Mathematical Work of Alejandro Maass

Alejandro Maass, a Full Professor at the Universidad de Chile, has made profound contributions to the study of symbolic dynamics and ergodic theory. His most outstanding achievements are in entropy theory, low complexity systems and symbolic dynamics of cellular automata, accumulating 340 citations (ISI reports) up to now and he has collaborated with several renowned mathematicians from all over the world. In total he has published over 40 papers in the best journals in the field such as Ergodic Theory and Dynamical Systems, Israel Journal of Mathematics, Journal of the London Mathematical Society, Annals of Probability, Journal für die Reine und Agewandte Mathematik, and Inventiones Mathematicae.

He started his seminal work on the mathematical framework of cellular automata theory in his mathematical engineering thesis at the Universidad de Chile. Further he obtained his Ph.D. in Mathematics and his Habilitation at the Institut de Mathématiques de Luminy (IML) of CNRS, an important meeting centre for mathematicians throughout the ‘90’s and where he profited from the wonderful ambiance there at that moment.

Alejandro Maas supervised 8 Ph.D. theses, some of them in co-direction with French universities, and hosted postdocs from different centres abroad. He is been regularly invited to important meetings in ergodic theory and he has been often invited to research positions abroad. He has organized 8 international meetings attracting students and researchers from the region and edited their proceedings in Cambridge U. Press, Kluwer Publ. and Hermann Ed.

Due to his interest in applications of mathematics to challenging scientific problems raised by contemporary science, Maass founded the Laboratory of Mathematics of the Genome (LBMG) in 2003, gathering together mathematicians, computer scientists, biologists and engineers on bioinformatics. The LBMG is the scientific counterpart for technological enterprises working in crucial industrial problems for Chile as the bioleaching of copper. Besides significant industrial results, Alejandro Maass has international patents and several articles in biological journals, the fruit of his research in these areas.

A summary of the main scientific contributions of Alejandro Maass follows:

Entropy theory: he participated in the development of local entropy theory, giving new insights into the classical ergodic notions. Using this theory he and collaborators solved a long-standing conjecture in differential dynamics: "positive entropy implies Li-Yorke chaos". His article in Crelle’s is highly referenced by specialists.

Low complexity systems: he and co-authors introduced the notion of topological complexity that laid the foundations of a new way of studying disordered systems. They succeeded in seeing this notion of purely combinatorial origin as a coupling property. Recently, he and collaborators succeeded to provide a structure theorem for topological dynamical systems, which is an analogue of the structure theorem behind the celebrated non-standard ergodic theorems by Host and Kra.

Symbolic extensions: together with T. Downarowicz they made a significant advancement in the theory of symbolic extensions of smooth maps. Solving the one-dimensional case and providing a general scheme that could serve to address the higher dimensional case. Their estimates coincide, in dimension 1, with a conjecture stated by Downarowicz and Newhouse also published in Inventiones Mathematicae.

Symbolic dynamics of cellular automata: he has settled basic results in the ergodic theory of cellular automata, results that were sought by the theoretical computer science community. In his first scientific work he solved several open problems concerning limit sets of cellular automata. His studies of expansive cellular automata with F. Blanchard revealed for the first time the existence of a dimension group structure behind these dynamics. In a second article with M. Boyle they gave a definitive and significant impulse to the theory that has raised interest in other research groups, cited as a seminal work in high-impact journals and motivating a new research line in symbolic dynamics.

Rigidity of invariant measures: he studied the rigidity of the invariant measures with respect to the Z^2 action induced by the shift and an algebraic cellular automaton. In a set of works he and co-authors used regeneration techniques to represent measures with complete connections and they prove that such measures evolve, under the action of the automaton, towards a measure of maximal entropy. Further, they gave fine conditions that involve entropy and ergodicity to characterize the rigid invariant measures in this algebraic setting in the spirit of Rudolph's solutions to the Furstenberg conjecture.

Bioinformatics and Mathematics of genomics: he has contributed to the mathematical study of large biological networks and has introduced symbolic dynamics techniques in bioinformatics. His main technological achievements are the development of bio-identification systems for bioleaching bacteria and wine contaminants and the validation of mathematical models developed to discover ways for improving biomass in microorganism communities, being author of 5 patents.