

# Open Data Visualization by Using Javascript Libraries

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**Abstract** — In order to represent data clearly and efficiently, data visualization approach can be applied. When we talk about open government data, this becomes even more important. Throughout this paper we will present one approach for visualization of open government data. By using this approach and contemporary JavaScript libraries we will show how they can be utilized in order to present government data in interactive manner, thus allowing stakeholders to extract new knowledge and information from open government data. Furthermore, our aim is to bring closer benefits of open data, as well as to show how software application based on open data can be developed. Therefore, in the first part of the application interactive visualization of the data on the geographic map is shown, while in the second part, a statistical representation of open data is performed.

**Keywords** - e-government; open government; javascript; open data; data visualization

## I. INTRODUCTION

Nowadays, a lot of people are talking about the concept of open data. Although people are aware of existence of open data, only small portion of them understand the real importance and benefits of this concept of open data for country, economy and citizens [1]. Although standard definition of open data is not yet formulated, we can freely say that open data is data that can be freely used, reused and redistributed by anyone, without any legal obstacles [1].

However, the question that arises is: Why is important open data? The answer to this question can be hidden in a huge practical, economic and creative potential of this kind of information [1]. Opening of governmental information leads to creation of different applications and utilizations of government data in various areas. These applications make life easier not only for citizens, but also for other stakeholders, which is the reason why many experts call open data the oil of the 21<sup>st</sup> century [2].

According to the research available in the literature [2, 3], most widely used approach for exploitation of open government data is through their visualization. Data visualization serves as a clear and efficient form of communication of information [4]. Visual availability of open data via charts, diagrams, maps and other forms of interactive representation of data, offers easy way to adopt information and extract valuable information assets. Correctly applied, data visualization helps users see, interpret, and understand data. Therefore, there is a need for displaying massive amounts of data in a way that is easily accessible and understandable, which is of high importance in case of open data. The amount of data available on the Web increases dramatically due to the fact that various organizations generate data every day. It is difficult for users to visualize, explore, and use this huge amount of data. The ability to visualize data is crucial to scientific research. Today, computers can be used to process large amounts of data. Data visualization is concerned with the design, development, and application of computer generated graphical representation of the data. It provides effective data representation originating from different sources. This enables decision makers to see analytics in visual form and make it easy for them to make sense of the data. It helps them discover patterns, comprehend information and form an opinion [5].

In this paper we will talk about elements and techniques of visualization, with special attention on JavaScript libraries which enables easier development of the application on the web. The question that arises is: What this paper brings? The answer to this question is approach for open data visualization. The application developed on the basis of the proposed approach will be presented as well. The paper is organized in the following manner: Second section gives review of elements and techniques needed for effective visualization of data. In third section we present JavaScript libraries which can be adopted for interactive visualization of open government data. Fourth section brings proposal of step by step approach for open data visualization, along with description of each building block of approach in UML. In the fifth section the use of case

study is given, where visualization of open data about libraries is performed on the basis of open data. Finally, a conclusion is given along with remarks for future work.

## II. ELEMENTS AND TECHNIQUES OF VISUALIZATION

Today, the use of data visualization is rapidly growing, and, therefore, gaining significant importance. Data visualization helps citizens to understand data more easily through graphical representation of data. If we ask a question what makes a good data visualization, the answer lies in the fact that a good data visualization must have the following characteristics: interestingness, functionality, integrity [6].

All of the previously mentioned statements are achieved by properly adopting basic elements of visualization, which are: color, shape, shades and interactivity. Color can enhance and clarify a presentation of data, and the most important use of color in data presentation is to distinguish one element from another [7]. It can be seen as a classification technique, and we can clearly point out on different data which belong to different classes. Colors are carefully selected for certain types of visualization. When color is used to represent data, we must choose effective colors to differentiate between data elements [5]. Shapes, like colors, can be used to show the class affiliation of data. They are mostly used to display different data characteristics, as well as to point out the ranking of importance [8]. Interactivity enables direct actions on the graphic display, such as click on a part of the graphic [9].

Techniques for data visualization mostly deal with different types of data representations, such as: charts, diagrams, maps and other forms of interactive representation of data [10].

Charts are graphical representations of data which are used to improve the understanding of some data by attracting human attention more than data in textual shape. Graphs and diagrams transform a large amount of hard-to-understand data to be meaningful and easily understandable. Maps are used for efficient representation of geographically related data. They enable display of location on the basis of geographic latitude and longitude.

Keeping in mind all of this, we came to the identification of important feature of data visualization, which is closely related with attracting user attention in order to understand the presented information more clearly [11]. A lot of tools for data visualization based on JavaScript language can be found in literature. Those tools are mainly available through JavaScript libraries, and some of the well-known are: leaflet.js and highchart.js. Both of them will be described in the next section of the paper.

## III. JAVASCRIPT LIBRARIES FOR VISUALIZATION

The most commonly used JavaScript libraries are: Leaflet.js, HighChart.js, chart.js and d3.js.

### A. Leaflet.js

Leaflet is the leading open-source JavaScript library for mobile-friendly interactive maps. Weighting just about 42 KB

of JS, it has all the mapping features most developers ever need [12]. Leaflet is designed with simplicity, performance and usability in mind. It works efficiently across all major desktop and mobile platforms, can be extended with lots of plugins, has a beautiful, easy to use and well-documented API and a simple, readable source code that is a joy to contribute to [12]. Furthermore, this library enables the creation of interactive maps, where interactivity is reflected in the fact that we can communicate with the map, move around, zoom in or zoom out the interesting parts, click on some part of the map, etc. To mark location of a library on a map, the leaflet.js library allows the use of markers that indicate something on them is located, in this case a library. The Leaflet.js also allows using many others tags such as: tiles, polygons, circles, etc.

### B. HighChart.js

HighChart.js is a popular open-source JavaScript library for different chart types based on CSV and JSON data, but also real-time data sources [13]. HighChart.js offers the most attractive and professional looking 2D / 3D charts on the market. HighChart.js can be used in different programming languages such as: .Net, PHP, Python, R, Java, but also can be used in iOS and Android operating systems [13]. It allows the creation of different types of interactive charts in the web application. Some available charts are: line charts, column charts, bar charts, pie charts, 3D charts, etc [13].

### C. Chart.js

One more library which we can use for data visualization is Chart.js library. This library allows combining with many others programs on JavaScript language, and it is suitable for implementation due to the fact that it can quickly and easily make graphs which fulfil the majority of user requirements, and this library has a very simple interface for use [11]. For this library, one of the characteristics that should be highlighted is possibility for transformation of graphs, etc. The transfer of information within data visualization is certainly one of the most efficient way by which people can be informed, and it must be taken into account when implementing any graphical elements [11].

### D. D3.js

A library like D3.js serves as a solution that is applied when there is a need for more complex shape of graphically interpretation of data [11]. This library is characterized by following three features: compatibility, debugging and performance [11]. Compatibility allows combining with other JavaScript libraries, with the goal of improving the usability of the web application. Debugging is an important mechanism for fixing errors and defects. Performance should improve the implementation of web services, so that the user does not notice when something is running slowly. This library provides the ability to implement interactive elements. Interactive elements enable transformation of the graph and display of new elements. However, it is necessary to emphasize that usage should be moderate, because excessive usage may cause the user to become distracted, and in that way his attention is diverted from the essence (understanding of information).

#### IV. APPROACH FOR OPEN DATA VISUALIZATION

On the Fig 1. we present an approach for open data visualization which is conducted through 4 steps. Before visualization starts, parameters of visualization must be chosen. They are reflected on a fact that developers perform tuning of parameters of used libraries for visualization. In the next step, open data used for visualization are loaded into application, either through API calls or directly loaded from web server which hosts developed application. After retrieving of open data, they are then cleaned, adjusted and prepared for final step which actually performs data visualization.



Figure 1. Steps for data visualization

The detailed scenario of the proposed approach is depicted on Fig. 2. Developed scenario takes into account development of application as web application. When user on client side starts the application, a request is sent from client to App Server. Next, the response from server to client is delivered. After this, client proceeds with requesting json data from Open Data Server. Upon receiving open data, its processing is performed before they are presented to the user.

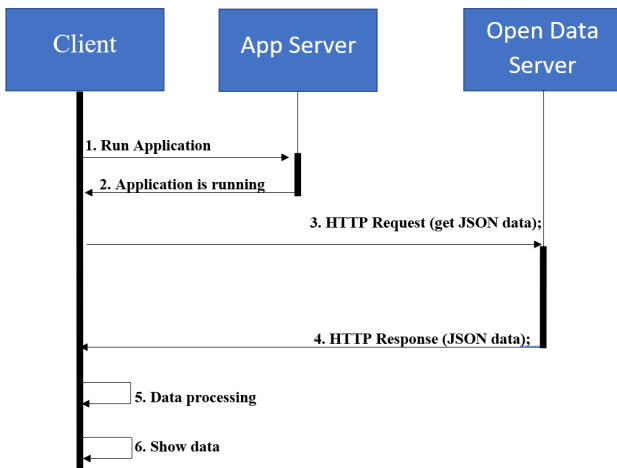


Figure 2. Approach scenario

#### V. USE CASE STUDY – VISUALIZATION OF OPEN DATA ABOUT LIBRARIES

In order to demonstrate the presented approach, we have developed web application for visualization of open data about libraries in Serbia. We have used dataset<sup>1</sup> available on the national open data portal of the Republic of Serbia, in line with JavaScript libraries Leaflet.js and HighChart.js.

The Application is executed solely on client side, and it is consisted of following files:

1. JSON file (open data),

2. HTML file (this file contains code for visualization and data display),
3. CSS file (this file is used for styling data on graphs).

JSON file contains data about each library that is opened and it makes library available on national open data portal. This data is processed in .html file by using JavaScript code, and is shown on the map and graphs.

A part of the used JSON file is given below. Via these data, each library is described.

```
{
  "coordinate": "46.06489, 20.05596",
  "direktor": "Чаба Буш",
  "e_mail": "jab@jab.org.rs",
  "id": 20210.0,
  "ime_ustanova_kina": "卡尼扎“约哲夫·阿提拉”图书馆",
  "ime_ustanova_rus": "Библиотека \“Йожеф Атила\“, Кањижа",
  "kontakt_lice": "Чаба Буш",
  "latitude": 46.06489,
  "longitude": 20.05596,
  "maticna_ustanova": null,
  "mesto": "КАЊИЖА",
  "mobil_tel": null,
  "naziv_ustanove": "Библиотека „Јожеф Атила“ Кањижа",
  "naziv_ustanove_eng": "Library \“Jožef Atila\“ Kanjiža",
  "okrug": "СЕВЕРНО-БАНАТСКИ ОКРУГ",
  "opstina": "Кањижа",
  "pozivni_broj": 24.0,
  "region": "Регион Војводине",
  "tel": "4877 323",
  "tip_ustanova_kina": "图书馆",
  "tip_ustanove": "Библиотеке",
  "tip_ustanove_eng": "Library",
  "ulica_broj": "Дамјанићева 2",
  "website": "www.jab.org.rs"
}
```

The application is constituted of several parts. The first part gives data about libraries by district on the map, where visualization of that data using JavaScript library leaflet.js is performed. In the second part of the application statistical representation of open data on the graphs is performed. For this purpose, we use HighChart.js JavaScript library. In our case, we used column chart. When user clicks on any showed district, then a subgraph for that district is shown, and a Drill Down option of JavaScript library HighChart.js is exploited. Fig. 3 shows application upon start.

<sup>1</sup> <https://data.gov.rs/sr/datasets/ustanove-kulture-biblioteke-1>

```

    }
  });

```

User can click on some of the markers which are shown on

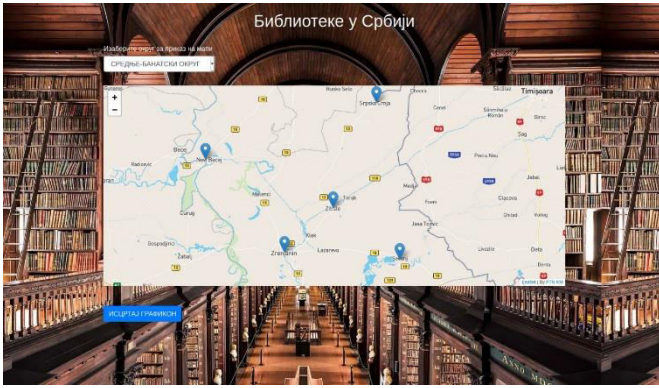


Figure 3. Initial appearance when the application is first loaded

The part of the code responsible for displaying the data on the map is shown below.

```

var mapaTEU = L.map('mapid').setView([42.892681,
20.867441], 9);
var map;
var markers = [];
var markersLayer = new L.LayerGroup();
var updateMap = function() {
  markersLayer.clearLayers();
  L.tileLayer('https://api.mapbox.com/styles/v1/{id}/
tiles/{z}/{x}/{y}?access_token={accessToken}', {
    attribution: 'By <a
href="http://www.ftn.pr.ac.rs">FTN KM</a>',
    maxZoom: 18,
    id: 'mapbox/streets-v11',
    tileSize: 512,
    zoomOffset: -1,
    accessToken:
'pk.eyJ1IjoicG1pbG1jIiw1YSI6ImNrbmQxd2FpOTI3NmgybW54a3IzbGZlZ2EifQ.2o_NoLcKBeCugwMvt1OYFQ'
  }).addTo(mapaTEU);
  $.each(data, function(index, element) {
    if(data[index]['okrug'] == 'КОСОВСКИ ОКРУГ')
    {
      var selectedValue = 'КОСОВСКИ ОКРУГ';
      $('#okrug').val(selectedValue);
      var marker =
L.marker([element.latitude,element.longitude]);
      marker.bindPopup("<b>Директор</b>" +
element.direktor + "<br><b>e_mail:</b> " +
element.e_mail + "<br><b>Контакт:</b> " +
element.kontakt_lice + "<br><b>Место:</b> " +
element.mesto + "<br><b>Назив установе:</b> " +
element.naziv_ustanove + "<br><b>Округ:</b> " +
element.okrug + "<br><b>Општина:</b> " +
element.opstina + "<br><b>Позивни број:</b> " +
element.pozivni_broj + "<br><b>Регион:</b> " +
element.region + "<br><b>Телефон:</b> " +
element.tel + "<br><b>Улица и број:</b> " +
element.ulica_broj + "<br><b>Website:</b> " +
element.website);
      markersLayer.addLayer(marker);
      markersLayer.addTo(mapaTEU);
    }
  });
}

```

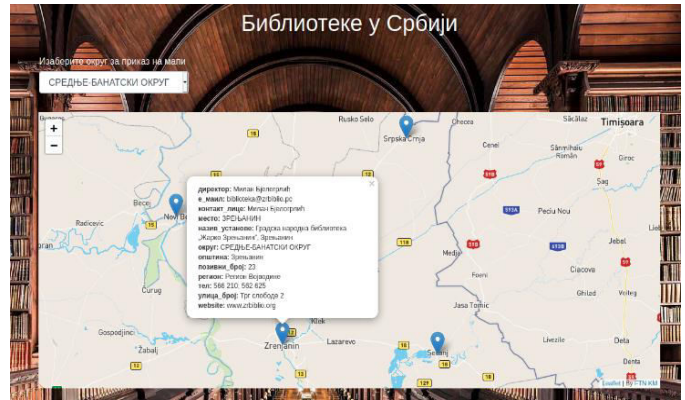
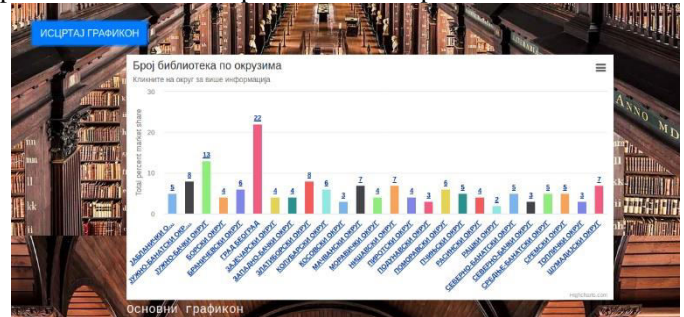


Figure 4. Click on the marker in city of Zrenjanin

If the user clicks on the drop-down he will see a list of all districts which contain libraries with visualizations.

Underneath this map, there is a possibility for user to preview a statistical representation of open data about libraries



as shown on Fig. 5. After clicking on the button a chart appears.

Figure 5. Statistical representation of open data about libraries

From the figure we can see that the application has displayed all districts which are found in the .json file. One more thing, it is important to mention that user can click on each district on that graph and then a subgraph will appear as in the following figure:



Figure 6. Subgraph for the district "City of Belgrade"

## VI. CONCLUSION

The application developed on the basis of presented approach in this paper was created by using data downloaded from Serbian open data portal in a machine-readable format, which is very important because it is data that can be easily read and processed by a computer. The contribution and importance of this work is reflected in the effective visualization of open data by using open source JavaScript libraries. This way of utilization of available tools as well as open data increases motivation and interest for development of more complex software solutions based on available open data. The aim of this work was oriented towards realization of innovative solutions which utilizes open government data.

The continuation of this research will be reflected in a more comprehensive assessment of tools and libraries used for data visualization in web applications in order to check their performance. These comparative assessments will provide developers with valuable insights in which direction their development should go.

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