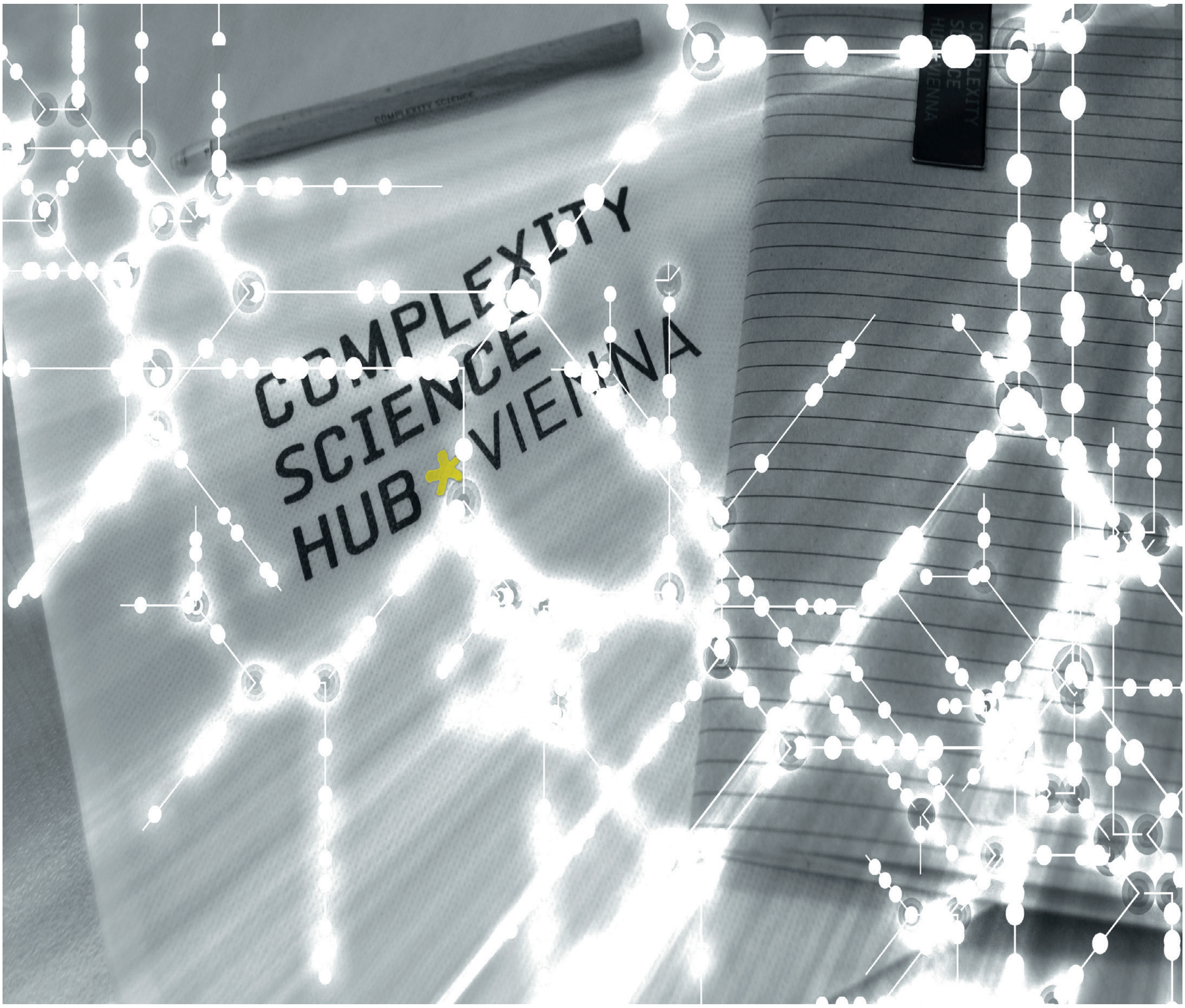
International Symposium, February 9th to 10th 2015, Vienna

COMPLEXITY
SCIENCE
HUB * VIENNA

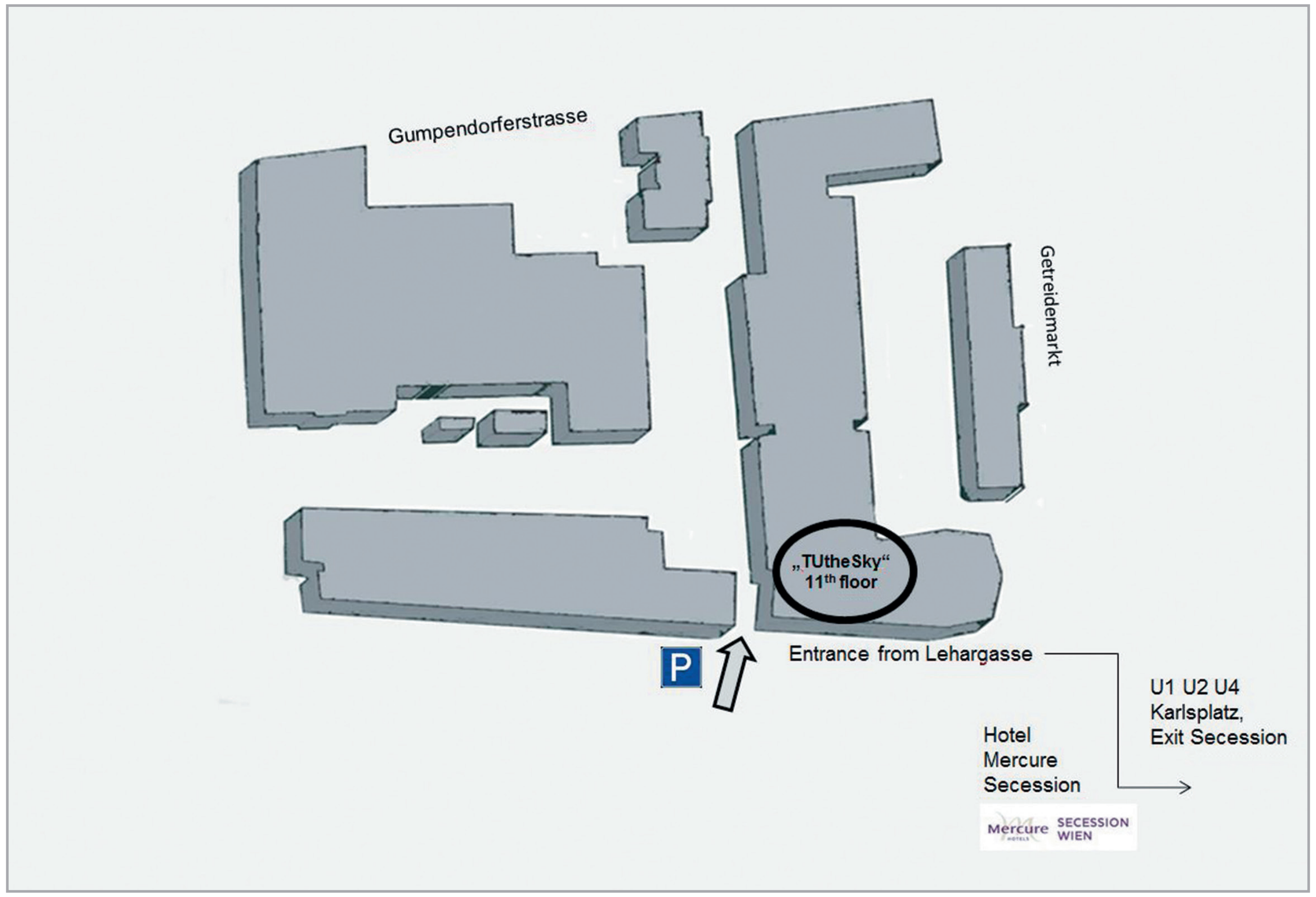
In a world that is getting more and more interconnected, complexity becomes more and more relevant.

Understanding Complexity

Offering Solutions to Problems of the 21st Century



PROGRAM



About the Conference

In a world that is getting more and more interconnected, complexity becomes more and more relevant. Understanding complexity by means of quantitative and predictive science turns out to become a bottleneck in essential aspects of our world, ranging from the taming of financial markets, design of sustainable health care systems, developing smart sustainable cities, management of supply chains, to opinion formation, and virtual life.

Ten leading complex systems scientists from around the world will present their work and provide an overview of where science of complexity stands today, what the big challenges and bottlenecks are, and what society might expect from a better understanding and management of complex adaptive systems.

Complexity Science Hub Vienna

The aim of the Complexity Science Hub Vienna is to identify and understand systemic risks and to find ways to manage them.

Why Vienna? Currently no Austrian institution exists which is able to bundle the different initiatives for Complexity Science, Systemic Analysis and Big Data Science. On goal of the Complexity Science Hub is to raise international awareness and local coordination and to collect objective data as a basis for decision-making thoughout various application opportunities. Such possibilities would include smart cities, medicine, bio-medical systems, the life sciences more generally, transport, e-governance, financial markets, public participation and other systemic issues.

With the Support of the City of Vienna, the active participation of TU Wien, TU Graz, AIT Austrian Institute of Technology Gmbh, Alpbach Technology Forum, Medizinische Universität Wien and IAASA Vienna has an ideal infrastructure for establishing this hub.

The Venue

The ‚Plus-Energie-Bürohochhaus' is the world's first office tower that can claim to feed more energy into the power grid than is required to operate AND use the building.

Primary energy demand is met by Austria's largest photovoltaics system integrated into the façade (façade, roof, total 2199 m^2), Server waste heat utilisation to heat the building and energy recovery from the lift system.

Extreme reduction in energy consumption by the evaluation of over 9300 components from 280 categories by a team of scientists - from the LED lamps, office equipment, kitchens and lighting through to the lift, ventilation and servers.

More information: http://www.univercity2015.at

Monday, February 9th, 2015

08:30 **Registration and Coffee**

09:30 *Chair: Wolfgang Knoll, AIT Austrian Institute of Technology GmbH*

Opening Ceremony
Sabine Seidler , TU Wien
Sybille Straubinger, City of Vienna, as representive of Michael Häupl, Mayor and Governor

09:45 *Chair: Stefan Thurner, Medizinische Universität*

"Taming Complexity: Controlling Networks"
Albert-László Barabási, Boston

"Environments for Future-Facing Research: Reflecting on Complexity Science"
Cathryn Carson, Berkeley

"Why Information Grows: The Evolution of Order, from Atoms to Economies"
Cesar A. Hidalgo, Cambridge

12:15 **Welcome Address**
Video: Bertil Andersson, Nanyang Technical University Singapore
Hannes Androsch, Entrepeneur and Consultant

12:30 **Lunch Break** *(a list of Restaurants is available at Registration Desk)*

14:30 *Chair: Horst Bischof, TU Graz*

"Perfect Order: Recognizing Complexity in Bali"
J. Stephen Lansing, Singapore

"What is Complexity?"
Hector Zenil, Sweden

16:10 **Coffee Break**

17:00 *Chair: Pavel Kabat, IAASA*

"Understanding Human Society with a Social Petri Dish"
Michael Szell, Boston

18:45 **Transfer to the Mayors' Reception at the City Hall of Vienna**

19:30 **Reception (by invitation only)**

Tuesday, February 10th, 2015

8:30 *Chair: Markus Müller, Medizinische Universität Wien*

"Engineering Evolutionary Transitions"
Ricard Solé, Barcelona

"Complexity, Big Data, and Healthcare Challenges"
Stefan Thurner, Vienna, Medizinische Uniervsität Wien

10:10 **Coffee Break**

10:40 *Chair: Jan W. Vasbinder, Nanyang Tehnological University, Singapore*

"Complexity Science Informed Urban Design: Future Cities "
Gerhard Schmitt, Zurich

"Managing Complexity in Urban Governance"
Peter Ho, Singapore

12:20 *Chair: Stefan Thurner*

Closing Remarks
Helga Nowotny

12:30 **End of Conference**

For further informations we recommend to subscribe to our Newsletter:
http://eepurl.com/bdunz5 or via mail to events@ait.ac.at; "Complexity Science Hub Vienna Newsletter"
https://twitter.com/CSHVienna

Barabási, Albert Laszlo

Center of Complex Networks Research,
Northeastern University and
Division of Network Medicine,
Harvard University, Boston

Barabási is both the Robert Gray Dodge Professor of Network Science and a Distinguished University Professor at Northeastern University, where he directs the Center for Complex Network Research, and holds appointments in the Departments of Physics and Computer Science, as well as in the Department of Medicine, Harvard Medical School and Brigham and Women Hospital, and is a member of the Center for Cancer Systems Biology at Dana-Farber Cancer Institute. A Hungarian born native of Transylvania, Romania, he received his Masters in Theoretical Physics at the Eötvös Loránd University in Budapest, Hungary and was awarded a Ph.D. three years later at Boston University. Barabási latest book is "Bursts: The Hidden Pattern Behind Everything We Do" (Dutton, 2010) available in five languages. He has also authored "Linked: The New Science of Networks" (Perseus, 2002), currently available in eleven languages, and is the co-editor of "The Structure and Dynamics of Networks" (Princeton, 2005). His work lead to the discovery of scale-free networks in 1999, and proposed the Barabási-Albert model to explain their widespread emergence in natural, technological and social systems, from the cellular telephone to the WWW or online communities.

Barabási is a Fellow of the American Physical Society. In 2005 he was awarded the FEBS Anniversary Prize for Systems Biology and in 2006 the John von Neumann Medal by the John von Neumann Computer Society from Hungary, for outstanding achievements in computer-related science and technology. In 2004 he was elected into the Hungarian Academy of Sciences and in 2007 into the Academia Europaea. He received the C&C Prize from the NEC C&C Foundation in 2008. In 2009 APS chose him Outstanding Referee and the US National Academies of Sciences awarded him the 2009 Cozzarelli Prize. In 2011 Barabási was awarded the Lagrange Prize-CRT Foundation for his contributions to complex systems, awarded Doctor Honoris Causa from Universidad Politécnica de Madrid, became an elected Fellow in AAAS (Physics) and is an 2013 Fellow of the Massachusetts Academy of Sciences.

Taming Complexity: Controlling Networks

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The ultimate proof of our understanding of biological or technological systems is reflected in our ability to control them. While control theory offers mathematical tools to steer engineered and natural systems towards a desired state, we lack a framework to control complex self-organized systems. Here we explore the controllability of an arbitrary complex network, identifying the set of driver nodes whose time-dependent control can guide the system's entire dynamics.

We apply these tools to several real networks, finding that the number of driver nodes is determined mainly by the network's degree distribution. We show that sparse inhomogeneous networks, which tend to be observed in most real systems, are the most difficult to control, but dense and homogeneous networks can be controlled via a few driver nodes. Overall issues related to control open a series of new fundamental questions pertaining to our understanding of complex systems.

Carson, Cathryn

Department of History,
University of California, Berkelex

Carson is a historian of science and technology at the University of California, Berkeley. Trained in condensed matter physics before taking her Ph.D. in the history of science, she has worked on the history of quantum mechanics and quantum field theory, on Heideggerian philosophy, and on the history and ethnography of modern research institutions.

During her service as Associate Dean of Social Sciences she launched and led Berkeley's new Social Sciences Data Laboratory (D-Lab).

She is currently engaged in building connections among computer scientists, statisticians, and natural and social scientists in the field of data science.

Environments for Future-Facing Research: Reflecting on Complexity Science

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The past trajectory and future prospects of complexity science invite us to reflect rigorously and imaginatively on its possible organizational settings.

Core to the field since its start, and central in many efforts at its institutionalization, has been the appeal of subsuming large swathes of territory under simple, shared laws.

The promise of this broad reach has underwritten particular forms of interdisciplinarity.

Hidalgo, Cesar A.

ABC Career Development Professor
The MIT Media Lab, Cambridge, MA

Hidalgo is the head of the Macro Connections group at The MIT Media Lab and the ABC Career Development Professor of Media Arts and Sciences at MIT. Hidalgo's work focuses on understanding the evolution of information in natural, social, and economic systems, and on the development of big data visualization engines designed to make available unwieldy volumes of data. Hidalgo's academic publications have been cited more than 4,500 times and his visualization engines have received more than 5 million visits. He is the author of Why Information Grows (Penguin, Forthcoming June 2, 2015) and the co-author of The Atlas of Economic Complexity (MIT Press).

Why Information Grows: The Evolution of Order, from Atoms to Economies

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The universe is made of energy, matter and information; but information is what makes the universe interesting. Without information, the universe would be an amorphous soup. It would lack the shapes, structures, aperiodic orders and fractal arrangements that give the universe both its beauty and complexity.

Yet information is rare. It hides in pockets as it battles the universe's perennial march: the growth of entropy.

This talk will discuss the growth of physical order – or information - in the universe by describing the physical, social, and economic mechanisms that allow order to grow; from atoms to economies.

Ho, Peter

Senior Advisor to the Centre for Strategic Futures, Singapore

Ho Hak Ean is the Senior Advisor to the Centre for Strategic Futures, and is also a Senior Fellow in the Civil Service College. He is Chairman of the Urban Redevelopment Authority of Singapore, and Chairman of the Singapore Centre on Environmental Life Sciences Engineering. He is a member of the National University Board of Trustees. He is a board member of the Lee Kuan Yew Exchange Fellowship, a board member of the S Rajatnam School of International Studies, and a council member of the International Institute of Strategic Studies. He is also a member of Statoil's Strategy Advisory Council, and the McKinsey Center for Government Advisory Council.

When he retired from the Singapore Administrative Service in 2010 after a career in the Public Service stretching more than 34 years, he was Head, Civil Service, concurrent with his other appointments of Permanent Secretary (Foreign Affairs), Permanent Secretary (National Security and Intelligence Coordination), and Permanent Secretary (Special Duties) in the Prime Minister's Office. Before that, he was Permanent Secretary (Defence). He was also the founding Chairman of the Maritime and Port Authority of Singapore.

Managing Complexity in Urban Governance

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Sound urban governance is vital to a small, densely-populated and resource-challenged country like Singapore.

But with the pace of urbanisation accelerating around the world, it ought to be of concern to other cities that confront problems of urbanisation no different from Singapore's. It is not just about good planning.

Urbanisation creates a complex operating environment that in turn generates strategic surprises and wicked problems.

The management of complexity is a unique but often unrecognised challenge of urban governance.

Using examples from urban planning process, and how tools like agent-based modelling and big data are deployed, the presentation will show how Singapore manages complexity in the urban milieu, and why.

Lansing, Stephen J.

Co-Director of the Complexity Institute at Nanyang Technological University, Singapore

Lansing co-directs the Complexity Institute at Nanyang Technological University in Singapore. He is also an external professor at the Santa Fe Institute, birthplace of complexity theory, an emeritus professor of anthropology at the University of Arizona, and a senior research fellow at the Stockholm Resilience Centre. Before moving to Arizona in 1998, Lansing held joint appointments at the University of Michigan in the School of Natural Resources & Environment and the Department of Anthropology, and earlier chaired the anthropology department of the University of Southern California. In the 1980's, Lansing and ecologist James Kremer showed that Balinese water temple networks can self-organize.

Later research showed that over the centuries, water temple networks expanded to manage the ecology of rice terraces at the scale of whole watersheds. In 2012, Bali's water temple networks were recognized as a UNESCO World Heritage. As the pieces of the water temple story were falling into place, Lansing became interested in self-organizing processes elsewhere in the archipelago. In 2000 he began to work with Indonesian geneticists, linguists and public health officials to study the co-evolution of social structure, language change and disease resistance on fourteen Indonesian islands. Recent publications and films are available at www.slansing.org.

Perfect Order: Recognizing Complexity in Bali

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Along a typical river in Bali, small groups of farmers meet regularly in water temples to manage their irrigation systems.They have done so for a thousand years. Over the centuries, water temple networks have expanded to manage the ecology of rice terraces at the scale of whole watersheds. Although each group focuses on its own problems, a global solution nonetheless emerges that optimizes irrigation flows for everyone.

Did someone have to design Bali's water temple networks, or could they have emerged from a self-organizing process?

This talk describes a series of fieldwork projects triggered by this question, ranging from the archaeology of the water temples to their ecological functions and their place in Balinese cosmology. Water temple networks are fragile, vulnerable to the cross-currents produced by competition among male descent groups.

But the feminine rites of water temples mirror the farmer's awareness that when they act in unison, small miracles of order regularly occur, as the jewel-like perfection of the rice terraces produces general prosperity. Insights from physics and evolutionary theory help explain how this is possible.

Schmitt, Gerhard

ETH Zürich and Singapore-ETH Centre

Schmitt is Professor of Information Architecture at the Swiss Federal Institute of Technology Zurich (ETH), Director of the Singapore-ETH Centre in Singapore, and ETH Zurich Senior Vice President for ETH Global. His work focuses on the definition and design of Information Architecture (iA) as the next level of Computer Aided Architecture Design (CAAD). The creation of a simulation, visualisation and interaction platform for the Future Cities Laboratory (FCL) is at the centre of his research, which focuses on the development of intelligent design support systems using artificial intelligence methods.

From 1998 - 2008, he served as Vice President for Planning and Logistics and Member of the Board of ETH Zurich. He directed the development of ETH's strategy and planning in cooperation with the 16 scientific departments and the central administration. In 2000, he initiated the development of a third and virtual campus, named ETH World, with an international master plan competition.In 2003, Prof Schmitt initiated the concept for Science City, ETH's new campus in Zurich, a revolutionary interchange between ETH Zurich and the public. In 2007, he initiated the transition of ETH Science City towards a zero carbon emission campus. Prof Schmitt's efforts in developing and transforming ETH Science City earned him the European Culture of Science Award in 2010.

Complexity Science Informed Urban Design: Future Cities

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Demand for urban design on a previously unprecedented scale meets exciting developments in big data and complexity science: In the coming 25 years, more than 2 billion people will need a new place to live and work in an existing or new city. Those cities must be liveable, sustainable and resilient. Existing planning and urban design approaches do not meet this demand.

Therefore, the ETH Future Cities Laboratory develops big data and science informed design methods to fulfil these requirements.

Complexity science takes on a special role in this context, as it may help to overcome the limitations of evidence based design and could assist urban designers to bridge the gap between the current situation and future design scenarios.

After having studied the urban metabolism in stable, shrinking and growing cities in distinctive climates and governance situations, we will present paths towards an urban design environment that allows the integration of the stocks and flows approach with complexity science.

Solé, Ricard

ICREA research professor, Universitat Pompeu Fabra

Solé is ICREA research professor (the Catalan Institute for research and Advanced Studies) currently working at the Universitat Pompeu Fabra, where he leads the Complex Systems Lab located at the PRBB. He completed two full degrees in both Physics and Biology at the University of Barcelona and received his PhD in Physics at the Polytechnic University of Catalonia with a thesis on spatiotemporal chaos and criticality in evolutionary ecology. He was founding member of the NASA-associated Astrobiology Centre on Madrid and is currently External Professor of the Santa Fe Institute (New Mexico, USA) as well as external faculty of the Center for Evolution and Cancer at UCSF. He is also on the editorial board of Biology Direct and PLoS ONE.

He has been awarded with many EU grants and a James McDonnell Foundation Award and received a European Research Council Advanced Grant (ERC 2012). He has published more than 200 papers in peer reviewed journals and his results have been featured in techical and general publications and books.

His main research interests involve the search for universal patterns of organization in complex systems, including prebiotic replicators, cancer, multicellularity, viruses, evodevo, protocells or language to evolved artificial objects and historical dynamics. He explores these issues using both theoretical and experimental approximations based on synthetic biology.

Engineering evolutionary transitions

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The evolution of life in our biosphere has been marked by a number of major events of innovation. These major transitions represent a fundamental set of changes involving in most cases a new way of storing, processing and sharing information with other units. Multicellularity, cooperation, sight, neural structures and even consciousness are examples of these transitions.

Despite the fact that we cannot reproduce these evolutionary events, it becomes possible to approach them by means of different "synthetic" approaches, including artificial life models, virtual worlds, evolutionary robotics and synthetic biology.

We can thus re-define the problem in terms of "synthetic" transitions, where information and computation are the main players towards an understanding of evolutionary patterns and their alternatives.

Szell, Michael

Northeastern University,
Center for Complex Network Research,
Boston

Szell is currently postdoctoral researcher at Northeastern University (Center for Complex Network Research). His interdisciplinary background of mathematics, computer science, and physics is well reflected in his research goals: To quantitatively understand collective behavior and the underlying patterns of our interlinked actions and decisions in a new kind of "computational social science", which typically involves mining large-scale data sets of human activity following a complex networks/systems approach. Szell's special focus is on online environments and media, in particular he is known for his work on multiplex networks, social dynamics and mobility from the players in his massive multiplayer online game "Pardus", www.pardus.at.

His research interests involve social networks, in particular analysis and modeling of structure, evolution, and processes; computational social science, in particular of human behavior online; complex systems, behavioral economics, and evolutionary game theory.

Understanding Human Society with a Social Petri Dish

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A petri dish is an isolated environment that allows close monitoring of the activities of simple forms of life to uncover basic biological processes.

In analogy, we define the concept of the "Social Petri Dish", a controlled environment containing a closed society of humans, in which all the interactions and decisions of individuals are recorded over time.

As a first proof of concept we present our online world "Pardus", in which we study the socio-economic activities of 400,000 individuals over several years, allowing insights into the functioning of human societies on a previously unthinkable scale.

Within this online world, users organize in teams, produce and trade commodities, wage wars and even conduct science. Using a multiplex approach we unveil the fundamental differences behind formation and structure of positive and negative interaction networks, study the patterns of the human behavioral alphabet, and explore gender effects in networking.
This setup allows testing of long-standing sociological hypotheses and quantification of the variables needed for modeling the underlying processes.

It solves previous bottlenecks of obtrusive and sparse data generation, and marks a new way for the social sciences to become fully experimental, with hypotheses being quantitatively formulated, predictive, and testable.

Thurner, Stefan

Medizinische Universität Wien,

Vienna

Thurner

Stefan Thurner is full professor for Science of Complex Systems at the Medical University of Vienna. Since 2007 he is external professor at the Santa Fe Institute and since 2010 a part time researcher at IIASA (International Institute for Applied Systems Analysis). He obtained a PhD in theoretical physics from the Technical University of Vienna, a second PhD in economics from the University of Vienna and his habilitation in theoretical physics.
Thurner has published more than 170 scientific articles in fundamental physics, applied mathematics, complex systems, network theory, evolutionary systems, life sciences, economics and lately in social sciences. He holds 2 patents.Thurner has (co-)organized many international workshops, conferences and summerschools, and has himself presented more than 200 talks. His work has received broad interest from the media such as the New York Times, BBC world, Nature, New Scientist, Physics World and is featured in more than 400 newspaper, radio and television reports. He has coordinated many national and international research projects, and is part in many European science initiatives. Thurner serves as a member of many scientific and editorial boards.

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Zenil, Hector

Karolinska Institute, Sweden

Zenil (BSc Math, UNAM; MPhil Logic, Paris 1 Sorbonne; PhD Computer Science, Lille 1) splits his research time between Stockholm and Oxford. He is a researcher in algorithmic information and computational biology at the Unit of Computational Medicine of the Karolinska Institute (the institution that awards the Nobel Prize in Medicine or Physiology), the Center for Molecular Medicine and the Karolinska University Hospital in Sweden. His work focuses on applying information theory and complexity science to genomics, synthetic and network biology. He is also in charge of the ItBit Programme on Physical and Computational Sciences at Oxford and act as head of the Algorithmic Nature Group (the lab responsible for the Online Algorithmic Complexity Calculator and the Human Randomness Perception and Generation Project); and as Principal Investigator of a John Templeton Foundation-funded project investigating tradeoffs of complexity in evolving causal networks.

He is also co-director of the Paris-based lab LABoRES for the Natural and Digital Sciences; and associate member of the PARIS Reasoning team (University Paris 8) undertaking research on algorithmic psychometrics and subjective randomness. Previously he was a Research Associate the Behavioural and Evolutionary Theory Lab in the Department of Computer Science at the University of Sheffield in the UK as a research Associate. In 2008, he was a Visiting Scholar at Carnegie Mellon University and a Summer Intern at the Massachusetts Institute for Technology (MIT) in 2007. He is the editor of "Randomness Through Computation", "A Computable Universe", and several other books published by World Scientific Publishing Company/Imperial College Press and Springer, for this latter he is also a member of the Editorial Board for the "Emergence, Complexity and Computation" book series. His work is at the intersection of information theory, complexity science and networkbiology.

He is the author of more than 50 papers published in indexed journals, conference proceedings and academic books. He has been invited to give keynote speeches at international conferences, such as IACAP 2014 (Greece) and IEEE BIBM 2013 (China). In 2014, he was invited as a young researcher to the prestigious 2nd. Heidelberg Laureate Forum in Germany interacting with Fields, Abel and Turing Laureates for one week. He is also a Senior Research Associate and external consultant for Wolfram Research (the creators of Mathematica), an invited member of the Foundational Questions Institute (FQXi), and a member of the national researchers list (SNI) in Mexico. In 2011 he was awarded the winning prize in the Computational Imagery category of the 2011 Kroto Institute Scientific Image Competition and in 2012 he was awarded the best ACM review in the classification of Theory of Computation. He was also an invited member of the prestigious Turing Centenary Advisory Committee in 2012.

What is Complexity?

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We may all have an intuitive sense of what it means to say that something is complex. Perhaps we may relate it to the number of elements involved in the functioning or evolution of a system. Are there any conditions that make complexity possible, or that set limits to complexity? What are the formal definitions of complexity? Do they accord with our intuitive understandings? Do they conform to a general standard? Can there be a universal measure of complexity? How is complexity related to information, randomness and structure? Or to order and dynamics? How useful would a measure for quantifying and characterizing complexity be? Are randomness and information opposing concepts? A general overview of current concepts of complexity and their possible applications will be offered, covering disciplines ranging from mathematics to cosmology to molecular biology.

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and (in alphabetical order):

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