International Journal of Business, Human and Social Sciences
ISSN: 2517-9411
Vol:5, No:8, 2011

A Study of Computational Organizational Narrative Generation for Decision Support

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***Abstract*—**Narratives are invaluable assets of human lives. Due to the distinct features of narratives, they are useful for supporting human reasoning processes. However, many useful narratives become residuals in organizations or human minds nowadays. Researchers have contributed effort to investigate and improve narrative generation processes. This paper attempts to contemplate essential components in narratives and explore a computational approach to acquire and extract knowledge to generate narratives. The methodology and significant benefit for decision support are presented.

***Keywords*—**Decision Support, Knowledge Management, Knowledge-based Systems, Narrative Generation

I. Introduction

HUMANS are narrative animals. When people are in their childhood, the first thing they are given to learn to approach the world is narrative. It is not limited to the stories in folktales, fables and legends. When they grow up, they still surround themselves with narratives such as biographies and case studies. Although there are different types of narratives available in the world, people are capable of manipulating and assimilating different narratives to support reasoning processes. Due to this phenomenon, some researchers have begun to investigate the use of narratives in different disciplines [1], [2]. It is believed that narratives are the most useful tool for representing actions and events and the most effective way to convey new knowledge to novices [3]. However, little research regarding using narratives to facilitate human decision making has been conducted. This paper attempts to investigate the use of narratives to support decision making processes. It first presents the evolution of narratives in human lives. Then, a review of narrative-based approaches and narrative structures are introduced in second section. The third section describes the methodology of using narratives in decision support. The forth and last sections present the results, significant benefits and conclusion.

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The work described in this paper was fully supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (Project No. PolyU 5145/09E). The authors would also like to express their sincere thanks to Research Committee of the Hong Kong Polytechnic University for financial support of the research work.

II. Related Work

A. Narratives

Narrative plays a critical role in human lives. Many researchers advocate that people have an inherent ability and predisposition to memorize, assimilate and recall information in narrative forms [4], [5]. However, people encounter a variety of narratives during their lifetime. Different narratives have their own natures and target audiences. In order to investigate the importance of narratives, the evolution of narratives in human lives is shown in Table I. The narratives change from simple and traditional to complicated and diverse when a person grows up. As children, they first approach the world by reading some traditional narratives such as fairy tales, folktales, fables and legends. Apart from fairy tales which are fantasies, others are constructed by past experience of ancestors or real history of the world. Simple language is used to present the traditional narratives. Non-human actors and personal dialogues are involved in traditional narratives in order to attract young readers' attentions.

TABLE I
EVOLUTION OF NARRATIVES IN HUMAN LIVES

Human Live Time	Children ----------> Youths ----------> Adults		
Narratives	Simple, Traditional ----------> Complicated, Diverse		
Example(s)	➢ Fairy Tales ➢ Folktales ➢ Fables ➢ Legends	➢ Fictions ➢ Blogs ➢ News	➢ Case Studies ➢ Incident Reports
Source(s)	Past experience or real history	Events happened around	Organizational incidents
Purpose(s)	To introduce the world to children	To entertain young people	To assist adults to complete particular tasks
Style(s)	Simple and casual	Formal and concise or simple and casual	Formal and concise

When they become young people, they continue to explore themselves in other forms of narratives such as fictions, blogs and news. The main purposes of young people to read the narratives are to learn the things around them so as to entertain themselves. The content of the narratives changes from the previous incidents or histories of the world to events happened around them. Some of the narratives, like blogs, are for entertainment. Simple and informal language is widely used for communication.

For adults, they tend to handle more specific and formal narratives such as the case studies or incident reports in organizations. Adults read the narratives in order to learn from previous events and complete particular tasks. The narratives are mainly used for knowledge sharing and knowledge retention. As a result, narratives are recorded based on real incidents. Formal and concise language is used to construct narratives. As narratives which contain meaningful information to people are ubiquitous in different stages of human lives, many researchers have raised interests of investigating narratives. A review of narrative related work is discussed in the narrative-based approached section.

B. Narrative-based Approaches

This section discusses the development of narrative-based approaches. In traditional forms of narrative generation, a vast amount of human effort and domain knowledge were involved in assuring coherence and eliminating conflicts in stories [6]. Due to the considerable amount of time and resources, researchers have been investigating the use of Information Technology (IT) to conduct narrative generation. There was a substantial amount of work in narrative generation in the 1970's and early 80's. In the early stage, researchers attempted to explore the ways to understand human narratives by using computer programs. Two story-understanding systems which are Script Applier Mechanism (SAM) and PAM were then built. SAM was developed for reading newspaper articles by using scripts. With the use of input clauses which are English texts ranging from two to ten sentences, SAM could produce summary output in English or Spanish. SAM was capable of analyzing narrative content and answering questions. It was well proven to understand stories constructed from several areas such as traffic, aviation accidents and oil spills [7]. However, there were several deficiencies in SAM. It was required to use structure form of knowledge and script-based stories as an input. Due to the fact that a massive system was developed to construct meaning of each sentence, the processing time of SAM was relatively long.

To approach the problems, PAM was built to manipulate goals and plans to interpret and understand stories. PAM was capable of identifying the goals and corresponding plans in the stories [7]. Although SAM and PAM could use scripts and goal and plan's representation method to interpret stories, they demonstrated limited power in story generation or telling. In order to further improve PAM, TALE-SPIN was developed to construct stories by setting goals for characters and then recording their plans to reach the goal. TALE-SPIN could produce simple and coherent stories. However, a limited range of stories were obtained as the stories were constructed from a canned frame in specific domains [7], [8]. As a result, this paper attempts to investigate narrative structures and to present a computational narrative generation method which can automatically acquire domain information to produce narratives.

C. Narrative Structures

Although researchers have been aware of the importance of narratives in human lives and adopted them in problem-solving, limited work was conducted to investigate what is narrative. Therefore, this paper contributes to explore what are the essential components in a story.According to Aristotle, there were three critical components in a narrative which were beginning, middle and end [9]. Branigan advocated that narrative was composed of events with a beginning, a middle and an end and spatial and temporal data are linked as a cause-effect way in the events [10]. Todorov suggested that narratives followed the following structures: Equilibrium→ Disruption→ Resolution [11]. Equilibrium represents the balanced situation at the initial stage. Then, disruption of an event changes balanced situation into imbalanced situation. A new equilibrium can finally be established in Resolution stage. Todorov's narrative structure is similar to that of Aristotle. A mapping between two types of narrative components is shown as Table II. Although there are different forms of narratives available in the world, scholars and researchers advocated that there are three essential components which are a beginning, a middle and an end in a narrative. This paper attempts to use these basic components to produce narratives.

TABLE II
A MAPPING OF NARRATIVE COMPONENTS

Advocator (s) of Narrative Structure	Aristotle & Branigan	Todorov
Timeline		
Start ⎪	Beginning	Equilibrium
⎪	Middle	Disruption
End ↓	End	Resolution

III. FRAMEWORK OF COMPUTATIONAL ORGANIZATIONAL NARRATIVE GENERATION SYSTEM (CONGS)

This section presents a framework of Computational Organizational Narrative Generation System (CONGS) as shown in Fig 1. Due to the fact that a huge amount of expert knowledge and human force are involved in producing narratives, researchers adopted different IT infrastructures to assist knowledge workers in narrative generation. However, the processing time of narrative generation systems was relatively long and limited stories were produced. The long processing time may due to the full analysis of narrative texts. Also, a defined frame which is used to construct a narrative reduces the number of generated stories.CONGS is developed in order to address the problems. It is composed of three main areas: Narrative Acquisition, Narrative Representation and Narrative Construction. The detail of each area is shown in section III A, III B, and III C, respectively.

A. Narrative Acquisition

CONGS attempts to acquire narrative data stored in external knowledge sources. For example, CONGS obtains narrative data by visiting organization's databases or Really Simple Syndication (RSS) feed from public domains such as websites or newspapers. Then, appropriate search engine technology is used to clean the narrative data. After identifying the target narratives data, the plain text of the narrative data is extracted and stored in knowledge base.

B. Narrative Representation

CONGS then represents the knowledge of narratives in the basic narrative format proposed by Aristotle and Branigan. The narrative data in plain text format is retrieved from knowledge base. By using an ontology coupled with WordNet (http://wordnet.princeton.edu/wordnet/download/), critical elements in each paragraph are indentified. CONGS analyzes the elements are analyzed and the paragraph is mapped into three stages by CONGS which are composed of a beginning segment, a middle segment and an end segment. The identified narrative segments are then undergone concept extraction process. Concepts are extracted by CONGS based on the Fuzzy Associated Concept Mapping (FACM) tool [12]. The concepts are then stored in knowledge base.

C. Narrative Construction

CONGS make use of a developed Genetic Algorithm (GA)-based narrative generation tool to produce a large amount of narratives in a reasonable period of time. The generated narratives are then undergone concept validation process so as to examine concepts contained in a narrative and narratives with contradiction are removed. Hence, new narratives can be obtained.

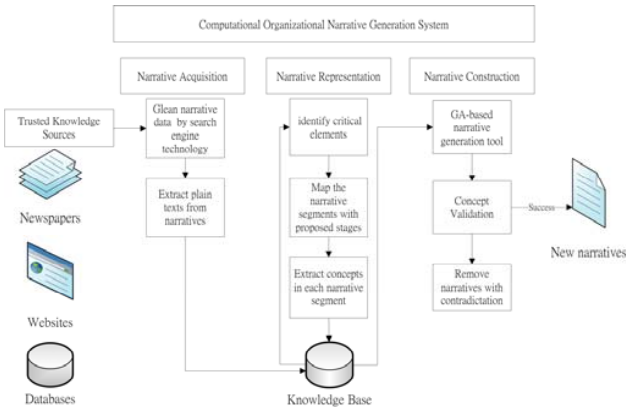

Fig.1 Framework of Computational Organizational Narrative Generation System (CONGS)

IV. Findings

To realize the capability of the proposed framework of CONGS, a pilot study has been conducted in construction industry. According to the recent statistics from Labour Department in Hong Kong, among three major industries including construction, catering and manufacturing, 20% of total industrial accidents and 83% of industrial fatalities were taken place in construction industry in 2008 respectively. On average, around 20% of industrial accidents and 76% of the industrial fatalities were found in the construction industry from 2004 to 2008 [13]. The statistics demonstrate an urgent need to reduce the number of accidents. As narrative is widely used in facilitating knowledge transfer to novices, it is important to acquire and generate new narratives in a short period of time in construction industry to educate new workers and support their decision making processes.

In this pilot study, the ontology coupled with WordNet is used to build a prototype for narrative representation. Preliminary experiment has been done manually to identify critical elements in narratives and investigate the frequency of critical elements occurred in narrative segments. Narratives regarding people falling from height are selected as the main theme and narratives related to this theme are sought and collected. Fig 2 shows a snapshot of a sample of collected narrative. After reviewing the collected narratives, seven critical elements in the narratives are identified. The explanations of each critical element are shown in Table III. To find the distribution of critical elements in the narrative segments, the frequency of critical elements occurred in narrative segments are measured and shown in Table IV.

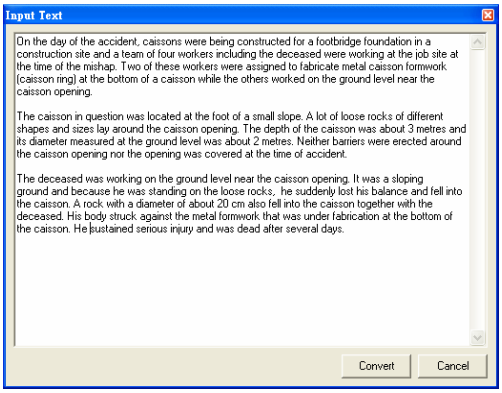

Fig.2 A snapshot of collected narrative

TABLE III
CRITICAL ELEMENTS IN NARRATIVES

Critical Elements	Explanations
Purpose	The aim of the event
Time	The period when the event happened
Location	The place where the event happened
Persona	The person involved in the event
Decision	The choice made by the persona
Consequence	The result after choosing the choice
Cause	The reasons led to the consequence happened

It shows that the purpose of the event and consequence after choosing the decision are usually found in the beginning and the end segment respectively. The time, location and persona of the event appear in the beginning and the middle segments. The decision made by the persona and the cause of the consequence occur in the middle and the end segments. The result shows that

different narrative segments contain different critical elements in the narratives. Through the identification the critical elements in the narratives, it can find the major narrative segments in the narratives and facilitate the narrative generation.

TABLE IV
FREQUENCY OF CRITICAL ELEMENTS OCCURRED IN NARRATIVE SEGMENTS

Critical Elements	Narrative Segment		
	Beginning	Middle	End
Purpose	1	0	0
Time	0.5	0.5	0
Location	0.5	0.5	0
Persona	0.5	0.5	0
Decision	0	0.375	0.625
Consequence	0	0	1
Cause	0	0.375	0.625

By investigating the use of narratives and CONGS into human decision making processes, several potential benefits can be realized which include:

1. Narratives from trusted sources can be directly acquired by CONGS which can speed up the narrative collection processes.
2. The new approach equipped with different IT infrastructures can help to extract knowledge in unstructured narratives and to reduce a vast amount of human force of domain experts in narrative generation.
3. Narratives obtained by CONGS can provide easier, more memorable and meaningful information for people to assimilate, remember and learn how to make decisions.

V. Conclusion

Narratives are ubiquitous in human life. It is a kind of invaluable asset of humans and organizations for decision support. However, traditional methods for narrative generation are inadequate to address the need for eliciting new and useful knowledge from a vast amount of narratives so as to generate new narrative for decision support. In this paper, a framework of a Computational Organizational Narrative Generation System (CONGS) is presented. By using CONGS, narratives residue in organizations or public domains can be acquired directly and represented in the basic format of narratives. It can reduce the labor force and speed up the narrative generation processes. Domain knowledge is acquired directly from valid knowledge sources which can enrich narrative knowledge to generate new narratives for decision support. In this pilot study, eight narratives are collected. Seven critical elements are identified and the frequency of each critical elements occurred in the narrative segments are shown. By using the critical elements, different narrative segments are recognized and relevant concepts are extracted in narrative segments. CONGS makes use of GA platform to produce new narratives. The framework of CONGS will be improved and extended to other domains so as to evaluate its applicability.

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