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# GT Energy Consumption

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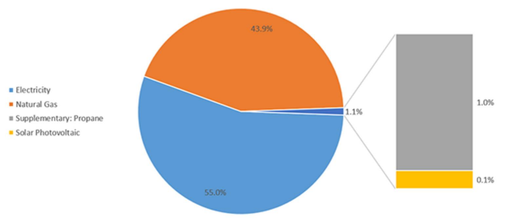
*https://facilities.gatech.edu/

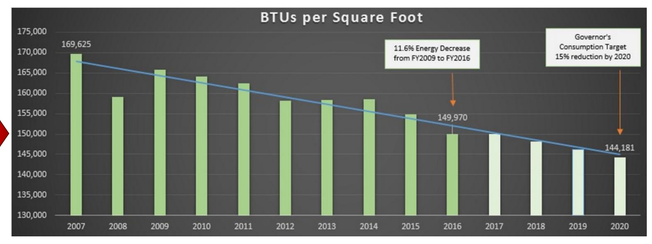
## Introduction

*Motivation & Problem statement*

### Motivation

- Georgia Tech is on track to meet the Governor's Consumption Target to Reduce BTUs per square foot by **15%** by **2020**.
- **No available application** to develop a prediction model for electrical consumption based on historical data from Georgia Tech.
- **Aims to facilitate the optimization** of electric power consumption in the Georgia Tech.

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### Problem Statement

**Community level energy analysis** systems require an intelligent operation and continuous adjustments to provide necessary power with minimal waste for technical and financial perspectives [1, 2]. In this respect, management of the energy system at the campus level is important and challenging beyond a single building.

## Research Approach

*Summary of the survey*

| | | |
|---|---|---|
| Energy consumption visualization has been studied for energy feedback | Clustering is a popular method to find out the similarity of electricity usage pattern in buildings | Neural networks (NN) is promising than regression analysis (More reliable) |

*Research framework*

***Comprehensive literature review***
- Energy consumption visualization
- Current algorithms and tools
- Other models for predicting energy consumption

\+ ***Interview with a facility manager in Georgia Tech***

| | |
|---|---|
| **Data collection & cleaning** | • Electrical consumption data for 99 buildings on campus from facility management office |
| **Machine learning for clustering** | • K-Means clustering algorithm to classify buildings into groups and detect abnormal data |
| **Neural Networks for Prediction** | • Developing NARX model (Nonlinear autoregressive network with exogeneous inputs) to predict usage for each cluster |
| **Visualization** | • Specific building for tracking consumption pattern<br>• Building type for planning the future energy allocation<br>• Summary view for the comprehensive control |

## Experiments & results

*Data collection & cleaning*

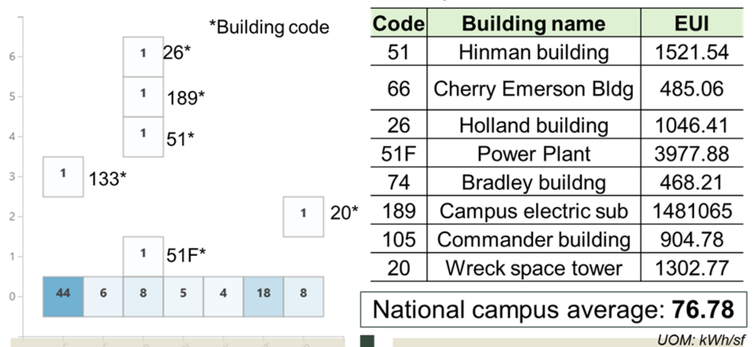
| | |
|---|---|
| **Data Collection** | Electrical consumption data of 99 buildings on campus |
| **Data Cleaning** | Removing the repeated records in the dataset |
| **Data Integration** | Integrating data measured several meters |
| **Data Normalization** | Normalizing data into the Energy Use Intensity (EUI)* |

*EUI = total energy consumption / total gross square footage of building

- All the above steps are carried out using **Perl Programming Language**

*Data clustering*

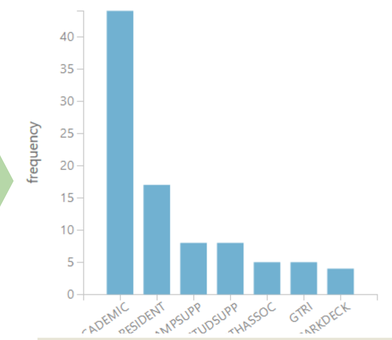
Outlier detecting




| Code | Building name | EUI |
|---|---|---|
| 51 | Hinman building | 1521.54 |
| 66 | Cherry Emerson Bldg | 485.06 |
| 26 | Holland building | 1046.41 |
| 51F | Power Plant | 3977.88 |
| 74 | Bradley buildng | 468.21 |
| 189 | Campus electric sub | 1481065 |
| 105 | Commander building | 904.78 |
| 20 | Wreck space tower | 1302.77 |

National campus average: **76.78**

UOM: kWh/sf

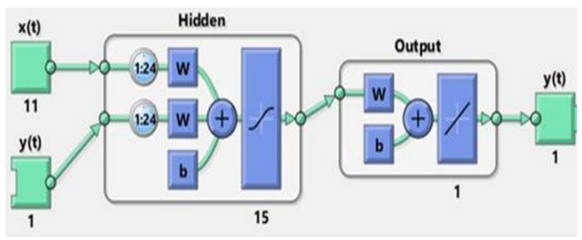



***K-Means algorithm*** + ***Heuristic adjustment*** → ***91 buildings data***

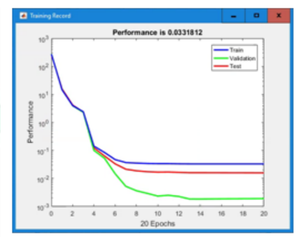

*Prediction with NARX*

- **Building Information**

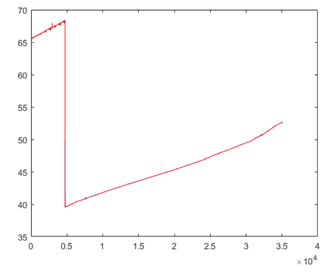
| *Code* | *Category* | *Name* | *Area* | *K-means cluster* |
|---|---|---|---|---|
| 17 | ATHASSOC | Bobby Dodd Stadium | 347,094 sf | 0 |




NARX Model for Bobby Dodd Stadium (2016), performance = 0.0259



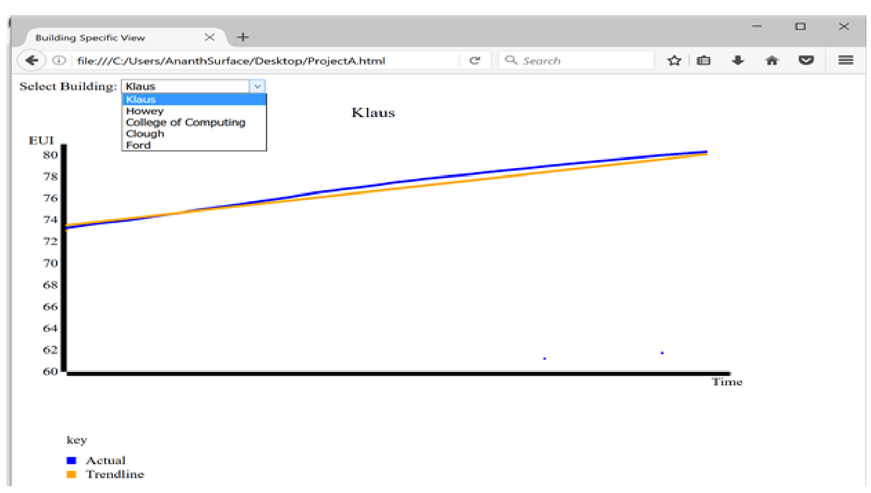

Performance testing, overall performance = 0.0331




Actual vs Predicted values, RMSE = 0.1611

## Visualization

*Specific Building View*




Demo – energy consumption view of a specific building compared to associated cluster

The Specific Building application will show a comparison of particular buildings' energy use as compared to the trend of its building type by gross usage or EUI (Available to select the building using drop down menu).

### References

[1] K. Powell, A. Sriprasad, W. Cole, and T. Edgar, "Heating, cooling, and electrical load forecasting for a large-scale district energy system," Energy, 2014.

[2] M. Hashmi, V. Arora, and J. Priolkar, "Hourly electric load forecasting using Nonlinear AutoRegressive with eXogenous (NARX) based neural network for the state of Goa, India," Instrum. Control …, 2015.