Peter Clote
Evangelos Kranakis

Clote · Kranakis

Boolean Functions and Computation Models

This advanced textbook is a survey of the present state of research in the study
of boolean functions, formulas, circuits, propositional proof systems, and models
of computation. All of these subjects are related to the overriding concern of how
computation can be modeled, and what limitations and interrelations there are
between different computation models.

Starting with methods for the construction of boolean circuits which compute
certain arithmetic and combinatorial functions, upper and lower bounds for
circuit families are investigated. The techniques used are from combinatorics,
probability and finite group theory. Then survey is given on steps taken in a
program initiated by S.A. Cook for investigating non-deterministic polynomial
time, from a proof-theoretic viewpoint. Specifically, lower bounds are presented
for lengths of proofs for families of propositional tautologies, when proven in
certain proof systems. Techniques here involve both logic and finite combina-
torics and are related to constant-depth boolean circuits and to monotone
arithmetic circuits.

Numerous exercises at the end of each chapter enhance understanding of
the material and expand research topics covered. Thus, the book will benefit
advanced undergraduate and graduate students as well as researchers in the
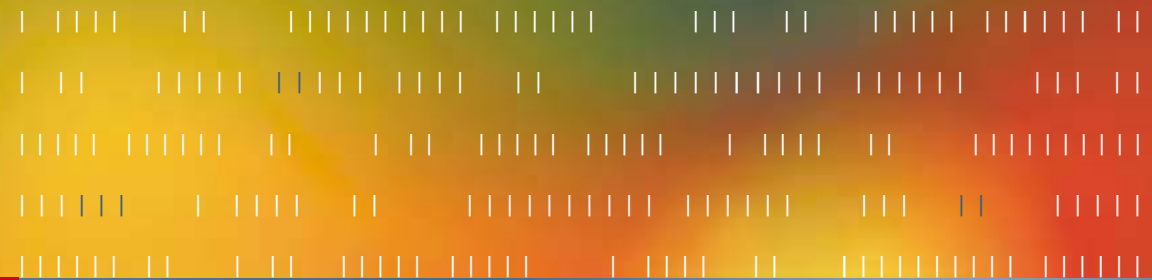field of complexity theory.

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