

Title	型階層論理における推論のダイアグラム化
Author(s)	吉岡, 卓
Citation	
Issue Date	2001-03
Type	Thesis or Dissertation
Text version	author
URL	<a href="http://hdl.handle.net/10119/1460">http://hdl.handle.net/10119/1460</a>
Rights	
Description	Supervisor:東条 敏, 情報科学研究科, 修士

# Reasoning with Diagrams for Order-Sorted Logic

Suguru Yoshioka

School of Information Science,  
Japan Advanced Institute of Science and Technology

February 15, 2001

**Keywords:** Order Sorted Logic, Reasoning with Diagrams, Dual Lattice, Cell, Deduction, Problem Solving.

Nonsentential representation is a very important tool, which we use daily in communication, information storage and changing, planning and problem solving. The propose of this paper is, one of the methods of knowledge representation, to represent a diagram for order-sorted logic.

The order-sorted logic is added to a hierarchical structure to describe the knowledge and infer on computer system. The order-sorted logic is consisted of sorts which are sets of objects, and there are hierarchical relations between sorts. To based on this hierarchical structure, it is possible to represent knowledge structurally, and widely applied among various branches of Artificial Intelligence. But it must be considered of the relation to the order with each set of sorts, such as noun sorts, verb sorts, and so on. Therefore, the more it extends the realm of objects, it must be investigate the various sort hierarchies and give a lot of troubles of inference. Moreover, it is difficult to implement a programming system without transformation.

On the other hand, when they are solving problems, human beings often use diagrammatic representation for annulment of the complexities and easy to understand. Diagrammatic representation is not suitable for describing a detailed phenomenon. But it is superior to represent an intuitive summary of this phenomenon. It is for this purpose that many methods utilizing visual information for the problem solving has studied since ancient times. Recently, especially department of computer science, attention has been directed to reasoning with diagrams as well, in order to argument the deficiency of reasoning with symbols only. Furthermore, there is a results that the proof steps by utilization of the characteristic of diagrammatic representation are much more shorter than by natural deduction.

So in this paper, we propose that diagrammatic representation reflected the dual lattice structure. And this representation deals effectively with the problem of increase in the

number of inference of order-sorted logic. Especially, we propose that the diagram with cell which is able to deal simultaneous with property of predicate abstractly and property of term abstractly. And cell representation has special characteristics that the product of prime number decide location of sorts. This prime number is allot for the each path from  $\top$  to  $\perp$ . To use the prime number, we are able to decide a subsumption relation for each sorts on the spot. Furthermore, inference rules of cell defined as follow:

- Dual lattice Coupling
- Insertion of Predicate Subsumption
- Insertion of Sort Subsumption
- Propagation of Negation
- Conjunctive Unification
- Disjunctive Unification
- Totality
- Weakening
- Predicate Negation as Totality
- Sort Negation as Totality

These rules correspond to an inference rules of order-sorted logic and assign to the well-formed representation. These definitions showed that the cell representation could reason more structural than dual lattice representation. And cell representation showed to could judge easily whether it has a subsumption relation for some long distance sorts.

Lastly, We implement a cell utilization system and conduct its advantage. Especially in this paper, we conduct about proof steps as follow:

- Natural Deduction and Cell Representation
- Dual Lattice and Cell Representation

We also conduct about new sort declaration as follow:

- Sentential Representation
- Simple Tabular Representation
- Cell Representation

As a result, we showed advantageous results to utilize of cell representation. But actually, it is difficult to implement a system because the number of product of prime number grows larger. Therefore, It is necessity to define of substitution for prime number. An otherwise, we propose to utilize a closed curve because more abstraction symbol is suitable for meaning of sort. We will think about these problems in future works.