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Hyper-document structure: Representing cognitive coherence in non-linear documents

Introduction

There are long and well-established literatures on textual devices that signal the coherence structure of a discourse to the reader, within theoretical, computational and psycholinguistics. Most of the work so far has addressed the traditional conceptualization of text as a two dimensional array on a physical page, traversed in a set pattern (e.g., left to right, top to bottom, in the Western tradition). A text type that does not follow this conceptualization is hypertext. Hypertext is to be read on a computer screen, and is non-linear, with several reading paths available through the document. The reader moves from node to node by mouse-clicking on links. A node can be the equivalent of a traditional text page or can contain just a few sentences. A link can be a word in the text or a graphical element in the node. As nodes contain multiple links, the author can only partially control the order in which the reader will access them. In other words, with hypertext, a new conceptualization of text has emerged as a three-dimensional array on a computer screen, which can be traversed in any number of ways. This presents a range of challenges for text analysis research.

For instance, coherence markers of the traditional notion of text do not work for this new medium. Therefore a new set of devices, not only textual but also graphical, is needed together with formation rules

to govern their usage, supported by sound theoretical frameworks. We explore here new possibilities for constructing coherence in non-linear documents to address this research challenge.

Coherence representation in linear text

Understanding a text depends on the reader's ability to construct a coherent representation of its content. To do so, the reader needs to be able to identify the conceptual relations holding between the set of discourse elements (sentences, paragraphs or entire text sections). In linear text this identification is facilitated by a number of cohesive elements. Over the years, the study of text coherence has concentrated on two types: those that function at the level of discourse structure and those that function at the level of document structure. Much work has focussed on discourse structure. This work has mainly studied the use of relational (for instance, *and*, *but*, *because*, etc.) and referring expressions (for instance, pronouns). Other work has highlighted the role played in text organization by graphical features such as punctuation, parentheses, dashes, etc. (*concrete features*) or layout and graphical formatting (*abstract features*) (Nunberg, 1990). Layout and formatting features constitute the *abstract document structure* (Power, Scott, & Bouayad-Agha, 2003) and they work differently from the way in which both

discourse markers and concrete textual features work, because whereas these are textual, devices like layout and formatting are visual.

Abstract discourse structure: visual versus textual

Abstract features transform the line of text into a visual configuration capable of conveying discourse structure on the space of the page. In visual configurations, the association between a sign and its meaning is characterized by a degree of isomorphism, which makes this association partially motivated. For instance, in the sentence ‘I had a busy morning: I had a work meeting; I went shopping; I picked up the children’, the text segments in the list play an equivalent role within the sentence. This rhetorical equivalence could be expressed through a bulleted list in which the segments are given the same visual rendering: each segment after the colon starting on a new line with a bullet. Likewise, the titles of the sections of a text will be visually more prominent than the titles of the subsections, in order to render the hierarchy of the text structure. Finally, emphasis is visually expressed through a format that stands out.

Unlike textual representations, visual representations tend to be regulated by conventions that are less strict and more dependent on the context of use. For instance, a list of clauses could be indented or not, bulleted, numbered or scored; whatever the chosen configuration, it is important that all listed clauses are rendered in the same way and occupy the same horizontal position. Also, the chosen convention should be consistently used throughout a document. Even though they respond to flexible conventions, visual features can express discourse connections so effectively that the use of discourse markers or punctuation becomes redundant. So, in a bulleted list the use of connectives, line-terminal commas or full stops are superfluous, because the conventions at work in the visual configuration of

the list override the conventions that regulate the use of discourse connectives and punctuation.

Coherence representation in non-linear text

Discourse markers such as connectives can only be effectively used when discourse units (clauses, sentences, sections) are arranged in a predefined sequence, so that they are accessed in a univocal order. However the order in which discourse parts will be accessed can only be partly controlled in hypertext, because this is a network of interconnected nodes. Order can be established locally (a node can be linked to another node), but it is hardly possible to establish it globally through a whole hypertext (unless one resorts to constrained paths, which would defeat the purpose of using a non-linear medium).

So, discourse markers cannot be used to signal the discourse relation between nodes, because each node is accessible in more than one way. Things, however, are different for abstract document features, because they are visual and work in space. Because of its technical characteristics, hypertext is a spatial medium (and indeed numerous proposals that tackle the issue of non-linearity seek to compensate for the lack of control on discourse order by exploiting the spatial nature of hypertext (compare Carter, 2000). But it is also a temporal medium, in which spatial structures have a temporal dimension and realization (Luesebrink, 1998). Thus, both space and time can be exploited in hypertext to express discourse coherence: in hypertext the notion of abstract document structure includes both spatial and temporal configurations working in a three-dimensional space.

We propose that graphics and animation could be used to express discourse coherence in hypertext. At present, most hypertexts (especially on the web) make no use of graphical features to signal rhetorical relations between nodes, and nodes often consist of long text pages with a few links targeting other pages, from

where the source page can no longer be seen. However, if hypertext nodes were made much smaller, then the screen could be used as a visual field across which they can distribute as links are clicked and new nodes appear, composing meaningful patterns. The appearance and distribution of the nodes should signify the rhetorical role that their content plays within the discourse. To achieve this, rhetorical relations could be used as document structuring principles during discourse construction to define hypertext links. These could then be dynamically rendered during navigation through the consistent and concurrent use of the medium's spatial and temporal graphic features.

In this respect, having established a parallel between textual and visual processing (Riley & Parker, 1998), Gestalt theory has proposed useful principles of document design (Campbell, 1995). Furthermore, a number of representational rules for visually expressing discourse relations between hypertext nodes can be derived from the semiology of graphics, according to which graphic features can be employed to express conceptual relationships of *similarity*, *difference*, *order* and *proportion* exploiting the properties of the visual image (Koch, 2001). Using these rules, we have designed and begun testing a series of prototype visual patterns expressing coherence relations in non-linear discourse (Mancini, 2005). Still in its infancy, this work aims to identify ways of presenting hypertext discourse which employ graphical features in a systematic and principled way, extending the notion of abstract document structure by making articulate use of the space-temporal dimensions of the electronic medium.

Conclusions

If readers are to understand a text, their mental representation of its content has to, at least to some degree, reflect the coherence structure intended by the writer. In linear documents, a number of textual devices signalling the

coherence structure of discourse facilitate this process of reconstruction. However, these devices only work within a linear structure and they are no longer helpful in the interpretation of non-linear documents. When it comes to non-linear media, such as hypertext, a different set of signalling devices is required, which are visual rather than textual. These visual elements constitute the abstract document structure in traditional text, where they work within the bi-dimensional space of the page. However, in hypertext they have to work in a three-dimensional space as well as in time, which extends the notion of abstract document structure. We have only begun to study this new concept of document structure and the principles that regulate the use of its features are yet to be established, but both theoretical and empirical work suggest that this is the route to follow if we are to fully exploit the potential of electronic text.

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