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Transformation Method of Law Sentences into Logical Forms

- Atomic Sentences -

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Structures and functions of our society are written clearly in law sentences. Therefore, we can regard law sentences as a kind of specifications which define information systems by using structures and functions of our society. Therefore, if we can represent law sentences in formal logical expressions, we can check information systems by theorem provers or reasoning systems and confirm whether the information system satisfy trustworthy conditions. Accordingly, law sentences written in natural language need to be converted into logical expressions which can be reasoned. This study aims to convert law sentences of natural languages into logical formulas.

We propose a two stage method to convert law sentences into logical formulas. The first is to capture a logical structure of a law sentence. The second is to convert subexpressions segmented in the first stage into a compound of atomic logical sentences. This research concerns the second stage.

An atomic logical sentence represents relations (deep cases) between a predicate verb and nouns, and such relations are analyzed by case analysis. For the case analysis, we built a case frame dictionary based on law sentences of two local government regulations, "Tiyodaku Seikatsu Kankyou Jourei" consisting of 28 articles and "Toyamaken Jouhou Tsushin ni Kansuru Jourei" consisting of 10 articles. The dictionary contains 129 kinds of case frames, which are made from 431 predicate verbs. Each case frame includes information about what nouns a verbs have as a deep case, frequency of each nouns which appears as the deep case, name of the deep case and case particle.

The system which transforms a segmented part of a law sentence into a compound of atomic sentences in four steps. First, morphological analysis and syntactic analysis are carried out by Japanese morphological analyzer JUMAN and Japanese dependency analyzer KNP. Second, the system scores phrases according to the degree how phrases can be deep cases. Third, the system fills deep cases according to a case frame and scores. scores are calculated mainly based on a particle (Joshi), similarity between a head noun of a noun phrase and a noun in a case frame. In addition, scores are also calculated based on linguistic expressions appeared typically in law sentences. Lastly the system assigns variables to nouns and event variables to predicate verbs, and construct atomic sentences which represent the corresponding case structure just analyzed.

We conducted case analysis for 122 predicate verbs appeared in "Toyamaken Jouhou Tsushin ni Kansuru Jourei" and the correct answers were 83.6%. The main failure are caused by dependency analysis errors and lack of nouns in a thesaurus used in measuring similarity between nouns. We also conducted case analysis for 131 predicate verbs in "Hiroshimashi Poisute Boushi Jourei" and the correct answers were 43.0%. The main failure was caused by lack of case frames in the dictionary. Though the above experiment shows case frame dictionary and case analysis based on

the above are effective, it is necessary to widen a coverage of the case frame dictionary in order to improve precision of the case analysis.