

# Preface

This volume is the proceedings of ALIFE 14: The Fourteenth International Conference on the Synthesis and Simulation of Living Systems, held July 30th to August 2nd, 2014, in Manhattan, New York (<http://alife14.org/>, or <http://alife2014.alife.org/>). ALIFE is the largest conference series focusing on the study of Artificial Life. Since its inception led by Chris Langton in 1987, it has been held at various international locations every other year, alternating with ECAL (European Conference on Artificial Life) since 1991. The history of those conferences and past websites can be found on the website of the International Society for Artificial Life (ISAL, <http://alife.org/>).

ALIFE 14 attracted a total of 203 submissions. Following the past ALIFE and ECAL rules, we solicited submissions in two formats: full paper (up to 8 pages) and extended abstract (2 pages). The extended abstract format was implemented in 2008 (ALIFE 11) to promote participation of researchers working in disciplines where conference submissions require abstracts only. This format may be used for presenting either original work or recently published work. Both full papers and extended abstracts were peer-reviewed by multiple (typically three to four) Program Committee members. As a result, we accepted 102 submissions for oral presentations and 62 submissions for poster presentations (oral acceptance rate: 50.2%).

The program of ALIFE 14 is composed of a number of scientific/professional/creative activities, including:

- Five keynote talks given by the following internationally renowned speakers:
  - Naomi Leonard (Princeton University, USA)
  - Jesse Louis-Rosenberg (Nervous System, USA)
  - Karl Sims (Digital Media Artist, USA)
  - Leroy (Lee) Cronin (University of Glasgow, UK)
  - John H. Conway (Princeton University, USA)
- Twenty parallel sessions on the following topics:
  - Evolutionary dynamics (3 sessions)
  - Robot and agent behavior (3 sessions)
  - Boolean networks, neural networks and machine learning (2 sessions)
  - Artificial chemistries, cellular automata and self-organizing systems (2 sessions)
  - Collective behaviors (2 sessions)
  - Social dynamics and evolution (2 sessions)
  - In-vitro and in-vivo systems
  - Artificial evolutionary ecosystems
  - Soft robotics and morphologies
  - Collective robotics
  - Evolutionary art, philosophy and entertainment
  - Methodologies
- A poster session with a plenary “Poster Blitz Movie Show”

- Nine workshops:
  - Computing with Biomolecules: From Network Motifs to Complex and Adaptive Systems  
(Organizers: Christof Teuscher, Darko Stefanovic, Milan N. Stojanovic)
  - CoSMoS 2014: 7th Workshop on Complex Systems Modelling and Simulation  
(Organizers: Susan Stepney, Paul Andrews)
  - Exploiting Synergies Between Biology and Artificial Life Technologies: Tools, Possibilities, and Examples  
(Organizers: Kasper Stoy, Martin Hanczyc, Ioannis Ieropoulos, Michal Wagner, Leroy Cronin)
  - Human-Machine Affective Coordination  
(Organizers: Luisa Damiano, Paul Dumouchel, Hagen Lehmann)
  - Information Theoretic Incentives for Artificial Life  
(Organizers: Christoph Salge, Keyan Ghazi-Zahedi, Georg Martius, Daniel Polani)
  - MEW 2014: Fourth Morphogenetic Engineering Workshop  
(Organizers: René Doursat, Hiroki Sayama)
  - SB-AI 2014: What Can Synthetic Biology Offer to (Embodied) Artificial Intelligence?  
(Organizers: Luisa Damiano, Yutetsu Kuruma, Pasquale Stano)
  - WebAL1: Artificial Life and the Web  
(Organizers: Tim Taylor, Josh Auerbach, Josh Bongard, Jeff Clune, Simon Hickinbotham, Greg Hornby)
  - Third Workshop on the Evolution of Physical Systems  
(Organizers: John Rieffel, Jean-Baptiste Mouret, Nicolas Bredeche, Evert Haasdijk)
- Six tutorials:
  - Algorithmic Graph Chemistry in Action  
(Instructors: Jakob L. Andersen, Christoph Flamm, Daniel Merkle)
  - An Introduction to Statistical Analysis of Alife Experiments  
(Instructor: Mark Wineberg)
  - Creating High-Quality Plots with Python and Matplotlib  
(Instructor: Jean-Baptiste Mouret)
  - Evolutionary Robotics  
(Instructors: Nicolas Bredeche, Stéphane Doncieux, Jean-Baptiste Mouret)
  - Evolving Neural Networks  
(Instructor: Risto Miikkulainen)
  - In Silico Experimental Evolution with the Aevol Software  
(Instructors: Guillaume Beslon, Carole Knibbe, David P. Parsons, Dusan Misevic)
- The first ISAL summer school:
  - Historical and Philosophical Perspectives on Artificial Life (instructor: Mark Bedau)
  - Unconventional Computing (instructor: Susan Stepney)
  - Digital Evolution (instructor: Charles Ofria)
  - Evolutionary Developmental Robotics (instructor: Josh Bongard)
- A science visualization competition
- A career advising luncheon for postdocs and graduate students  
... and other social events

Needless to say, organizing a conference requires a lot of work, and we would not have been able to achieve our goal without help from a number of individuals and organizations. First and foremost, our highest gratitude goes to Craig Ryan, our event coordinator, for his heroic work in essentially all aspects of the conference, including negotiations with the conference venue, handling registrations, and making millions of other logistic arrangements. We are also very fortunate to have had Emily

Ryan design the impressive “ALIFE 14 bird” artwork used on the conference website and the cover of this proceedings volume, which has become a unique, memorable visual identity to the conference. We also thank Ira Fraitag and Mike Blain for their help.

To maintain a high standard of scientific quality for the conference, it is critical to have a rigorous peer review process to evaluate submissions. Luckily, we were able to rely on a very cooperative, hard working Program Committee and other reviewers who have provided constructive comments on the submissions in a timely manner (individual names listed below in an alphabetical order).

*Program Committee of ALIFE 14:*

Hussein Abbass	Angelo Cangelosi	Mario Giacobini	Carole Knibbe
David Ackley	Peter Cariani	Sherri Goings	David Knoester
Andy Adamatzky	Timoteo Carletti	Heather Goldsby	Marcelo Kuperman
Christoph Adami	Pedro Castillo	Jonatan Gomez	Yutetsu Kuruma
Andreas Albrecht	José M. Cecilia	Ángel Goñi Moreno	Renaud Lambiotte
Bradly Alicea	Marin Cenek	Erik Goodman	Joel Lehman
Fernando Almeida e Costa	Gregory Chirikjian	Charles Goodnight	Tom Lenaerts
Lee Altenberg	Sung-Bae Cho	Jerzy Gorecki	Lukas Lichtensteiger
Martyn Amos	Insook Choi	Laura Grabowski	Soo Ling Lim
Timothy Andersen	Dominique Chu	Robin Gras	Xiaoxia Nina Lin
Claes Andersson	Brian D. Connelly	Hugo Gravato Marques	Kristian Lindgren
Takaya Arita	David Cornforth	Patrick Grim	Joseph Lizier
Joshua E Auerbach	Luis Correia	Thilo Gross	Daniel Lobo
Wolfgang Banzhaf	Ernesto Costa	Pauline C Haddow	Robert Lowe
Thomas Barbalet	Art Covert	Heiko Hamann	Herve Luga
Jeffrey Barrick	Leroy (Lee) Cronin	Martin M. Hanczyc	Bruce MacLennan
Jacob Beal	Sylvain Cussat-Blanc	Emma Hart	George Magoulas
Mark Bedau	Thomas Dandekar	Taichi Haruna	Narine Manukyan
Randall Beer	Christian Darabos	Inman Harvey	Georg Martius
Roman Belavkin	Kerstin Dautenhahn	Robert Heckendorn	Joanna Masel
Mariana Benitez	James Decraene	J. Michael Herrmann	Jerzy Maselko
Katie Bentley	Jordi Delgado	Simon Hickinbotham	John Mccaskill
Peter Bentley	Ralf Der	Arend Hintze	Bob McKay
Hugues Bersini	Gianni Di Caro	Thomas Hinze	Philip Mckinley
Guillaume Beslon	Peter Dittrich	Paulien Hogeweg	Barry McMullin
Navneet Bhalla	Stéphane Doncieux	Gregory Hornby	Peter McOwan
Erik Billing	Alan Dorin	Kazufumi Hosoda	Juan J. Merelo
Eleonora Bilotta	Alastair Droop	Cristian Huepe	Daniel Merkle
Daniel Bisig	Boris Duran	Paul Humphreys	Rob Mills
Tim Blackwell	Yves Duthen	Phil Husbands	Jeremy Minty
Alan Blair	James Dyke	Tim Hutton	Dusan Misevic
Christian Blum	Matthew Egbert	Genki Ichinose	Shuhei Miyashita
Johan Bollen	Margaret Eppstein	Fumiya Iida	Pierre-Alain Monnard
Josh Bongard	Brent Eskridge	Hiroyuki Iizuka	Sara Montagna
Terry Bossomaier	Harold Fellermann	Takashi Ikegami	Jean-Marc Montanier
Amine Boumaza	Christoph Flamm	Yasumasa Imamura	Melanie Moses
Paul Bourguin	David Fogel	Eduardo Izquierdo	Jean-Baptiste Mouret
Markus Brede	Gary Fogel	Christian Jacob	Andres Moya
Nicolas Bredeche	Robert Freitas	Klaus Jaffe	Joshua Nahum
John Bryden	Tom Froese	Yaochu Jin	Chrystopher Nehaniv
David Bryson	Rudolf M. Füchslin	Michal Joachimczak	Peter Nielsen
Thomas Buhrmann	Simon Garnier	Sardanyés Josep	Martin Nilsson Jacobi
Larry Bull	Nicholas Geard	George Kampis	Stefano Nolfi
Seth Bullock	Philip Gerlee	Yoshihiko Kayama	Shin-Ichiro Nomura
Lola Cañamero	Carlos Gershenson	Jozef Kelemen	Surya Nurzaman

Oliver Obst	William Ratcliff	Kasper Stoy	Tatsuo Unemi
Charles Ofria	Thomas Ray	John Sullins	Edgar Vallejo
Yuta Ogai	Craig Reynolds	Hideaki Suzuki	Sergi Valverde
Mizuki Oka	Danny Richards	Keisuke Suzuki	Andrew Vardy
Eckehard Olbrich	Luis M. Rocha	Reiji Suzuki	Jeffrey Ventrella
Randal Olson	Andrea Roli	Yasuhiro Suzuki	David Vernon
Bjørn Østman	Adam Rotaru	Eors Szathmary	Nathaniel Virgo
Elizabeth Ostrowski	Kepa Ruiz-Mirazo	Nobuto Takeuchi	Sebastian von Mammen
Pierre-Yves Oudeyer	Erol Sahin	Uwe Tangen	Aaron Wagner
Andreas Pape	Christoph Salge	Charles Taylor	Richard Watson
Lael Parrott	Francisco C. Santos	Tim Taylor	Justin Werfel
Jonathanascalie	Kazutoshi Sasahara	Jason Teo	Uri Wilensky
Joshua Payne	Thomas Schmickl	Christof Teuscher	Janet Wiles
Dov Pechenick	Roberto Serra	Guy Theraulaz	Lance Williams
Alexandra Penn	Jae Kyun Shin	Serge Thill	Paul Williams
Robert Pennock	Eric Silverman	Jon Timmis	Borys Wrobel
Ferdinand Peper	Lee Spector	Michael Travisano	Andrew Wuensche
Simone Pigolotti	Russell Standish	Vito Trianni	Lidia Yamamoto
Marcin Pilat	Kenneth Stanley	Soichiro Tsuda	Xin-She Yang
Daniel Polani	Pasquale Stano	Elio Tuci	Tetsuya Yomo
Simon Powers	Kathleen Steinhofel	Andy Tyrrell	Luis Zaman
Mikhail Prokopenko	Susan Stepney	Jon Umerez	Hector Zenil

*Other Reviewers:*

Anton Bernatskiy	Nazim Fates	Trevor Hinkley	Stéphane Sanchez
Moritz Buck	Matthew Fricke	Neal Holtshulte	Danesh Tarapore
Andrés Bueno	The Anh Han	Nikhil Joshi	Mark Wagyu
Alexandre Campo	Joshua Hecker	Koichi Nishiyama	

We are very grateful to the following sponsors for their financial and in-kind support for the conference, which was essential in making ALIFE 14 a successful event:

- US National Science Foundation
- MIT Press
- Cornell University
- Thomas J. Watson School of Engineering and Applied Science at Binghamton University
- Wolfram Research

Finally, we would like to express our sincere thanks to keynote speakers and contributing authors whose quality presentations are what make ALIFE 14 a truly unique, outstanding academic meeting.

We hope you will enjoy the breadth and depth of various topics covered in this volume. They collectively represent the state of the art of Artificial Life, a vibrant intellectual melting pot stirred and served fresh in the middle of Manhattan.

June 2014

Hiroki Sayama  
John Rieffel  
Sebastian Risi  
René Doursat  
Hod Lipson