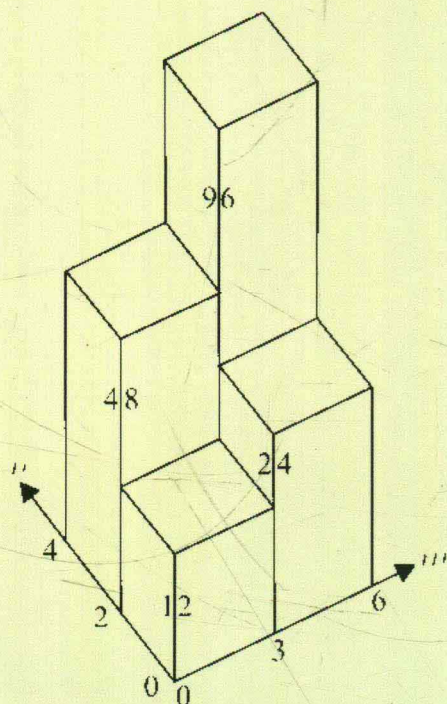


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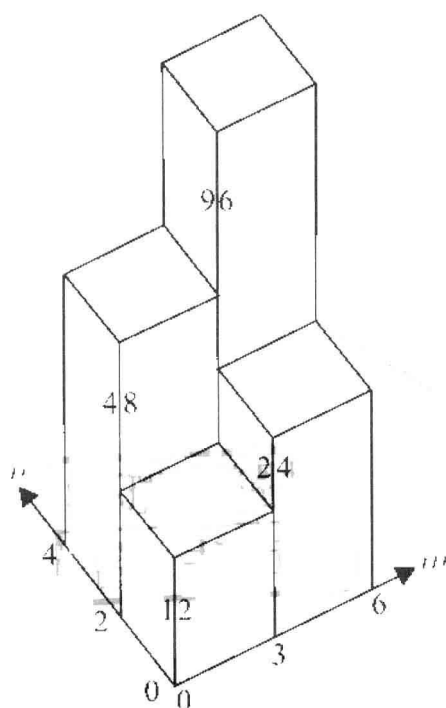
MUTUALLY-INVERSISTIC LOGIC, MATHEMATICS, AND THEIR APPLICATIONS



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Zhou Xunwei

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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.

My email is zhouxunwei@263.net.

CONTENTS

Preface..... 1

Part 1 Mutually-inversistic logical calculus

Chapter 1 Fundaments of predicate calculus 2

1.1 Material implication vs. mutually inverse implication 2

1.2 Formation of terms and propositions 4

1.3 Simple-complex composition..... 15

1.4 Zeroth-level predicate calculus 16

Chapter 2 Human cognitive processes and basic principles of
mutually-inversistic logic 18

2.1 Mutually inverse special propositions vs. mutually inverse general propositions 18

2.2 Unary cognitive processes..... 18

2.3 Binary cognitive processes..... 19

2.4 Man’s cognitive route..... 21

2.5 Classification of cognitive processes 22

2.6 Inductive composition vs. decomposition..... 23

2.7 The principle of inductive composition, the principle of decomposition,
and the principle of mutual inverseness between inductive composition and
decomposition 26

2.8 Truth tables of inductive composition and decomposition for the connection
operators 27

2.9 Mutually inverse diagrams for the connection operators..... 31

2.10 The principle of meaningfulness and meaninglessness duality for the
distinguished propositions..... 32

Chapter 3 First-level single quasi-predicate calculus 34

3.1 Meaningless and meaningful first-order single empirical or mathematical
connection propositions 34

- 3.2 Free and bound first-order single empirical or mathematical connection propositions 34
- 3.3 First-level explicit inductive composition..... 36
- 3.4 First-level implicit inductive composition 38
- 3.5 Contradictory propositions..... 39
- 3.6 First-level decomposition..... 39
- 3.7 Quasi-logical connection propositions 39
- 3.8 The decomposition system of first-level single quasi-predicate calculus 43

- Chapter 4 Second-level single quasi-predicate calculus..... 45**
 - 4.1 Meaningless and meaningful second-order single logical connection propositions 45
 - 4.2 Free and bound second-order single logical connection propositions 45
 - 4.3 Second-level explicit inductive composition 46
 - 4.4 Second-level implicit inductive composition..... 47
 - 4.5 Second-level decomposition 49
 - 4.6 Quasi-transcendent logical connection propositions..... 50
 - 4.7 Knowledge-cognition science 50
 - 4.8 The decomposition system of second-level single quasi-predicate calculus 51

- Chapter 5 First-level multiple predicate calculus 54**
 - 5.1 Property fact proposition segments vs. non-property fact propositions..... 54
 - 5.2 Mutually inverse multiple diagrams..... 54
 - 5.3 Success diagrams vs. failure diagrams..... 57
 - 5.4 Least success diagrams 57
 - 5.5 Proposition chains and property proposition segment chains 60
 - 5.6 Multiple empirical or mathematical connection propositions..... 63
 - 5.7 Meaningful and bound multiple empirical or mathematical connection propositions 63
 - 5.8 Mutually inverse multiple diagrams for multiple empirical or mathematical connection propositions 64
 - 5.9 Proposition chains, property proposition segment chains, and least success diagrams of multiple empirical or mathematical connection propositions 66
 - 2.10 Decomposition system of first-level multiple predicate calculus 69

Chapter 6	Second-level multiple predicate calculus	70
6.1	Meaningful and bound multiple logical connection propositions.....	70
6.2	Establishment by implicit inductive composition of mutually inverse implication propositions.....	71
6.3	Establishment by implicit inductive composition of contradictory propositions.....	71
6.4	Establishment by implicit inductive composition of contrary propositions.....	74
6.5	Establishment by implicit inductive composition of subcontrary propositions	76
6.6	Square of opposition among multiple empirical or mathematical connection propositions	77
6.7	Decomposition system of second-level multiple predicate calculus.....	77
Chapter 7	Mutually-inversistic propositional calculus	79
7.1	Formation of fact propositions	79
7.2	First-level single quasi-propositional calculus.....	79
 Part 2 Mutually-inversistic set theory		
Chapter 8	Fundamentals of mutually-inversistic set theory	84
8.1	Set operators.....	84
8.2	Elements, sets, and propositions	85
8.3	Empirical abstraction, mathematical abstraction, and set-theoretic abstraction	88
8.4	Mutually inverse coordinate systems hierarchy	89
8.5	Intersections	94
8.6	Power sets.....	98
8.7	Principle of meaningfulness—meaning-lessness duality for distinguished sets....	98
8.8	Paradoxes	98
8.9	Ordinal numbers and cardinal numbers are wrong theories.....	99
8.10	Comparison of mutually-inversistic set theory with naïve set theory and axiomatic set theory	100
Chapter 9	The Main	101
9.1	Binary relations	101
9.2	Empirical or mathematical connection operators.....	107
9.3	The main in mutually-inversistic set theory vs. binary relations in naïve set theory.....	110

Chapter 10	The auxiliary.....	111
10.1	Functions	111
10.3	Reflexivity vs. idempotency, symmetry vs. commutativity	121
10.4	The auxiliary in mutually-inversistic set theory vs. functions in naïve set theory.....	121
10.5	Relations vs. functions	122

Part 3 Mutually-inversistic proof theory vs. mutually-inversistic model theory

Chapter 11	Proof theory vs. model theory	124
11.1	Origins of proof theory and model theory.....	124
11.2	Relationship between proof theory and model theory.....	124
11.3	Circular argument between conventional proof theory and conventional model theory.....	126
11.4	Model-theoretic semantics of material implication.....	129

Chapter 12	Mutually-inversistic proof theory.....	130
12.1	Axiomatic system of second-level single quasi-predicate calculus	130
12.2	Mutually-inversistic elementary number theory	130
12.3	The proofs of Godel’s incompleteness theorems are erroneous.....	132

Chapter 13	Mutually-inversistic model theory	139
13.1	Model theory of term space.....	139
13.2	Model theory of fact space	140

Part 4 Mutually-inversistic recursion theory

Chapter 14	Mutually-inversistic recursion theory	144
14.1	Prolog	144
14.2	Second-level single quasi-prolog	146

Part 5 Mutually-inversistic granular computing

Chapter 15	Mutually-inversistic fuzzy logic based granular computing.....	156
15.1	Mutually-inversistic fuzzy logic	156
15.2	Mutually-inversistic rough fuzzy logic	164
15.3	Mutually-inversistic fuzzy quotient space	166
15.4	Mutually-inversistic fuzzy interval logic	167
15.5	Mutually-inversistic rough fuzzy interval logic and mutually-inversistic fuzzy interval quotient space.....	171
15.6	Conclusions of mutually-inversistic fuzzy logic based granular computing	171
Chapter 16	Mutually-inversistic rough set based granular computing.....	172
16.1	Mutually-inversistic rough set.....	172
16.2	Weakly mutually inverse intersection connection mining algorithm.....	176
16.3	Mutually-inversistic fuzzy rough set.....	178
16.4	Mutually-inversistic mathematical morphology	181
16.5	Mutually-inversistic evidence theory	183
16.6	Mutually-inversistic point set topology	183
16.7	Mutually-inversistic concept lattice	183
16.8	Mutually-inversistic second-type covering rough set	184
Chapter 17	Unified logics	186
17.1	Unification of classical logic.....	186
17.2	Unification of Aristotelian logic.....	186
17.3	Unification of ancient Chinese logic.....	186
17.4	Unification of mutually-inversistic modal logic	186
17.5	Unification of extensional logic and intensional logic.....	188
17.6	Unification of relevance logic	188
17.7	Unification of inductive logic and deductive logic	188
17.8	Unification of two-valued logic and many-valued logic.....	188
17.9	Unification of Boolean algebra	188
17.10	Unification of fuzzy logic	189
17.11	Unification of natural deduction.....	189

17.12	Unification of paraconsistent logic	189
17.13	Unification of non-monotonic logic.....	189

Part 7 Mutually-inversistic analytic geometry

Chapter 18	Mutually-inversistic analytic geometry.....	192
18.1	Analytic geometry of terms	192
18.2	Analytic geometry of facts	195
18.3	Loci of moving points	199

Part 8 Mutually-inversistic mathematical analysis

Chapter 19	Double-sided discrete calculus.....	202
19.1	Double-sided discrete calculus of unary functions	202
19.2	Double-sided discrete calculus of binary functions	207
Chapter 20	Single-sided discrete calculus	211
20.1	Single-sided discrete calculus of unary functions	211
20.2	Single-sided discrete calculus of binary functions.....	222
20.3	Single-sided discrete ordinary differential equations.....	224
20.4	Single-sided discrete partial differential equations	226
Chapter 21	Unified calculus.....	227
21.1	Overview of this chapter	227
21.2	Unified calculus of unary functions	228
21.3	Unified calculus of binary functions	231
21.4	Unified ordinary differential equations	232
21.3	Unified partial differential equations	236

Part 9 Mutually-inversistic abstract algebra

Chapter 22	Auxiliary algebras	242
22.1	Algebraic structures.....	242
22.2	Transaxis straight lines.....	245
22.3	Associative auxiliary algebras.....	247

22.4	Binary bijective auxiliary algebras.....	247
22.5	Idempotent auxiliary algebras	259
22.6	Complementary idempotent auxiliary algebras	261
22.7	Isomorphism between algebras	264
22.8	Summary on transaxis straight lines-derivatives-algebraic properties.....	266
22.9	Comparisons among various algebras of two binary operations	266
22.10	The laws various auxiliary algebras of one binary operation satisfy	267
22.11	Comparison between auxiliary algebras and classical abstract algebra	267
Chapter 23	Main-auxiliary algebras.....	268
23.1	Lattices	268
23.2	Boolean algebras	271
23.3	Main-auxiliary algebras for set theorems.....	275
Part 10	Universal matrices	
Chapter 24	Universal matrices.....	294
24.1	Representation of n-dimensional matrices	294
24.2	Multiplications	297
24.3	Isodimensional matrices.....	299
24.4	Tensor matrices.....	320
Part 11	Applications of decomposition	
Chapter 25	Inference rule systems vs. mutually-inversistic automated decomposition systems	324
25.1	Recessive hypothetical inference vs. dominant hypothetical inference.....	324
25.2	Inference rule systems vs. mutually-inversistic automated decomposition systems	327
Chapter 26	Mutually-inversistic relational databases	330
26.1	First-level single quasi-relational databases.....	330
26.2	Second-level single quasi-relational databases	331
26.3	Combined single quasi-relational databases	335

- Chapter 27 Mutually-inversistic planning and scheduling338
 - 27.1 Mutually-inversistic agent planning..... 338
 - 27.2 Mutually-inversistic multiagent planning 340
 - 27.3 Mutually-inversistic multiagent scheduling 345
- Chapter 28 Mutually-Inversistic Semantic Network347
 - 28.1 First-level semantic network 347
 - 28.2 Second-level semantic networks 357
 - 28.3 Conclusions about semantic networks 360
- Chapter 29 Mutually-inversistic expert systems.....362
 - 29.1 A semantic network 362
 - 29.2 First-level single quasi-expert systems 362
 - 29.3 Bottom-up second-level single quasi-expert systems 363
 - 29.4 Top-down second-level single quasi-expert systems 364
 - 29.5 Improved version of top-down second-level single quasi-expert systems 365
- Chapter 30 Transformation of second-level inference rule systems into second-level automated decomposition systems368
 - 30.1 Mutually-inversistic program verification 368
 - 30.2 Automated deduction system of functional dependency of relational database 374
 - 30.3 Mutually-inversistic operational semantics..... 375
 - 30.4 Second-level hypothetical inference based LK system of proof theory..... 375
 - 30.5 Second-level hypothetical inference based propositional logic of natural deduction system 377
 - 30.6 Second-level hypothetical inference based nonassociative Lambek calculus of categorial grammar 379
- Chapter 31 Applications of First-Level Hypothetical Inference.....381
 - 31.1 Mutually-inversistic natural language understanding 381
 - 31.2 Mutually-inversistic hardware verifier..... 387

Chapter 32 Axiomatic systems brought into mutually-inversistic automated decomposition systems 394

32.1 L system of propositional calculus of classical logic brought into third-level automated decomposition systems 394

32.2 KLG system of predicate calculus with equality brought into second-level automated decomposition systems 395

32.3 G system of group theory brought into second-level automated decomposition systems 396

Part 12 Applications of implicit inductive compositions

Chapter 33 Applications of implicit inductive compositions 400

33.1 Quasi-logical theorem prover and quasi-transcendent logical theorem prover 400

33.2 Single logical theorem prover 401

33.3 Multiple logical theorem prover 407

33.4 Semilogical theorem prover 410

Part 13 Applications of explicit inductive composition

Chapter 34 Mutually-inversistic machine learning 414

34.1 Introduction to mutually-inversistic machine learning 414

34.2 Mutually-inversistic machine learning systems 414

34.3 Summary on mutually-inversistic machine learning 423

Chapter 35 Multiple connection operators association rule mining 424

35.1 Double connection operators association rule mining 424

35.2 Triple connection operators association rule mining and degradation mining .. 428

Chapter 36 Mutually-inversistic program refinement 433

36.1 Introduction to mutually-inversistic program refinement 433

36.2 Introduction to rule refinement method 433

36.3 Refinement axioms 435

36.4 Mutually-inversistic program refinement system 436

36.5 Examples..... 437

36.6 Structure of solutions 438

36.7 Summary of mutually-inversistic program refinement..... 439

Part 14 Applications of mutually-inversistic mathematics

Chapter 37 Applications of universal matrix 442

37.1 Applications of universal matrix to OLAP of data warehouse..... 442

37.2 Application of universal matrix to two-dimensional digital signal processing ... 447

37.3 Application of universal matrix to coordinate transformation 447

Chapter 38 Mutually-inversistic many-valued computer 449

38.1 Mutually-inversistic many-valued NAND gates..... 449

38.2 Mutually-inversistic many-valued ANDORN gates 451

Chapter 39 Applications of mutually-inversistic mathematical
analysis 459

39.1 Mutually-inversistic modern control theory..... 459

39.2 Application of single-sided discrete calculus and unified calculus to
experiment orobservation data 468

39.3 Mutually-inversistic fuzzy controller..... 475

References 481

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

Fundamentals 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	$A \rightarrow B$
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 $A \rightarrow B$. 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.

$(P \wedge Q \rightarrow R) \rightarrow (P \rightarrow R) \vee (Q \rightarrow R)$ is a tautology. In $(P \wedge Q \rightarrow R) \rightarrow (P \rightarrow R) \vee (Q \rightarrow R)$, 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 $x \leq y$, Q is assigned $x \geq y$, R is assigned $x = y$. Then it says: if $x \leq y$ and $x \geq y$ implies $x = y$, then $x \leq y$ implies $x = y$, or, $x \geq y$ 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 $A \rightarrow B$ and A being true are the fourth row of Table 1.1, in which B is true. Thus, from $A \rightarrow B$ 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, $A \rightarrow B$ is the unknown, the value, therefore, Table 1.1 can only be used to establish $A \rightarrow B$ 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, $A \rightarrow B$ 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 $\leq^{-1}$

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

Table 1.3

Decomposition one for $\leq^{-1}$

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

Table 1.4

Decomposition two for $\leq^{-1}$

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