Atlas Of Paths: a Formal Ontology of Historical Pathways in Italy*

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Abstract. The *Atlas of Paths* project has two main goals: (i) the creation and implementation of an ontology network representing information contained in the MiBACT's *Atlante dei Cammini d'Italia* and defining the concept of path; (ii) the design of a prototype for a modular software platform allowing the production of the *Atlante* Linked Open Data as foreseen in its ontological formalization.

Keywords: Formal Ontology · Atlas of Paths · Cultural Heritage.

1 Introduction

The project *Atlas of Paths* (AoP) aims at creating and implementing a network of ontologies for representing *Atlante dei Cammini d'Italia* (*Atlante* in short), a collection of Italian paths that, from north to south, cross the country promoting a new tourist dimension. This initiative, funded by the MiBACT, is promoting a slow and green mobility infrastructure, which offers the opportunity to travel throughout Italy on foot, by bike or even on horseback. To become part of the *Atlante*, a path must satisfy eleven criteria[3], defined by a MiBACT Committee, related to a path physical and administrative features. Those paths not meeting all the criteria are called "Paths in progress". Currently, the *Atlante* includes only 44 out of 116 proposed paths.

The AoP ontology is part of the *OntoPiA* ontology network[4], as one of the result of the *Italian Digital & Analytics Framework* (DAF)[5], a project intended

** Route ontology was designed in collaboration with Dr. Giorgia Lodi, consultant for the Agency for Digital Italy (AgID): giorgia.lodi@agid.gov.it.

[3] https://www.turismo.politicheagricole.it/en/home-cammini-ditalia/atlas-of-paths/

[4] https://github.com/italia/daf-ontologie-vocabolari-controllati

[5] https://teamdigitale.governo.it/en/projects/daf.htm

to improve the interoperability between Italian public administrations by defining a shared conceptualization of data and promoting the adoption of Open Data. For modeling AoP we benefit from reusing some ontological modules from *OntoPiA*, namely: `LO`, which defines top-level concepts (e.g. Event, Object etc.); `CVL`, as the ontology on addresses and places; `POI`, on points of interests; `ACCO`, on accommodation facilities; `TI`, on the temporal dimension of concepts; `MU`, on the measurement units.

2 Methodology

How to describe a Path? This theoretical question summarizes 25 competency questions (CQs) - a common tool for defining modeling requirements to be satisfied by a ontology [3] - that guided the design of AoP ontology. Following the *eXtreme Design* method [1], we used CQs as a support to recognize potential *Ontology Design Patterns* [2] to be reused. Our CQs has been elicited from both the documentation available from the *Atlante* and for each path therein collected.

The CQs led us to design two networked ontological modules: (i) `Route`[6], which is a general conceptualization for supporting the domain ontology; (ii) `Atlas of Paths`[7], which defines more specific concepts imported by the supporting ontology.

2.1 Route Ontological Module

Taking into account the modelling of *Semantic Trajectories* [4], which applies to the scenarios of personal travel and wildlife monitoring, in `Route` ontological module we define general concepts that are shared by all routes (e.g. their stages) and associated to a possible trip plan.

The class `:Route` is defined as an intersection of `LO:Sequence`, which represents a sequence of ordered objects, and `LO:Description`, which represents socially constructed objects (i.e. texts, values, categories, relationships, contexts) used to describe something else in a structured way. In addition, an instance of `:Route` can be connected by means of `CLV:hasGeometry` to an instance of `CLV:Geometry`, which provides the possibility of georeferencing a spatial object through `CLV:lat` (latitude) and `CLV:long` (longitude). The object property (op) `:crosses` allows to connect a `:Route` to any object having a spatial representation, so that it is possible to assert that a pathway crosses a certain area.

The class `:Stage` represents the elements of a `:Route`. Stages ordering of a route allows to identify the direct successor and predecessor of a stage through `LO:directlyFollows` and `LO:directlyPrecedes`. Georeferencing can also be associated with a stage by reusing the `CLV` module.

The class `:TripPlan` represents a travel plan for a specific route by means of `:hasRoute`. It is modeled by associating a certain trip time with the traveled route through `:hasEstimatedDuration`. In addition, a trip plan can be split into sub-trip plans through `:hasSubTripPlan`.

[6] `https://w3id.org/italia/onto/Route`
[7] `https://w3id.org/italia/onto/AtlasOfPaths`

2.2 Atlas of Paths Ontological Module

The concepts defined in the Route module are specialized in AoP, as depicted in Figure 1.

The class `:Pathway`, defined as a subclass of `Route:Route`, describes a pathway in its physical meaning. E.g., since a path to be included in the *Atlante* must be paved in asphalt for a maximum of 40% of its total length, the `:QuantifiedPathwayPaving` represents the n-ary relation able to quantify the `MU:maxPercentage` of a `:Pathway` (op `:forPathway`) with a specific `:Paving` (op `:withPaving`), represented as the instance `:asphalt`. In Manchester Syntax:

```
:Pathway subClassOf inverse(:forPathway)
 only ((:withPaving value :asphalt) and
  (MU:maxPercentage exactly 1 xsd:double[<"40.0"8sd:double])).
```

The class `:PathStage`, a `subClassOf Route:Stage`, is associated with `:SupportService`, representing any walker support services, defined by `:hasService Type`. A path stage is also associated with some `POI:PointOfInterest`, e.g. hotel facilities, represented by `ACCO:Accommodation`, and catering activities, represented by `:Restaurant`.

The class `:PathPlan`, a `subClassOf Route:TripPlan`, is a n-ary relation with three arguments: (i) `:TravelingMethod` which can be either on foot, on horseback, or by bicycle; (ii) `TI:TemporalEntity`, which specifies which period of the year is most suitable for planning the journey, and linked to a `:PathPlan` by means of `:bestWhen`.

The class `:Path` is the main and peculiar one of the *Atlante* domain. A `:Path` can be associated with one or more `:Pathway`, through `Route:hasRoute`. In addition, its sub-properties `Route:hasPreRoute`, `Route:hasAltRoute` and `Route:hasDeviation` allow to associate a `:Path` to a `:Pathway` so that it can be identified as the main path, an alternative or a deviation, respectively. These arguments contribute to strongly define the concept of `:Path`, which implies the possibility of choosing at each `:PathStage` to change the `:Pathway`.

2.3 Linked Open Data Production

We designed a modular software platform[8] for supporting data-entry by users proposing new Italian paths to be evaluated by the MiBACT Committee. This platform prototype provides a series of input forms that guide users in filling the necessary information to describe a path as foreseen in its ontological formalization. It has been implemented according to the *Model-View-Controller* pattern. The use of this pattern allows to implement: (i) the *Model* as the ontologies themselves; (ii) the *View* as the input forms; (iii) the *Controller* as a software module (implemented in PHP) to generate a pipeline of input forms based on the logical representation defined in the ontology.

[8] `http://wit.istc.cnr.it/atlas-of-paths/upload-form.html`

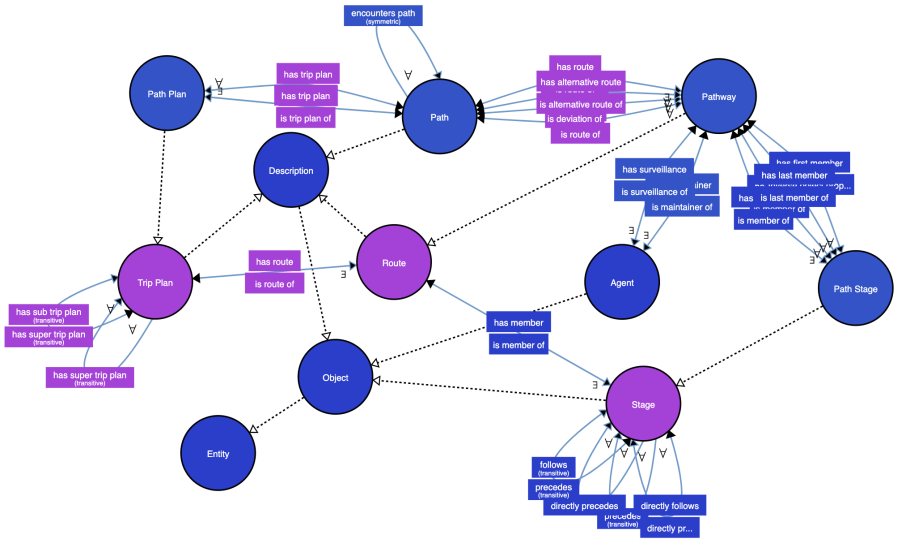

Fig. 1. Atlas of Paths visualization provided by WebVOWL.

3 Conclusion and Future Work

The AoP project has brought the following results: (a) a formal ontology defining the concept of path; (b) a prototype for a modular software platform to perform a LOD production consistent with the AoP ontology.

In addition to the progressive LOD production by means of the data-entry, it will be possible to link AoP with other datasets already available as LOD, such as Cultural-ON[9], ArCo[10] and FOOD[11] representing Italian assets of cultural heritage and food products in those areas that are crossed by a given path.

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[9] http://dati.beniculturali.it/cis/
[10] https://w3id.org/arco
[11] http://etna.istc.cnr.it/food/