Energy Consumption and Human Life

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Abstract. In this project, Several interactive visualization applications are built up. On one hand, focusing on energy consumption data, a choropleth map and information panel with sunburst chart and stacked bar chart are created. On the other hand, visualization on showing how index interact with energy consumption data is also plotted. We further analyze how the graphs work, and their merits and flaws.

1 Introduction

Today, we see lots of news about how air quality and environment got affected by the large amount of energy consumed. People also talk about sustainable development, by promoting environment-friendly, renewable energy. As the idea of open data become popular, users can easily get abundant information and data of issues they are interested in, this is also true for energy. On one hand, no one want their homeland got polluted; on the other hand, the prosperity of a country's economic could have been relied on industries that consume large amount of energy, limiting energy usage may even cause living standard drops. Then what standpoint shall we have? It's quite confusing and hard to strike a balance.

Our visualization let users to explore the quantity, proportion of energy consumed in different countries, to see the growing or dropping trends of energy of countries in past few decades. In addition,we would like to take social indicators like Gross Domestic Product (GDP), and Social Progress Index (SPI) as measurements of quality of human life, and create visualization on how they interact with energy consumption.

Target Audience Our application is not only for policy makers, governors, but also for everyone who is interested in the topic. We aim on providing a system that can be use intuitively, easy to interact with and graphs easily comprehended.

2 Literature Review

2.1 Energy Data from BP Company

BP, formerly British Petroleum, is an oil and gas company. The webiste of the company integrates abundant statistics and data, and thus become very helpful for people who are interested about energy-related industries or issues. We obtain the data on energy consumption from the website.

2.2 Enerdata Website

Similar to BP, Enerdata also host rich data which is related to energy. Enerdata concerns more about energy efficiency, climate change and other energy-related issues. The website has nice visualization of the various type of energy production trade, and consumption around the world, presented in the format of choropleth map. Their visualization displays energy data of past 26 years.

2.3 Social Progress Index 2017

The Social Progress Index website is a website designed completely for detailed definition, explanation of the index. They also have well-designed choropleth map and delicate information panel to display different components and perspectives of Social Progress Index, for the selected country. There are only four years of Social Progress Index data available.

3 Project Overview

3.1 Web Technology

A single-page application (SPA) is a web application or website that interacts with the user by dynamically rewriting the current page rather than loading entire new pages from a server.single page application. Our website is a SPA so that all the required resources, like HTML, JavaScript, CSS are dynamically loaded based on users specific requirement.

Angular MVC framework for spa, model, view, controller. separated into components, developing each component individually, as our data source are separate in many files and contains large amount of energy data for different types. we are accessing data of a single country in the country information panel frequently, to ease the load of reading IO, Angular's data service can help us load CSV at first and when a country got selected and data panel component pump up, query for data of the target country and deliver it to the components without extra IO.

Bootstrap To support the responsiveness of the website, we use Bootstrap 4 to build pages layout. The whole web page are fit in a responsive, fluid-width container so that the content can automatically change its relative size with the window. Bootstrap also provides user-friendly components and utilities that help to improve the user-experience, which makes it the world's most popular front-end component library.

D3.js D3.js help us build up interactive visualization of wide range of visualization. And it is flexible to customize and implement. D3 also has abundant templates, which are handy to pick up and make changes on it.

3.2 Development Plan

At preparation stage, we collected data source and do data preprocessing. Data preprocessing include cleaning up messy data, unifying data unit (for energy, we use a unified unit: Million Tonnes of Oil Equivalent, Mtoe), and integrating file format to make later importing and applying process easier and smoothly. We also start researching on web technologies we need to implement our ideal system.

At design stage, we finished up a preliminary blueprint of the comprehensive web application layout. After that, we built up the Angular MVC framework, set up Bootstrap layout and created several angular components to host separate parts of our visualization. This process helped a lot when we move to implementation stage. Each components can be developed individually.

At implementation stage, we started working on each visualization: a interactive choropleth map of energy consumption, a side information panel for details country data, and a section to show comprehensive interaction between energy and social indicators.

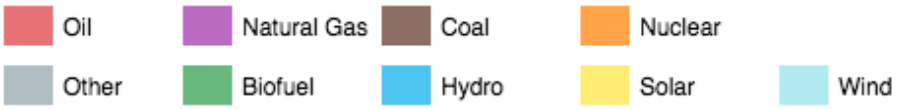
Finally, at testing stage, we got feedback from our critique group and the instructor, and polished up the overall application accordingly.

Time line	Preparation	Design	Implementation	Testing
Till	Oct. 25	Nov. 1	Nov. 29	Dec. 1

4 World Energy Consumption Map

4.1 Color theme of Energy

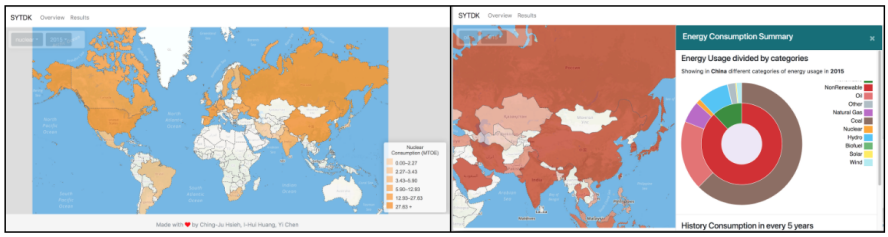
Energy can be categorized into two types: Non-renewable energy and renewable energy. Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human timescale. We have designed a color theme for the two types of energy and their subordinates. The theme focus on providing an intuitive, consistent and clear view of energy data throughout our application:



4.2 Interactive Choropleth Map

Data are presented with a choropleth map. We introduce the Leaflet, a lightweight JavaScript library are used to build the interactive energy-consumption choropleth map.We use OpenStreetMap as our base map source and the original data source is from Mapbox Tile Map Service. This WTMS uses Web Mercator as the spatial reference. Based on that, our map can seamlessly combine the tile map with the thematic map layer we use in our project.

As for the energy consumption thematic map, we render different energy type on a geoJSON-format world political map. Leaflet initially load the OpenStreetMap WMTS once and add/refresh energy geoJSON layer based on the users request. The map support zooming in or out to focus on area of interest. There is also a navigation bar on the top with drop-down to select different type of energy and year of data to present, letting user have an overview of the world for different year and type. Different energy type has different color scheme.



4.3 Side Information Panel

When you click on a country on the choropleth map, a side panel with detailed information of the country's energy consumption will pump up on the right side of the screen. It displays a sunburst chart and a stacked bar chart inside the panel. The sunburst chart has two layers: the inner layer display the proportion of non-renewable energy and renewable energy. The outer layer lies under the inner layer and subordinate, more specific energy type of non-renewables and renewables and their corresponding proportions. Users can click on partitions of the chart to display only the subordinate data under the specified type, and to get back to views with more layers by clicking on the middle circle of the chart. The data displayed in the sunburst chart are of the year user selected in main map's nav bar.

The stacked bar below displays the energy consumption from 1965 to 2015 for every five years. It give out a clear view of how fast the country's energy consumption grows. Both of the graph inside the panel follow the theme colors. Both of the visualization apply angular data service to query for data they need to render the visualization efficiently. Some interesting facts we found through the visualization include that, as the overall world energy consumption grows, we may wonder if energy consumption of every country in the world is growing. it turns out that for some countries, energy consumption actually drops. For some countries having nuclear plant, the stacked bar also implies the approximate time on when the country start(or even stop, like Japan) using nuclear electricity.

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5.1 Social Indicators

The definition of GDP, Gross Domestic Product is probably well-known for everyone. It is a monetary measure of the market value of all final goods and

services produced in a period (quarterly or yearly) of time. Here we apply the Per capita GDP at current prices in US dollars from UNdata's website. The Social Progress Index is an aggregate index of social and environmental indicators that capture three dimensions of social progress: Basic Human Needs, Foundations of Wellbeing, and Opportunity.

5.2 Visualization for SPI Definition

Under each dimension of Social Progress Index, there are several components, and each component is built up with multiple indicators. To let users obtain comprehensive understanding on how Social Progress Index is calculated, we create a visualization to illustrate components of Social Progress Index.

5.3 Analysis on Energy v.s. SPI and GDP

To figure out the relationship between energy consumption and the two social indicators, we created a scatter plot, taking energy consumption divided by population of the country as x axis, and Social Progress Index as y axis. Each data point on the scatter plot represents a country. The radius of data points reflect the quantity of Gross Domestic Product for the country. It turns out that points have a obvious trend going from bottom-left to top-right. As energy consumption per capita grows larger, the Social Progress Index is also likely to go higher; so does Gross Domestic Product. There are two obvious outliers in the scatter plot, Kuwait and Saudi Arabia, who don't have high Social Progress Index but still consume quite large amount of energy.

6 Responsiveness

The responsiveness of Bootstrap website layout works perfect: buttons, navigation bar, image backgrounds and texts work well in different situations. As for our visualization, in the overview page, the three charts (bubble chart, tree map and scatter plot) have some sort of responsiveness when the web page is not squeeze too much. But graphs would still break when under extreme situations. For the sunburst chart and stacked bar chart in the side panel, they also have some sort of responsiveness: they would resize when screen changes, but need refreshing (activating, clicking on the country after resizing) to make it happen. Such responsiveness would still break under extreme situations. the map works fine under intermediate squeezing of the page, but when it is squeeze too much, such responsiveness would also break.

References

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3. The Social Progress Imperative: 2017 Social Progress Index, https://www.socialprogressindex.com