Ontologies, Logic and Interaction: Approaches to Semantic Web ranging from Lexical Semantics to Geometrical Compatibility. And further perspectives

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Goal: a Web of ontologies

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- KR experts to design the ontologies
- and trained people to classify resources

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That is generally speaking information not described by *ad hoc* metadata

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- with objects which are text documents (i.e. big grain objects)
- most of all: following this approach the meaning must be found all in the words

Differences . . . and crucial common features

The engineers' approach:

- PROs: good for the formal description of resources, at any level of grain (not only whole text-documents but any information item one wants to identify)
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Both

- work by means of a stack of (meta)languages to deal with lower levels elements (data about data, i.e. metadata)

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After all, it is the delicate issue of the relationship between language and ontology and their ability to deal with reality

And what if common people classify resources?

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Instead of KR experts or text analysing bots

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Folksonomies emerge from the aggregation of every user's tag assignments to resources within a given community.

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- shows no interest in producing a sound classification of resources
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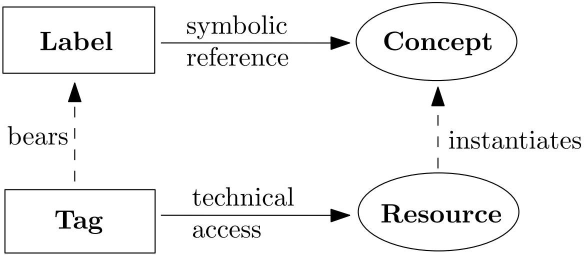
- thus provides a dirty-but-working cataloguing of large amounts of data
- thanks to large communities of users with no specific skills nor training

How tags work



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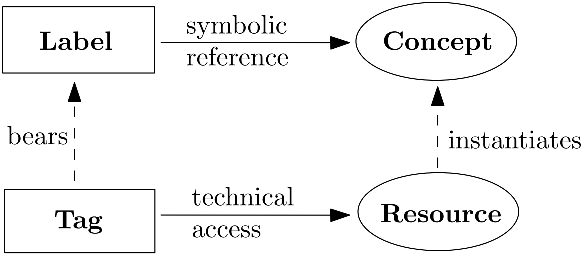

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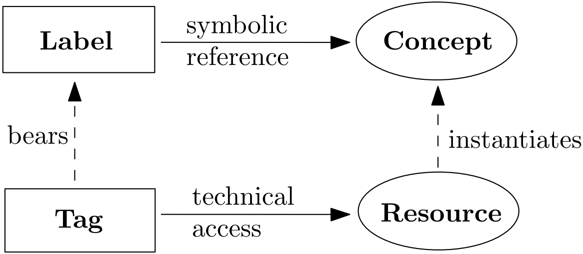

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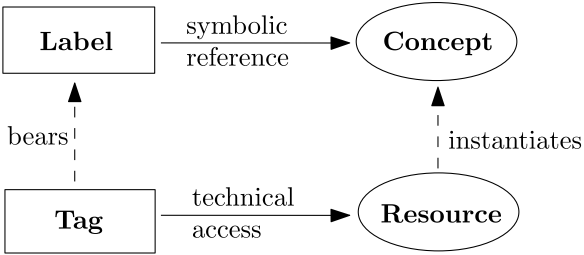

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All that is shown in the figure also holds for ontologies and the other ways to classify resources in the Web, the only difference being whether the label comes from a special vocabulary or is freely chosen (which implies also a subtle difference in what the label stands for)

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Since the technical access relation works always smoothly, whereas troubles appear as soon as one gets at the upper level, where labels (as lexical items) are supposed to have some meaning, let's try to discard this upper level for a while.

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- simmetric: if $r \supset r'$ then $r' \supset r$ too
- reflexive: every resource is also compatible with itself
- not transitive: there may be x, y, z s.t. $x \supset y$, $y \supset z$ but x is not compatible with z – just think of pairs with different tags: $\langle t, x \rangle$, $\langle t, y \rangle$, $\langle t', y \rangle$ and $\langle t', z \rangle$

Tagging spaces

Definition (Tagging space)

We may define a tagging space P *as the collection of all the pairs* $\langle t, r\rangle$ *in* $P \subseteq T \times R$*, that is the set of all the assignments of tags* ($t \in T$) *to resources* ($r \in R$) *recorded by*

- *either one single user* u *in a tagging community*
- *or any expert in one given KR system (who all obey the same strict conventional rules)*
- *or an automatic program that always runs the same algorithm*

Compatibility Spaces

Definition (Compatibility Space (CS), informal)

A Compatibility Space X is the web whose support $|X|$ is made of all the resources occurring in the assignments recorded in a given tagging space P, and the points in it are connected according to the Compatibility relationship above defined.

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Once fixed the dimension of User by recurring to the notion of tagging space, let $x \in |X|$ and $t \in T$ be respectively

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Coherence Spaces provide denotational semantics for Linear Logic:

- a Coherence Space interprets some formula
- operations between Coherence Spaces interpret compositions of formulas according to LL connectives

Cliques: approximating concepts

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and which approximates ‘anticoncepts’.

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- negation relates both allowing to switch from one another

Logical operations on Compatibility Spaces

Operations between Compatibility Spaces, like for Coherence Spaces, rely on LL connectives divided into additive ($\oplus$ and its dual &) and multiplicative ($\multimap$, $\otimes$ and its dual $\parr$), plus negation.

An initial study of these operations has been approached on the occasion of my PhD thesis. They look promising to consider duality as an alternative way to reason (draw inferences) on ontologies, besides representing some of the common operations on ontologies.

A few **closure results** have been found concerning the special class of decidable Compatibility Spaces:

- the class of positive decidable OCSs is closed under the $\oplus$
- the class of positive decidable OCSs is closed under the &
- negation relates both allowing to switch from one another
- the class of general OCSs is closed under $\oplus$

Ludic querying of Compatibility Spaces

Ludics [Girard, 2001] is a logical theory aiming to overcome the distinction between syntax (the formalism) and semantics (its interpretation). Through the process of *focalization* and the notions of *paraproof* and *location*, syntax and semantics get reduced to the same matter: objects called *designs* that can interpret a logical process in form of a dialogue between two agents.

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Communication appears as exploration of other agents’ knowledge.

Basics of Ludics

Focalization (grouping of consecutive actions of same polarity) and locations (what remains of formulas) unveil the geometrical nature of any logical proof in sequent calculus: one may forget connectives and quantifiers and just look at an alternance of actions of opposite polarity (positive and negative) taking place on some specific address (location) – which is promoted as *focus* of one given action – and leading to new locations *via* subaddressing.

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A design may contain valid proofs together with mere paraproofs, the criterion to recognize them depending on the interaction between (para)proofs . . .

Interaction as a dialogue

The mark of interaction is the *cut*: two designs interact when their bases can be cut, i.e. the same address is the focus of a positive play in one design and of a corresponding negative play in the other design.

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If cut-reduction leads to a special action called daimon (✠) in one of the two chronicles, it succeeds and the chronicle where the daimon appears, indicates the other design as a valid proof, since it contains (at least) one winning strategy (or meaningful path) to affirm the basis of that design.

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The alternation positive/negative actions, matching all along a dispute, makes room also for hosting the interplay of two agents that play one action at a time, of opposite polarity to each other’s action.

Ideas for a ludic querying protocol

‘Semantic querying’ as a dialogue between Web agents

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- a chronicle is any possible exploration of a tagging space (or of the Knowledge Base – KB – of an agent)

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‘Semantic querying’ as a dialogue between Web agents

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- a design is a representation of the knowledge of an agent (the knowledge of an agent is represented by the set of all the ‘discourses’ that it is able to tell)

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‘Semantic querying’ as a dialogue between Web agents

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- interaction happens between (at least) two agents that engage in a query-answer dialogue (one interrogating and one answering agent) (networks of designs – cut nets – may represent the interaction between many agents)

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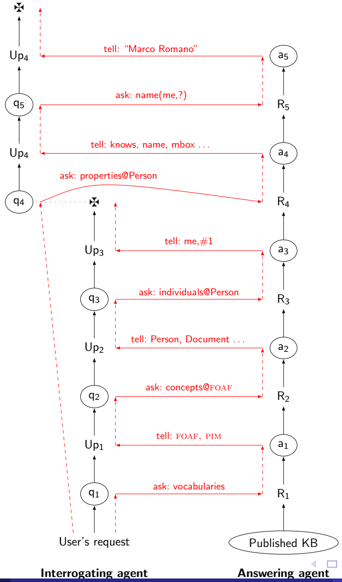
Note that here *loci* are URIs and exploration is to follow relations between resources

An example dialogue



✠

Up$_4$

tell: "Marco Romano"

a$_5$

q$_5$

ask: name(me,?)

R$_5$

Up$_4$

tell: knows, name, mbox . . .

a$_4$

ask: properties@Person

q$_4$

✠

R$_4$

Up$_3$

tell: me,#1

a$_3$

q$_3$

ask: individuals@Person

R$_3$

Up$_2$

tell: Person, Document . . .

a$_2$

q$_2$

ask: concepts@FOAF

R$_2$

Up$_1$

tell: FOAF, PIM

a$_1$

q$_1$

ask: vocabularies

R$_1$

User's request

Published KB

Interrogating agent

Answering agent

Conclusions – Compatibility Spaces

While passing through the representation of ontologies as well as folksonomies through Compatibility Spaces we firstly discard the conceptual meaning – somehow the primary meaning of ‘meaning’ in Semantic Web – and preserve just a loose notion of compatibility between resources which can be seen as a shadow of the intentional meaning of the agent that tags the resources (as far as tags, for instance, may suggest possible uses of the resources).

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But afterwards we may recover an interesting approximation of concepts (conceptual meanings) by looking for (maximal) cliques. Concepts ‘built’ this way however may have no correspondence with linguistic terms (lexical items), but are in any case the result of some kind of use (and of proposals of use) of the resources, which may open the way to a discourse on pragmatics along with semantics in Semantic Web.

Conclusions – Ludic querying

Discovery of the meaning of resources (or data) by means of exploration of *loci*, their locations (forgetting the meaning of the labels they are given)

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since – as Semantic Web claims – the meaning is in the relations between data and resources (remember of linked data), as far as these support communication.

Thanks

Questions?

Thanks