Visual Search Demonstrator – Elections Graph Semantic Web

(Report)

Stefan Velev, 0MI3400521

Introduction

The project presents a **visual search demonstrator** built using **Sparnatural**, a tool that enables intuitive **SPARQL query building** through a natural language-inspired interface. The goal of the project is to provide an accessible, user-friendly way to explore and analyse election-related data stored in **GraphDB** – a semantic graph database.

The application connects to an **RDF** dataset hosted on an **Ontotext GraphDB** instance via a public **SPARQL** endpoint. The ontology and dataset focus on **Bulgarian elections**, including entities such as municipalities, electoral districts (MIR), polling sections, political parties, candidates, and vote counts across multiple years and election types. The project emphasizes ease of use, multilingual support, and interactive exploration of linked election data through a web-based interface.

Technology Stack

- **GraphDB** – graph database hosting the RDF election data and providing a public SPARQL endpoint
- **Sparnatural** – configurable visual SPARQL query builder used to create intuitive, natural language-like query interfaces over RDF data
- **IntelliJ IDEA** – IDE for editing the project files
- **Firefox Browser** – browser to be used for opening the project HTML page
- **Microsoft Excel** – tool to edit the configuration which is to be transformed in SHACL format

Data

The core of this project is a curated **RDF dataset** related to **elections** in Bulgaria, stored in a semantic graph database (**GraphDB**) and exposed via a **SPARQL** endpoint. The data is hosted on an **Ontotext GraphDB** repository and accessed through the following public **SPARQL** endpoint:

https://elections.ontotext.com/graphdb/repositories/elections

A **proxy** that is described in the documentation of **Sparnatural** is used for **CORS compliance**. It simply forwards the queries it receives to the target **SPARQL** endpoint. A query from server to server is not subject to the **CORS** limitation:

https://proxy.sparnatural.eu/sparql-proxy/sparql?endpoint=https://elections.ontotext.com/graphdb/repositories/elections

The **RDF** dataset uses a domain-specific ontology tailored to the structure of **Bulgarian elections**. The dataset is queried through a configuration (`myconfig.ttl`) that defines the **RDF** classes and properties to be exposed in the **Sparnatural** interface. This configuration maps **SPARQL** patterns to user-friendly labels and determines the visual structure of the query builder.

Project Steps

1. Enable dynamic loading of local files in Firefox Browser

The first **challenge** that I had to resolve was the loading of local dynamic files in my browser. By default, this is not possible and the **Sparnatural** widget will not load properly. This is because browsers for **security reasons** disable by default the dynamic loading of other files from local directories – in our case the **Sparnatural** configuration file. For it to work, we need to instruct the browser that it is safe to dynamically load local files. This is called "**enabling CORS for local files**".

The procedure to enable **CORS** for local files depends on the browser. For that project I chose to use **Firefox Browser**. In order to make it **CORS-enabled** for local files the following steps are required:

1. Open **Firefox Browser**
2. Type "**about:config**" in the address bar
3. Accept **security warning**
4. Search for the config "**security.fileuri.strict_origin_policy"**
5. Set this config to **false**
6. **Restart** your browser to make sure this is taken into account

Once I followed these steps and configured this setting, I reopened the `index.html` page and I was able to see the **Sparnatural** widget loading properly.

2. Connect with Elections Graph in GraphDB using proxy

CORS stands for **Cross-Origin Resource Sharing**. It is a mechanism by which a web client can retrieve resources from a server different from the one which was originally loaded. With **CORS**, servers can indicate they allow clients loaded from other domains to send them requests. This restriction applies to client-server interactions, not to server-server interactions.

In order to enable **CORS** on **GraphDB**, I needed to set some specific runtime properties. However, since the repository is public, I am not an administrator and I do not have the full rights to modify the settings. That is why I turned to the next option which is to use **Sparnatural SPARQL proxy**. This solution is appropriate when we cannot modify the parameters, or the security policy do not allow it. In that case, we use a **SPARQL proxy** that is provided by **Sparnatural** for that purpose and is **CORS-enabled**. That will forward the request to a target **SPARQL** endpoint that is just acting as a bridge between **Sparnatural** and the target **SPARQL** endpoint. This is only a temporary workaround, and we must not use this proxy in production. In my project queries are sent to:

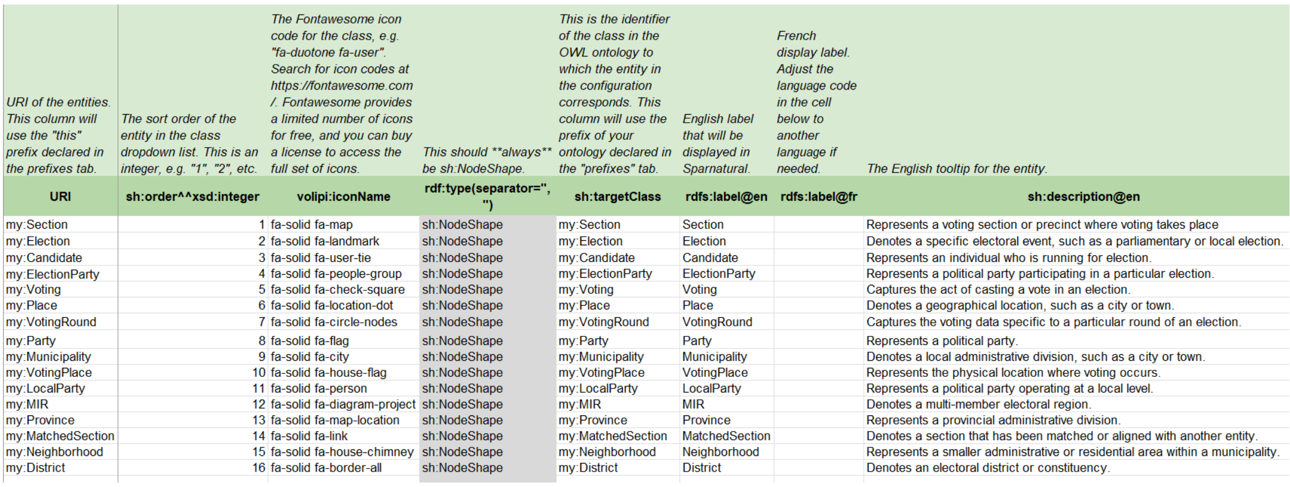
https://proxy.sparnatural.eu/sparql-proxy/sparql?endpoint=https://elections.ontotext.com/graphdb/repositories/elections

```
<spar-natural
    src="myconfig.ttl"
    endpoint="https://proxy.sparnatural.eu/sparql-
proxy/sparql?endpoint=https://elections.ontotext.com/graphdb/repositories/elections"
    lang="en"
    defaultLang="en"
    distinct="true"
    limit="1000"
    debug="true">
</spar-natural>
```

3. Setup configuration

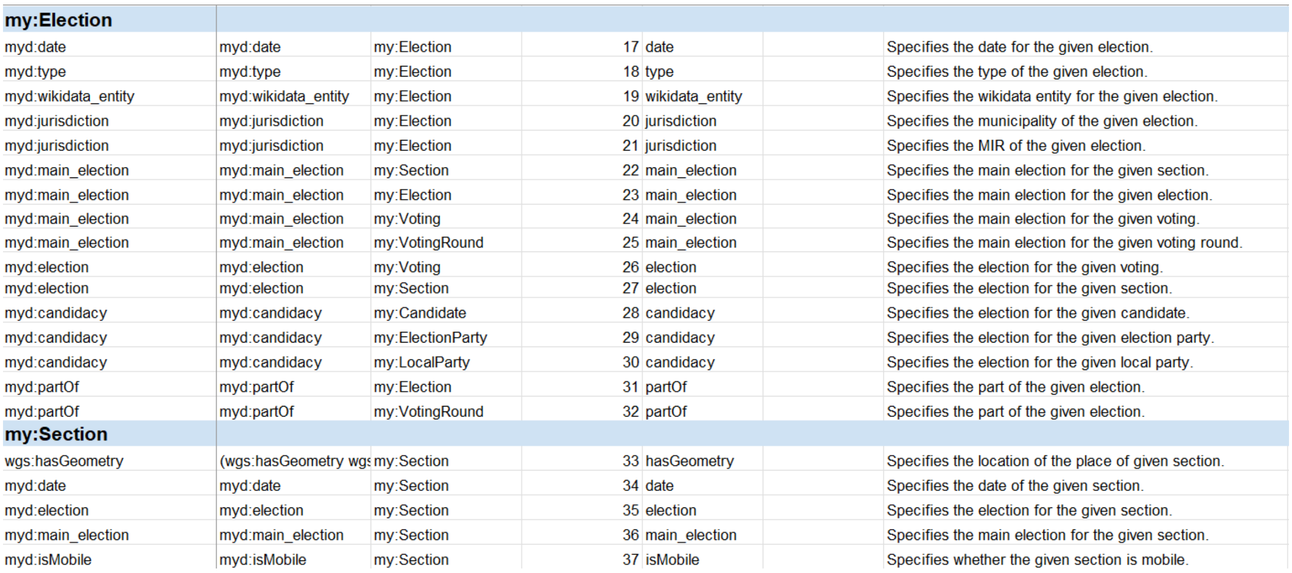
My next step is to configure the **query builder** following the **structure** of the **elections data**. All this was done in the configuration spreadsheet `config.xlsx`. This spreadsheet is actually a way to encode a **SHACL** specification of my specific data model which **Sparnatural** will use as an input.

The **spreadsheet** consists of several tabs. The first one is `Prefixes`. There we have to define all prefixes that will be used in the **SPARQL** queries. The next important tab is `Entities`. In that section we have to define all the entity classes that will be used and are present in our data model. We have to follow the instructions in the table when we fill it. We have to provide the order, the icon name, the type, the label and the description.



URI of the entities. This column will use the "this" prefix declared in the prefixes tab.	*The sort order of the entity in the class dropdown list. This is an integer, e.g. "1", "2", etc.*	*The Fontawesome icon code for the class, e.g. "fa-duotone fa-user". Search for icon codes at https://fontawesome.com/. Fontawesome provides a limited number of icons for free, and you can buy a license to access the full set of icons.*	*This should **always** be sh:NodeShape.*	*This is the identifier of the class in the OWL ontology to which the entity in the configuration corresponds. This column will use the prefix of your ontology declared in the "prefixes" tab.*	*English label that will be displayed in Sparnatural.*	*French display label. Adjust the language code in the cell below to another language if needed.*	*The English tooltip for the entity.*
URI	**sh:order^^xsd:integer**	**volipi:iconName**	**rdf:type(separator=", ")**	**sh:targetClass**	**rdfs:label@en**	**rdfs:label@fr**	**sh:description@en**
my:Section	1	fa-solid fa-map	sh:NodeShape	my:Section	Section		Represents a voting section or precinct where voting takes place
my:Election	2	fa-solid fa-landmark	sh:NodeShape	my:Election	Election		Denotes a specific electoral event, such as a parliamentary or local election.
my:Candidate	3	fa-solid fa-user-tie	sh:NodeShape	my:Candidate	Candidate		Represents an individual who is running for election.
my:ElectionParty	4	fa-solid fa-people-group	sh:NodeShape	my:ElectionParty	ElectionParty		Represents a political party participating in a particular election.
my:Voting	5	fa-solid fa-check-square	sh:NodeShape	my:Voting	Voting		Captures the act of casting a vote in an election.
my:Place	6	fa-solid fa-location-dot	sh:NodeShape	my:Place	Place		Denotes a geographical location, such as a city or town.
my:VotingRound	7	fa-solid fa-circle-nodes	sh:NodeShape	my:VotingRound	VotingRound		Captures the voting data specific to a particular round of an election.
my:Party	8	fa-solid fa-flag	sh:NodeShape	my:Party	Party		Represents a political party.
my:Municipality	9	fa-solid fa-city	sh:NodeShape	my:Municipality	Municipality		Denotes a local administrative division, such as a city or town.
my:VotingPlace	10	fa-solid fa-house-flag	sh:NodeShape	my:VotingPlace	VotingPlace		Represents the physical location where voting occurs.
my:LocalParty	11	fa-solid fa-person	sh:NodeShape	my:LocalParty	LocalParty		Represents a political party operating at a local level.
my:MIR	12	fa-solid fa-diagram-project	sh:NodeShape	my:MIR	MIR		Denotes a multi-member electoral region.
my:Province	13	fa-solid fa-map-location	sh:NodeShape	my:Province	Province		Represents a provincial administrative division.
my:MatchedSection	14	fa-solid fa-link	sh:NodeShape	my:MatchedSection	MatchedSection		Denotes a section that has been matched or aligned with another entity.
my:Neighborhood	15	fa-solid fa-house-chimney	sh:NodeShape	my:Neighborhood	Neighborhood		Represents a smaller administrative or residential area within a municipality.
my:District	16	fa-solid fa-border-all	sh:NodeShape	my:District	District		Denotes an electoral district or constituency.

The next important tab is `Properties`. This is the most crucial one because we have to describe all types of relationships that are possible between the different classes of entities. As this has to be done manually, I used the **SPARQL** editor in **GraphDB** to form suitable queries that can help me find the relations and reverse engineer the knowledge graph. I managed to define **100 properties** divided into different sections based on the key entity that I investigated.



my:Election						
myd:date	myd:date	my:Election	17	date		Specifies the date for the given election.
myd:type	myd:type	my:Election	18	type		Specifies the type of the given election.
myd:wikidata_entity	myd:wikidata_entity	my:Election	19	wikidata_entity		Specifies the wikidata entity for the given election.
myd:jurisdiction	myd:jurisdiction	my:Election	20	jurisdiction		Specifies the municipality of the given election.
myd:jurisdiction	myd:jurisdiction	my:Election	21	jurisdiction		Specifies the MIR of the given election.
myd:main_election	myd:main_election	my:Section	22	main_election		Specifies the main election for the given section.
myd:main_election	myd:main_election	my:Election	23	main_election		Specifies the main election for the given election.
myd:main_election	myd:main_election	my:Voting	24	main_election		Specifies the main election for the given voting.
myd:main_election	myd:main_election	my:VotingRound	25	main_election		Specifies the main election for the given voting round.
myd:election	myd:election	my:Voting	26	election		Specifies the election for the given voting.
myd:election	myd:election	my:Section	27	election		Specifies the election for the given section.
myd:candidacy	myd:candidacy	my:Candidate	28	candidacy		Specifies the election for the given candidate.
myd:candidacy	myd:candidacy	my:ElectionParty	29	candidacy		Specifies the election for the given election party.
myd:candidacy	myd:candidacy	my:LocalParty	30	candidacy		Specifies the election for the given local party.
myd:partOf	myd:partOf	my:Election	31	partOf		Specifies the part of the given election.
myd:partOf	myd:partOf	my:VotingRound	32	partOf		Specifies the part of the given election.
my:Section						
wgs:hasGeometry	(wgs:hasGeometry wgs	my:Section	33	hasGeometry		Specifies the location of the place of given section.
myd:date	myd:date	my:Section	34	date		Specifies the date of the given section.
myd:election	myd:election	my:Section	35	election		Specifies the election for the given section.
myd:main_election	myd:main_election	my:Section	36	main_election		Specifies the main election for the given section.
myd:isMobile	myd:isMobile	my:Section	37	isMobile		Specifies whether the given section is mobile.

The most important things that we have to point are the **subject class** and the **object class**, as well as what type of property it is (**sh:Literal /xsd:integer**, **xsd:string**, **geo:wktLiteral**/, **sh:IRI**) and how to visualise it (**core:ListProperty**, **core:NumberProperty**, **core:MapProperty**, **core:BooleanProperty**, etc.).

In addition, **Sparnatural** and **SHACL** provide some extended functionalities in **defining properties**. One of them that I have used is **querying inverse properties**. That is when we want the user view to differ from the underlying graph structure as we want to provide the user with an inverse relationship that does not exist in the data. I used this scenario for **Section** and **Voting** classes. In the original scenario, it was only possible for the **Voting** to be subject and the **Section** to be object. However, I wanted to be able to see the results of the voting for given section from the subject **Section**. That is why I used the special syntax: `[sh:inversePath myd:section]` to make a new property that I named `hasResult`.

Another option that is provided is **querying a sequence of properties**. This is used when we want to show the user a simplified view of the more elaborate structure in the graph with entities corresponding to a selection of resources and properties corresponding to a path in the graph. We do this in **SHACL** with the sequence path written in parenthesis "`()`", containing the list of properties to follow in sequence separated by a whitespace. In my visual search demonstrator, I have used that syntax mainly for the map search elements where the coordinate points are in two following properties distance. That is why I use: `(wgs:hasGeometry wgs:asWKT)` to make the illusion for the user that it is only one property: `wgs:hasGeometry`.

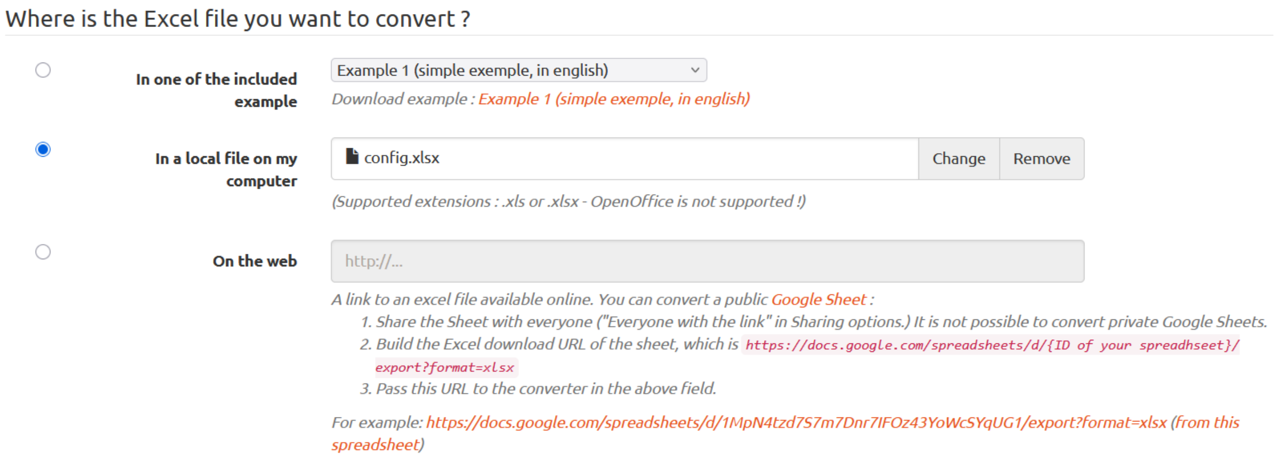
Moreover, we can use **SHACL alternative paths** for specific cases with our data as in this scenario:

```
(myd:votingPlace [ sh:alternativePath (geo:hasGeometry wgs:hasGeometry) ]
                 [ sh:alternativePath (geo:asWKT wgs:asWKT) ] )
```

The final important tab that I relied on is `Datasources`. By default, **Sparnatural** only extract a certain number of results when it searches for labels. Therefore, I had to define **custom datasources** that relied on the original one but without the **LIMIT** clause. Therefore, I copied the original from the specification and adapted them for my use case.

4. Convert the spreadsheet in RDF

Sparnatural can be configured by a **SHACL** specification, and we can use an **Excel** spreadsheet to start creating a **SHACL** config for **Sparnatural**. The configuration spreadsheet can be edited in a local file or in an online (**Google**) spreadsheet. Before **Sparnatural** to be able to read the configuration, it needs to be converted to **RDF**. This can be done with **Excel-2-RDF converter** that is available from the **Sparna** organisation. For our local file conversion we can use the online form at `https://skos-play.sparna.fr/play/convert?lang=en` and choose the field "**In a local file on my computer**". Then we check the "**Ignore SKOS post-processings on the data**" box at the bottom of the form and click on "**Convert**" button. Finally, we save the results in the `myconfig.ttl` file that contains our **SHACL specification**.



Where is the Excel file you want to convert ?

○ **In one of the included example** — Example 1 (simple exemple, in english)

Download example : Example 1 (simple exemple, in english)

● **In a local file on my computer** — config.xlsx

(Supported extensions : .xls or .xlsx - OpenOffice is not supported !)

○ **On the web** — http://...

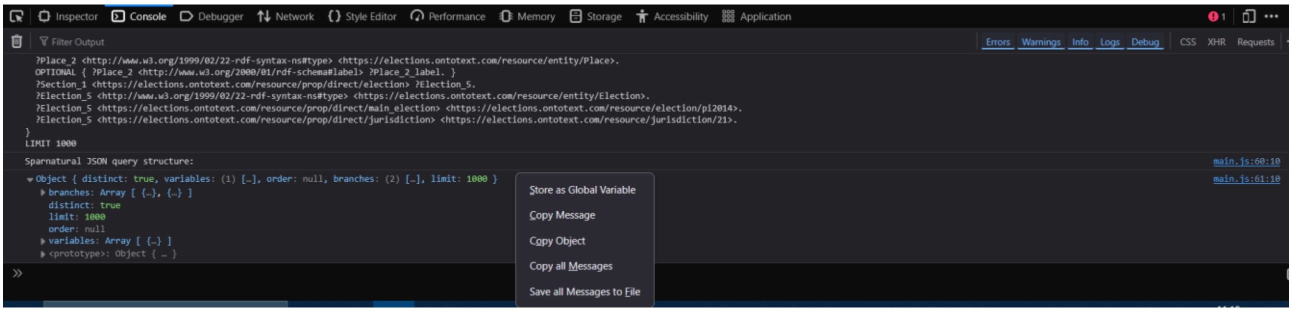
A link to an excel file available online. You can convert a public Google Sheet :

1. *Share the Sheet with everyone ("Everyone with the link" in Sharing options.) It is not possible to convert private Google Sheets.*
2. *Build the Excel download URL of the sheet, which is `https://docs.google.com/spreadsheets/d/{ID of your spreadhseet}/export?format=xlsx`*
3. *Pass this URL to the converter in the above field.*

For example: https://docs.google.com/spreadsheets/d/1MpN4tzd7S7m7Dnr7IFOz43YoWcSYqUG1/export?format=xlsx (from this spreadsheet)

5. Create example queries

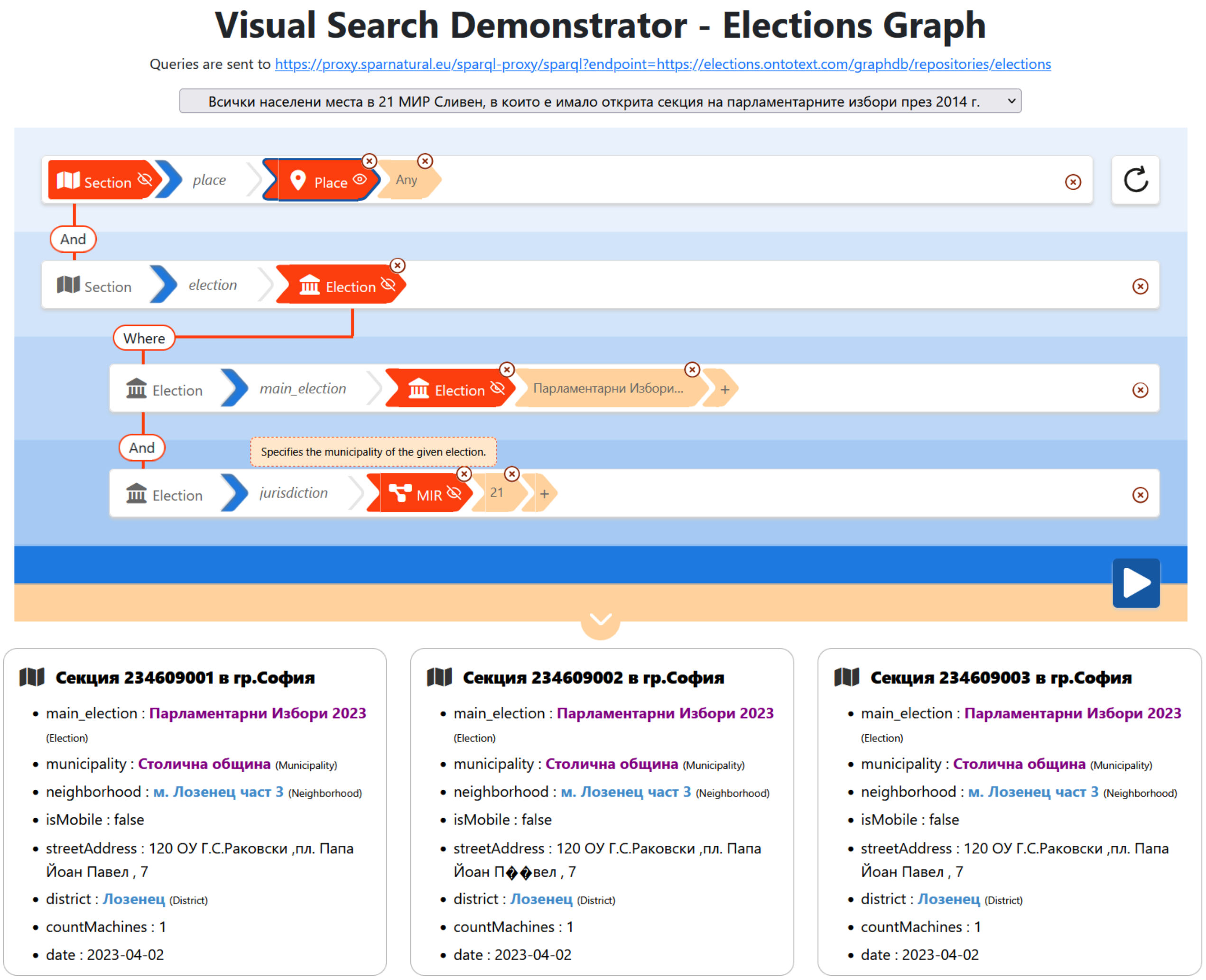
Sparnatural gives us an opportunity to save some **example queries** that we can display in the **HTML** page. In order to save a query, we have to open the **developer console** of our browser and copy the object that we see at the bottom only after we have constructed the desired query.



```
    ?Place_2 <http://www.w3.org/1999/02/22-rdf-syntax-ns#type> <https://elections.ontotext.com/resource/entity/Place>.
    OPTIONAL { ?Place_2 <http://www.w3.org/2000/01/rdf-schema#label> ?Place_2_label. }
    ?Section_1 <https://elections.ontotext.com/resource/prop/direct/election> ?Election_5.
    ?Election_5 <http://www.w3.org/1999/02/22-rdf-syntax-ns#type> <https://elections.ontotext.com/resource/entity/Election>.
    ?Election_5 <https://elections.ontotext.com/resource/prop/direct/main_election> <https://elections.ontotext.com/resource/election/pi2014>.
    ?Election_5 <https://elections.ontotext.com/resource/prop/direct/jurisdiction> <https://elections.ontotext.com/resource/jurisdiction/21>.
  }
  LIMIT 1000
  Sparnatural JSON query structure:                                                                         main.js:60:18
▾ Object { distinct: true, variables: (1) […], order: null, branches: (2) […], limit: 1000 }               main.js:61:18
   ▸ branches: Array [ {…}, {…} ]
     distinct: true
     limit: 1000
     order: null
   ▸ variables: Array [ {…} ]
   ▸ <prototype>: Object { … }
```

Results

The **Sparnatural-based** elections visualization project successfully validates the feasibility of using a visual query builder over **semantic election data**. It demonstrates how complex **SPARQL** queries can be made **accessible** to users through an **intuitive interface**, removing the need for in-depth technical knowledge. Throughout the development, challenges such as data modelling, RDF transformation, and user interaction design were addressed to deliver a responsive and flexible search experience.



Visual Search Demonstrator - Elections Graph

Queries are sent to https://proxy.sparnatural.eu/sparql-proxy/sparql?endpoint=https://elections.ontotext.com/graphdb/repositories/elections

Всички населени места в 21 МИР Сливен, в които е имало открита секция на парламентарните избори през 2014 г.

Секция 234609001 в гр.София

- main_election : **Парламентарни Избори 2023** (Election)
- municipality : **Столична община** (Municipality)
- neighborhood : **м. Лозенец част 3** (Neighborhood)
- isMobile : false
- streetAddress : 120 ОУ Г.С.Раковски ,пл. Папа Йоан Павел , 7
- district : **Лозенец** (District)
- countMachines : 1
- date : 2023-04-02

Секция 234609002 в гр.София

- main_election : **Парламентарни Избори 2023** (Election)
- municipality : **Столична община** (Municipality)
- neighborhood : **м. Лозенец част 3** (Neighborhood)
- isMobile : false
- streetAddress : 120 ОУ Г.С.Раковски ,пл. Папа Йоан П��вел , 7
- district : **Лозенец** (District)
- countMachines : 1
- date : 2023-04-02

Секция 234609003 в гр.София

- main_election : **Парламентарни Избори 2023** (Election)
- municipality : **Столична община** (Municipality)
- neighborhood : **м. Лозенец част 3** (Neighborhood)
- isMobile : false
- streetAddress : 120 ОУ Г.С.Раковски ,пл. Папа Йоан Павел , 7
- district : **Лозенец** (District)
- countMachines : 1
- date : 2023-04-02