# The Computer Journal

## The international journal of information technology and computer applications

Editor-in-Chief P Hammersley, Middlesex Polytechnic, The Burroughs, Hendon, London NW4 4BT, UK

#### Coverage

The Computer Journal is one of the world's most eminent periodicals in the field of information technology and computer applications. Its coverage is unmatched by any other computing periodical. It includes advanced programming, computer science theory, databases, hardware and logic design and business applications. It also covers the newer disciplines such as parallel computing, object-oriented programming, logic programming and electronic publishing. Papers are always in the mainstream of new developments; their results are significant and far reaching; above all they are readable.

#### Type of Articles Published

The Computer Journal publishes original research papers, practical accounts of the latest developments and their likely impact, shorter communications, correspondence about recently published articles, and review articles.

The quality and scope of The Computer Journal can be seen from just a selection of recent and forthcoming articles. Send for a free sample copy and see for yourself!

#### Subscription information

The Computer Journal (ISSN 0010-4620), Volume 34: February, April, June, August, October and December 1991. £174 for UK subscribers, £185 for subscribers elsewhere.



Cambridge University Press
The Edinburgh Building, Cambridge CB2 2RU, England
40 West 20th St, New York, NY 10011-4211, USA

# A NEW journal in the applications of categorical, algebraic and geometric methods in Computer Science

# Mathematical Structures in Computer Science

#### Why a new journal?

Mathematical Structures in Computer Science (MSCS) is a new journal of theoretical computer science which focuses on the application of ideas from the structural side of mathematics and mathematical logic to computer science. The journal aims to bridge the gap between theoretical contributions and software design, publishing original papers or broad surveys with original perspectives in all areas of computing, provided that ideas or results from algebra, geometry or category theory form a basis for the work. MSCS is distinct from existing titles in that it specialises in the art of applying mathematics of genuine interest and general applicability to computer science; its objective is to promote the useful application of high level mathematics to language design and software implementation. The journal will increase the circulation of new results in this fast growing area.

#### Editor-in-Chief

G Longo Ecole Normale Supérieure, 45 rue d'Ulm, 75230 Paris (email: longo@earn.frulm63)

#### **Associate Editors**

P L Curien Laboratoire d'Informatique, Ecole Normale Supérieure, Paris A M Pitts

Computer Laboratory, University of Cambridge

#### Forthcoming articles

From Petri Nets to Linear Logic
NARCISIO MARTI-OLIET & JOSE MESEGUER
Impredicative Calculi of Dependent
Types
THOMAS STREICHER

Operations on Records
LUCA CARDELLI & JOHN C MITCHELL
Predicate Transformer Semantics
ERNIF MANES

Declarative Continuations: An Investigation of Duality in Programming ANDRZEJ FILINSKI

A Category-theoretic Account of Program Modules Eugenio Moggi

What is Functional Programming? R F C WALTERS

#### Subscription information

Mathematical Structures in Computer Science, Vol 1: March, July and November 1991: £75/\$135. Delivery by airmail £9.50 per year extra (dollar price includes airfreight to New York). ISSN 0960-1295

Send your order to Journals Publicity Department, Cambridge University Press, FREEPOST\*, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 1BR, England TEL: (0223) 325806, FAX (0223) 315052

\*no postage stamp necessary if posted in UK
In US & Canada, write to: Cambridge
University Press, 40 West 20th Street,
New York,
NY 10011-4211,

\*\*\*Cambridge\*\*

d Tournals

# <u>Cambridge</u>

### The Principles of Computer Networking

D. RUSSELL

This new textbook about an immensely important area, puts emphasis on understanding fundamental principles rather than specific systems which may rapidly become out of date. The book ranges from systems linked by telephone lines to tightly coupled networks of processors.

£45.00 net Hard covers 0 521 32795 4 513 pp. 1989 £15.95 net Paperback 0 521 33992 8 Cambridge Computer Science Texts 25

New Series

#### Cambridge Series on Human-Computer Interaction

This new series will reflect the diversity of disciplines interested in HCI, from software engineering to psychology, sociology, ergonomics, AI and education. It will contain books at graduate level and above, as well as some undergraduate texts.

#### Cognitive Ergonomics and Human-Computer Interaction

Edited by J. LONG and A. WHITEFIELD

The first book in this new series provides detailed reports of a number of long-term research projects. It discusses substantial empirical investigations, rather than being a summary of specific areas or theoretical speculations.

£27.50 net Hard covers 0 521 37179 1 288 pp. 1989 Cambridge Series on Human-Computer Interaction 1

#### Science and Reform

Selected Works of Charles Babbage Edited by **ANTHONY HYMAN** 

This book contains carefully selected passages from the diverse publications of a key figure in the history of computing. It is a fascinating tribute to the relentless spirit of inquiry of the founding father of the computer.

£37.50 net Hard covers 0 521 34311 9 363 pp. 1989

### Research and Development in Expert Systems VI

Edited by N. SHADBOLT

This volume contains papers from Expert Systems '89, held with the theme of 'Applications and Methods in Knowledge Based Systems'. The papers describe practical applications in finance and industry as well as important theoretical work.

£35.00 net Hard covers 0 521 38477 X 320 pp. 1989 British Computer Society Workshop Series Now in paperback

### Efficient Parallel Algorithms A. GIBBONS and W. RYTTER

This self-contained introduction to efficient parallelisation presumes no special knowledge of parallel computers or particular mathematics. The approach concentrates on the essence of algorithmic theory, and on determining and taking advantage of the inherently parallel nature of certain types of problem.

£14.95 net Paperback 0 521 38841 4 267 pp. 1990

#### Information Technology

Agent of Change

**MURRAY LAVER** 

This is a non-technical assessment of IT and its influence on people and communities. It provides a realistic overview, steering a middle course between rosy utopias and bleak apocalyptic nightmares.

£27.50 net Hard covers 0 521 35035 2 203 pp. 1989 £9.95 net Paperback 0 521 35925 2

### Raster Imaging and Digital Typography

Edited by J. ANDRÉ and R. HERSCH

These papers present the most recent developments, including curve fitting, shape manipulation, character design, and representation and page-description languages.

£32.50 net Hard covers 0 521 37490 1 250 pp. 1989 Cambridge Series on Electronic Publishing

#### Graphic Tools for Software Engineers

Edited by A. KILGOUR and R. EARNSHAW

This book considers the development of graphical aids for software engineers, the construction of user interfaces by graphical and textual interaction, and the display of program behaviour during its execution.

£22.50 net Hrd covers 0 521 37221 6 126 pp. 1989 British Computer Society Workshop Series

#### People and Computers V

Edited by A. SUTCLIFFE and L. MACAULAY

This book presents the proceedings of the major international conference, HCI '89. The book's themes are: the theoretical basis and methodical practice of HCI; the integration of HCI with other disciplines; and the industrial relevance of HCI. It represents a comprehensive guide to current research in the field.

£37.50 net Hard covers 0 521 38430 3 502 pp. 1989 British Computer Society Workshop Series

Order from our Customer Services department on 0223 325970. For further information write to Susan Chadwick at the address below.



The Edinburgh Building, Cambridge CB2 2RU

# Cambridge

## ML for the Working Programmer

#### L. C. PAULSON

This book teaches the methods of functional programming, in particular, how to program in Standard ML. The author shows how to use such concepts as lists, trees, high-order functions and infinite data structures and includes a chapter on formal reasoning about functional programming. However, this is a practical book, avoiding dogma, emphassing efficiency and including many useful and real programs.

## Topics in Distributed Algorithms

#### G. TEL

This book presents a collection of recent computer algorithms and protocols used in distributed computing and distributed system implementation. Each algorithm is explained intuitively, proved correct, and analysed thoroughly in order to establish what its essential features are.

£20.00 net HB 0 521 40376 6 256 pp. Cambridge International Series on Parallel Processing 1

#### **Nonmonotonic Reasoning**

From Theoretical Foundation to Efficient Computation

#### G. BREWKA

0/

The author gives a broad overview of different areas of research in nonmonotonic reasoning, and presents some new results and ideas based on his research.

£19.50 net HB 0 521 38394 3 192 pp. Cambridge Tracts in Theoretical Computer Science 12

# Now in paperback Formal Methods in Artificial Intelligence

#### **ALLAN RAMSAY**

Artificial intelligence has recently turned to formal logic in the search for powerful knowledge representation languages. Covering a wide range of topics, this book is aimed at all researchers in artificial intelligence.

£14.95 net PB 0 521 42421 6 296 pp. Cambridge Tracts in Theoretical Computer Science 6

-3
☐ Please send me further information about computer science from Cambridge
☐ Please send me a catalogue in the following subject area
Name
Address

Please send to Susan Chadwick at the address below



The Edinburgh Building, Cambridge CB2 2RU, UK.

# Cambridge

#### **Process Algebra**

J. C. M. BAETEN and W. P. WEIJLAND

This is an introduction to process algebra. The book provides a self-contained mathematical approach to the theory and will be essential reading for all computer scientists interested in parallel processing and algebraic methods in computer science.

£17.50 net HB 0 521 40043 0 256 pp. Cambridge Tracts in Theoretical Computer Science 18

### Theoretical Foundations of VLSI Design

Edited by K. McEVOY and J. V. TUCKER The physical technologies of very large scale integration (VLSI) are having major effects on the electronics industry. This book discusses recent research in the theoretical foundations of several subjects of importance for the design hardware, and for computer science in general. £35.00 net HB 0 521 36631 3 448 pp. Cambridge Tracts in Theoretical Computer Science 10

#### A Unifying Framework for Structured Analysis and Design Models

T. H. TSE

Many different structured methodologies exist, each employing a number of models, and so a specification must be converted from one form to another during the development process. To solve this problem, Dr Tse here proposes a unifying framework, approaching the problem from the viewpoints of algebra and category theory.

£19.50 net HB 0 521 39196 2 192 pp. Cambridge Tracts in Theoretical Computer Science 11

#### **Applications of Process Algebra**

Edited by J. C. M. BAETEN

This book gives applications of the theory of process algebra, that is, the study of concurrent or communicating processes using an algebraic framework. The theory is applied to many situations, including systolic algorithms, semantics of an object-orientated language, and protocols.

£27.50 net HB 0 521 40028 7 336 pp. Cambridge Tracts in Theoretical Computer Science 17

# Design Theory and Computer Science SUBRATA DASGUPTA

The logic and methodology of design is examined in this book from the perspective of computer science. Computers provide the context for this examination, and the central question posed by Professor Dasgupta is whether or not we can construct a theory of design.

£30.00 net HB 0 521 39021 4 432 pp. Cambridge Tracts in Theoretical Computer Science 15

### Updating Logical Databases MARIANNE WINSLETT

This book tackles the problems of update algorithms for databases. The author has produced a formal method for specifying the desired change intentionally, using a 'formula-based' approach to updating needs rather than a 'model-based' technique. The complexity of the algorithms, choice of semantics and a means of enforcing integrity constraints are also discussed.

£20.00 net HB 0 521 37371 9 224 pp. Cambridge Tracts in Theoretical Computer Science 9



The Edinburgh Building, Cambridge CB2 2RU, UK.

#### INSTRUCTIONS TO AUTHORS

#### Scope

Papers may describe original technical work, survey an area, or present a tutorial; and may be either short or long. Anything related to functional programming is of interest, including: foundations (semantics, abstract interpretation, lambda calculi, rewriting, logic, type theory, category theory); implementation (compilation, architectures, parallelism, garbage collection, I/O, debugging, profiling); linguistics (pure and impure language features, non-determinism, side effects, logical variables, relation to other programming paradigms, proofs about programs, program transformation, program synthesis, partial evaluation); applications (applications programs, practical experience, programming techniques, prototyping).

#### Submission of manuscripts

Papers may be submitted to any of the editors. Four copies should be sent, accompanied by the author's mailing address, telephone number and, if possible, an electronic mailing address. Papers should not be submitted in the same form elsewhere. Upon acceptance of a paper, the author will be asked to transfer copyright to the publisher.

#### Layout of Manuscripts

Papers should be type-written or type-set in double spacing throughout, on one side of the paper. Please avoid footnotes if possible. Papers must begin with an abstract of not more than 300 words.

#### Illustrations

Figures should be drawn in indian ink on good quality white paper or produced by computer to comparable quality. Wherever possible they will be reproduced with the author's original lettering. Originals of figures should not be sent until the paper has been accepted. A list of captions for figures should be attached separately.

#### Proof reading

Please submit papers in their final form. Typographical or factual errors only may be changed at the proof stage. Authors may be charged for correction of non-typographical errors. No page charge is made.

#### References

The Harvard system of references will be used in order to make alterations easier. Papers should be referred to in the text by author's surname and year of publication and listed in alphabetical order at the end of the main text. Please include the article's title in the reference, which should be in the order: author's surname, initials; year in parentheses; article title; journal name, abbreviated in accordance with the World List of Scientific Periodicals (4th Edn); volume number (underlined); inclusive page numbers.

#### Offprints

25 offprints of each article will be supplied free to each first named author. Extra offprints may be purchased from the publisher.

Please contact the editors for clarification of any of the above points.

#### COPYING

This journal is registered with the Copyright Clearance Center, 27 Congress Street, Salem, MA 01970. Organisations in the USA who are also registered with the C.C.C. may therefore copy material (beyond the limits permitted by sections 107 and 108 of US copyright law) subject to payment to C.C.C. of the per-copy fee of \$5.00. This consent does not extend to multiple copying for promotional or commercial purposes. Code 0956-7968/91 \$5.00 + .00.

ISI Tear Service, 3501 Market Street, Philadelphia, Pennsylvania 19104, USA, is authorised to supply single copies of separate articles for private use only.

For all other use, permission should be sought from Cambridge or the American branch of Cambridge University Press.

# JOURNAL OF Functional Programming

VOLUME 1 PART 4 OCTOBER 1991

#### CONTENTS

Explicit substitutions	
M. ABADI, L. CARDELLI, PL. CURIEN AND JJ. LEVY	375
A semantic basis for Quest	
LUCA CARDELLI AND GIUSEPPE LONGO	417
Using transformations in the implementation of higher-order functions	
HANNE RIIS NIELSON AND FLEMMING NIELSON	459
Author index to Volume 1	495

# CAMBRIDGE UNIVERSITY PRESS The Pitt Building, Trumpington Street, Cambridge CB2 1RP 40 West 20th Street, New York, NY 10011-4211, USA

10 Stamford Road, Oakleigh, Victoria 3166, Australia

Printed in Great Britain by the University Press, Cambridge