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Personal storytelling: Using Natural Language Generation for children with complex communication needs, in the wild…

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ABSTRACT

This paper describes a Natural Language Generation system (NLG), How was School Today? that automatically creates a personal narrative from sensor data and other media (photos and audio). It can be used by children with complex communication needs in schools to support interactive narrative about personal experiences. The robustness of story generation to missing data was identified as a key area for improvement in a feasibility study of the system at a first special needs school. This paper therefore suggests three possible methods for generating stories from unstructured data: clustering by voice recording, by location, or by time. Clustering based on voice recordings resulted in stories that were perceived as most easy to read, and to make most sense, by parents in a quantitative evaluation. This method was implemented in the live system, which was developed and evaluated iteratively at a second special needs school with children with different usage profiles. Open challenges and possibilities for NLG in augmented and alternative communication are also discussed.

1. Introduction

Natural Language Generation (NLG) systems automatically create understandable texts in English or other human languages. These typically start from non-linguistic representations of information as an input, and use knowledge about language and the application domain to automatically produce these texts (Reiter and Dale, 2000). In this paper, we describe how NLG technology has been used to help users create stories from lifelog data; in particular for children with complex communication needs (CCN). The term CCN describes individuals who, due to motor, language, cognitive, and/or sensory perceptual impairments (e.g., as a result of cerebral palsy), do not develop speech and language skills as expected. This heterogeneous group typically experiences restricted access to the environment, limited interactions with their communication partners, and few opportunities for communication (Light and Drager, 2007).

Electronic Augmentative and Alternative Communication (AAC) systems enable individuals with CCN to verbally communicate their needs, often using Text-to-Speech technology, using single words or simple sentences. AAC is a novel domain for Natural Language Generation, and this work is different from much of the previous NLG work on narrative, which has focused on automatically summarising technical data to help expert users perform clearly defined tasks (such as decision making or handover) (Goldberg et al., 1994; Reiter et al., 2005; Gatt et al., 2009a). In contrast to the above, the NLG in this paper focuses on generating phrases to support individuals with little or no functional speech to engage in interactive conversation about everyday events, primarily to enhance social interaction. Also, the system described in this paper differs from a stand-alone report generator as it is part of an authoring tool. Since the goal is supporting social interaction, the NLG system supports a child in generating, and interactively telling, a story about his or her day. This work also differs from research on fictional story generation in the computational creativity community (Pérez y Pérez and Sharples, 2004). Since (logged) personal stories are constrained to communicate real-world data, the system cannot develop original content in order to enhance the story.

This paper makes two key contributions, aimed to resolve the issue of generating data from unstructured and possibly limited data. The first, is a quantitative evaluation of algorithms for constructing a coherent personal narrative from raw input data (together with a small amount of contextual knowledge). The second contribution, is a qualitative evaluation of the wider How was School Today? project.

In the next section, we look at related work in assistive technology, the importance of personal narrative, and narrative in

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Natural Language Generation. In Section 3, we describe the narrative generation system: How was School Today? We start with a short overview of a feasibility study with the first prototype in a first special needs school. This overview is kept brief, as it is reported elsewhere (Black et al., 2012), but is used to highlight the changes incorporated into the current version of the system. The changes among other things address a key technical challenge of how to generate stories from unstructured and occasionally limited sensor data. This challenge is addressed in Section 4, where we present three different methods for segmenting data into distinct events. Section 5 presents an evaluation of the different methods: 26 parents evaluated the resulting stories on their degree of realism, completeness and readability. The best performing method (clustering around voice recordings) was implemented in the system that was developed incrementally at a second special needs school. Section 6 describes a qualitative evaluation of the improved system (using clustering around voice recordings) over 6 months with two children, staff, and parents at the second special needs school. We conclude with an identification of open challenges in Section 7.

2. Related work

In this section, we discuss related work in the domains of Alternative and Augmentative Communication, the importance of personal narrative, and narrative in Natural Language Generation.

2.1. Alternative and Augmentative Communication (AAC)

Although AAC includes equipment such as simple switches, communication boards and other, 'low-tech' approaches, our project concentrates on the use of 'high-tech' communication devices. High-tech AAC devices generally consist of a computer or tablet[1] running software that allows users to type in text to be spoken out loud, or provides access to pre-stored words and phrases, using multi-meaning symbol sequences (Minspeak) or a hierarchical structure of category pages (dynamic screens). The vocabulary content can be edited, but in reality this level of technical skill cannot be expected from most carers and family.

Advances in text-to-speech technology and mobile computing have made a large range of Augmented and Alternative Communication (AAC) devices available to the public. The launch of the iPad in 2010 severely disrupted the marketplace (Reddington, 2014). Internet connected devices such as iPads and other tablets now have significant market penetration. For example, British National Health Service (NHS) Trusts buy more iPads for AAC than any other equivalent device (Reddington, 2013).

Current commercial AAC tools are however poor at supporting storytelling. Basic storytelling can be achieved using 'low-tech' AAC by recording a sequence of spoken narrative phrases on a simple voice recording device where the AAC user can 'tell' their story by pressing a single switch/button (Waller, 2006).[2] Some AAC developers have explored how narrative can be supported using templates. For example, Fig. 1 shows a dynamic story template system available in a DynaVox Pageset.

While AAC can be used in many communicative contexts, most current uses of AAC focus on transactional communication. This is the sort of communication that expresses needs, wants, and information transfer, such as, "I am thirsty", or "I use a straw for drinking". Transactional communication is less dynamic, and less interesting from a natural language engineering perspective. In this paper, we instead focus on an AAC tool that facilitates a conversation about *personal narrative*. By personal narrative, we mean someone telling a story about what happened to him or her. More importantly, this type of communication (in contrast to transactional communication) has a pivotal role in cognitive and social development (as discussed below in Section 2.4).

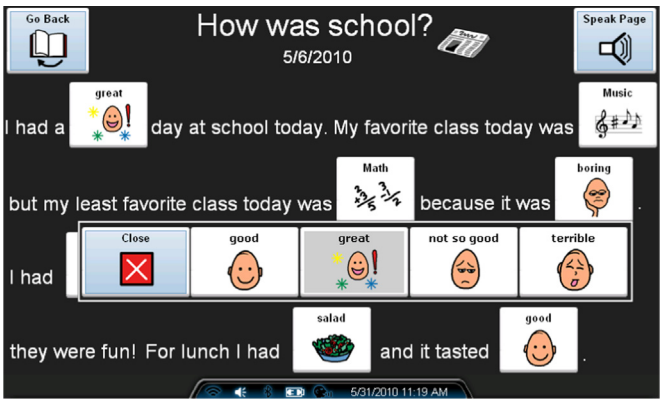

Fig. 1. Example template for a child's story about their day at school used on a Dynavox system.

An approach that considers personal narrative in AAC is particularly timely given the high proportion of internet connected AAC devices (Reddington, 2014) and recent developments in producing an open format for AAC devices (Whitmer, 2015). These developments mean that current systems can make better use of real-world knowledge (via the internet), and have the potential to support a larger vocabulary (via open formats).

2.2. Potential for NLG in AAC

Natural Language Generation (NLG) systems generate texts in English and other human languages from non-linguistic input (Reiter and Dale, 2000). In their review of Natural Language Processing (NLP) and AAC, Newell et al. (1998) suggest that NLG could be used to generate complete utterances from the limited input that AAC users are able to provide. For example, the Compassion project (McCoy, 1998) used NLG techniques to expand telegraphic user input, such as "*Mary go store*?", into complete utterances, such as "*Did Mary go to the store*?". Another approach has been for users to author utterances using Blissymbolics,[3] and then to apply NLG to translate this to English and Hebrew texts (Netzer and Elhadad, 2006).

The use of NLG in AAC is somewhat different from most uses of NLG. Since the goal of AAC is to help the user communicate, the NLG system must be used interactively, under the user's control; we want to assist the user in communication, not replace him or her with an NLG communicator. Also, since most human communication is social, NLG AAC systems will often need to generate texts that have the communicative goal of social interaction. Hence, NLG AAC systems are very different from systems that summarise information in a task-oriented context, which has been the focus of most NLG research to date.

In addition to helping users interact with others, NLG techniques can also be used to support language learning, and to encourage children with disabilities. The STANDUP system for example, used NLG and computational humour techniques to allow children who use AAC devices to generate novel punning jokes (Manurung et al.,

[1] This may be as simple as an iPad or a specially designed system with features like waterproofing, support for additional access methods, and impact protection.

[2] The use here of low-tech is intentional. These voice-recording devices do use technology, in contrast to e.g., laminated cards. They are however not as advanced in capability as the communication aids outlined in the previous paragraph.

[3] BLISS is an ideographic writing system using graphical symbols representing concepts that can be combined to form words.