FNSNF
Swiss National Science Foundation

Universität Zürich[UZH]

Promenade
of a French female mathematician in Switzerland

★ ★ ★ ★ ★ ★ ★ ★

Four years with permutations, Marie Heim-Vögtlin, a loving family and so much more

Mathilde Bouvel (Institut für Mathematik, Universität Zürich)

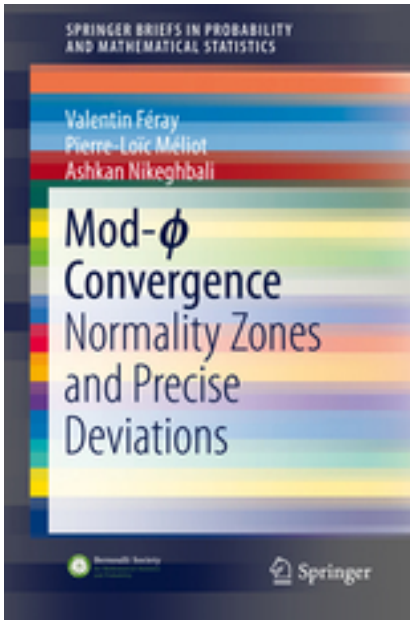
Awarding of the Marie Heim-Vögtlin prize 2017.

May 2012: My first visit to Switzerland

Valentin in Zürich



Valentin in Zürich



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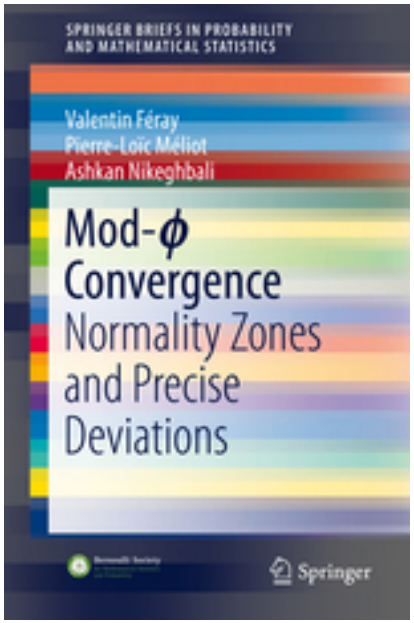

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CH-8057 Zürich

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Fax: +41 44 635 57 05
Campus Zürich-Irchel
Büro: Y27J22

September 2013: We are moving to Zürich!

- Valentin's combinatorics group (in March 2017)

- I join the group of Joachim Rosenthal

↪ Coding Theory and Cryptography . . . and combinatorics?

November 2013: MHV interview

Created with NuageDeMots.fr

2014 - 2016: Working with the MHV grant

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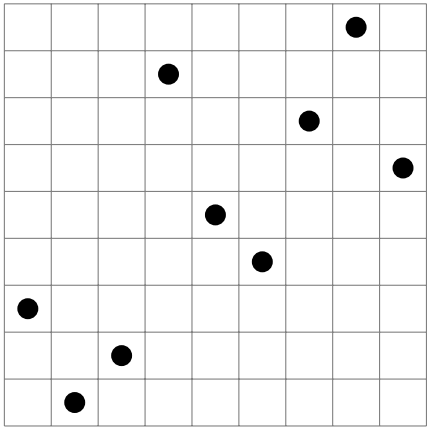
My MHV project was entitled *Permutation classes: from structure to combinatorial properties* and had three axes:

- Random permutations in permutation classes;
- Structural bijections and enumerative consequences;
- Permutation patterns and induced subgraphs.

Permutations

- A permutation of size n is a sequence of integers containing exactly once each of $1, 2, \ldots, n$.
- Equivalently, it is an $n \times n$ grid filled with dots, with exactly one dot per row (resp. column).



$\sigma = 3\ 1\ 2\ 8\ 5\ 4\ 7\ 9\ 6$

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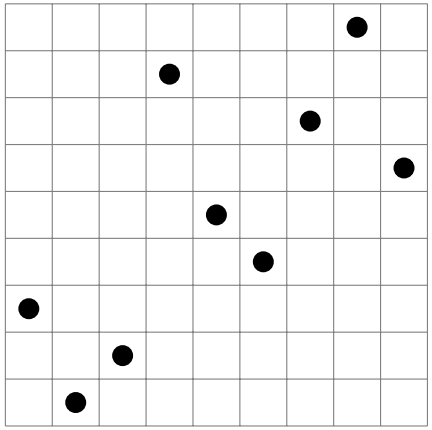

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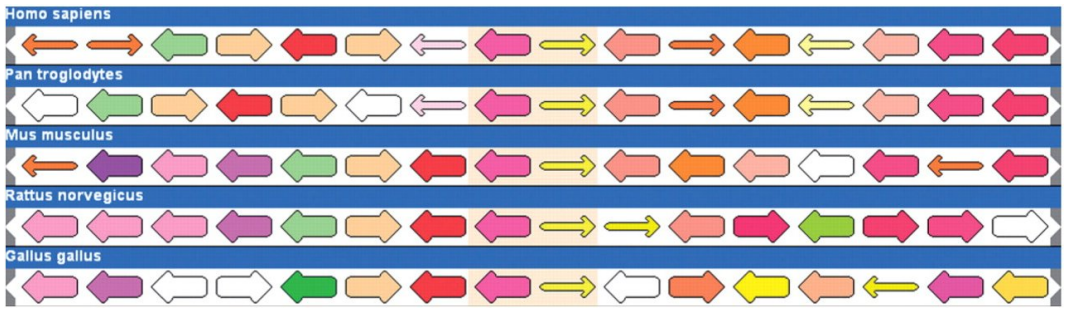
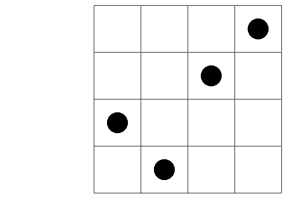
- Permutations model any finite set of elements that are totally ordered:
  - a shuffle of a card deck
  - the order of the genes on a chromosome



Patterns and permutation classes

- π is a pattern of σ when



$\pi = 2\ 1\ 3\ 4$

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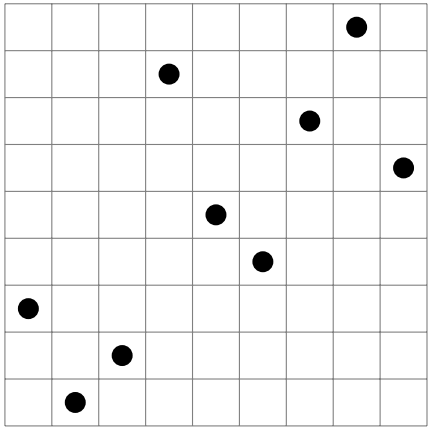

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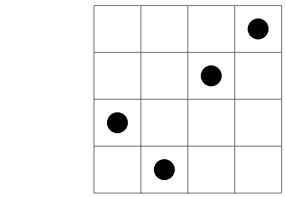

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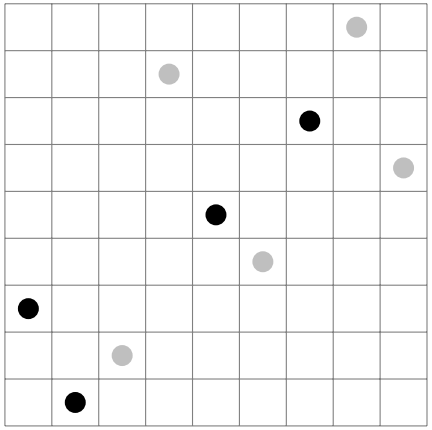

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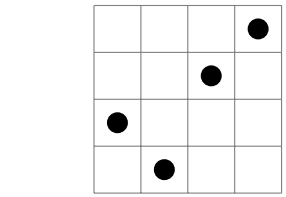

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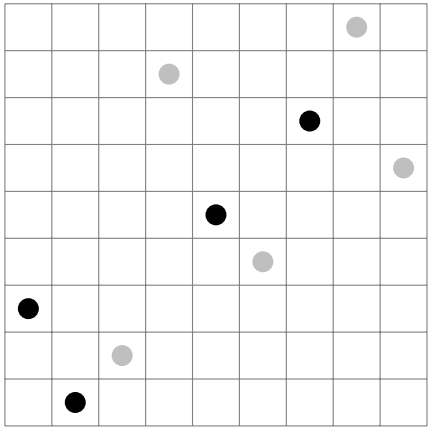

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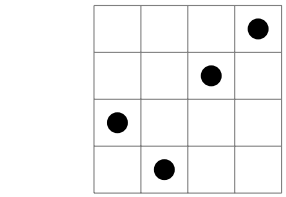

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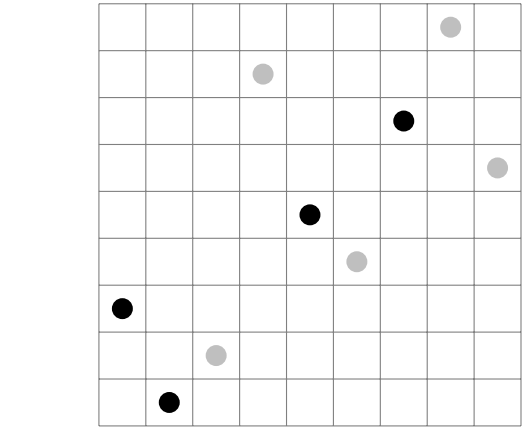

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- $\preccurlyeq$ is a partial order on permutations. What can we say about it?

- A permutation class is a set $\mathcal{C}$ of permutations that is downward closed for $\preccurlyeq$, i.e. whenever $\pi \preccurlyeq \sigma$ and $\sigma \in \mathcal{C}$, then $\pi \in \mathcal{C}$.

For every permutation class, there exists a (finite or infinite) set of patterns whose avoidance characterizes the class. We write $\mathcal{C} = Av(B)$.

The power of bijections

With Michael Albert (Univ. of Otago, New Zealand)

Object of study: the subclasses $Av(231, \pi)$ of the famous Catalan class $Av(231)$ (for $\pi \in Av(231)$).

- Observation: It often happens that $Av(231, \pi)$ and $Av(231, \tau)$ have the same enumeration sequence.

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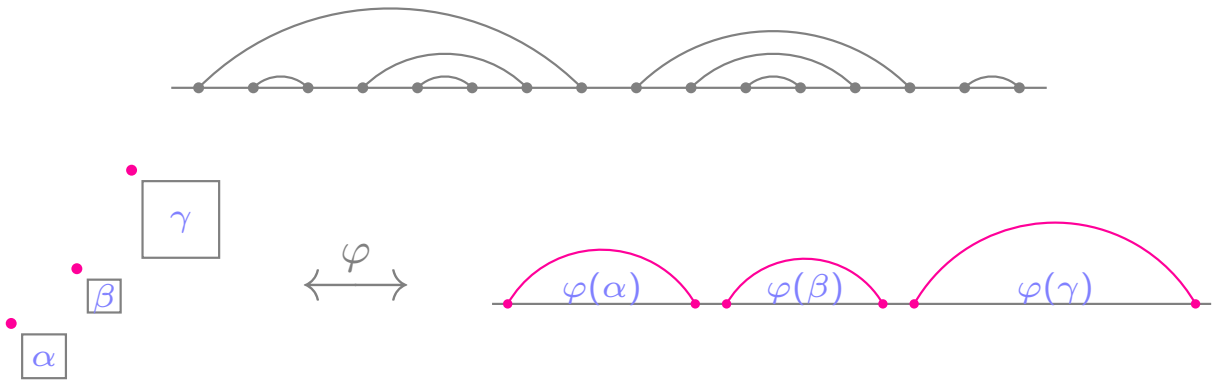
By means of a relation $\sim$ on arch systems described by four rules:



(1) $A \sim B \implies \overset{\frown}{A} \sim \overset{\frown}{B}$

(2) $a \sim b \implies PaQ \sim PbQ$

(3) $PabQ \sim PbaQ$

(4) $a\overset{\frown}{bc} \sim \overset{\frown}{ab}c$

where A, B, P and Q denote arbitrary arch systems and a, b and c denote atoms or empty arch systems.

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  $\hookrightarrow$ Unifies many results from the literature.

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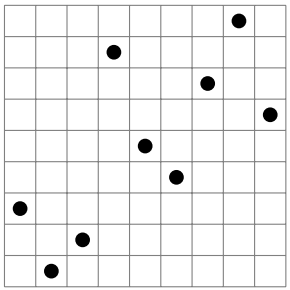
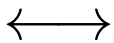
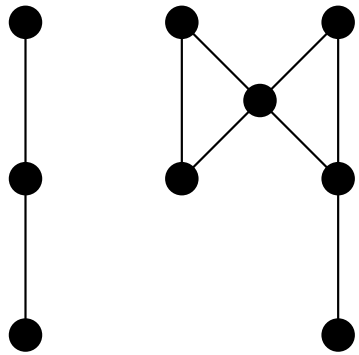
- Conjecture: Our condition is also necessary, that is to say $\sim$ characterizes completely equi-enumeration among classes $Av(231, \pi)$.

The challenge of graphs

Permutations are in correspondence with graphs (via *inversion graphs*).







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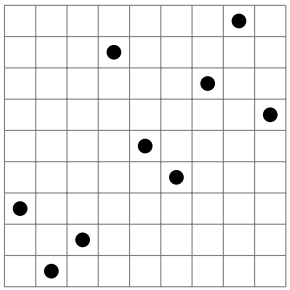

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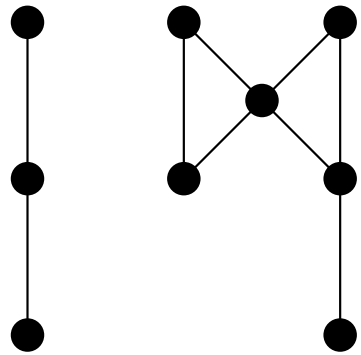

 Patterns correspond to induced subgraphs.

 The correspondence is neither onto nor one-to-one.

Can we still make use of this correspondence?

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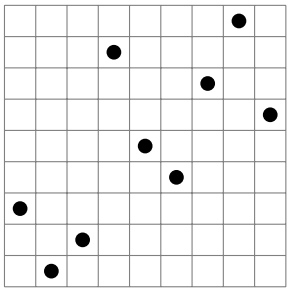

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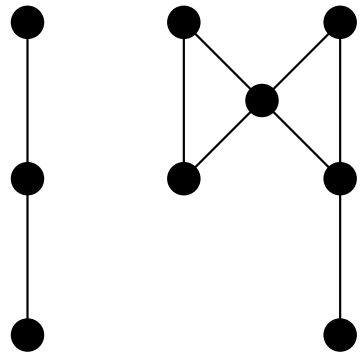

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2016-2017: Marc Egger's master thesis

Study the relationship between the computational problems *Permutation Pattern Matching* and *Induced Subgraph Isomorphism*

The beauty of randomness

(Uniform) random permutations in classes:

- How to produce them?
- How to explain what we see?

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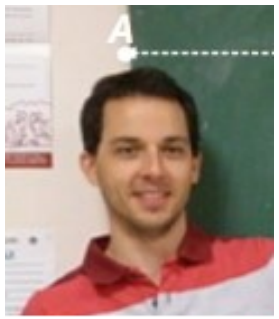
Staring:

Frédérique Bassino

Valentin Féray

Lucas Gerin



Mickaël Maazoun

Adeline Pierrot

Carine Pivoteau

Dominique Rossin

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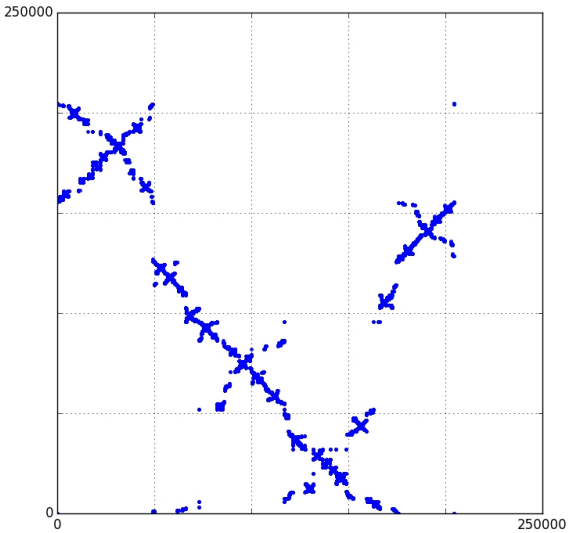
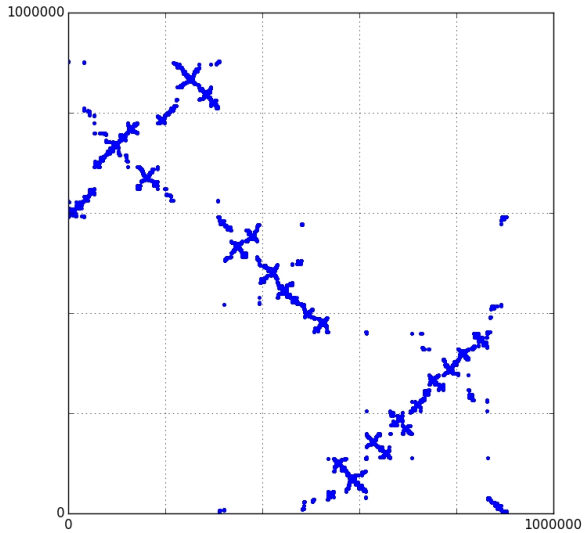
Separable permutations: the class $Av(2413, 3142)$





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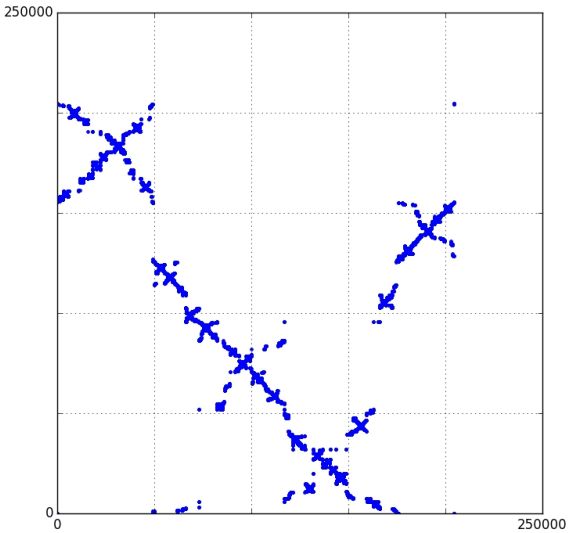
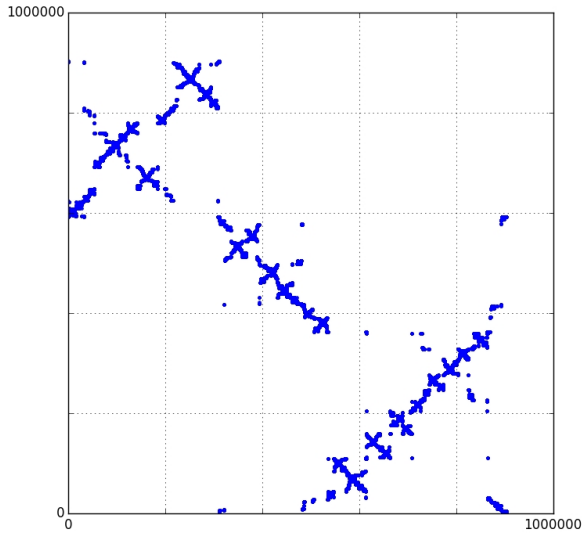


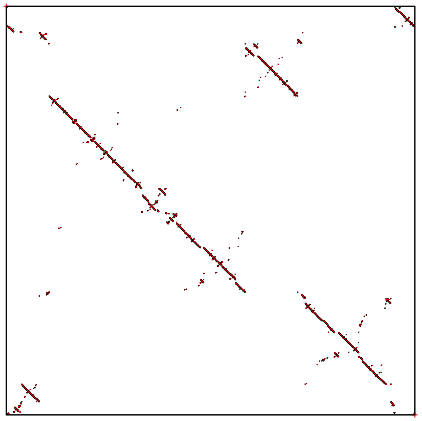


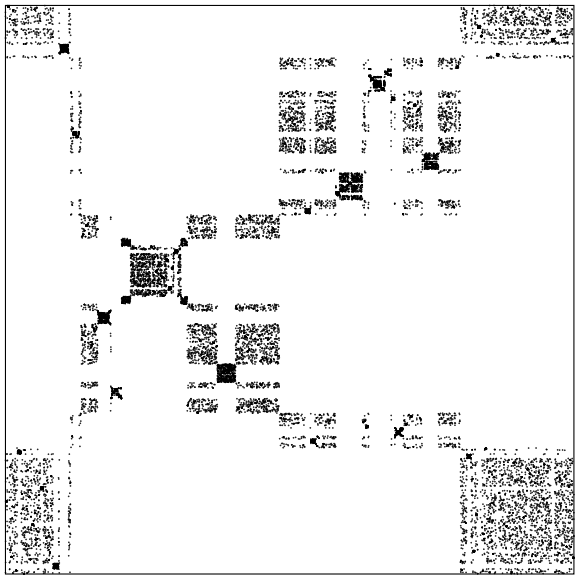
Their limit is the Brownian separable permuton, related to the Brownian excursion or the Continuous Random Tree.

The beauty of randomness, continued and generalized

- Description of permuton limits of substitution-closed classes:

biased Brownian separable permuton, and stable permutons.





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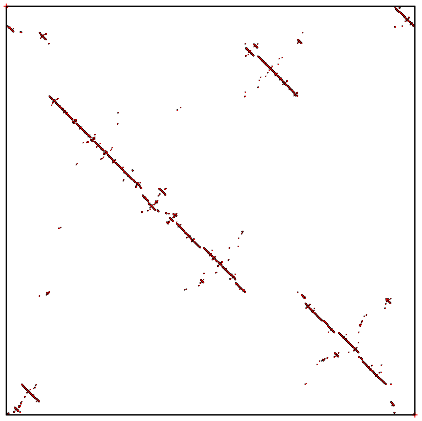

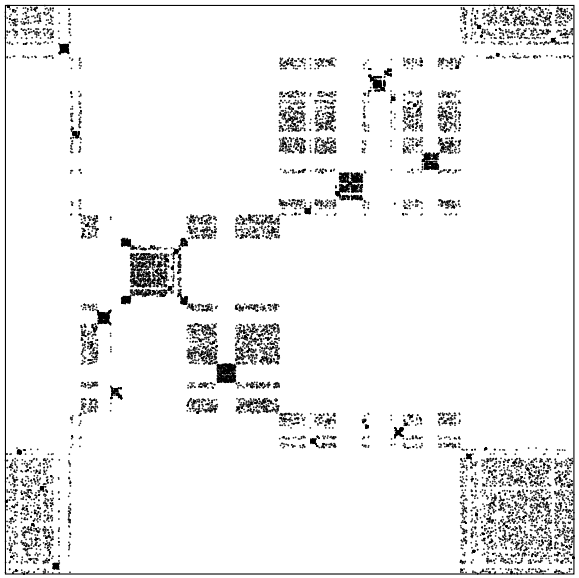

- Alternative notion of convergence: local convergence.

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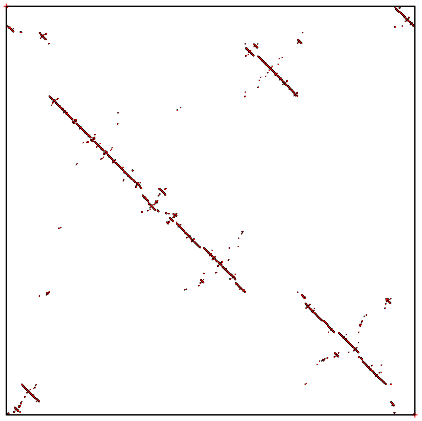

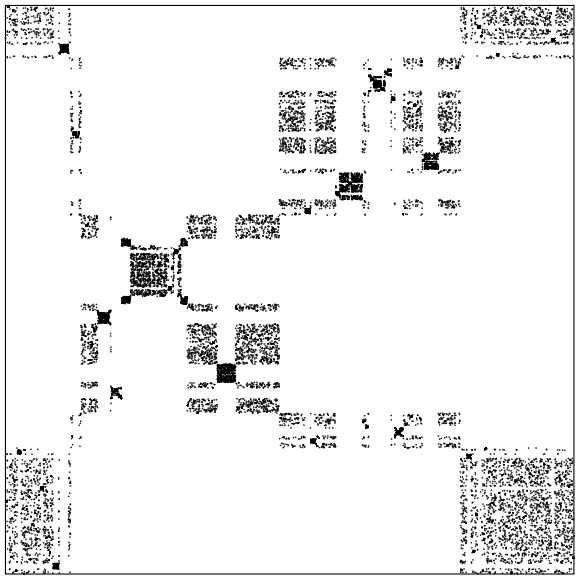

• Alternative notion of convergence: local convergence.

This is the topic of the PhD thesis of Jacopo Borga.

2013 - 2017: Nothing has changed...

I still work with permutations and patterns...

2013 - 2017: . . . but everything has changed!

I still work with permutations and patterns. . .

At work

Created with NuageDeMots.fr

MHV prize

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At work

Created with NuageDeMots.fr

MHV prize

At home

$2 + 1 + 1$

What's next?

2017-2019:

- Continue to enjoy Zurich and UZH
- Continue to advise students:

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- SNF project about non-uniform random permutations

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For ever:
- Keep good balance between work and home, and continue to enjoy family life

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