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Preface

Recent highly visible and impactful applications of AI have resulted in tremendously increased public and commercial interest in AI. This interest is spurring large investments in the development of further applications of AI. Many of these applications, like autonomous cars and drones, personal assistants on mobile devices, and increased robotic automation of factories, have the potential to create major changes in society. As a result there has also been growing concern over the potential negative impacts of AI.

These developments inspired the theme of IJCAI-2017: Autonomy and AI. The aim of this year's theme is to further debate and analysis of the limits and safeguards that must be established in order to ensure that AI research is used in a manner that best contributes towards a more just and prosperous society.

This year we received a record number of 2540 papers, accepting 660 (26%). All papers had an oral presentation and were also displayed as posters at the conference venue so as to facilitate better one-to-one interactions with the authors. Each paper received at least three reviews with most (80%) receiving four or more reviews. Every paper was monitored by one Senior Program Committee Member and one Area Chair. The Program Committee consisted of 44 Area Chairs, 384 Senior Program Committee Members, 1123 Program Committee Members and 392 Review Assistants. That is, a total of 1945 researchers made careful and rigorous reviews, discussed the papers and came to a recommendation on acceptance. Authors had the opportunity to provide feedback to their reviews. This feedback was analysed by the reviewing team at discussion time. Senior Program Committee Members wrote a metareview for each paper and the program chair consulted with all the area chairs to reach final decisions.

A number of new features in the review process were introduced. Reviewers were asked to upload their own papers into the Toronto Paper Matching System (TPMS, <http://papermatching.cs.toronto.edu>) and 80% of them did it. At submission deadline we computed the matching degrees between reviewers' papers and the submitted papers: 2.8M degrees. For those that uploaded their papers into TPMS the matching degrees were shown to help in the paper bidding process. This was considered useful or very useful by 71% of the reviewers. 74% of the reviewers were satisfied or very satisfied with the papers assigned to them. Differently from previous editions, this Year, Senior Program Committee members reviewed papers. This was done with the purpose of making a better use of the expertise of the more experienced researchers and to have more informed discussions. Finally, reviewers performed a peer-assessment of the reviews that gave extra information to Area Chairs in order to make final recommendations.

We received 58 papers for the Track on autonomy and AI and accepted 12 covering different philosophical, ethical, legal and technical aspects. These papers were presented in special sessions with an open debate at the end. We also include in these proceedings abridged versions of previously published papers in major AI Journals (JAIR and AIJ) that had never been exposed in a major conference, and of the best papers of many specialised conferences on AI.

We had seven outstanding invited speakers, partly or totally touching upon Autonomy and the social benefits of AI: Georg Gottlob, Marti Hearst, Rong Jin, Ugo Pagallo, Joelle Pineau, Stuart Russell, and Tuomas Sandholm. Talks by the 2017 Computer and Thoughts Award winner Devi Parikh, and the 2017 John McCarthy Award winner Dan Roth were also featured.

A conference the size and scope of IJCAI-2017 requires tremendous effort from many people, to whom we are very thankful. First of all, the authors, who submitted the best of their work to this conference. IJCAI is such an outstanding conference thanks to the high respect that the whole community has on it. Second, the program committee members, that made an effort to cope with the deadlines, the heavy load of work, and the extra effort required by the several new features introduced this Year. Third, all the people that helped in the different stages of the review process. Francisco Cruz (aka Tito) and Marc Pujol who led the production of a new paper submission system for the proceedings, performing paper formatting quality control and giving professional feedback to authors. Francisco Cruz, Marc Pujol and Xavier Ferrer led the programming of a new user-friendly software to build the scientific program. Many others have helped in different phases of the process: Anna Enciso with multiple tedious clerical tasks; Thomas Preuss giving technical support on ConfMaster, sometimes at midnight and on weekends; Laurent Charlin making it easy to integrate TPMS in the process; Blai Bonet customising his software to allocate papers to reviewers, also over a weekend and under pressure; Jordi Levy and Mateu Villaret codifying the paper-to-session allocation as a SAT problem and solving it.

In addition to those whose work made the content of the conference possible, many worked to make the operation of the conference possible. The local arrangements committee (LAC) did a tremendous job for which we are very thankful. The LAC was co-chaired by Chengqi Zhang, Toby Walsh and Andy Song who all worked tirelessly to make IJCAI-2017 happen. Other members of the LAC included Michael Georgeff, Abdul Sattar Ling Chen, Yang Yu, Kai Qin, Truyen Tran, Tianqing Zhu, Ke Deng, Ping Yu, Christoph Bergmeir, Sebastian Sardina, Christian Guttmann, Jeffery Chan, and Guodong Long. We thank them all. Finally, last but by no means least we would like to thank Vesna Sabljakovic-Fritz, Executive Secretary for IJCAI, without

whom we would not have even known where to start!

Organising IJCAI-2017 has been a great experience that we are very grateful to have had, and we hope that the conference will be a great experience for everyone who participates.

- Carles Sierra (Program Chair)
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Awards and Distinguished Papers

The IJCAI-17 Award for Research Excellence, the John McCarthy Award and the Computers and Thought Award are awarded by the IJCAI Board of Trustees, upon recommendation by the IJCAI-17 Awards Selection Committee, which consists this year of

- Craig Boutilier, University of Toronto (CANADA) and Google (USA)
- Yolanda Gil, University of Southern California (USA)
- Joelle Pineau, McGill University (CANADA)
- Francesca Rossi, University of Padova (ITALY) and
- Qiang Yang, Hong Kong University of Science and Technology (Chair) (HONG KONG, CHINA)

The IJCAI Awards Selection Committee receives advice from members of the IJCAI-17 Awards Review Committee, who comment on the accuracy of the nomination material and provide additional information about the nominees. The IJCAI-17 Awards Review Committee is the union of the former Trustees of IJCAI, the IJCAI-17 Advisory Committee, the Program Chairs of the last three IJCAI conferences, and the past recipients of the IJCAI Award for Research Excellence and the IJCAI Distinguished Service Award, with nominees excluded.

IJCAI-17 Award for Research Excellence:

The Research Excellence award is given to a scientist who has carried out a program of research of consistently high quality throughout an entire career yielding several substantial results. Past recipients of this honor are the most illustrious group of scientists from the field of Artificial Intelligence.

They are: John McCarthy (1985), Allen Newell (1989), Marvin Minsky (1991), Raymond Reiter (1993), Herbert Simon (1995), Aravind Joshi (1997), Judea Pearl (1999), Donald Michie (2001), Nils Nilsson (2003), Geoffrey E. Hinton (2005), Alan Bundy (2007), Victor Lesser (2009), Robert Anthony Kowalski (2011), Hector Levesque (2013), Barbara Grosz (2015), and Michael I. Jordan (2016).

The winner of the 2017 Award for Research Excellence is Andrew Barto, Professor Emeritus, College of Information and Computer Sciences, University of Massachusetts Amherst. Professor Barto is recognized for his groundbreaking and impactful research in both the theory and application of reinforcement learning.

IJCAI-17 Computers and Thought Award:

The Computers and Thought Award is presented at IJCAI conferences to outstanding young scientists in artificial intelligence. The award was established with royalties received from the book, *Computers and Thought*, edited by Edward Feigenbaum and Julian Feldman. It is currently supported by income from IJCAI funds. Past recipients of this honor have been: Terry Winograd (1971), Patrick Winston (1973), Chuck Rieger (1975), Douglas Lenat (1977), David Marr (1979), Gerald Sussman (1981), Tom Mitchell (1983), Hector Levesque (1985), Johan de Kleer (1987), Henry Kautz (1989), Rodney Brooks (1991), Martha Pollack (1991), Hiroaki Kitano (1993), Sarit Kraus (1995), Stuart Russell (1995), Leslie Kaelbling (1997), Nicholas Jennings (1999), Daphne Koller (2001), Tuomas Sandholm (2003), Peter Stone (2007), Carlos Guestrin (2009), Andrew Ng (2009), Vincent Conitzer (2011), Malte Helmert (2011), Kristen Grauman (2013), Ariel Procaccia (2015), and Percy Liang (2016).

The winner of the 2017 IJCAI Computers and Thought Award is Devi Parikh, Assistant Professor at School of Interactive Computing, Georgia Institute of Technology. Professor Parikh is recognized for her contributions at the intersection of words, pictures, and common sense --- from semantic image understanding, to the use of visual attributes for human-machine collaboration and visual abstractions for learning common sense, to enabling humans to interact with visual content via natural language.

IJCAI-17 John McCarthy Award:

The IJCAI John McCarthy Award is intended to recognize established mid-career researchers, typically between fifteen to twenty-five years after obtaining their PhD, that have built up a major track record of research excellence in artificial

intelligence. Nominees of the award will have made significant contributions to the research agenda in their area and will have a first-rate profile of influential research results.

The award is named for John McCarthy (1927-2011), who is widely recognized as one of the founders of the field of artificial intelligence. As well as giving the discipline its name, McCarthy made fundamental contributions of lasting importance to computer science in general and artificial intelligence in particular, including time-sharing operating systems, the LISP programming languages, knowledge representation, common-sense reasoning, and the logicist paradigm in artificial intelligence.

The award was established with the full support and encouragement of the McCarthy family.

Past recipients of this honor have been: Bart Selman (2015) and Moshe Tennenholtz (2016).

The winner of the 2017 John McCarthy Award is Dan Roth, The Beckman Institute, University of Illinois at Urbana-Champaign. Professor Roth is recognized for major conceptual and theoretical advances in the modeling of natural language understanding, machine learning and reasoning.

Donald E. Walker Distinguished Service Award:

The IJCAI Distinguished Service Award was established in 1979 by the IJCAI Trustees to honor senior scientists in AI for contributions and service to the field during their careers. Previous recipients have been: Bernard Meltzer (1979), Arthur Samuel (1983), Donald Walker (1989), Woodrow Bledsoe (1991), Daniel G. Bobrow (1993), Wolfgang Bibel (1999), Barbara Grosz (2001), Alan Bundy (2003), Raj Reddy (2005), Ronald J. Brachman (2007), Luigia Carlucci Aiello (2009), Raymond C. Perrault (2011), Wolfgang Wahlster (2013), Anthony G. Cohn (2015), and Erik Sandewall (2016).

At IJCAI-17, the Donald E. Walker Distinguished Service Award will be given to Ramon López de Mántaras, Research Professor of the Spanish National Research Council (CSIC) and Director of the Artificial Intelligence Research Institute of the CSIC. Professor López de Mántaras is recognized for his substantial contributions, as well as his extensive service to the field of Artificial Intelligence throughout his career.

Distinguished Papers

Finalists for Distinguished Paper

Mark Kaminski, Bernardo Cuenca Grau, Egor V. Kostylev, Boris Motik, Ian Horrocks: Foundations of Declarative Data Analysis Using Limit Datalog Programs

Abstract: Motivated by applications in declarative data analysis, we study DatalogZ---an extension of positive Datalog with arithmetic functions over integers. This language is known to be undecidable, so we propose two fragments. In limit DatalogZ predicates are axiomatised to keep minimal/maximal numeric values, allowing us to show that fact

entailment is coNExpTime -complete in combined, and coNP -complete in data complexity. Moreover, an additional stability requirement causes the complexity to drop to ExpTime and PTime , respectively. Finally, we show that stable DataLogZ can express many useful data analysis tasks, and so our results provide a sound foundation for the development of advanced information systems.

Frédéric Koriche, Sylvain Lagrue, Éric Piette, Sébastien Tabary: Constraint-Based Symmetry Detection in General Game Playing

Abstract: Symmetry detection is a promising approach for reducing the search tree of games. In General Game Playing (GGP), where any game is compactly represented by a set of rules in the Game Description Language (GDL), the state-of-the-art methods for symmetry detection rely on a rule graph associated with the GDL description of the game. Though such rule-based symmetry detection methods can be applied to various tree search algorithms, they cover only a limited number of symmetries which are apparent in the GDL description. In this paper, we develop an alternative approach to symmetry detection in stochastic games that exploits constraint programming techniques. The minimax optimization problem in a GDL game is cast as a stochastic constraint satisfaction problem (SCSP), which can be viewed as a sequence of one-stage SCSPs. Minimax symmetries are inferred according to their microstructure complement of these one-stage constraint networks. Based on a theoretical analysis of this approach, we experimentally show on various games that the recent stochastic constraint solver MAC-UCB, coupled with constraint-based symmetry detection, significantly outperforms the standard Monte Carlo Tree Search algorithms, coupled with rule-based symmetry detection. This constraint-driven approach is also validated by the excellent results obtained by our player during the last GGP competition.

Yong Luo, Yonggang Wen, Tongliang Liu, Dacheng Tao: General Heterogeneous Transfer Distance Metric Learning via Knowledge Fragments Transfer

Abstract: Transfer learning aims to improve the performance of target learning task by leveraging information (or transferring knowledge) from other related tasks. Recently, transfer distance metric learning (TDML) has attracted lots of interests, but most of these methods assume that feature representations for the source and target learning tasks are the same. Hence, they are not suitable for the applications, in which the data are from heterogeneous domains (feature spaces, modalities and even semantics). Although some existing heterogeneous transfer learning (HTL) approaches are able to handle such domains, they lack flexibility in real-world applications, and the learned transformations are often restricted to be linear. We therefore develop a general and flexible heterogeneous TDML (HTDML) framework based on the knowledge fragment transfer strategy. In the proposed HTDML, any (linear or nonlinear) distance metric learning al-

gorithms can be employed to learn the source metric beforehand. Then a set of knowledge fragments are extracted from the pre-learned source metric to help target metric learning. In addition, either linear or nonlinear distance metric can be learned for the target domain. Extensive experiments on both scene classification and object recognition demonstrate superiority of the proposed method.

Finalists for Distinguished Student Paper

Chaoyue Wang, Chaohui Wang, Chang Xu, Dacheng Tao: Tag Disentangled Generative Adversarial Network for Object Image Re-rendering

Abstract: In this paper, we propose a principled Tag Disentangled Generative Adversarial Networks (TD-GAN) for re-rendering new images for the object of interest from a single image of it by specifying multiple scene properties (such as viewpoint, illumination, expression, etc.). The whole framework consists of a disentangling network, a generative network, a tag mapping net, and a discriminative network, which are trained jointly based on a given set of images that are completely/partially tagged (i.e., supervised/semi-supervised setting). Given an input image, the disentangling network extracts disentangled and interpretable representations, which are then used to generate images by the generative network. In order to boost the quality of disentangled representations, the tag mapping net is integrated to explore the consistency between the image and its tags. Furthermore, the discriminative network is introduced to implement the adversarial training strategy for generating more realistic images. Experiments on two challenging datasets demonstrate the state-of-the-art performance of the proposed framework in the problem of interest.

Wei-Cheng Chang, Chun-Liang Li, Yiming Yang, Barnabas Póczos: Data-driven Random Fourier Features using Stein Effect

Abstract: Large-scale kernel approximation is an important problem in machine learning research. Approaches using random Fourier features have become increasingly popular, where kernel approximation is treated as empirical mean estimation via Monte Carlo (MC) or Quasi-Monte Carlo (QMC) integration. A limitation of the current approaches is that all the features receive an equal weight summing to 1. In this paper, we propose a novel shrinkage estimator from "Stein effect", which provides a data-driven weighting strategy for random features and enjoys theoretical justifications in terms of lowering the empirical risk. We further present an efficient randomized algorithm for large-scale applications of the proposed method. Our empirical results on six benchmark data sets demonstrate the advantageous performance of this approach over representative baselines in both kernel approximation and supervised learning tasks.

Yanyu Xu, Nianyi Li, Junru Wu, Jingyi Yu, Shenghua Gao: Beyond Universal Saliency: Personalized Saliency Prediction

with Multi-task CNN

Abstract: Saliency detection is a long standing problem in computer vision. Tremendous efforts have been focused on exploring a universal saliency model across users despite their differences in gender, race, age, etc. Yet recent psychology studies suggest that saliency is highly specific than universal: individuals exhibit heterogeneous gaze patterns when viewing an identical scene containing multiple salient objects.

In this paper, we first show that such heterogeneity is common and critical for reliable saliency prediction. Our study also produces the first database of personalized saliency maps (PSMs). We model PSM based on universal saliency map (USM) shared by different participants and adopt a multi-task CNN framework to estimate the discrepancy between PSM and USM. Comprehensive experiments demonstrate that our new PSM model and prediction scheme are effective and reliable.

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This volume contains the proceedings of the twenty-sixth IJCAI conference. The locations and times of all 26 IJCAI conferences are as follows:

- 26 IJCAI-17: Melbourne, Australia (August 19-25)
- 25 IJCAI-16: New York, USA (July 9-15)
- 24 IJCAI-15: Buenos Aires, Argentina (July 25--31)
- 23 IJCAI-13: Beijing, China (August 3--9)
- 22 IJCAI-11: Barcelona, Catalonia, Spain (July 16--22)
- 21 IJCAI-09: Pasadena, California, USA (July 11--17)
- 20 IJCAI-07: Hyderabad, India (January 6--12)
- 19 IJCAI-05: Edinburgh, Scotland (July 30--August 5)
- 18 IJCAI-03: Acapulco, Mexico (August 9--15)
- 17 IJCAI-01: Seattle, Washington, USA (August 4--10)
- 16 IJCAI-99: Stockholm, Sweden (July 31--August 6)
- 15 IJCAI-97: Nagoya, Japan (August 23--29)
- 14 IJCAI-95: Montreal, Canada (August 20--25)
- 13 IJCAI-93: Chambéry, France (August 28--September 3)
- 12 IJCAI-91: Sydney, Australia (August 24--30)
- 11 IJCAI-89: Detroit, Michigan, USA (August 20--26)
- 10 IJCAI-87: Milan, Italy (August 23--29)
- 9 IJCAI-85: Los Angeles, California, USA (August 18--23)
- 8 IJCAI-83: Karlsruhe, Germany (August 8--12)
- 7 IJCAI-81: Vancouver, Canada (August 24--28)
- 6 IJCAI-79: Tokyo, Japan (August 20--23)
- 5 IJCAI-77: Cambridge, MA, USA (August 22--25)
- 4 IJCAI-75: Tbilisi, Georgia, USSR (September 3--8)
- 3 IJCAI-73: Stanford, California, USA (August 20--23)
- 2 IJCAI-71: London, UK (September 1--3)
- 1 IJCAI-69: Washington, D.C., USA (May 7--9)