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PROJECT PROPOSAL: ENERGY PERFORMANCE VISUALIZATION OF BUILDINGS

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1. Project Background and Description

The proposed project aims to facilitate a better understanding of a building's energy performance. The building chosen for this project is the Center for Interactive Research on Sustainability on UBC campus. Having talked to the building's manager and looked at the annual energy performance reports of the building, I have noticed a need for an improvement in the way the energy data of this building is being visualized. Therefore, the aim of this project is to improve the state of the energy performance visualization of CIRS from rudimentary excel charts to more advanced interactive charts. Moreover, as the CIRS building is dubbed as a "Living Lab" in sustainability, there is extra interest in knowing how sustainable the building is and pass the knowledge gained to the world. However, except for some existing yearly charts that show the overall energy performance of the building or some visually cluttered excel charts there is no single tool which can easily accommodate the needs of a researcher studying the energy performance of the building such as comparing daily vs. weekly patterns in a span of two years. A lot of useful lessons are not seen because of how poorly the information is being visualized. Having explained the rationale for this project, I will start describing the domain, task, and the dataset I will be working with.

1.1. Domain and Dataset

The dataset is comprised of readings from the electricity panels in the building in form of tables. Data from 24 of the 27 electricity panels in the building will be used for the purpose of this project. Each panel gives out a number every minute and that number is saved with the relevant time stamp and the panel's name in an Excel worksheet. Each worksheet is comprised of 24 separate sheets, each covering half of each month in a year. The size of each worksheet is typically around 40 MB. In order to get the minute by minute consumption of a panel, each row of the table has to be subtracted from the previous row which will give the relevant consumption in Kilowatts. There is data starting from 2012 until the end of 2016. However, my main focus will be on the last three years. Also there is a need to cleanse the data as some of the data is tagged with a "BAD" attribute which means the data for that minute is not correct. According to which panel is being looked at, one can understand if the consumption is related to plug load or lighting load. Lastly, there is hope that I can gain the temperature data too.

1.2. Task

Tasks to be facilitated by the proposed visualization for researchers are as follows:

- Discovering and presenting daily, weekly, monthly and yearly trends and patterns in consumption
- Discovering and presenting correlations between outside temperature and plug load consumption as some may use personal heaters at their desks
- Normalizing the data based on the area of the building
- Identifying the maximum consumers
- Comparing the consumption to its average value, for instance a Monday during school term with the average consumption of all Mondays during that school term

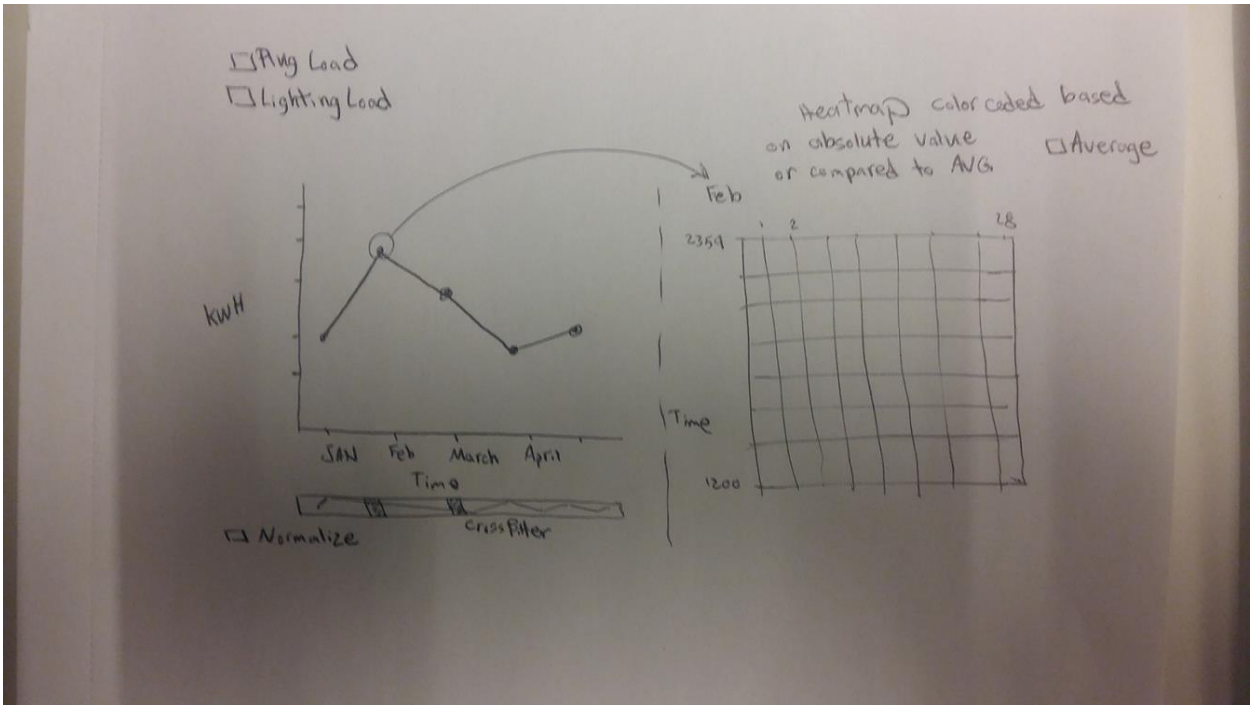
2. Personal Expertise

As a course project last term, I used Tableau to visualize this data. However, I only had access to 2016 data at that time. This project will both serve me in terms of having a comparison between what I have done in Tableau and what I can achieve by programming. Also it lays the foundation for my future work related to my thesis.

I have very limited background in programming in C++. Learning to properly use D3.js is one of my course objectives.

3. Proposed InfoVis

The following hand sketch is the proposed visualization.



It provides the user with an overview by using line charts and lets the user navigate through time by the cross filter embedded to the bottom of the chart (overview). Upon clicking on any of the marks, the relevant heat map of that month's consumption will be shown which color codes the blocks according to either absolute values or compared to the average value of that day (detail view). Also the user has the ability to view the normalized consumption and also either plug load or lighting load consumption or both. To facilitate the investigation of weather effects on plug load consumption, a scatter plot is proposed which would come below the heat map but as mentioned before there is doubt in gaining weather data at this moment.

4. Implementation

I am aiming to use the JavaScript library D3.js to implement this visualization and use the existing blocks for cross filter navigation and the heat map and also interactivity.

5. Milestones

Milestone	Date
Data Cleansing Finished	March 10th

Line Chart with Cross Filter Implemented	March 20th
Heat Map Implemented	March 25th
Views are Linked and polished	March 30th and April 15th
Interim Write up	March 31st
Presentation	April 25th
Paper	April 28th

6. Previous Work

A close look at the needs and requirements of the building operators and managers is taken and even a prototypical visualization is introduced to address those requirements [1]. In short, two of the requirements of a proper visualization that help the building operators and managers are as follows:

- High-level overview with drill-drown capabilities, including visualization of end-use energy information including lighting, plug loads, and HVAC components
- Support for normalization

Also the use of a calendar matrix is identified as a potential match for the overview task in visualizing energy performance [2]. However, the heat map with daily time stamps that is proposed for this project is serving as a detail view compared to the overview with line chart having monthly time stamps.

Lastly, the breakdown of the building's electricity consumption into plug load and lighting load was first done in the building's annual report. However, as the file is not publicly available, I am not able to give a proper reference to it in the bibliography.

7. Bibliography

[1] Lehrer, D. and J. Vasudev, 2010. Visualizing information to improve building performance: a study of expert users. 2010 ACEEE Summer Study on Energy Efficiency in Buildings. Pacific Grove, CA, August 15-20. 10 pp.

[2] Matthew Brehmer, Jocelyn Ng, Kevin Tate, Tamara Munzner: matches, Mismatches, and Methods: Multiple-View Workflows for Energy Portfolio Analysis. IEEE Trans. Vis. Comput. Graph. 22(1): 449-458 (2016)