Enterprise Information Systems Lab

Linked Data Visualization and Exploration Technical System Documentation

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[This document describes the technical system specification for implementing LinDa Visualization Web Application Software]

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Table of Contents

1. Generalities

1.1. Overview

The goal of this project is to improve some aspect of LinDa Visualization Tool. The aspect improved are: Key-based search in a tree; filtering for numerical fields from the tree and scrolling for the Data-Table. With this improvements the software will become more powerful and flexible for end-users' needs.

1.2. Reference

The following are the reference document names:

- Linked Data Visualization and Exploration Tools Requirement Presentation
- Linked Data Visualization and Exploration Tools Requirement Document
- Linked Data Visualization and Exploration Tools Architectural presentation
- Linked Data Visualization and Exploration Tools Use Case Presentation
- Linked Data Visualization and Exploration Tools Documentation Presentation

These documents are available on github. Below is the link:

https://github.com/EIS-Bonn/MA-INF3232-Lab-SS2015/tree/master/GroupD/Presentations

1.3. Definitions, Acronyms, Abbreviations

- SME: Small and Medium Enterprises.
- LinDA: Linked Data Analytics.
- RDF: Resource Description framework is a family of World Wide Web

Consortium (W3C) specifications used as a general method for conceptual description or modeling of information that is implemented in web resources, using a variety of syntax notations and data serialization formats.

- Data-Table: Any display of information in a tabular form, with rows and/or columns.
- Filtering: refers to a wide range of solutions for refining data sets.
- Dataset: A named collection of data that contains individual data units organized (formatted) in a specific way.
- Searching: Any data structure that allows the efficient retrieval of specific items from a set of items.
- Paging: Is a method of writing data to, and reading it from, secondary storage for use in primary storage, also known as main memory.
- Sorting: Is any process of arranging items systematically, and has two common, yet distinct meaning.

2. About LinDA Visualization Tool

The aim of the LinDA project is to make the benefits of Linked Open Data accessible to SMEs and data providers by providing libraries for Open Data consumption. One of the main tasks in this context is to build an ecosystem of tools for visualizing Linked Data to assist SMEs in their daily tasks by hiding complexity through automation and an intuitive user interface.

To complete this task, a generic visualization work-flow is being implemented based on state-of-the-art Linked Data visualization approaches. Most existing approaches are only usable by a technical audience or limited to certain domains or data representations. LinDA proposes a generic approach for visualization selection in form of a faceted browser that imposes on the user the task of describing the visualization at an unfamiliar level of abstraction.

3. Project Description

The project is aim at improving some aspect of LinDA Visualization Tool.

3.1. Use Case Diagram:

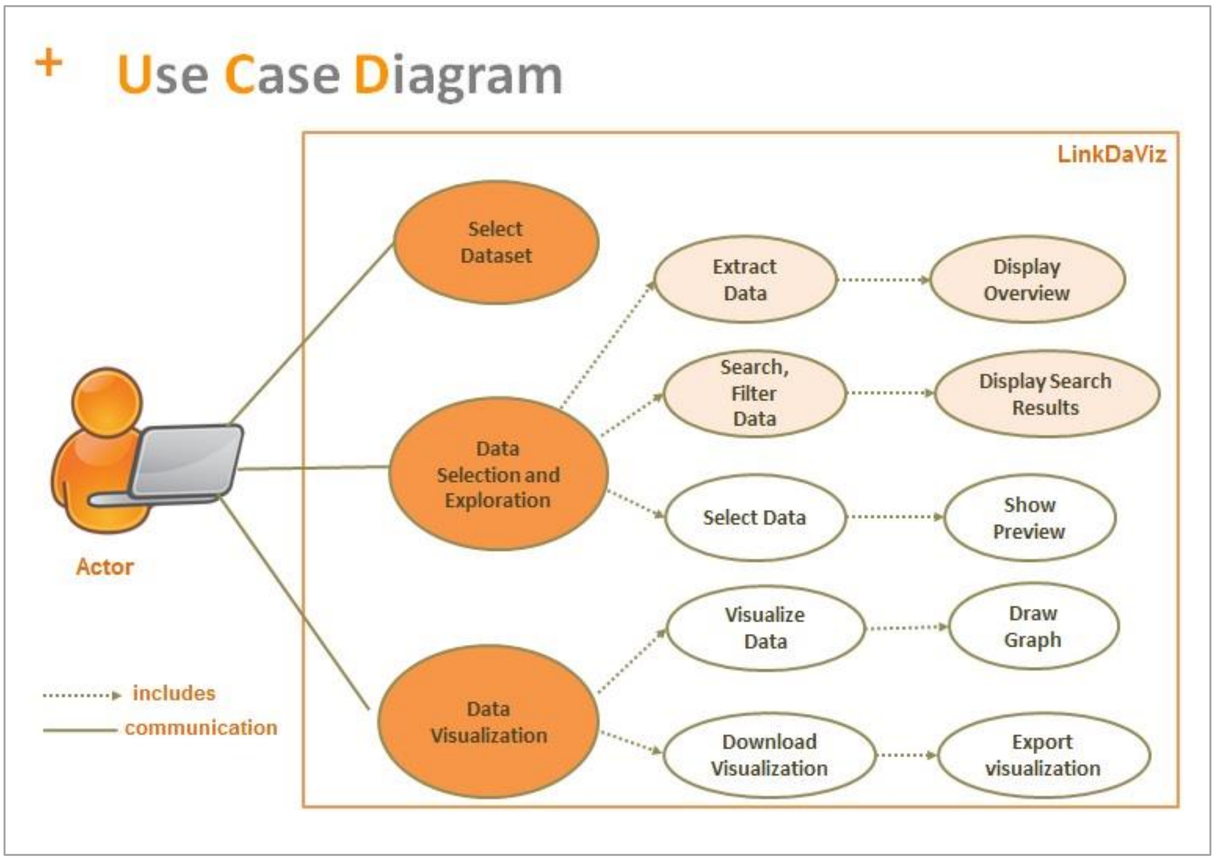


Image 1. Use case diagram

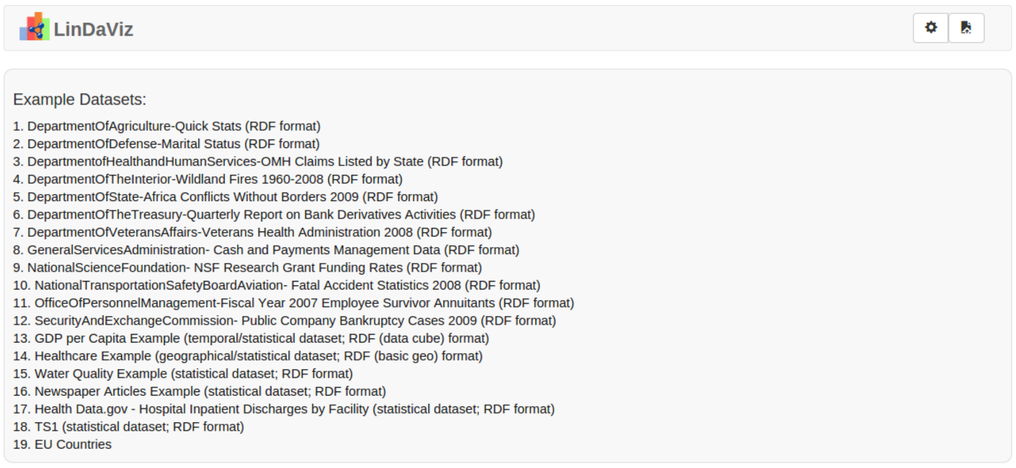
Actor: A UML element representing the role of a person, object or device that interacts with the system.

Use Case Diagram: A UML behavior diagram that visually describes the functional requirements of a proposed system and shows the relationships between Actors and Use Cases. A Use Case diagram is mainly formed by Actors, Use Cases and Associations (connectors).

3.2. Scenario:

STEP 0: Selecting a dataset

User selects a RDF dataset containing statistical data for exploration and visualization (Image 2).



Example Datasets:

1. DepartmentOfAgriculture-Quick Stats (RDF format)
2. DepartmentOfDefense-Marital Status (RDF format)
3. DepartmentofHealthandHumanServices-OMH Claims Listed by State (RDF format)
4. DepartmentOfTheInterior-Wildland Fires 1960-2008 (RDF format)
5. DepartmentOfState-Africa Conflicts Without Borders 2009 (RDF format)
6. DepartmentOfTheTreasury-Quarterly Report on Bank Derivatives Activities (RDF format)
7. DepartmentOfVeteransAffairs-Veterans Health Administration 2008 (RDF format)
8. GeneralServicesAdministration- Cash and Payments Management Data (RDF format)
9. NationalScienceFoundation- NSF Research Grant Funding Rates (RDF format)
10. NationalTransportationSafetyBoardAviation- Fatal Accident Statistics 2008 (RDF format)
11. OfficeOfPersonnelManagement-Fiscal Year 2007 Employee Survivor Annuitants (RDF format)
12. SecurityAndExchangeCommission- Public Company Bankruptcy Cases 2009 (RDF format)
13. GDP per Capita Example (temporal/statistical dataset; RDF (data cube) format)
14. Healthcare Example (geographical/statistical dataset; RDF (basic geo) format)
15. Water Quality Example (statistical dataset; RDF format)
16. Newspaper Articles Example (statistical dataset; RDF format)
17. Health Data.gov - Hospital Inpatient Discharges by Facility (statistical dataset; RDF format)
18. TS1 (statistical dataset; RDF format)
19. EU Countries

Image 2. List of datasets

STEP 1: Data selection and exploration

A preview is generated by the Data Tree consisting of classes (Image 3), their properties (Image 4) and a filter tab for choosing the exact data (Image 4).

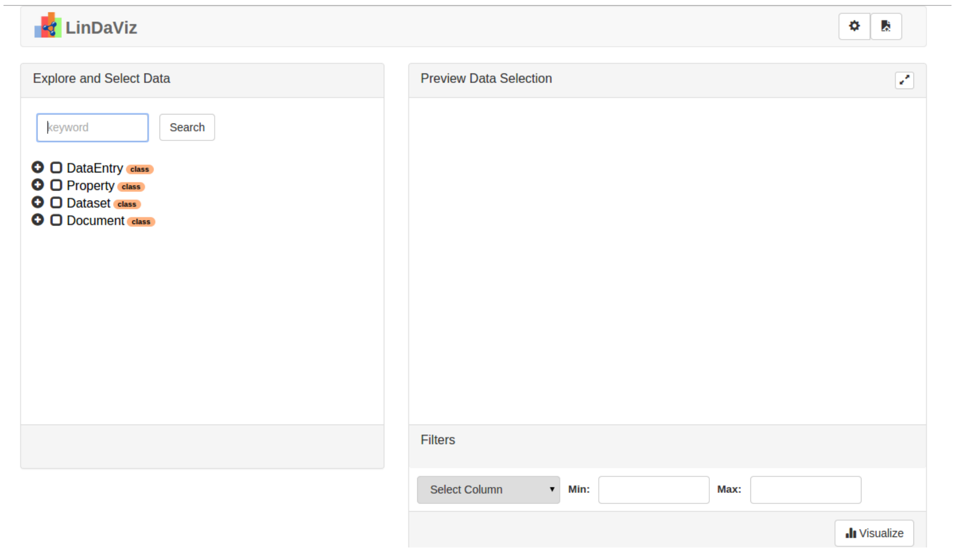
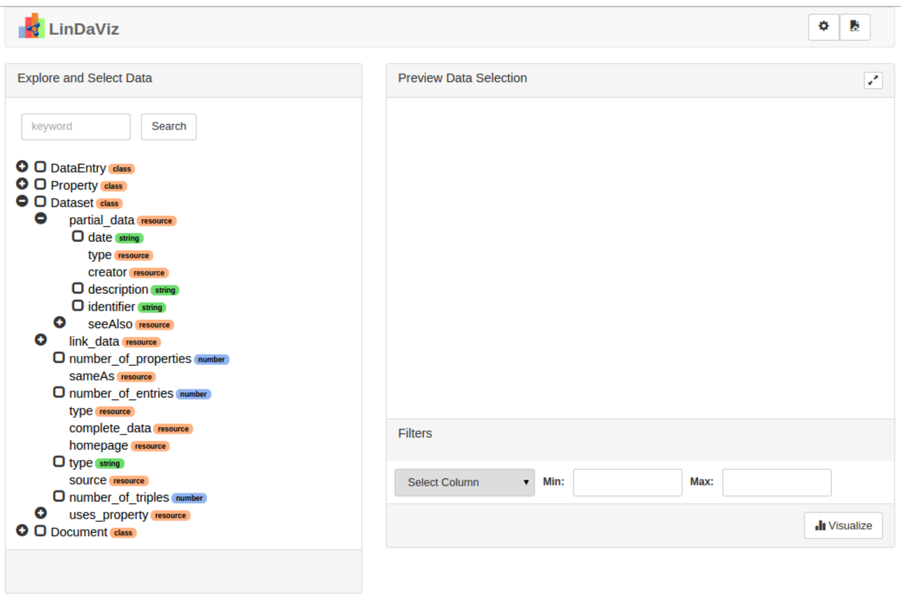
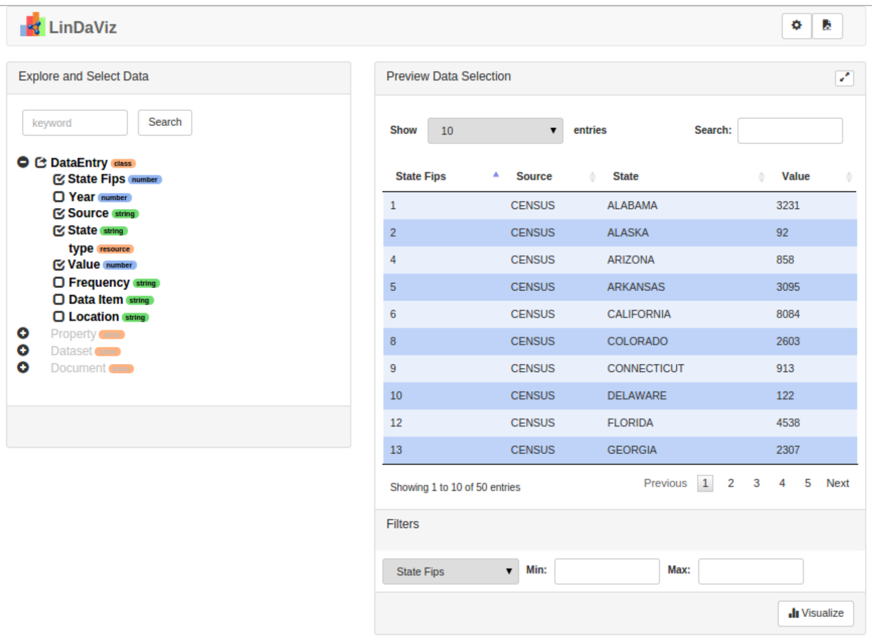


Image 3. Data Tree consisting of classes



- DataEntry class
- Property class
- Dataset class
  - partial_data resource
    - date string
    - type resource
    - creator resource
    - description string
    - identifier string
    - seeAlso resource
  - link_data resource
  - number_of_properties number
  - sameAs resource
  - number_of_entries number
  - type resource
  - complete_data resource
  - homepage resource
  - type string
  - source resource
  - number_of_triples number
  - uses_property resource
- Document class

Image 3. Data Tree consisting of classes and properties



- DataEntry class
  - [✓] State Fips number
  - Year number
  - [✓] Source string
  - [✓] State string
  - type resource
  - [✓] Value number
  - Frequency string
  - Data Item string
  - Location string
- Property
- Dataset
- Document

State Fips	Source	State	Value
1	CENSUS	ALABAMA	3231
2	CENSUS	ALASKA	92
4	CENSUS	ARIZONA	858
5	CENSUS	ARKANSAS	3095
6	CENSUS	CALIFORNIA	8084
8	CENSUS	COLORADO	2603
9	CENSUS	CONNECTICUT	913
10	CENSUS	DELAWARE	122
12	CENSUS	FLORIDA	4538
13	CENSUS	GEORGIA	2307

Showing 1 to 10 of 50 entries

Filters: State Fips

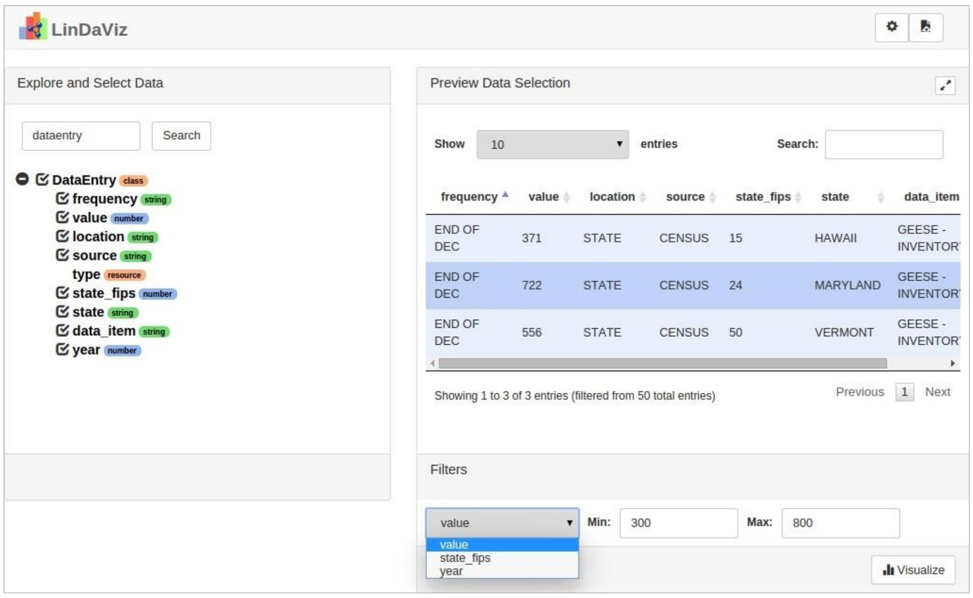
Image 4. Filter tab for choosing extract data

STEP 2: Data filtering/searching

The User inspects the Data Tree and proceeds with filtering the data properties from classes he/she is interested in and by searching for classes, properties and subproperties containing a certain keyword.

Filtering:

A user selects data which he wants to visualize, the data appears in a data table, and the filter dropdown list is being filled with corresponding column names.


LinDaViz

Explore and Select Data

dataentry Search

- DataEntry class
  - frequency string
  - value number
  - location string
  - source string
  - type resource
  - state_fips number
  - state string
  - data_item string
  - year number

Preview Data Selection

Show 10 entries Search:

frequency	value	location	source	state_fips	state	data_item
END OF DEC	371	STATE	CENSUS	15	HAWAII	GEESE - INVENTOR
END OF DEC	722	STATE	CENSUS	24	MARYLAND	GEESE - INVENTOR
END OF DEC	556	STATE	CENSUS	50	VERMONT	GEESE - INVENTOR

Showing 1 to 3 of 3 entries (filtered from 50 total entries) Previous 1 Next

Filters

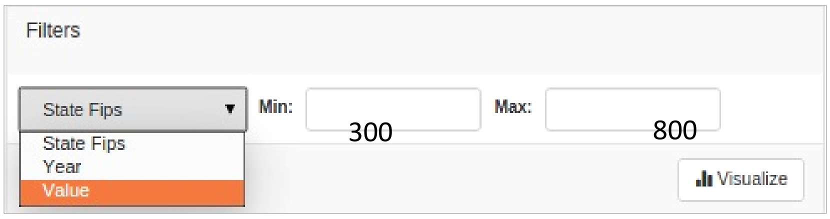
value Min: 300 Max: 800

value
state_fips
year

Visualize

Image 5. List item

Then a user chooses a list item (Image 5), types in min and max values and sees how the table changes in real-time according to the selected criteria (Image 6).


Filters

State Fips Min: 300 Max: 800

State Fips
Year
Value

Visualize

Image 5. Filter parameters

Searching:

A user types a keyword in a text field and presses a button “search” if there is such word in the dataset then a new tree with search results will be displayed (Image 6), otherwise “No matches” will be displayed (Image 7). If the user enters too short word, a hint will be displayed (Image 8).

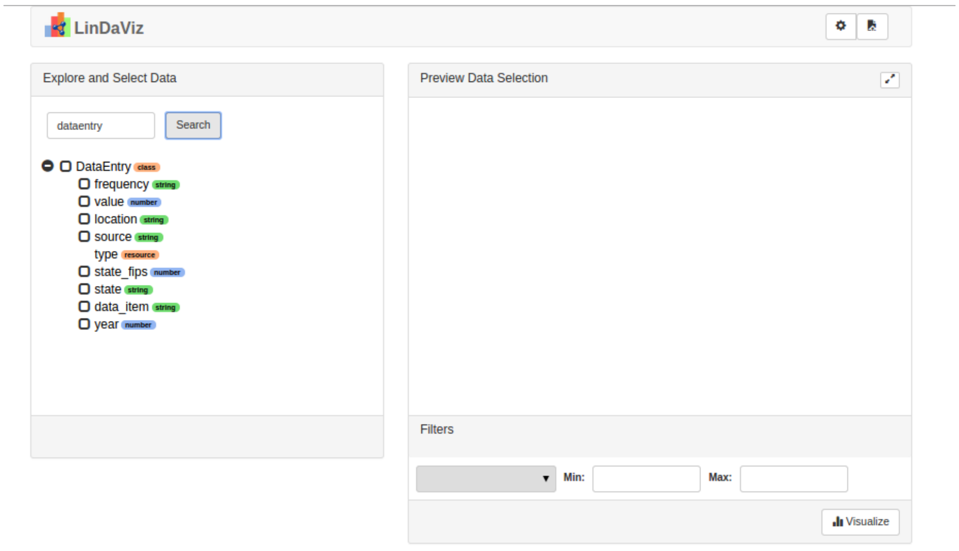


Image 6. Search results

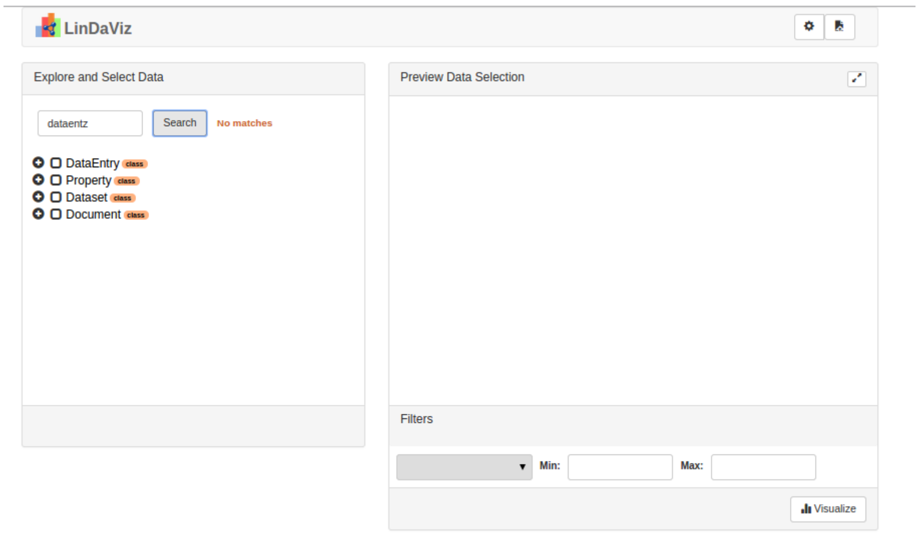
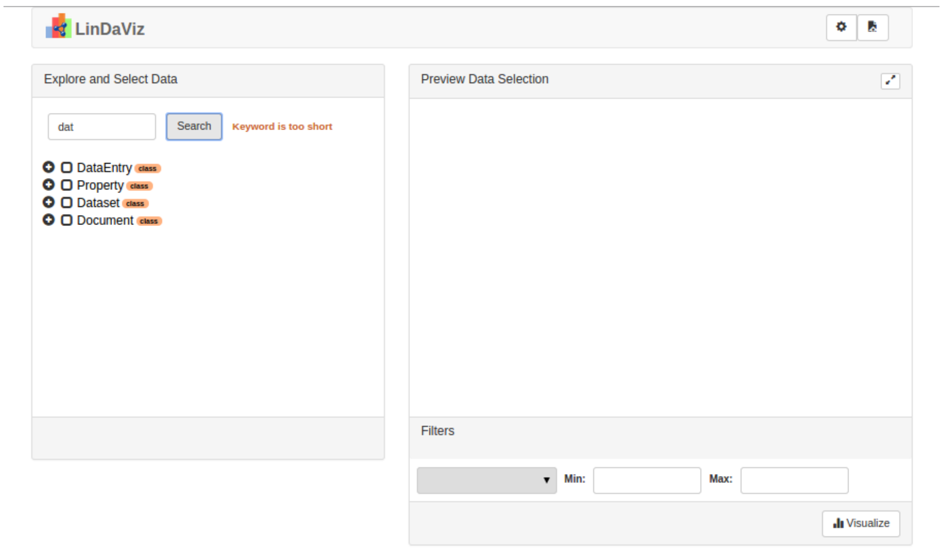


Image 7. Keyword was not found

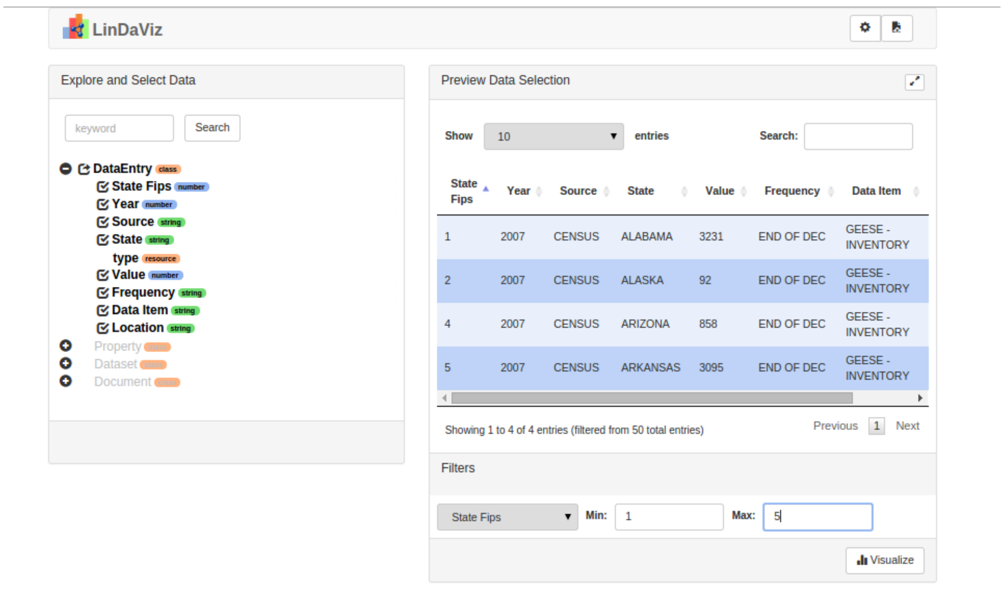


Keyword is too short

Image 8. Keyword is too short

STEP 3: Data table overview

The data properties are computed and showed to a User as a table. If there is more than 7 columns, the table becomes scrollable (Image 9).



State Fips	Year	Source	State	Value	Frequency	Data Item
1	2007	CENSUS	ALABAMA	3231	END OF DEC	GEESE - INVENTORY
2	2007	CENSUS	ALASKA	92	END OF DEC	GEESE - INVENTORY
4	2007	CENSUS	ARIZONA	858	END OF DEC	GEESE - INVENTORY
5	2007	CENSUS	ARKANSAS	3095	END OF DEC	GEESE - INVENTORY

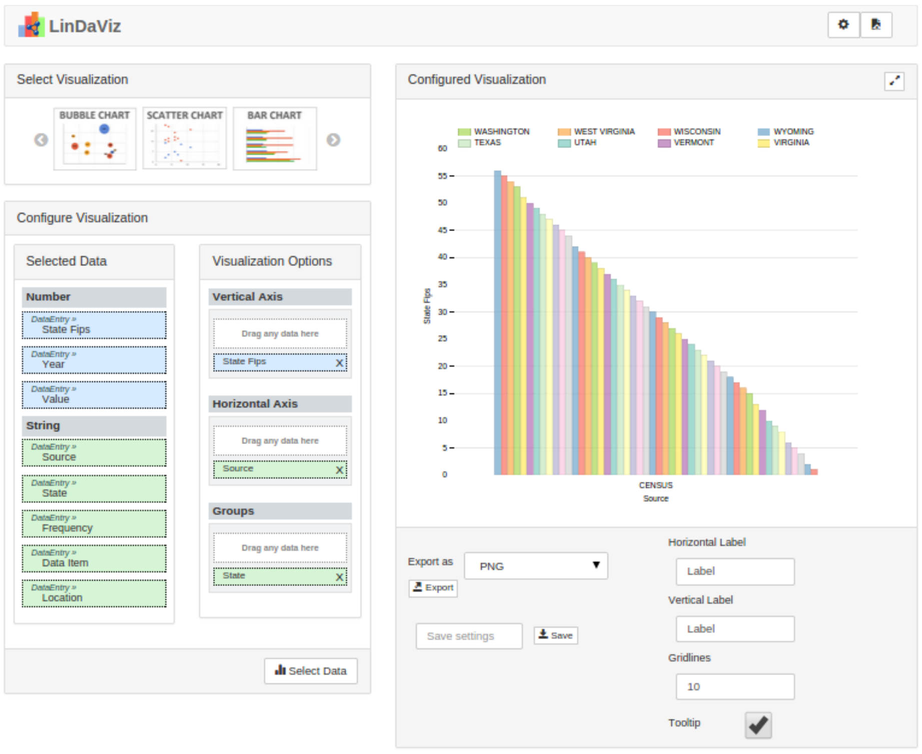
Showing 1 to 4 of 4 entries (filtered from 50 total entries)

Previous 1 Next

Image 9. Horizontal scrolling

STEP 4: Visualizing the data

The User inspects the results and proceeds with configuring and visualizing the selection (Image 10).



Vertical Axis: Drag any data here; State Fips

Horizontal Axis: Drag any data here; Source

Groups: Drag any data here; State

Export as: PNG

Horizontal Label: Label

Vertical Label: Label

Gridlines: 10

Tooltip: ✓

Image 10. Visualization

4. Requirements

4.1. Functional Requirements:

REQ_ID	REQ_NAME	DESCRIPTION	PRIORITY
1	**Display overview**	Improvement of display overview by decreasing the number of columns in the data table	3
2	**Sorting**	Provide sorting for the Data Tree (e.g. by A-Z)	3
3	**Filtering**	Provide filtering for the data properties from the Data Tree	1
4	**Searching**	Provide means for searching by keywords	1
5	**Hiding/Loading**	Provide the possibility to hide/load classes in the Data Tree for improving the Tree overview	2
6	**Export data**	Data table export selection to .csv format	3

4.2. Non - Functional requirements:

REQ_ID	REQ_NAME	DESCRIPTION	PRIORITY
2	**Data table scalability**	The ability to scale large data in order to get the full overview. (e.g. by scrolling)	1
3	**Usability (Search, Filter data)**	Easy to use search for filtering classes and properties	1
4	**Technical System Documentation**	The document must contain the whole procedure of testing (quick-reference guides)	1
7	**Backup**	The ability to restore the original data after the loss (copying, archiving)	4
8	**Robustness**	The ability of the system to deal with errors and normally operate despite abnormalities in input, calculations	5

5. Technical Software Requirement

5.1. Software Aspects

The following are the software requirement for LinDA visualization tool:

- Git
- Nodejs
- Emberjs
- Virtuoso 7
- Bower
- LinDA
- Ubuntu
- Nodemon

6. Operational Specification

6.1. Installing Git

The git can be installed by the following command in Ubuntu:

sudo apt-get install git-core

Git is mainly used to download the LinDA software from the GitHub repository.

6.2. Installing NodeJS

The following commands are used to install Nodejs in Ubuntu:

sudo apt-get update

sudo apt-get install nodejs

sudo apt-get install npm

npm install –g nodemon

6.3. Installing EmberJS

The link below is where you can steps for installing emberjs:

http://guides.emberjs.com/v1.12.0/getting-started/

Ember.js installs through the npm. Install the Ember.js build tools with npm.

The following commands are used to install Emberjs in Ubuntu:

npm install -g ember-cli

6.4. Installing Virtuoso 7

- Virtuoso 7 can be downloaded from the below link:

  http://sourceforge.net/projects/virtuoso/files/virtuoso/7.1.0/

- Navigate to the downloaded folder.

- Extract the package.

- Run the following comand in Ubuntu:

sudo apt-get install libssl-dev

- Go the extracted package location. It is better to run autogen.sh by typing ./autogen.sh, which checks for the presence and right version of some of the required components, and if it reports any missing package then, install that package.
- Set following environmental variable by typing

CFLAGS=”-O2”

export CFLAGS

- Execute ‘./configure’ command to configure the package for your system.
- Execute ‘sudo make’ command to compile the package
- Type `sudo make install’ to install the programs and any data files and documentation.
- Start the Virtuoso Server by the following step:

sudo /usr/local/virtuoso-7.1.0/bin/virtuoso-t +config /usr/local/virtuoso-7.1.0/var/lib/virtuoso/db/virtuoso.ini

6.5. Installing Bower

The link below is where you can steps for installing bower:

Bower installs through the npm. Install the Ember.js build tools with npm.

The following commands are used to install Bower in Ubuntu:

npm install -g bower

Bower depends on Nodejs and npm. Also make sure that git is installed as some bower packages require it to be fetched and installed.

6.6. Installing LinDA Visualization

The LinDA Visualization tool can be installed in Ubuntu by the following commands:

```
git clone https://github.com/LinDA-tools/visualisation.git
cd visualisation/frontend
npm install
bower install
cd ../backend
npm install
```

The LinDA can be started by the following commands:

```
nodemon & (from linda-viz-be)
ember server (from linda-viz-fe)
sudo /usr/local/virtuoso-7.1.0/bin/virtuoso-t +config /usr/local/virtuoso-
7.1.0/var/lib/virtuoso/db/virtuoso.ini
```

6.7. Installing Nodemon

Nodemon is installs through the npm. Install the Nodemon build tools with npm.

The following commands are used to install Nodemon in Ubuntu:

```
npm install Nodemon
```

6.8. Docker

As showed on Image 1, Docker allows you to package an application with all of its dependencies into a standardized unit for software development. Docker containers wrap up a piece of software in a complete file system that contains everything it needs to run: code, runtime, system tools, system libraries – anything you can install on a server. This guarantees that it will always run the same, regardless of the environment it is running in.

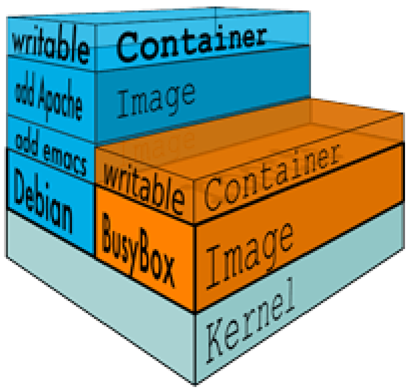


Image 1

7. List of Datasets

- Department of agriculture – Quick Stats

  Type: rdf

  Source: *http://www.linda-project.org/examples/DepartmentOfAgriculture-QuickStats.nt*

- Department of defense – Marital status

  Type: rdf

  Source: *http://www.linda-project.org/examples/DepartmentOfDefense-MaritalStatus.nt*

- Department of health and human services – OMH claims listed by state

  Type: rdf

  Source: *http://www.linda-project.org/examples/DepartmentofHealthandHumanServices-OMHClaimsListedbyState.nt*

- Department of the interior – Wildland fires 1960-2008

  Type: rdf

  Source:http://www.linda-project.org/examples/DepartmentOfTheInterior-WildlandFiresand1960-2008.nt

- Department of state Africa conflicts without borders 2009

  Type: rdf

  Source:http://www.linda-project.org/examples/DepartmentofState-AfricaConflictsWithoutBorders2009.nt

- Department of the treasury quarterly report on bank derivatives a ctivities

  Type: rdf

  Source:http://www.linda-project.org/examples/DepartmentOfTheTreasury-QuarterlyReportonBankDerivativesActivities.nt

- Department of veterans affairs veterans health administration 2008

  Type: rdf

  Source:http://www.linda-project.org/examples/DepartmentOfVeteransAffairs-VeteransHealthAdministration2008.nt

- General services administration cash and payments management da ta

  Type: rdf

  Source:http://www.linda-project.org/examples/GeneralServicesAdministration-CashandPaymentsManagementData.nt

- National science foundation NSF research grant funding rates

  Type: rdf

  Source:http://www.linda-project.org/examples/NationalScienceFoundation-NSFResearchGrantFundingRates.nt

- National transportation safety board aviation accidents, fatalities, a nd rates, 2008

  Type: rdf

  Source:http://www.linda-project.org/examples/NationalTransportationSafetyBoardAviation-AccidentStatistics2008.nt

- Office of personnel management fiscal year 2007 employee and survivor annuitants by geographic distribution

  Type: rdf

  Source:http://www.linda-project.org/examples/OfficeofPersonnelManagement-FiscalYear2007EmployeeSurvivorAnnuitants.nt

- Security and exchange commission public company bankruptcy case s opened and monitored for fiscal year 2009

Type: rdf

Source:http://www.linda-project.org/examples/SecurityAndExchangeCommission-PublicCompanyBankruptcyCases2009.nt

- GDP per capita example

  Type: rdf (data cube)

  Source: http://www.linda-project.org/examples/worldbank-slice-5000

- Healthcare example

  Type: rdf

  Source: http://www.hospitals_reviewer.com/2014

- Water quality example

  Type: rdf

  Source: http://water_quality_check.it/info

- Newspaper articles example

  Type: rdf

  Source: http://newspaper.org/articles_2007

- Heakth data.gov – Hospital inpatient distarges by facility

  Type: rdf

  Source: http://HealthData.govHospitalInpatientDischargesbyFacility

- TS1

  Type: rdf

  Source: http://www.linda-project.org/TS1_LinearRegression_Result_Original

- EU countries

Type: rdf

Source: [*http://eucountries.org*](http://eucountries.org)

8. Implementation

8.1. Horizontal Scrolling

As we simulate a work-flow to see the behavior of the data-table; we discover that as a dataset is selected while the instance data property is queried from the back-end and display as a column on the right side, the more data you select the larger the table gets and grows out of proportion.

Our task is to look at how to improve on this. We introduced horizontal scrolling in the data-table since there was already a data-source controller and handler template. We implemented this in the data-table component of the LinDA project that is basically an integrated JavaScript plug-in which is used to generating preview. We achieved this through data-table examples extension. This will enable users view hidden columns.

8.2. Keyword-based search

There may be occasions when a user wants to find a keyword in a data tree. As soon as the user typed the keyword and pressed a button “Search” *‘search action’* in datasource.js controller is activated. It invokes a function *search* in tree-selection-data-module.js. Then there is checking of a length of the keyword. If the length is more than 0 and less than 4, a hint „Keyword is too short“ is displayed . If the length is 0, null is returned and an initial tree is displayed. Otherwise, a promise is returned and *fullTextSearch* function from sparql-data-module.js is invoked. A SPARQL query with the keyword is executing and after execution the results are got. The next step is parsing the results in a tree structure as the initial tree has. There are two steps: 1) *find children* function for properties and subproperties; 2) creating roots (classes) and adding children there; Roots are returned as the result of *fullTextSearch* function (in sparql-data-module.js) and *createSearchResultTreeContent* function (in tree-selection-data-module.js) is invoked and after executing results for visualization are returned. If the word was not found and there are no results then functions *queryClasses* (in sparql-data-module.js) and *createTreeContent* (in tree-selection-data-module.js) are invoked and the initial tree with a hint “No matches” is displayed.

SPARQL query:

There is a search in:

- Classes’ labels;
- Properties’ labels;
- Subproperties’ labels;
- Instances of classes’ labels;
- Instances of properties’ labels;
- Instances of subproperties’ labels;
- Classes’ URIs;
- Properties’ URIs.

Difficulty: there are different results for bif:contains and FILTER(contains).

Example:

- ?classLabel bif:contains \'"' + term + '*"\' .';
- FILTER(contains(?classLabel, "' + term + '")) ';

8.3. Interface Design and Functionality – Filtering

There may be occasions when the end user wishes to narrow down the data shown in the Data-Table based on specific criteria. A common example is the number range search (in between two numbers). DataTables[1] provides an API method `$.fn.dataTable.ext.search` that allows to implement custom search function in our project.

New filtering function with lower and upper limits for numeric columns in Linda Data Table was implemented.

[1] http://datatables.net - is a plug-in for the jQuery Javascript library.

9. Test cases

№	Functionality	Test case description	Expect results	Passed/ not passed
1	**Scrolling**	Agriculture dataset is chosen. Selecting the following fields from the tree from class Data Entry: value, year, state-fips, state, source, frequency, data item, location (number of columns is 8).	Horizontal scrolling is appeared.	**Passed**
		Agriculture dataset is chosen. Selecting the following fields from the tree from class Data Entry: value, year, state-fips, state, source, frequency and data item (number of columns is 7).	Horizontal scrolling is not appeared.	**Passed**
2	**Filtering**	Agriculture dataset is chosen. Selecting the following fields from the tree: value, year, state-fips, location and state. The filter drop-down list is being filled with only numerical items: value, year and state-fips.	The filter drop-down list contains only numerical fields. When the min and max values for one particular field are chosen, the data table changes automatically with corresponding limits.	**Passed**
		Agriculture dataset is chosen. Selecting the following fields	Deselecting some numerical fields,	**Passed**

		from the tree: value, year, state-fips, location and state. The filter drop-down list is being filled with only numerical items: value, year and state-fips. Deselecting value and year fields, the filter drop-down list will show only year field.	the filter drop-down list will show only fields which are selected in the tree.	
		Agriculture dataset is chosen. Selecting the following fields from the tree: value, year, state-fips, location and state. The filter drop-down list is being filled with only numerical items: value, year and state-fips. Firstly year field is chosen, min and max values are typed in, the data table changed automatically, then value field is chosen, min and max values are typed in, the data table changed automatically.	Changing selection of numerical fields will allow to type in min and max values again and the data table will change continuously, depending on what numerical field is now selected.	**Passed**
3	**Searching**	Agriculture dataset is chosen. The user types „dataentry“ in a text-field and press button „search“.	A new tree with search results is displayed: class Data Entry: with properties (value, year, state-fips, state, source, frequency, data item, location).	**passed**

		Agriculture dataset is chosen. The user types „dat“ in a text-field and press button „search“.	A hint “Keyword is too short” is displayed.	**Passed**
		Agriculture dataset is chosen. The user types „dataentrz“ in a text-field and press button „search“.	A hint “No matches” is displayed.	**Passed**
		Agriculture dataset is chosen. The user types „dataentry“ in a text-field and press button „search“ and then clears the text-field and press button “search”.	An initial tree is displayed.	**Passed**

External References

- https://datatables.net/reference/option/scrollX
- http://guides.emberjs.com/v1.12.0/getting-started/
- https://www.npmjs.com/package/bower
- http://sourceforge.net/projects/virtuoso/files/latest/download?source=files
- http://www.rdfdata.org/
- https://github.com/LinDA-tools/Visualization/tree/master/backend/testsets
- http://www.w3.org/wiki/DataSetRDFDumps