Verbalization of RDF Triples with Applications

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Abstract. This paper first describes a technique to generate verbal descriptions of sequences of RDF triples. Then, it discusses how to apply the technique to create verbal descriptions of geographic maps which are useful to the visually impaired users or in situations where visual information cannot be displayed.

Keywords: Natural Language Generation, Verbal Assistance, RDF.

1 Introduction

We first describe a technique to systematically generate verbal descriptions of sequences of RDF triples. The technique is independent of on the application domain and is based on the W-Ray approach [10], which generates natural language sentences that correspond to sets of RDF triples. Then, we discuss how to apply the technique to create verbal descriptions of geographic maps which are useful to the visually impaired users or in situations where visual information cannot be displayed. We illustrate the technique in three map applications [1]: exploration and localization of points of interest; orientation and movement; and educational purposes.

2 Verbalization of Sequences of RDF Triples

Briefly, the first stage of the W-Ray approach [10] consists of specifying database views that define which data should be published. The second stage creates an RDF schema that describes the conceptual organization of the views. The last stage triplifies the view data according to the RDF schema, generates well-structured natural language sentences to describe the triples and then publishes the sentences as Web pages, with RDFa. The approach is supported by a tool, described in http://www.inf.puc-rio.br/~hpiccinini/step-by-step.htm.

The synthesis of the natural language sentences uses templates and is based on the mapping from the entity-relationship model to RDF proposed in Noy at al. (2006) [9] and on the mapping of OWL ontologies to natural language sentences proposed in Fliedl et al. (2010) [2] and Kalyanpur et al. (2005) [5]. The templates are associated with the classes and properties defined in the RDF schema. The type of a template depends on the type of the property: *simple*, when the property is a single-valued datatype property; *multivalued*, when the property is a multivalued datatype property; and *relationship*, when the property is an object property. Templates pertaining to properties of the same class may be combined into a single template to generate longer and more meaningful sentences. The n-ary relationships are represented by reification in an RDF schema with the help of 1-n object properties. Then, it would be reasonable to combine all templates pertaining to properties generated by reification thereby generating single sentences which describe n-ary relationship instances.

Once we know how to map RDF triples into natural language sentences, it is a simple matter to synthesize a voice output description of sequences of RDF triples.

3 Examples of Map Verbalization

Map for exploration and localization of points of interest. Suppose that a user submits the following request through a mobile device, say: (R1) *"Get the nearest typical Brazilian food restaurants, ordered by classification and price"*. To answer such request, the application must include a (geographic) database view with the location of the restaurants, their cuisine type, classification and price range. Furthermore, the view must have been processed using the W-Ray system. Request R1 would return a sequence of triples that, when translated using the NL templates, would generate, for example, the following sentence:

`- Restaurant À Mineira has four stars and low price range.`

Map for orientation and movement. Suppose that a user submits the following request through a mobile device: (R2) "*Get the directions from here to the À Mineira Restaurant"*. Using the map fragment of Figure 1, we obtain the following directions:

1. `Walk on Rui Barbosa Avenue towards Goitacazes Street.`
2. `Turn right on Quintino Bocaiúva Avenue.`
3. `The destination is on the right.`

These sentences might be useful, but we generate additional sentences to help the user create a mental map of the route:

1. `À Mineira Restaurant has address 353, Quintino Bocaiúva Avenue, São Francisco, Niterói, RJ, CEP 24360-022.`
2. `À Mineira Restaurant is located to the northwest.`
3. `À Mineira Restaurant is located in front of the São Francisco Beach.`
4. `Quintino Bocaiúva Street crosses Rui Barbosa Avenue.`
5. `Rui Barbosa Avenue is crossed on the West by Goitacazes, Araribóia, General Rondon and Quintino Bocaiúva Streets.`
6. `Nossa Senhora da Assunção School is a reference point near the À Mineira Restaurant.`
7. `Nossa Senhora da Assunção School is located at General Rondon Street with Rui Barbosa Avenue.`

In this example, all views represent topological relationships and order is important. The first few sentences describe the destination point. The next sentences refer to the route to be followed. The last few sentences indicate reference points according to their relevance and their distance from the origin, destination and streets crossed along the route. In particular, to synthesize the sixth sentence, we observe that the RDF schema (not shown here) indicates that `School` is a subclass of `ReferencePoint`. Hence, we may infer that the "`Nossa Senhora da Assunção School`" is a reference point.

Indeed, the verbal assistance depends on the degree of granularity of the map content and how much of the map content should be verbalized. To overcome these questions, we include an additional property that indicates the relevance of the geographic objects. An application will then use this additional property to calibrate how many objects will be retrieved and verbalized to answer a user's request.

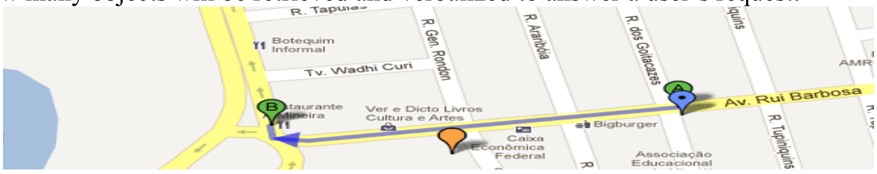

Figure 1 – Google Maps used to illustrate the results of Request R2.

Map for educational purposes. Suppose a user is browsing a tactile map and that the system verbalizes descriptions of the geographic objects touched. When touching the State of Rio de Janeiro, the user will hear:

1. The State of Rio de Janeiro has as capital the City of Rio de Janeiro, an area of 43.780,157 square kilometers, population equal to 15.989.929 people, demographic density equal to 365,23 inhabitants per square kilometer and the number of counties equal to 92.
2. The State of Rio de Janeiro is crossed by the Paraíba do Sul River.
3. The State of Rio de Janeiro touches the State of Minas Gerais to the North, the State of Minas Gerais to the West, the State of Espírito Santo to the Northeast, the State of São Paulo to the Southeast the Atlantic Ocean to the South.

In this case, the designer created views over a geographic database containing maps such as those in Figure 2, which represents the following topological relationships: *crosses (between river and state)* and *touches (between states)*.

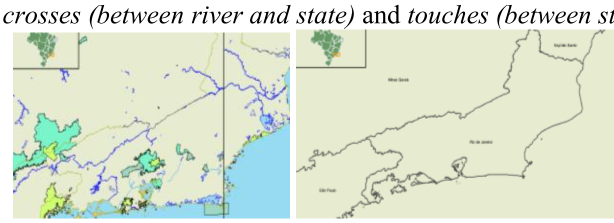

Figure 2 – Hydrograph and political limits maps of the State of Rio de Janeiro.

3 Related Work

Recent research demonstrated that verbal descriptions, together with tactile maps, are more effective to construct mental models of the geographic space [3]. Some of these references use verbal assistance to generate maps that are cognitively adequate to the blind [4, 6]. Miele et al. [8] showed that, with the help of a Talking Tactile Tablet (T3) [7] and a Scalable Vector Graphics (SVG) file, one may automatically add voice annotations to a tactile map to create interactive audio tags. Atlas.txt [6] is a prototype that uses knowledge bases to create text summaries that describe how the results of the UK 2001 census are geographically distributed. Habel et al. [4] uses a knowledge base combined with trajectory segmentation and a categorization of movement. Their system is able to describe spatial relations as the user moves a haptic device over a map. The system also anticipates future descriptions, using verbs in the future tense.

4 Conclusions

In this paper, we briefly outlined a technique to verbalize sequences of RDF triples based on the synthesis of natural language sentences. The technique adopts templates and a strategy to generate longer and more meaningful sentences that explores the structure of the RDF schema. The technique is not application dependent and may be used in a variety of situations, as long as the database is encapsulated as advocated by the W-Ray approach.

Then, we discussed how to apply the technique to generate verbal assistance to users that access geographic maps. We adopted a simple and useful solution to verbalize geo-spatial data at the appropriated granularity level.

Finally, as future work, we plan to combine verbal assistance with SVG files to provide access to geo-spatial data on the Web.

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