Preface

This new volume is a collection of selected papers presented at the Joint Conference of the Third Asian Workshop on Philosophical Logic and the Third Taiwan Philosophical Logic Colloquium (AWPL-TPLC 2016), held during 5–8 October 2016, at Department of Philosophy, National Taiwan University, Taiwan.

Ever since Gottlob Frege's *Begriffsschrift* (1879) and the pioneering works originating with the so-called new logic (to be compared with the then traditional Aristotelian syllogism), by George Boole, Georg Cantor, Giuseppe Peano, David Hilbert, Bertrand Russell and Alfred N. Whitehead, etc., logicians had concerned themselves with the establishment of the foundation of mathematics, which had led to various attempts to reduce arithmetic (and *a fortiori* mathematics) to logic. The new logic was thus entitled 'mathematical logic'. Russell during the 1910s and 1920s highlighted a more philosophical and methodological aspect of this new logic, suggesting that a logical theory not only builds up a solid foundation for mathematical reasoning, but also provides a comfortable framework for analysis of the nature of mathematical propositions and concepts. Basic concepts in mathematics and controversial issues regarding the foundation of mathematics can thus be explicitly articulated in a logical theory. Russell maintained that this methodology can be applied to philosophical propositions in general—the gist of his well-known logical atomism is that 'logic is fundamental in philosophy'.

It was soon realized that the framework of the new style of logical theory, taken as the orthodox or paradigm in the Fregean tradition, may not be comprehensible enough to deal with all kinds of philosophical propositions. It was well observed that certain types of propositions such as propositions concerning future events seemingly defy the basic logical laws of the orthodox logic, which suggests that the logic should be modified or revised. A variety of logical theories alternative to, or deviant from, the orthodox logic were proposed, such as Jan Łukasiewicz's three-valued propositional calculus (for future contingent propositions around 1917), Clarence Irving Lewis's strict implication calculus (for propositions with necessity/possibility, during the 1910s–1920s), Arend Heyting's intuitionistic logic (for a formal basis for Brouwer's intuitionism in the foundation of mathematics in 1930). In a more general sense, they were treated as the rivals of the so-called new logic, and gained the label 'non-classical logics', leaving the term 'classical logic' to the Fregean orthodox logic.

The flourishing of non-classical logics after late 1960s has proved that substantial analyses of certain philosophical propositions and the related concepts can be obtained based on the formulation of the correspondent non-classical logic and its semantical framework, such as modal logics for necessity/possibility and epistemic logic for knowledge/beliefs, to mention a few. This goal can be achieved typically by virtue of structural analyses of the models involved and aximatization, or theorization, of a group of related philosophical doctrines. The impact that non-classical logics have on philosophy is manifested by the fact that the term 'philosophical logic' has been widely used to cover the study of non-classical logics and the study of philosophical topics and concepts (typically, identity, existence, truth, predication, meaning, modality, etc.) that can be dealt with in the framework of non-classical logic. *The Journal of Philosophical Logic*, arguably the first journal mainly devoted to original works in philosophical logic, came into being in 1972 (the first volume of *The Journal of Symbolic Logic*, by comparison, was in 1936). And the first edition of *the Handbook of Philosophical Logic* (four volumes) was published during 1983–1989 (in comparison to the one volume *the Handbook of Mathematical Logic*, edited by Jon Barwise, North Holland, 1977). The second edition of *the Handbook of Philosophical Logic* has become an open-ended project, giving rise to an unlimited series of collection, and since 2001, 17 volumes have been published. This new edition of the Handbook has marked dramatic changes in the landscape of philosophical logic: New areas have been included by the establishment of a large number of new logics; while old areas were significantly enriched and expanded.

Since 2000, more and more logicians and philosophers in Asia area have paid great attention to philosophical logic. To promote mutual understanding and collaboration for future researchers in Asian on philosophical logic, a series of biennial conferences—*Asian Workshop on Philosophical Logic* (AWPLs), was initiated by Professor Hiroakira Ono (Japan Advanced Institute of Science and Technology, JAIST, Japan) and some others. *The First Asian Workshop on Philosophical Logic* (AWPL-2012) was held at JAIST in February 2012, followed by *The Second Asian Workshop on Philosophical Logic* (AWPL-2014) in April 2014 at Sun Yat-sen University, Guangzhou, China. A post-conference proceedings of AWPL-2014, *Modality, Semantics and Interpretations* (Ju Shier, Liu Hu and Hiroakira Ono, eds. 2015) was published as the first volume of the then newly established LIAA-book series ('Logic in Asia'), a subseries of Studia Logica Library, Springer. Almost at the same time, The Taiwan Philosophical Logic Colloquium (TPLCs), another series of biennial conferences in philosophical logic, hosted by the Department of Philosophy, National Taiwan University, Taiwan, with funding from the private sector, was established. A post-conference proceedings of TPLC-2014, *Structural Analysis of Non-classical Logics* (Syraya Chin-Mu Yang, Duen-Min Deng and Hanti Lin, eds.), was published as the second volume of LIAA-book series by Springer in 2015.

The aim of AWPLs and TPLCs is to provide a forum for dialogues amongst logic-minded philosophers and philosophically oriented logicians. The scope of AWPLs and TPLCs covers philosophical logic (in a broad sense), non-classical logics, algebraic logic, mereology, their applications to computer science, cognitive science, linguistics, game theory, and other social sciences, etc., and all kinds of semantics/logics relating to philosophical concepts and their applications in philosophical issues. It is dedicated to promoting both theoretical and empirical studies of logic (typically non-classical logics), with a close connection to disciplines that draw on diverse methods and approaches from philosophy, computer science, mathematics, psychology and linguistics.

The present volume, together with the two aforementioned volumes, *Modality, Semantics and Interpretations* and *Structural Analysis of Non-Classical Logics*, intends to flag a significant portion of the landscape of the development of philosophical logic in Asia at the early twenty-first century. We hope that these volumes can provide a useful and representative survey of the main fields to which distinguished logicians and philosophers in Asia, and perhaps in Australasian regions, have devoted their research.

In the opening chapter, "Representing and Completing Lattices by Propositions of Cover Systems," Robert Goldblatt continues his project of developing a theory of cover systems that encompasses non-distributive logics. In previous papers, he has used this to provide structural semantics for the logic of residuated ordered semigroups and quantales, intuitionistic modal logics, classical bilinear logic, relevant logic and the storage and consumption modalities of linear logic. The present article studies cover systems on the set of principal filters of a lattice and their role in lattice representations, obtaining presentations of the ideal completion and the MacNeille completion of the original lattice as lattices of propositions of a cover system. This is explored further for ortholattices, and for Heyting algebras in relation to Grothendieck topologies.

Hiroakira Ono's Chapter "A Uniform Algebraic Approach to Cut Elimination Via Semi-Completeness" introduces an algebraic condition 'semi-completeness' of sequent systems (due originally to Shoji Maehara, 1991). It is proved that the semi-completeness of a given system S without cut rule gives a sufficient condition of eliminating cut. Moreover, many of existing semantical proofs of cut elimination, using either Kripke semantics or algebraic one, can be naturally transformed into algebraic proofs of semi-completeness. The author concludes that semi-completeness offers a uniform algebraic way of understanding cut elimination, of both single- and multiple-succedent sequent systems, for a wide variety of non-classical propositional and predicate logics as well.

Chapter "Ancient Indian Logic, Pakṣa and Analogy" (by Jeffrey Paris and Alena Vencovská), provides a formalization which intends to capture the suggestion of B.K. Matilal, and earlier J.F. Staal, that the Indian Schema from Gotama's Nyāya–Sūtra should be understood in terms of an 'occurrence' relation linking events to their loci. It goes on to show that in consequence the Schema inherits a rational justification as analogical reasoning within Unary Pure Inductive Logic from the widely accepted principle of Atom Exchangeability, itself a property of the Carnap's Continuum of Inductive Methods.

Shih Ping Tung in Chapter "Provability and Decidability of Arithmetical Sentences", proves several results about the decidability, axiomatizability, recursive enumerability, etc., of certain rather basic families of arithmetic sentences. More specifically, it shows that the sets of all sentences of the form $\forall z \exists x \forall y\, f(x,y) - az \neq 0$, where $f(x,y) \in \mathbb{Z}[x, y]$ and $a \in \mathbb{Z}$, true in $\mathbb{N}$, $\mathbb{Z}$, and $\mathbb{Q}$ are axiomatizable, respectively. It follows that the sets of all sentences of the form $\exists z \forall x \exists y\, f(x,y) - az = 0$ true in $\mathbb{N}$, $\mathbb{Z}$ and $\mathbb{Q}$ are decidable, respectively. These results use earlier, seemingly more ground-breaking, work of the author's (from over 30 years ago) but nevertheless make a worthwhile contribution to the subject which may pave a new path to future work of researchers in this field.

In Chapter "On the Minimization Principle in the Boolean Approach to Causal Discovery", Jiji Zhang examines a Boolean approach to causal inference, which is rooted in John Mackie's celebrated INUS theory of causation and has been developed into several sophisticated data analysis methods for social scientists. The target of Zhang's criticism is the minimization steps in a most recent implementation of this approach, known as the method of Coincidence Analysis (CNA). Zhang presents prima facie counterexamples to the soundness of the minimization steps in CNA and discusses two possible responses to them. The author then argues that while one of the responses is viable, it renders the role of minimization much less substantial than it is usually intended to be.

Chapter "Contentual and Formal Aspects of Gentzen's Consistency Proofs", (by Ryota Akiyoshi and Yuta Takahashi) offers an analysis of Gentzen's second consistency proof for first-order arithmetic in 1936. Wilfried Sieg has recently highlighted two distinct notions of consistency proofs in Gentzen's series of work then: contentual correctness proofs (semantic manner in character, typically Gentzen's consistency proof in 1935); and formal correctness proofs (substantially a proof-theoretic approach, as shown in a 1938 paper). The authors show that Gentzen's 1936 proof is both contentual and formal. The connection between the contentual aspect of this proof and its formal aspect is specified and some consequences are noted.

Hao-Cheng Fu in Chapter "Saving Supervaluationism from the Challenge of Higher-Order Vagueness Argument" proposes a revised version of supervaluationism which could govern the puzzle of vagueness. Some plausible solutions to the problem of vagueness are reviewed, and shown to fail due to the phenomenon of higher order vagueness. Fu further argues that the proposed supervaluationism could be appealing if we can construct a dynamic model instead of the static model of supervaluationism.

Chapter "Cut Free Labelled Sequent Calculus for Dynamic Logic of Relation Changers", (by Ryo Hatano, Katsuhiko Sano, and Satoshi Tojo), provides a cut-free labelled sequent calculus **GDLRC** for van Benthem and Liu's dynamic logic of relation changers (**DLRC**, 2007), a variant of dynamic epistemic logic (**DEL**) that provides a general framework to capture many dynamic operators of **DEL** in terms of relation changing operation written by programs in propositional dynamic logic

(**PDL**). In contrast, proof theory for **DLRC** has not been well-studied except for a Hilbert-style axiomatization proposed in van Benthem and Liu's work. The authors further show that **GDLRC** is equipollent with the aforementioned Hilbert-style axiomatization.

Ryo Kashima in Chapter "On Second Order Propositional Intuitionistic Logics", studies two second-order propositional intuitionistic logics: the first one, with the full comprehension axiom; the other, including the constant domain axiom. The completeness theorems for these two logics with respect to corresponding Kripke models were proved by Sobolev (1977) and Gabbay (1974), respectively. Kashima here offers some slightly strong alternative proofs, using the technique of nested sequent calculi, and consider a closure condition on Kripke models, namely 'the domain of quantification is closed under any operation that is induced by a formula'. The author shows that this condition depends on the characterization of disjunction because at propositional level, a disjunction of the form 'A∨B', taking '∨' as primitive, and the formula (for all x)((A $\rightarrow x$) $\rightarrow$((B $\rightarrow x$) $\rightarrow x$)) induce different operations, whereas at second order level, A∨B can be defined by (for all x)((A $\rightarrow x$) $\rightarrow$ ((B $\rightarrow x$) $\rightarrow x$)). Noticeably, this difference is critical in the argument on the constant domain condition in that if the language does not contain disjunction as primitive, the constant domain axiom is not required for the completeness with respect to constant domain models.

In Chapter "Classical Model Existence Theorem in Subclassical Predicate Logics. II", Jui-Lin Lee shows that there are some much weaker logics satisfying the classical model existence property (*CME*)—every consistent set has a classical model. By using weak deduction theorem, in propositional logics, Lee improves previous results and shows that some weak extensions of *BCI*/*BCIW* logic satisfy *CME*. Glivenko's Theorem for corresponding logics is also proved. In predicate logics, under such a weak propositional logic part, Lee uses the Herbrand-Henkin style approach (via prenex normal form theorem) and also the Hintikka style approach to construct weaker subclassical predicate logics which satisfy *CME*.

Ren–June Wang's Chapter "On Incorporating Reasoning Time into Epistemic Logic", introduces the notion of *reasoning-based knowledge*, a concept of knowledge taking reasoning time into account, in contrast with the *information-based knowledge*, which is normally formulated by the plain possible world semantics. Two formal systems, $\mathbf{tMEL^K}$ and $\mathbf{tMEL^\infty}$, are proposed, with each of them having a device representing the information-based knowledge and reasoning-based knowledge, respectively. The author further applies $\mathbf{tMEL^\infty}$ to investigate the epistemic valid formula $\sim K(p \ \& \sim Kp)$, with a detour to discuss the Moore's paradox from the reasoning-based knowledge perspective.

Sakiko Yamasaki and Katsuhiko Sano in Chapter "Proof-Theoretic Embedding from Visser's Basic Propositional Logic to Modal Logic K4 via Non-Labelled Sequent Calculi" employ **G3**-style *non-labelled* sequent calculi to establish a proof-theoretic embedding from Visser's Basic Propositional Logic **BPL** into modal logic **K4** via a variant of Gödel–McKinsey–Tarski translation sending an atom P to $P \ \& \Box P$, where the logic **BPL** is obtained by dropping the requirement of reflexivity from Kripke semantics for intuitionistic logic. The authors first provide for **BPL** a **G3**-style non-labelled sequent calculus **G3BPL**, which enjoys cut elimination theorem and is proved to be sound and complete for intended Kripke semantics. Then they establish a proof-theoretic embedding where the above translation plays a key role in the proof for the direction of faithfulness, i.e. if the translation of a formula of **BPL** is provable in **K4** then the original formula is provable in **BPL**. By this proof-theoretic embedding, the authors also provide another syntactic proof of cut elimination theorem for **G3BPL** by reducing the admissibility of cut of **G3BPL** to that of a **G3**-style non-labelled sequent calculus for **K4**.

It is noteworthy that AWPL-TPLC 2016 organized two special workshops. The first one is a one-day plus workshop on Williamson's philosophy to honour Professor Timothy Williamson (Wykeham Professor of Logic, University of Oxford) for his outstanding contribution to philosophical logic (typically on identity, vagueness, knowledge first epistemology and metaphysics of modality). We regret that for the sake of the limitation of the space, papers based on talks at this workshop could not be included in this volume. A second workshop on mereology was organized to signify certain philosophical aspect of mereology. The remaining two chapters of this volume come out from presentations at this workshop.

In Chapter "Varieties of Parthood", Paul Hovda addresses formal patterns that emerge on the view that there are a variety of parthood relations, and that certain general principles govern these relations and connect them to one another. One such principle is shown to connect with the strong supplementation principle of classical mereology, and also to the classical notion of mereological fusion. The main line of development shows roughly that, for any given variety of parthood, relating objects in a given domain, for any larger domain that includes the given one, and where the new objects may have the old objects as parts in a new manner, then, on one general way of being a part, there is a 'unique' possible structure resulting, itself intimately related to classical mereology. The uniqueness is measured relative to a notion like the standard notion of isomorphism, but weaker, which we call 'quasi-isomorphism.'

In the final Chapter, "Infinite 'Atomic' Mereological Structures", Hsing–Chien Tsai shows that the strongest first-order atomic mereological theory which can be generated by axioms found in the literature, that is, General Extensional Mereology with the atomicity axiom, as well as a natural second-order extension of such a theory, that is, Classical Mereology with the atomicity axiom, still cannot secure an atomic domain, where a domain is atomic if it contains a collection of 'atoms' (an atom is something which has no proper parts) and each of its members is composed of some atoms and nothing else. These are further results of what have been done earlier by the author.

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