

*Commenced Publication in 1973*

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

## Editorial Board

David Hutchison

*Lancaster University, UK*

Takeo Kanade

*Carnegie Mellon University, Pittsburgh, PA, USA*

Josef Kittler

*University of Surrey, Guildford, UK*

Jon M. Kleinberg

*Cornell University, Ithaca, NY, USA*

Alfred Kobsa

*University of California, Irvine, CA, USA*

Friedemann Mattern

*ETH Zurich, Switzerland*

John C. Mitchell

*Stanford University, CA, USA*

Moni Naor

*Weizmann Institute of Science, Rehovot, Israel*

Oscar Nierstrasz

*University of Bern, Switzerland*

C. Pandu Rangan

*Indian Institute of Technology, Madras, India*

Bernhard Steffen

*TU Dortmund University, Germany*

Madhu Sudan

*Microsoft Research, Cambridge, MA, USA*

Demetri Terzopoulos

*University of California, Los Angeles, CA, USA*

Doug Tygar

*University of California, Berkeley, CA, USA*

Gerhard Weikum

*Max Planck Institute for Informatics, Saarbruecken, Germany*

*Commenced Publication in 1973*

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

## Editorial Board

David Hutchison

*Lancaster University, UK*

Takeo Kanade

*Carnegie Mellon University, Pittsburgh, PA, USA*

Josef Kittler

*University of Surrey, Guildford, UK*

Jon M. Kleinberg

*Cornell University, Ithaca, NY, USA*

Alfred Kobsa

*University of California, Irvine, CA, USA*

Friedemann Mattern

*ETH Zurich, Switzerland*

John C. Mitchell

*Stanford University, CA, USA*

Moni Naor

*Weizmann Institute of Science, Rehovot, Israel*

Oscar Nierstrasz

*University of Bern, Switzerland*

C. Pandu Rangan

*Indian Institute of Technology, Madras, India*

Bernhard Steffen

*TU Dortmund University, Germany*

Madhu Sudan

*Microsoft Research, Cambridge, MA, USA*

Demetri Terzopoulos

*University of California, Los Angeles, CA, USA*

Doug Tygar

*University of California, Berkeley, CA, USA*

Gerhard Weikum

*Max Planck Institute for Informatics, Saarbruecken, Germany*

Fei Wang Dinggang Shen  
Pingkun Yan Kenji Suzuki (Eds.)

# Machine Learning in Medical Imaging

Third International Workshop, MLMI 2012  
Held in Conjunction with MICCAI 2012  
Nice, France, October 1, 2012  
Revised Selected Papers

## Volume Editors

Fei Wang  
IBM Research Almaden  
650 Harry Road, San Jose, CA 95120, USA  
E-mail: wangfe@us.ibm.com

Dinggang Shen  
University of North Carolina, School of Medicine  
Department of Radiology and Biomedical Research Imaging Center  
130 Mason Farm Road, Chapel Hill, NC 27599, USA  
E-mail: dgshen@med.unc.edu

Pingkun Yan  
Chinese Academy of Sciences, Xi'an Institute of Optics and Precision Mechanics  
17 Xinx Road, New Industrial Park, Xi'an, Shaanxi 710119, China  
E-mail: pingkun.yan@opt.ac.cn

Kenji Suzuki  
The University of Chicago, Department of Radiology  
5841 South Maryland Avenue, Chicago, IL 60637, USA  
E-mail: suzuki@uchicago.edu

ISSN 0302-9743  
ISBN 978-3-642-35427-4  
DOI 10.1007/978-3-642-35428-1  
Springer Heidelberg Dordrecht London New York

e-ISSN 1611-3349  
e-ISBN 978-3-642-35428-1

Library of Congress Control Number: 2012953042

CR Subject Classification (1998): I.4.3, I.4.6, I.4.0-1, I.4.7-10, I.5.2, J.3, I.2.1, I.2.6, I.2.10, H.2.8, I.3.3

LNCS Sublibrary: SL 6 – Image Processing, Computer Vision, Pattern Recognition, and Graphics

© Springer-Verlag Berlin Heidelberg 2012

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

*Typesetting:* Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

# Preface

The Third International Workshop on Machine Learning in Medical Imaging (MLMI) 2012 was held at the Acropolis Convention Center, Nice, France on October 1, 2012, in conjunction with the 15th International Conference on Medical Image Computing and Computer-Assisted Intervention (MICCAI).

Machine learning plays an essential role in the medical imaging field, including computer-aided diagnosis, image segmentation, image registration, image fusion, image-guided therapy, image annotation, and image database retrieval. With advances in medical imaging, new imaging modalities and methodologies such as cone-beam/multi-slice CT, 3D ultrasound imaging, tomosynthesis, diffusion-weighted MRI, positron-emission tomography (PET)/CT, electrical impedance tomography and diffuse optical tomography, and new machine-learning algorithms/applications are demanded in the medical imaging field. Single-sample evidence provided by the patient's imaging data is often not sufficient for satisfactory performance. Because of large variations and complexity, it is generally difficult to derive analytic solutions or simple equations to represent objects such as lesions and anatomy in medical images. Therefore, tasks in medical imaging require learning from examples for accurate representation of data and prior knowledge.

MLMI 2012 was the second in a series of workshops on this topic. The main aim of this workshop is to help advance scientific research within the broad field of machine learning in medical imaging. This workshop focuses on major trends and challenges in this area, and it presents work aiming to identify new cutting-edge techniques and their use in medical imaging. We hope the series of workshops becomes a new platform for translating research from bench to bedside.

The range and level of submissions for this year's meeting were of very high quality. Authors were asked to submit full-length papers for review. A total of 67 papers were submitted to the workshop in response to the call for papers. Each of the papers underwent a rigorous double-blinded peer-review process, with each paper being reviewed by at least two (typically three) reviewers in the Program Committee composed of 51 known experts in the field. Based on the reviewing scores and critics, a total of the 33 best papers (49%) were accepted for presentation at the workshop and chosen to be included in this Springer LNCS volume. The large variety of machine learning techniques necessary for and applied to medical imaging was well represented at the workshop.

We would like to thank our invited keynote speaker, Anand Rangarajan, Department of Computer and Information Science and Engineering, University

of Florida, whose keynote address was a highlight of the workshop. We are grateful to the Program Committee for reviewing submitted papers and giving constructive comments and critiques, to the authors for submitting high-quality papers, to the presenters for excellent presentations, and to all those who supported MLMI 2012 by attending the meeting.

August 2012

Fei Wang  
Dinggang Shen  
Pingkun Yan  
Kenji Suzuki

# Organization

## Program Committee

Akinobu Shimizu	Tokyo University of Agriculture and Technology, Japan
Anant Madabhushi	Rutgers - State University of New Jersey, USA
Axel Wismueller	University of Rochester, USA
Bram van Ginneken	Radboud University Nijmegen Medical Centre, The Netherlands
Clarisa Sanchez	Radboud University Nijmegen Medical Center, The Netherlands
Daniel Rueckert	Imperial College London, UK
Daoqiang Zhang	Nanjing University of Aeronautics and Astronautics, China
Edward H. Herskovits	University of Pennsylvania, USA
Emanuele Olivetti	Fondazione Bruno Kessler, Italy
Ghassan Hamarneh	Simon Fraser University, USA
Guangzhi Cao	GE Healthcare, USA
Guorong Wu	University of North Carolina, Chapel Hill, USA
Guoyan Zheng	University of Bern, Switzerland
Heang-Ping Chan	University of Michigan Medical Center, USA
Hidetaka Arimura	Kyusyu University, Japan
Hongtu Zhu	University of North Carolina, Chapel Hill, USA
Hotaka Takizawa	University of Tsukuba, Japan
Ipek Oguz	University of North Carolina, Chapel Hill, USA
Jianming Liang	Arizona State University, USA
Jianwu Xu	University of Chicago, USA
Joachim Hornegger	Friedrich Alexander University, Germany
Kazunori Okada	San Francisco State University, USA
Kevin Zhou	Siemens Corporate Research, USA
Kilian Pohl	University of Pennsylvania, USA
Li Shen	Indiana University School of Medicine, USA
Luping Zhou	CSIRO, Australia
Marc Niethammer	University of North Carolina, Chapel Hill, USA
Marius Linguraru	National Institutes of Health, USA
Marleen de Bruijne	University of Copenhagen, Denmark
Min C. Shin	UNC Charlotte, USA
Minjeong Kim	UNC Chapel Hill, USA
Nico Karssemeijer	Radboud University Nijmegen Medical Centre, The Netherlands

## VIII Organization

Olivier Pauly	Technische Universität München, Germany
Ritwik Kumar	IBM Almaden Research Center, USA
Roman Filipovych	University of Pennsylvania, USA
Sean Zhou	Siemens Medical Solutions, USA
Sebastien Ourselin	UCL, UK
Shuo Li	GE Healthcare, Canada
Siamak Ardekani	JHU, USA
Ting Chen	IBM Almaden Research Center, USA
Tolga Tasdizen	University of Utah, USA
Xiangrong Zhou	Gifu University, Japan
Xiaoyi Jiang	University of Münster, Germany
Xu Qiao	University of Chicago, USA
Yang Li	Allen Institute for Brain Science, USA
Yiqiang Zhan	Siemens Medical Solutions, USA
Yong Fan	Chinese Academy of Sciences, China
Yong Zhang	IBM Almaden Research Center, USA
Yoshitaka Masutani	University of Tokyo, Japan
Yu Qiao	Shanghai Jiao Tong University, China
Yun Zhu	University of California, San Diego, USA



# Table of Contents

Transductive Prostate Segmentation for CT Image Guided Radiotherapy .....	1
<i>Yinghuan Shi, Shu Liao, Yaozong Gao, Daoqiang Zhang, Yang Gao, and Dinggang Shen</i>	
Model-Driven Centerline Extraction for Severely Occluded Major Coronary Arteries .....	10
<i>Yefeng Zheng, Jianhua Shen, Huseyin Tek, and Gareth Funka-Lea</i>	
MRI Confirmed Prostate Tissue Classification with Laplacian Eigenmaps of Ultrasound RF Spectra .....	19
<i>Mehdi Moradi, Christian Wachinger, Andriy Fedorov, William M. Wells, Tina Kapur, Luciant D. Wolfsberger, Paul Nguyen, and Clare M. Tempany</i>	
Hierarchical Ensemble of Multi-level Classifiers for Diagnosis of Alzheimer's Disease .....	27
<i>Manhua Liu, Daoqiang Zhang, Pew-Thian Yap, and Dinggang Shen</i>	
Dense Deformation Reconstruction via Sparse Coding .....	36
<i>Yonghong Shi, Guorong Wu, Zhijian Song, and Dinggang Shen</i>	
Group Sparsity Constrained Automatic Brain Label Propagation .....	45
<i>Shu Liao, Daoqiang Zhang, Pew-Thian Yap, Guorong Wu, and Dinggang Shen</i>	
Sparse Patch-Guided Deformation Estimation for Improved Image Registration .....	54
<i>Minjeong Kim, Guorong Wu, and Dinggang Shen</i>	
Computer-Aided Detection of Aneurysms in 3D Time-of-Flight MRA Datasets .....	63
<i>Santiago Suniaga, Rene Werner, Andre Kemmling, Michael Groth, Jens Fiehler, and Nils Daniel Forkert</i>	
Data Driven Constraints for the SVM .....	70
<i>Sune Darkner and Line H. Clemmensen</i>	
Towards Improving the Accuracy of Sensorless Freehand 3D Ultrasound by Learning .....	78
<i>Juliette Conrath and Catherine Laporte</i>	

A Novel 3D Joint MGRF Framework for Precise Lung Segmentation ...	86
<i>Behnoush Abdollahi, Ahmed Soliman, A.C. Civelek, X.-F. Li, G. Gimel'farb, and Ayman El-Baz</i>	
Nonlinear Discriminant Graph Embeddings for Detecting White Matter Lesions in FLAIR MRI .....	94
<i>Samuel Kadoury, Guray Erus, and Christos Davatzikos</i>	
Use of Pattern-Information Analysis in Vision Science: A Pragmatic Examination .....	103
<i>Mathieu J. Ruiz, Jean-Michel Hupé, and Michel Dojat</i>	
Human Age Estimation with Surface-Based Features from MRI Images .....	111
<i>Jieqiong Wang, Dai Dai, Meng Li, Jing Hua, and Huiguang He</i>	
Biomedical Images Classification by Universal Nearest Neighbours Classifier Using Posterior Probability .....	119
<i>Roberto D'Ambrosio, Wafa Bel Haj Ali, Richard Nock, Paolo Soda, Frank Nielsen, and Michel Barlaud</i>	
Simultaneous Registration and Segmentation by L1 Minimization .....	128
<i>Pratik Shah and Mithun Das Gupta</i>	
On the Creation of Generic fMRI Feature Networks Using 3-D Moment Invariants .....	136
<i>Loizos Markides and Duncan Fyfe Gillies</i>	
Description and Classification of Confocal Endomicroscopic Images for the Automatic Diagnosis of Inflammatory Bowel Disease .....	144
<i>Sara Couceiro, João P. Barreto, Paulo Freire, and Pedro Figueiredo</i>	
A Localized MKL Method for Brain Classification with Known Intra-class Variability .....	152
<i>Aydın Ulaş, Mehmet Gönen, Umberto Castellani, Vittorio Murino, Marcella Bellani, Michele Tansella, and Paolo Brambilla</i>	
Supervised Image Segmentation across Scanner Protocols: A Transfer Learning Approach .....	160
<i>Annegreet van Opbroek, M. Arfan Ikram, Meike W. Vernooij, and Marleen de Bruijne</i>	
Learning to Locate Cortical Bone in MRI .....	168
<i>Gerardo Hermosillo, Vikas C. Raykar, and Xiang Zhou</i>	
Quality Classification of Microscopic Imagery with Weakly Supervised Learning .....	176
<i>Xinghua Lou, Luca Fiaschi, Ullrich Koethe, and Fred A. Hamprecht</i>	

Graph-Based Inter-subject Classification of Local fMRI Patterns . . . . .	184
<i>Sylvain Takerkart, Guillaume Auzias, Bertrand Thirion, Daniele Schön, and Liva Ralaivola</i>	
Combining Multiple Image Segmentations by Maximizing Expert Agreement . . . . .	193
<i>Joni-Kristian Kamarainen, Lasse Lensu, and Tomi Kauppi</i>	
Cardiac LV and RV Segmentation Using Mutual Context Information . . . . .	201
<i>Dwarikanath Mahapatra and Joachim M. Buhmann</i>	
Non-parametric Density Modeling and Outlier Detection in Medical Imaging Datasets . . . . .	210
<i>Virgile Fritsch, Gaël Varoquaux, Jean-Baptiste Poline, and Bertrand Thirion</i>	
Learning Correspondences in Knee MR Images from the Osteoarthritis Initiative . . . . .	218
<i>Ricardo Guerrero, Claire R. Donoghue, Luis Pizarro, and Daniel Rueckert</i>	
Gradient Projection Learning for Parametric Nonrigid Registration . . . . .	226
<i>Stefan Pszczolkowski, Luis Pizarro, Declan P. O'Regan, and Daniel Rueckert</i>	
Learning to Rank from Medical Imaging Data . . . . .	234
<i>Fabian Pedregosa, Elodie Cauvet, Gaël Varoquaux, Christophe Pallier, Bertrand Thirion, and Alexandre Gramfort</i>	
Integrating Statistical Shape Models into a Graph Cut Framework for Tooth Segmentation . . . . .	242
<i>Johannes Keustermans, Dirk Vandermeulen, and Paul Suetens</i>	
A Random Forest Based Approach for One Class Classification in Medical Imaging . . . . .	250
<i>Chesner Désir, Simon Bernard, Caroline Petitjean, and Laurent Heutte</i>	
Finding Deformable Shapes by Correspondence-Free Instantiation and Registration of Statistical Shape Models . . . . .	258
<i>Weiguo Xie, Steffen Schumann, Jochen Franke, Paul Alfred Grützner, Lutz-Peter Nolte, and Guoyan Zheng</i>	
Computer Aided Skin Lesion Diagnosis with Humans in the Loop . . . . .	266
<i>Orod Razeghi, Guoping Qiu, Hywel Williams, and Kim Thomas</i>	
<b>Author Index . . . . .</b>	<b>275</b>