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BerlinViz - Systematic approach of visualizing governmental budget data over time

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"In the long run we are all dead. Economists set themselves too easy, too useless a task if in tempestuous seasons they can only tell us that when the storm is long past the ocean is flat again."
— John Meynard Keynes,
A Tract on Monetary Reform.
Macmillan and Co. 1923. p. 80

BerlinViz - Systematic approach of visualizing governmental budget data over time

ABSTRACT

BerlinViz visualises the public budgets of the state Berlin and its boroughs in Germany. It creates a semantical view on the data by adding inflation, demographic and unemployment data to the budget data. Data of multiple years is used to analyse the development, trends of chapters in the budget and policy changes. BerlinViz uses the inflation data to visualise the real worth of investments and incomes after the loss of monetary value. The data of the boroughs is used to compare budgets and demography between boroughs. It is also used to compare the efficiency of administrations between boroughs. BerlinViz uses unemployment data to visualise efficiency of welfare and employment policies. Demographic data is used to visualise the allocation of public resources to the group of interest of chapters. Also, in this work the structure and law foundations of the public budgets in Germany and Berlin are explained and how they are represented in a database. Further this work does a comparison between visualisation techniques for hierarchical, multivariate and geospatial data. A user test is done, evaluating the usefulness of the different views and the user experience.

Keywords: semantic visualisation;public budgets ;open government.

BerlinViz - Abordagem sistemática de visualizar dados orçamentários governamentais ao longo do tempo

RESUMO

BerlinViz permite visualizar os orçamentos públicos do Estado de Berlin. Ele cria uma visão semântica dos dados pelo acréximo de inflação, e de dados demográficos e de empregos, para dados do orçamento. Dados de múltiplos anos são usados para analisar o desenvolvimento, tendências de capítulos no orçamento e mudanças políticas. BerlinViz usa os dados de inflação para visualizar o valor real dos investimentos e rendimento após a perda de valor monetário. Os dados dos municípios são usados para comparar orçamentos e demografia entre os mesmos. É também usado para comparar eficienciência de adminstrações entre os municípios. BerlinViz usa dados de desemprego para visualizar eficiência das políticas de bem-estar e de emprego. Os dados demográficos são usados para visualizar a alocação de recursos públicos para o grupo de interesse dos capítulos. Além disso, neste trabalho são explicados os fundamentos estruturais e legais dos orçamentos públicos em Berlin, na Alemanha, assim como o modo pelo qual eles são representados no banco de dados. Ainda mais, este trabalho faz uma comparação entre técnicas de visualizações para dados geoespaciais, multivariados e hierarquicos. Um teste de usuário é feito, avaliando a utiliadade das diferentes visões e a experiência de uso.

Palavras-chave: visualização semântica;orçamentos públicos;Governo Aberto;.

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PRNG   Pseude-random-number-generator

ACKNOWLEDGMENTS

CONTENTS

1 INTRODUCTION

This chapter presents the motivation, goals, contributions and structure of this work. The first part describes the motivation of this work, following the goals of and the structure of this work.

1.1 Motivation

Public budgets are the key to doing politics. Due to the economic allocation problem of resources, spendings give a footprint of policies. Politicians and governments gain their money from taxpayers, so they have the obligation to make investments and incomes public to the society. At this moment, it is hard to find lonely investments of the government, and it is even more difficult to compare the data over time and in relation to other economic data, such as population, unemployment and inflation. With the OpenData of the government of Berlin, this data can be made available to a broader publicity so that the citizens of Berlin and the media can check the success or fail of governance.

1.2 Goals

This work has the goal, to use OpenData from the government of Berlin, to facilitate the access to the information behind the governmental budgets of the years 2008 till 2015. Additional data like inflation rates, unemployment statistics and demographic statistics are supplied to interpret the information easier. The user should be able to see the real worth of expenses in policies, by using inflation rates. Visualising budget data in relation to demographic data, citizens should be able to see the per capita share of public services. The user should also be able to compare expenses and incomes between the boroughs of Berlin, to see the efficiency of administrations in the boroughs. Also with this work, the user should be able to see policy changes and where the government invests the taxes. From the viewpoint of a parliamentarian, this work is intended to facilitate his job. He should be able to see the budgets for his department from the former years and take conclusions, where he has to take focus to invest.

1.3 Contribution

This work contributes to the existing visualisations of the public budget of the state of Berlin in Germany. With this work, the data is visualised over the period of 8 years to see the changes in spending policies, further this work adds additional economic and demographic data to the visualisation, to get a more detailed view of the spendings and political foci of the government.

1.4 Structure of this work

Eight chapters divide this work. The first chapter explains the motivation, goals and contributions of this work. The second chapter describes the law and structure of the public budgets of Berlin. It also describes the additional data used. Also in the second chapter, a presentation and comparison of techniques for visualising hierarchical, multivariate and geospatial data is given and related work that visualises public budgets and their advantages and disadvantages is presented. The third chapter describes the design of BerlinViz, the database used and the communication between the views and the database. The fourth chapter explains the implementation details of BerlinViz. In the fifth chapter, an explanation of the user interface is given. Chapter six explains, how BerlinViz is used to solve tasks and how to interpret the graphics produces by BerlinViz. The seventh chapter explains and evaluates the user test of BerlinViz. The eighth chapter presents the conclusion and further work on how to extend BerlinViz.

2 STATE OF ART

This chapter explaines the data used and shows techniques for visualising hierarchical, multivariate and geospatial data and compares them. Further, this chapter presents related work in visualising public budget data and how this work adds more significance to budget data.

2.1 Data

In this section of the work, the law foundations and the structure of the public budgets is explained. Further the use of the additional data is explained. Also in this section the sources of the data for this work are shown.

2.2 Public Budget Data
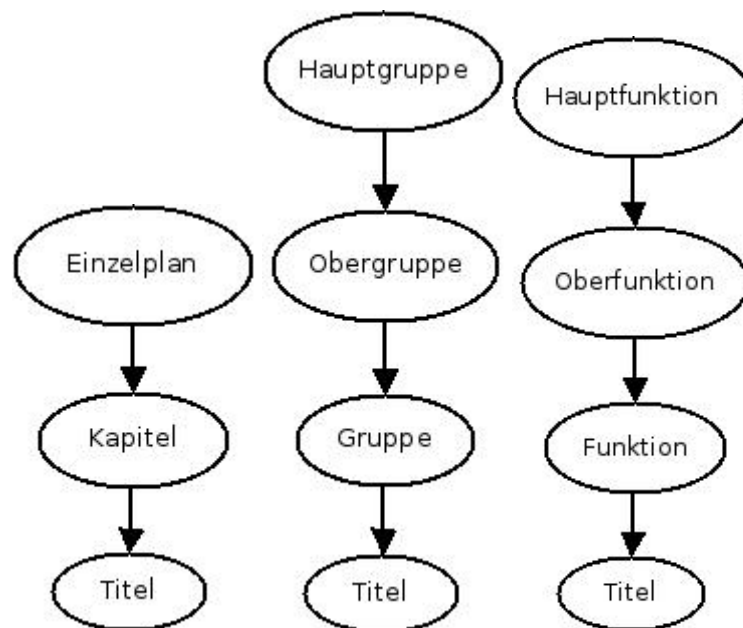
Figure 2.1 – Hierarchy of budget data.

The federal Haushaltsgrundsätzegesetz (HGRG..., 2013) law, which organises the structure of the federal budget also arranges the structure of the public budgets in Germany. The Landeshaushaltsordnung (LHO..., 2009) describes the regional ordinances of this law in Berlin. The parliament of Berlin approves the public budgets of Berlin for two years in a row and adjusts some chapters after a year. The data was taken from the website of the Senate for Finance(BERLIN, 2015). The data is ordered in three distinct hierarchies as shown in Figure 2.1.

The first hierarchy is the Einzelpläne-Kapitel, further referred to as single plan hierarchy, which orders the budget after the ministries. Since the resorts of the ministries change after a legislation period, this hierarchy changes too. The second hierarchy is the Hauptgruppe-Obergruppe-Gruppe, further referred to as group hierarchy, which orders the income and expenses after the source. The third hierarchy is the Hauptfunktion-Oberfunktion-Funktion, further referred to as function hierarchy, which orders the budget after political fields. On the bottom of all hierarchies is the Title, which represents one particular investment or income. The dataset gets multivariate, having these data over multiple years. Further, the budget is divided into Bereiche, which represent the main administration and the administration of the boroughs of Berlin. The status as a city-state of Berlin causes this division into multiple administrations. The following Table 2.1 shows the Bereich corresponding to a particular administration.

Table 2.1 – Corresponding administrations to Bereich.

Bereich	Administration
30	Main administration
31	Mitte
32	Friedrichshain-Kreuzberg
33	Pankow
34	Charlottenburg-Wilmersdorf
35	Spandau
36	Steglitz-Zehlendorf
37	Tempelhof-Schöneberg
38	Neukölln
39	Treptow-Köpenick
40	Marzahn-Hellersdorf
41	Lichtenberg
42	Reinickendorf

To identify a particular expense or income, the Haushaltsstelle is used. The Haushaltsstelle is a combination of Bereich, Kapitel, title number as following:

$< Bereich > - < Kapitel > - < Titelnumber > - < Funktion >.$

2.3 Additional Data

Inflation decreases the worth of money over years leading to growing expenses to achieve the same service in a state (TARSCHYS, 1985). Stagnating expenses reduce the service in a state over time. The inflation data for Germany was taken from the GENESIS database (BUNDESAMT, 2015).

A number of inhabitants share the resources of a state. Demographic changes change

this share per capita (LADD, 1992). Different demography in regions changes this share for public services in the region. Also, it is used to identify the demographic structure of boroughs. The demographical data for this work is obtained from the StatIS-BBB database (BERLIN-BRANDENBURG, 2015). The population data gets multivariate, having data over multiple years.

Unemployed and employable residents share the welfare and employment resources in a state. Analysing this share, also in relation to gender, employment policies and prosperity of a city can be examined. The unemployment data was taken from DESTATIS (BUNDESAMT, 2015). The unemployment data gets multivariate, having data over multiple years.

2.4 Hierarchical Visualisation Techniques

This section will present the traditional ways to visualise hierarchical datasets. It starts with the Treemap technique, followed by the Sunburst technique and the Node-Link Diagram technique. After the presentation of the techniques, a comparison between them is done.

2.4.1 Treemap
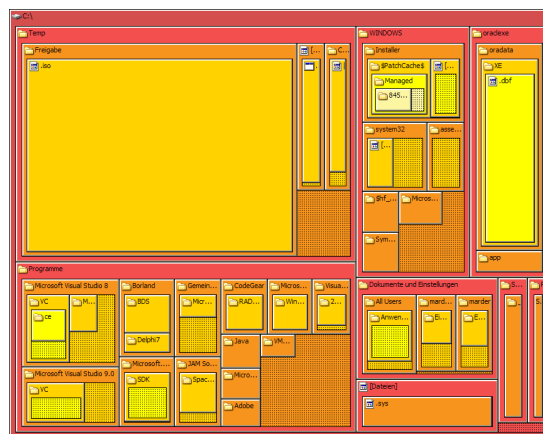
Figure 2.2 – Example of Treemap technique (COMMONS, 2008).

The space-filling Treemap technique, as seen in Figure 2.2, is a visualisation that uses bounding boxes of different sizes, to visualise a hierarchical structure (JOHNSON, 1992). It uses the size of the bounding boxes to visualise the values and position inside the hierarchy of nodes in a tree. Inside a bounding box, that represents a node, are smaller bounding boxes, which represent the children. The sum of the values of the children is equal to the value of the parent node.

2.4.2 Sunburst
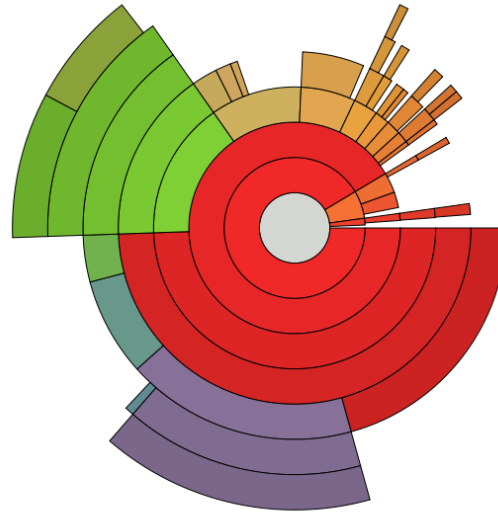
Figure 2.3 – Example of Sunburst technique (COMMONS,).

The space-filling Sunburst technique, as seen in Figure 2.3, is a hierarchical, radial visualisation, that uses concentric rings to encode the levels of the hierarchy. The rings are built through arcs, which size is dependent on the value of the nodes inside the same level of the hierarchy (ANDREWS; HEIDEGGER, 1998). To visualise small items in the hierarchy, approaches like Angular Detail, Detail Outside and Detail inside (STASKO; ZHANG, 2000). The Angular Detail method uses a focus selection, which zooms the focused part of the Sunburst into a separate window, where the items are magnificated. The Detail outside method uses an extra ring on the outside of the Sunburst graph, to draw all the arcs of the elements of the currently selected level in hierarchy on the 360-degree ring, whereas the Detail inside method does this on an extra circle before the first level.

2.4.3 Node-Link Diagram

The Node-Link Diagram technique shows the hierarchy by drawing the nodes as circles and the relation between these nodes as lines, also called vertices. The size and color of the circles can visualise attributes of the nodes. The color and thickness of the lines connecting nodes can visualise the connectivity. Figure 2.4 shows an example of this technique.
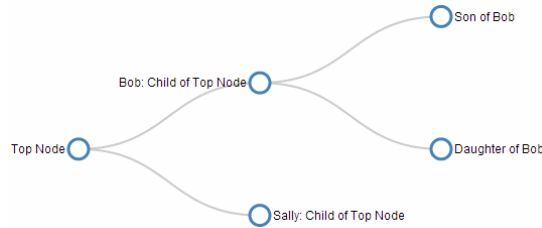
Figure 2.4 – Example of Node-Link technique (D3NOOB.ORG,).

2.4.4 Comparison

The Treemap approach focuses on visualising the ordinal data inside the hierarchy, on the other side the Sunburst approach focuses on visualising the structure of the hierarchy, whereas the Node-Link Diagram totally focuses on the hierarchy (MERČUN; ŽUMER, 2013). Also, the Sunburst technique appears to have a more shallow learning curve then the Treemap technique, although both space-filling techniques have the problem, that deeper hierarchies can make the task of identifying items harder (STASKO et al., 2000). For the Sunburst technique, the Detail Outside technique can improve this weakness.

2.5 Multivariate Data Visualisation Techniques

For visualising multivariate data, multiple techniques were already developed. This section describes the classical approaches and their modifications. These techniques were originally 2D techniques, but it is possible to expand them to higher dimensions. In this work, the focus is on the 2D techniques. This section starts by describing the Scatterplot technique, followed by the Line chart technique, the Histogram technique and the Icon technique. At the end of this section, a comparison between these techniques is done.

2.5.1 Scatter Plot

The scatter plot technique, as seen in Figure 2.5, associates a tuple from a dataset to the x-axis and y-axis and plots this point into the coordinate system (WARD; GRINSTEIN; KEIM, 2010). Typically the independent variable is associated with the x-axis and the dependent variable with the y-axis. Extensions to this technique are that the size of the point grows with a third dimension. The color of the point defines a fourth dimension.

Scatterplot for quality characteristic XXX
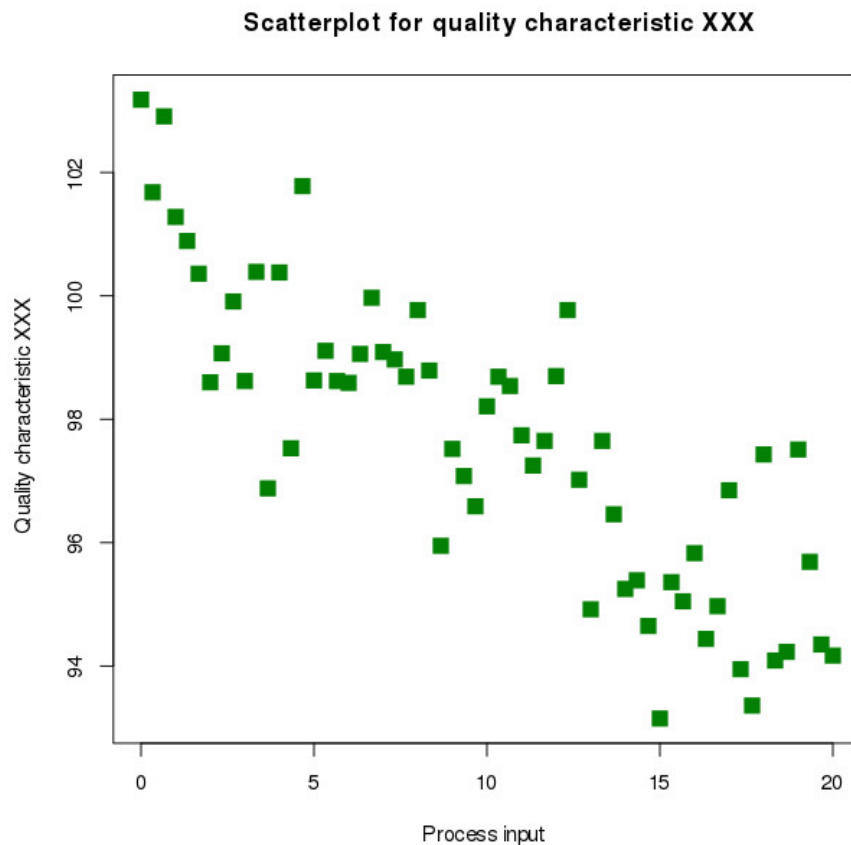
Figure 2.5 – Example of Scatterplot technique (PENFIELD, 2010a).

2.5.2 Line Chart

The line chart technique, as seen in Figure 2.6, associates, similar to the scatterplot technique, a tuple from the dataset to the x-axis and y-axis. Typically the x-axis is associated with the independent variable and the y-axis with the dependent variable. Instead of plotting a point in the graph, two pairs of tuples form a line in the chart. Also as in the scatterplot technique, this technique can be extended to a third dimension with modifying the width of the lines and a fourth dimension by changing the color of the lines.

2.5.3 Histogram

The Histogram technique, as seen in Figure 2.7, associates the position on the x-axis to the independent variables of a tuple and the height of the bar to the dependent variables of the tuple. Sometimes the mapping is inverted so that the width of the bar represents the dependent value.
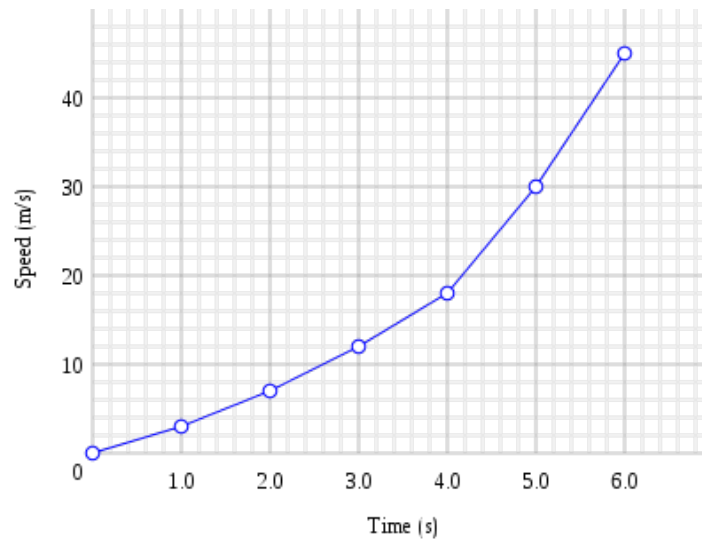
Figure 2.6 – Example of Line Chart technique (NADA, 2007).

2.5.4 Icons

Icons can be used to encode variate or multivariate data. In this work, the term icon represents a pictorial representation of a process. For this, one or more dimensions of the data are mapped to one or more visual attributes (WARD, 2002). In this work, the focus is on the one-to-many relation. Thus, one dimension is mapped to multiple visual attributes. Visual attributes can be, amongst others, the color, size or orientation of an icon.

2.5.5 Comparison

Whereas the Scatterplot technique and Icons, with one-to-many relationships, focuses on a single measurement, the Line chart and Histogram technique focuses on the continuity of a measurement. For the Scatterplot and Line chart technique, the problem of cluttering occurs (ELLIS; DIX, 2007), whereas the number of bars in combination with the screen size is a limiting factor for the Histogram (WARD; GRINSTEIN; KEIM, 2010).

2.6 Geo-spatial Visualisation Techniques

Geographic data has been in the focus of the visualisation community for a long time. This kind of data corresponds to phenomena in the real world.
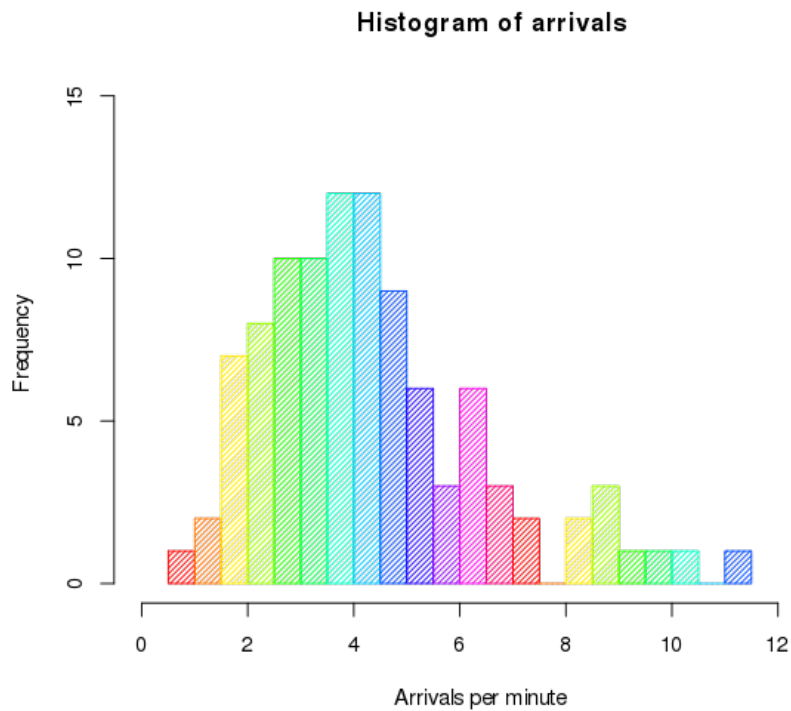
Figure 2.7 – Example of Histogram technique (PENFIELD, 2010b).

2.6.1 Thematic Maps

Thematic maps can be used to compare different regions about a particular phenomena. This work focuses on the visualisation of area data, for which different approaches exist. The approaches shown in this section are choropleth maps and cartograms.

2.6.1.1 Choropleth Maps
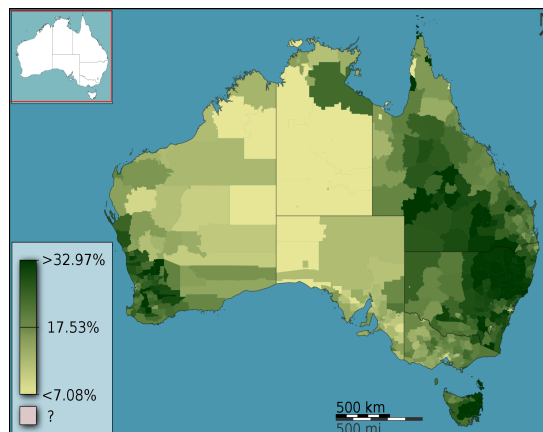
Figure 2.8 – Example of Choropleth Map (HUDSON, 2012).

The choropleth map technique uses the color of the enclosed polygonal shapes that form

regions on the map, to communicate differences between regions. For this technique, the choice of color mapping and normalisation is of high importance.

2.6.1.2 Cartogram
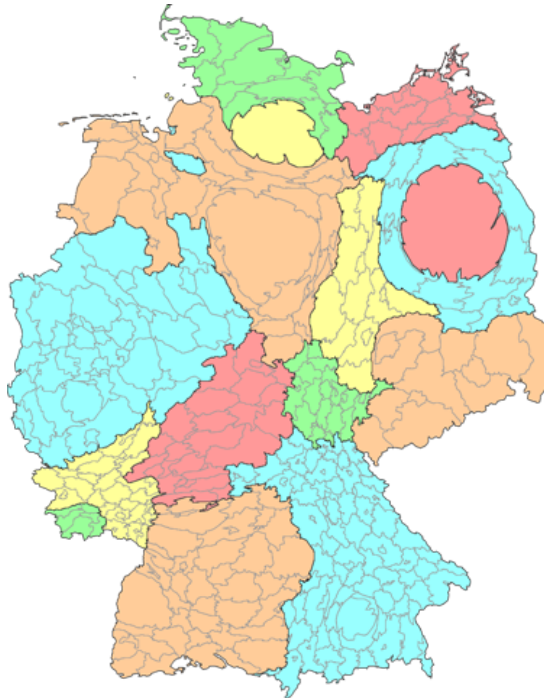
Figure 2.9 – Example of Cartogram (STOEPEL, 2010).

Cartograms communicate differences between regions, by distorting the regions or the map. Three types of cartograms can be distinguished. The noncontinuous cartogram, continuous cartogram and circular cartogram. The noncontinuous cartogram keeps the original shapes of the regions but distorts the map of the cartogram, whereas the continuous cartogram distort the map but does not distort the regions inside the map. The circular cartogram ignores both, the original shape of the regions and the map.

2.6.2 Comparison

Choropleth maps have the disadvantage that they highlight big areas, which sometimes have less important information and occult small areas, which have maybe more interesting information. For maps, where the regions are more or less of the same size, this technique produces good results. On the other side, the Cartogram tries to give regions with more interesting information a bigger area. Although the Cartogram technique has the disadvantage that the original size of the polygons restricts their scaling, so that small regions still can appear

small in comparison. Another disadvantage of the Cartogram technique is that the continuous cartogram problem is NP-complete (KEIM et al., 2002).

2.7 Visualisation in Political Sciences

Since political sciences try to measure economic and social factors by indicies and compare these indices between regions and countries, a growing amount of data is produced in these sciences. Since the human perception is limited in processing information, the information have to be filtered, so that interesting conclusions can be taken and profounded arguments can be developed. Amongst the data visualisations used in the political sciences, there are statistical graphics and infographics, geographical information systems, graph visualisations and data cartography (ZINOVYEV, 2010).

2.8 Linking budget data

There is ongoing research to build ontologies for semantic web services to create a semantical view on the budget data in relation to tenders and spending documents (VAFOPOULOS et al., 2013). The goal of this researches is to get a dynamical view of the budgets. Since budget data is released statically for a period by most governments, there is almost no information about the money that is actually left in the proposed chapters of a budget. By combining the data from tenders and spending documents, which are decisions of the government actually to spend money, a more dynamic approach should by implemented to check budgets (VAFOPOULOS; MEIMARIS, 2012). Also with this, the authors want to evaluate the effectiveness of actual of spendings.

2.9 Tagging budget data

One way to link public budget data with additional resources was presented at the CHI 2015 (KIM et al., 2015). In this paper, the research group visualised the public budget of South-Korea and let the user tag the programs in the budget with issues. They used a voting mechanism and a game, which presents the users randomly issues issued by other users and sections of the public budget, where the user has to choose, whether the issue is related to this section or not, to relate the issues to particular sections of the public budget. The number of votes for a relation

has to be higher than the votes that there is no relationship involved, to link an issue to a section of the public budget. The goal of this work was to connect budget data with public interests so that the government could adjust their spendings, according to the needs of the population. With this, they supported a more dynamical approach of governmental budgeting, to democratise the process of budgeting. Although they were aware that is is not suitable for a good government to add a new accounting scheme, whenever there is a new issue.

2.10 Augmented reality and budget data

Another approach is using augmented reality to inform the citizen about spendings. The OpenSpending Foundation has a proposal for a smartphone app and web platform, which shows the costs of investments or planned investments by the government (DIMITROVA LUCY CHAMBERS, 2015). The goal of this work is to make the allocation process of public budgets more efficient and implement a public control about proposed investments. For this, the user should be able to see all investments, according to his actual position in a region. On the web platform, the user should be able, according to the proposal, to suggest investments in their area. This approach can be seen as an extension of the participative budgets that were first implemented in Porto Alegre (ALEGRE, 2015).

2.11 Related Work

This section describes already implemented, public available, visualisations of public budgets and their limitations. The first part of this section shows already existing visualisation of German budgets and the second part shows visualisations about the US budget.

2.11.1 Budget Visualisations in Germany

The existing approaches to visualise public budgets of the state Berlin can be found on the website of the state Ministry of Finances which is based on OpenSpending (OPENSPENDING, 2015), which is based on the treemap technique. On the federal level, the Ministry of Finances visualised their budget using the sunburst technique (BMF, 2015). Although they visualise the structure and the values of the chapters of the budget plan, they are neither comparing multiple years nor taking additional data into account to help the user interpret the data.
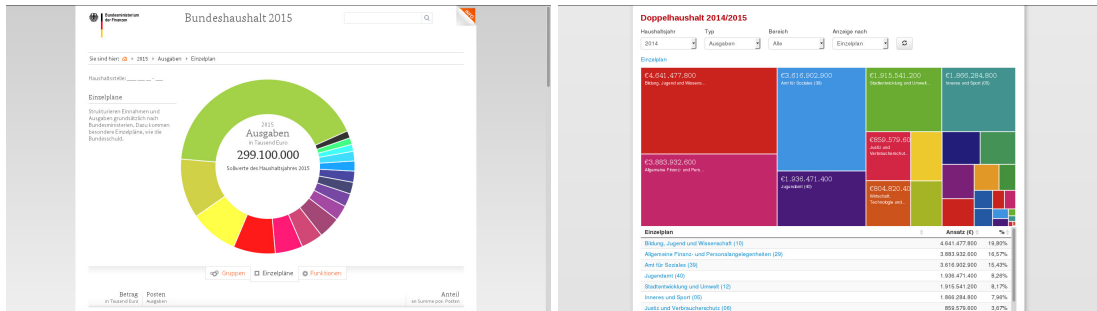
Figure 2.10 – Bundeshaushalt.info(left) and Interaktiver Haushalt(right).

2.11.2 Budget Visualisations in the USA
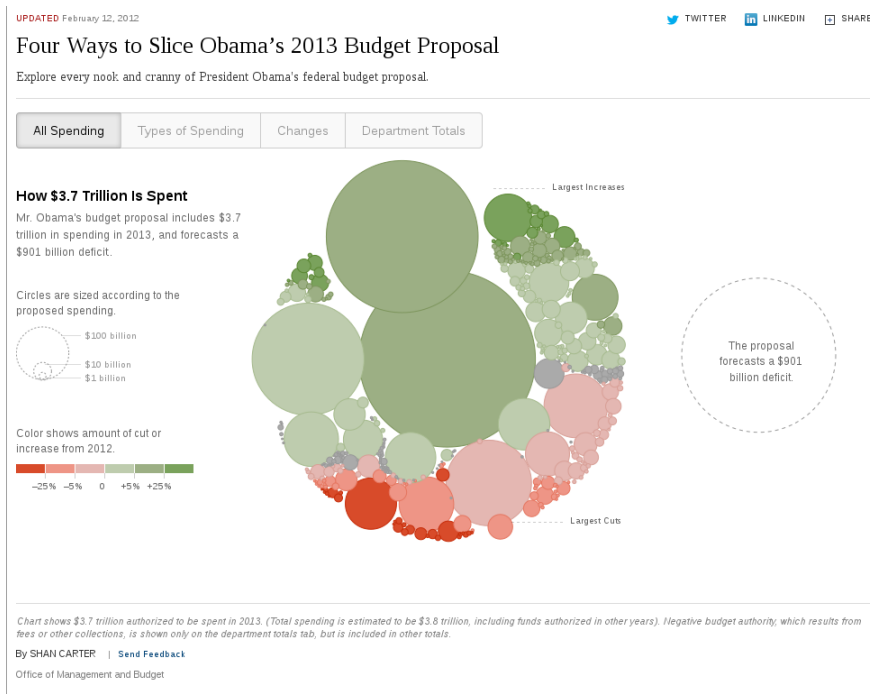
Figure 2.11 – US budget visualised by NY-Times.

For the public budget of the USA, the NY-Times did an interactive visualisation in the year 2013 as shown in Figure 2.11. They compare the chapters relative to the total budget and do a comparison of increase or decrease of these chapters to the former year. They do a comparison between the departments and the type of spending. Although they neither compare between regions nor do they calculate trends. Also with just two years of data, a reasonable comparison over time is hardly possible. Another visualisation for the US budget has been done by Brightpoint inc., as shown in Figure 2.12. They show the values of the budget relative to the former level encoded as the width of the vertices and size of the children nodes. They do a comparison between the state budgets and the local and state budgets, but they do not show the differences between the regions inside the local data. Another problem with this visualisation

occurs, when there are too many children. In this case, the visualisation shows a warning, that it can not display this amount of children.
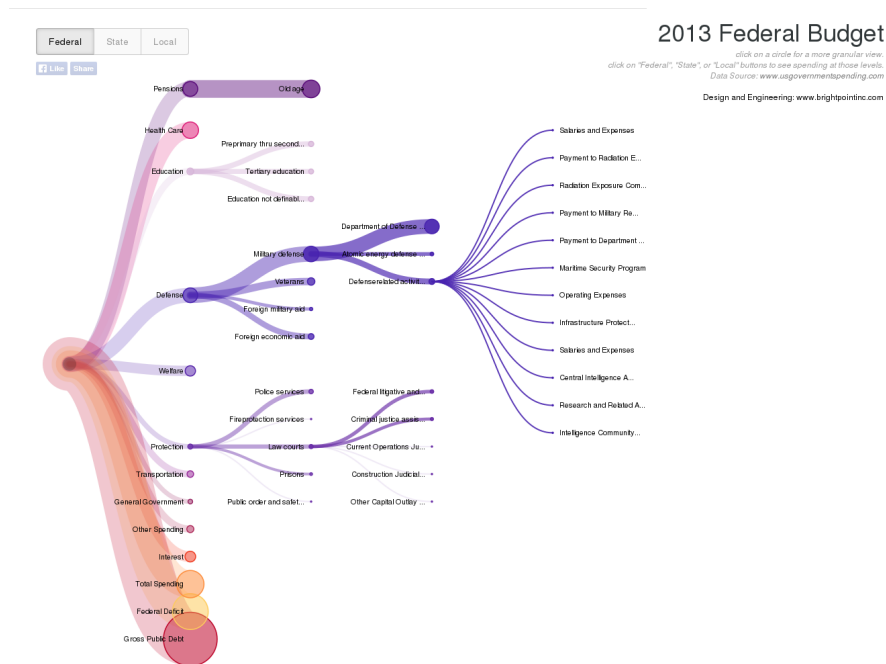
Figure 2.12 – US budget visualisation from Brightpoint inc.

2.12 Conclusions

Knowing the advantages and disadvantages of the already existing visualisations of the public budgets of Germany and the USA, they are used as a reference for developing Berlin-Viz. The approach of connecting the public budget to issues shows a way to connect budgets with interests semantically. The use of augmented reality links public budgets in an interesting way with geographical data. The linking of public budgets to tenders and calls is an interesting way to be able to visualise public budgets dynamically. The dataset used in this work is hierarchical, multivariate and geospatial. The choice of adequate visualisation techniques is critical. All visualisation techniques have advantages and disadvantages, the proper selection of the visualisation technique to the data to be visualised is of importance.

3 SOFTWARE DESIGN

In this chapter, the software design of BerlinViz is explained. First the used tools are listed, then the design of the database is described. Second the used components are explained. After this, the choice of the visualisation techniques and the sequence diagrams for querying the data of interest for the views are explained. An overview of the components used in this visualisation is shown in Figure 3.1.
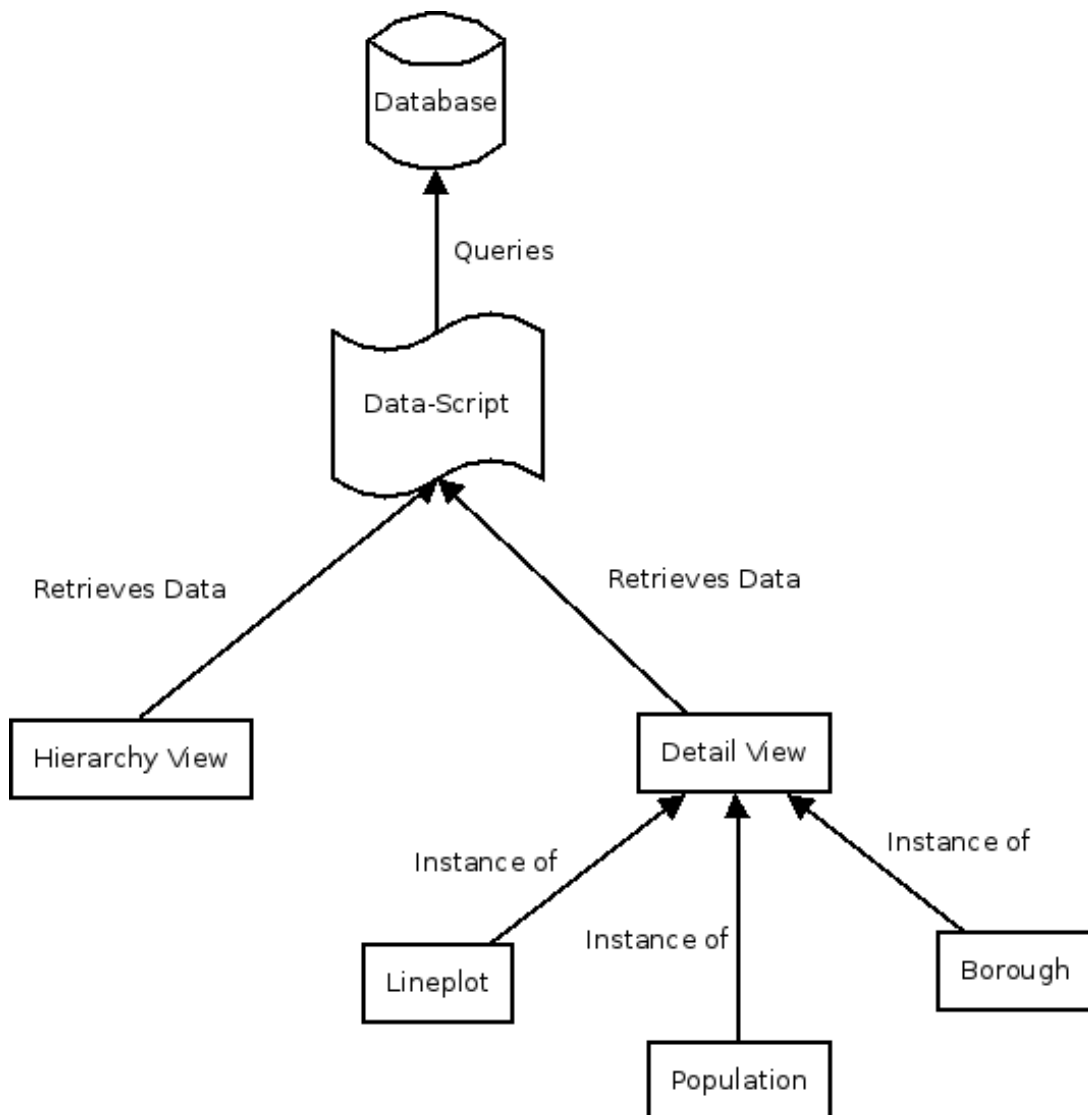
Figure 3.1 – Components of BerlinViz.

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3.1 Used Tools

For this Work HTML5 (W3C, 2015) is used in combination with Javascript (EICH, 2015), which uses the libraries jQuery (TEAM, 2015) and D3JS (BOSTOCK, 2015) in combination, to render the visualisation. PHP (GROUP, 2015) and MariaDB (FOUNDATION", 2015) are used for the backend, which delivers the data to the visualization component. LibreOffice (FOUNDATION, 2015) was used to clean the spreadsheets from unnecessary data and Python (FOUNDATION, 2014) was used to parse the data out of the spreadsheets provided by the government.

3.2 Choices of Visualisation Techniques

For the Hierarchy view, a modified Sunburst technique was chosen since it visualises four dimensions of the dataset. It visualises the depth of the hierarchy, the elements in the same depth of the hierarchy, the relative values of the absolute values of the chapters and the trend over the selected range of years. It was also chosen since it has a better focus on the hierarchy than the Treemap and a better focus on the attributes of the node as the Node-Link technique.

For the Over-Time-Compare View, the Line chart technique was chosen, since it shows the continuity of a dataset over time and encodes three dimensions of data. It encodes the year, the value and the element in the hierarchy.

For the Borough-Compare View, the Choropleth Map technique was chosen since the boroughs of Berlin correspond to geographical localities. This technique was also chosen since the areas of the map are more or less of the same size.

For the Population View, a modified version of the Histogram technique was chosen since it visualises three dimensions of data. It encodes the age, amount and gender of a group of inhabitants. It was also chosen for the similarity to the population pyramid.

3.3 Database Design

The database consists of nine tables, which represent the hierarchy of Figure 2.1. Further, there are tables for population, unemployment, inflation rates and the names of the boroughs. The Figure 3.2 shows the database ER.
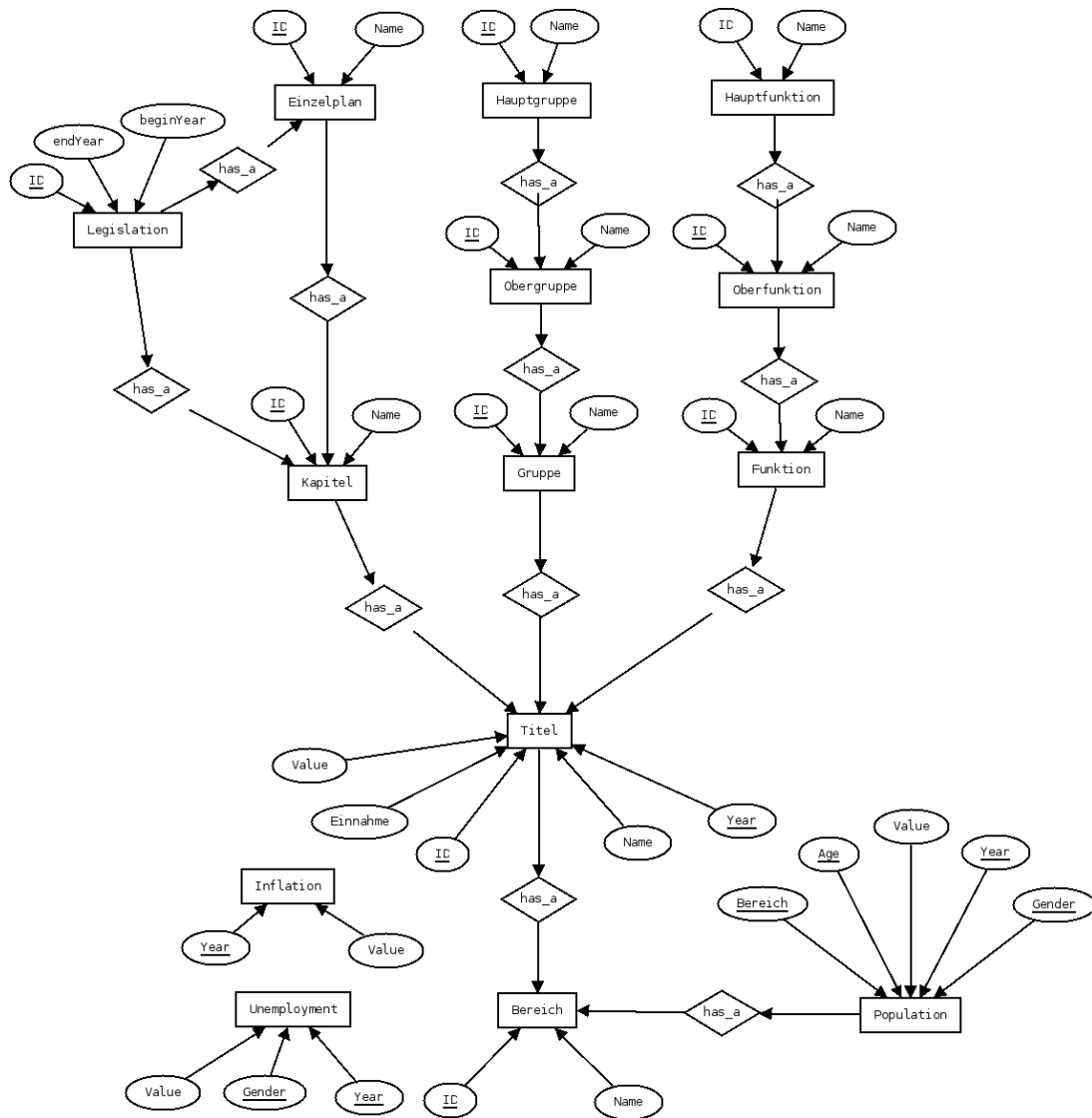
Figure 3.2 – Database design for financial and demographic data.

3.4 Communication between Views and Server

To communicate between the Javascript part of the visualization and the MariaDB database, a PHP-Script is used. The PHP script gets the query parameters as GET-Variables (FIELDING et al., 2009) and responds with a JSON (BRAY, 2014). The classes to encapsulate the responses from the data script are shown in Figure 3.3. This Section describes which data is queried by the views.

The Hierarchy View queries for the names of the chapters, the total of the current selected element, the names of the chapters, the value and ID of the chapters for the reference year and for the time range selected. Further, it queries for the inflation rates in the selected time range. The sequence diagram is shown in Figure 3.4.

The Overt-Time-View queries for the inflation rates, the chapters inside the selected
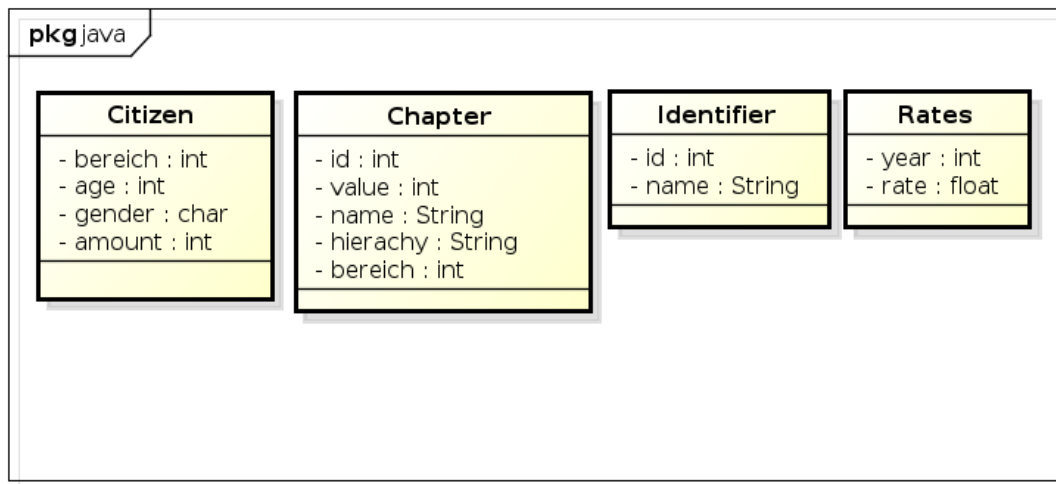
Figure 3.3 – Classes to encapsulate the responses.

element, the unemployment and population data for the selected time range and its totals. The sequence diagram is shown in Figure 3.5.

The Population View queries for population data as seen in Figure 3.6.

The Borough-Compare-View queries for the budget and population data and its totals and the names of the boroughs. The sequence diagram is shown in Figure 3.7.
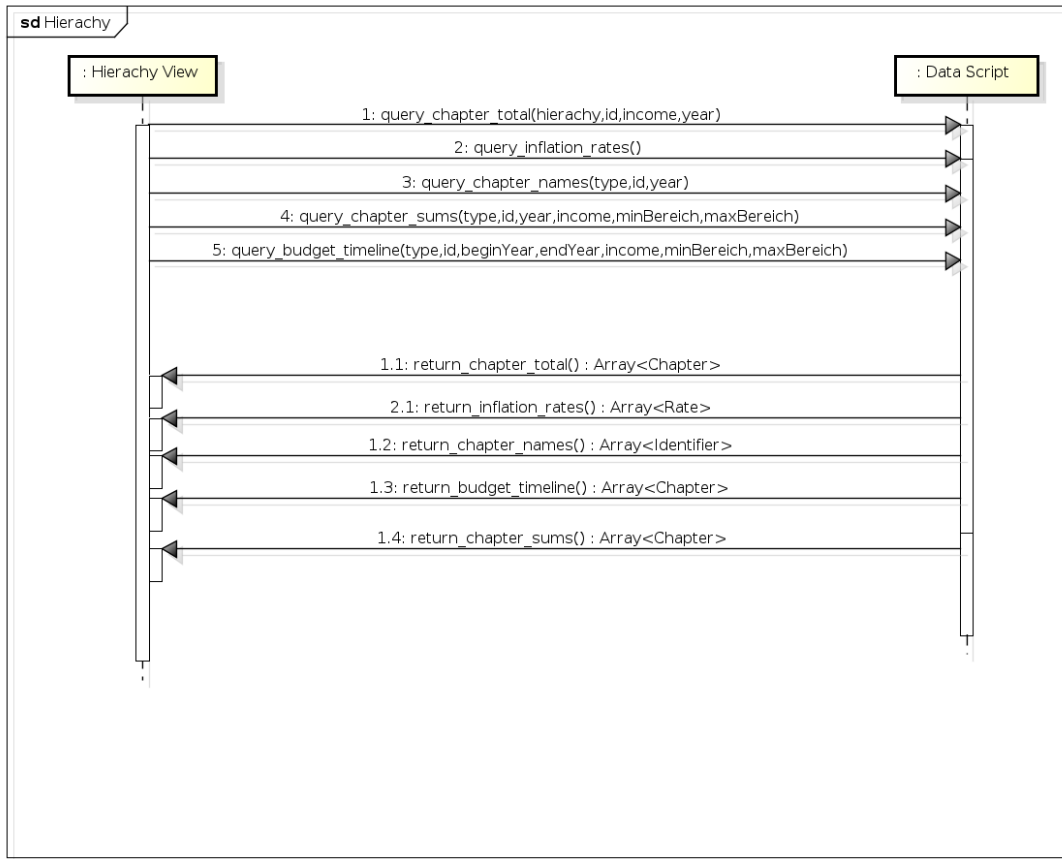
Figure 3.4 – Sequence Diagram Hierarchy View.
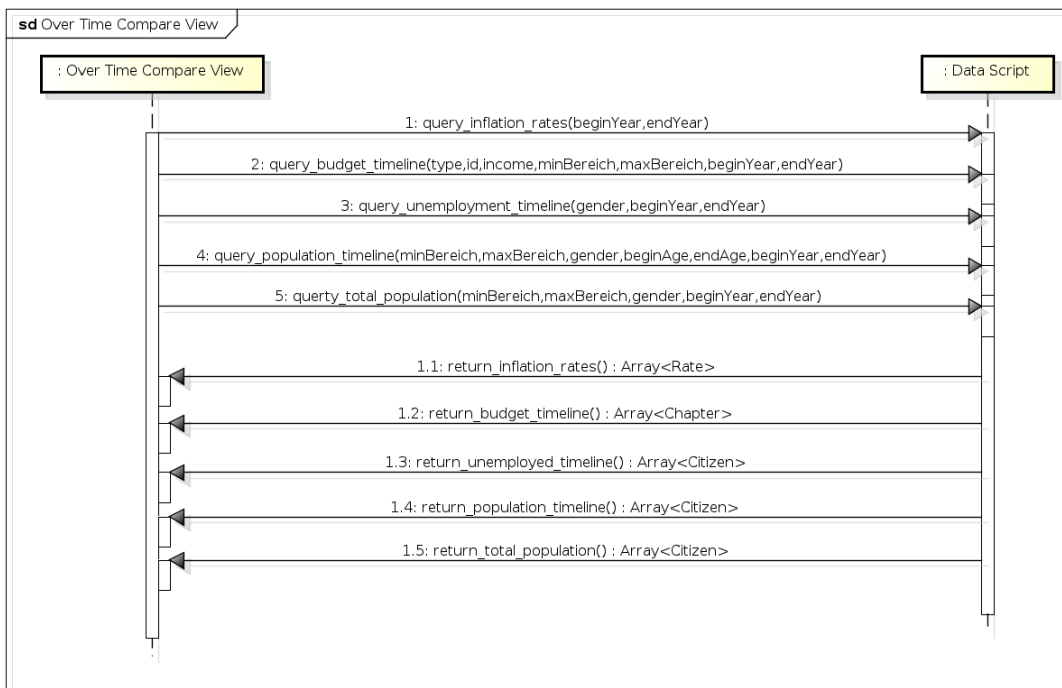
Figure 3.5 – Sequence Over Time View.
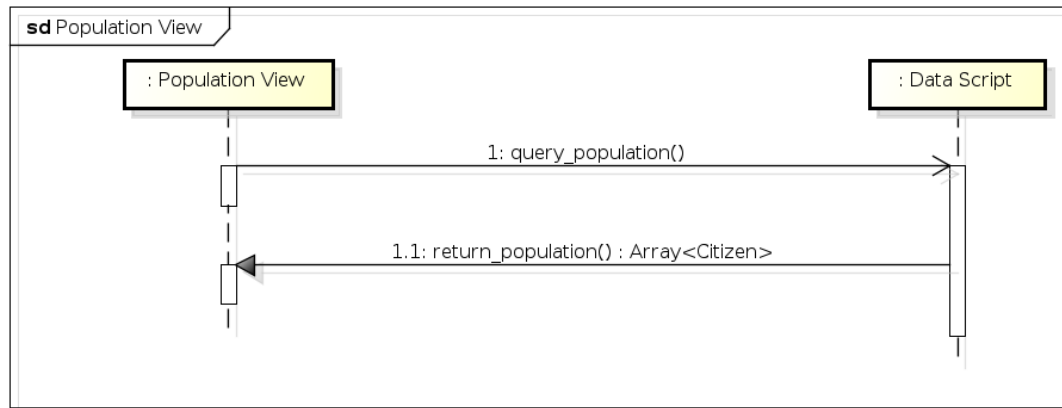
Figure 3.6 – Sequence Diagram Population View.
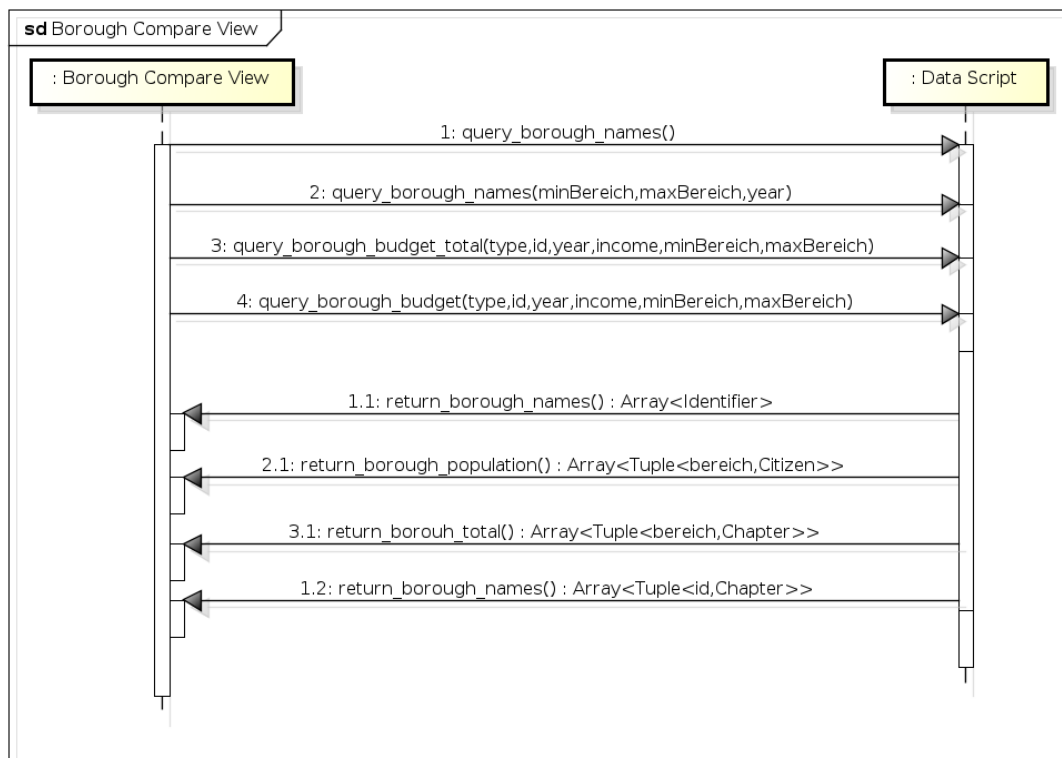
Figure 3.7 – Sequence Diagram Borough Compare View.

4 IMPLEMENTATION

This chapter describes the implementation details of BerlinViz. First the implementation of the data retrieval is explained. The following part describes the implementation of the views used in BerlinViz and the last part explains the auxiliary functions used in BerlinViz.

4.1 Querying the Data

The data retrieval script is organized as a finite state machine. In all cases, the script takes a command and additional parameters, as shown in Figure 4.2, depending on the command. The command itself is splitted into the type of query and the hierarchy that is queried as following: $< TYPE > \_ < HIERARCHY >$. The type of query is the prefix of the command string and the hierarchy level to query the suffix of the hierarchy. In Figure 4.1 the used prefixes and the actions are listed.

Prefix	Action	Group By
n	Return names of elements in queried hierarchy	ID
s	Sum over all elements of queried hierarchy	ID
t	Total of queried item	ID
b	Sum of all elements in queried hierarchy	Bereich
c	Sum of all elements in queried hierarchy	ID, Year
a	Sum over ages of selected year	Year, Gender
bc	Sum of all elements in queried hierarchy	Bereich ,ID, Year

Table 4.1 – Prefixes and corresponding actions.

Prefix	Parameters	Return
n	ID, Year	ID, name
s	ID, Year, minBereich, maxBereich, Income	ID, value
t	Year, ID	ID, value
b	ID, Year, Income, minBereich, maxBereich	Bereich, ID, value,
c	ID, beginYear, Year, endYear, minBereich, maxBereich, Income	ID, Year, value
a	minAge, maxAge	Year, Gender, Age
bc	ID, Year, Income, minBereich, maxBereich, beginYear, endYear	Bereich , ID, Year, Value

Table 4.2 – Prefixes, parameters and returns.

4.1.1 Querying the Database

The query script first joins the tables according to Figure 4.1 and then filters the rows in the resulting tables to query the database for financial data.

$$einzelplan_{join} = (((\sigma_{Legislation.beginYear>=year \land Legislation.endYear<=year}($$
$$Einzelplan \bowtie_{Einzelplan.legislation=Legislation.id} Legislation))$$
$$\bowtie_{Einzelplan.id=Kapitel.einzelplan}$$
$$(\sigma_{Legislation.beginYear>=year \land Legislation.endYear<=year}($$
$$Kapitel \bowtie_{Kapitel.legislation=Legislation.id} Legislation)))$$
$$\bowtie_{Kapitel.id=Titel.kapitel} Titel)$$

$$kapitel_{join} = (\sigma_{Legislation.beginYear>=year \land Legislation.endYear<=year}($$
$$Kapitel \bowtie_{Kapitel.legislation=Legislation.id} Legislation) \bowtie_{Kapitel.id=Titel.kapitel} Titel)$$

$$hauptgruppe_{join} = (((Hauptgruppe \bowtie_{Hauptgruppe.id=Obergruppe.hauptgruppe} Obergruppe)$$
$$\bowtie_{Obergruppe.id=Gruppe.obergruppe} Gruppe)$$
$$\bowtie_{Gruppe.id=Titel.gruppe} Titel)$$

$$obergruppe_{join} = ((Obergruppe \bowtie_{Obergruppe.id=Gruppe.obergruppe} Gruppe)$$
$$\bowtie_{Gruppe.id=Titel.gruppe} Titel)$$

$$gruppe_{join} = (Gruppe \bowtie_{Gruppe.id=Titel.gruppe} Titel)$$

$$hauptfunktion_{join} = (((Hauptfunktion$$
$$\bowtie_{Hauptfunktion.id=Oberfunktion.hauptfunktion} Oberfunktion)$$
$$\bowtie_{Oberfunktion.id=Funktion.oberfunktion} Funktion)$$
$$\bowtie_{Funktion.id=Titel.funktion} Titel)$$

$$oberfunktion_{join} = ((Oberfunktion \bowtie_{Oberfunktion.id=Gruppe.oberfunktion} Funktion)$$
$$\bowtie_{Funktion.id=Titel.funktion} Titel)$$

$$funktion_{join} = (Funktion \bowtie_{Funktion.id=Titel.funktion} Titel)$$

Figure 4.1 – Joins of tables.

After the joins, the rows are filtered according to the prefix. The selection operations for budget data are shown in Figure 4.2. The selection operations for population data are shown in Figure 4.3.

The last step in retrieving the data is to select the columns of interest. The respective projection operations according to the prefix for budget data are shown in Figure 4.4 and for

$$t_{budget} = \sigma_{titel.year=year \wedge titel.income=income \wedge <hierachy_old>.id=id}($$
$$\sigma_{titel.bereich>=minBereich \wedge titel.bereich<=maxBereich}(< hierachy >_{join}))$$

$$s_{budget} = \sigma_{titel.year=year \wedge titel.income=income \wedge <hierachy_old>.id=id}($$
$$\sigma_{titel.bereich>=minBereich \wedge titel.bereich<=maxBereich}(< hierachy >_{join}))$$

$$c_{budget} = \sigma_{titel.income=income \wedge <hierachy_old>.id=id}($$
$$\sigma_{titel.bereich>=minBereich \wedge titel.bereich<=maxBereich}($$
$$\sigma_{titel.jahr>=beginYear \wedge titeljahr<=endYear}(< hierachy >_{join})))$$

$$b_{budget} = \sigma_{titel.jahr=year \wedge titel.income=income \wedge <hierachy_old>.id=id}($$
$$\sigma_{titel.bereich>=minBereich \wedge titel.bereich<=maxBereich}(< hierachy >_{join}))$$

$$bc_{budget} = \sigma_{titel.income=income \wedge <hierachy_old>.id=id}($$
$$\sigma_{titel.bereich>=minBereich \wedge titel.bereich<=maxBereich}$$
$$\sigma_{titel.jahr>=beginYear \wedge titel.jahr<=endYear}(< hierachy >_{join})))$$

Figure 4.2 – Resulting selections for budget data.

population data in Figure 4.5. If the queried hierarchy level is the top level of the singel plan, group or function hierarchy, the predicate $< hierachy_old > .id = id$ is not used in the selection.

$$b_{budget} = \sigma_{jahr=year \land bereich>=minBereich \land bereich<=maxBereich}(Population)$$

$$bca_{budget} = \sigma_{gender=gender \land bereich>=minBereich \land bereich<=maxBereich}($$
$$\sigma_{year>=beginYear \land year<=endYear}(Population))$$

Figure 4.3 – Resulting selections for population data.

$$\Pi_{id,name}(<hierachy>)$$

$$\Pi_{id,SUM(Titel.ansatz)}()$$

$$\Pi_{id,name,SUM(Titel.ansatz)}()$$

$$\Pi_{id,year,SUM(Titel.ansatz)}()$$

$$\Pi_{bereich,SUM(Titel.ansatz)}()$$

$$\Pi_{bereich,year,SUM(Titel.ansatz)}()$$

Figure 4.4 – Resulting queries for budget data.

4.2 Hierarchy View

The hierarchy view is implemented as a multi-level pie chart. The absolute value of the items is used to calculate the sizes of the pieces. The hierarchy view saves the selected ID's of the previous levels in an array. This saving is used, to grey out all elements of the former levels, except the selected ones. Each SVG DOM-Node is associated the id of the item and the level in the hierarchy. This association is used to identify the elements to delete or save as selected. It is also used for the hovered action handler. The hovered handler takes the ID of the currently hovered element and highlights the line in the Over-Time-Compare View and the corresponding row in the hierarchy. Also, the id is used to communicate with the detail view so that the detail view uses the currently selected id in the hierarchy view. The on-click handler updates the hierarchy view and the legend according to the selected element. In the hierarchy

$$\Pi_{gender,SUM(value)}(s_{population})$$

$$\Pi_{gender,year,SUM(value)}(bc_{population})$$

Figure 4.5 – Resulting Queries for population data.

view, it adds a new ring when a level in the currently selected level is selected, or, if in a lower level in the hierarchy an element was selected, it deletes rings.

4.3 Detail View

The detail view is implemented as a callback function. If the chosen detail view is changed, the detail view pointer is changed to the chosen detail view function. The respective implementations of the detail views are described below.

4.3.1 Over-Time-View

The Over-Time-View is implemented as a line chart. The corresponding values in the range $[beginYear, endYear]$ are mapped into an array of tuples $(year, value)$. This array is then mapped into the tuple $(id, values)$. For each id, an SVG path is generated, with the color corresponding to the color of the element in the hierarchy view. The corresponding chapter id is associated in the DOM-Nodes. For elements not present anymore in the reference year, the color black is used. The y-axis is normalized in the range $[0, maxVal]$ whereas maxVal is the maximum values encountered amongst all tuples $(id, values)$ in the values array. The x-axis is normalized in the range $[beginYear, endYear]$. The label of the y-axis is generated corresponding to the selected options. If the maximum value is greater than 1000, the values are displayed in thousands on the y-axis.

4.3.2 Population View

The population view is implemented as a back-to-back bar chart. The width of the bars corresponds to the number of people. The width of the bars is normalized according to the

maximum amount of people encountered through all the ages and genders. Each bar is drawn as an SVG-rect. The x-axis of the population view goes from 0 to the maximum value encountered for both backs. The y-axis is precomputed to show the ages between 0 to 95. The hover-handler displays a tooltip with information about the hovered element.

4.3.3 Borough-Compare-View

The Borough-Compare-View is implemented as a thematic map. The values are normalized to the median of the values of all boroughs. Values that are not in the range $[-1, +1]$ are clamped to -1 when the normalized value is smaller than -1 nd to $+1$ when the normalized value is greater than $+1$. For incomes, the range is mapped to the gradient from red, which represent the value -1, to green, which represents the value $+1$. For expenses, mapping is inverted. For each borough, an SVG-path is generated. Each path is the id of the borough associated in the DOM-Node. The onclick handler changes the administration to the clicked borough. The hover-handler displays a tooltip with demographic and budget information about the hovered element.

4.4 Auxilary functions

To generate the colors for the elements inside the multi-level pie chart a PRNG is used with a fixed seed to reproduce the same color set. Since JavaScript does not allow to set the seed of the PRNG, a simple implementation of a PRNG is used, which is shown in Appendix A of this work.

Figure 4.6 shows the mathematical calculation of the investment power relative to a reference year. An implementation of this formula is listed in Appendix B.

Before reference year:
$$valuenew_{year} = value_{ryear} * \prod_{n=year}^{ryear-1} (1 + infl_n)$$
After reference year:
$$valuenew_{year} = value_{ryear} * \prod_{n=ryear+1}^{year} (1 - infl_n)$$

Figure 4.6 – Calculating inflation adjusted values.

The calculation of the slope of the trendline is shown in Figure 4.7. An implementation

of this formula is listed in the Appendix C.

$$amount = ryear - (byear + 1)$$

$$a = amount * \sum_{n=1}^{ryear-(byear+1)} (n * v(n + byear - 1))$$

$$b = \sum_{n=1}^{ryear-(byear+1)} (n) * \sum_{n=1}^{ryear-(byear+1)} v(n)$$

$$c = amount * \sum_{n=1}^{ryear-(byear+1)} (n^2)$$

$$d = (\sum_{n=1}^{ryear-(byear+1)} (n))^2$$

$$slope = \frac{a-b}{c-d}$$

Figure 4.7 – Calculation of trendline slope.

5 USER INTERFACE

This chapter presents the user interface, which is splitted into four parts. Figure 5.1 shows the user interface of the visualisation. The part labeled with 1 is used for general options for the Visualisation. The part marked with 2 represents the hierarchical view of the chosen hierarchy. This part is also used to navigate through the hierarchy. The part labeled with 3 is used for a more detailed view of the data and the part 4 represents the budget table.
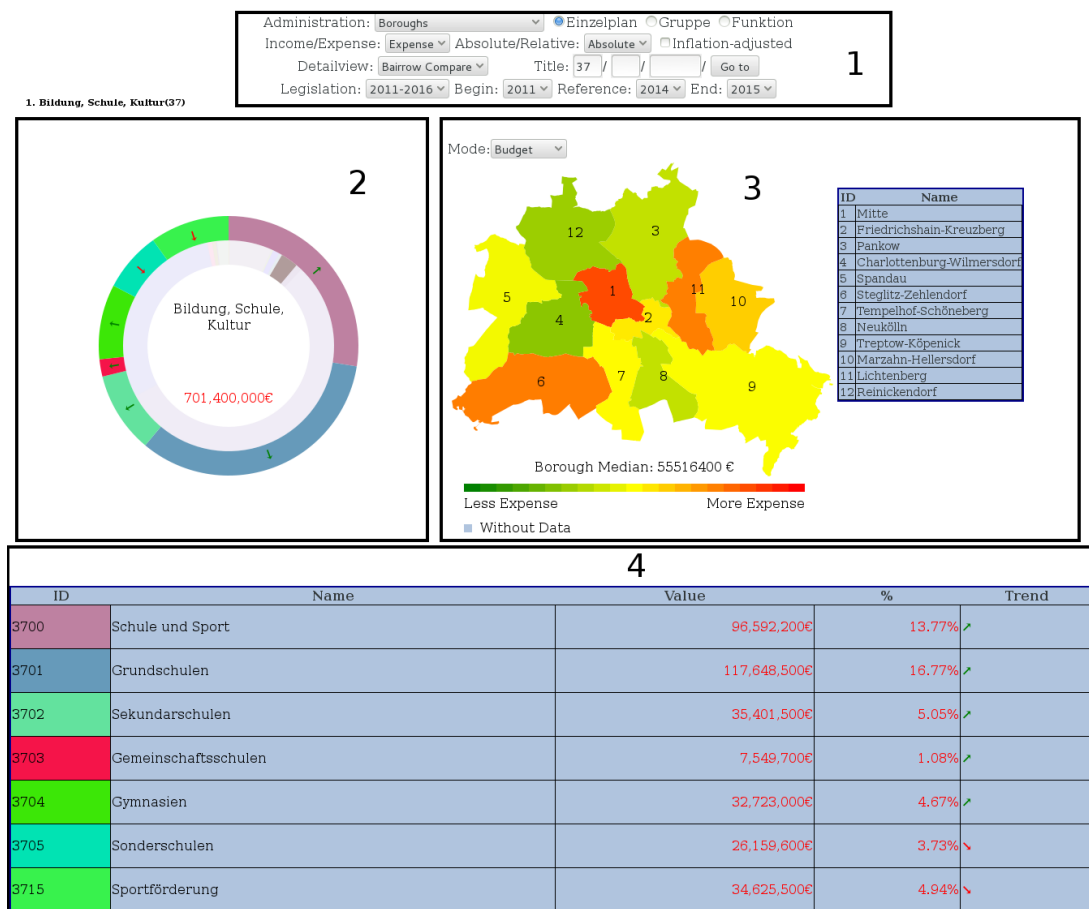
Figure 5.1 – User Interface of BerlinViz.

5.1 General options

In the general options, as seen in Figure 5.2, the user can choose the main administration or the regional administrations to analyse. Also, the user can choose from which hierarchy he wants to analyse the budgets and whether he wants to analyse the accounting book of incomes or expenses. Further, the user can choose, whether he wants to see the detail views in absolute or relative values and whether he wants timeline data and trends to be inflation adjusted or not.

Further, the user can choose the detail view he wants to use for analysing the data. Also, the user can directly access a title and select the legislation and time range he wants to analyse.

Figure 5.2 – General options.

5.2 Hierarchy View

The hierarchical pie chart, as shown in Figure 5.3, shows the absolute values of an element in the hierarchy. The arrows inside the arcs show the trends based on the settings for the range of years to analyse and inflation adjustion. The next level is displayed and the parents, except the selected one, are getting translucent, clicking an element. Also, the detail view and budget table is updated with the children elements. In the center of the hierarchical pie chart, the user can see the total value of the selected item, or when hovered over elements, the value of the hovered element. The user interface keeps a consistency between the colors used in the different views when using budget data. The same color is used in the different views when referring to an element in the hierarchy.

The budget table is used to show the color keys, names, absolute and relative values of the currently selected element in the hierarchy. It also calculates a trend for the following year and displays this as a green arrow for a positive trend and as a red arrow for a negative trend. This information is redundantly also encoded with the direction of the arrow. An arrow showing down correspondents to a negative trend and an arrow showing up correspondents to a positive trend. It is also used to navigate through the hierarchy and is the better option for small items in the current level of the hierarchy.

5.3 Detail View

This section explains the detail views used in BerlinViz and which focus they give to the data, explaining the Over-Time-View, followed by the Population-View and the Borough-Compare-View.
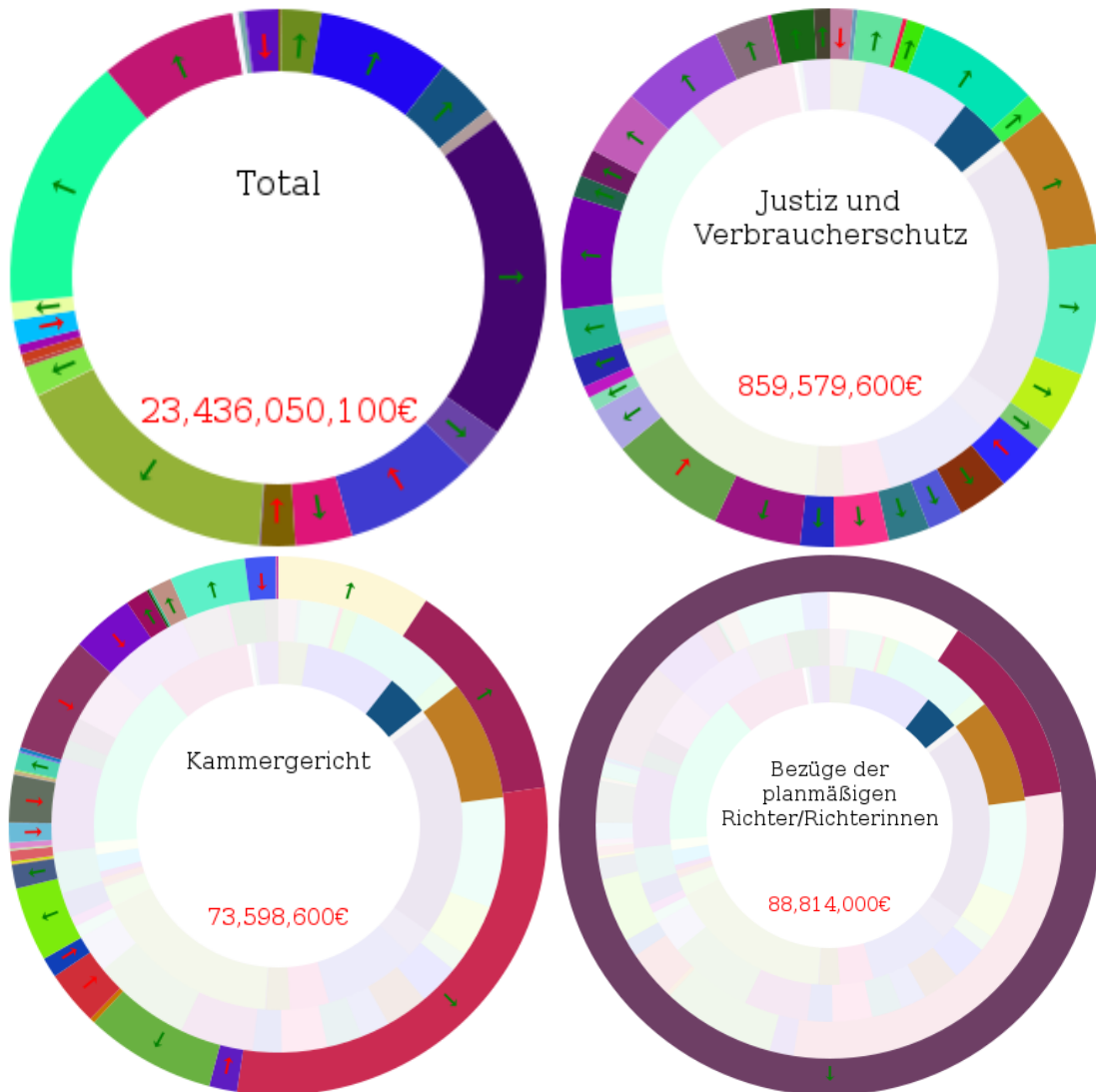
Figure 5.3 – Hierarchy view expanding the single plan hierarchy.

5.3.1 Over-Time-View

The Over-Time-View, as shown in Figure 5.4, is used to compare the children elements inside the selected elements over time. The budgets can be additionally visualised in relation to demography and unemployment. It is also used to visualise the development of inflation, demography and unemployment. Unemployment and demography can be visualised according to the selected gender. Demography additionally can be visualised for a range of ages of people. The x-axis represents the time, whereas the y-axis represents the value. When comparing budgets, the lines are encoded according to the color keys used in the Hierarchy-View. If an element from the former years does not exist anymore in the current budget, the line is drawn black. When displaying demography or unemployment, the pink color represents feminine, the color blue masculine and the color black both genders. The color black is used, when visualising
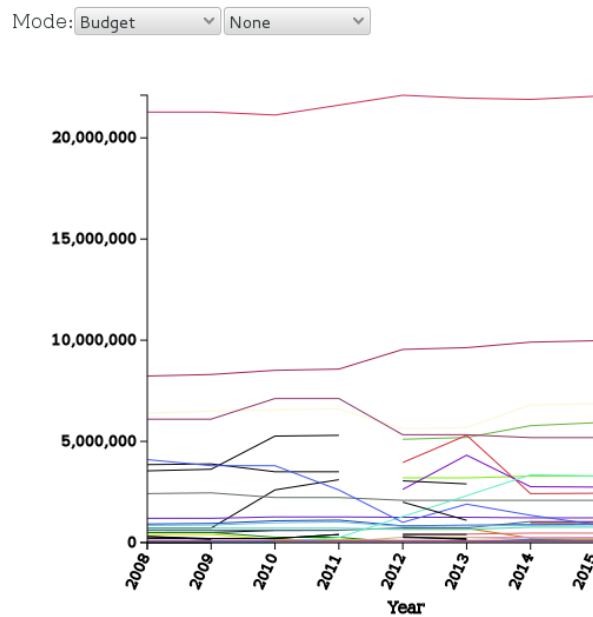
Figure 5.4 – Over-Time-View.

inflation rates. The y-axis label changes according to the selected modifiers.

5.3.2 Population-View

The Population-View, as shown in Figure 5.5, shows the age distribution inside Berlin or a particular borough. The y-axis shows the age of people and the x-axis a number of persons. The x-axis is splitted where the left side represents the feminine population and the right side represents the masculine population, creating an analogy to the demographic tree. The color blue encodes the masculine part, and the color pink the feminine part. Hovering over a bar, shows the age, gender and amount of people in a tooltip. The legend shows the total amount of masculine, feminine and both genders. Hovering the feminine or masculine row in the legend hides the other gender.

5.3.3 Borough-Compare-View

The Borough-Compare-View, as shown in Figure 5.6, visualises a comparison of the selected element in the hierarchy between the boroughs and demographic comparisons between the boroughs relative to the borough's median in a thematic map. Budgets can be additionally visualised in relation to demography. A red-to-green color scale is used to show the results of this comparison, where red means worse and green better than the median. A borough is
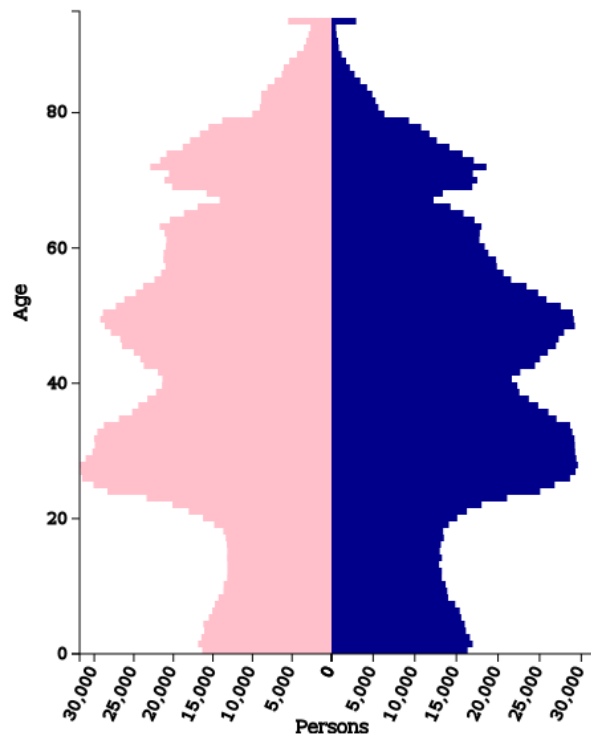
Figure 5.5 – Population-View
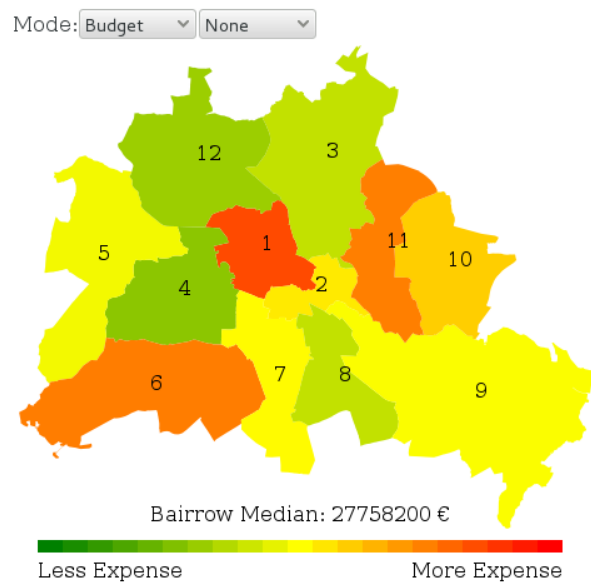
Figure 5.6 – Borough-Compare-View.

highlighted and a tooltip with information about the demography, the absolute value of the selection and the derivation from the median is shown, hovering over an area on the map. Below the map, the calculated median and the meaning of the color scale is visualised. The legend shows the number keys for the boroughs used in the thematic map. When hovered over a row in the legend, the corresponding borough is highlighted.

6 ANALYSING BUDGETS

This chapter describes how budget data can be analysed with BerlinViz. The first part describes how spendings can be analysed to find patterns for savings, policy changes and regional differences. The second part describes how demography can be analysed to see the structure of boroughs in Berlin.

6.1 Spendings

This section describes the use of BerlinViz to identify patterns for savings, policy changes and regional differences in the boroughs about spending and efficiency of the services offered.

6.1.1 Relative to Inflation

This example shows, how to use the inflation adjust option, to see savings over time due to stagnation. For this, the expenses in "matter administration expenses" in the second level of the group-hierarchy is analysed over the years 2008 till 2015 with and without inflation adjusting, as seen in Figure 6.1. Without inflation adjusting, this item stagnates with a slight trend of increasing. The item is also stagnating, adjusting inflation, but contrary it seems to have a trend of decreasing slightly over the years. This behaviour is also indicated by the trend arrows in the hierarchical pie chart.

6.1.2 Relative to Population

This example shows how to use the optionally added relation to population, to see savings due to demographic change. For this example, the expenses in the title "education and training" in the function hierarchy for elementary school's educational administration for all boroughs and the main administration are used. Without the group of pupils ranging from 6 to 12 years, this title appears stagnating. This title is increasing from 2009 to 2010 but is decreasing after 2010 adding the relation to pupils. Although this decrease in absolute values is not high.
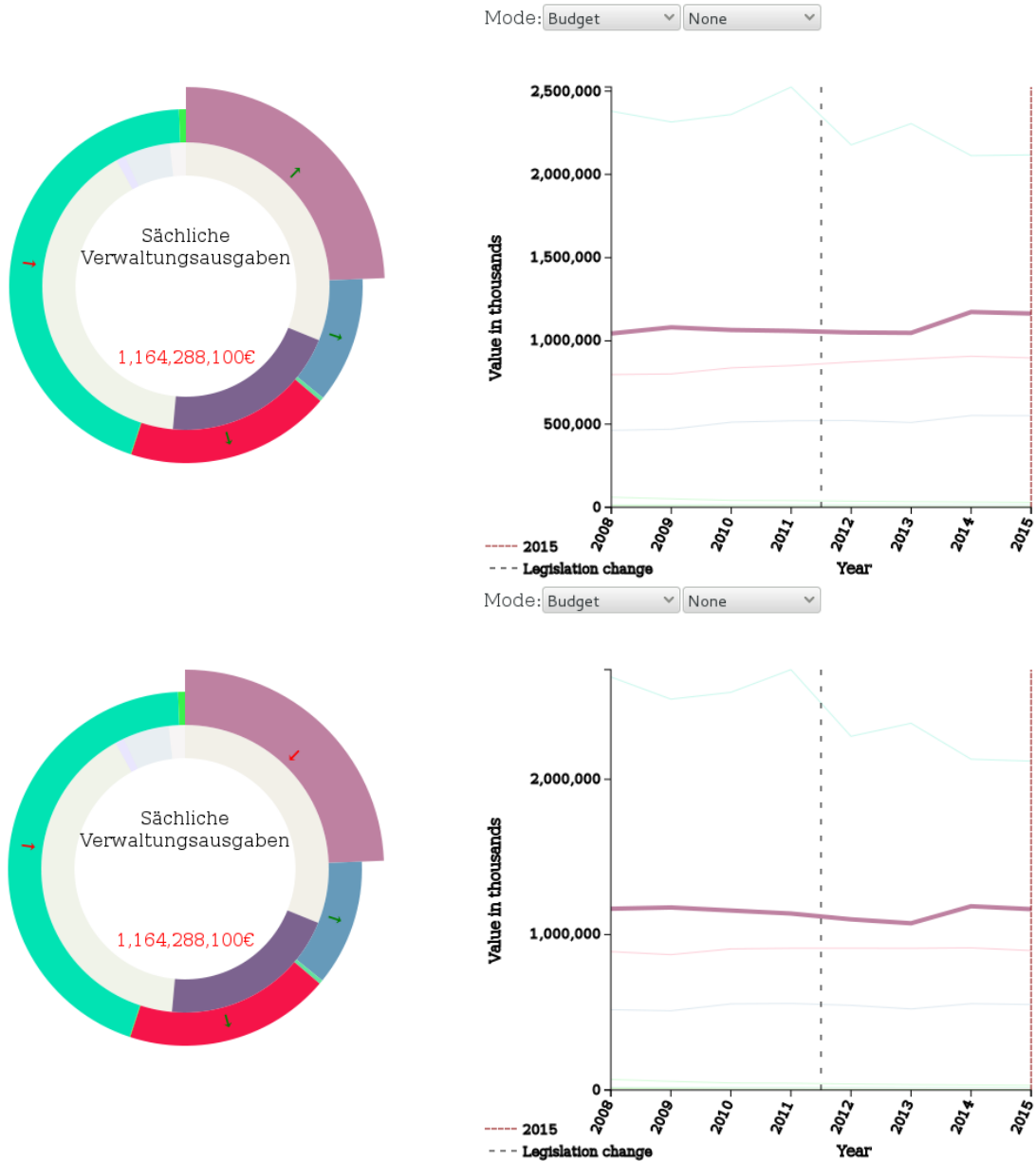
Figure 6.1 – Without inflation adjustion (top) and with adjustion (bottom).

6.1.3 Relative to Unemployment

This example shows, how to use the optionally added relation to unemployed people, to see the effectivity of employment policies. For this example, the expenses in the function "employment policies" in the function hierarchy for "welfare and employment policies" for all boroughs and the main administration are used. In Figure 6.3 the budget is shown relative to unemployed people without adjusting inflation. Although, without adjusting inflation, it appears that the budget for "employment policies" is increasing slightly, taking into account the decreasing number of unemployed persons, the budget is growing faster. In Figure 6.3 the budget is shown relative to unemployed persons and adjusting inflation, where it seems, that

Mode: Budget None

Mode: Budget Population
From Age: 6 To Age: 12 Gender: Male & Female

Mode: Population
From Age: 6 To Age: 12 Gender: Male & Female

ID	Gender	Value
	Male	104090
	Female	98187
	Total	202277
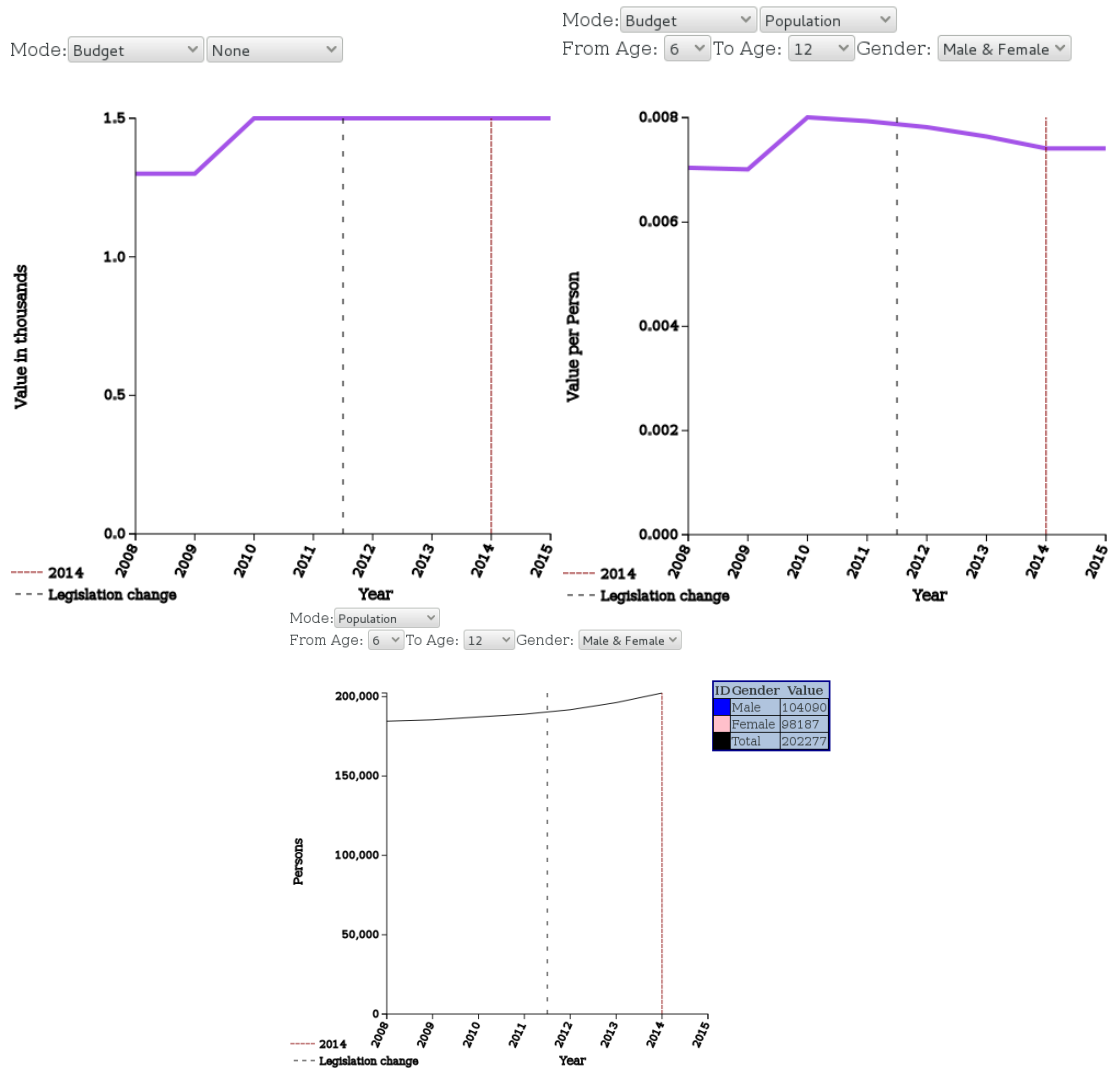
Figure 6.2 – Investments into "education and training" relative to pupils without inflation adjustion (left) and with adjustion (right). Total amount of pupils (bottom).

inflation compensates the extra expense per person.

6.1.4 Comparing Boroughs over Time

This example shows how to compare boroughs over time. For this example, the "welfare and employment policies" item in the function-hierarchy is used. In Figure 6.5 the development of this function for the boroughs Friedrichshain-Kreuzberg and Lichtenberg are shown. The borough Friedrichshain-Kreuzberg lowered expenses in welfare and employment policies, whereas the borough Lichtenberg increased expenses in employment policies over time.
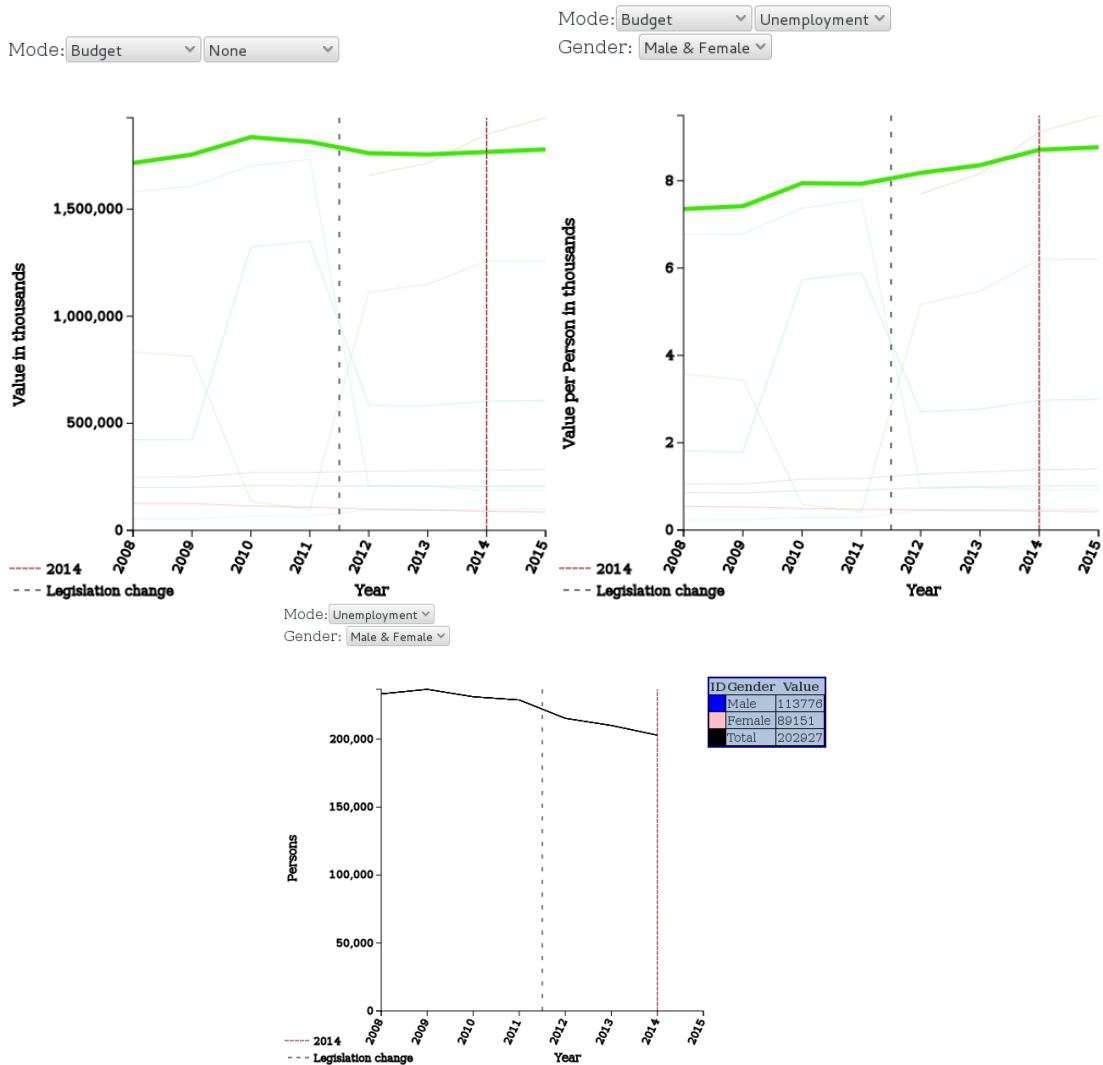
Figure 6.3 – Investments into employment policies (left) relative to unemployed persons without inflation adjustion (right). Total amount of unemployed people (bottom).

6.1.5 Comparing between Boroughs relative to Population

This example shows how to compare budgets between boroughs in relation to population. This example uses the expenses in the "elementary school" budgets in the single plan hierarchy to compare between the boroughs. Figure 6.6 shows this comparison without and with relation to population. The distribution of the budgets between the boroughs without relation to population shows that the boroughs in the west and south-east have fewer expenses than the other boroughs in Berlin. The boroughs in the south-west and center have the most expenses. Using the option to show the budget in relation to the population in the ages six to twelve, the boroughs in the north have fewer expenses.
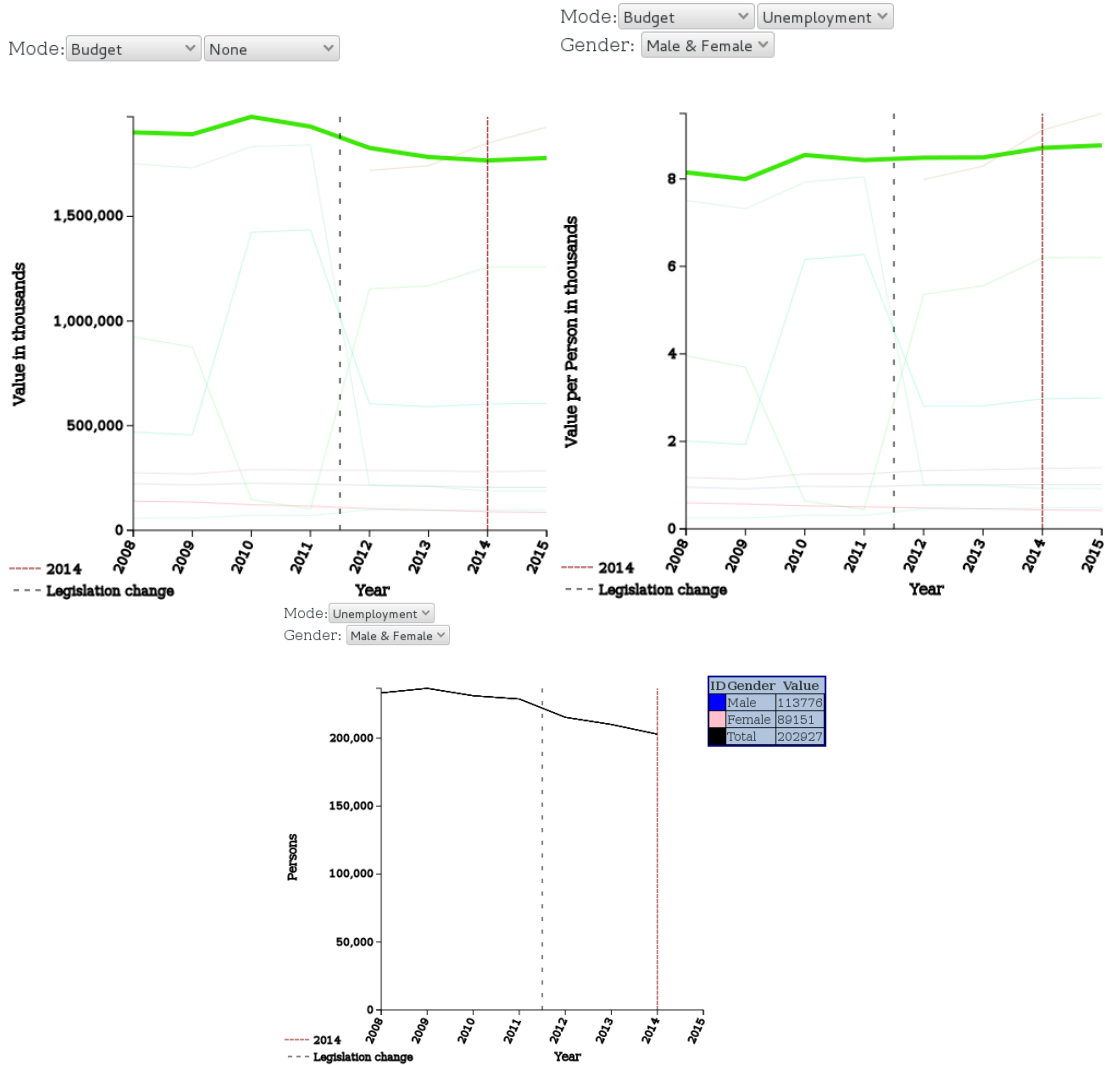
Figure 6.4 – Investments into employment policies(left) relative to unemployed persons with inflation adjustion (right). Total amount of unemployed people (bottom).

6.1.6 Comparing between Boroughs over Time

In this example, the comparison between the boroughs over time is shown on the budget of "elementary schools" in the single plan hierarchy. Figure 6.7 shows the comparison from 2011 till 2014, where the boroughs in the east were getting worse over time than the boroughs in the west. An exception in the west is the borough labeled with 6.

6.1.7 Seeing policy changes

This example shows, how the option to visualise budgets relative, can be used to show policy changes. In Figure 6.8 a policy change from state servants to state employers in the elementary schools can be seen in the subchapters of the budget for "Elementary schools".
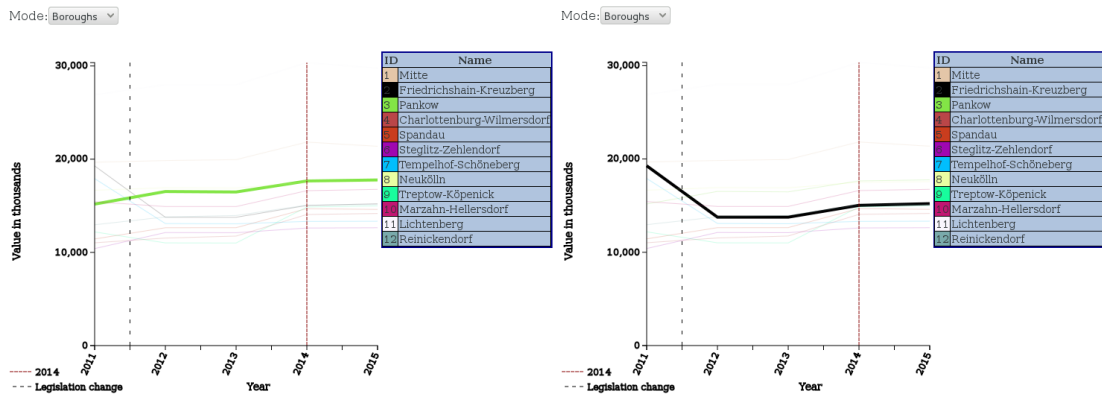
Figure 6.5 – Investments in "welfare and employment policies" compared in the boroughs Mitte (left) and Friedrichshain-Kreuzberg (right).
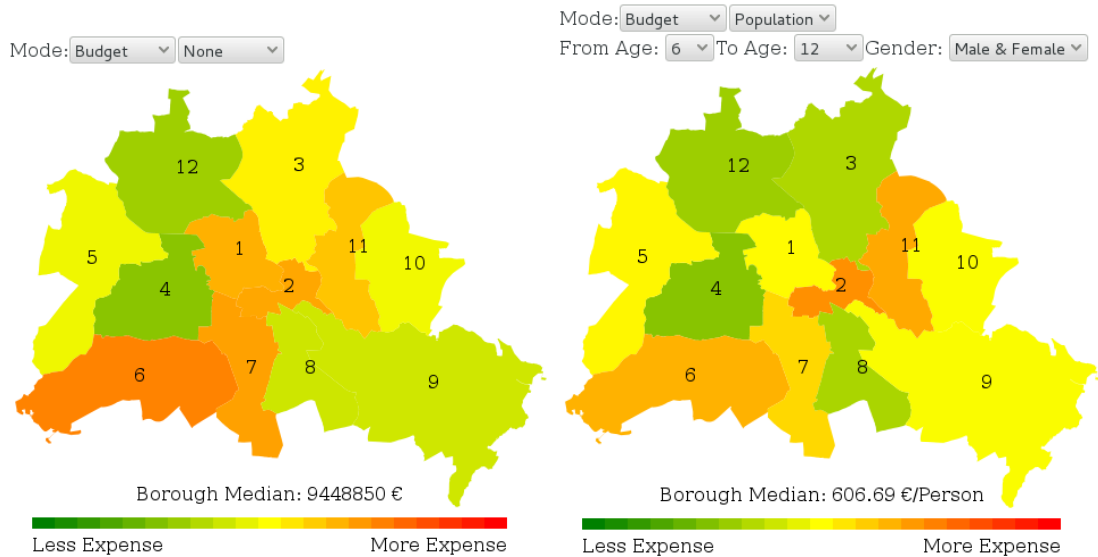
Figure 6.6 – Distribuition of budgets for the chapter "elementary Schools" without relation to population (left) and with relation to population (right).

Relatively, the budgets for state servants, are decreasing whereas the budgets for state employers are increasing.

6.2 Demography

The goal of this section is to interprete demography in Berlin and its boroughs. The first part of this section shows, how to see demographic changes over time for a group of people. The second part of this section will show, how to see the distribution of demographic groups in the boroughs of Berlin.
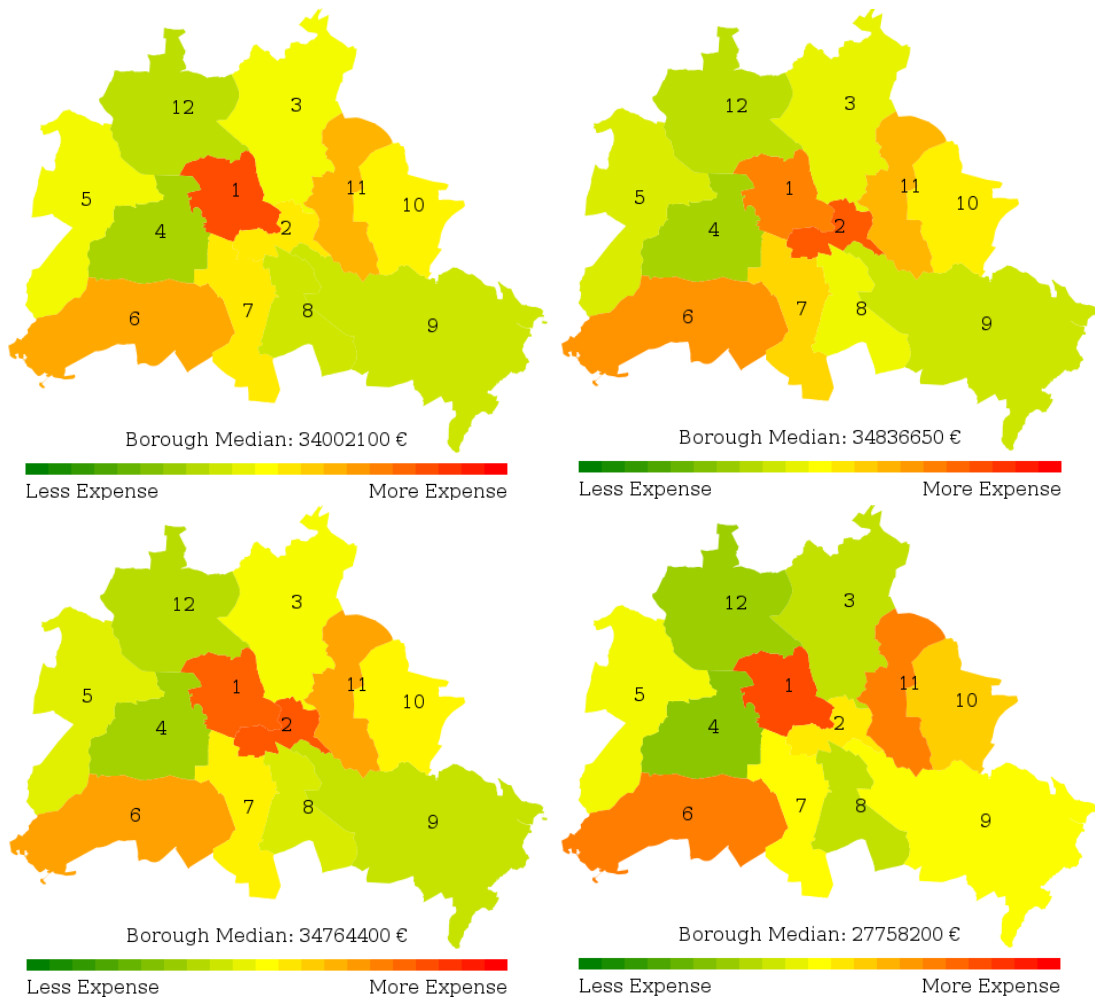
Figure 6.7 – The development of the chapter "Education, Schools and Culture" in the boroughs of Berlin for 2011 (top left), 2012 (top right), 2013 (bottom left), 2014 (bottom right).

6.2.1 Demographic structure of an administration

The demographic structure of whole Berlin or just a borough can be analysed for the reference year choosing the population view. In this example, the demographic structure of the borough Friedrichshain-Kreuzberg for the year 2014 is analysed. Figure 6.9 shows the demographic structure in Friedrichshain-Kreuzberg, which reveals that in this borough are more young residents then old residents.

6.2.2 Demographic Distributions between all Boroughs

The age distribution can be analysed between the boroughs using the Borough-Compare-View. This example shows the relative distribution of pensioners between the boroughs. Figure 6.10 shows that more pensioners live in the south-west of Berlin and the borough labeled
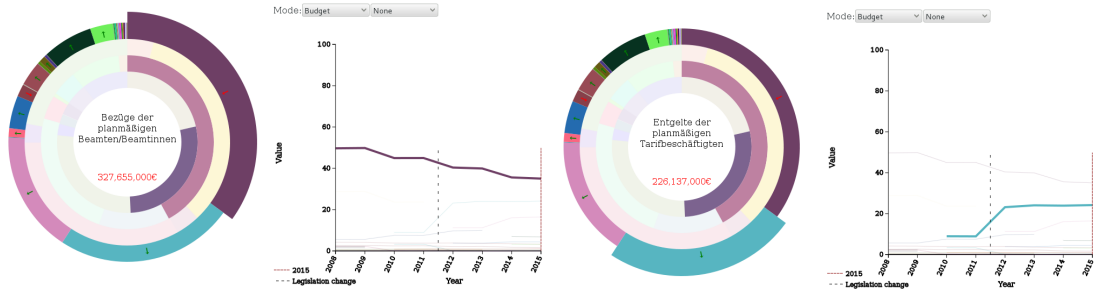
Figure 6.8 – A relative reduction of the budget for state servants in public schools (left) and an increase of budgets for public employers (right).
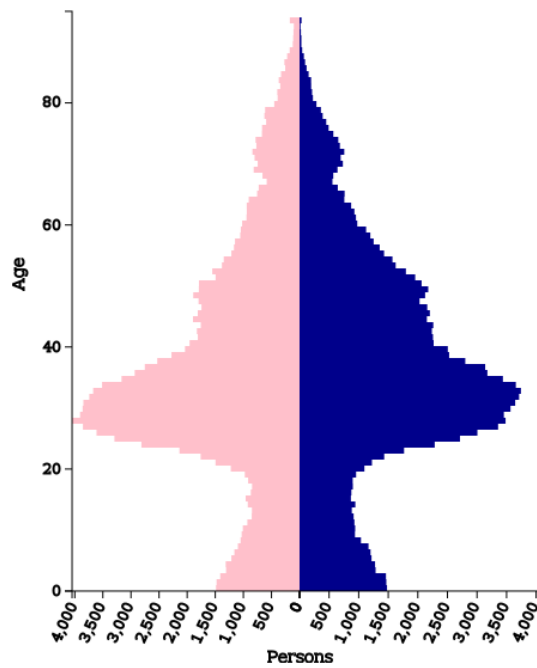
Figure 6.9 – Demographic Structure of Friedrichshain-Kreuzberg.

with 9. The centrum of Berlin has the fewest pensioners.

6.3 Final remarks

The public budget consists of nearly 21000 items per year, just a few examples were chosen in this chapter but the methodology can be used to compare other parts of the budget.
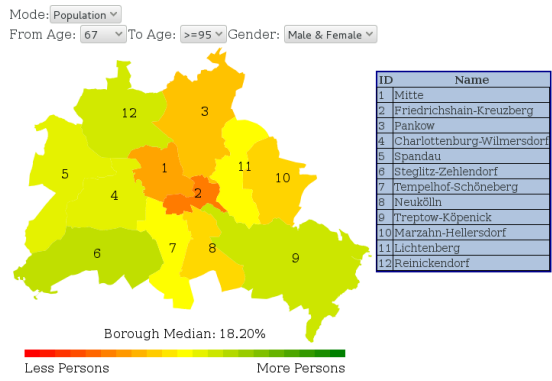
Figure 6.10 – Demographic distribution of pensioners in the boroughs.

7 USER TEST

This chapter discusses the evaluation of the user interface. The first section describes the contextual analysis of the user and identifies the tasks. The second section discusses the evaluation based on the identified tasks and defines the independent and dependent variables of the user test.

7.1 Contextual Analysis

In the contextual analysis was identified one user group for this visualisation. The user is a politically interested person who has completed his studies at the university in human sciences, economy or law. The age of the person is between 25 to 40 years. He uses his computer every day to read news and has used interactive visualisation from time to time on the website of a regional newspaper. The use-case diagram for this user is shown in Figure 7.1.
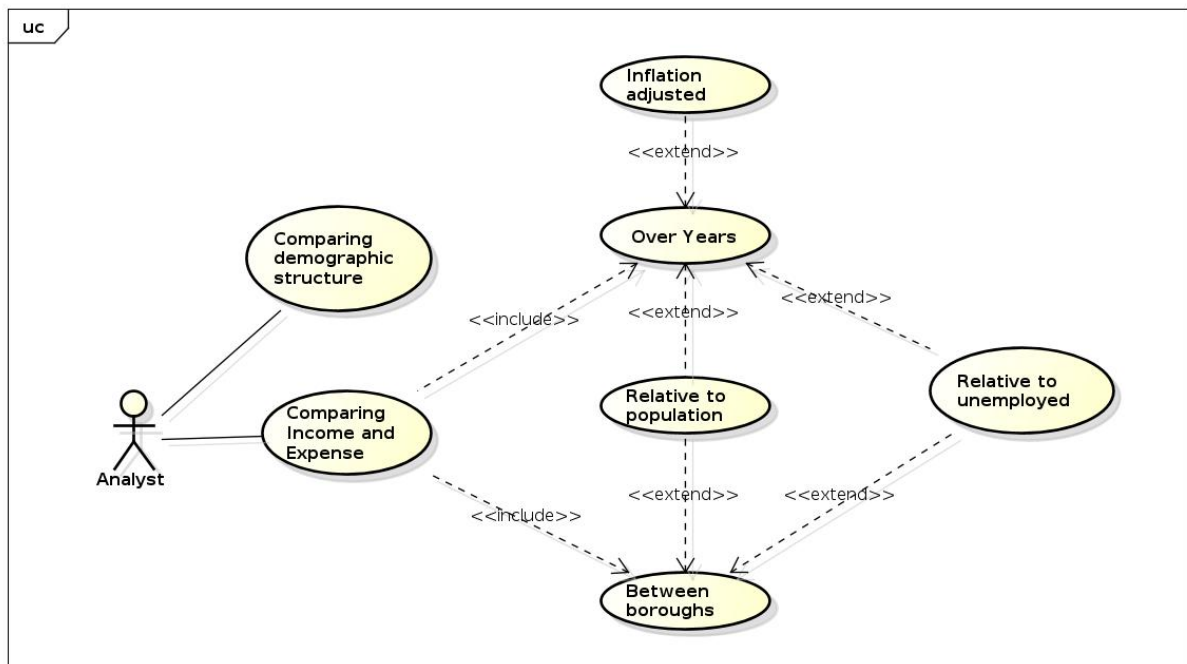
Figure 7.1 – Use Case Diagram

7.1.1 Identified Tasks

In the AHT-Diagram, shown in Figure 7.2, four tasks were identified. The first task identified was the general configuration of the visualisation. The second task identified was the discovery of demography. The third task identified was the browsing of the hierarchy and the fourth task identified was the comparison of details.
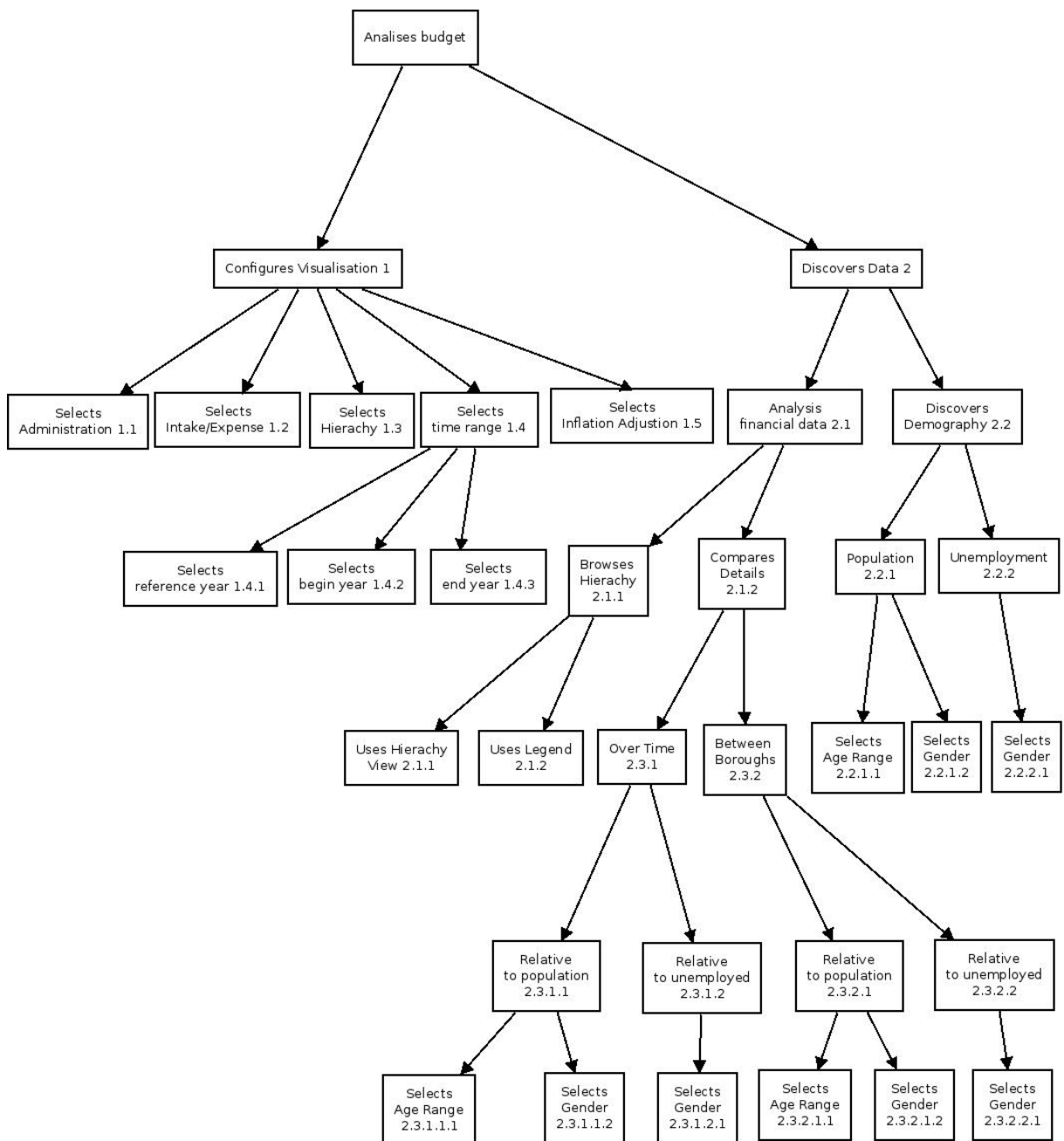
Figure 7.2 – AHT Diagram User

7.2 Evaluation with Users

The hypothesis in this user tests was that the user uses the Hierarchy View for browsing through big chapters of the public budget and uses the Legend to browse small chapters in the public budget. Another hypothesis in this user test was that the user needs time to understand the general options. Following this, another hypothesis was, that the Borough-Compare-View and the Population View are simpler to understand than the Over-Time-View. Questions about the development of budget values and boroughs with and without inflation were used, to guarantee that the tester was doing all the tests.

7.2.1 Independent Variables

For the user test, two independent variables were used. The first independent variable was the depth in the hierarchy. The second independent variable was the amount of items in the same level of the hierarchy.

7.2.2 Dependent Variables

The dependent variable for the hierarchy browsing was the errors in responses. For the Borough-Compare-View, Population-View, the mistakes in selecting the right answer are the dependent variables. For the Over-Time-View, errors in interpreting the trend of the lines are used as dependent variables.

7.2.3 Questions used in the Test

The user test was splitted into three parts. The first part of the user test asked about the profile of the tester. Questions about the age, educational background, experience with public budgets and interactive visualisations were asked. The second part had questions about quantitative evaluation. For this, the users had to solve tasks and respond with the results they had. For this, a simulated workflow was used, where questions about the absolute values of chapters, an interpretation of the lines in the Over-Time-View and the best and worse borough of selected chapters was asked. In the last part, questions for qualitative evaluation were asked. The users should rate the usefulness of the views, legend and trend arrows. Further, the users

should rate the general user experience and the usefulness of BerlinViz. The questions used in this test are listed in Appendix D and Appendix E.

7.3 Evaluation

This section describes the tester profile and the evaluation of the quantitative and qualitative questions of the user test.

7.3.1 Tester Profile

The user test had seven participants. All, except one participant, who was older than 35 years, were between 25 and 35 years old. All of them had completed at least the high school. Four of them completed a master's degree and one of them a bachelor's degree. Most of the testers had none to basic knowledge of public budgets in Germany. Four of the participants had not much experience with interactive visualisations, whereas two of them had good experience with interactive visualisations.

7.3.2 Quantitative Evaluation

View	Task involved	avg errors
Hierarchy-View	4	2.0
Over-Time-View	5	2.8
Borough-Compare-View	6	2.5

Table 7.1 – Results of quantitative evaluation

From the 15 tasks the user should do, tasks involving the Over-Time-View have more errors than tasks involving the Borough-Compare-View. The results of the quantitative evaluation are shown in Table 7.1. From the four tasks involving the Hierarchy-View, trend arrows or budget table, in average 2.0 errors were done. From the five tasks involving the Over-Time-View in the average 2.8 errors were done. From the six tasks involving the Borough-Compare-View in average 2.5 errors were done. Most mistakes in the Borough-Compare-View were done, when the questioned item had a close derivation from the median as other items. In general, many errors were done, when using the relation to demography or unemployed people.

7.3.3 Qualitative Evaluation

View/Experience	1*	2*	3*	4*	5*	STD
Hierarchy-View	1	1	0	4	1	1.29
Over-Time-View	2	0	0	3	2	1.59
Borough-Compare-View	1	0	1	1	4	1.41
Population-View	2	0	2	0	3	1.67
Trend arrows	0	1	5	1	0	0.53
Legends	2	1	1	3	0	1.28
Experience	1	2	3	1	0	0.90
Usefullness	1	1	1	2	2	1.40

Table 7.2 – Results of qualitative evaluation

Additional to the quantitative evaluation, the users were asked to evaluate subjectively the usefulness and quality of the different views from 0 to 5, where 0 means awful and 5 means excellent. The results of the qualitative evaluation is shown in Table 7.2. Further, the users had the ability of individual comments about BerlinViz. Five of the users gave a rating of four to five for the usefulness of the Hierarchy-View navigation. Two users gave a rating of one or two. The standard deviation of the ratings is 1.29.

For the Over-Time-View, five users gave a rating of four to five. Two users gave a rating for this view of one. The standard deviation of the ratings is 1.59.

For the Borough-Compare-View, four users gave a rating of five, one user a rating of three and one user a rating of one. The standard deviation of the ratings is 1.41.

The usefulness of the Population-View was rated by three users with five, by two users with three and by two users with one. The standard deviation of the ratings is 1.67.

The legends were rated by three users with four, by two users with one or two and by one user with three. The standard deviation of the ratings is 0.53.

The trend arrows were rated by five users with three, by one user with two and by one user with four. The standard deviation of the ratings is 1.28.

The general user experience was rated by three users with one or two, by three users with three and by one user with four. The standard deviation of the ratings is 0.90. The usefulness of BerlinViz was rated by four users with four to five, by one user with three and by one user with two. The standard deviation of the ratings is 1.40. In the individual commentaries, the users mentioned that they had difficulties with the user interface finding the options.

7.4 Conclusions

The usefulness of the views was considered, in general, a bit better then neutral, whereas the users considered the Borough-Compare-View as useful. The trend arrows did not appear to be useful for the users. The legends appeared to be less useful for the users. BerlinViz appeared to be a useful tool for the users, whereas the usability appeared bad.

8 CONCLUSIONS AND FUTURE WORK

This work shows, how computer science, political sciences, economy and law can be combined to facilitate the analysis of public budgets. In this work, more than 165635 rows of budget data and 17465 rows of demographic data were used, to create a visualisation of the public budgets from the year 2008 till 2015 of Berlin. For this, a complex database design, representing the hierarchies in the public budgets and the law regulations, was created. With the use of web technologies, easy access for the population was established. This work extended the available public visualisations of the public budgets of the state Berlin in Germany with comparisons over time, between the boroughs and the demographic structures. It also gives the comparison over time a better understanding by adding inflation adjusting and visualising trends. Compared to existing approaches, this work does not focus on absolute values, but on relative values, so that savings, policy changes, regional differences in spendings and efficiency of policies can be compared. With this work identifying groups of interest in the boroughs of Berlin, is achieved by using the demography of the boroughs of Berlin. The user test showed that the users could use the Hierarchy View well to navigate through the boroughs. Also, they could distinguish well between the boroughs when the derivation from the median was not to close to other boroughs. The testers could also identify trends, with the Over-Time-View and the trend arrows, well. Although, adding relations to unemployment and demographic data was difficult for the testers. In the qualitative evaluation, the Borough-Compare-View was considered the most useful view, whereas the trend arrows appeared not to help the testers solving the tasks. Although the goal to give easy access to the data could just be achieved partially.

8.1 Formats of Public Data

The use of public data in this work was not without difficulties since the spreadsheets of the government were changing the columns of the spreadsheets so that for every spreadsheet, the parsing had to be altered. A unified format of the columns in the spreadsheets offered by the government could make further work on public budgets easier. Creating a table in the statistics database StatIS-BBB could be an option for the government to unify the budget data and create easier access for persons working with public budget data.

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8.2 Future Work

More economic and demographic filters can be added to extend this work. Also, this work can be extended to visualise the federal budget and the budgets of the other states of Germany. Also the usability, as the results of the user test showed, can be improved. The legends can be improved to be more useful for the user. To improve the Borough-Compare-View, a better determination of boroughs with a close derivation from the median can be done. To improve the Over-Time-View a better focus on small elements, which are growing less than the biggest item, can be done. Also, by adding calls and tenders, the visualisation of the actual budget can be improved, to see the remaining money in the chapters.

REFERENCES

BRAY, Tim. 2007. <https://upload.wikimedia.org/wikipedia/commons/0/02/ ScientificGraphSpeedVsTime.svg>. [Online; accessed 13-May-2015].

ALEGRE, M. de P. **Orcamento participativo**. 2015. <http://www2.portoalegre.rs.gov.br/op/>. [Online; accessed 13-May-2015].

ANDREWS, K.; HEIDEGGER, H. Information slices: Visualising and exploring large hierarchies using cascading, semi-circular discs. In: **Proc of IEEE Infovis' 98 late breaking Hot Topics**. [S.l.: s.n.], 1998. p. 9–11.

BERLIN-BRANDENBURG, A. für S. **StatIS-BBB**. 2015. <https://www. statistik-berlin-brandenburg.de/statis/login.do?guest=guest>. [Online; accessed 13-May-2015].

BERLIN, S. für F. **Haushaltsplan**. 2015. <http://www.berlin.de/sen/finanzen/haushalt/ downloads/>. [Online; accessed 13-May-2015].

BMF. **Bundeshaushalt.info**. 2015. <http://www.bundeshaushalt-info.de/startseite.html>. [Online; accessed 13-May-2015].

BOSTOCK, M. **"D3JS"**. 2015. <http://d3js.org/>. [Online; accessed 13-May-2015].

BRAY, T. The javascript object notation (json) data interchange format. 2014.

BUNDESAMT, S. **GENESIS**. 2015. <https://www-genesis.destatis.de/genesis/online?__site= >. [Online; accessed 13-May-2015].

COMMONS, W. <https://upload.wikimedia.org/wikipedia/commons/2/2c/Disk_usage_ %28Boabab%29.png>. [Online; accessed 13-May-2015].

COMMONS, W. 2008. <https://upload.wikimedia.org/wikipedia/commons/8/8b/Tree_Map. png>. [Online; accessed 13-May-2015].

D3NOOB.ORG. <http://2.bp.blogspot.com/-pAOa7d8OOXo/UtIDvAcPMwI/ AAAAAAAAAhw/x3KZOlVdUYY/s1600/tree-01.png>. [Online; accessed 13-May-2015].

DIMITROVA LUCY CHAMBERS, F. L. V. **OpenSpending.mobi**. 2015. <http: //community.openspending.org/research/mobi/>. [Online; accessed 13-May-2015].

EICH, B. **Javascript**. 2015. <https://developer.mozilla.org/en-US/docs/Web/JavaScript/ Reference>. [Online; accessed 13-May-2015].

ELLIS, G.; DIX, A. A taxonomy of clutter reduction for information visualisation. **Visualization and Computer Graphics, IEEE Transactions on**, IEEE, v. 13, n. 6, p. 1216–1223, 2007.

FIELDING, R. et al. Rfc 2616, hypertext transfer protocol–http/1.1, 1999. **URL http://www. rfc. net/rfc2616. html**, 2009.

FOUNDATION", M. C. M. **"MariaDB"**. 2015. <https://mariadb.org/>. [Online; accessed 13-May-2015].

FOUNDATION, P. S. **Python"**. 2014. <https://www.python.org/>. [Online; accessed 13-May-2015].

FOUNDATION, T. D. **LibreOffice**. 2015. <http://de.libreoffice.org/>. [Online; accessed 13-May-2015].

GROUP, T. P. **PHP**. 2015. <https://php.net/>. [Online; accessed 13-May-2015].

HGRG:HAUSHALTSGRUNDSäTZEGESETZ. 2013.

HUDSON, T. 2012. <https://upload.wikimedia.org/wikipedia/commons/f/f7/Australian_Census_2011_demographic_map_-_Australia_by_SLA_-_BCP_field_2715_Christianity_Anglican_Persons.svg>. [Online; accessed 13-May-2015].

JOHNSON, B. Treeviz: Treemap visualization of hierarchically structured information. In: **Proceedings of the SIGCHI Conference on Human Factors in Computing Systems**. New York, NY, USA: ACM, 1992. (CHI '92), p. 369–370. ISBN 0-89791-513-5. Disponível em: <http://doi.acm.org/10.1145/142750.142833>.

KEIM, D. et al. Efficient cartogram generation: A comparison. In: IEEE. **Information Visualization, 2002. INFOVIS 2002. IEEE Symposium on**. [S.l.], 2002. p. 33–36.

KIM, N. W. et al. Budgetmap: Issue-driven navigation for a government budget. In: ACM. **Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems**. [S.l.], 2015. p. 1097–1102.

LADD, H. F. Population growth, density and the costs of providing public services. **Urban Studies**, SAGE Publications, v. 29, n. 2, p. 273–295, 1992.

LHO:LANDESHAUSHALTSORDNUNG. 2009.

MERČUN, T.; ŽUMER, M. User perception of 4 hierarchical layouts. In: AMERICAN SOCIETY FOR INFORMATION SCIENCE. **Proceedings of the 76th ASIS&T Annual Meeting: Beyond the Cloud: Rethinking Information Boundaries**. [S.l.], 2013. p. 127.

OPENSPENDING. **OpenSpending**. 2015. <https://openspending.org/>. [Online; accessed 13-May-2015].

PENFIELD, D. 2010. <https://upload.wikimedia.org/wikipedia/commons/a/af/Scatter_diagram_for_quality_characteristic_XXX.svg>. Scatter diagram for quality characteristic XXX - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons[Online; accessed 13-May-2015].

PENFIELD, D. 2010. <https://upload.wikimedia.org/wikipedia/commons/c/c3/Histogram_of_arrivals_per_minute.svg>. "Example, showing frequencies of arrivals per minute [Online; accessed 13-May-2015]".

STASKO, J. et al. An evaluation of space-filling information visualizations for depicting hierarchical structures. **International Journal of Human-Computer Studies**, Elsevier, v. 53, n. 5, p. 663–694, 2000.

STASKO, J.; ZHANG, E. Focus+ context display and navigation techniques for enhancing radial, space-filling hierarchy visualizations. In: IEEE. **Information Visualization, 2000. InfoVis 2000. IEEE Symposium on**. [S.l.], 2000. p. 57–65.

STOEPEL, C. 2010. <https://upload.wikimedia.org/wikipedia/commons/3/30/Germany-population-cartogram.png>. [Online; accessed 13-May-2015].

TARSCHYS, D. Curbing public expenditure: current trends. **Journal of Public Policy**, Cambridge Univ Press, v. 5, n. 01, p. 23–67, 1985.

TEAM jQuery. **"jQuery"**. 2015. <http://www.jquery.com>. [Online; accessed 13-May-2015].

VAFOPOULOS, M. et al. Insights in global public spending. In: **Proceedings of the 9th International Conference on Semantic Systems**. New York, NY, USA: ACM, 2013. (I-SEMANTICS '13), p. 135–139. ISBN 978-1-4503-1972-0. Disponível em: <http://doi.acm.org/10.1145/2506182.2506201>.

VAFOPOULOS, M. N.; MEIMARIS, M. Weaving the economic linked open data. In: **7th Semantic and Social Media Adaptation and Personalization (SMAP) Workshop, Luxembourg City, Luxembourg**. [S.l.: s.n.], 2012. v. 3.

W3C. **HTML5**. 2015. <http://www.w3.org/TR/html/>. [Online; accessed 13-May-2015].

WARD, M. O. A taxonomy of glyph placement strategies for multidimensional data visualization. **Information Visualization**, SAGE Publications, v. 1, n. 3-4, p. 194–210, 2002.

WARD, M. O.; GRINSTEIN, G.; KEIM, D. **Interactive data visualization: foundations, techniques, and applications**. [S.l.]: CRC Press, 2010.

ZINOVYEV, A. Data visualization in political and social sciences. **arXiv preprint arXiv:1008.1188**, 2010.

APPENDICES

Appendix A - Implementation of Color Generation

```
var seed=31234123;
function random()
{
    var x = Math.sin(seed++) * 10000;
    return x - Math.floor(x);
}

function genColors(numcolor)
{
        var colors = Array();
        for(var i=0;i<numcolor;i++)
        {
            var r = random()*255;
            var g = random()*255;
            var b = random()*255;
                colors[i] = d3.rgb(r,g,b);
        }
        return colors;
}
```

Appendix B - Implementation of Inflation Calculation

```
function inflationCalc(rYear, beginYear, endYear, inflation)
{
    var rates = Array(rYear-beginYear+1);
    rates[rYear-beginYear]=1.0;
    if(rYear>=beginYear)
    {
        var i;
        for(i=parseInt(rYear)-1;i>=beginYear;i--)
        {
            if(typeof(inflation[i-beginYear])!="undefined")
            {
                var rate=parseFloat(inflation[i-beginYear].rate);
                var infl=1.0+rate/100.0;
                rates[i-beginYear]=(infl)*rates[i-beginYear+1];
            }
            else
            {
                rates[i-beginYear]=1.0*rates[i-beginYear+1];
            }
        }
        for(i=parseInt(rYear)+1;i<=endYear;i++)
        {
            if(typeof(inflation[i-beginYear])!="undefined")
            {
                var rate=parseFloat(inflation[i-beginYear].rate);
                var infl=1.0-rate/100.0;
                rates[i-beginYear]=infl*rates[i-beginYear-1];
            }
            else
            {
                rates[i-beginYear]=1.0*rates[i-beginYear-1];
            }
        }
    }
    else
    {
        for(var i=year;i<=endYear;i++)
        {
            var rate=parseFloat(inflation[i-beginYear].rate);
            var infl=1.0-rate/100.0;
            rates[i-beginYear]=infl*rates[i-beginYear-1];
        }
    }
        return rates;
```

}

Appendix C - Implementation of Trendslope Calculation

```
function computeTrend(rYear, beginYear, endYear, data)
{
  data = data.filter(function(d){
    if(parseInt(d.jahr)<=rYear)
    {
      return true;
    }
    return false;
  });
  var a = data.length * data.reduce(function(prev,current,i){
    return prev + ((i+1) * current.gesamt);
  },0);

  var b = data.reduce(function(prev,current,index){
    return prev + current.gesamt;
  },0) * data.reduce(function(prev,current,i){
    return prev + (i+1);
  },0);

  var c = data.length * data.reduce(function(prev,current,i){
    return prev + (i+1)*(i+1);
  },0);

  var d = data.reduce(function(prev,current,i,array){
    return prev + (i+1);
  },0);
  d=d*d;

  return (a-b)/(c-d);
}
```

Appendix D - Questions for User Test

UserTest des visuellen Analysetools BerlinViz

Allgemeine Benutzerinformationen

* Erforderlich

1. **Wie alt sind Sie? ***
   Markieren Sie nur ein Oval.

   - ◯ jünger als 16
   - ◯ 16 bis 18
   - ◯ 19 bis 24
   - ◯ 25 bis 34
   - ◯ älter als 35

2. **Welchen Bildungsabschluss haben Sie? ***
   Markieren Sie nur ein Oval.

   - ◯ Realschule/Hauptschule
   - ◯ Abitur
   - ◯ Bachelor
   - ◯ Master/Diplom/Staatsexamen
   - ◯ Doktor

3. **Wie viel Erfahrung haben Sie mit öffentlichen Haushalten ***
   Markieren Sie nur ein Oval.

	1	2	3	4	5	
wenig	◯	◯	◯	◯	◯	viel

4. **Wie viel Erfahrung haben Sie mit interaktiven Visualisierungen? ***
   Markieren Sie nur ein Oval.

	1	2	3	4	5	
wenig	◯	◯	◯	◯	◯	viel

Über BerlinViz

7. **Wie hoch waren die Ausgaben im Staat Berlin in der Oberfunktion ("Arbeitsmarktpolitk(25)") im Jahr 2013? Wenn nicht ersichtlich 0 eingeben. ***

Hauptfunktion "Soziale Sicherung, Familie und Jugend, Arbeitsmarktpolitik(2)" -> Oberfunktion "Arbeitsmarktpolitik(25)"

....

8. **Wie hoch waren die Ausgaben im Staat Berlin in der Oberfunktion ("Arbeitsmarktpolitk(25)") in der Legislaturperiode 2011-2016 im Jahr 2013 inflationsbereinigt? ***

Hauptfunktion "Soziale Sicherung, Familie und Jugend, Arbeitsmarktpolitik(2)" -> Oberfunktion "Arbeitsmarktpolitik(25)"
Markieren Sie nur ein Oval.

( ) sinkend

( ) stagnierend

( ) steigend

( ) Kein Ergebnis

9. **Wie hoch waren die Ausgaben im Staat Berlin in der Oberfunktion ("Arbeitsmarktpolitk(25)") in der Legislatur 2011-2016 im Jahr 2013 runtergerechnet auf die männlichen Arbeitslosen? Wenn nicht ersichtlich 0 eingeben ***

Hauptfunktion "Soziale Sicherung, Familie und Jugend, Arbeitsmarktpolitik(2)" -> Oberfunktion "Arbeitsmarktpolitik(25)"

....

10. **Wie hoch waren die Ausgaben im Staat Berlin in der Funktion "Öffentliche berufliche Schulen(127)" in der Legislatur 2011-2016 im Jahr 2014? Wenn nicht ersichtlich 0 eingeben. ***

Hauptfunktion "Bildungswesen, Wissenschaft, Forschung, kulturelle Angelegenheiten(1)" -> Oberfunktion "Allgemeinbildende und berufliche Schule(12)" -> Funktion "Öffentliche berufliche Schulen(127)"

....

11. **Wie hoch waren die Ausgaben im Staat Berlin in der Funktion "Öffentliche berufliche Schulen(127)" in der Legislatur 2011-2016 im Jahr 2014 runtergerechnet auf die Bevölkerungsgruppe zwischen 17 und 25 Jahren? Wenn nicht ersichtlich 0 eingeben. ***

Hauptfunktion "Bildungswesen, Wissenschaft, Forschung, kulturelle Angelegenheiten(1)" -> Oberfunktion "Allgemeinbildende und berufliche Schule(12)" -> Funktion "Öffentliche berufliche Schulen(127)"

....

12. **Welcher Bezirk hat die meisten Einnahmen im Titel ("Zuweisungen für Investitionen(38530)" in der Legislatur 2011-2016 im Jahr 2014? ***

Einzelplan "Allgemeine Finanzangelegenheiten(45)" -> Kapitel "Allgemeine Finanzangelegenheiten(4500)" -> Titel "Zuweisungen für Investitionen(38530)"
Markieren Sie nur ein Oval.

- ◯ Mitte
- ◯ Friedrichshain-Kreuzberg
- ◯ Pankow
- ◯ Charlottenburg-Wilmersdorf
- ◯ Spandau
- ◯ Steglitz-Zehlendorf
- ◯ Tempelhof-Schöneberg
- ◯ Neukölln
- ◯ Treptow-Köpenick
- ◯ Marzahn-Hellersdorf
- ◯ Lichtenberg
- ◯ Reinickendorf
- ◯ Kein Ergebnis

13. **Wie ist der Trend für die kommenden Jahre im Einnahmetitel ("Zuweisungen für Investitionen(38530)") in der Legislatur 2011-2016 im Jahr 2014?) ***

Einzelplan "Allgemeine Finanzangelegenheiten(45)" -> Kapitel "Allgemeine Finanzangelegenheiten(4500)" -> Titel "Zuweisungen für Investitionen(38530)"
Markieren Sie nur ein Oval.

- ◯ Positiv
- ◯ Negativ
- ◯ Kein Ergebnis

14. **Wie ist der Trend der Oberfunktion "Politische Führung und Zentrale Verwaltung" inflationsbereinigt in allen Legislaturperioden zwischen den Jahren 2008-2015?** *

Hauptfunktion "Allgemeine Dienste(0)" -> Oberfunktion "Politische Führung und Zentrale Verwaltung"
Markieren Sie nur ein Oval.

- ◯ sinkend
- ◯ steigend
- ◯ Kein Ergebnis

15. **Wie hat sich der Bezirk Neukölln im Vergleich zum Medianbezirk zwischen den Jahren 2011-2014 im Einzelplan "Schule, Bildung und Kultur(37)" entwickelt?** *

Einzelplan "Schule, Bildung und Kultur(37)"
Markieren Sie nur ein Oval.

- ◯ Schlechter als der Median
- ◯ Median
- ◯ Besser als der Median
- ◯ Kein Ergebnis

16. **Welcher Bezirk hat absolut die meisten Minderjährigen** *

Altergruppe 0-17, beide Geschlechter zusammen.
Markieren Sie nur ein Oval.

- ◯ Mitte
- ◯ Friedrichshain-Kreuzberg
- ◯ Pankow
- ◯ Charlottenburg-Wilmersdorf
- ◯ Spandau
- ◯ Steglitz-Zehlendorf
- ◯ Tempelhof-Schöneberg
- ◯ Neukölln
- ◯ Treptow-Köpenick
- ◯ Marzahn-Hellersdorf
- ◯ Lichtenberg
- ◯ Reinickendorf
- ◯ Kein Ergebnis

17. **Welcher Bezirk hat absolut die wenigsten Minderjährigen** *

Altergruppe 0-17, beide Geschlechter zusammen.
Markieren Sie nur ein Oval.

◯ Mitte

◯ Friedrichshain-Kreuzberg

◯ Pankow

◯ Charlottenburg-Wilmersdorf

◯ Spandau

◯ Steglitz-Zehlendorf

◯ Tempelhof-Schöneberg

◯ Neukölln

◯ Treptow-Köpenick

◯ Marzahn-Hellersdorf

◯ Lichtenberg

◯ Reinickendorf

◯ Kein Ergebnis

18. **Welcher Bezirk hat absolut die wenigsten Rentner** *

Altergruppe 67-95+, beide Geschlechter zusammen.
Markieren Sie nur ein Oval.

◯ Mitte

◯ Friedrichshain-Kreuzberg

◯ Pankow

◯ Charlottenburg-Wilmersdorf

◯ Spandau

◯ Steglitz-Zehlendorf

◯ Tempelhof-Schöneberg

◯ Neukölln

◯ Treptow-Köpenick

◯ Marzahn-Hellersdorf

◯ Lichtenberg

◯ Reinickendorf

◯ Kein Ergebnis

19. **Welcher Bezirk hat absolut die meisten Rentner** *
Altergruppe 67-95+, beide Geschlechter zusammen.
Markieren Sie nur ein Oval.

- ◯ Mitte
- ◯ Friedrichshain-Kreuzberg
- ◯ Pankow
- ◯ Charlottenburg-Wilmersdorf
- ◯ Spandau
- ◯ Steglitz-Zehlendorf
- ◯ Tempelhof-Schöneberg
- ◯ Neukölln
- ◯ Treptow-Köpenick
- ◯ Marzahn-Hellersdorf
- ◯ Lichtenberg
- ◯ Reinickendorf
- ◯ Kein Ergebnis

Bewertung des Nutzungserlebnisses

20. **Wie nützlich fanden Sie die Kreisnavigation?** *
Markieren Sie nur ein Oval.

	1	2	3	4	5	
nicht nützlich	◯	◯	◯	◯	◯	sehr nützlich

21. **Wie nützlich fanden Sie die Zeitansicht** *
Markieren Sie nur ein Oval.

	1	2	3	4	5	
nicht nützlich	◯	◯	◯	◯	◯	sehr nützlich

22. **Wie nützlich fanden Sie die Bezirksvergleichsansicht?** *
Markieren Sie nur ein Oval.

	1	2	3	4	5	
nicht nützlich	◯	◯	◯	◯	◯	sehr nützlich

23. **Wie nützlich fanden Sie die Bevölkerungsansicht** *
Markieren Sie nur ein Oval.

	1	2	3	4	5	
nicht nützlich	◯	◯	◯	◯	◯	sehr nützlich

24. **Wie nützlich fanden Sie die Legenden** *
Markieren Sie nur ein Oval.

	1	2	3	4	5	
nicht nützlich	◯	◯	◯	◯	◯	sehr nützlich

25. **Wie nützlich fanden Sie die Trendpfeile** *
Markieren Sie nur ein Oval.

	1	2	3	4	5	
nicht nützlich	◯	◯	◯	◯	◯	sehr nützlich

26. **Wie fanden Sie das generell Benutzerlebnis von BerlinViz** *
Markieren Sie nur ein Oval.

	1	2	3	4	5	
nicht nützlich	◯	◯	◯	◯	◯	sehr nützlich

27. **Wie nützlich fanden Sie BerlinViz?** *
Markieren Sie nur ein Oval.

	1	2	3	4	5	
nicht nützlich	◯	◯	◯	◯	◯	sehr nützlich

28. **Was hat Ihnen gefallen und was nicht?** *

....

....

....

....

....

Appendix E - Translation into English of Questions

1. How old are you?

   - younger than 16 years
   - 16 to 18 years
   - 19 to 24 years
   - 25 to 34 years
   - older than 35 years

2. Which level of education do you have?

   - Middle School
   - High School
   - Bachelor degree
   - Master degree
   - Doctorate

3. How much experience do you have with public budgets?

   less 1 2 3 4 5 much

4. How much experience do you have with interactive visualisations?

   less 1 2 3 4 5 much

7. How much were the expenses of the main administration in the second level of the function hierarchy in "employment policies(25)" in the Legislation 2011-2016 in the year 2013

8. How much were the expenses of the main administration in the second level of the function hierarchy in "employment policies(25)" in the Legislation 2011-2016 in the year 2013 inflation adjusted? 0 When no answer.

9. How much were the expenses of the main administration in the second level of the function hierarchy in "employment policies(25)" in the Legislation 2011-2016 in the year 2013 in relation to male unemployed persons? 0 When no answer.

10. How much were the expenses of the main administration in the third level of the function hierarchy in "public professional schools(127)" in the Legislation 2011-2016 in the year 2014

11. How much were the expenses of the main administration in the third level of the function

hierarchy in "public professional schools(127)" in the Legislation 2011-2016 in the year 2014 in relation to persons between 17 and 25 years? 0 When no answer.

12. Which borough has the most income in the title "Allocations to investments(38530)" in the legislation 2011-2016 in the year 2014?

- Mitte
- Friedrichshain-Kreuzberg
- Pankow
- Charlottenburg-Wilmersdorf
- Spandau
- Steglitz-Zehlendorf
- Tempelhof-Schöneberg
- Neukölln
- Treptow-Köpenick
- Marzahn-Hellersdorf
- Lichtenberg
- Reinickendorf
- No Answer

13. How is the trend for the following years in the income title "Allocation to investments(38530)" in the legislation 2011-2016 with reference year 2014?

- positive
- negative
- no answer

14. How was the trend of the second level of the function hierarchy "Political administration and central administration" inflation adjusted in all legislation periods between the years 2008-2015?

- decreasing
- increasing

15. How was the development of the borough Neukölln in comparision to the borough median over the years 2011-2014 in the singlplan "School, Education and Culture"?

- Worse than the median

- Median
- Better than the median
- No Answer

16. Which borough has absolute the most underaged people?

    People between 0 and 17, both genders

    - Mitte
    - Friedrichshain-Kreuzberg
    - Pankow
    - Charlottenburg-Wilmersdorf
    - Spandau
    - Steglitz-Zehlendorf
    - Tempelhof-Schöneberg
    - Neukölln
    - Treptow-Köpenick
    - Marzahn-Hellersdorf
    - Lichtenberg
    - Reinickendorf
    - No Answer

17. Which borough has absolute the fewest underaged people?

    People between 0 and 17, both genders

    - Mitte
    - Friedrichshain-Kreuzberg
    - Pankow
    - Charlottenburg-Wilmersdorf
    - Spandau
    - Steglitz-Zehlendorf
    - Tempelhof-Schöneberg
    - Neukölln
    - Treptow-Köpenick
    - Marzahn-Hellersdorf
    - Lichtenberg

- Reinickendorf
- No Answer

18. Which borough has absolute the fewest pensioners?

People between 67 and 95+, both genders

- Mitte
- Friedrichshain-Kreuzberg
- Pankow
- Charlottenburg-Wilmersdorf
- Spandau
- Steglitz-Zehlendorf
- Tempelhof-Schöneberg
- Neukölln
- Treptow-Köpenick
- Marzahn-Hellersdorf
- Lichtenberg
- Reinickendorf
- No Answer

19. Which borough has absolute the most pensioners?

People between 67 and 95+, both genders

- Mitte
- Friedrichshain-Kreuzberg
- Pankow
- Charlottenburg-Wilmersdorf
- Spandau
- Steglitz-Zehlendorf
- Tempelhof-Schöneberg
- Neukölln
- Treptow-Köpenick
- Marzahn-Hellersdorf
- Lichtenberg
- Reinickendorf

- No Answer

20. How useful was the Hierarchy-View for you?

    not useful 1 2 3 4 5 very useful

21. How useful was the Over-Time-Compare-View for you?

    not useful 1 2 3 4 5 very useful

22. How useful was the Borough-Compare-View for you?

    not useful 1 2 3 4 5 very useful

23. How useful was the Population-View for you?

    not useful 1 2 3 4 5 very useful

24. How useful were the legends for you?

    not useful 1 2 3 4 5 very useful

25. How useful were the trend arrows for you?

    not useful 1 2 3 4 5 very useful

26. How was the user experience of BerlinViz for you?

    very bad 1 2 3 4 5 very good

27. How useful was BerlinViz for you?

    not useful 1 2 3 4 5 very useful

28. What did you like and what not?