

# Visualization Term Project

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# 1 Introduction

## 2 Materials

### 2.1 Building Layout

#### 2.1.1 Basic

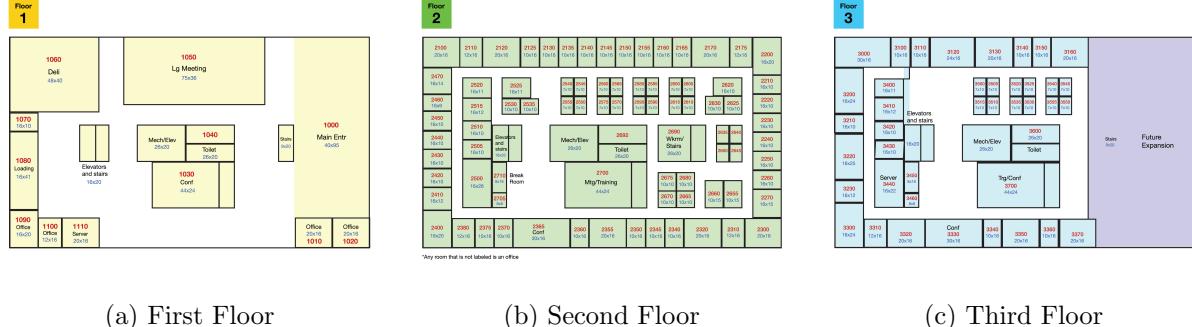


Figure 1: Main Layout of the building

The main layout of this building is as figure 1.

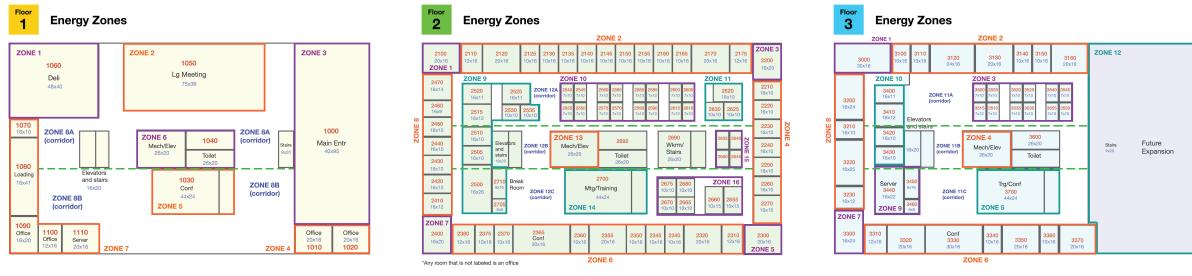


Figure 2: Energy Zone of the Building

The energy zone of this building is as figure 2.

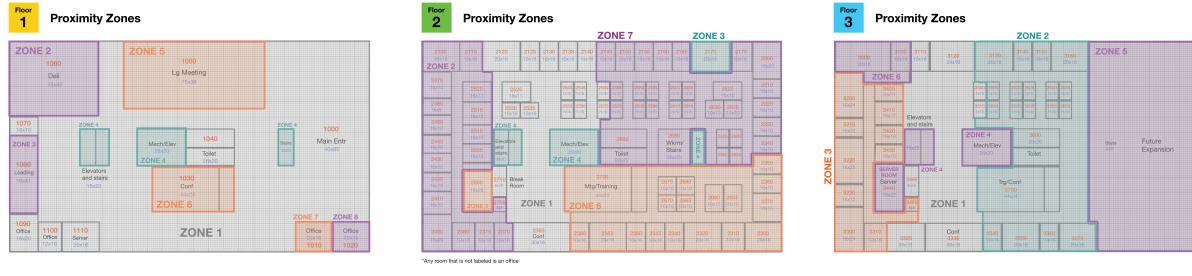


Figure 3: Prox zone of the Building

The prox zone of this building is as figure 3.

To analyzing movement data, we should find corresponding coordinate with zone data. To find matching coordinate, we calculate the approximate center of all zones, and consider the approximate center coordinate as representative of its zone.

## 3 Methods

### 3.1 Scikit-learn: Machine Learning in Python

*Scikit-learn* is a Python module integrating a wide range of state-of-the-art machine learning algorithms for medium-scale supervised and unsupervised problems [1].

### 3.2 Matplotlib

*Matplotlib* is a Python 2D plotting library which produces publication quality figures in a variety of hardcopy formats and interactive environments across platforms [2].

### 3.3 Pandas

*Pandas* is a Python library of rich data structures and tools for working with structured data sets common to statistic, finance, social sciences, and many other fields [3].

### 3.4 SciPy

*SciPy* is a Python-based ecosystem of open-source software for mathematics, science, and engineering [4].

### 3.5 TSNE

T-distributed Stochastic Neighbor Embedding (TSNE) is a machine learning algorithm for visualization high-dimensional data in a low-dimensional space [5].

## 4 Results

### 4.1 What are the typical patterns in the prox card data? What does a typical day look like for GAStech employees?

First of all, we drew the distribution of movement distance as figure 4. Also, the basic statistics values of movement distance is in table 1.

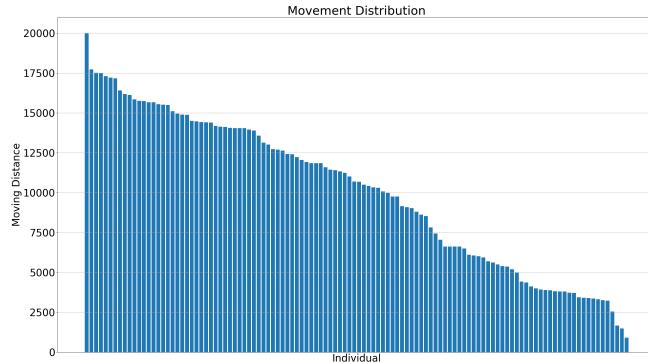


Figure 4: Distribution of Movement Distance

Table 1: Basic Statistics Data within Movement Distance

Item	Minimum	Maximum	Average	q1	Median	q3	Standard Deviation
Value	902.44	19999.38	10083.95	5642.54	10688.57	14134.16	4750.46

## 4.2 Describe up to five of the most interesting patterns that appear in the building data. Describe what is notable about the pattern and explain its possible significance.

First of all, we drew the distribution of the building data using TSNE technique. The TSNE plot of general building data is shows as figure 5.

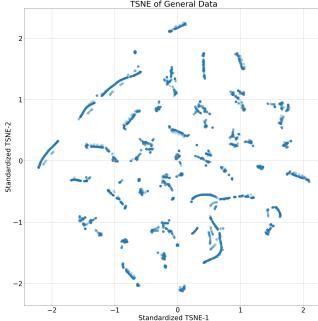


Figure 5: TSNE Plot for General Building Data

To find patterns which appear in the building data, we should find that normality/abnormality in the building data. However, there are over 400 columns in the general building data; therefore, it is almost impossible to find abnormality column-by-column by human. Hence, we used these four algorithms which are included in scikit-learn: *EllipticEnvelope* [6], *OneClassSVM*, *IsolationForest* [7, 8], and *LocalOutlierFactor* [9].

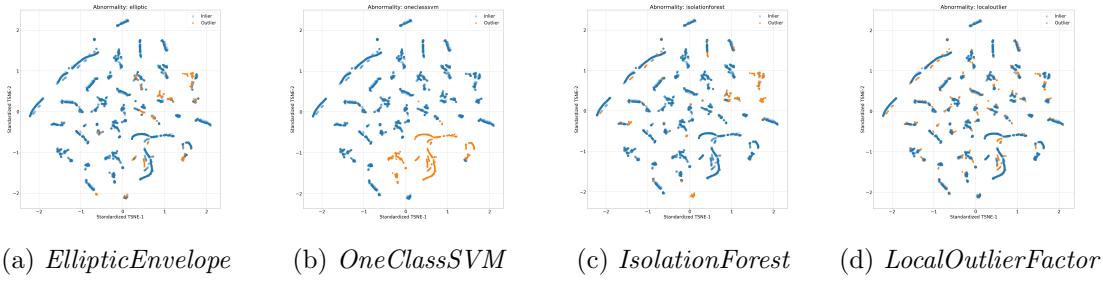


Figure 6: Abnormality Founded by Algorithms

Abnormality founded is shows as figure 6. Note that some data were considered as abnormal in multiple algorithms; however, no data were considered as abnormal in all algorithms. Moreover, with the data in figure 6, we can display the timeline of abnormality as figure 7.

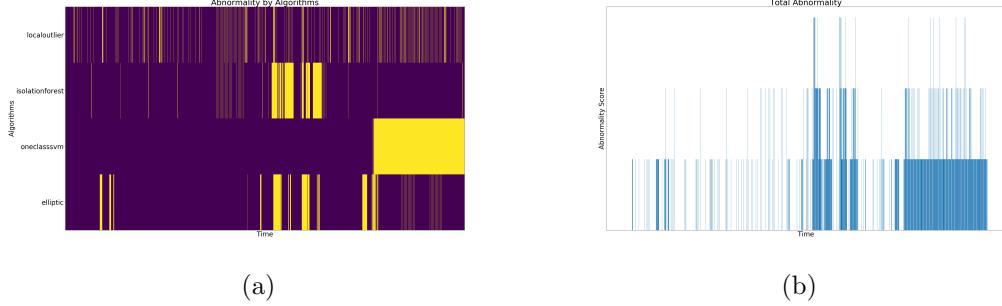


Figure 7: Abnormality by Timeline

In the figure 7-(a), we can know that which algorithm consider specific time as abnormal events (yellow marked is abnormal); and, in the figure 7-(b), we can realize that how many algorithms consider specific time as abnormal events.

- 4.3** Describe up to five notable anomalies or unusual events you see in the data. Prioritize those issue that are most likely to represent a danger or a serious issue for building operations.
- 4.4** Describe up to three observed relationships between the proximity card data and building data elements. If you find a causal relationship, describe your discovered cause and effect, the evidence you found the support it, and your level of confidence in your assessment of the relationship.

## 5 Discussion

## References

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