Map4RDF-iOS: a tool for exploring Linked Geospatial Data

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Abstract

In this paper we describe Map4RDF-iOS, a tool that allows visualizing and navigating through RDF-based geographic datasets available via a SPARQL endpoint, as well as connecting that data with statistical data represented with the W3C DataCube vocabulary or sensor data represented with the W3C Semantic Sensor Network ontology.

Introduction and Motivation

During the last years, we have seen an increase in the amount of geospatial data published following Linked Data (LD) principles[1]. Some examples are LinkedGeoData,[2] the UK's Open Government Data initiative,[3] or the European Environmental Agency portal[4]. Currently, several vocabularies are used to describe geographic information: GeoSPARQL,[5] NeoGeo,[6] W3C Basic Geo Vocabulary,[7] ISA Programme Location Core Vocabulary,[8] and schema.org. And there are standardization initiatives, such as the W3C Location and Addresses Community Group,[9] where work is being done on bridging between such vocabularies in order to describe geospatial locations as LD.

However, there are not too many examples of tools or services that allow visualizing Linked Geospatial Data (LGD). The LinkedGeoData project (Stadler et al. 2012) offers a faceted browser[10] to visualize and edit the OpenStreetMap[11] dataset. Similarly, Map4RDF (Leon et al. 2012) was initially used in the geolinkeddata.es project to visualize and explore LGD, providing the possibility of editing the underlying data and selecting more types of maps. Keßler et al. (2012) converted metadata about publications, authors, and conferences of the GIScience field into LGD. The resulting dataset can be explored in the spatial@linkedscience portal.[12] More recently, SexTant (Bereta et al. 2013) allows visualizing and browsing time-evolving LGD, and users can collaborate in the creation and sharing of thematic maps that combine multiple LGD sources.

The work presented in this paper stems from our earlier work in the Map4RDF web-based framework. When using this and other tools in tablets, we realized that the performance (in terms of user responsiveness, and hence in terms of quality of service) of existing tools was not good enough, especially

[1] http://www.w3.org/DesignIssues/LinkedData.html
[2] http://linkedgeodata.org
[3] http://data.gov.uk/
[4] http://semantic.eea.europa.eu/
[5] http://www.opengeospatial.org/standards/geosparql
[6] http://geovocab.org/doc/neogeo.html
[7] http://www.w3.org/2003/01/geo/
[8] http://www.w3.org/ns/locn
[9] http://www.w3.org/community/locadd/
[10] http://browser.linkedgeodata.org/
[11] http://www.openstreetmap.org
[12] http://spatial.linkedscience.org/

since such tools did not benefit from the use of native code. As a result, we decided to develop Map4RDF-iOS in parallel to Map4RDF, with a focus on providing similar functionalities to the web-based version, although exploiting usability features that are allowed by tablet-based applications. In Calbimonte et al. (2013) we already demonstrated the use of Map4RDF-iOS to visualize static and dynamic RDF data, in the context of presenting transport data in Madrid, but we did not provide yet an exhaustive description of its functionalities.

Map4RDF-iOS Description

Map4RDF-iOS is a configurable app that allows exploring and visualizing RDF datasets that are enriched with geographic information and available via SPARQL endpoints. It can be installed in mobile devices running iOS (versions 5 to 7), preferably iPads. While it shares many of the features of its web counterpart Map4RDF, there are two main features that distinguish both of them. First, Map4RDF-iOS is highly customizable by end users. For example, end users can select the SPARQL endpoint that they want the app to work with or configure at runtime the queries that need to be sent to that SPARQL endpoint, depending on the type of geospatial vocabulary used to represent the data in that SPARQL endpoint. This is not possible at the moment in Map4RDF, which is thought to be configured by web administrators instead. And second, Map4RDF-iOS has an optimized memory management, what makes it run much more smoothly than its web counterpart when used through a mobile device.

Besides these functionalities, there are others that are also relevant to be considered, and which are detailed below.

- Map4RDF-iOS supports multiple map servers, such as OpenStreetMap, Google Maps, Apple Maps, and Nokia Here,[13] that can be selected by the user at runtime. It is also possible for developers to add other map servers as long as they are compatible with the WGS 84 / Pseudo-Mercator and EPSG3857 projections.
- Two different types of data are obtained from SPARQL endpoints, whose URLs, graph to use and queries to evaluate can be configured, as shown in figure 1. One of them is used to evaluate the queries that allow retrieving the thematic categories to be shown in the faceted browser (that is, the concepts whose instances may have a geometric representation, as shown in figure 2) and the geospatial properties of data points. The another one is used for the retrieval of statistical data in DataCube[14].
- The *visualization module* supports the following geospatial data models: W3C Geo XG,[15] GeoLinkedData,[16] and WKT (Polygon and Point). One of the main features of Map4RDF-iOS is the possibility of clustering data points, what enhances the browsing experience in densely populated scenarios.

[13] http://here.com/
[14] http://www.w3.org/TR/vocab-data-cube/
[15] http://www.w3.org/2005/Incubator/geo/
[16] http://geo.linkeddata.es/web/guest/modelos

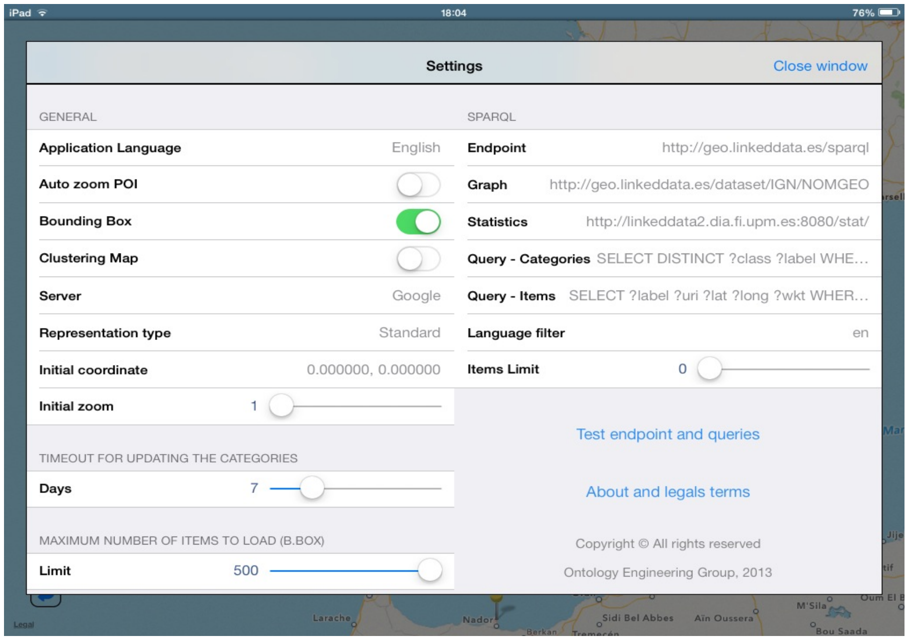

Figure 1: Configuration panel of Map4RDF-iOS

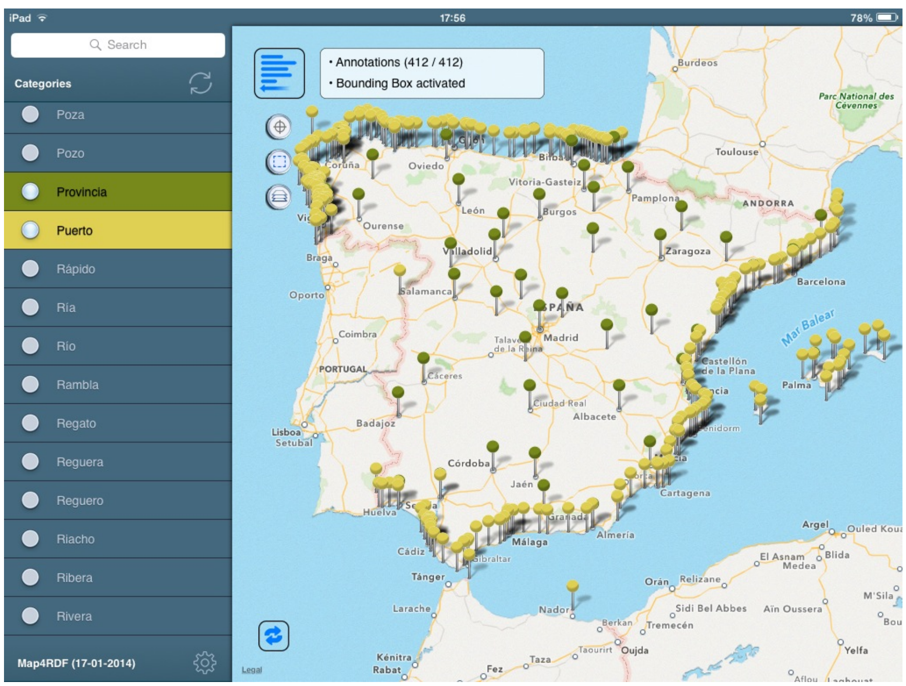

Figure 2: Example of data visualization of Map4RDF-iOS - Harbours and provincial capitals of Spain.

When a data point is selected in the map, the name and category appears in a dialog box together with an information button. By clicking this button, a new interface (figure 3, left) shows various options to obtain additional information about the data point (described next in clockwise order):

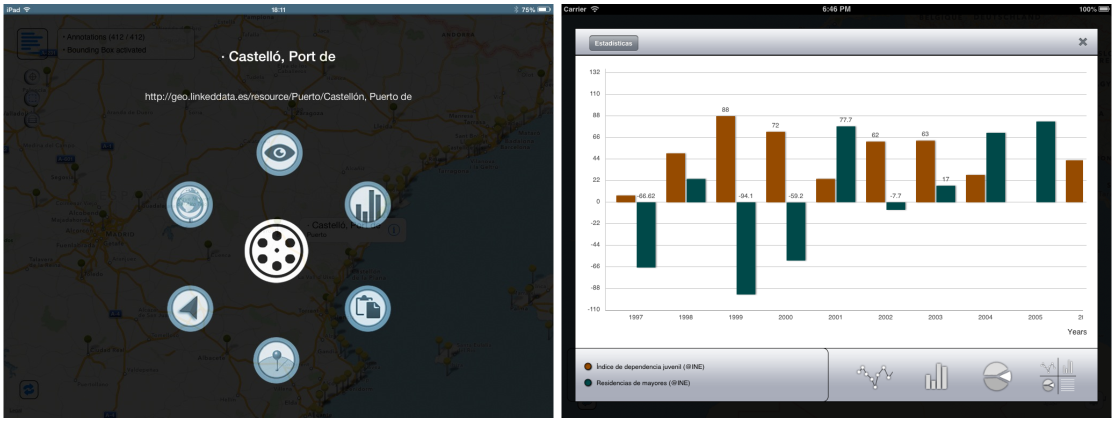

Figure 3: Interface to show additional information of a specific data point (left); DataCube-based statistics interface for Map4RDF-iOS (right).

- Full visualization of the HTML representation for that URI, if dereferenceable in HTML. If the URI provides access to a sensor data stream, this can be also configured to show an ad-hoc representation of values, as described in (Calbimonte et al. 2013).
- The *statistics module* offers statistical visualizations related to the selected data point (up to ten to allow for a better user experience), as shown in figure 3 (right). Statistics are generated by an external service that analyzes the DataCube-enabled RDF dataset.
- Paste into clipboard.
- The *buffer tool* allows visualizing resources within a circular buffer defined by the user.
- The *route service* uses the Google API to create and display routes between two or more points (foot, public transport and car). Any of these points can be the current geolocation of the device, if available.
- The *search service* looks for the URI in other SPARQL endpoints with services like sameas.org, which can be configured as well.

Figure 4 provides a high-level overview of the main architecture of Map4RDF-iOS. The main libraries and frameworks that we use (as shown at the bottom of figure 4) are: ***Core Graphics*** (to manage 2D geometries, such as polygons, circles, etc.); ***Core Location*** (to access the device location, among others); ***UIKit*** (to support drawing images and for animating the content of views); ***Quartz Core*** (contains the Core Animation interfaces that are an advanced compositing to create view-based animations); and ***MapKit*** (to display maps and customize their content, appearance, use annotations and overlays).

We have also developed application-specific modules (as shown at the top part of figure 4): ***Menu*** (sliding menu and interface categories, it shows the colors associated with categories, bar search and layout of the map); ***Map Tiles*** (displays different layers or WMS map service associated with the standard described in the document); ***Statistics*** (displays statistics associated with a URI); ***Uri Finder and Viewer*** (searches a URI in a web service like sameas.org and shows RDF data easily); ***Settings*** (for the configuration panel); ***Custom Annotation*** (module that changes the default iOS SDK MKAnnotation Class to provide cluster control, parameters, colors or bounds); and ***AlertView iOS7*** (implementation of the original UIAlertView with support for images, animations, data tables, etc.).

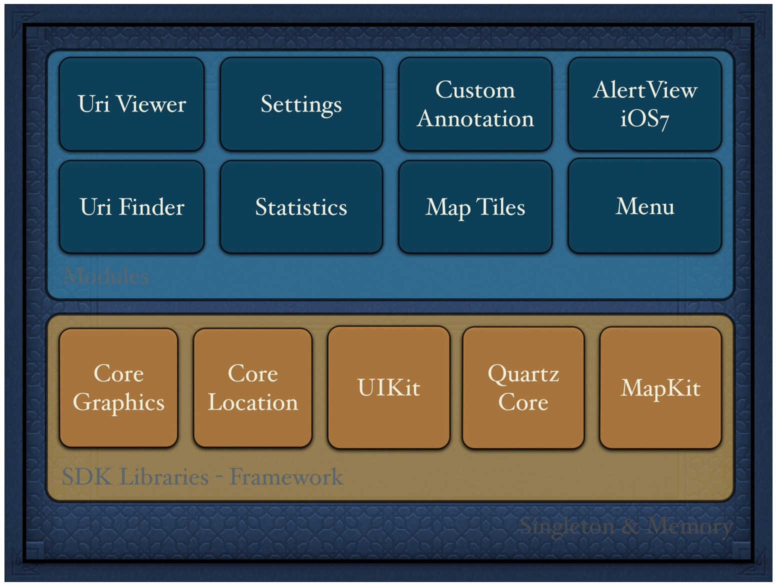

Figure 4: Architecture diagram of Map4RDF-iOS.

Conclusions and Future Work

The Map4RDF-iOS offers an intuitive and usable interface to visualize and explore RDF datasets containing geographic information. The advantages of using native code are reflected in an enhanced user experience. Loading and browsing huge RDF datasets is now much faster than in the web-based version. We think that the development of tools to visualize and explore LGD fosters the reuse of public and private RDF data. This is one of the reasons why we have already developed two sister tools (Map4RDF and Map4RDF-iOS), and continue updating them in order to provide support for the latest developments in this area.

The development of Map4RDF-iOS is still ongoing. A lite version is available at the Apple Store,[17] and there is also a previous stable released version online[18]. In our roadmap, we plan to incorporate the following features, coming from real requirements derived from its deployment and usage:

- The data point interface will be improved with a module for data edition suggestions. This module will allow users to notify data providers about errors or to suggest links to other datasets.
- We will add a connectivity module to allow sharing snapshots, configuration files, and RDF data among devices running iOS, as well as its publication in social networks, such as Twitter or Facebook.
- Finally, we are also working on a more general real-time visualization of RDF data streams, improving the work done previously with Madrid's bus transport data.

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[17] https://itunes.apple.com/us/app/map4rdf-lite/id828604407?mt=8
[18] http://delicias.dia.fi.upm.es/~afernandez/CyL/Map4rdf_CyL.ipa

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