

Lecture Notes in Artificial Intelligence 5809

Edited by R. Goebel, J. Siekmann, and W. Wahlster

Subseries of Lecture Notes in Computer Science

Ricard Gavaldà Gábor Lugosi
Thomas Zeugmann Sandra Zilles (Eds.)

Algorithmic Learning Theory

20th International Conference, ALT 2009
Porto, Portugal, October 3-5, 2009
Proceedings

Series Editors

Randy Goebel, University of Alberta, Edmonton, Canada

Jörg Siekmann, University of Saarland, Saarbrücken, Germany

Wolfgang Wahlster, DFKI and University of Saarland, Saarbrücken, Germany

Volume Editors

Ricard Gavaldà

Universitat Politècnica de Catalunya

LARCA Research Group, Departament de Llenguatges i Sistemes Informàtics

Jordi Girona Salgado 1-3, 08034 Barcelona, Spain

E-mail: gavalda@lsi.upc.edu

Gábor Lugosi

Pompeu Fabra Universitat, ICREA and Department of Economics

Ramon Trias Fargas 25-27, 08005 Barcelona, Spain

E-mail: gabor.lugosi@gmail.com

Thomas Zeugmann

Hokkaido University, Division of Computer Science

N-14, W-9, Sapporo 060-0814, Japan

E-mail: thomas@ist.hokudai.ac.jp

Sandra Zilles

University of Regina, Department of Computer Science

Regina, Saskatchewan, Canada S4S 0A2

E-mail: zilles@cs.uregina.ca

Library of Congress Control Number: 2009934440

CR Subject Classification (1998): I.2, I.2.6, K.3.1, F.2, G.2, I.2.2, I.5.3

LNCS Sublibrary: SL 7 – Artificial Intelligence

ISSN 0302-9743

ISBN-10 3-642-04413-1 Springer Berlin Heidelberg New York

ISBN-13 978-3-642-04413-7 Springer Berlin Heidelberg New York

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.

springer.com

© Springer-Verlag Berlin Heidelberg 2009

Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper SPIN: 12760312 06/3180 5 4 3 2 1 0

Preface

This volume contains the papers presented at the 20th International Conference on Algorithmic Learning Theory (ALT 2009), which was held in Porto, Portugal, October 3–5, 2009. The conference was co-located with the 12th International Conference on Discovery Science (DS 2009). The technical program of ALT 2009 contained 26 papers selected from 60 submissions, and 5 invited talks. The invited talks were presented during the joint sessions of both conferences.

ALT 2009 was the 20th in the ALT conference series, established in Japan in 1990. The series Analogical and Inductive Inference is a predecessor of this series: it was held in 1986, 1989 and 1992, co-located with ALT in 1994, and subsequently merged with ALT. ALT maintains its strong connections to Japan, but has also been held in other countries, such as Australia, Germany, Hungary, Italy, Singapore, Spain, and the USA. The ALT series is supervised by its Steering Committee: Naoki Abe (IBM Thomas J. Watson Research Center, Yorktown, USA), Shai Ben-David (University of Waterloo, Canada), Phil Long (Google, Mountain View, USA), Gábor Lugosi (Pompeu Fabra University, Barcelona, Spain), Akira Maruoka (Ishinomaki Senshu University, Japan), Takeshi Shinohara (Kyushu Institute of Technology, Iizuka, Japan), Frank Stephan (National University of Singapore, Republic of Singapore), Einoshin Suzuki (Kyushu University, Fukuoka, Japan), Eiji Takimoto (Kyushu University, Fukuoka, Japan), György Turán (University of Illinois at Chicago, USA, and University of Szeged, Hungary), Osamu Watanabe (Tokyo Institute of Technology, Japan), Thomas Zeugmann (Chair, Hokkaido University, Japan), and Sandra Zilles (Publicity Chair, University of Regina, Canada). The ALT web pages have been set up (together with Frank Balbach and Jan Poland) and are maintained by Thomas Zeugmann.

The present volume contains the texts of the 26 papers presented at ALT 2009, divided into groups of papers on online learning, learning graphs, active learning and query learning, statistical learning, inductive inference, and semi-supervised and unsupervised learning. The volume also contains abstracts of the invited talks:

- Sanjoy Dasgupta (University of California, San Diego, USA): *The Two Faces of Active Learning*
- Hector Geffner (Universitat Pompeu Fabra, Barcelona, Spain) *Inference and Learning in Planning*
- Jiawei Han (University of Illinois at Urbana-Champaign, USA) *Mining Heterogeneous Information Networks by Exploring the Power of Links*
- Yishay Mansour (Tel Aviv University, Israel) *Learning and Domain Adaptation*
- Fernando C.N. Pereira (Google, Mountain View, USA) *Learning on the Web*

Papers presented at DS 2009 are contained in the DS 2009 proceedings.

The *E. Mark Gold* Award has been presented annually at the ALT conferences since 1999, for the most outstanding student contribution. This year, the award was given to Hanna Mazzawi for the paper *Reconstructing Weighted Graphs with Minimal Query Complexity*, co-authored by Nader Bshouty.

We would like to thank the many people and institutions who contributed to the success of the conference. Thanks to the authors of the papers for their submissions, and to the invited speakers for presenting exciting overviews of important recent research developments. We are very grateful to the sponsors of the conference for their generous financial support: University of Porto, Artificial Intelligence and Decision Support Laboratory, Center for Research in Advanced Computing Systems, Portuguese Science and Technology Foundation, Portuguese Artificial Intelligence Association, SAS, Alberta Ingenuity Centre for Machine Learning, and Division of Computer Science, Hokkaido University.

We are grateful to the members of the Program Committee for ALT 2009. Their hard work in reviewing and discussing the papers made sure that we had an interesting and strong program. We also thank the subreferees assisting the Program Committee. Special thanks go to the local arrangement chair João Gama (University of Porto). We would like to thank the Discovery Science conference for its ongoing collaboration with ALT, which makes it possible to provide a well-rounded picture of the current theoretical and practical advances in machine learning and the related areas. In particular, we are grateful to the conference chair João Gama (University of Porto) and Program Committee chairs Vítor Santos Costa (University of Porto) and Alípio Jorge (University of Porto) for their cooperation. Last but not least, we thank Springer for their support in preparing and publishing this volume of the Lecture Notes in Artificial Intelligence series.

August 2009

Ricard Gavaldà
Gábor Lugosi
Thomas Zeugmann
Sandra Zilles

Organization

Conference Chair

Ricard Gavaldà

Universitat Politècnica de Catalunya,
Barcelona, Spain

Program Committee

Peter Auer

University of Leoben, Austria

José L. Balcázar

Universitat Politècnica de Catalunya,
Barcelona, Spain

Shai Ben-David

University of Waterloo, Canada

Avrim Blum

Carnegie Mellon University, Pittsburgh, USA

Nader Bshouty

Technion, Haifa, Israel

Claudio Gentile

Università degli Studi dell’Insubria, Varese,

Italy

Peter Grünwald

Centrum voor Wiskunde en Informatica (CWI),
Amsterdam, The Netherlands

Roni Kharon

Tufts University, Medford, USA

Phil Long

Google, Mountain View, USA

Gábor Lugosi

ICREA and Pompeu Fabra University,
Barcelona, Spain (Chair)

Massimiliano Pontil

University College London, UK

Alexander Rakhlin

UC Berkeley, USA

Shai Shalev-Shwartz

Toyota Technological Institute at Chicago, USA

Hans Ulrich Simon

Ruhr-Universität Bochum, Germany

Frank Stephan

National University of Singapore, Singapore

Csaba Szepesvári

University of Alberta, Edmonton, Canada

Eiji Takimoto

Kyushu University, Fukuoka, Japan

Sandra Zilles

University of Regina, Canada (Chair)

Local Arrangements

João Gama

University of Porto, Portugal

Subreferees

Jacob Abernethy

Nicolò Cesa-Bianchi

Andreas Argyriou

Jiang Chen

Marta Arias

Alexander Clark

John Case

Sanjoy Dasgupta

VIII Organization

Tom Diethe	Mario Martin
Ran El-Yaniv	Samuel Moelius III
Tim van Erven	Rémi Munos
Steve Hanneke	Francesco Orabona
Kohei Hatano	Ronald Ortner
Tamir Hazan	Dávid Pál
Colin de la Higuera	Joel Ratsaby
Jeffrey Jackson	Nicola Rebagliati
Sanjay Jain	Lev Reyzin
Sham Kakade	Sivan Sabato
Jyrki Kivinen	Ohad Shamir
Wouter Koolen	Robert Sloan
Timo Kötzing	Jun’ichi Takeuchi
Lucy Kuncheva	Christino Tamon
Steffen Lange	György Turán
Alex Leung	Vladimir Vovk
Guy Lever	Yiming Ying
Tyler Lu	Thomas Zeugmann
Eric Martin	

Sponsoring Institutions

University of Porto
Artificial Intelligence and Decision Support Laboratory
Center for Research in Advanced Computing Systems
Portuguese Science and Technology Foundation
Portuguese Artificial Intelligence Association
SAS
Alberta Ingenuity Centre for Machine Learning
Division of Computer Science, Hokkaido University

Table of Contents

Invited Papers

The Two Faces of Active Learning	1
<i>Sanjoy Dasgupta</i>	
Inference and Learning in Planning	2
<i>Hector Geffner</i>	
Mining Heterogeneous Information Networks by Exploring the Power of Links	3
<i>Jiawei Han</i>	
Learning and Domain Adaptation	4
<i>Yishay Mansour</i>	
Learning on the Web	7
<i>Fernando C.N. Pereira</i>	

Regular Contributions

Online Learning

Prediction with Expert Evaluators' Advice	8
<i>Alexey Chernov and Vladimir Vovk</i>	
Pure Exploration in Multi-armed Bandits Problems	23
<i>Sébastien Bubeck, Rémi Munos, and Gilles Stoltz</i>	
The Follow Perturbed Leader Algorithm Protected from Unbounded One-Step Losses	38
<i>Vladimir V. V'yugin</i>	
Computable Bayesian Compression for Uniformly Discretizable Statistical Models	53
<i>Lukasz Dębowski</i>	
Calibration and Internal No-Regret with Random Signals	68
<i>Vianney Perchet</i>	
St. Petersburg Portfolio Games	83
<i>László Györfi and Péter Kevei</i>	

Learning Graphs

Reconstructing Weighted Graphs with Minimal Query Complexity	97
<i>Nader H. Bshouty and Hanna Mazzawi</i>	

Learning Unknown Graphs	110
<i>Nicolò Cesa-Bianchi, Claudio Gentile, and Fabio Vitale</i>	
Completing Networks Using Observed Data	126
<i>Tatsuya Akutsu, Takeyuki Tamura, and Katsuhisa Horimoto</i>	

Active Learning and Query Learning

Average-Case Active Learning with Costs	141
<i>Andrew Guillory and Jeff Bilmes</i>	
Canonical Horn Representations and Query Learning	156
<i>Marta Arias and José L. Balcázar</i>	
Learning Finite Automata Using Label Queries	171
<i>Dana Angluin, Leonor Becerra-Bonache, Adrian Horia Dediu, and Lev Reyzin</i>	
Characterizing Statistical Query Learning: Simplified Notions and Proofs	186
<i>Balázs Szörényi</i>	
An Algebraic Perspective on Boolean Function Learning	201
<i>Ricard Gavaldà and Denis Thérien</i>	

Statistical Learning

Adaptive Estimation of the Optimal ROC Curve and a Bipartite Ranking Algorithm	216
<i>Stéphan Cléménçon and Nicolas Vayatis</i>	
Complexity versus Agreement for Many Views: Co-regularization for Multi-view Semi-supervised Learning	232
<i>Odalric-Ambrym Maillard and Nicolas Vayatis</i>	
Error-Correcting Tournaments	247
<i>Alina Beygelzimer, John Langford, and Pradeep Ravikumar</i>	

Inductive Inference

Difficulties in Forcing Fairness of Polynomial Time Inductive Inference	263
<i>John Case and Timo Kötzing</i>	
Learning Mildly Context-Sensitive Languages with Multidimensional Substitutability from Positive Data	278
<i>Ryo Yoshinaka</i>	

Uncountable Automatic Classes and Learning	293
<i>Sanjay Jain, Qinglong Luo, Pavel Semukhin, and Frank Stephan</i>	
Iterative Learning from Texts and Counterexamples Using Additional Information	308
<i>Sanjay Jain and Efim Kinber</i>	
Incremental Learning with Ordinal Bounded Example Memory	323
<i>Lorenzo Carlucci</i>	
Learning from Streams	338
<i>Sanjay Jain, Frank Stephan, and Nan Ye</i>	
Semi-supervised and Unsupervised Learning	
Smart PAC-Learners	353
<i>Hans Ulrich Simon</i>	
Approximation Algorithms for Tensor Clustering	368
<i>Stefanie Jegelka, Suvrit Sra, and Arindam Banerjee</i>	
Agnostic Clustering	384
<i>Maria Florina Balcan, Heiko Röglin, and Shang-Hua Teng</i>	
Author Index	399