VOLUME 27, NUMBER 4

WINTER 2006

ISSN 0738-4602



Cover: AI@50-We Are Golden, by James Gary, New York, New York.

#### FIFTY YEARS OF ARTIFICIAL INTELLIGENCE RESEARCH

- 12 A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence
  - John McCarthy, Marvin L. Minsky, Nathaniel Rochester, and Claude E. Shannon
- 15 Happy Silver Anniversary, AI! Edward A. Feigenbaum
- 17 AI@50: We Are Golden! Alan K. Mackworth
- 19 (AA)AI More Than the Sum of Its Parts Ronald J. Brachman
- 35 What Do We Know About Knowledge? Bruce G. Buchanan
- 47 AI Meets Web 2.0: Building the Web of Tomorrow, Today Jay M. Tenenbaum
- A Personal Account on the Development of Stanley, the Robot That Won the DARPA Grand Challenge Sebastian Thrun
- 83 Review of Thinking About Android Epistemology Robert Morris

#### REPORTS

- 87 The Dartmouth College Artificial Intelligence Conference: The Next Fifty Years
- 92 Reports on the Twenty-First National Conference on Artificial Intelligence (AAAI–06) Workshops

Wolfgang Achtner, Esma Aimeur, Sarabjot Singh Anand, Doug Appelt, Naveen Ashish, Tiffany Barnes, Joseph E. Beck, M. Bernardine Dias, Prashant Doshi, Chris Drummond, William Elazmeh, Ariel Felner, Dayne Freitag, Hector Geffner, Christopher W. Geib, Richard Goodwin, Robert C. Holte, Frank Hutter, Fair Isaac, Nathalie Japkowicz, Gal A. Kaminka, Sven Koenig, Michail G. Lagoudakis, David Leake, Lundy Lewis, Hugo Liu, Ted Metzler, Rada Mihalcea, Bamshad Mobasher, Pascal Poupart, David V. Pynadath, Thomas Roth-Berghofer, Wheeler Punal Stefan Schulz, Sven Schwarz, Stephanic Saneff Amit Shoth, Pan Sun Michael Thielech Ruml, Stefan Schulz, Sven Schwarz, Stephanie Séneff, Amit Sheth, Ron Sun, Michael Thielscher, Afzal Upal, Jason Williams, Steve Young, and Dmitry Zelenko

- 103 AAAI's National and Innovative Applications Conferences Celebrate 50 Years of AI Sara Reese Hedberg
- 111 Report on the Nineteenth International FLAIRS Conference Geoff Sutcliffe

### **DEPARTMENTS**

- 4 AAAI News
- 113 Calendar of Events
  - 3 Editorial David Leake
- 118 Crossword Puzzle Jonathan Glick
- 120 AI in the News Jonathan Glick

# **Al** magazine

#### aimagazine.org

#### Submissions

Send all submissions to AI Magazine, AAAI, 445 Burgess Drive, Menlo Park, CA 94025-3442. Electronic submissions should be submitted using the web-based submissions form. Submissions information is available at aimagazine.org. Although no particular style is required for submissions, electronic submissions must be in PDF form. Authors whose work is accepted for publication, will be required to revise their work to conform reasonably to *AI Magazine* styles. Author's guidelines are available at aimagazine.org. If an article is accepted for publication, a new electronic copy will also be required. Although AI Magazine generally grants great deference to an author's work the Magazine retains the right to determine the final published form of every article.

Calendar items should be posted electronically (at least one month prior to the event or deadline). Use the calendar insertion form at aimagazine.org. News items should be sent to the News Editor, AI Magazine, 445 Burgess Drive, Menlo Park, CA 94025-3442. (650) 328-3123. Please do not send news releases via either e-mail or fax, and do not send news releases to any of the other editors.

#### Advertising

AI Magazine, 445 Burgess Drive, Menlo Park, CA 94025-3442, (650) 328-3123; Fax (650) 321-4457. Web: aimagazine.org. Web-based job postings can be made using the job bank submissions form at aimagazine.org.

#### Microfilm, Back, or Replacement Copies

Replacement copies (for current issue only) are available upon written request and a check for \$10.00. Back issues are also available (cost may differ). Send replacement or back order requests to AAAI. Microform copies are available from ProQuest Information and Learning, 300 North Zeeb Road, Ann Arbor, MI 48106. Telephone (800) 521-3044 or (734) 761-4700.

#### Copying Articles for Personal Use

Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, or for educational classroom use, is granted by AAAI, pro-

vided that the appropriate fee is paid directly to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923. Telephone: (978) 750-8400. Fax: (978) 750-4470. Website: www.copyright.com. E-mail: info@copyright.com. This consent does **not** extend to other kinds of copying, such as for general distribution, resale, advertising, Internet or internal electronic distribution, or promotion purposes, or for creating new collective works. Please contact AAAI for such permission

#### Address Change

Please notify AAAI eight weeks in advance of a change of address. Send old label with new address to AAAI, 445 Burgess Drive, Menlo Park, CA 94025-3442. We encourage you to notify us via the web: www.aaai.org/Membership/change-form.html.

#### Subscriptions

The AI Magazine (ISSN 0738-4602) is published quarterly in March, June, September, and December by the American Association for Artificial Intelligence (AAAI), 445 Burgess Drive, Menlo Park, CA 94025-3442, telephone (650) 328-3123. The AI Magazine is a direct benefit of membership in the AAAI. Membership dues are \$95.00 regular, \$35.00 student, and \$190.00 academic / corporate libraries. Foreign members add \$40.00. Subscription price of \$40.00 per year is included in dues; the balance of your dues may be tax deductible as a charitable contribution; consult your tax advisor for details. Inquiries regarding membership in the AAAI should be sent to the AAAI at the above address.

Periodicals Postage paid at Menlo Park, CA and additional mailing offices. Postmaster: Change Service Requested. Send address changes to AI Magazine, 445 Burgess Drive, Suite 100, Menlo Park, CA 94025-3442.

Copyright © 2006 by the American Association for Artificial Intelligence. All rights reserved. No part of this publication may be reproduced in whole or in part without prior written permission. Unless otherwise stated, the views expressed in published material are those of the authors and do not necessarily reflect the policies or opinions of AI Magazine, its editors and staff, or the American Association for Artificial Intelli-

PRINTED & BOUND IN THE USA.

#### AI Magazine Staff

Editor-in-Chief David Leake, Indiana University Reports Editor Robert Morris, NASA Ames Research Center

#### AI Magazine **Editorial Board**

James Allen, University of Rochester Craig Boutilier, *University of Toronto* Cynthia Breazeal, *MIT* Henrik Christensen,

Swedish Royal Institute of Technology Marie desJardins, University of Maryland, Baltimore County

Boi Faltings, Swiss Federal Institute of Technology Usama Fayyad, Yahoo!

Kenneth Ford, Institute for Human and Machine Cognition Janice Glasgow, Queen's University

Kristian Hammond, Northwestern University Patrick Hayes, Institute for Human and Machine Cognition

Henry Kautz, University of Washington Janet Kolodner, Georgia Tech Ramón Lopez de Mántaras, IIIA, Spanish Scientific Research Council

Leora Morgenstern, IBM Watson Labs Martha Pollack, University of Michigan Bruce Porter, University of Texas, Austin Jude Shavlik, University of Wisconsin Barry Smyth, University College Dublin Moshe Tennenholtz, Technion Manuela Veloso, Carnegie Mellon University Chris Welty, IBM Research Holly Yanco, University of Massachusets

Lowell Feng Zhao, Microsoft Research

#### AAAI Officials

President Alan Mackworth

University of British Columbia President-Elect

Eric Horvitz, Microsoft Research Past-President

Ronald J. Brachman, Yahoo! Research

Secretary-Treasurer Ted Senator

Councilors (through 2007)

Oren Etzioni, University of Washington Lise Getoor, University of Maryland,

Karen Myers, SRI International Illah Nourbakhsh, NASA Ames Research Center / Carnegie Mellon University

Councilors (through 2008)

Maria Gini, University of Minnesota Kevin Knight, USC/Information Sciences Institute

Peter Stone, University of Texas at Austin Sebastian Thrun. Stanford University

Councilors (through 2009)

David Aha, U.S. Naval Research Laboratory David Musliner, Honeywell Laboratories Michael Pazzani, Rutgers University Holly Yanco, University of Massachusetts Lowell

#### Standing Committees

Conference Chair Yolanda Gil, USC / ISI

Awards, Fellows, and Nominating Chair Ronald J. Brachman, Yahoo! Research

Finance Chair

Ted Senator

Conference Outreach Chair

Lise Getoor, University of Maryland, College Park

Membership Chair Haym Hirsh, Rutgers University

Publications Chair

David Leake, Indiana University Symposium Chair

Alan Schultz, Naval Research Labs

#### AAAI Staff

Executive Director Carol Hamilton Accountant / Office Manager Colleen Boyce Senior Conference Coordinator Keri Vasser Harvey Conference Coordinator Ann Stolberg Information Technology Manager Richard A. Skalsky Membership Coordinator Alanna Spencer

#### AAAI Press

Editor-in-Chief Anthony Cohn, University of Leeds

Editorial Board

Aaron Bobick, Georgia Institute of Technology Ken Forbus, Northwestern University Enrico Franconi, Free University of

Bozen-Bolzano Thomas Hofmann, Darmstadt University of Technology

Craig Knoblock, Information Sciences Institute, University of Southern California George Luger, University of New Mexico David Poole, University of British Columbia Oliviero Stock, ITC IRST

Gerhard Widmer, Johannes Kepler University Mary Anne Williams, University of Technology, Sydney

#### AAAI Corporate Sponsors

ACM/SIGART ActivMedia Ask Jeeves Boeing DARPA **Evolution Robotics** Google IBM Research Idaho National Lab IISI / Cornell University

Intel **ITA Software** Microsoft Research National Science **Foundation** Naval Research Lab Sony Teknowledge Yahoo! Research



## **Editorial**

The 1956 Dartmouth Summer Research Project on Artificial Intelligence was a watershed event, and its fiftieth anniversary has been observed with meetings, writings, and discussions about the past and future of the field. Our special issue to close this historic year begins with three items spanning fifty years of progress: an excerpt from the Dartmouth Project proposal prepared by John McCarthy, Marvin Minsky, Nathaniel Rochester and Claude Shannon, a reprint of Edward Feigenbaum's 1981 AAAI President's Message for the silver anniversary, and AAAI President Alan Mackworth's fiftieth anniversary message, "AI@50: We are Golden!"

The articles that follow give perspective on the foundations of the field and new milestones. Ronald Brachman's Presidential Address, "(AA)AI — More Than the Sum of its Parts," discusses the importance of integrated systems to the mission of AI and underlines the vital role for AAAI in AI's future. Bruce Buchanan's Engelmore Memorial Lecture article, "What Do We Know About Knowledge?" examines insights about the nature of knowledge from philosophy and lessons from fifty years of AI. Jay Tenenbaum's article, "AI Meets Web 2.0: Building the Web of Tomorrow, Today" presents a vision of how to grow internet-scale knowledge systems harnessing the collective intelligence of humans and computers. Sebastian Thrun's "A Personal Account on the Development of Stanley, the Robot that Won the DARPA Grand Challenge" provides an insider's story of the team effort leading to a landmark recent success. Conference reports and a book review round out the issue.

The issue closes with two special anniversary features by Jon Glick: A crossword testing readers' ingenuity and knowledge of AI old and new, and a historical AI in the News column, featuring excerpts from the news of 1956.

Happy golden anniversary!

David Leake, Editor-in-Chief

## New books from The MIT Press



## **How the Body Shapes** the Way We Think

A New View of Intelligence

Rolf Pfeifer and Josh Bongard foreword by Rodney Brooks illustrations by Shun Iwasawa

"In this thoroughly engaging and unusually wide-ranging book, Pfeifer and Bongard make the case for the central role of embodiment in understanding natural intelligence and building artificial intelligence."

- Phil Husbands, University of Sussex A Bradford Book • 480 pp., 26 illus. \$40



http:// mitpress. mit.edu

800-405-1619

## Online Stochastic **Combinatorial Optimization**

Pascal Van Hentenryck and Russell Bent A framework for online decision making under uncertainty and time constraints, with online stochastic algorithms for implementing the framework, performance guarantees, and demonstrations of a variety of applications. 236 pp., 75 illus. \$35

## **Semi-Supervised** Learning

edited by Olivier Chapelle, Bernhard Schölkopf, and Alexander Zien A comprehensive review of an area of machine learning that deals with the use of unlabeled data in classification problems: state-of-the-art algorithms, a taxonomy of the field, applications, benchmark experiments, and directions for future research. Adaptive Computation and Machine Learning series 498

**New Directions** in Statistical Signal Processing

pp., 98 illus. \$50

### From Systems to Brains

edited by Simon Haykin, José C. Príncipe, Terrence J. Sejnowski, and John McWhirter Leading researchers in signal processing and neural computation present work aimed at promoting the interaction and cross-fertilization between the two fields.

Neural Information Processing series 544 pp., 149 illus. \$50



