - val_loss: 1.3483 - val_accuracy: 0.6337
Epoch 97/100
- 5s - loss: 0.3223 - accuracy: 0.8043 - val_loss: 1.1165 - val_accuracy: 0.7398
Epoch 98/100
- 5s - loss: 0.3113 - accuracy: 0.8103 - val_loss: 1.4016 - val_accuracy: 0.6337
Epoch 99/100
- 5s - loss: 0.3271 - accuracy: 0.8030 - val_loss: 1.0619 - val_accuracy: 0.6993
Epoch 100/100
- 6s - loss: 0.3131 - accuracy: 0.8100 - val_loss: 1.3721 - val_accuracy: 0.6403
```

Machines can learn - Energy Disaggregation

- Segregation of **individual appliances** on simulations.

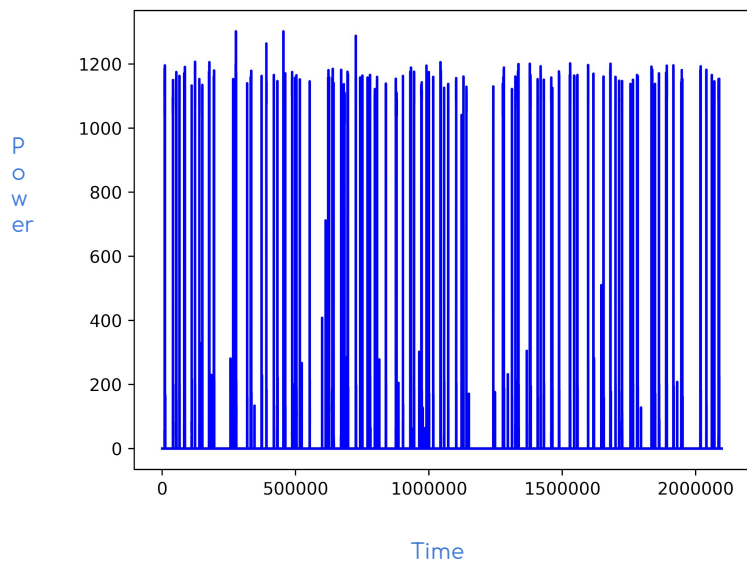
Aggregated power readings



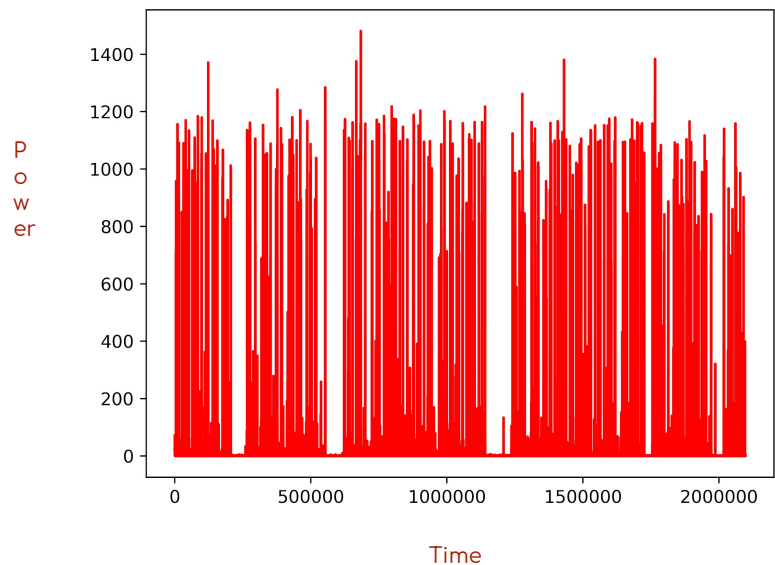
Machines can learn - Energy Disaggregation

- Segregation of **washing machine** on simulations.

Ground truth readings



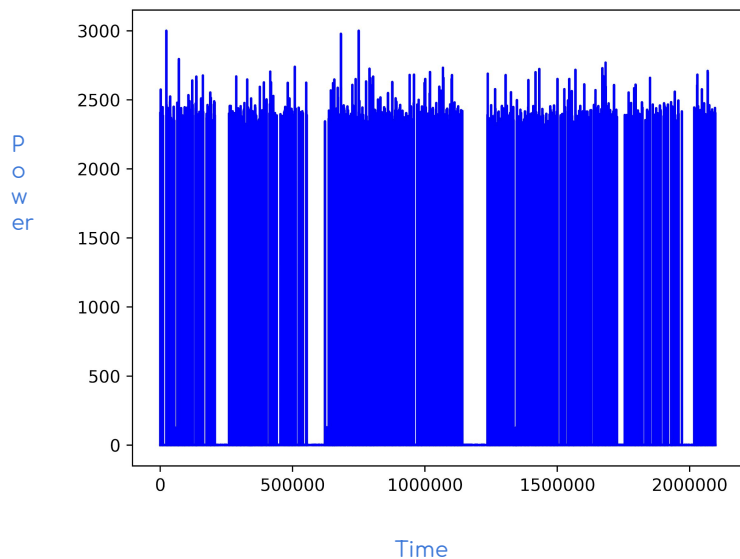
Predicted values



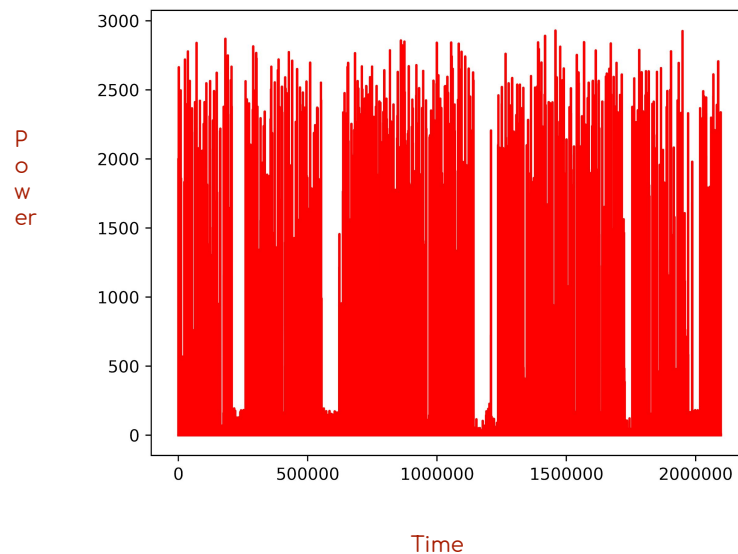
Machines can learn - Energy Disaggregation

- Segregation of kettle on simulations.

Ground truth readings

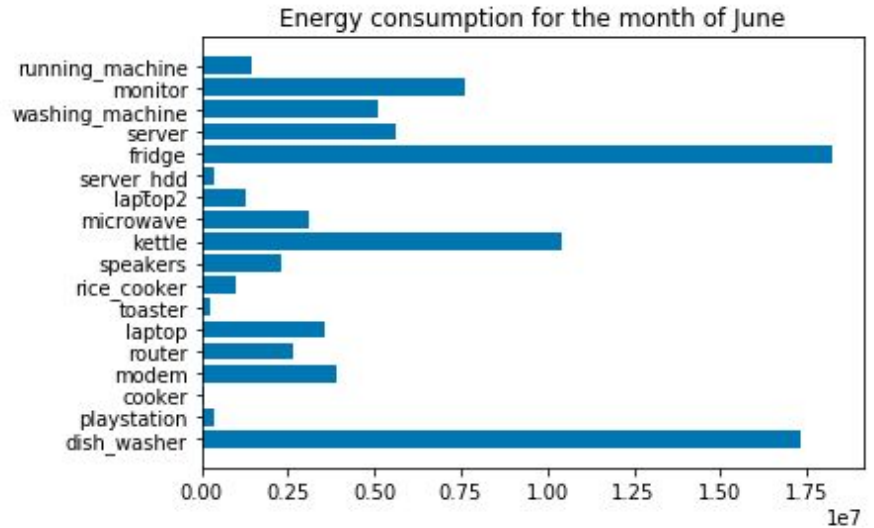


Predicted values



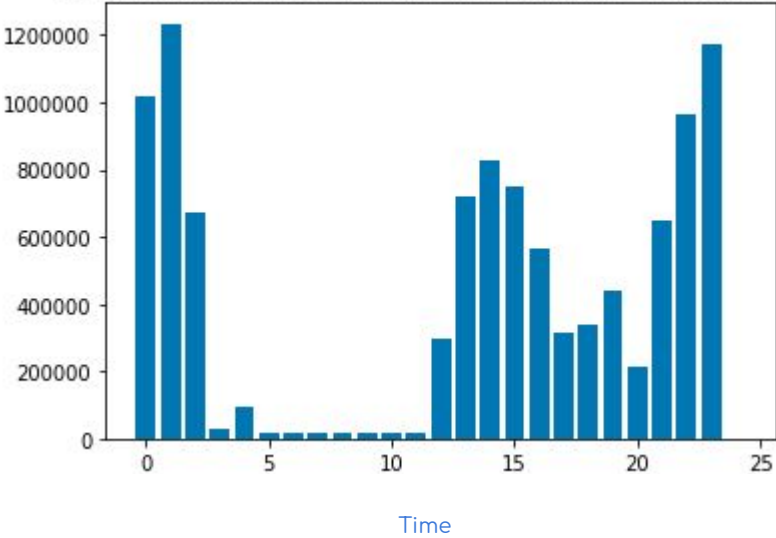
Machines can learn - Data Analytics

- Classified and segregated data opens door to data analytics for power optimization.
- Per device, inter-device, inter-time, inter-house analytics can be performed.

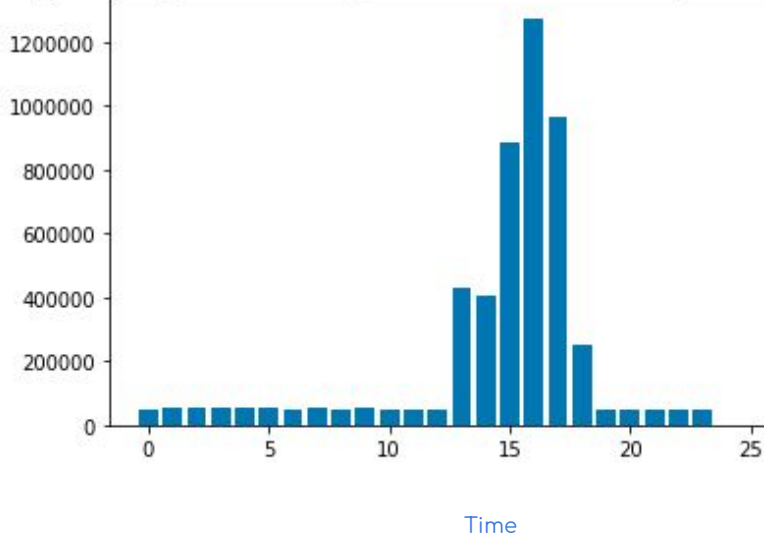


Machines can learn - Data Analytics

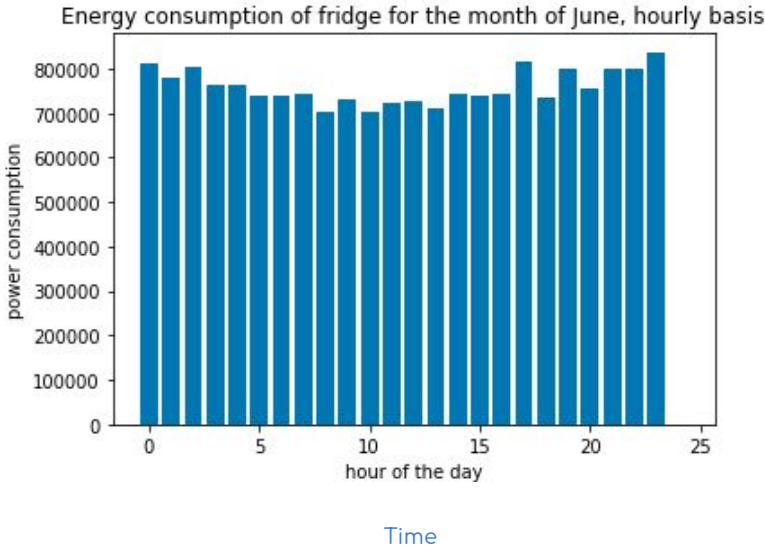
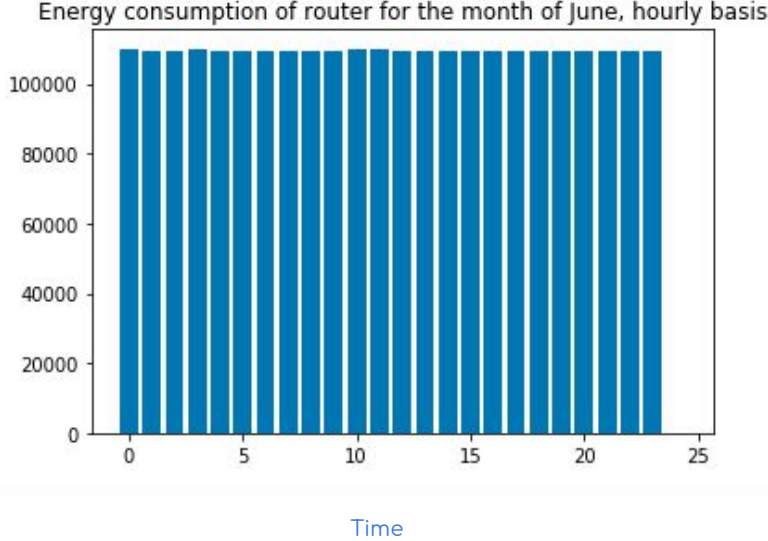
Energy consumption of kettle for the month of June, hourly basis



Energy consumption of washing machine for the month of June, hourly basis



Machines can learn - Data Analytics



Thor is worthy, so is our solution

- No tapping of wires to measure current. It's **non-invasive and safe**.
- **Power saving** by only having a single device which can be **scalable** across building.
- **Health monitoring** of appliances. This will save the power in small scale industries, for example - faulty machines can be detected which are not working efficiently while consuming the same power as normal machines.
- **Giving feedback** to the consumers about the daily localized power consumption.
- This system can be doable **on the edge**



DEMO!

THANK YOU!