



MSCS

Mathematical Structures in Computer Science

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

OCTOBER 2012 VOLUME 22 NUMBER 5

CAMBRIDGE
UNIVERSITY PRESS

EDITOR-IN-CHIEF

Giuseppe Longo

Laboratoire d'Informatique (CNRS) et DI, Ecole Normale Supérieure, 45, Rue D'Ulm, 75005 Paris (France), e-mail: Giuseppe.Longo@ens.fr

ASSOCIATE EDITORS

Pierre-Louis Curien

PPS – Case 7014, Université Paris 7, 2 pl. Jussieu, 75251 Paris, Cedex 05, France
e-mail:curien@pps.jussieu.fr

Philip J. Scott

Department of Mathematics, University of Ottawa, 585 King Edward, Ottawa,
Ontario K1N 9B4, Canada
e-mail:phil@site.uottawa.ca

EDITORIAL BOARD

Eugene Asarin Université de Paris VII, France

Richard Blute University of Ottawa, Canada

Cristian S. Calude The University of Auckland, New Zealand

Robin Cockett University of Calgary, Canada

Thierry Coquand Chalmers University of Technology, Göteborg, Sweden

Vincent Danos Università di Edinburgo, UK

Rocco De Nicola Università di Firenze, Italy

Thomas Ehrhard Université Denis Diderot, France

Hartmut Ehrig Technische Universität Berlin, Germany

Martin Escardo University of Birmingham, UK

Yuxi Fu Shanghai Jiaotong University, China

Nicola Gambino Università di Palermo, Italy

Simon Gay University of Glasgow, UK

Alessandro Giuliani Istituto Superiore Sanità e Università Roma 1, Italy

Bob Harper Carnegie Mellon University, USA

Masahito Hasegawa Kyoto University, Japan

Martin Hyland University of Cambridge, UK

Max Kanovitch Russian Humanities State University, Russia

Stephen Lack University of Western Sydney, Australia

Mike Mislove Tulane University, USA

Eugenio Moggi Università di Genova, Italy

Ugo Montanari University of Pisa, Italy

Catuscia Palamidessi Ecole Polytechnique, France

Prakash Panangaden McGill University, Canada

Thierry Paul CNRS and Ecole Normale Sup., France

Benjamin Pierce University of Pennsylvania, USA

Andy Pitts University of Cambridge, UK

Gordon D. Plotkin University of Edinburgh, UK

Barry Sanders University of Calgary, Canada

Robert A. G. Seely McGill University, Montreal, Canada

Alex Simpson University of Edinburgh, UK

Colin Stirling University of Edinburgh, UK

Hebert Wiklicky Imperial College, UK

Glynn Winskel University of Cambridge, UK

© CAMBRIDGE UNIVERSITY PRESS 2012

SUBSCRIPTIONS. *MSCS-Mathematical Structures in Computer Science* (ISSN: 0960-1295) is published bimonthly in February, April, June, August, October and December by Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 8RU, UK/Cambridge University Press, 40 West 20th Street, New York, N.Y. 10011-4211. The subscription price (excluding VAT) of Volume 22, 2012, which includes print and electronic access, is £530 net (UK), (USA, Canada and Mexico US \$940). The electronic-only price available to institutional subscribers is £480 (USA, Canada and Mexico US \$830). Single parts cost £95 net (USA, Canada and Mexico US \$160). Prices include delivery by air. Six parts form a volume. EU subscribers (outside the UK) who are not registered for VAT should add VAT at their country's rate. VAT registered subscribers should provide their VAT registration number. Orders, which must be accompanied by payment, may be sent to any bookseller, subscription agent or to the publisher: Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 8RU, or in the USA, Canada and Mexico to Cambridge University Press, Journals Fulfillment Department, 100 Brook Hill Drive, West Nyack, New York 10994-2133. Japanese prices for institutions are available from Kinokuniya Company Ltd, P.O. Box 55, Chitose, Tokyo 156, Japan. Periodicals postage is paid at New York, NY and at additional mailing offices.

POSTMASTER: send address changes in USA, Canada and Mexico to *MSCS-Mathematical Structures in Computer Science*, Cambridge University Press, 100 Brook Hill Drive, West Nyack, New York 10994-2133.

Claims for missing issues should be made immediately on receipt of the subsequent issue.

INTERNET ACCESS. This journal is included in the Cambridge Journals Online service which can be found at <http://journals.cambridge.org>. For further information on other Press titles access <http://www.cambridge.org>.

COPYING. This journal is registered with the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, USA (www.copyright.com). Organizations in the USA who are also registered with CCC may therefore copy material (beyond the limits permitted by sections 107 and 108 of US copyright law) subject to payment to CCC. This consent does not extend to multiple copying for promotional or commercial purposes.

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

Organisations authorised by the Copyright Licensing Agency may also copy material subject to the usual conditions.

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

This journal issue has been printed on FSC-certified paper and cover board. FSC is an independent, non-governmental, not-for-profit organization established to promote the responsible management of the world's forests. Please see www.fsc.org for information.

Printed in the UK by MPG Books Ltd