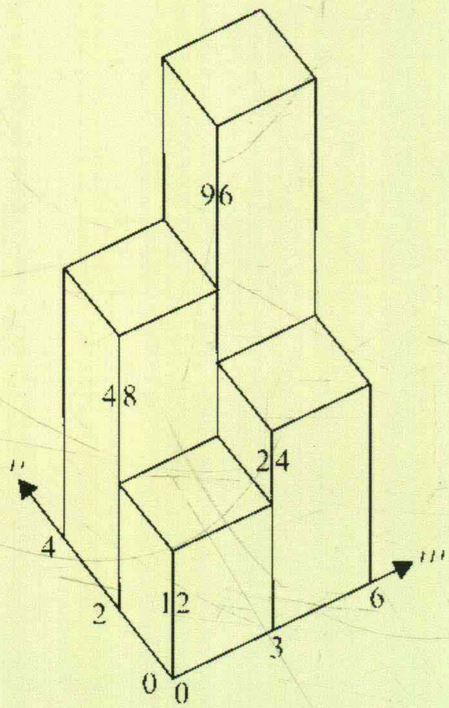
Zhou Xunwei

MUTUALLY-INVERSISTIC LOGIC, MATHEMATICS, AND THEIR APPLICATIONS



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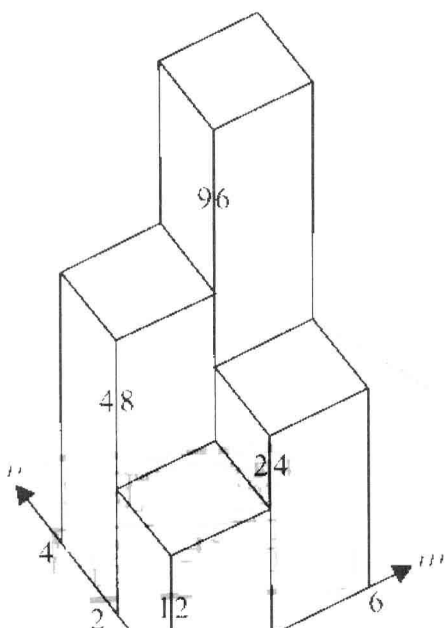

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Preface

In 1984, when I taught myself discrete mathematics, I found out that the definition of material implication is both valuable and defective. Its value lies in that it correctly reflects the establishment of implicational propositions. Its defect lies in that it cannot be used to make hypothetical inference, but its generalized inverse functions can make. Just like that when we know the summand 2 and the sum 5 and we want to find the addend, we cannot use addition 2+?=5 but its inverse operation subtraction 5−2=? to find it.

Since then, I have been constructing mutually-inversistic mathematical logic. Now, it is fully fledged. It includes mutually-inversistic logic, mutually-inversistic mathematics, and their applications. Mutually-inversistic logic includes two calculi and four theories of mutual-inversism, mutually-inversistic granular computing, unified logics. Mutually-inversistic mathematics includes mutually-inversistic analytic geometry, mutually-inversistic mathematical analysis, mutually-inversistic abstract algebra, universal matrix. Applications include logic programming (see Part 4), automated theorem proving, planning and scheduling, database, semantic network, expert system, program verification, natural language processing, hardware verification, machine learning, data mining, data warehouse, program refinement, many-valued computer, modern control theory, etc..

All branches of mutually-inversistic mathematical logic are discrete, so, mutually-inversistic mathematical logic can also be regarded as mutually-inversistic discrete mathematics.

This monograph is suitable for faculty members, researchers, graduate students working in the field of logic, mathematics, computer science, automation to use.

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Part 13 Applications of explicit inductive composition

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Part 1
Mutually-inversistic logical calculus

Mutually-inversistic logical calculus is composed of mutually-inversistic propositional calculus and predicate calculus. As predicate calculus is more useful than propositional calculus, the author introduces predicate calculus first and in detail, introduces propositional calculus second and in brief.

Chapter 1
Fundaments of predicate calculus

1.1 Material implication vs. mutually inverse implication

Material implication is defined as Table 1.1.

Table 1.1 Material implication

A	B	A→B
F	F	T
F	T	T
T	F	F
T	T	T

The author finds out that Table 1.1 is both valuable and defective. The value of Table 1.1 lies in that it correctly reflects the establishment of A→B.Take "if it rains, then the ground is wet" as an example.On October 1, 2006, in Beijing, it didn't rain, and the ground was not wet. This is the first row of Table 1.1. On September 30, 2006, in Beijing, it didn't rain, but sprayers sprayed the ground wet. This is the second row of Table 1.1. On August 20, 2006, in Xi'an, it rained, and the ground was wet. This is the fourth row of Table 1.1. It is not the case that it rains and the ground is not wet. Hence, the third row of Table 1.1 never occurs. So, from "it rains" and "the ground is wet" we establish "if it rains, then the ground is wet", using Table 1.1.

Material implication has a well known defect: material implication paradox. For example, $P \wedge \neg P \rightarrow Q$ is a material implication paradox. Material implication paradox has two characteristics: (1) If the antecedent is false, or the consequent is true, then the antecedent implies the consequent; (2) there is no nexus of contents between the antecedent and the consequent. The above material implication paradox only depends on logical knowledge, the author calls it logical material implication paradox. The proposition "if snow is black, then 2+2=4"satisfies the second row of Table 1.1, it is a true proposition. It also satisfies the two characteristics of material implication paradox. The author calls it empirical or mathematical material implication paradox, because it depends on empirical or mathematical knowledge. Mutually-inversistic logic requires that the antecedent not be permanently false, the consequent not be permanently true, the antecedent and the consequent share the same variables. In mutually-inversistic logic, the two characteristics of material implication paradox are not satisfied. So, mutually-inversistic logic is free of implication paradox.

$(P\wedge Q\to R)\to(P\to R)\vee(Q\to R)$ is a tautology. In $(P\wedge Q\to R)\to(P\to R)\vee(Q\to R)$, the antecedent is not permanently false, the consequent is not permanently true, the antecedent and the consequent share the same variables P, Q, and R. It does not satisfy the two characteristics of material implication. It is not a material implication paradox. Yet, it is still absurd. Suppose P is assigned $x\leqslant y$, Q is assigned $x\geqslant y$, R is assigned $x=y$. Then it says: if $x\leqslant y$ and $x\geqslant y$ implies $x=y$, then $x\leqslant y$ implies $x=y$, or, $x\geqslant y$ implies $x=y$. Absurd! Its corresponding proposition in mutually-inversistic logic is not a logical theorem.

The author finds out Table 1.1 has a less obvious, but more serious defect: it cannot be used to make hypothetical inference. Proponents of classical logic say: "Table 1.1 can be used to make hypothetical inference. Take the affirmative expression of hypothetical inference as an example, both A→B and A being true are the fourth row of Table 1.1, in which B is true. Thus, from A→B being true and A being true we infer B being true."But there is a principle in philosophy: human cognition is from the known to the unknown. Table 1.1 is a truth function. And there is a principle in mathematics: an evaluation of a function is from its arguments to its value. If we want to evaluate from its value to its argument, then we should use its inverse functions. In order to mathematize human cognition, we let the known be the arguments, let the unknown be the value, so that the human cognition from the known to the unknown becomes the evaluation of the function from the arguments to the value. In Table 1.1, A and B are the known, the arguments, A→B is the unknown, the value, therefore, Table 1.1 can only be used to establish A→B from A and B. Using Table 1.1 to make hypothetical inference is from the unknown to the known, from the value to the argument, is in violation of the principles of philosophy and mathematics.

Although Table 1.1 cannot be used to make hypothetical inference, in its inverse functions, A or B is a value, A→B is an argument, so, its inverse functions can be used to make hypothetical inference. Following this clue, mutually inverse implication is defined as Tables 1.2 to 1.4.

Table 1.2
Inductive composition for $\leqslant^{-1}$

tv(A)	tv(B)	tv(A$\leqslant^{-1}$B)
F	F	T
F	T	n
T	F	F
T	T	T

Table 1.3
Decomposition one for $\leqslant^{-1}$

tv(A$\leqslant^{-1}$B)	tv(A)	tv(B)
F	F	u
F	T	u
T	F	u
T	T	T

Table 1.4
Decomposition two for $\leqslant^{-1}$

tv(A$\leqslant^{-1}$B)	tv(B)	tv(A)
F	F	u
F	T	u
T	F	F
T	T	u