

# GENERATING AND UNDERSTANDING OF WEAK INFORMATION STRUCTURES BY HUMANS

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**Abstract:** We have proposed an information representation called *weak information structures* which connects a wide variety of information media such as natural language texts, hypertexts and images without defining the semantics rigorously to integrate heterogeneous information. We have set a hypothesis that “the weak information structures are easy to generate from raw data, and therefore useful to extract and integrate information from a wide variety of information sources.” In this paper, we investigate how people generate and understand the weak information structures based on three experiments.

**Keywords:** weak information structures, associations, generating, understanding

## 1 Introduction

We have proposed an information representation called *weak information structures* which connects a wide variety of information media such as natural language texts, hypertexts and images without defining the semantics rigorously to integrate heterogeneous information. We have set a hypothesis that “the weak information structures are easy to generate from raw data, and therefore useful to extract and integrate information from a wide variety of information sources.”

To investigate how effective the weak information structures are in real world problems, we have developed a system called CoMeMo and tested several cases so far[1, 2, 3].

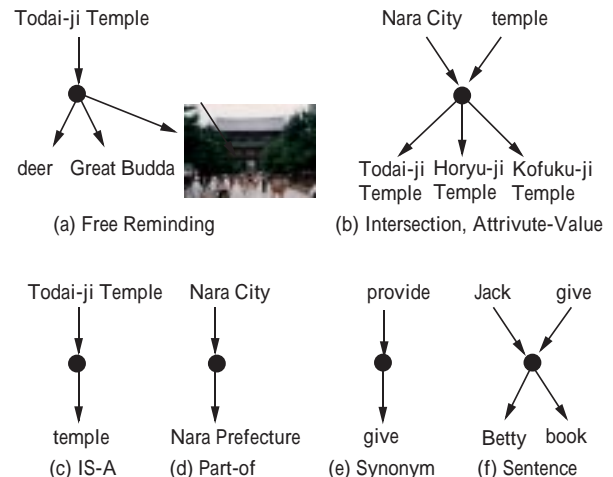
In this paper, we investigate how people generate the weak information structures, and how people understand the semantics of them based on three experiments.

In what follows, we first give an overview of an information representation called *Associations* which is a kind of weak information structures. We then describe three experiments to investigate the hypothesis.

## 2 Associations

Associations is a kind of weak information structures which connects information units with direction and many-to-many mapping.

The basic entities of the associations are a *unit* which represents either a concept or an external da-



- (a) **Free Reminding:** Deer, Great Buddha, and a photo of Todai-ji Temple are reminded by Todai-ji Temple.
- (b) **Intersection, Attribute-value:** There are Todai-ji Temple, Horyu-ji Temple, and Kofuku-ji Temple as temples in Nara.
- (c) **IS-A:** Todai-ji Temple is a temple.
- (d) **Part-of:** Nara City is a part of Nara Prefecture.
- (e) **Synonym:** “Provide” and “give” are synonymous.
- (f) **Sentence:** Jack gives Betty a book.

Figure 1: An Example of Various Associations

tum, and an *association* which connects a collection of key concepts with a collection of units which are normally reminded by the given keys. A dot represents an association and arrows associated the dot represent direction of the associations.

As Woods pointed out[4], there are various meanings in links in semantic networks. Figure 1 shows an example of associations whose relations represent various semantics.

In the text of this paper, we describe “Nara City & temple → Todai-ji Temple, Horyu-ji Temple, Kofuku-ji Temple” for representing Figure 1(a) association.

### 3 Experiment 1

The purpose of Experiment 1 is to investigate how people generate associations from various information such as ideas, research memoranda or articles, and how people understand the semantics of associations.

#### 3.1 Method

**Apparatus** CoMeMo Workbench.

**Subjects** The subjects were postgraduate students in our laboratory as follows. Three Ph.D. students (hereafter D), five 2nd-year M.Eng. students (hereafter M2), and four 1st-year M.Eng. students (hereafter M1)<sup>1</sup>.

#### Procedure

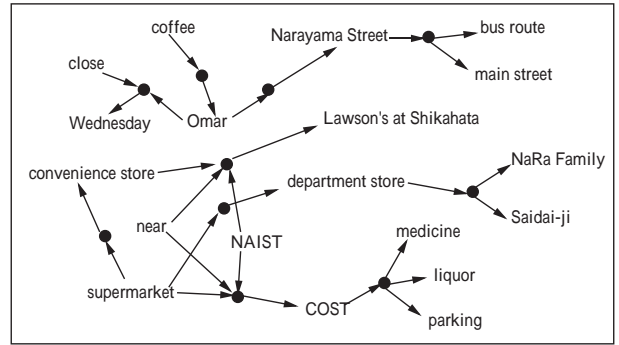
- (1) 5 test screens were prepared using the CoMeMo Workbench.
- (2) The subjects were shown these 5 test screens (from Test 1 to 5) and answered the following questions for each test: “Do you understand the outline of the screen?”, “Say the meaning of each circles<sup>2</sup>?”

#### Test Screens

- Test 1: shop information around the Institute possessed by an author. (See Figure 2 for the generated screen, and Table 2 for the generating process.)
- Test 2: description of the Peru Case generated from an newspaper article.

<sup>1</sup>1st-year M.Eng. students were all newcomers at the experiment because the Institute has postgraduate students only.

<sup>2</sup>We didn’t explain associations and therefore used terms “circle.”



I guess the most of readers are not clear what are written. I claim that this is because we don’t share the background knowledge about our Institute and Japanese language.

Figure 2: Test Screen 1 (Shop Information around the Institute)

Table 1: Restoration Rate

Subjects	Test 1	Test 2	Test 3	Test 4	Test 5	Mean
D	100%	66%	100%	100%	97%	93%
M2	100%	56%	80%	100%	56%	78%
M1	60%	70%	40%	93%	44%	61%
Mean	87%	64%	73%	98%	66%	78%

- Test 3: information of CFP(call for papers) announced in our laboratory. (See Figure 4).
- Test 4: research memoranda about agents possessed by an author.
- Test 5: research memoranda about knowledge media possessed by an author.

In Test Screen 1,2,3 and 4, concepts were originally written in Japanese. They were written in English in Test screen 5.

#### 3.2 Results and Discussion

Table 1 shows the restoration rate in Experiment 1.

We evaluate that associations are comprehensible to adults who have computing skills as a result that (1) all subjects answered the outline in Test 1 without being explained the meaning of associations and (2) the restoration rate was 78% on average.

We analyze the result that the restoration rate was better in D(93%) > M2(78%) > M1(61%) suggests the more human background knowledge people have, the more people understand associations.

The subjects restored the meaning of associations by referring units they can understand when they didn’t understand the unit’s labels. This tendency was apparent in Test 3 in which the structure of associations were

Table 2: Generating Process of Test Screen 1

no.	Ideas	Generated Associations
1.	COST(a supermarket) is reminded by NAIST(the Institute).	“NAIST & near & supermarket -> COST”
2.	Medicine and liquor is sold at COST, and COST has parking.	“COST -> medicine, liquor, parking”
3.	By supermarkets, convenience stores are reminded.	“supermarket -> convenience store”
4.	The convenience store nearest NAIST is Lawson’s (a famous convenience store in Japan) at Shikahata (a place)”	“NAIST & near & convenience store -> Lawson’s at Shikahata”
5.	Supermarkets remind me of department stores.	“supermarket -> department store”
6.	Department stores remind me of NaRa Family (a department store) in Saidai-ji (a place)	“Saidai-ji & department store -> NaRa Family”
7.	I buy coffee beans at Omar (a shop).	“coffee -> Omar”
8.	Omar closes every Wednesday.	“Omar & close -> Wednesday”
9.	Omar besides at the Narayama Street (a street)	“Omar -> Narayama Street”
10.	The Narayama Street is a bus route and the main street around here.	Narayama Street -> bus route, main street”

coherent (e.g. conference names, their venues, periods and so on). We analyze that the context helps human understanding of associations.

## 4 Experiment 2

The purpose of Experiment 2 is to investigate how people generate associations from ideas and how people understand those generated by others.

### 4.1 Method

**Apparatus** The same as in Experiment 1.

**Subjects** One Ph.D. students, four 2nd-year M.Eng. students, and one staff in our laboratory.

### Procedure

- (1) The subjects were trained how to generate associations (students only).
- (2) They generated associations reminded by a keyword “agent” on the CoMeMo Workbench (students only).
- (3) They were shown associations generated by other subjects and answered the following questions: “Do you understand what are written?”, “Do you identify who wrote this screen?”, “If you identify who, why?” and “Say anything you felt in this experiment” (students only).
- (4) The same as (3) (the staff subject only).

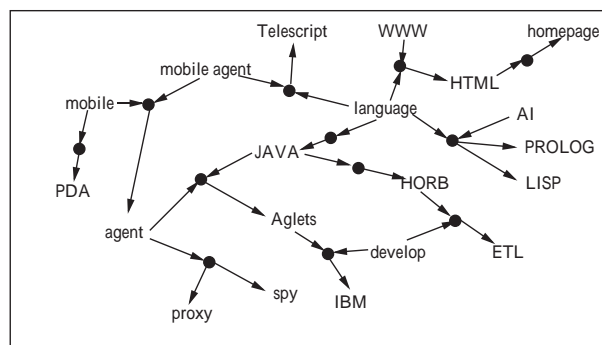


Figure 3: A Screen Generated by Subject A

### 4.2 Results and Discussion

An example screen generated by the Subject A is shown in Figure 3<sup>3</sup>

All subjects generated associations within 30 minutes. We analyze that adults who have computing skills can generate associations without difficulty.

All subjects understood the meaning of associations generated by others. Concerning a screen generated by the subject C, all other subjects identified that it was made by him. We analyze that ideas can be transmitted using associations among people who share knowledge. All subjects except for the subject C laughed when they saw screens wrote by the subject C. 80%(4 out of 5 student subjects) said that they had some fun during the experiment. The staff subject said that “I can assume the subject’s knowledge level concerning research topics”, “I may want to ask a report for

<sup>3</sup>Concepts were originally written in Japanese.

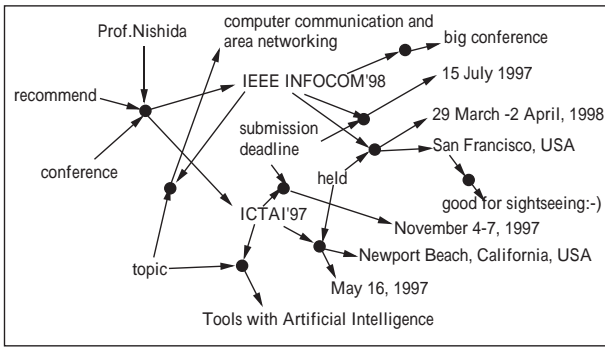


Figure 4: Test Screen 3 (Information of CFP Announced in our Laboratory)

this subject”, “I want to talk to this subject, because s/he may be interesting”, and so on. We think that transmitting ideas using associations between groups leads to know people and therefore facilitates for human communication.

## 5 Experiment 3

We investigate the difference of understanding between natural language texts and information extracted from them using associations.

### 5.1 Method

**Apparatus** The same as in Experiment 1.

**Subjects** Three 2nd-year M.Eng students in our laboratory.

**Procedure** The following cases were tested.

- Test 1: Subjects were shown Test Screen 2 of Experiment 1 and original articles, and asked some comments.
- Test 2: Subjects were shown Test Screen 3 of Experiment 1 and 3 CFPs (each CFP is written in a A4 paper), and asked some comments.

In both tests, subjects were not explained the meaning of associations.

### 5.2 Results and Discussion

Some of the Comments are described below.

- Test 1:
  - “An index like the test screen is helpful for browsing an newspaper article. (Subject 1)”

- “I thought I understood the meaning of information in the test screen first but I found that I misunderstood the article after reading it. (Subject 2)”

- Test 2:

- “The test screen is helpful because I can pick up important information quickly although it took me for a while to know how to understand the associations. (Subject 1)”
- “I prefer seeing the test screen to reading a collection of CFPs (Subject 2).”

We think that it is useful to extract information from information sources using associations.

## 6 Conclusions

We investigated how people generate and understand the weak information structures based on three experiments. We found the following. (a) Adults who have computing skills can generate weak information structures without difficulty. (b) Ideas can be transmitted using weak information structures among people who share knowledge. (c) Associations are comprehensible to adults who have computing skills. (d) The more human background knowledge people have, the more people understand weak information structures.

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