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Helena Rasiowa's Heritage in Mathematical Logic

Centenary Special Issue

The present special issue is a tribute to Helena Rasiowa on the occasion of her centenary, she was born on the 20th of June, 1917.

The research work of Helena Rasiowa is grounded in a tradition exposed in the title of one of the first books by George Boole published in 1847: *The Mathematical Analysis of Logic* with the subtitle *Being an Essay towards a Calculus of Deductive Reasoning*. His mathematical tool constructed for such an analysis gave rise to what is known today as Boolean algebras. From that tradition originated an extensive research on algebras which provide semantics to non-classical logics. Helena Rasiowa contributed substantially to that line of development of algebraic logic and its methodology.

Helena Rasiowa was a descendant of the Lvov-Warsaw school of logic which won fame due to the important contributions of its members, in particular, Jan Łukasiewicz, Stanisław Leśniewski, Kazimierz Ajdukiewicz, Alfred Tarski, Andrzej Mostowski. The research results of Helena Rasiowa have been an inspiration for several generations of scientists all over the world, not only those working on mathematical logic but also universal algebra, theoretical computer science, and artificial intelligence. Her broad-mindedness towards applications of logic in other fields has been an example to many of us. Of particular importance are her activities in promoting logics for computer science. In early 1970s she initiated the *Concurrency Specification and Programming* series of conferences organized by the Humboldt University of Berlin and the University of Warsaw by turns. In 1977, together with Zdzisław Pawlak, she founded the journal Fundamenta Informaticae and had been its editor in chief for the end of her life, she passed away on the 9th of August, 1994.

The bibliography of Helena Rasiowa includes a number of research articles and two monographs. The first monograph *Mathematics of Metamathematics* joint with Roman Sikorski was first published in 1963 by Polish Scientific Publishers. In this monograph the Authors presented an algebraic apparatus for studying propositional and first order classical and intuitionistic logics, and briefly mention the analogous treatment of modal and positive logics. Their approach was based on an idea of interpreting formulas as mappings in some lattices. In the second monograph *An Algebraic Approach to Non-classical Logics* Helena Rasiowa developed a general framework for methodological studies of logics. She presented several examples of non-classical logics showing how they can be treated within that framework.

The papers collected in the present special issue are a sample of recent results on algebras related to logics dedicated to the memory of Helena Rasiowa.

The paper by Janusz Czelakowski is a study of the algebraic method of construction of models of first order formal languages presented by Helena Rasiowa and Roman Sikorski in their paper *A proof of the completeness theorem of Gödel* published in Fundamenta Mathematicae 37, 1950, 193-200. The idea of the authors was to construct the models from a subfamily of the family of Lindenbaum-Tarski sets. Czelakowski describes a construction of that subfamily using forcing techniques.

In the paper by Ivo Düntsch, Leonard Kwuida, and Ewa Orłowska a representation theorem for a class of dicomplemented, not necessarily distributive lattices is presented. Dicomplemented lattices originated as an abstract generalization of concept algebras introduced by Rudolf Wille within the framework of his formal concept analysis. The two complements in dicomplemented lattices are some analogs of pseudocomplement and dual pseudocomplement. The representation is based on a topology-free version of Alasdair Urquhart representation of general lattices published in his paper *A topological representation theorem for lattices*, Algebra Universalis 8, 1978, 45-58.

Melvin Fitting investigates analogies and differences between the universal and existential quantifiers and operators of necessity and possibility of modal logics. He presents a number of axiom systems of modal logics, including non-normal ones, and their first order analogs. A hierarchy of those logics is also presented based on a sublogics relationship. For the logics from the hierarchy tableaux systems, decidability, and interpolation property are discussed.

Anna Romanowska and Jonathan Smith developed a duality for quasilattices based on duality for lattices presented in the paper by Ch. Hartonas and M. Dunn *Stone duality for lattices*, Algebra Universalis 37, 391-401. In that paper the representation algebra is constructed from two-sorted frames and its join and meet operators are defined using Birkhoff polarities (in logic also referred to as sufficiency operators) which form a Galois connection. Romanowska and Smith proposed a construction referred to as pairing instead of polarities.

The paper by Viorica Sofronie-Stokkermans presents several results concerning representability, algebraic semantics, interpolation property, decidability, and complexity of some description logics. From the mathematical logic perspective description logics form a subclass of the class of multimodal logics. Their formulas provide descriptions of semantics of modal formulas. From the applied logic perspective description logics are knowledge representation logics.

The paper by Dimiter Vakarelov develops an algebraic semantics for intuitive concepts of actual existence in space and time. The signature extensions of Boolean algebras obtained by endowing them with some relations are introduced and investigated. For those new classes of algebras the set-theoretic and topological representation theorems are proved.

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