THE INTELLIGENT WEB

F. Javier del Álamo, Raquel Martínez and José Alberto Jaén

Department of Control, Electronics and Computer Science
E.T.S. Ingenieros Industriales-Universidad Politécnica de Madrid, Spain

Keywords: Rhetoric structure theory, Rhetoric-semantic relation, Semantic network, Knowledge node.

Abstract: Many people are working on the Semantic web with the main objective being to enhance web searches. Our proposal is a new research strategy based on the existence of a discrete set of semantic relations for the creation and exploitation of semantic networks on the web. To do so, we have defined in a previous paper (Álamo, Martínez, Jaén) the Rhetoric-Semantic Relation (RSR) based on the results of the Rhetoric Structure Theory. We formulate a general set of RSR capable of building discourse and making it possible to express any concept, procedure or principle in terms of knowledge nodes and RSRs. These knowledge nodes can then be elaborated in the same way. This network structure in terms of RSR makes the objective of developing automatic answering systems possible as well as any other type of utilities oriented towards the exploitation of semantic structure, such as the automatic production of web pages or automatic e-learning generation.

1 BASICS: SUMMARY OF THE RHETPORICAL SEMANTIC RELATIONS (RSR)

The primary objective of computational linguistics is the study and computerized treatment of human language, with the goal of providing a natural language model.

Based on the significant contributions of the Rhetorical Structure Theory (William Mann, Sandra Thomson 1999), we have formulated a set of Rhetorical Semantic Relations (RSR) for knowledge representation.

The RST provides an explanation of the coherence of the discourse. We assume the results of RST and propose a set of relations capable for representing knowledge.

In short, the RST defends the principle that the reading of a text does not always produce an expression of coherence. There are texts that are syntactically and semantically correct but difficult to understand. The theory explains the coherence of the discourse in terms of the existence of a kind of relation between blocks of text: the nucleus-satellite relations and the multinuclear ones. Without going into further detail, RST explains that the fact we can understand some texts is related both to the presence of rhetorical relations and to the distance between the fragments of text. (William Mann, Sandra Thomson 1999),(Bosma, 2005).

1.1 RSR Formulation

Based on RST, we wonder if, as there is a finite set of rhetorical relations between two different blocks of text, there is also a reasonable bound set of relations (semantic primitives) in the same way for any knowledge representation. This set must include the rhetorical relations as a subset. We will call this set RSR (Rhetorical Semantic Relations), and our goal is to build the semantic networks definitions in terms of RSR.

There are situations, such as those studied by Katheleen McKeown in Text Generation (McKeown, 1985), in which there are rhetorical structures nested within others. According to our results, by analyzing this structure in a large number of cases, we have seen that there is a certain point when the fragment has a semantic structure that does not correspond to the relations proposed by the RST. For this reason, as a second step, we propose to continue analysing the blocks of text obtained from the rhetorical analysis by the detection of semantic relations, such as "is_a", both in "is_a (individual-category)" such as "is_a (category-category)" forms the "is_part_of" relation and the "causal" ones.

In "Basic Method of instruction" (Reigeluth, 2007), the author makes a distinction between common features, referred to as those features shared by all the members (or subclasses) of the class, and differential features, such as those which differentiate the individual or subclass from the rest of the individuals (or subclasses) of the same class.

The summarized results are shown in the table below, where we have included the canonical expression, showing the representative fragment of text for all the rhetorical-semantic relations including both the relation to be used and the type of content of the child node in capital letters

Table 1: RSR Canonical expression.

Nr.	Denomination	Canonical expression (*)
1	Transformation	Changes the 'OBJECT' …
2	Feature	Shows the 'FEATURE'…
3	Function	Performs the 'FUNCTION'…
4	Location	Places in the 'LOCATION'…
5	Objective	Pursues the 'OBJECTIVE'…
6	Classify	Belongs to the 'CLASS'…
7	Coincidence	Shows the 'COINCIDENCE'…
8	Difference	Shows the 'DIFFERENCE'…
9	Part	Shows the 'PART'…
10	Effect	Produces the 'EFFECT'…
11	Result	Yields the 'RESULT'…
12	Activity	Develops the 'ACTIVITY'…
13	Method	Is reached by the 'METHOD'…
14	Comparison	Is compared to the reference 'OBJECT'…
15	Taxonomy	Is organized in 'CLASSES'
16	Cause	Because of the 'CAUSE'…
17	Evaluation	Has the 'VALUE'…
18	Condition	Has the 'CONDITION'…
19	Elaboration	Is elaborated in the 'OBJECT'…

Table 1: RSR Canonical expression (cont.).

20	Antithesis	Is opposed to the 'OBJECT'…
21	Summary	Is summed up in the 'OBJECT'…
22	Restatement	Can be expressed as 'OBJECT'…
23	Background	Is understood because of the 'OBJETCT'…
24	Instrumental relation	Is related to the 'OBJECT' …
25	Interpretation	Must be interpreted in the 'CONTEXT'
26	Concession	Although the 'PREDICATE' can be true …
27	Justify	Is justified by the ´THESIS' …
28	Motivation	Is interesting because of the 'REASON'…
29	List	Includes the 'OBJECT /CLASS'…
30	Following	Follows the 'ELEMENT'…

(*) Note that some of the relations make sense only in singular or only in plural. A plural expression is equivalent to a set of several identical relations between the same knowledge father node and different knowledge child nodes.

In this way, the definition of C= {x, y, z} is equivalent to: C includes x object; C includes y object; C includes z object; (The LIST relation in the Table 4). An alternative formulation in RSR is by means of the inverse relation: x Є C; y Є C; z Є C. That is the CLASS relation.

1.2 RSR Verification

For the set of RSR verification, we decided to test the behavior of the defined set of relations with the categories of questions defined in the classic theory of QA (Question Answering) proposed for the generation of automatic systems.

Of the 13 different categories of questions defined by in the conceptual categorization in question answering (Lehnert, 1978), we have marked the ones that are supported in the proposed set of RSR, followed by the corresponding RSR in brackets.

1. Causal antecessor. (Cause)
2. Objective oriented. (Objective)
3. Enabling. (Condition)

4. Causal consequent. (Effect)
5. Verification
6. Disjunctive. (List)
7. Instrumental / Procedural.(Method)
8. Complete concepts.
9. Prospects. (Explanation)
10. Judgment. (Evaluation)
11. Quantification. (Evaluation)
12. Specification de characteristics. (Features)
13. Request. (Result)

Regarding verification question support, once we have expressed a discourse in terms of RSR, it is possible, for example, to have a direct translation in terms of prolog predicates. The use of an inference mechanism over this knowledge, as a prolog query, it is the base for the implementation of a question answering system. If the result of this query is true, this implies that the facts are true. If false, it is not possible to confirm that the proposition is true or false with the available knowledge.

Completing concepts requires a recompilation process of all the semantic networks including this node and the corresponding predicates.

The rest of the possible questions are completely supported by the set of rhetorical-semantic relations defined in the present article, concluding that our model supports in a reasonable way the questions that an agent can make, either by means of the relation or by means of its inverse.

1.3 Innovation Aspects

The main innovation aspect of the proposed approach is the semantic enhancement of the resulting representation. We can represent a set of linked pages and resources as a set of knowledge nodes interconnected solely by means of RSR (or specific RSR synonyms in specific domains). The set of web pages will then be rhetorical-semantic networks based on these special relationships. Ontology corresponds just to one specific RSR (classify), but it is not the only one: In this paper, we propose a set of 30 basic relations to be used as an alternative and more complete treatment of ontology, by using the same technological support.

An important contribution of the RSR approach to the semantic web exploitation is to provide an instrument for automatic building knowledge bases for different applications such as intelligent question answering, by replacing node names as variables and RSR as relationships of the knowledge base.

The main applications are in the field of automatic e-consulting, e-learning generation or automatic document production.

2 PROOF OF CONCEPT

We have developed a large number of different examples to test our proposal. As important as the correct interpretation in the stage in which we find ourselves, is the didactic feature of the example. From this point of view, we have developed examples in the field of mechanical engineering, instructional design and e-learning production.

We will show here an example in the field of physical sciences and the role of RSR in explaining the Archimedes Principle:
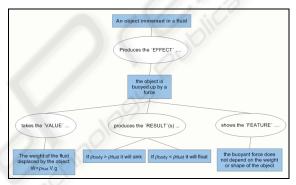

Figure 1: Archimedes Principle.

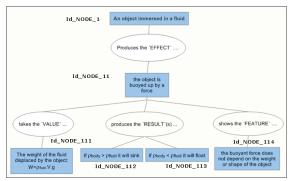By automatic identification of nodes, we can obtain a set of Node IDs, for example:

Figure 2: Archimedes Principle Node Identification.

The set of RSR is valid for knowledge representation, and it supports the questions categories in Q&A theory. We can express any content as a network composed of nodes and relations of the defined set, and the use of the appropriate synonyms It means we can translate

directly as a set of Horn clauses in a knowledge database:

Produces_the_EFECT(id_node_1, id_node_11),
Takes_the_VALUE(id_node_11, id_node_111),
Produces_the_RESULT(id_node_11, id_node_112),
Produces_the_RESULT(id_node_11, id_node_113),
Shows_the_FEATURE(id_node_11, id_node_114)

This approach is the basis for the e-consulting application. It is solved like a query to the knowledge database yielding the node identification. By using the resultant id_node, it recovers the associated content (text, text + graphics, animation, web page, equations, etc…).

3 THE INTELLIGENT WEB

Many people are working on the semantic web, with the main objective being to simplify and to enhance web searches. This work is based on the presence of certain kinds of tags specifying 'ontologies'.

That is finally the main idea of the semantic web: if we can specify the classes to which a word belongs and tag it, we are establishing absolute relationships between words and categories in such a way that we have an 'implicit relationship of 'belongs to the class' between the tagged word and all classes to which it belongs. Certainly, the inverse relation is present by means of the implementation of a mechanism for recovering all the words belonging to a certain class.

What we propose is a way for tagging the existent RSR in an explicit way on every text in a web page. As far as we satisfy this proposal, we will exploit the resultant text in different ways.

In our goal of representing knowledge, we must begin by wonder what is knowledge? This is probably one of the most difficult questions we can ask, and the most profound philosophical answer is surely out of the scope of this paper, but we can agree that "knowledge is a representation of the reality in our mind".

We think in terms of ideas that we usually express in different ways, such as texts, drawings, equations, images, sequences of memories, such as videos, etc.

The important thing here is that they are connected in our mind by means of certain kinds of relations. Our intention is integrate different contributions proceeding from different theories, such as the idea of building mental maps in Meaningful Learning Theory (Novak, Ausubel, 2002).

4 CONCLUSIONS

The set of RSR is valid for knowledge representation and it supports the question categories in Q&A theory. We can express any content as a network composed of nodes and relations of the defined set, and the use of the appropriate synonyms. It means we can translate directly as a set of Horn clauses in a knowledge database.

We can use different synonyms for different domain applications without losing the semantic connectivity. It provides a means for the development of natural language answering systems. It can be a means for the definition of general ontology and relations on the semantic web.

It is possible to automatically generate e-learning lessons, documents or Q&A systems from any knowledge base generated automatically from an RSR expression of contents.

5 FUTURE LINES OF RESEARCH

The main lines of research in which we are interested and in which we are intensifying our efforts include the following:

- Operations on RSR (RSR Inverses and plurals, RSR combinations, The treatment of verbal trends in RSR)
- Creation of a knowledge representation and storage model and data architecture capable of supporting the definition of knowledge networks based on RSR at the same time.
- Fundamental Cognitive Networks: Formulation of a molecular structure of knowledge by using the patterns most frequently used by people, for discourse construction.
- The elaboration of Knowledge Representation Methodology, by using rhetoric-semantic networks.
- The application of Walter Bosma's results regarding rhetorical distance application and treatment as semantic weighted networks.

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