Lorne Szabolcsi, *Numerical Term Logic* (edited by George Englebretsen, foreword by Fred Sommers), Lewiston, New York: The Edwin Mellen Press, 2008, xii+119pp., ISBN 0-7734-5027-0, $99.95 (hardcover).

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Received: 15-10-2009. **Accepted**: 10-12-2009.

Everyday life reasoning and argumentation involve quantifying expressions that go beyond what can be captured with modern predicate logic. Typical examples include *most*, *many*, and *all except a few*. The universal quantifier (∀) and the existential quantifier (∃) of modern predicate logic may be used for the representation of propositions which are expressed by phrases like "all" and "at least one", respectively. Their practical utility for the formalization of natural language arguments or everyday life reasoning, however, is quite restricted.

The universal quantifier is too strong, as it does not allow for *exceptions* (unless these are not made explicit in the antecedent). One counterexample is enough to falsify a universally quantified proposition. Moreover, in everyday argumentation, words like "all" are mentioned, but they are often pragmatically used in the sense of "most" or "almost-all".

Likewise, the practical utility of the existential quantifier is quite restricted. Reasoning about *at least one* thing is very useful in formal sciences like mathematics (e.g., important theorems establish the (non-)existence of some mathematical objects). However, such reasoning rarely occurs in everyday life reasoning and argumentation. Therefore, reasoning systems which express and thus serve to represent reasoning with expressions whose

[1] Austrian Science Fund project *Mental Probability Logic*.

meaning "lies in between" the universal and the existential quantifier are desirable.

To build a logic that is expressible enough to capture quantifying expressions that are used in everyday reasoning requires going beyond modern predicate logic. Lorne Szabolcsi successfully built on (and improved) Fred Sommers's and George Englebretsen's *logic of terms* (1996), and combined Philip Peterson's *intermediate quantifiers*[2] and Wallace Murphree's *numerically exceptive quantifiers* (1991) in a fruitful way (see also Pfeifer, 2006, for related work developed independently). Szabolcsi calls the resulting logic "*Numerical term logic*" (short NTL).

The book contains a foreword by Fred Sommers, who highlights the reasoning mechanisms of Szabolcsi's numerical term logic and his contributions to quantification theory. After a brief introduction (first chapter), the second chapter introduces Szabolcsi's "Numerical Term Logic", his logical notation, including formalizations of various natural language quantifying expressions. "More than 4 clowns are scary", for example, is formalized by +4C+S. The book continues with a chapter on "Inference in NTL", containing several detailed proofs.

The section "Further Developments in NTL" includes various topics like existential implication, and definite descriptions. Also, relations to other systems of non-standard quantifiers (e.g., Peterson 2000 and Murphree 1991) are discussed in the third chapter. Unfortunately, there is only a very brief note on generalized quantifiers. If the author had had the opportunity to incorporate more recent work (e.g., Peters and Westerståhl 2005) this section would have been much more substantial and informative. Unfortunately, in 2002, Szabolcsi died in a tragic car accident at the age of 28. George Englebretsen edited a corrected and lightly edited version of Szabolcsi's work posthumously. A number of typos very likely stem from scanning the original document (e.g., "modem" instead of "modern" on pages 7 and 102). More careful proofreading would have been beneficial. The final four chapters contain a brief conclusion, notes, a bibliography and an index.

NTL is constructed within—but is not restricted to—the classical syllogistic framework, taking neither the existential nor the universal quantifier

[2] Sczablocsi cites a series of papers by Peterson, but not the book of 2000. The interested reader is referred to this book as it provides an overview of Peterson's work.

as basic. Rather, NTL provides a rich and unified (algebraic) framework for numerous different kinds of quantifying expressions. Examples include (i) quantifiers that handle exceptions explicitly (e.g., *all except thirty*), (ii) comparative quantifiers (e.g., *(no) more ..., than ...*), and (iii) fractional quantifiers (e.g., *80% of ... are ...*).

The expressions of everyday reasoning do usually not contain explicit numbers or percentages which, however, are extremely useful for making explicit *to what degree* the relationships among given terms hold. It is well known that humans may interpret one and the same phrase differently. This also holds for the interpretation of phrases containing quantifying expressions. Szabolcsi's NTL provides useful tools for the logical analysis of different interpretations of phrases that involve quantifiers. For example, "ten out of thirty objects having property *P*" may be interpreted as "few objects have property *P*", "many ...", "more than enough ...", or "not enough ..." (Szabolcsi, p. 26f). All interpretations differ from each other, and so do their formalizations. Thus, NTL is rich enough to express various subjective interpretations of a wide range of natural language quantifying expressions.

Over the last 100 years, many empirical studies have investigated how people reason about classical syllogisms (e.g., Störring 1908; Chapman and Chapman 1968; Prowse Turner and Thompson 2009). Almost all psychologists took it for granted that modern predicate logic provides the gold standard of reference for evaluating the quality of human inferences. Consequently, they focused on the classical quantifiers. The present book could be used as an inspiration for designing tasks which target quantifiers that are closer to everyday life reasoning and argumentation than those designed in the framework of modern predicate logic.

The book is therefore a valuable source for anyone interested in reasoning and argumentation about quantified propositions. It is not only interesting for logicians, but also for philosophers, linguists, and psychologists working on the interpretation and understanding of quantifiers.

The major strength of this book is its clear and unified logical treatment of a broad variety of interpretations for natural language quantifying expressions. Notably, the author shows how logical validity can be determined by relatively simple algebraic manipulations. Throughout the book, the systematic application of the theory to everyday arguments highlights its practicability and the importance of Lorne Szabolcsi's theoretical achieve-

ments. The book does not provide a comprehensive overview of modern quantification theory (see e.g. Peters and Westerståhl 2005). Recent work on generalized quantifiers and the relationships to numerical term logic are missing. Nevertheless, the theory exposed in this book is self-contained, fruitful, and deserves scientific attention.

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