REPORT ON DISCO 2011

Workshop on the Dynamics of Complex Systems
24-26 November 2011, Valparaíso, Chile

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The workshop DISCO 2011 on the Dynamics of Complex Systems (named after its Spanish title, "DInámica de Sistemas COmplejos") took place in the Chilean port of Valparaíso between the 24th and 26th of November. It was held to celebrate the 60th birthday of Eric Goles, and its venue was the Instituto de Sistemas Complejos de Valparaíso (ISCV).

The organizing committee consisted of Anahí Gajardo and Julio Aracena from the Universidad de Concepción, Andrés Moreira from the Universidad Técnica Federico Santa María, and Ricardo Espinoza from the Pontificia Universidad Católica de Valparaíso, with a strong support from the staff at the ISCV. The meeting was supported by the project IMSA (Conicyt ACT-88) as well as other institutions listed at the conference web site (`http://www.ci2ma.udec.cl/disco/`).

The celebration congregated more than 18 Chilean researchers, 32 colleagues from other countries, and 14 students. The foreign visitors came mostly from France, a token of Eric Goles' long-standing relationship with that country, but a number of other countries were also represented. Since Automata 2011, the yearly meeting on the theory of cellular automata and discrete dynamical systems, took place in Santiago in the first days of the same week, many participants made the best of their plane tickets and attended both events.

The career of Eric Goles spans the last three decades and has been mostly devoted to automata networks and related discrete dynamical systems, ranging from discrete neural networks to sand piles to cellular automata; his interest has been in the dynamics (bounds on attractors and transients) and computational capabilities of these systems. He has also created scientific centers (the Center for Mathematical Modeling at the Universidad de Chile, and the ISCV itself), directed many large projects, and presided the Chilean office for science and technology for six years. This time, however, it was his research that was celebrated, and hence the topics of most of the talks fell within or around the areas mentioned above.

The list of the speakers of the first day, along with brief descriptions of their topics, are listed below:

- **Andrés Moreira** opened the meeting with an overview of Dr Goles' career, showing the growth of his network of collaborators and describing the topics that dominated each period.

- **Cristian Calude** discussed the complexity of mathematical problems defined by computable predicates, and which would therefore be solved by an oracle for the halting problem.

- **Dominique Perrin** described recent results on the relation between bifix codes, Sturmian words and subgroups of free groups.

- **Guillaume Theyssier** recounted several results on the limit behaviour of cellular automata, in terms of both the possible and the typical configurations appearing after arbitrarily long runs.

- **Ioan Todinca** gave positive and negative results, as well as many open questions, on a model of frugal computation on a graph to which a universal vertex is added.

- **Iván Rapaport** reported results on the computational power of graph-based models of distributed computing in which each node additionally has (limited) access to a global whiteboard.

- **Michel Cosnard** talked about directed acyclic graphs with the unique directed path property, applied to the problem of minimizing the number of wavelengths used for routing.

- **Marcos Kiwi** presented a result on the growth of the number of perfect matchings of cubic bridgeless planar graphs, obtained through the study of the Ising model on their associated triangulations.

- **Martín Matamala** showed an alternative proof of a lemma by N. Thiant, arriving to it in terms of the existence of a winning strategy for a special two-player domino game.

The first day continued with a cocktail at the Lord Cochrane Museum, with a splendid view over the harbor and several delicious birthday cakes. A subset of the participants went on to finish the evening with an unofficial social activity at the typical Bar Cinzano, where a certain 60 years old mathematician is rumoured to have joined the singers. The second day of the workshop comprised the talks listed here:

- **Petr Kůrka** discussed fast arithmetical algorithms for "Möbius number system", which are representations of the unitary circle in terms of sequences of Möbius transformations.

- **Eric Rémila** talked about the avalanches and fixed points of the Kadanoff sand pile model.

- **Jarkko Kari** answered a question first formulated by Stanislaw Ulam, showing a 1-D cellular automaton which, starting from a finite configuration, produces all possible finite patterns over its alphabet.

- **Gregory Chaitin** mentioned part of his work towards a mathematical understanding of biological evolution, and commented on some other scientific novelties.

- **Gregory Lafitte** gave a talk on cellular automata and games.

- **Bruno Durand** provided an overview of the difficulties of performing universal computation in faulty cellular automata, and of even defining the problem properly.

- **Eric Goles** reminisced about his early research and its intellectual context, and went on to describe some of the main topics of his career and the questions guiding it.

- **Alejandro Maass** reviewed a number of rigidity results on cellular automata; in particular, results on the iteration of measures and on invariant measures.

- **Hans Herrmann** in his "Apollonian variations" described his work on constructing space-filling Apollonian packings of bearings where contiguous discs rotate in opposite senses.

- **Sergio Rica** described his recent work with Eric and Nicolás Goles on Schelling's social segregation model; he discussed qualitative and quantitative observations from a physical point of view.

- **Pablo Marquet**, an ecologist, talked about several mathematical models on which he has worked, ranging from the formation of plant stripes in the desert to mitigation strategies for climate change.

The last day of the meeting was a Saturday, and the program finished with a barbecue for lunch. The crowd waited for it by listening to the last set of talks:

- **Bruno Martin** sketched a "how-to" for the construction of universal computation, by describing and comparing the strategies and chains of simulation used in several of Eric Goles' results.

- **Nicolas Ollinger** showed his construction of aperiodic tile sets based on 2×2 substitution systems, and related it to the work "hidden" in an appendix of Robert Berger's 1966 thesis.

- **Nicolas Schabanel** gave some reflexions on the relation between computer science and complex systems theory, discussing different ways in which the first has contributed (and still can contribute) to the second.

- **Henning Mortveit** described how the tools from group theory may be used to assess the long-term dynamics of asynchronous discrete dynamical systems.

- **Julio Aracena** talked about update schedules in Boolean networks, and how their relation to the dynamics can be studied through the "update digraphs" they induce.

- **Jacques Demongeot** made a tour de force through several levels of biological complexity, discussing the requisites for the robustness of different systems. In addition, he shared some memories of the early 80's in Grenoble, when Eric Goles was first a student and then a CNRS researcher.

    In summary, it was a successful meeting, with great contributions by all the participants (and here we do *not* refer to the bottle of wine which was required as the sole registration fee). The talks dealt with a number of areas in theoretical computer science and discrete mathematics; there were even some forays into other disciplines. However, a sense of unity was provided by their relation to the research done in the last 30 years by Eric Goles and his collaborators, both in the wide world and in the "Chilean school" that has flourished under his guidance.

    The slides from the talks can be found at the workshop's web site. Videos of the talks are available through the web site of the ISCV (`http://www.iscv.cl`). In addition, a special issue of *Theoretical Computer Science* will be published, based on the research and surveys presented during the meeting.