Generating Coherent Text from Finely Classified Semantic Network

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1 Introduction

Natural Language Generation (NLG) is a subfield of Artificial Intelligence (AI) and Computational Linguistics. It is the automatic generation of natural language by computer in order to meet communicative goals. The first significant pieces of work in the field of NLG appeared during the 1970s(Dale, 1998), and most of the research focused on solving sentence-level issues. From the 1980s, text generation became the center task of NLG. Text generation involves many issues, one of the important issues is how to generate coherent text. Much previous research could solve this problem on either sentence level or text level. However, generating coherent text on both sentence and text level flexibly is still regarded to be a difficult problem.

Three years ago, a Japanese Generation System(Ozaki, 1997) which can generate coherent Japanese text was build. In the generation system, semantic network was used as the internal Knowledge Representation. Now, on the basis of the previous research, we used the same method and constructed an English generation system. Our research has two stages. At the first stage, the research concentrates on generating coherent text containing only simple sentences. At the second stage, the research will concentrate on generating coherent text containing both simple and multiple sentences. In this paper, we describe the first stage in detail.

The rest of the paper is organized as follows. Section 2 introduces semantic network of the English generation system. Section 3 introduces generating coherent text flexibly on both sentence and text level. Section 4 introduces experiment and generation results. Section 5 introduces future directions.

2 Semantic network

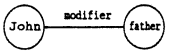
A semantic network is a graph of the structure of meaning in which nodes represent concepts and links represent relations and abstractions(Lehmann, 1992).

In the English generation system, nodes are classified into two types according to the word classes: entity node (eg. noun) and event node (eg. verb, adjective, adverb).

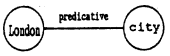
Links are classified into three types according to the grammatical relations:

1. entity-entity link: it represents the relation between two entity nodes. It has two types.

(1)modifier link: it has attributive function. The node modified is parent node, the other one is son node.

Example: John's father 

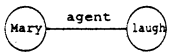
(2)predicative link: it has predicative function. The node representing subject is son node, the other one is parent node.

Example: London is a city. 

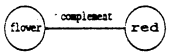
2. entity-event link: it represents the relation between entity node and event node. Event node is parent node, entity node is son node.

We classify entity-event link into nine types.

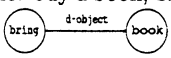
(1) agent link: it represents the relation between subject and verb.

Example: Mary laughs. 

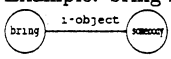
(2) complement link: it represents the relation between noun and its complement(subject complement or object complement).

Example: The flower is red. 

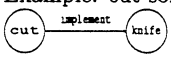
(3) d-object link: it represents the relation between verb and its direct object.

Example: buy a book; bring somebody a book(bring–book). 

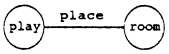
(4) i-object link: it represents the relation between verb and its indirect object.

Example: bring somebody a book(bring–somebody). 

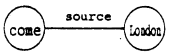
(5) implement link: it functions as adverbial.

Example: cut something with a knife 

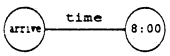
(6) place link: it functions as adverbial.

Example: play in the room. 

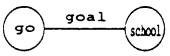
(7) source link: it functions as adverbial

Example: come from London. 

(8) time link: it functions as adverbial.

Example: arrive at 8:00. 

(9) goal link: it functions as adverbial.

Example: go to school. 

3. event-event link: it represents the relation between two verbs. We do not disscuss this problem in this paper because it is concerned with the issue of generating multiple sentence.

Sentences have two types: simple sentence and multiple sentence. A simple sentence consists of a single independent clause. A multiple sentence contains one or more clauses as its immediate constitutes. Here, we just discuss what kind of simple sentences the system can generate.

3 Generating coherent text

Generally speaking, text is constituted of several sentences. A coherent text should satisfy two conditions at least: on sentence level, word order according with grammar; on text level, the connection between sentences according with the characteristics of text structure. Next, we introduce how the generation system realizes text generation on these two levels.

3.1 Generation on sentence level

English is commonly described as a 'fixed word-order language'(Quirk, 1985). That is, English has strict limitations on the ordering of clause elements, though the more peripheral an element is, the more freedom of position it has(Quirk, 1985). In "A comprehensive grammar of the English language", clause constitutes are classified into five functional categories, three of which are further subcategorized:

subject	(S)
verb	(V)
object	(O)-direct object(O_d)
	-indirect object(O_i)
complement	(C)-subject complement(C_s)
	-object complement(C_o)
adverbial	(A)-subject-related(A_s)
	-object-related(A_o)

Based on the permissible combinations of these functional categories, "A comprehensive grammar of the English language" established seven basic structures of simple sentences. The following table shows the seven basic types in their normal order in a simple declarative sentence.

Table 1 Basic types of simple sentence

S + V
S + V + O
S + V + C
S + V + A
S + V + O_i + O_d
S + V + O + C
S + V + O + A

As mentioned above, nodes and links are finely classified, so the system can generate at least such sentence whose basic structure is the same as any type shown in Table 1. The generation results also prove the conclusion.

3.2 Generation on text level

In this part, we discuss the characteristics of the structure of English text, and introduce what we did about generation on text level.

Firstly, we describe the principle of END-FOCUS(Quirk, 1985). Please look at the following sentence:

Example 3.2-1
Mary invited me to her birthday party. It was held in a big hotel where I met her brother. He was a dentist.

Here, "her birthday party" and "her brother" are called "new information"; "it" and "he" are called "old information". Each sentence ends with a new information, and begins with an old information. In a sentence, one constitute can be regarded as an information unit. Each information unit has information value. The information value is determined by the position of the information unit in a sentence. The information value of "new information" is the highest, the information value of "old information" is the lowest. In English, it is common to process information in a sentence "so as to achive a liner presentation from low to high information value". This is called the principle of END-FOCUS(Quirk, 1985).

Secondly, let us see the main characteristic of English text from the view point of information value.

In the SEU(Survey of English Usage)spoken corpus, vast majority of clauses have the same structure as Example 3.2-1. That is, the change of information value in English text has regular pattern.The following figure shows the regular change of information value in English text.

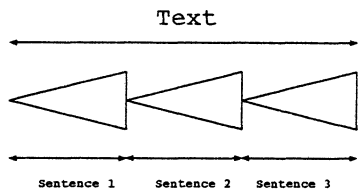


Figure 1: Regular change of Information value in English text.

On the basis of the main characteristic of English text, we decided generation strategies on text level:

Strategy 1
The system selects an entity node having high information value from the first generated sentence, and generates the second sentence using the selected node as its subject.

For example, if the first sentence is "Yahoo is a company.", the entity nodes which are potential for use as the subject of the second sentence are "company" and "Yahoo", we call them "subject candidate". The subject candidates are arranged in order, that is, the entity node who has higher information value is piror. So, "company" is selected by the system first. If no sentence can be generated by using "company" as the subject, the system will select the next candidate till the second sentence is generated.

At last, if no sentence can be generated using the first strategy, the system will use strategy 2.

Strategy 2
The system selects an entity node from the subject candidates, and uses this node as input to generate the second sentence. At this time, the selected entity node is not the subject of the second sentence.

If no sentence can be generated, the system will use strategy 3.

Strategy 3
The system selects an entity node from the unused entity nodes randomly, and uses this node as input to generate the second sentence.

The generation results prove that the three strategies are effective.

4 Experiment and generation results

We input the semantic network which is shown by Figure 2. Then the system can generate coherent text according to the input of the user.

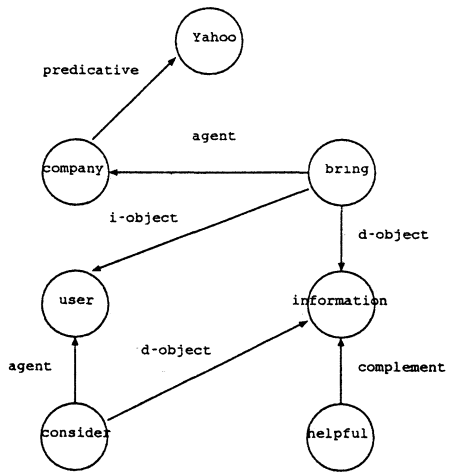


Figure 2: Example of Semantic Network.

Input: Yahoo
Output:
Yahoo is a company.
The company brings users information.
The users consider the information helpful.

Input: company
Output:
A company brings users information.
The users consider the information helpful.
Yahoo is the company.

Input: information
Output:
A company brings users information.
The users consider the information helpful.
Yahoo is the company.

5 Future directions

Future work will concentrate on generating coherent text containing both simple and multiple sentences. We will classify event-event links into several types, cause-effect relationship, time relationship, for example. We hope that the result of future work will further prove that semantic network is an effective method of generating coherent text.

Reference

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