



Creativity and evolution. Games, language, robots, life, art

Como, 5 – 9 September 2016 Lake Como School of Advanced Studies

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MONDAY 5/9	TUESDAY 6/9	WEDNESDAY 7/9	THURSDAY 8/9	FRIDAY 9/9
Arrivals	Morning lecture Prof. Stuart Kauffman	Morning lecture Prof. Gerd Müller	Morning lecture Prof. Andreas Wagner	Morning lecture Prof. Francesca Tria
	Coffee break	Coffee break	Coffee break	Coffee break
	Ateliers (4 in parallel)	Ateliers (4 in parallel)	Ateliers (4 in parallel)	Ateliers (4 in parallel)
Lunch	Lunch	Lunch	Lunch	Lunch
Opening lecture Prof. Luc Steels	Ateliers (4 in parallel)	Ateliers (4 in parallel)	Ateliers (4 in parallel)	Ateliers (4 in parallel)
Ateliers (4 in parallel)				
Coffee break				
Evening lecture Prof. Stefan Thurner	Public lecture Prof. Vittorio Loreto	Elevator pitches and poster session	Evening lecture Prof.s Chris Knight and Camilla Power	Ateliers (final presentations)
Evening lecture Prof. Andreas Roepstorff			Evening lecture Prof. Pierre-Yves Oudeyer	
Welcome dinner				
Artistic atelier	Artistic atelier	Artistic atelier	Artistic atelier	Artistic atelier



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Lecturers

The following speakers will deliver the plenary lectures. The titles, abstracts and bios are presented in order of appearance.

Luc Steels

Monday 5 sept, 14h30

Institut de Biologia Evolutiva (UPF-CSIC), Barcelona.

<http://biologiaevolutiva.org/lsteels/>

HOW LANGUAGE INNOVATES ITSELF.

Human language is unique, not only because of its complexity but, even more so, because it is open-ended. New sounds, words, grammatical constructions, meanings and interaction patterns emerge in situated linguistic interactions between a speaker and a listener and spread in the population to become part of the shared common language, which is forever changing and adapting to the needs and fashions of its users. How can we explain this remarkable creativity and never-ending innovation? It is certainly not due to a central organizing force that explicitly controls how everybody should speak but rather through a distributed adaptive self-organizing process that spontaneously leads to novelty. In order to understand language innovation, we need breakthroughs at two levels: the level of the individual speaker and the level of the population. With respect to the individual, I will argue that we need to view language comprehension and production as a problem solving process and language invention as insight problem solving. Insight problem solving rests on meta-level processes including diagnostics that detects impasses in language processing (for example, a missing word, a novel grammatical construction, a meaning that does not fit with the current context) and repair strategies that flexibly adapt or expand existing conventions to deal with these impasses. With respect to the population level, I will argue that replicator dynamics and level formation, two processes which are also the basis for explanations in evolutionary biology, can provide an adequate explanatory framework when transposed to the cultural level. The talk will not only introduce these basic theoretical ideas but also show how they translate into computer simulations and robotic experiments exhibiting the self-organization of sound systems, lexical and grammatical inventories, and meanings.

Steels, L. (1999/2015) The Talking Heads Experiment. The origins of words and meanings. Language Science Press, Berlin.

<http://langsci-press.org/catalog/book/49> (free download)

Steels, L. (2016) Agent-based models for the emergence and evolution of grammar. Phil. Trans. R. Soc. B 371: 20150447.

<http://rstb.royalsocietypublishing.org/content/royptb/371/1701/20150447.full.pdf>

Bio: Luc Steels is currently ICREA research Professor at the Institut de Biologia Evolutiva (UPF-CSIC) in Barcelona, where he founded in 2011 the Language Evolution Lab which is part of the complex systems group in the Department of Experimental and Health sciences (DCEXS) of the Universitat Pompeu Fabra. His research is focused on developing a theory for the origins and evolution of language, for which he is using concepts, methods, and theories adapted from evolutionary biology and mapped to the cultural level. Steels studied linguistics at the University of Antwerp (Belgium) and computer science at the Massachusetts Institute of Technology (USA), with specialisation in Artificial Intelligence. Before joining the Institut de Biologia Evolutiva, he was a full professor of computer science at the University of Brussels (VUB) (from 1983) and founding chairman of the computer science department at the VUB. Later he was founding director of the Sony Computer Science Laboratory in Paris (from 1996 to 2011). Google scholar lists 300 articles, with 13.748 citations, an H-index of 62, and an i10-index (> 10 citations) of 161. His articles have appeared in prestigious journals including Behavioral and Brain Sciences, Nature Physics, Physics of Life, Trends in Cognitive Science, Artificial Intelligence Journal, Advances in Complex Systems, Phil. Transactions of Royal Society. Steels edited 12 books directly related to his research. Recent books are on topics related to language evolution and the technologies needed to carry out agent-based experiments: Design patterns in Fluid Construction Grammar (2011, John Benjamins, A'dam), Experiments in cultural language evolution (2012, John Benjamins), and Computational Issues in

Fluid Construction Grammar (2012, Springer Verlag, Berlin). He also holds 12 patents related to AI, robotics, and language technologies, and was involved in several start-up companies. Steels is an elected member of the the Royal Academy of Arts and Sciences of Belgium, and the European Academy of Sciences.

Stefan Thurner

Monday 5 sept, 17h30

Medical University of Vienna.

<http://www.complex-systems.meduniwien.ac.at/people/sthurner/>

COMBINATORIAL EVOLUTIONARY DYNAMICS – A QUANTITATIVE FRAMEWORK FOR EVOLUTIONARY DYNAMICS

We present a simple combinatorial network co-evolution model of Schumpeterian evolutionary dynamics. Novel goods are endogenously created through combinations of already existing goods. New goods alter networks of possibilities of future combinations. New goods enter the market and compete with other goods which may be driven out from the market and thereby trigger cascades of defects. The model's generic dynamics explains punctuated equilibria and power laws in evolutionary data without effort. We show that the model can be used to understand statistical features of the fossil record and market data. We show the existence of the long hypothesised Schumpeterian creative destruction in world trade data and use the model to understand the corresponding diversity dynamics of goods.

Chris Knight (1) and Camilla Power (2)

Monday 5 sept, 18h30

(1) Departement of Anthropology, University College London

(2) Anthropology Program, University of East London.

<http://www.chrisknight.co.uk>

<http://radicalanthropologygroup.org/person/person/66>

THE EMERGENCE OF LANGUAGE AS A MAJOR TRANSITION

The key principle of the 'major transitions' paradigm is that the shift to each higher level of organization is undermined in the preceding period by selfish-gene replication on the lower level. Conflicting interests prevent the emergence of each novel level of complexity. In the case of their eighth transition, Maynard Smith and Szathmáry (1995) argue that communal ritual plays a crucial role in generating the solidarity necessary for language to begin evolving in a population of evolving hominins. In this presentation, our aim is to build on this general model, developing concrete and specific hypotheses testable in the light of the fossil, archaeological and ethnographic records. Luc Steels (2009) has demonstrated how, given sufficiently high levels of cooperation and trust between agents, a complex lexicon and grammar can evolve through processes of self-organization. Instead of presupposing a language-specific grammar module, linguistic complexity requires only standard hominin sensory, motor and cognitive capacities augmented with modern human capacities for joint attention and egocentric perspective reversal. As soon as any motive for selfishness (e.g. competition for energy) is introduced, then language evolution is impeded. In the case of hominin evolution, the most persistent source of conflict, aggression and potential deception would have been sexual competition, both between and within each sex. This points to the particular form of ritual – initiation or gender ritual – needed to overcome the problem of sexual conflict which jeopardises the transition. Ritual action of the necessary kind opens the way to a whole new level of cooperation involving group-level sexual and other morality. From this standpoint, the biological potential for language had long lain dormant in evolving hominins, its expression in processes of lexical accumulation and grammaticalization being held back until the establishment of appropriate sociopolitical conditions (Knight and Power 2012). This approach eliminates the need for any 'hopeful monster' mutation for generating language suddenly among modern humans.

Knight, C. and C. Power (2012). Social conditions for the evolutionary emergence of language. In M. Tallerman and K. Gibson (eds), *Handbook of Language Evolution*. Oxford: Oxford University Press, pp. 346-49.

(Maynard Smith, J. and E. Szathmáry. *The Major Transitions in Evolution* 1995. Oxford: Freeman.

Steels, L. 2009. Is sociality a crucial prerequisite for the origins of language? In R. Botha and C. Knight (eds.) *The Prehistory of Language*. Oxford: Oxford UP, pp.36-57.)

Bio: Camilla Power is Senior Lecturer in Anthropology at the University of East London. Her research has focused on social contexts for the evolutionary emergence of symbolic culture, language, art and religion, drawing on fieldwork with the Hadza hunter-gatherers of Tanzania. She has co-edited *The Evolution of Culture* (1999, Edinburgh UP, Dunbar, Knight, Power eds) and *Human Origins: Contributions from Social Anthropology* (in press, Berghahn, Power, Finnegan, Callan eds). She has published numerous articles on the evolution of human life history and reproductive strategies; hunter-gatherer cosmology; gender ritual and rock art.

Stuart Kauffman

Tue 6 sept. 9h00

University of Calgary

<http://stuartkauffman.com/>

THE UNPRESTATABLE CREATIVE BECOMING OF LIFE

I will tell the full story of Peter S, Rupert R, Sly S, and Gus G, Protocells, imagined to have existed about 3.7 billions years ago. Peter and his friends are autopoietic systems that can “build themselves, thus they are Kantian wholes, where the parts exist for and by means of the whole. The universe is vastly non ergodic above the level of atoms. Most complex things will never come to exist. One way to exist above the level of atoms is to be a Kantian whole such as Peter and his friends. We think, since Pythagoras and Newton, that we should be able to mathematize the becoming of Peter and company. We cannot. Nor can we prestate what will happen. We do not know what can happen. Peter, Rupert, Sly, and Gus, even if imaginary, unleashed an open ended, unprestatable, radically emergent creativity of the evolving biosphere and above, that literally changed the history of the universe. I ask you to listen to their tale, pretend it is true, and help me understand what the story tells us.

Bio: Originally a medical doctor, Kauffman is an emeritus professor of biochemistry at the University of Pennsylvania, and a seminal member and an external professor of the Santa Fe Institute. Also a MacArthur Fellow and a Trotter Prize winner, Kauffman has published three major books, among them is *At Home in the Universe: The Search for the Laws of Self- Organization and Complexity*(1995), which the Oxford University Press says “weaves together the excitement of intellectual discovery and a fertile mix of insights to give the general reader a fascinating look at this new science – and at the forces for order that lie at the edge of chaos.” The FidiPro program brings Kauffman to Tampere University of Technology. The subject of the program is stochastic modeling of gene regulatory networks. The project will focus on modeling the gene regulatory networks using gene expression data. The expertise of the Institute for Biocomplexity and Informatics and the modeling experience of the CSB-group led by professor Olli Yli-Harja support each other very well. The results are expected to help in understanding the mechanisms of diseases so that diseases could be identified in an early phase. They are also to be used in predicting the individual effects of different medicines therefore helping to select the best possible treatment for each patient. Stuart Kauffman is also the director of the Institute for Biocomplexity and Informatics (IBI). He is the pioneer and the founding father of biocomplexity research. Kauffman was able to look at gene regulatory networks from a new and different point of view, and it was this ground-breaking perspective that has ever since attracted new researchers and scientists worldwide. Kauffman himself got interested in gene regulatory networks at San Francisco medical school in 1964 when he wanted to unravel the mysteries of cell differentiation. Quickly noticing the possibilities of his revolutionary ideas, he started working on biocomplexity and was eventually able to show that the behaviour of genetic networks depends critically on the level at which the genes are connected.

Vittorio Loreto

Tue 6 sept. 18h30

Sapienza, Rome

<http://samarcanda.phys.uniroma1.it/vittorioloreto/cv/>

LA SCIENZA DEL NUOVO: GIOCO, CREATIVITA E INNOVAZIONE

(The science of the new: play, creativity and innovation –
public lecture in Italian)

Accademia di Belle Arti Aldo Galli IED Como, via Petrarca 9 – 22100 Como

Registrazione gratuita e obbligatoria su <https://scienzadelnuovo.eventbrite.it>

Free and compulsory registration on <https://scienzadelnuovo.eventbrite.it>

How to reach Accademia di Belle Arti Aldo Galli IED Como

Noi tutti sperimentiamo il nuovo. Le novità fanno parte della nostra quotidianità. Incontriamo nuove persone, impariamo ed usiamo nuove parole, ascoltiamo una nuova canzone, vediamo un film o adottiamo una nuova tecnologia. Le innovazioni sono fattori chiave per l'evoluzione delle società umane, in quanto esse rappresentano il motore principale per esplorare nuove soluzioni in ambienti imprevedibili ed in continua evoluzione. Nuovi artefatti tecnologici, nuove scoperte scientifiche, nuove strutture sociali e culturali, sono molto spesso stimolati dalle mutazioni della condizioni esterne. Storicamente la nozione del “nuovo” ha sempre rappresentato una sfida per l'umanità. Ciò che è nuovo spesso sfida la naturale tendenza degli esseri umani a prevedere e controllare gli eventi futuri. Eppure, la maggior parte delle decisioni che prendiamo sono basate sulle nostre aspettative per il futuro. Da questo punto di vista un'indagine approfondita e una profonda comprensione dei meccanismi attraverso i quali novità e innovazioni emergono, si diffondono, competono e si affermano è cruciale per il progresso in tutti i settori delle attività umane. In questo

conferenza del ciclo Mondi Nuovi Lontanissimi

Loreto presenterà una panoramica degli approcci recenti alla scienza del nuovo che uniscono da un lato teorie e dati, e dall'altro la possibilità di sfruttare i giochi come strumento per studiare i meccanismi alla base della creatività e dell'innovazione e dell'apprendimento.

We all experience the new. Novelties occur frequently in our individual daily lives. We meet new people, learn and use new words, listen to new songs, watch a new movie, adopt a new technology. Innovations are key factors in the evolution of human societies, since they represent the primary motor to explore new solutions in ever-changing and unpredictable environments. New technological artefacts, scientific discoveries, new social and cultural structures, are very often triggered by mutated external conditions. Historically the notion of the new has always offered challenges to humankind. What is new often defies the natural tendency of humans to predict and control future events. Still, most of the decisions we take are based on our expectations about the future. From this perspective a thorough investigation and a deep understanding of the underlying mechanisms through which novelties and innovations emerge, diffuse, compete and stabilise is key to progress in all sectors of human activities. In this conference of the series Mondi Nuovi Lontanissimi Loreto will present recent approaches to the science of the new that combine theories and data on the one hand and the possibility to exploit games as a tool to study the basic mechanisms at play whenever we learn, create and innovate.

Gerd Mueller

Wed 7 sept. 9h00

University of Vienna

<http://theoretical.univie.ac.at/people/gerd-mueller/>

CREATIVE DEVELOPMENT AND THE EXTENDED EVOLUTIONARY SYNTHESIS

The evolutionary process modifies embryonic development to result in a change of organismal forms. The responsive properties of developmental systems add a creative component to evolution. Recent advances in evolutionary theory integrate these developmental factors with new concepts of organism-environment interaction, inclusive inheritance, and population dynamics to form a more comprehensive evolutionary framework than provided by traditional theory. A widened set of predictions about the evolutionary process can be derived from the extended synthesis concept.

Bio: Gerd B. Müller is professor at the University of Vienna where he heads the Department of Theoretical Biology. He is president of the Konrad Lorenz Institute for Evolution and Cognition Research at Klosterneuburg, Austria. His research interests focus on vertebrate limb development, evolutionary novelties, EvoDevo theory, and the Extended Evolutionary Synthesis.

Andreas Wagner

Thu 7 sept. 9h00

University of Zürich

<http://www.ieu.uzh.ch/wagner/>

THE ORIGINS OF INNOVATIONS IN LIFE'S EVOLUTION

Life can be viewed as a four billion year long history of innovations. These range from dramatic macroscopic innovations like the evolution of wings or eyes, to a myriad molecular changes that form the basis of macroscopic innovations. We know many examples of such innovations, but we have no systematic understanding of the principles that allow organisms to innovate. Most phenotypic innovations result from changes in three classes of systems: metabolic networks, regulatory circuits, and protein or RNA molecules. I will discuss evidence that these classes of systems share two important features that are essential for their ability to innovate. These features not only help us understand the origins of innovations in life's history. They may also help accelerate technological innovation in areas such as biotechnology and robotics.

Bio: Andreas Wagner is professor and chair of the Institute of Evolutionary Biology and Environmental Studies at the University of Zurich in Switzerland, and External Professor at the Santa Fe Institute. His main research interests are the evolution of biological systems, from genomes to complex molecular networks. Wagner is the author of more than 150 scientific publications in journals that include Nature, Science, and PNAS, as well as two scientific monographs, Robustness and Evolvability in Living Systems (Princeton University Press, 2005), and The Origins of Evolutionary Innovations (Oxford University Press, 2011). Wagner received his Ph.D in 1995 at Yale University, where his research won the J.S. Nicholas prize for best dissertation in his field. He has lectured widely worldwide, and held research fellowships at several institutions, such as the Institute for Advanced Studies in Berlin, Germany, and the Institut des Hautes Etudes in Bures-sur-Yvette, France. Wagner is an elected member of the EMBO, an elected fellow of the American Association for the Advancement of Sciences, a member of the Faculty of 1000 Biology, as well as of the editorial boards of multiple scientific journals that include Genome Biology and Evolution as well as BMC Evolutionary Biology.

Andreas Roepstorff

Thu 8 sept. 17h30

Aarhus University

andreas.roepstorff@cas.au.dk

COUPLED CREATIVITY

When two or more people collaborate, their bodies and behaviors come to coordinate in complex patterns of coupling, the dynamics of which appears related to the success of the interaction. I will review some recent studies that explore empirically shared problem solving and creativity. This allows us to explore the emergence of embodied couplings through interactions. It seems that although coordination appears crucial, problem solving and creativity may not only be contingent on synchrony, but also on more complex processes that are perhaps more akin to complementarity. Further, correlations between indices of successful outcomes, and of physiological markers may not necessarily be found at the level of individuals, but at times at the level of dyads or groups.

This creates a somewhat complicated relation between 'intersubjective rapport' and problem solving and creativity.

I explore whether a shared feeling of 'playfulness' may be one way to jump out of local minima of interaction, thus potentially expanding a shared search space.

Pierre-Yves Oudeyer

Thu 8 sept. 18h30

INRIA, Bordeaux

<http://www.pyoudeyer.com/>

WHAT CAN WE LEARN FROM BABY ROBOTS ABOUT DEVELOPMENT? SCIENCE, EDUCATION AND ARTISTIC APPLICATIONS.

(Presentation of the 2016 Life-time Achievement Award of the Evolutionary Linguistics Association.)

Understanding infant development is one of the greatest scientific challenges, as this is a massive complex dynamical system. The development of sensorimotor, cognitive and communication skills can be viewed as pattern formation through the interactions of multiple mechanisms at multiple spatio-temporal scales. To understand better these processes, it is insightful to build and experiment with robots that model the growing infant brain and body, as well as its interaction with the physical and social environment, in constant dialogue with human and living sciences. Moreover, work with robots has enabled researchers to consider the body as a variable that can be systematically changed to study the impact on skill formation, something developmentalists could only dream about decades earlier.

I will illustrate these points by presenting a series of computational and robotics models that study how sensorimotor, cognitive and linguistic structures can be formed and discovered at the level of individuals and populations.

In particular, I will discuss how moment-to-moment processes such as imitation and curiosity-driven attention and exploration can self-organize major developmental structure on the long term, ranging from the discovery of the body to the formation of vocal interaction structures in social interaction.

I will also outline several recent projects that show how this fundamental research program can find applications in education and art. In particular, I will present the Poppy project, a new open-source platform for creating 3D printed robots and that is accessible to a wide population of users from multiple disciplines, from children to artists.

References:

Oudeyer, P-Y. and Smith. L. (2016) How Evolution may work through Curiosity-driven Developmental Process Topics in Cognitive Science, 1(11).
<http://www.pyoudeyer.com/OudeyerSmithTopicsCogSci14.pdf>

P-Y. Oudeyer, J. Gottlieb and M. Lopes (in press) Intrinsic motivation, curiosity and learning: theory and applications in educational technologies, Progress in Brain Research.
<http://www.pyoudeyer.com/oudeyerGottliebLopesPBR16Preprint.pdf>

Bio: Dr. Pierre-Yves Oudeyer is Research Director at Inria and head of the Inria and Ensta-ParisTech FLOWERS team (France). Before, he has been a permanent researcher in Sony Computer Science Laboratory for 8 years (1999-2007). He studies mechanisms of learning and development of sensorimotor, cognitive and social skills in humans and robots, including artificial curiosity, intrinsic motivation, the role of morphology in learning motor control, human-robot interfaces, joint attention and joint intentional understanding, and imitation learning. Following a multidisciplinary approach, where computational and robotic sciences contribute to our understanding of humans, he focuses on the role self-organization and active learning through interactions among brains, bodies and environment. His team conceived the first worldwide open-source 3D printed hu-

manoid robot now widely used in science, education and artistic projects. He was awarded an ERC grant and the prize Le Monde for academic research. He is chair of the IEEE CIS Technical Committee on Cognitive and Developmental Systems (CDS), editor of the IEEE CIS Newsletter on CDS, and associate editor of IEEE TCDS. He is also working actively for the diffusion of science towards the general public, through the writing of popular science books, articles and participation to radio and TV programs as well as science exhibitions.

Web: <http://www.pyoudeyer.com>

Francesca Tria

Friday 9 sept. 9h00

Institute for Scientific Interchange (ISI), Torino.

<http://www.kreyon.net/kreyonWorkshop/index.php/2015/08/19/francesca-tria/>

MODELING THE EMERGENCE OF NOVELTIES

Novelties are part of our daily lives. We constantly adopt new technologies, conceive new ideas, meet new people, experiment with new situations.

At different scales, innovation is also a crucial feature of many biological, technological and social systems. Recently, large databases witnessing human activities allowed the observation that novelties – such as the individual process of listening to a song for the first time – and innovation processes – such as the fixation of new genes in a population of bacteria – share striking statistical regularities. I will here briefly review scientific attempts to effectively model the emergence of the new and its regularities. I will then present a new framework based on Polya's urn. What seems to be key in the successful modelling schemes proposed so far is the idea of looking at evolution as a path in a complex space, physical, conceptual, biological, technological, whose structure and topology get continuously reshaped and expanded by the occurrence of the new. This will be identified as a process of expansion into the adjacent possible, a concept originally introduced by Stuart Kauffman in the framework of biological evolution. We will identify statistical signatures of the presence of the expansion into the adjacent possible in the analyzed datasets, and we will show that our modeling scheme is able to predict remarkably well these observations.

Bio: Francesca Tria is a researcher at the Physics Department of Sapienza University of Rome. She got her degree in physics at Sapienza University of Rome and her PhD in physics at the University of Naples Federico II. She spent two years as a post-doc at the ICTP Institute in Trieste before moving at the Institute for Scientific Interchange (ISI) in Turin. Starting from a background in statistical physics and complex systems, she explored different research realms where this expertise could be successfully applied. In particular, her research activity includes complex systems approaches to biologically related problems, such as evolutionary dynamics and phylogeny reconstruction, to social phenomena, such as language evolution, learning and innovation dynamics. She was recently part of the EU project EveryAware, locally coordinating the activities of the group of ISI. She is currently coordinating the ISI team in the KREYON project.

Summer School on:

“Creativity and evolution. Games, language, robots, life, art”

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Artistic Ateliers

1. "Foundations of creativity"

Pietro Gravino (Physics Dept Rome), Bernardo Monechi (ISI Foundation Turin)

How can we define and measure the creative products of human and social activities, including language or socio-cultural activities on the web and social media? Can we observe and measure how novelties are adopted at a community scale, becoming real cultural innovations? This atelier addresses these questions by introducing some of the most interesting investigation tools: web-experiments, data science, in silico simulations and theoretical modeling. With these instruments participants will be guided in a real research path: from the definition of quantitative metrics, to data analysis and simulations, to the conception of new gaming environments to measure creativity and monitor innovation processes. The final aim is to identify the main ingredients of creativity and the dynamics underlying the evolution and the innovations in socio-technical-cultural systems.

2. "Evolutionary semantics on real robots"

Michael Spranger (Sony Computer Science Tokyo), Katrien Beuls (VUB AI Lab Brussels), Brigitte Krenn (Austrian Institute for AI, Vienna)

This atelier investigates early language learning from a multitude of perspectives ranging from multi-modal corpus studies, over NLP analysis of child language corpora to grounded robot experiments. The atelier focuses in particular on the integration of multiple modalities such as gaze, gesture, vocalisations and speech in semantics-based models of language emergence in infants. Participants will learn 1) how to analyse multi-modal human-human, human-robot task description corpora, 2) how to extract patterns of child speech from large corpora and 3) how to build models for the emergence of gestures, vocabulary and early grammar. Models and analyses will be evaluated on robot data.

3. "Evolutionary Grammar"

Remi van Trijp (Sony Computer Science Paris) and Paul van Eecke (VUB AI Lab Brussels)

The question of the origins and evolution of human language is one of the most fascinating mysteries in science, but also one of the hardest problems due to a lack of data and fossil records of the first languages. Nevertheless, recent methodological and technological breakthroughs have made it possible to come up with solid scientific theorizing, making Evolutionary Linguistics a young but thriving field of inquiry. This atelier introduces its participants to these methods, including a hands-on experience on how to construct multi-agent models for exploring the emergence of vocabularies from scratch and a concrete demonstration of state-of-the-art experiments on the evolution of grammar. Participants will familiarize themselves with Babel2, an open-source software framework for developing agent-based models that includes the grammar formalism Fluid Construction Grammar, and they will learn which set of skills they need to acquire or bring to the table for conducting cutting edge experiments on language evolution.

4. "Evolution of Collective Adaptive Systems on the Web"

Michael Rovatsos (University of Edinburgh) and Fauso Giunchiglia

The overall objective of the atelier is to build a Web-based collective intelligence system that has adaptive capabilities. Participants will be trained in the fundamental theoretical and technological building blocks of such systems. There will be a couple of hours of lectures at the start of every day, then a guided lab session (one hour) to introduce relevant SmartSociety technology and for students to play with it, and the rest of the day group work implementation of an actual case study. The theoretical introductions will focus only very briefly on general material, and then go into aspects specific to collective adaptive systems for the most part. Prerequisites: Participants need to have a background in formal/mathematical notation, logic, probability theory, and good programming skills. Experience with web programming (REST, Javascript, etc) is strongly recommended.