to Francisco Varela (1946-2001),
Founder of ECAL
Foreword

ECAL’11: Back to the Origins of Alife

There is a long tradition of software simulations in theoretical biology to complement pure analytical mathematics, which are often limited in their ability to reproduce and understand self-organisation phenomena resulting from nonlinear and spatially grounded interactions of a huge number of various and evolving biological objects. Researchers in Artificial Life (Alife) bet that they can assist biologists in this domain, transcending their daily modelling and measuring practice by using software simulation in the first instance, and robotics, too, in order to abstract and elucidate the fundamental mechanisms common to living organisms. They hope to do so by discovering the most informative level of abstraction and resolutely neglecting a lot of physical and quantitative information deemed not indispensable. The computer is apparently the best microscope to achieve this. They want to focus on the rule-based mechanisms that make life possible, supposedly neutral with respect to their underlying material embodiment, and replicate them in a non-biochemical substrate. The hypothesis is that minimal life begins at the intersection of a series of processes that need to be isolated, differentiated and duplicated as such in computers, and that only software development and execution make possible to understand the way these processes are intimately interconnected in order for life to emerge at the crossroad.

The rejection of an authoritative definition of “life” is often compensated for by a list of functional properties that never finds unanimity amongst its authors. Some demand more properties, others require fewer of those properties that are often indicated in vague terms such as “self-maintenance”, “self-organisation”, “metabolism”, “autonomy”, “self-replication”, or “open-ended evolution”. A first determining role of Alife consists in writing and implementing software versions of these properties and the way they actually interact. The goal is to disambiguate them and make them algorithmically precise enough so that, in the end, the only remaining cause of disagreement on the definition of life would reside in the length or the composition of this list but not in its items.

Biologists obviously remain the most important partners; but what may they expect from this Alife business? What can they expect from these new “Merlin hackers”, whose ambitions seem, above all, disproportionately naïve. Computer platforms are useful and necessary in several ways. First of all, they open the door to a new style of teaching and advocating major biological ideas: in other words, computer software as a pedagogical tool. For example, Richard Dawkins is the best advocate of Darwinian ideas when running a computer simulation in which sophisticated creatures known as “biomorphs” evolve on a computer screen by means of a genetic algorithm. These same platforms and simulations can, insofar as they are sufficiently flexible, quantifiable and universal, be used more accurately by biologists, who will find in them a simplified way of simulating and validating a given biological system under study. Cellular automata, Boolean networks, genetic algorithms and algorithmic chemistry are excellent examples of softwares to download, parameterise and use to reproduce the required natural phenomenon. Their predictive
power varies from very qualitative (where results apparently reproduce general trends of the real world) to very quantitative (where numbers produced by the computer may be precise enough to be compared with those measured in the real world).

Although being at first very qualitative, precise and clear coding is already the guarantee of an advanced understanding accepted by all. Algorithmic writing is an essential stage in formalising the elements of the model and making them objective. The linguistic and qualitative style of many biological papers could benefit in clarity by attempting a software instantiation of their contents. The more the model allows to integrate what we know about the reality being reproduced, the detailed structure of the objects and the relationships between them, the more the predictions will move from qualitative to precise, and the more easily the model will be validated according to Karl Popper’s “falsification” process of good scientific practice.

Ideally, through systematic software experiments, these platforms can lead to the discovery of new natural laws, whose impact will be all the greater as the simulated abstractions will be present in many biological realms. In the 1950’s, when Alan Turing discovered that a simple diffusion phenomenon, propagating itself at different speeds, depending on whether it is subject to a negative or positive influence, produces zebra or alternating motifs, it had a considerable effect on a whole section of biology studying the genesis of forms. This was Alife at its best. The same happened with John von Neumann’s self-replicating automata. Because of these seminal works, Turing and von Neumann remain the two spiritual fathers of the field. When scientists discovered that the number of attractors in a Boolean network (Kauffman) or a neural network (Hopfield) exhibited a given dependency on the number of units in these networks, these results could equally well apply to the number of cell types expressed as dynamic attractors in a genetic network or the quantity of information capable of being memorised in a neural network. Entire chapters of biology dedicated to networks (neural, genetic, protein, immune, hormonal) had to be re-written in the light of these discoveries. When other scientists recently observed non-uniform connectivity in many networks, whether social, technological or biological, showing a small number of hubs with a large number of connections and a greater number of nodes with far fewer, and when, in addition, they explained the way in which these networks are built in time by preferential attachment (Barabási), again biology was clearly affected.

Alife is of course at its best when it reveals new biological facts, destabilizing biologists’ presuppositions or generating new knowledge, rather than simply illustrating or refining the old. Roughly said, we could construe Alife as being to theoretical biology what mathematics is to physics, that is, a more neutral scientific endeavour to provide open-minded biologists with new tools and new formal terms to describe and conceptualize the objects of their study. At the moment, the fact that this discipline is still young and shows relative immaturity in comparison with mainstream biology might explain why some observers remain skeptical in front of the current discrepancy between promises and reality. In our opinion, however, they tend to underestimate the importance of the results already obtained, as they are too riveted to their microscope. They should show less reluctance, indifference or even arrogance – and more
curiosity and conviviality – towards these new computer explorers who have set out on the conquest of life, just like them but in front of their computer screens.

This is how we saw Alife when Francisco Varela, Paul Bourgine and myself decided to organize the first European Conference on Artificial Life (ECAL) in Paris twenty years ago. We were very impressed by the Sante Fe workshops, which Chris Langton had started, and decided to initiate a European counterpart. We were aware of this very long tradition of theoretical biology in Europe, nevertheless a tradition still largely unaffected by the new opportunities offered by software simulations. We also realized that an opportunity existed to expand Alife “toward a practise of autonomous systems” with their “embodied cognition”, including not only all forms of life but also autonomous robots and collective intelligence. We emphasised the importance of developing artificial life toward new trends in theoretical biology, based on such practise of autonomous systems and not only on purely literary descriptions or purely mathematical formulations.

This opportunity exists more than ever for the future and we wanted to provoke discussions at ECAL about all major forms of autonomous systems, characterized by self-organized architectures, morphogenesis and adaptation, from minimal forms of life to the ecosphere, from minimal forms of cognition to human social intelligence, mediated through internet and the web. Besides, we did not want artificial life to become a sub-branch of engineering only weakly inspired by biology. In fact, other conferences already existed for that. ECAL ought to be different and unique, genuinely centred on theoretical biology and the physics of complex autonomous systems.

Today, although we are proud of this series of very successful and exciting ECAL conferences, we feel that the domain of Alife should look back to these origins and take even more inspiration from the new high-throughput developments at the intersection between computer science and theoretical biology. Closing a loop, this year’s ECAL will mark the 20th anniversary of the first ECAL and will be framed as a tribute to the late Francisco Varela. It was summer 1990, the three of us, with Paul Bourgine, were sitting in a café in Paris, drinking an excellent wine, when Francisco proposed to make our own version of an Alife conference. Thanks Francisco, we miss you.

Welcome to ECAL 2011!

Hugues Bersini

Brussels
August 2011
Preface

ECAL, the European Conference on Artificial Life, is a biennial event that alternates with the US-based Alife conference series. In the early 1990’s, the first two ECAL conferences in Paris and Brussels were mainly centered on theoretical biology and the physics of complex systems. After 20 years and 10 editions of this event, we felt that the domain should look back on these origins and our wish was to refocus the ECAL conference on complex biological systems.

Over the past two decades, biological knowledge has grown at an unprecedented rate, giving rise to new disciplines such as systems biology, testimony of the striking progress of modeling and quantitative methods across the field. During the same period, highly speculative ideas have matured, and entire conferences and journals are now devoted to them. Synthesizing artificial cells, simulating large-scale biological networks, storing and making intelligent use of an exponentially growing amount of data (e.g., microarrays), exploiting biological substrates for computation and control, and deploying bio-inspired engineering are all cutting-edge topics today.

ECAL’11 leveraged this remarkable development of biological modeling and extended the topics of Artificial Life to the fundamental properties of living organisms: their multiscale pattern-forming morphodynamics, their autopoiesis, robustness, capacity to self-repair, cognitive capacities, and co-adaptation at all levels, including ecological ones. Bringing together a large interdisciplinary community of biologists, computer scientists, physicists, and mathematicians, the conference gave them a moment to reflect on how traditional boundaries between disciplines have become blurred, and to revisit in depth what constitutes “life”.

In order to make the event attractive to researchers from a wide range of disciplines, we decided to open the possibility to submit 2-page abstracts discussing work previously published by the authors in a journal. In addition to 148 full-length (8-page) articles reporting on new, unpublished work, we received 29 overview abstracts, for a total of 177 submissions.

Although intrinsically interdisciplinary, these submissions referred in particular to the main conference topics, as described by the histogram below. All submissions were subject to peer review. The work of our excellent Program Committee (see list of members below) allowed us to select 128 papers, subdivided into 72 oral presentations (for a 40.7% acceptance rate) and 56 posters (31.6%), with no distinction being made between the two submission options, full paper or abstract. Two accepted papers were later withdrawn by their authors, reducing the total number to 126 (72 + 54).

All papers were presented during the four days of the plenary conference, which was held at the Cité Internationale Universitaire de Paris, France from August 9 to 12, 2011. Oral and poster sessions alternated with six world-class keynote speakers, whose invited contributions (abstracts or full papers) are also published in the front section of these proceedings: Jacques Demongeot, David Harel, James D. Murray, Jordan Pollack, Ricard Solé, and Eric Wieschaus (see their biosketches below). We thank them for taking the time and effort to participate in the conference.
Satellite Workshops

In addition to the plenary conference, we were also pleased to give Alife researchers the opportunity to organize satellite workshops and tutorials in two “bookend” sessions, on the first day (August 8) and last afternoon (August 12). These special sessions were dedicated to the same general topics as the main conference, while allowing for more focused interactions among participants. They were independently managed by their organizers and could comprise any combination of peer-reviewed papers, posters, invited talks, panel discussions, etc. Workshop contributions were not included in these proceedings. We received 15 proposals, of which 14 effectively took place, testimony of the liveliness of the field:

- **AAALE: Alife Approaches to Artificial Language Evolution**
  Luc Steels and Tony Belpaeme

- **ACCS: Artificial Chemical Computing Systems**
  Hideaki Suzuki and Hiroki Sayama

- **BioChemIT: 1st COBRA Workshop on Biological and Chemical Information Technologies**
  Peter Dittrich, Zarka Khan and Martyn Amos
• CoSMoS: 4th Workshop on Complex Systems Modelling and Simulation
  Paul Andrews, Susan Stepney, Peter Welch and Carl Ritson

• CS-Sports: Complex Systems in Sports
  Juan Julián Merelo Guervós, Antonio Mora García and Carlos Cotta Porras

• DDLab: Exploring Discrete Dynamics: From Cellular Automata to Random Networks
  Andy Wuensche, Andy Adamatzky and Genaro Juárez Martínez

• iBioMath: First International Workshop on Integral Biomathics
  Plamen Simeonov, Andrée Ehresmann and Leslie Smith

• INCUP: Information Coding in Unconventional Computing Substrates
  Jerzy Gorecki and Andy Adamatzky

• MASms: Workshop on Multi-Agent Systems in Biology at meso or macroscopic scales
  Pascal Ballet, Marie Beurton-Aimar, Guillaume Hutzler and Bertrand Laforge

• MEW: 3rd Morphogenetic Engineering Workshop
  René Doursat and Hiroki Sayama

• RUTSAC: Research Using The Stringmol Artificial Chemistry
  Simon Hickinbotham, Ed Clark and Adam Nellis

• SIM-A: System Immunology Models of Autopoiesis
  Uri Hershberg and Sol Efroni

• SynBioCCC: Workshop on the Design, Simulation, Construction and Testing of Synthetic Gene Regulatory Networks for Computation, Control and Communications
  Nawwaf Kharma and Taras Kowaliw

• WAAT: Workshop on Artificial Autonomy: 20 years of practice of autonomous systems
  Tom Froese, Matthew Egbert and Xabier Barandiaran

**Keynote Speakers**

• **Jacques Demongeot** is presently director of the TIMC-IMAG Laboratory, “Techniques of Medical Engineering & Complexity” (CNRS 5525) and is also head of the Institute of Bioengineering (IFRT 130 IpV) at the University Joseph Fourier, Grenoble, France. He has an MD and a PhD in mathematics and has been appointed Chairman of Biomathematics at the Institut Universitaire de France in 1994. Jacques Demongeot is also in charge of the Department of Medical Information at the University Hospital of Grenoble (CHUG) and is the founder of the doctoral school of bioengineering “Health, Cognition & Environment”. He is currently creating a new laboratory AGIM, in Archamps near Geneva, devoted to studies of development and ageing.

• **David Harel** is a professor of computer science at the Weizmann Institute of Science in Israel. Harel is best known for his work on dynamic logic, computability and software engineering. In the 1980s he invented the graphical language of Statecharts, which has been adopted as part of the UML standard. He has also published expository accounts of computer science, such as his award winning 1987 book “Algorithmics: The Spirit of Computing” and has made appearances on Israeli
radio and television. He currently works on many diverse topics, including visual languages, graph layout, systems biology and the communication of odours. He is now working on a computer model of a nematode, ‘Caenorhabditis elegans’, which was the first multicellular organism to have its genome completely sequenced. The eventual completeness of such a model depends on his updated version of the test developed by Alan Turing to identify whether computers could reason well enough that a human communicating with them could not tell whether a human or a machine was at the other end of the communication.

- **James D. Murray**, FRS, Foreign Member of the French Academy, is Professor Emeritus of Mathematical Biology at the University of Oxford, Professor Emeritus of Applied Mathematics at the University of Washington, and Senior Scholar at Princeton University. His research is characterized by its great scope and depth: an early example is his fundamental contributions to understanding the biomechanics of the human body when launched from an aircraft in an ejection seat. He has made contributions to many other areas, ranging from understanding and preventing severe scarring, to fingerprint formation, sex determination, modeling of animal coat patterns, territory formation in wolf-deer interacting populations, growth and control of brain tumors, quantifying patient treatments prior to use, and modeling marital interaction and divorce prediction with 94% accuracy in a 12-year longitudinal study. He is best known for his authoritative and extensive work entitled Mathematical Biology, whose 3rd edition in two volumes came out in 2004.

- **Jordan Pollack** is professor of computer science and complex systems professor at Brandeis University, where he is also chairman of the computer science department and director of the Dynamical and Evolutionary Machine Organization (DEMO) lab. The laboratory’s work on AI, Artificial Life, Neural Networks, Evolution, Dynamical Systems, Games, Self-designed Robotics, Machine Learning, and Educational Technology has been reported on by the New York Times, Time, Science, NPR, Slashdot.org and many other media sources worldwide.

- **Ricard Solé** heads the Complex Systems Lab at Universitat Pompeu Fabra, Barcelona, and is an External Professor at the Santa Fe Institute. One of his main research interests is understanding the possible presence of universal patterns of organization in complex systems, from prebiotic replicators to evolved artificial objects. Key questions are how robust structures develop, how information is incorporated into these structures and how computation emerges. He is also interested in how to determine what are the contributions of selection, chance and self-organization to the evolution of complexity. One of his main goals is searching for the principles of organization responsible for the emergence of fundamental components of complexity, including the origins of self-reproduction, development, life cycles, computational processes and multicellularity. His work has been featured in newspapers as well as several popular and technical books.

- **Eric Wieschaus** is the Squibb Professor in Molecular Biology at Princeton. His research work has focused on embryogenesis in the fruit fly Drosophila melanogaster, specifically in the patterning that occurs in the early Drosophila embryo. Most of the gene products used by the embryo at these stages are already present in the unfertilized egg and were produced by maternal transcription during oogenesis. A small number of gene products, however, are supplied by transcription in the embryo itself. He has focused on these “zygotically” active genes because he believes the temporal and spatial pattern of their transcription may provide the triggers controlling the normal sequence of embryonic development. In 1995, he was awarded the Nobel Prize in Physiology or Medicine with Edward B. Lewis and Christiane Nüsslein-Volhard as co-recipients, for their work revealing the genetic control of embryonic development.
Alife Pioneers Panel Discussion

In addition to an exceptional selection of keynote speakers, an exciting panel discussion involving several internationally renowned pioneers of Artificial Life took place at the end of the second day of the plenary conference. Mark Bedau, Takashi Ikegami, Stuart Kauffman, Norman Packard, Steen Rasmussen, Luc Steels, and Susan Stepney all talked about the most impressive achievements of Alife in the past, since inception of the field, and pointed to what they thought were the most promising research directions for the future. Some of them also provided an invited contribution (abstract or full paper), which can be found in the same section as the keynotes’ contributions.

- **Mark Bedau** (Reed College, Portland – European School of Molecular Medicine, Milan – Initiative for Science, Society, and Policy, Denmark) pioneered the field of quantifying and comparing the evolutionary activity in artificial and natural systems, and is an international leader in the evolutionary design of complex biochemical systems using statistical models and prediction algorithms. Because he combines training in analytical philosophy with over a decade of experience in artificial life, he is recognized as a uniquely qualified expert in the philosophical foundations of complex adaptive systems. Mark Bedau is Editor-in-Chief of the international journal *Artificial Life* (published by MIT Press), he co-organized five international conference on artificial life, co-founded a start-up company, ProtoLife SRL, and co-founded the European Center for Living Technology, a research institute in Venice, Italy, that investigates theoretical and practical issues associated with living systems.

- **Takashi Ikegami** is a professor at the Department of General Systems Sciences of the Graduate School of Arts and Sciences, University of Tokyo, where he specializes in complex systems and artificial life. Takashi takes a computational/philosophical approach to designing artificial life, exploring issues at the margins of his discipline. He is also an arts collaborator with Keichiro Shibuya (ATAK) on making three-dimensional sound installations. Keywords: chemical computing, smart chemical agents, chemotaxis, living technology, artificial life, first cell.

- **Stuart Kauffman** (University of Vermont, Burlington) is an American theoretical biologist and complex systems researcher concerned with the origin of life on Earth. He is best known for arguing that the complexity of biological systems and organisms might result as much from self-organization and far-from-equilibrium dynamics as from Darwinian natural selection, as well as for applying models of Boolean networks to genetic circuits. Stuart Kauffman rose to prominence through his association with the Santa Fe Institute, where he was faculty in residence (1986-1997), and his work on models in various areas of biology. These included autocatalytic sets in origin of life research, gene regulatory networks in developmental biology, and fitness landscapes in evolutionary biology. Stuart Kauffman held a joint appointment at the University of Calgary in Biological Sciences and Physics and Astronomy (2005-2009), then joined in 2010 the University of Vermont where he will continue his work with UVM's Complex Systems Center.

- **Barry McMullin**’s primary research activity at the Rince Research Institute, Dublin City University (DCU), is in the domain of Artificial Life. He serves on the organizing committees of both ECAL and Alife conferences, and as a member of the Editorial board of the *Artificial Life* journal. He has a secondary research interest in the area of Web Accessibility, engineering web sites and services to best meet the requirements of all users, specifically including those with disabilities. Between 1999 and 2004, Barry McMullin was the first DCU Dean of Teaching and Learning. In this role he was responsible for the development of a wide series of initiatives to significantly enhance the quality of the student learning experience at DCU. Barry McMullin was
appointed to the rank of Associate professor at DCU in September 2010, and became Director of RINCE, a national research institute specializing in Engineering technology innovation, in February 2010.

- **Norman Packard** (European Center for Living Technology, Venice) has worked in the areas of chaos, learning algorithms, predictive modeling of complex time series, statistical analysis of evolution, artificial life, and complex adaptive systems. He was co-founder of Prediction Company in 1991 and served as its CEO (1997-2003) and chairman until 2005. Norman Packard is currently working in a new scientific and business direction based on development of evolutionary chemistry in programmable microfluidic technology. Long-range applications of this technology include the fabrication artificial cells from non-living material, and their programming for useful functionality. In 2004, Norman Packard was co-founder of ProtoLife S.r.l. (Venice, Italy), which applies machine learning techniques to the design of experiments (DoE) for high throughput experiments in biotechnology. As part of the PACE project (Programmable Artificial Cell Evolution, 2004-2008), he also participated in the founding of ECLT, the European Center for Living Technology.

- **Steen Rasmussen** is currently the Head of the Center for Fundamental Living Technology (FLinT), a Research Director at the Department for Physics and Chemistry at University of Southern Denmark, Odense, and External Research Professor at the Santa Fe Institute. He has pioneered approaches, methods, and applications for self-organizing processes in natural and artificial systems: abstract self-programmable matter, molecular dynamics (MD) lattice gas simulations for molecular self-assembly, rational and evolutionary protocell design, disaster mitigation and decision support systems based on collective intelligence, as well as novel simulations for large-scale sociotechnical systems. Steen Rasmussen was heading the Protocell Assembly (LDRD-DR) project and the Astrobiology program (origins of life) at Los Alamos, developing experimental and computational protocells and cell-like entities. He also co-directed the European PACE project (Programmable Artificial Cell Evolution) project.

- **Luc Steels** is professor of Computer Science (at the moment part-time) at the Free University of Brussels (VUB), founder and director (since 1983) of the VUB Artificial Intelligence Laboratory and co-founder and chairman (1990-1995) of the VUB Computer Science Department. He has also been the director of Sony CSL in Paris since its creation in 1996. His scientific research interests cover the whole field of artificial intelligence, including natural language, vision, robot behavior, learning, cognitive architecture, and knowledge representation. At the moment his focus is on dialogs for humanoid robots and fundamental research into the origins of language and meaning. Current work focuses on developing the foundations of semiotic dynamics and on fluid construction grammars.

- **Susan Stepney** leads the Non-Standard Computation research group, and is one of the instigators of the new interdisciplinary York Centre for Complex Systems Analysis, University of York. Originally a theoretical astrophysicist, she has spent the bulk of her professional career in industrial R&D (GEC-Marconi and Logica), mostly in mathematical and computational modelling, researching aspects of novel computation. She is a moderator of the UKCRC Grand Challenge 7 in Non-Classical Computation and is helping to build a conceptual meta-framework for bio-inspired computation. Current research interests also include theories of emergence and self-organising systems, and nature-inspired computational metaphors. She is the PI of the Complex Systems Modelling and Simulation project and was PI of the EIVIS novel computation cluster, rated “outstanding”. She also teaches complex biosystems simulation and is responsible for designing the new Masters course in Natural Computation at York.
**Alife Art Exhibit and Performance**

Inspiration, imagination and aesthetics are an integral part of science, and they are of particular importance in the Alife community, which fuels some of the most creative and provocative research at the edge (of chaos) between biology and technology. Accordingly, ECAL’11 welcomed a prominent visual artist, Louis Bec, and a distinguished musician, François Pachet, who showcased their exciting work in the exhibit rooms and main auditorium.

- **Louis Bec**, born in Algeria and living in France, is a biologist and zoosystematician who extends his scientific field with a fabulatory epistemology based on Artificial Life and Technozoosemiotics. In 1972, Bec founded the Institut Scientifique de Recherche Paranaturaliste, where he studies the incapability of living beings to understand their own existence. Bec is both artist and scientist in the field of artificial life and 3D technologies. He is as much a biologist, artist, curator and educator, and has been a ministry officer for new technologies in arts. Bec is Director of CYPRES (Centre Interculturel de Pratiques et Echanges Transdisciplinaires) in Marseille. He has presented his ideas in many exhibitions, such as Alife II (invited by Chris Langton) and *From Animals to Animats*, and articles.

  - *Upokrinomenes: a fabulated epistemology* Zoosystemician Louis Bec forces us to question the validity of each claim by reformulating and staging scientific discourse. His reasoning possesses all the marks of scientific assertiveness, combining scientific jargon with scholarly neologisms. Questioning life and our inability to understand it through traditional investigative methods, he founded the field of *Upokrinomenology*. It is a theory of life using models based on computer science, robotics, video and other interactive devices, where irony holds a significant place. By putting scientific discourse into perspective, he challenges us to investigate, unravel and interpret the propositions that he makes. In this research, scientific discourse becomes poetic and Louis Bec becomes a storyteller. Founder of the Scientific Institute of Paranaturalistic Research, he invites us to discover a life we did not know existed, one that looms at the border between shapes, language and behavior [after C. Beaugrand & A. Charre, *Reinventing the museum*]. (Art exhibit at ECAL’11 designed and installed with François Mourre, Patrice Bersani and Delphine Fabbri-Lawson.)

- **François Pachet** is a Civil Engineer (Ecole des Ponts and Chaussées) and was an Assistant Professor in Artificial Intelligence and Computer Science, University of Paris 6, until 1997. He then set up the music research team at the Sony Computer Science Laboratories, Paris, and developed the vision that metadata can greatly enhance the musical experience in all its dimensions, from listening to performance. His team conducts research in interactive music listening and performance and musical metadata and developed several innovative technologies and award winning systems (MusicSpace, constraint-based spatialization, PathBuilder, intelligent music scheduling using metadata, The Continuator for Interactive Music Improvisation). He is the author of over 80 scientific publications in the fields of musical metadata and interactive instruments.

  - *The Continuator Project: playing with virtual musicians* François Pachet (guitar player) and Jeff Suzda (professional sax player) performed a short Jazz concert with their band “Quintet of Two”. They comprised the two human musicians in the group, performing alongside three “software” musicians. The goal of this project was to play “standard” jazz using virtual instruments intimately controlled by the human players. The technologies employed, developed at Sony CSL, involve Markov chains, constraint programming, signal processing, and a great degree of musical tuning. Performance was still exploratory, but the goal is to enhance musical expressivity through controllable machines.
Program Committee

An event like ECAL’11 would not have been possible without the following dedicated members of the Program Committee and additional reviewers. Our gratitude goes to all of them.

Hussein Abbass          Joachim De Beule          Pedro U. Lima          Matthias Scheutz
Andy Adamatzky          Bart De Boer          Daniel Lobo          Thomas Schmickl
Chris Adami             Ralf Der              Fernando Lobo         Marc Schoenauer
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Fernando Almeida e Costa Cecilia Di Chio        Penousal Machado      Roberto Serra
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Paul Andrews            Marco Dorigo          Davide Marocco        Ricard Sole
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Joshua Auerbach          Pedro Mariano           Flavio Pinheiro        Liyu Wang
Julian Garcia            Hugi Marques            Stuart Rossiter        Nicolae-Radu Zabet
Heather Goldsby          Bjørn Østman             Pedro Santana
Laura Grabowskki         Danilo Pianini           Porfirio Silva
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- Paul Bourgine (Co-Founder)  Complex Systems Institute, Paris Ile-de-France, CNRS – CREA, Ecole Polytechnique & CNRS, Paris
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- Mario Giacobini (Program Chair)  Dept. of Animal Productions, Epidemiology and Ecology – Molecular Biotechnology Center, University of Torino
- Marco Dorigo (Co-Organizer)  IRIDIA, Université Libre de Bruxelles

Administrative and Onsite Staff

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- Marcel Skrobek (office head)
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- Eliseo Ferrante (PhD student)
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- Gabriel Varela (student)  Bowdoin College, Brunswick, Maine

Art Exhibit: Graphic & Electronic Engineers, Set Designers

- François Mourre (founder)  3D from Mars
- Patrice Bersani (CEO)  DreamLabs
- Delphine Fabbri-Lawson (art curator)

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