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A knowledge extraction and representation system for narrative analysis in the construction industry

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ABSTRACT

Many researchers advocate that the real-world narratives shared by experts or knowledge workers are helpful in teaching and educating novices to learn new knowledge and skills. Narrative analysis is a useful method for experts to understand narratives. However, it does not produce any clear or explicit layouts. This is not easy for a new learner without prior knowledge to glean the right messages from narratives within a short time. In this paper, a narrative knowledge extraction and representation system (NKERS) is presented to extract and represent narrative knowledge in an effective manner. The NKERS is composed of a narrative knowledge element extraction algorithm, a narrative knowledge representation method and a narrative knowledge database. A prototype system has been built and trial implemented in the construction industry. The results show that the domain experts agree that the narrative maps generated by the NKERS can effectively represent narrative elements and flows. Three-quarters of respondents expressed that they will use the produced narrative maps in their training courses to facilitate students' learning.

1. Introduction

Narratives exist in the human world with an infinite diversity of forms (Barthes & Duisit, 1975). Narrative is an international, trans-historical and transcultural medium for human beings. Narrative has a special function in the area of memorization and learning (Taylor, 1989). It helps to retain humans' memory especially culture memory of things that have happened in the past (Ong, 1982). For example, narratives can record ancient incidents such as Trojan wars and foster people's memories of incidents and benefit from lessons learnt in the past. People can recall additional information by reading others' narratives (Gabriel, 2000). By relating critical ideas with previous knowledge and experience, people can construct situations mentally by using narratives, simulating actions and predicting the consequences before they actually perform tasks in the real world (Gee, 2004). Narrative comprises human rationality and narrative structures (Johnson, 1987). It helps people in repairing and restoring meaning when they are in adversity (Bury, 2001). Narratives are useful for people to remember and learn how to solve problems and make decisions (Jonassen & Hernandez-Serrano, 2002). How humans read and understand narrative texts greatly depend on human capability. Hence, people with different reading capability can have a different understanding or interpretation after reading the same narrative texts. People may misunderstand the information in the narratives. The misunderstandings generate great hindrances to gaining new knowledge (Guzzetti, 1990). This is not easy to rectify in their minds. If people do not have any relevant knowledge or experience, it is not easy for them to understand the correct information in the narratives in a short time. To facilitate humans to understand narratives, it is important to develop a method to systematically analyze narratives and present correct narrative information in a clear and explicit way.

The construction industry is well-known for being one of the highest-risk industries in the world due to its high number of fatalities and accident rate (Al-Humaidi & Tan, 2010; Navon & Sacks, 2007). Governments and organizations have stipulated several regulations and guidelines to achieve better safety performance (Government of Alberta, 2011; Queensland Government, 2011; United States Department of Labor, 2011). However, there are still some areas that are not covered by laws and in which lessons have not been learnt from overseas and therefore deserve more attention. Researchers have contributed a lot to developing different intelligent systems to improve the situation, especially in the area of genetic algorithms, neural networks, and knowledge-based and expert systems (Irani & Kamal, 2014). Recent studies focus on process management (Hajdasz, 2014) or company failure detection

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(Horta & Camanho, 2013). However, limited studies are found to use narratives to support crisis management as well as workers' learning in the construction industry. Currently, construction investigators document incidents as narratives to disseminate important messages to workers. The traditional approach requires knowledge of experts and knowledge workers to understand the causes, developments and consequences of the incidents. This information is critical for crisis management (Paraskevas, 2006). However, it is immersed in the narrative texts without a clear indication. It is also not easy for a new learner to perceive the right messages in narratives within a short time. Once a new learner digests a concept wrongly or misunderstands the moral of a narrative, extra effort is needed to rectify his thinking. As a result, it is vital to know what can help to analyze narratives, extract and represent narrative knowledge from the narratives and facilitate people to understand and learn the narratives in a clear way. In this paper, a narrative knowledge extraction and representation system (NKERS) is presented to effectively extract narrative knowledge elements and represent narratives in a clear layout. This system incorporates techniques in computational linguistics and rule-based reasoning and provides a semi-automatic method to conduct narrative analysis and generate narrative maps. Encouraging results are found through a case study in the construction industry.

2. Literature review

2.1. Narrative

Narratives are everywhere and enterprises and organizations are no exception. Organizational documents such as handbooks, incident reports, newspaper articles and personal experience are examples of narratives. Most business knowledge and expertise are embedded in narratives in organizations. Instead of learning from incidents happening currently, people can learn from the narratives in organizations or from human experience. Indeed, narratives have different dimensions. As shown in Table 1, there are four different narrative dimensions: story, recount, newspaper report and procedure. According to Labov (1972), a story includes six elements which are abstract, orientation, complication, evaluations, resolutions and coda. An abstract is a brief summary introducing the main idea of the story. Orientation shows the background information (such as personas, time and place) of the story to the readers. Complication means a series of events before showing the climax or highpoint of the story. The information for the readers to know the reason of telling the story is found in the evaluation. Resolution is the attempt to handle the complicated situation. The coda is the consequence of the attempt or the ending of the story. Due to the presence of various stories, it should be noted that not all six elements are included in every story (McCabe & Peterson, 1991). In general, orientation, complication, resolution and coda are usually found in stories. Elements such as abstract and evaluation seem always to be overlooked. However, the evaluation gives the key information regarding why you need to read the story.

Recounting can also be found in organizations. The experience of knowledge workers can be regarded as an example of a personal recount while incident reports are regarded as factual reports. It descriptively relates a real incident or an imaginary event to the readers (Schleppegrell, 2003). Newspapers, having different scaffolds from factual recounting, report current issues to the public. They highlight the most critical information in the news by using headlines (Van Dijk, 1985). Instructions or manuals are examples of procedure in organizations. Sometimes procedure is classified as a part of narrative although it contains detailed information regarding the flow and sequences of events (Lewis & Wray, 1996). The usage of stories is prevalent as it is good at motivating readers to think about the issues and providing a lesson to be learnt by the readers (Labov, 1972; Özyıldırım, 2009). As a result, this study selects stories as the main narrative scaffold for investigation.

Table 1
A review of different narrative functions and scaffolds.

Narrative Dimensions (Examples)	Function(s)	Scaffold
Story (e.g. novels, fables, folktales, legend, etc.)	• To encourage readers to think about the issues • To provide a lesson to be learnt by the readers	Abstract Orientation (who, where, when) ↓ Complication ↓ Evaluation ↓ Resolution ↓ Coda Labov (1972)
Recount	• To descriptively relate a real incident (such as an author's experience or a particular incident or event) or an imaginary event (like fiction) to the readers	Setting (protagonist, situation, time, etc.) ↓ Series of events (in time order) ↓ Concluding statement or ending Schleppegrell (2003)
Newspaper report	• To report the current issues to the public	Headline ↓ By-line ↓ The Lead (summary of the most important information, i.e. protagonist, situation, time, etc.) ↓ Next most important point ↓ Least important point ↓ Conclusion (consequences, possible future leads) abcteach (2004)
Procedure (e.g. user manual, instruction materials, etc.)	• To indicate how to make or do something	↓ Introduction of the aim or goal ↓ Materials required for completing the procedure ↓ Series of events in the correct order ↓ Evaluation Lewis and Wray (1996)

2.2. Narrative analysis and narrative map

Different disciplines have drawn increasing attention to narrative analysis (Bury, 2001). It is popular to use narrative analysis to understand clients' experience such as dangerous or embarrassing experiences (Stephens, 2011; Özyıldırım, 2009). There is a wide range of narrative analysis methods (Delamont, 2012). Özyıldırım (2009) suggested that one of the most influential narrative models is presented by Labov and Waletzky (1967) and Labov (1972). Labov's model can be used to analyze narratives in written or oral form