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Author(s)	菊池, 健太郎
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Gentzen Style Sequent Calculi for Some Subsystems of Intuitionistic Logic

Kentaro Kikuchi

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

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Abstract

In this thesis we study subsystems of intuitionistic propositional logic, some of which have not been given satisfactory Gentzen style sequent calculi. We provide appropriate sequent calculi for such logics mainly by the method of *dual-context sequents* and give a new insight into the realm of subsystems of intuitionistic logic.

First we discuss sequent calculi for subintuitionistic logics K^I and BPC which are defined semantically using Kripke models. Extending a known sequent calculus for K^I with ordinary sequents, we introduce a sequent calculus for BPC. These systems are, however, not satisfactory in the respect that the rule for implication involves many premisses. Then we consider dual-context sequents, which have proved popular in the field of linear logic. After giving an interpretation of the sequents in Kripke models, we develop a dual-context sequent calculus, which is closely related to Gentzen's sequent calculus for intuitionistic logic. The completeness theorem of the system with respect to the class of Kripke models for K^I is shown by means of a construction of the canonical model. We also introduce a dual-context sequent calculus that is complete with respect to the class of Kripke models for BPC. The cut-elimination theorem for the dual-context sequent calculi is proved by syntactical methods including more global proof transformation than the ordinary proof of cut-elimination.

Next we investigate relationships between subintuitionistic logics and substructural logics, considering Hilbert style systems that characterize the implicational fragments of subintuitionistic logics and substructural logics. The investigation clarifies the inclusion relationships between the sets of formulas that are provable in each Hilbert style system for these logics.

Finally we discuss sequent calculi for noncommutative substructural logics, particularly the logic $BB'I$. This logic is important in the respect that it is a noncommutative version of the implicational fragment of linear logic. While the usual sequent calculus for $BB'I$ is defined using merge operation, we introduce a sequent calculus for $BB'I$ without any merge operation. Roughly speaking, the system is obtained from the dual-context sequent calculus for BPC by deleting the structural rules, according to the observation that $BB'I$ is a subsystem of BPC. The cut-elimination theorem for the system is proved using global proof transformation technique analogous to that used in the proof of the cut-elimination theorem for the dual-context sequent calculi for subintuitionistic logics.

Key Words: subintuitionistic logics, substructural logics, sequent calculus, completeness theorem, cut-elimination theorem