Abstract

We demonstrate a report generation system called WiseReporter. The WiseReporter generates a text report of a specific topic which is usually given as a keyword by verbalizing knowledge base facts involving the topic. This demonstration does not demonstrate only the report itself, but also the processes how the sentences for the report are generated. We are planning to enhance WiseReporter in the future by adding data analysis based on deep learning architecture and text summarization.

1 Introduction

The necessity of well-organized information about emerging topics grows fast, but the conventional search engines such as Google or Bing provide just a list of relevant documents. Since the results of the search engines are unstructured, there should be additional and expensive cost to provide users with exact information. However, due to extremely large volume of information amount, it is nearly impossible for users themselves to look over all contents and get the insight of topics of interest from them. From this point of view, we argue the need of a tool which enables analyzing a large volume of documents and summarizing them as a report that can be easily understood by the users.

As the very first step of the report generation tool, we demonstrate a prototype system called WiseReporter that translates knowledge in a knowledge base (KB) to text reports. There exist many large scale KBs such as Freebase and DBpedia, and several algorithms to add knowledge from web documents into a KB automatically (Carlson et al., 2010). Therefore, in this demonstration of WiseReporter, we focus only on the verbalization of the facts in a KB to generate a report for a specific topic.

Basically, WiseReporter is a template based generation system (Mellish et al., 2006). This approach has been broadly used for generating natural language texts from KB facts (Nadjet et al., 2014), where a KB fact consists of a relation and two entities linked by the relation. If there are natural language templates for every relation in a KB, then the facts can be easily transformed into natural language sentences by filling slots of the proper template with the entities of the facts. In addition to the templates and template-slot-filling, WiseReporter contains many processes for report generation such as macro- and micro-planning, and surface-form realization.

In this demonstration, we use two KBs for text report generation. One is a manually-constructed domain-specific KB associated with IT products, and the other is DBpedia to cover more general topics. With the KBs, we prove that WiseReporter provides reasonable results in terms of linguistic quality evaluation of DUC task, and also demonstrate how sentences of a report are generated from the KBs by visualizing some generation rules.

2 Overview of WiseReporter

2.1 System Architecture

WiseReporter adopts a pipelined architecture for natural language generation following several studies on ontology verbalization (Androutsopoulos et al., 2013; Nadjet et al., 2014). The architecture is typically composed with three major modules (Mellish et al., 2006): (i) text planning (also referred to as macro-planning), (ii) sentence planning (also known as micro-planning), and (iii) surface-form realization. The text planning module is responsible for choosing what to say and organizing the selected content in a coherent way. The sentence planning module is re-
WiseReporter actually implements the pipelined architecture with the following five components (see Figure 1).

- **Content selection.** Both open planning and closed planning (Nadjet et al., 2014) are used for IT product KB and DBpedia respectively.

- **Content ordering.** Following the work of Androutsopoulos et al. (2013), we focus on enhancing local coherence by considering smooth topic change among adjacent sentences.

- **Fact-to-template transformation.** The rules for fact-to-template transformation are carefully designed with the consideration for Korean language phenomena such as Subject-Object-Verb (SOV) word-order and decision of postposition (josa) (Yang, 1995).

- **Sentence aggregation.** Several aggregation rules are applied to merging multiple simple sentences into a complex sentence. This step allows various and fluent natural language expressions.

- **Surface realization.** This component deals with several issues about realization of Korean surface-form including the problem of determining verbal endings (Yang, 1995). Especially, the endings related to tense, conjunction, and passive expressions are treated intensively.

The generated report consists of a number of paragraphs and an image related to the report topic. The image is inserted for helping users understand the generated texts better, and this image is simply obtained by Google image search. The typical layout of the report is pre-defined in this version of WiseReporter. The automatic layout arrangement and the appropriate image selection (or generation) remain as our future work.

We evaluated the quality of the generated reports by human judgement. The linguistic quality evaluation for summarization was taken from the previous study of Over et al. (2007). Five native evaluators were asked to score the generated reports from 1 to 5 points on five evaluation items of grammaticality, non-redundancy, structure and coherence, referential clarity, and focus (Over et al., 2007). The grand average score on 10 reports was 3.6 of 5.0. This result is competitive with the average score of 1.96 at the work of Androutsopoulos et al. (2013)\(^1\).

### 2.2 Knowledge Bases

WiseReporter makes use of two KBs for report generation. One is a domain-specific ontology constructed manually, and the other is DBpedia. Domain-specific ontologies are usually designed to represent specifications of a subject, but this is not enough for report generation to deliver information such as background or related events. Therefore, an ontology is designed that describes IT products in detail by analyzing the documents on IT products. For this, a number of natural language patterns are collected, and then many facts are harvested from the documents by pattern matching the patterns with the documents (Gerber and Ngomo, 2012). After that, the collected facts are refined manually for accuracy. The final IT product KB contains 239 facts in total.

In addition to domain-specific ontology in hand, DBpedia is also included in WiseReporter for wide coverage of the system. In order to generate reports for the topics in DBpedia, we defined 167 templates. After all, WiseReporter can produce reports on 29,255 different topics.

\(^1\)This study evaluated their system by 1 to 3 scale on English texts from Wine Ontology.
3 Outline of Demonstration

The following three steps outline our demonstration:

1. WiseReporter accepts a keyword such as ‘3D 프린터 (3D printer)’ in the title position of the report cover interface (see Figure 2).

2. WiseReporter returns a text report including an image about the topic if our domain-specific KB or DBpedia has facts related to the keyword (see Figure 3).

3. One can choose the Analyze button for switching the mode to demonstrate how each sentence in the report is generated (see Figure 4). In this mode, the system shows a list of KB facts and sentence generation rules that are actually used in generating each sentence.

3.1 Report Presentation

WiseReporter starts with the report cover interface as shown in Figure 2. This interface accepts a keyword as the title of a report. That is, WiseReporter generates a report about the given keyword. The sample report in Figure 3 is about ‘3D printer’. This report consists of two pages with a number of paragraphs. It provides various information about ‘3D printer’ including its definition, resources, various mechanisms, and its pros and cons.

3.2 Demonstration of Sentence Generation

Figure 4 shows the demonstration mode that is activated by choosing the Analyze button located on top right of the main report page. This mode lists the sentences that appear in the report line by line. Each sentence line can be selectable to demonstrate how the sentence is generated. The information provided is (i) the KB facts involved in the sentence, (ii) the templates for the facts, and (iii) the aggregation rules of the templates.

The system also shows the used KB facts as a graph (see Figure 5). The facts involved in generating the selected sentence are easily recognized as a red-colored part of the graph. The corresponding templates to the facts are also presented in Figure 5. These templates shows a notable SOV word-order characteristic of Korean well.

Finally, we can see how WiseReporter forms a complex sentence (“3D printer is a printer that prints 3D objects”) from multiple single sentences in Figure 6. The example of Figure 6 demonstrates one of the rules combining two sentences which share a common subject. The rule in this figure
Figure 5: The graph presentation of the IT product KB focused on the topic of ‘3D printer’ (left side). The nodes and edges marked with red color are the facts used to generate the first sentence “3D printer is a printer that prints 3D objects”. The corresponding Korean templates to the facts are also presented on the right side.

Figure 6: The demonstration screen capture of the sentence aggregation. Two templates are combined into a complex sentence template.

explains how a sentence (“3D printer is a printer.”) embeds another sentence (“3D printer prints 3D objects.”) when they share a subject.

4 Conclusion

In this paper, we briefly introduced WiseReporter, a prototype text report generation system, and our demonstration of the system at IJCNLP 2017. The system uses two KBs for getting information of topics of interest, and verbalizes the information coherently. We are planning to extend it in the future by going beyond KB verbalization. We also plan to make the system available to the public by transplanting the system as a web-based service.

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