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Coherent narrative summarization with a cognitive model

Renxian Zhang [a,*], Wenjie Li [b], Naishi Liu [c], Dehong Gao [d]

[a] *Department of Computer Science and Technology, Tongji University, China*
[b] *Department of Computing, The Hong Kong Polytechnic University, Hong Kong*
[c] *Department of English, School of Foreign Languages, Shanghai Jiaotong University, China*
[d] *1688 Search and Recommendation, Alibaba.Inc., China*

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Abstract

For summary readers, coherence is no less important than informativeness and is ultimately measured in human terms. Taking a human cognitive perspective, this paper is aimed to generate coherent summaries of narrative text by developing a cognitive model. To model coherence with a cognitive background, we simulate the long-term human memory by building a semantic network from a large corpus like Wiki and design algorithms to account for the information flow among different compartments of human memory. Proposition is the basic processing unit for the model. After processing a whole narrative in a cyclic way, our model supplies information to be used for extractive summarization on the proposition level. Experimental results on two kinds of narrative text, newswire articles and fairy tales, show the superiority of our proposed model to several representative and popular methods.

Keywords: Cognitive modeling; Summarization; Coherence; Proposition extraction

1. Introduction

This paper is devoted to a special task in automatic text summarization: generating coherent as well as informative summaries for narrative text. Ever since Luhn (1958), summarization researchers have made great efforts to increase the information coverage, or **informativeness**, of a summary. But equally important is a summary's **coherence**, which is our current emphasis.

The concern with coherence is motivated by the ultimate purpose of automatic text summarization – to provide human readers, not machines, with a sufficiently abridged summary of a long document or document set to facilitate efficient information processing. In this sense, the summary serves as a surrogate for the original document(s) in terms of informativeness and expressiveness. Informatively, the summary is expected to maximally reproduce the original document's essential information in a reduced space. Expressively, it is expected to convey the information in an intelligible and coherent way to human readers.

* Corresponding author. Tel.: +86 13816793063.
E-mail addresses: rxzhang@tongji.edu.cn (R. Zhang), cswjli@comp.polyu.edu.hk (W. Li), rong@sjtu.edu.cn (N. Liu), dehong.gdh@alibaba-inc.com (D. Gao).

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Many coherence-oriented or coherence-based approaches to summarization concentrate on textual content, such as word cohesion (Halliday and Hasan, 1976; Barzilay and Elhadad, 1997), sentence similarity (Hatzivassilogiou et al., 2001; Zhang, 2011), rhetorical structure (Marcu, 2000), etc. But since the ultimate consumers and judges of a summary are human readers, there is no reason why we cannot model coherence in *human terms*. But such attempts are surprisingly rare in the summarization community. To account for such human terms, we can resort to the theories and models developed by cognitive psychologists over decades.

We choose to summarize narrative text because compared with expository or argumentative text, a narrative text relies more on coherence for successful human understanding. When reading a typical expository article such as a biography, we can choose to read only the parts that interest us (e.g., birth place, education, marriage) and the lack of coherence between the chosen parts does not affect our understanding of the person. When reading a typical argumentative article such as a scientific thesis, we can focus on only particular sections to get the *method*, *result*, *conclusion*, etc. to understand the topic despite the lack of global coherence. What about reading a typical narrative article such as a story? Reading only parts of the story disrupts the development of plot and renders an incoherent representation of the characters, their relations, and events in our mind, which prevents us from understanding it. The situation is true for both the original text and the summary.

In this work, we will build a novel computational model based on a popular cognitive model (Kintsch, 1998) of narrative text comprehension, establishing its computational counterparts in the model's cognitive process. Coherence is an underlying constituent of the model, which is then used to summarize narrative text. Moreover, summary sentences extracted with this model are not only coherent but also important, a point that will be validated by experiments on event-centric news and fairy tales, both typical instances of narrative text. This is our major contribution to the summarization community.

We will discuss related work in the literature in Section 2. In Section 3, we will computerize a cognitive model of narrative text comprehension with all the technical details. In Section 4, the cognitive model-driven coherence will be used to summarize narrative text, where propositions instead of sentences will be taken as the basic processing units. Section 5 presents the experimental results on two kinds of narrative text. The highlights of our work are concluded in Section 6, where we also point out future directions.

2. Related work

Our work is informed by several sources of related work. The modeling of coherence has its root in cognitive accounts of text comprehension; the concern with coherence is generally preceded by many exemplar works; narrative summarization is not a new topic in the summarization community. We will briefly introduce works from those sources that jointly shape up the current endeavor.

2.1. Cognitive accounts of text comprehension and coherence

In cognitive psychology, a large body of research focuses on text comprehension, as many researchers relate the linguistic aspects and processes involved in reading to activities in the human memory. Coherence is, for cognitive psychologists, concomitant with text comprehension which is intensively studied to understand human cognition. According to many theories and models of cognitive psychology (Tapiero, 2000; van Dijk and Kintsch, 1983; Gernsbacher, 1996; Kintsch, 1988, 1998; van den Broek et al., 1996; Zwaan et al., 1995; Tapiero, 2007), a coherent representation is required for text comprehension. In order to make sense of a text, readers must establish coherent relations between textual units. Therefore, coherence and text comprehension are the two sides of the same coin. Guided by Centering Theory-based coherence, Cristea and Iftene (2010) empirically show that human cognition is near optimal and economical (stack-like).

To capture coherence in this flavor, many models have been developed, such as the Construction-Integration (CI) Model (Kintsch, 1998), the Structure Building Framework (Gernsbacher, 1990), the Landscape Model (van den Broek et al., 1996), the Event-Indexing Situation Model (Zwaan et al., 1995), and the Intentional Partial Order Causal Link Planning Model (Riedl and Young, 2010). The Landscape model, for example, captures the changing patterns of word activation guided by anaphoric clarity and clausal coherence. The CI model accounts for how propositions from input text are associated in a network with stored knowledge from the long-term memory. Its extended version, CI-2 (Kintsch and Mangalath, 2011), employs a dual-memory model that highlights the role of the explicit context of words.