UDC 519.68

MATEMATICHESKIE TRUDY
2005, V. 8, N 1, 3–42

MATHEMATICAL FOUNDATIONS OF COMPUTER ARITHMETICS

S. P. Kovalyov

We propose mathematical methods aimed at formalizing the computer implementation of arithmetic computations. A model-theoretic method of partial interpretation is elaborated for constructing formal specifications of computation models which takes resource limitations into account. Using this method we produce and analyze various integer and rational computation models including, in particular, the positional number systems. Architecture models of the arithmetic are created based on the language of the finite-valued Łukasiewicz logic and logics that enrich it. The weak completeness of such logics enabled us to research into the structural characteristics of operations independent of the representation of numbers. In particular, the mechanisms of detection and processing overflows have been analyzed. Various computation models are represented as bases of logic functions. A technique is proposed for verifying the absence of overflow in computing arithmetic expressions by proving many-valued logic theorems.

Key words and phrases: computer arithmetic, partial interpretation, Łukasiewicz logic, overflow, carry flag.

Kovalëv Sergej Protasovich
Institute of Computational Technologies,
630090 Novosibirsk, Russia.
E-mail: kovalyov@nsc.ru

Received
July 28, 2004

Translated into English:
Siberian Advances in Mathematics, V. 15, N 4, 34–70 (2005).