Tools for Representing and Processing Narratives

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INTRODUCTION

Narratives describe and link events. Narratives are pervasive. The representation of the handling of a project or life experiences are narratives (i.e., it is we that draw the links). Some suggest that Web sites should be designed considering visits as narratives. In research in museology, it has become popular to consider visiting a museum as a narrative. Narrative is stressed in some approaches to diagnosis (including in knowledge acquisition for intelligent systems). It stands to reason that handling narratives should loom large in information processing, or at the very least in artificial intelligence (AI). In fact, after the 1980s (during the "AI Winter"), AI retreated from a concern with narratives. However, narrative has leaked since then into other domains of computing, such as human interface design and multimedia (e.g., in tools for assisting in the editing of videos). Computational or computer tools for handling crime analysis and legal evidence need be aware of legal scholars' work on legal narratives and how to apply argumentation to their reconstruction. Ethical arguments are applied in a narrative context. Consider computer crime events: hypothetical reconstruction constructs possible narratives to match what actually happened. We focus on AI tools for analyzing or generating narratives. We also devote a section of this article to organizational storytelling, which sometimes uses databases of stories.

BACKGROUND: A CONCISE HISTORY OF THE DOMAIN

Roger Schank's *conceptual-dependency* approach to the automatic understanding of narratives is goal driven. It is based on a set of basic notions of action or thought, and in analysis it proceeds in a bottom-up fashion. Characters have a hierarchy of goals. To achieve a goal they select a plan, which itself sets some goal or goals. Schank's several books include Schank and Abelson (1977) and Schank (1986). A high level of sophistication was already achieved by conceptual-dependency theory practitioners by the early 1980s, for example in Michael Dyer's BORIS system (Dyer, 1983). Robert Wilensky (1983) introduced a detailed classification of characters' goals. Tools like BORIS parse and make sense of a narrative in a bottom-up fashion. Ethics in BORIS concerns breach of contract (e.g., adultery).

Schank's school appeared to supersede the *story-grammar* approach (Frisch & Perlis, 1981; Garnham, 1983), which is top-down and rooted in structuralism. Story grammars remain central to narratology as practiced in folklore studies. Following the appearance in 1958 of an English translation of Vladimir Propp' seminal work (Propp, 1928), in turn Dundes (1962-1975) and Jones (1979) became the foundation of the structural narratological study of folktales.

Also consider Maria Nowakowska's cluster of mathematical theories from the 1970s: her motivational calculus (Nowakowska, 1984, ch. 6), theory of actions (ch. 9), theory of dialogues (ch. 7), and theory of multimedia units for verbal and nonverbal communication (Nowakowska, 1986, ch. 3).

SOME OLDER HISTORY

In the late 1970s and early 1980s, Roger Schank's research group at Yale University "quickly became focused on understanding narratives. In a series of programs, they developed a theory of the knowledge structures necessary to understand narratives" (Mateas & Sengers, 2003, p. 2). "[T]hese early narrative systems fell out of favor" as "[t]hey were intensely knowledge-based" and therefore were difficult to be made more general (p. 2). "Except for occasional exceptions continuing in the Yale tradition, such as Mueller's model of daydreaming [(Mueller, 1990)] and Turner's

MINSTREL model of storytelling [(Turner, 1994)], sustained work on narrative disappeared from AI" (p. 3). Mueller's bibliography and portal on story processing programs (Mueller, 2005) shows that few, yet important contributions to the field kept being made throughout the 1990s. Whatever remained of narrative processing was marginalized within AI, while awareness of the importance of handling narratives surfaced sometimes in other areas of computer science (hypertext design and human-computer interface design).

Proceedings continued to appear, for example, of the *1995 AAAI Spring Symposium on Interactive Story Systems.* The MIT Media Lab's Narrative Intelligence Reading Group, active during in the 1990s, continues as an e-list. CMU's OZ interactive fiction project is influential; GLINDA fits in OZ (Kantrowitz, 1990). Story generation models include Okada and Endo (1992) and Smith and Witten (1991).

Schubert and Kwang (1989) discussed an episodic knowledge representation for narrative texts. Within Stuart Shapiro's long-lived SNePS project in knowledge-representation, consider Shapiro and Rapaport (1995) about narrative understanding. Zarri (1998) developed knowledge-representation tools, applied to narrative reports.

Several systems of interest to narrative processing were specifically concerned with explanation, such as Leake's ACCEPTER (Leake 1992, 1994)—Leake also worked on SWALE (Schank 1986)—Kass's TWEAKER/ABE (1994), and Hobbs' TACITUS (Hobbs, Stickel, Appelt, & Martin, 1993). Connectionist approaches to narrative processing include St. John's Story Gestalt model (1992), Langston, Trabasso, and Magliano (1999), and UCLA's ROBIN and DISCERN projects (Miikkulainen, 1993). Schrodt, Davis, and Weddle (1994) reported about KEDS, a program that processes event data from a Reuters data source and answers queries about news events. Hayes, Knecht, and Cellio (1988) reported about a news story categorization system. Janet Kolodner's CYRUS, applying case-based reasoning, answered queries about the travels and meetings of U.S. Secretary of State Cyrus Vance (Kolodner, 1984).

SOME RECENT WORK

AI research into the processing of narratives, active in the 1980s, declined in the 1990s, until the current comeback. See Mateas and Sengers's edited book (2003) and Bringsjord and Ferrucci on BRUTUS (2000), Mueller (2004), Halpin, Moore, and Robertson (2004), Green et al. (2004), Pérez y Pérez & Sharples (2001), Liu and Singh (2002), and Szilas and Rety (2004). Lang (ch. 12 in Mateas & Sengers, 2003) augments the story grammar approach with a treatment of goals rooted in Schank's school; Lang's system generates folktale-like stories. The 1990s saw steady progress in the field of automatic summarization as applied to reports (narrative or otherwise); see Nissan (2003a).

Introducing MAKEBELIEVE, their interactive story-generation agent, Liu and Singh (2002) claimed: "We picked story generation because we feel it is a classic AI problem that can be approached with a creative use of commonsense knowledge. Compared to problem solving or question answering, story generation is a 'softer' problem where there is no wrong solution per se, and that solution is evaluated subjectively."

MEXICA produces frameworks for short stories (Pérez y Pérez & Sharples, 2001). It combines engagement (which comprises generation) and reflection, during which, for example, it "evaluates the novelty and interestingness of the story in progress." MEXICA goes beyond "those models of computerized story-telling based on traditional problem-solving techniques where explicit goals drive the generation of stories": generation in MEXICA is done "avoiding the use of explicit goals or story-structure information" (Pérez y Pérez & Sharples, 2001), thus committing to neither goal-driven narrative processing, nor story grammars.

In COLUMBUS (unimplemented), Nissan (2002a) showed how, making a hierarchy of goals explicit, these are either character's goals or goals of the narration (which may, e.g., resort to mock-explanation). The given humorous literary text is in the genre of pastiche, and intertextuality (allusions to texts from the literary canon) plays a major role; the model captures this, just as it captures the mock-explanatory strategy of the narrator. A formal representation for narratives, which captures concepts such as beliefs, goals, purposeful action, perceptions, communication, testimony, deception, physical possession and ownership, various modes of holding or assuming an identity, and so forth, very much in debt to Schank's conceptual-dependency theory, was applied by Nissan (e.g., 2003b) to the analysis of various narratives. Nissan (2002b) analyzed Pirandello's play *Henry IV.* The

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