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## Fast Track Training Project

After completing the *Fast-Track* training period successfully, we made up groups to proceed with our fast track training project. Me, Fawsan, and Fasna made up a group of three members and selected a project from the “WSO2-Redmine”. We scheduled a meeting with Mr. Srinath Perera to discuss about the project details. He inspired us with the project idea and gave the approval for us to continue working on the project.

### Project Description – IgViz (Interactive Generic Visualization Library)

WSO2-Products, despite of having very powerful and efficient functionalities, do not consist of a killer mechanism to visualize data. This can lead potential customers to underestimate the eminent productivity of their products. Therefore a generic web tool (a *widget* as we may address) for visualizing data, without expertise knowledge on the subject, is a vital requirement. Our task, therefore, was to create a generic JavaScript library which can be used by open-source developers to draw charts with minimal effort.

### Getting Started – Inception Phase

The library will be a simple JavaScript library from a high level point of view. However doing this without the aid of external libraries is discouraged due to 3 *mundane* facts,

* Limited time frame
* Having to *reinvent the wheel*
* Neglecting the best open-source practices.

Nevertheless we have to be extra careful when selecting external libraries for a software project. We must ensure that the resource is trustworthy and able to perform the expected task. Considering all above mentioned facts, we agreed upon using **d3js** to lay the foundation for our tool.

#### Why *we* chose d3js over other similar libraries?

The term 'd3' stands for *data driven documents*. It is a kind of low level JavaScript library for manipulating documents based on data. So to answer the question, 'why d3?',

* It provides several reusable and advanced functionalities, which would have consumed a lot of time, if attempted to write from scratch.
* It has gained a good reputation over time, even from experts, for its strongly written code base.
* A lot of samples are available for new developers to grasp the d3 environment.
* Neatly written documentations are also available.



##### Figure 2.1 - d3js Logo



##### Figure 2.2 – Samples from d3js.org

During this time period, I mainly focused on learning the core technologies that will be used for this project. *The-NewBoston'*s free video tutorial series (www.thenewboston.com) on JavaScript was pretty helpful. Additionally I followed few more videos to learn the d3 basics for svg manipulation.

Adapting to the JavaScript development environment was not much of a challenge as it is a scripting language used for web development which does not require any additional configurations to be installed. The only requirements were a *text editor* and a *web browser*.

The plan we made during the **Inception phase** of the fast track project can be summarized as follows,

* Project Idea : Build a generic tool for chart visualization
* Proposed Core Technologies: JavaScript, d3js, WebStorm IDE, Sublime Text IDE.
* Expected Delivery Date: 23/01/2015
* Proposed Core Deliverable(s): A generic JavaScript library
* Version Controlling: git via github

### Packing up - Elaboration Phase

After the initial stage, we started designing the tool. Considering the requirement explained in an earlier discussion, we identified the need to implement the following chart types in the initial version of the tool.

* Single Number diagram: A chart which summarizes the data set into a single number representation.

In our case, we will show the average, maximum, and minimum value.

* **Line Chart Diagram:** A two dimensional chart which shows the change in one dimension against a

unit change in the other as a continuous line.

* Bubble Chart: A chart that displays three dimensions of data in a two dimensional plain.
* Table: A Straight forward representation of the complete data set with custom styles.
* **Map Diagram:** A diagram which shows data specific to a location on the world map.
* Bar Chart: A chart that represents the correlation of data of one discrete variable against another

discrete/continuous variable using rectangle bars.

We discussed and analyzed above mentioned chart types giving thought to how each would be implemented without losing consistency and extensibility. We had to come up with some mechanism to accomplish these as well as other common non functional requirements.

Therefore we planned to create a *JSON* skeleton to which a data set will be modeled into, before sending to draw a chart.

"dataTable": {

"metadata":{

"names":["Country","Area","GDP","Inflation","Life.expect","Military","Pop.growth"],

"types":['C', 'N', 'N', 'N', 'N', 'N', 'N','N']

},

"data": [

["Austria", 83871, 41600, 3.5, 79.91, 0.8, 0.03],

["Belgium", 30528, 37800, 3.5, 79.65, 1.3, 0.06],

["Bulgaria", 110879, 13800, 4.2, 73.84, 2.6, -0.8],

["Croatia", 56594, 18000, 2.3, 75.99, 2.39, -0.09],

["Czech Republic", 78867, 27100, 1.9, 77.38, 1.15, -0.13]

]

}

##### Figure 2.3 – Modeled dataset sample

Fig 2.3 shows how the ‘types’ section labels the columns defined by the ‘names’. ‘C’ stands for *categorical* and ‘N’ stands for *numerical*. This categorization will come in handy when we have to suggest suitable chart types according to the selected columns. The ‘data’ section contains a matching set of data to the metadata section defined earlier.

Considering the above design constraints and the complexity of each chart type, we divided the work among ourselves. Shown below is the milestone plan we created to present to the project stake holders.

#### Milestone Plan for the project

We prepared an on-line milestone plan for the project according to design considerations and sent it via email to Mr. Samissa for getting the approval. Shown below is the accepted milestone plan according t which we continued the project.



##### Figure 2.4 – Milestone plan for the fast-track training project

### Setting off - Construction Phase

We created a repository for the project in *git* as planned and each member forked a copy from the main repository. I was assigned earlier to implement the line chart and the map diagram. I started my task with the line chart diagram. However while working on our individual tasks, we had to implement the frame for the library to which individual charts would be *plugged in* after they are implemented.

#### Skeleton JavaScript file with the shared primitive functions

Seven functions were implemented in this file to accomplish the following sub tasks

* Plot Chart
* Create Scales
* Create Axes
* Configure Points
* Configure Point Labels
* Re Draw Clicked
* Create Form

If we examine the js functions written for above, the one for “Re-Draw-Clicked” plays a special role. This contains a variable called *chartConfigs* which defines the dimensions needed to draw the charts. The code segment for *chartConfigs* is shown below,

var chartConfig = {

"title": "Title",

"xLog": false,

"yLog": false,

"xAxisData": getValue('xAxis'),

"yAxisData": getValue('yAxis'),

"yAxis2Data": getValue('yAxis2'),

"yAxis3Data": getValue('yAxis3'),

"mapLocation": getValue('mapLocation'),

"pointColor": getValue('pointColor'),

"pointSize": getValue('pointSize'),

"pointLabel": 0,

"chartWidth": 600,

"chartHight": 400,

"padding": 60,

"chartType": targetChartId.replace("#", "")

}

##### Figure 2.5 – JavaScript Code Segment of *chartConfig* Variable

The plot function is implemented to call the correct function to plot a chart. The key parameter for selecting the chart type is extracted from the variable mentioned above which will be passed to the plot function as a parameter.

igViz.plot = function (divId, chartConfig) {

if ("scatter" == chartConfig.chartType) {

drawScatterPlot(divId, chartConfig, this.dataTable)

} else if ("bar" == chartConfig.chartType) {

drawBarChart(divId, chartConfig, this.dataTable)

} else if ("singleNumber" == chartConfig.chartType) {

drawSingleNumberDiagram(divId, chartConfig, this.dataTable)

} else if ("map" == chartConfig.chartType) {

drawMapDiagram(divId, chartConfig, this.dataTable)

} else if ("lineChart" == chartConfig.chartType) {

drawLineChart(divId, chartConfig, this.dataTable)

}

else {console.error("Unknown chart type " + chartConfig.chartType);return;}

}

##### Figure 2.6 – JavaScript Code Segment of *igviz.plot* function

#### Line Chart Diagram Implementation

The main concepts, sub tasks, and challenges I came across while this implementation phase can be listed as follows,

* Sorting the data set with respect to the X-axis coordinates
* Mapping coordinates according to a scale
* Connecting coordinates and *interpolation*
* Coloring each line chart
* Appending labels

Sorting the data set is a vital requirement. This makes sure that the coordinates are connected in correct order. Unlike in a situation where we would connect the dots with our hand, this causes the path to be a scribble if unsorted. Shown below is a case in which the X coordinates are not sorted properly.

****

##### Figure 2.7 – Line chart drawn using an unsorted data set

This issue was solved using the following handy function to sort the data set.

dataSet.sort(function (a, b) {

return a.data[xAxisID] - b.data[xAxisID];

});

##### Figure 2.8 – JavaScript code segment for sorting a data set

This *algorithm* sorts the data set *in place***.** The logic underneath is similar to *bubble sort*. Comparison is done internally by evaluating the sign of the subtraction. JavaScript language provides several such functions which can be used to replace complex code segments.

When everything else is setup correctly, the code segment for appending the path to the svg can be executed. Interpolation and line coloring can be done in the same code segment if the programmer knows how to play with his stuff. The code segment I wrote is shown below.

graph.append("path")

.attr("class", "line")

.attr("d", function (d) {

return line.interpolate(mode)(d.values);

})

.style("stroke", function (d, i) {

return getColor(i % 3)

});

##### Figure 2.9 – JavaScript code segment for appending path to data points

The interpolation *mode* in the above code segment can be one of linear, basis, step-before, step-after, cardinal or monotonous.

Shown below are chartsdrawn in 3 such interpolation modes



##### Figure 2.10 – Line chart with linear interpolation mode

##### Figure 2.11 – Line chart with cardinal interpolation mode



##### Figure 2.12 – Line chart with Step-before interpolation mode

I created a sub menu to select chart configurations (i.e. - columns, colors and interpolation mode) for drawing the chart. Shown below is a snapshot of the menu.



##### Figure 2.13 – HTML menu for selecting

**chart configurations**

#### Map Diagram Implementation

A major issue I faced while implementing this chart type was d3 not supporting advanced functions for map manipulation. The abstract map provided by d3 is very basic. The maximum possible zoom-level is country level. That means that users cannot visualize a data set local to a country like Sri Lanka.

Therefore I had to import another library to lay the foundation for the Map-diagram. After some research, I came across two possibilities

* Google visualization charts
* D3 based Data Maps

Considering the ease of use and the list of supporting functionalities, Google visualization charts library appeared to be a better candidate.

However, one major con of using google-charts was identified as the inability to draw the chart offline. But considering the features and the use case of the IgViz library, this trade off was evaluated as profitable.

**Important code quotations**

The LoadMap() function is responsible for fetching the chart definitions from google. This google.load(…) function can be seen as a common feature in all kinds of google charts. It should be noted that this does not load the map, it is responsible only for loading the chart definitions.

function LoadMap() {

google.load('visualization', '1', {'packages': ['map', 'geochart']});

}

##### Figure 2.14 – JavaScript code segment for loading google geochart

After loading the definitions, the following code segment will draw the map.

var chart = new google.visualization.GeoChart(document.getElementById('chart\_div'));

chart.draw(data, options);

##### Figure 2.15 – JavaScript code segment for drawing the map on an html div

In the above function, the ‘options’ parameter can be modified to set custom map configurations. Shown below is an example that I have set in the IgViz library.

var options = {

region: regionO,

displayMode: mode,

colorAxis: {colors: ['red', 'blue']},

magnifyingGlass: {enable: true, zoomFactor: 3.0},

enableRegionInteractivity: true

};

##### Figure 2.16 – JavaScript code segment for setting options for the google chart

In the above variable, the displayMode can be one of

* Regions Chart
* Markers Chart
* Terrain Map
* Normal Map

Regions Chart

This chart type is used when the data table contains countries in the location field. If this chart type is selected in a case where the location field contains cities, google will map the city name with a country and then draw the chart. Shown below is a *Regions Chart* generated from our IgViz library. The styles are set from the *options* variable (see Fig. 2.16).



##### Figure 2.17 –Regions Chart example

When this chart type is selected, the complete world map will be shown by default. To zoom to a specific region, the region number should be selected from the *ISO 3166 Country Codes* list.

E.g. - 150: Europe, SL: Sri Lanka, US: United States

Markers Chart

This chart type can be drawn using any location on the google map as the location field. The concept is similar to a bubble chart in which we plot 3 dimensions on a two dimensional chart. The three dimensions are identified by location, point color and point size.

I have implemented this chart type in such a way that the user does not have to select the region exclusively. The region covering all the points will be selected internally.



##### Figure 2.18 –Markers Chart example

Terrain Map

This is a map rather than a chart. I have added this type for users to visualize their data set on a google map. This enables the users to use any of the general features (panning, zooming, etc) provided by the world famous google maps. Terrain Map and Normal Map are quite similar. The only difference is that normal maps do not consist of the terrains.

##### Figure 2.19 –Terrain Map example

Terms used: javascript , d3js, svg, version controlling, git, github, webstorm, sublime text, WSo2, IDE, text editor, web browser, widget,json,igViz, bubble sort, sort, algorithm, google