Minisymposium on discrete dynamical systems

Science Building No. 6, Shanghai Jiao Tong University

August 26 - 28, 2019

Conference Schedule

Monday, August 26

10:10 – 11:00	Scott Schmieding, *The stabilized automorphism group of a subshift*
13:30 – 14:20	Eric Goles, *Two dimensional signed majority cellular automata*
14:30 – 15:20	Uijin Jung, *On decomposition of factor maps between shift spaces on groups*
15:30 – 16:20	Yinfeng Zhu, *Path-liftable digraph homomorphisms and non-liftable indices*

Tuesday, August 27

09:20 – 10:10	Jarkko Kari, *Piecewise affine functions, Sturmian sequences and aperiodic tilings*
10:20 – 11:10	Alejandro Maass, *Finite rank and S-adic systems dynamics*
13:30 – 14:20	Tullio Ceccherini-Silberstein, *The Garden of Eden Theorem: from cellular automata to algebraic dynamical systems*

14:30 – 15:20	Fan Cheng, *Complete Monotonicity Conjecture of Heat equation*
15:30 – 16:20	Dou Dou, *Entropy, metric mean dimension and variational principles*
16:30 – 17:20	Minkyu Kim, *On the existence of invariant Gibbs measure and balanced shifts*

Wednesday, August 28

09:20 – 10:10	Mike Boyle, *The mapping class group and automorphism group of a shift of finite type*
10:20 – 11:10	Collin Bleak, *On the interplay between the 'chameleon' groups $G_{n,r}$ and the automorphism groups of bi-infinite full shift spaces*
13:30 – 14:20	Jisang Yoo, *Relative equilibrium states and random dynamical systems*
14:30 – 15:20	Guohua Zhang, *Symbolic Extensions of Amenable Group Actions*
15:30 – 16:20	Rezki Chemlal, *Irrational eigenvalues of one dimensional cellular automata*

Abstract

On the interplay between the 'chameleon' groups $G_{n,r}$ and the automorphism groups of bi-infinite full shift spaces

Collin Bleak
University of St Andrews

We begin with our result characterising the automorphisms of the Higman-Thompson groups $G_{n,r}$, and show how the groups Aut($0, 1, ..., n-1^{\mathbb{Z}}, \sigma$) sit naturally as subgroups of the outer automprphism groups Out($G_{n,r}$). This leads to new combinatorial representations of elements of Aut($0, 1, ..., n-1^{\mathbb{Z}}, \sigma$). We use these representations to uncover information, both old and new, about the groups Aut($0, 1, ..., n-1^{\mathbb{Z}}, \sigma$).

Joint with J. Belk, P. Cameron, A. Navas, F. Olukoya, and Y. Maissel.

The mapping class group and automorphism group of a shift of finite type

Mike Boyle
University of Maryland, College Park, USA

The automorphism group of a shift of finite type S, Aut(S), is the countable group of homeomorphisms commuting with S. The mapping class group of S, MCG(S), is the countable group of orientation-preserving homeomorphisms, up to isotopy, of the mapping torus of S. I'll discuss and contrast the structure of Aut(S) and MCG(S); the tools available for their study; rigidity results; constraints on rigidity results; and open problems.

Parts of this are joint with Sompong Chuysurichay; with Doug Lind; and with Toke Carlsen and Soren Eilers.

The Garden of Eden Theorem: from cellular automata to algebraic dynamical systems

Tullio Ceccherini-Silberstein
Università del Sannio (Benevento), Italy

The Garden of Eden Theorem (proved by Moore and Myhill in 1963) is a central result in the theory of cellular automata. It gives a necessary and sufficient condition for a cellular automaton $\tau\colon A^{\mathbb{Z}^d} \to A^{\mathbb{Z}^d}$ - with finite alphabet A over the free abelian group $\mathbb{Z}^d$ of rank d as universe to be surjective. This result was extended to amenable groups by CS-Machi'-Scarabotti in 1999. Bartholdi (2010, 2016) showed that the GOE Theorem only holds for amenable groups. Following an indication of Gromov, who suggested that the GOE Theorem should hold, more generally, for dynamical systems with a suitable "hyperbolic flavour", with Michel Coornaert in 2016 we proved a GOE type theorem for Anosov diffeomorphisms of tori. An algebraic dynamical system is a pair (X, G) where X is a compact abelian group and G is a group acting by continuous automorphisms of X. Given a group G we consider the integer group ring $\mathbb{Z}[G]$ and, for $f \in \mathbb{Z}[G]$, we denote by X_f the Pontryagin dual of the abelian group underlying the ring $\mathbb{Z}[G]/\mathbb{Z}[G]f$ obtained by quotienting $\mathbb{Z}[G]$ by the principal ideal generated by f. Then (X_f, G) is called a principal algebraic dynamical system. Hanfeng Li (in press) proved a beautiful general GOE type theorem for expansive principal algebraic dynamical systems over amenable groups. Later, in a joint paper CS-Coornaert-Li (2019) we introduced a notion of "weak expansivity" for principal algebraic dynamical systems and in this framework, we presented a GOE type theorem for abelian groups. This result covers the harmonic models for transient abelian groups as well as the Laplace models on $\mathbb{Z}^d$ for all $d \geq 2$.

Irrational eigenvalues of one dimensional cellular automata

Rezki Chemlal
Université de Béjaia

Complete Monotonicity Conjecture of Heat equation

Fan Cheng
Shanghai Jiao Tong University

In this talk, we will introduce the history and the current progress on the complete monotonicity conjecture on heat equation/Gaussian distribution (Or Gaussian complete monotonicity conjecture).

The second law of thermodynamics stated that the entropy of an isolated system is always nondecreasing. Consider the case of heat equation along the line:

$$\frac{\partial}{\partial t} f(x,t) = \frac{1}{2} \frac{\partial^2}{\partial x^2} f(x,t) \tag{1}$$

where x denotes the location and t denotes time.

Without loss of generality, assume that the initial condition $f(x,0) \geq 0$. In the literature of mathematical physics, it is well known that the entropy of $f(x,t)$ is increasingly concave in t; i.e.,

$$\frac{\partial}{\partial t} h(f(x,t)) \geq 0 \tag{2}$$

$$\frac{\partial^2}{\partial t^2} h(f(x,t)) \leq 0 \tag{3}$$

A function $f(t)$ is called complete monotone, e.g., $1/t$, if the consecutive derivatives of $f(t)$ alternates in signs.

Conjecture:

$$(-1)^n \frac{\partial^n}{\partial t^n} h(f(x,t)) \leq 0 \tag{4}$$

That is $h(f(x,t))$ is complete monotone in t.

Current progress:

1. In 1966, H. P. McKean [1] considered the problem in studying Boltzmann equation. However, he failed to make any progress. The problem was not accepted as a serious conjecture till 2015 as there is no evidence. Cedric Villani [2] noted this result in his textbook on Boltzmann equation as “super-H” theorem.
2. In 2015, independent of the work of H. P. McKean and Cedric Villani, we [3] proved that up to $n \leq 4$ the conjecture holds.
3. For the general case, the conjecture remains open.

References

[1] H. P. McKean, Jr., “Speed of approach to equilibrium for Kacı-s caricature of a Maxwellian gas,” Arch. Rational Mech. Anal., 21:343-367, 1966.

[2] C. Villani, A review of mathematical topics in collisional kinetic theory.

[3] F. Cheng and Y. Geng, “Higher Order Derivatives in Costa’s Entropy Power Inequality,” IEEE Trans. Inform. Theory, vol. 61, no. 11, pp. 5892-5905, Nov. 2015.

Entropy, metric mean dimension and variational principles

Dou Dou
Nanjing University

Mean dimension is a meaningful quantity introduced by Gromov, Lindenstrauss and Weiss. It measures the dimensional characteristic for dynamical systems with infinite entropy. Based on entropy theory, we obtain several kinds of variational principles for metric mean dimensions.

Two dimensional signed majority cellular automata

Eric Goles
Universidad Adolfo Ibanez

I will study the complexity of signed automata on a planar grid. Over each vertex we consider the majority function with states -1 and 1. Each edge has a sign, so locally the majority consider the values in the neighborhood weighted by the edge' s signs. Depending on the symmetry and uniformity of the signs distribution we determine the complexity of those networks: Turing Universality, P-Completeness related to some decision problems, etc. We also show that the asymmetric rules exhibit super polynomial cycles.

On decomposition of factor maps between shift spaces on groups

Uijin Jung
Ajou University, Korea

For any $\mathbb{Z}$-shift space X, we show that the set of topological entropies of symbolic factors of X is dense in the interval $[0, h(X)]$. A relative version shows that if there is a symbolic factor map from X to Y, then the set of topological entropies arising from the decomposition of the map is dense in the interval $[h(Y), h(X)]$. We present several generalization of the result to subshifts on more complicate groups other than $\mathbb{Z}$.

Piecewise affine functions, Sturmian sequences and aperiodic tilings

Jarkko Kari
University of Turku

We discuss constructions of Wang tilings that simulate iterations of piecewise rational affine functions. Our method uses elementary algebra and representations of real numbers as Sturmian sequences. The method provides small aperiodic Wang tile sets, and leads to a simple proof of the undecidability of the domino problem. One also easily establishes analogous undecidability results about tilings on the hyperbolic plane and on Baumslag–Solitar groups.

On the existence of invariant Gibbs measure and balanced shifts

Minkyu Kim
Ajou University, Korea

It is well known that if f is a Hölder continuous function from a mixing shift of finite type X to $\mathbb{R}$, then there exists a unique equilibrium state which is a Gibbs measure for the potential f. Recently, Baker and Ghenciu showed that there exists a (non-invariant) Gibbs measures for the potential 0 if and only if X is (right-)balanced. By defining f-balancedness condition, we extend this result and show that there exists an invariant Gibbs measures on X for the real-valued continuous potential f if and only if X is bi-balanced with respect to f. Using this result, we construct a class of subshifts which have a Gibbs measure but do not have invariant Gibbs measures for the potential 0, answering a question raised by Baker and Ghenciu.

Finite rank and S-adic systems dynamics

Alejandro Maass
University of Chile

In this talk we present topological finite rank minimal Cantor systems and its symbolic version, the S-adic subshifts. First we prove that both classes coincide (up to topological conjugacy) when considering minimal and recognizable S-adic subshifts. Then we provide necessary and sufficient conditions for a minimal subshift to be of topological finite rank. In the case a minimal subshift has non-superlinear complexity we prove it has topological finite rank. Concerning dynamical properties of topological finite rank systems, when the rank is two we prove that the number of asymptotic classes is bounded and thus the automorphism group is virtually $\mathbb{Z}$. Interestingly, we construct examples of topological rank two systems where the complexity is superlinear.

This is a joint work with Fabien Durand, Samuel Petit and sebastián Donoso.

The stabilized automorphism group of a subshift

Scott Schmieding
Northwestern University

The automorphism group of a subshift consists of all self-homeomorphisms which commute with the shift map. We'll discuss this group in the case of a shift of finite type, and give some background and problems related its study. Finally, we'll discuss recent work with Yair Hartman and Bryna Kra in which we introduce a certain stabilized automorphism group, and outline some results which allow us to distinguish (up to isomorphism) certain cases of stabilized automorphism groups of full shifts.

Relative equilibrium states and random dynamical systems

Jisang Yoo
Sungkyunkwan University

The main subject of this talk is random subshifts of finite type (RSFT) introduced by V.M. Gundlach and Yu. Kifer. This subject will be explained from the point of view of someone whose first interest is in (not random) subshifts. We first explain why RSFTs naturally occur in the study of subshifts and their factor maps. Its connection to the systematic study of entropy theory of random dynamical systems started by Anthony H. Dooley and Guohua Zhang will be mentioned. One novel result we will mention is a way to decompose a non-mixing RSFT into mixing RSFTs. This is useful because RSFTs occurring in mixing subshifts are usually non-mixing and there is a complete theory of mixing RSFTs. This is a non-trivial result because most non-mixing RSFTs that we see are not merely disjoint unions of mixing RSFTs.

Symbolic Extensions of Amenable Group Actions

Guohua Zhang
Fudan University

The entropy theory of symbolic extensions for a single transformation, plays an important role in the study of topological dynamics and smooth dynamical systems. In this talk, we shall extend this theory to actions of countable infinite discrete amenable groups.

This is a joint work with T. Downarowicz from Poland.

Path-liftable digraph homomorphisms and non-liftable indices

Yinfeng Zhu
Shanghai Jiao Tong University

Let ϕ be a digraph homomorphism from a digraph G to a digraph H. A walk $a_1, \ldots, a_k$ in G is called a lifting along ϕ of a walk $e_1, \ldots, e_k$ in H if $e_i = \phi(a_i)$ for all $i \in [1, k]$. We call ϕ a path-liftable homomoprhism if every walk in H has a lifting in G. If ϕ is not path-liftable, the length of a shortest walk in H without any lifting, denoted by $\delta(\phi)$, is called the non-liftable index of ϕ. Let $\delta(n)$ be the the largest non-liftable index among all non-path-liftable homomorphisms from an n-vertex digraph. We prove that $\delta(n) = 2^n - 1$. We show that it is NP-complete to decide whether or not ϕ is path-liftable and, on the additional condition that G and H are strongly connected and have the same spectral radius, there is an algorithm to determine whether or not ϕ is path-liftable in $O(|V_G|^3)$ time.

This is a joint work with Yaokun Wu.

List of participants

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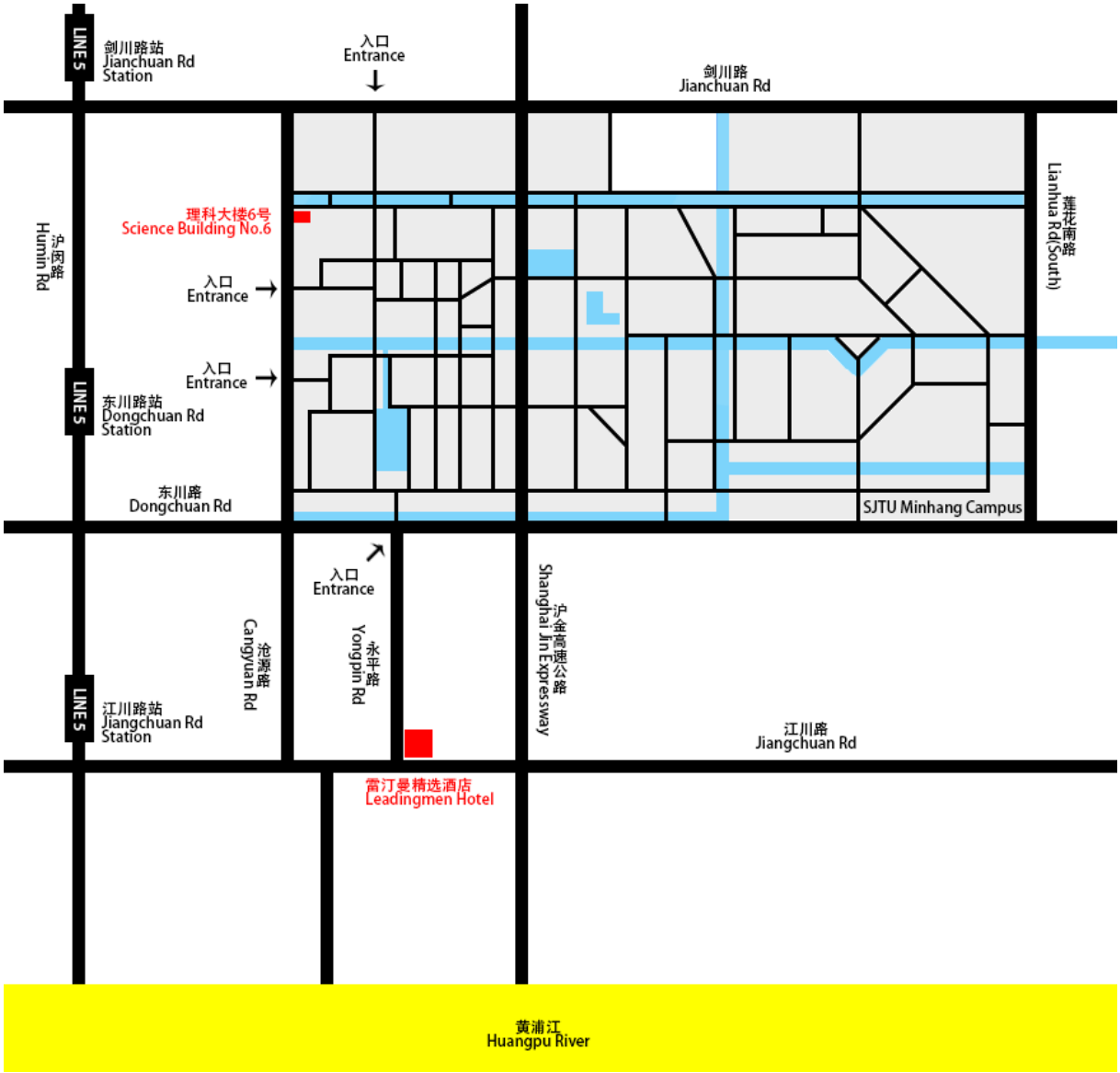
Local Information

Emergency phone numbers

- Police: 110
- Ambulance: 120
- Foreign hotline: (+86)-962288 (This is a hotline for foreigners in Shanghai.)
- Organizer:
  Wu Yaokun 吴耀琨 (+86)13795231236

Useful phrases

- 请送我去雷汀曼酒店, 永平路 178 号。
  Please take me to the Leadingmen hotel, Yongping Rd. 178.
- 请送我去上海交大理科大楼 6 号楼。
  Please take me to Science Building No. 6, SJTU.
- 请告诉我最近的地铁站该怎么走。
  Please show me the direction to the closest subway station.
- 我在访问上海交通大学。请您帮我给我的联系人吴耀琨老师 (13795231236) 打个电话。
  I am visiting SJTU and my host is Yaokun Wu. Pls. help to give him a call (13795231236).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