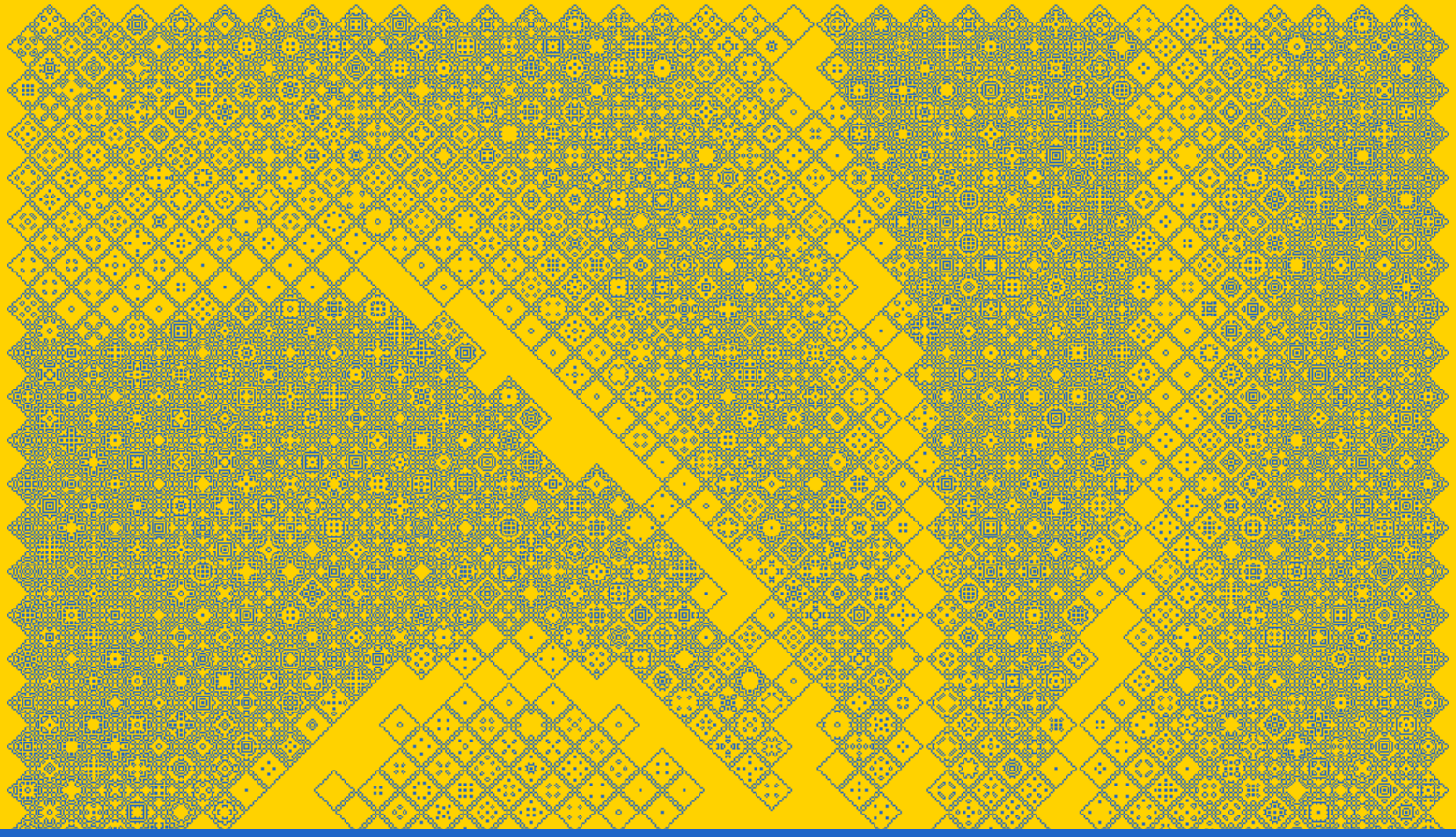
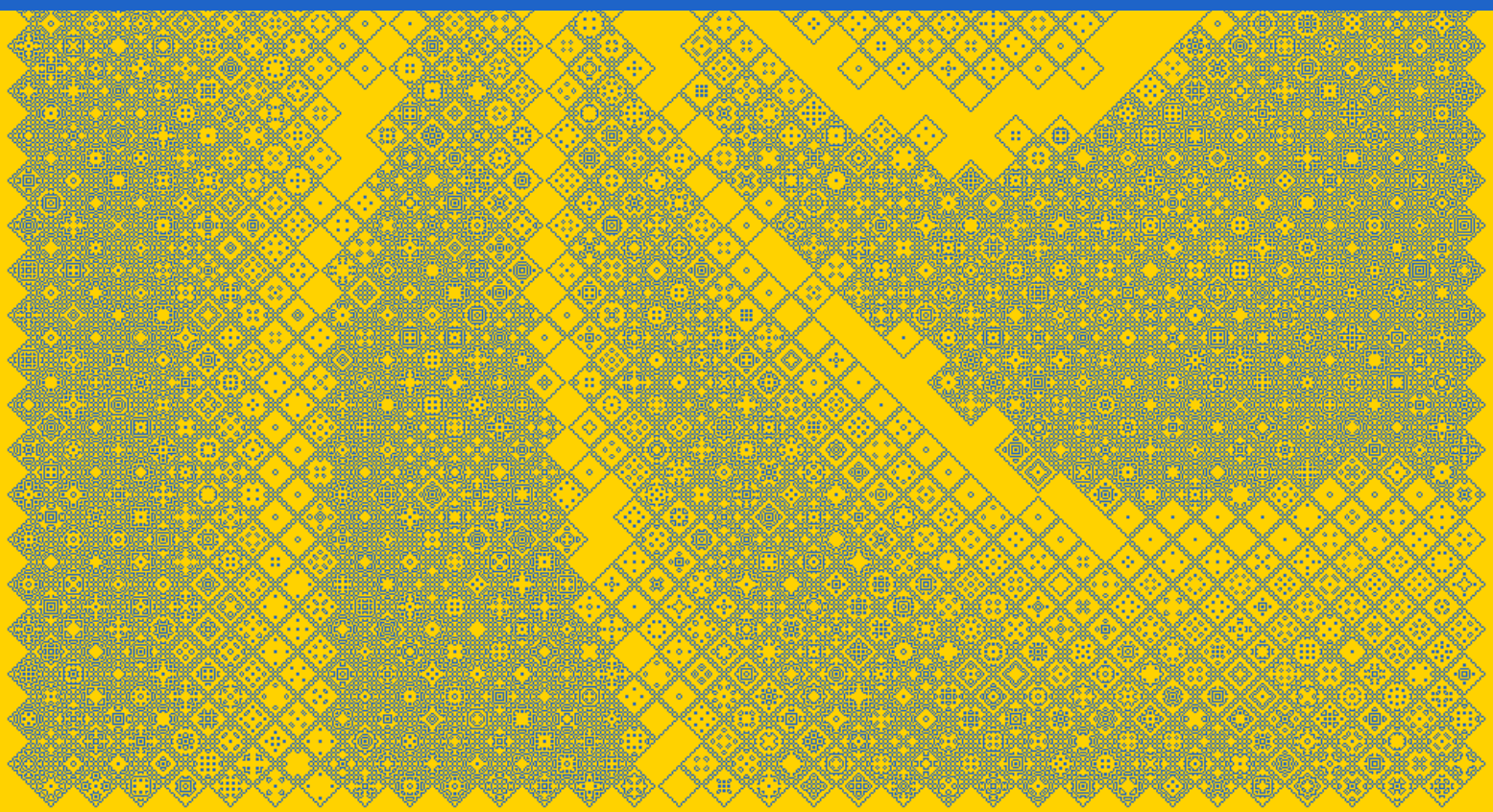


AUTOMATA & ACRI 2026

The two leading conferences on cellular automata join forces

6–10 July 2026

Ghent University & University of Gdańsk



AUTOMATA & ACRI 2026

Conference booklet

Conference booklet. Prepared for the joint AUTOMATA & ACRI 2026 conference. This conference is held in Ghent, Belgium, from 6 to 10 July 2026. The Organising Committee is chaired by Jan M. Baetens (ACRI) and Barbara Wolnik (AUTOMATA).

Design. Michiel Rollier (booklet and website) and Jeroen Galle (website).

Editorial. Content provided and edited by Michiel Rollier, Maciej Dziemiańczuk, and Barbara Wolnik.

Publication note. This booklet is a conference programme and abstract booklet; it is not a proceedings volume. The full papers associated with the conference are published separately in the Springer proceedings in the Lecture Notes in Computer Science series, subject to the applicable editorial and review process.

Cover design. The cover artwork was generated using an optimisation-art algorithm by Robert Bosch, as described in *Opt Art: From Mathematical Optimization to Visual Design* (Princeton University Press, 2019), and developed further by Michiel Rollier in the GitHub repository `mrollier/game-of-life-mosaics`.

Version. This is the digital version last updated on July 5, 2026. The physical version is identical except for its A5 page format and the omission of non-invited abstracts.

Further information. Programme updates and practical information are available at `https://automataandacri2026.ugent.be`

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i Introduction

It is our great pleasure to welcome you to AUTOMATA & ACRI 2026, a landmark event that brings together, for the first time, two of the most established and influential conference series in the field of cellular automata and discrete dynamical systems. Taking place in Ghent, Belgium, from 6 to 10 July 2026, this joint edition represents a unique opportunity to unite communities that have been advancing the theory, applications, and interdisciplinary impact of cellular automata for decades.

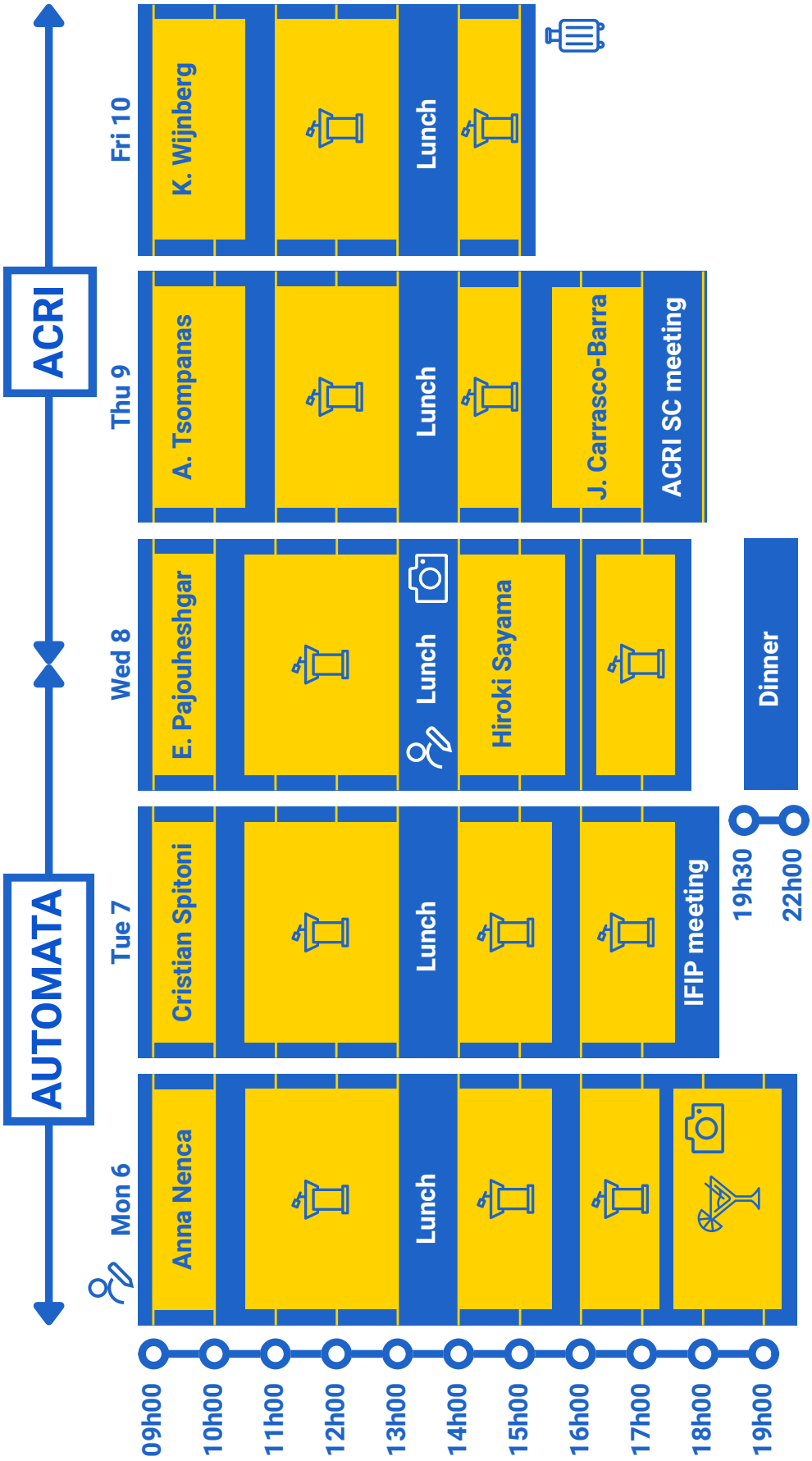
The year 2026 marks the 32nd edition of the International Workshop on Cellular Automata and Discrete Complex Systems (AUTOMATA), the official conference of IFIP Working Group 1.5 on Cellular Automata and Discrete Complex Systems. At the same time, it celebrates the 17th edition of the International Conference and School "Cellular Automata for Research and Industry" (ACRI), a conference renowned for fostering dialogue between fundamental research and practical applications. By joining forces, AUTOMATA and ACRI create a shared platform where established scholars, early-career researchers, and industry practitioners can exchange ideas, present new results, and explore emerging directions in the study of complex discrete systems.

This historic first joint edition is the result of a close collaboration between the Faculty of Mathematics, Physics and Informatics of the University of Gdańsk and the Faculty of Bioscience Engineering of Ghent University. We are deeply grateful to all authors, reviewers, keynote speakers, sponsors, and members of the organising and programme committees whose dedication has made this event possible. Above all, we thank the participants whose contributions form the heart of this conference. We hope that the coming days will provide not only stimulating scientific discussions and valuable insights, but also opportunities to establish new collaborations, strengthen existing partnerships, and celebrate the vibrant international community that continues to shape the future of cellular automata research.

ii Programme overview

You may find the detailed programme of this joint conference in chapters 1 to 5 in this booklet, and on the website.

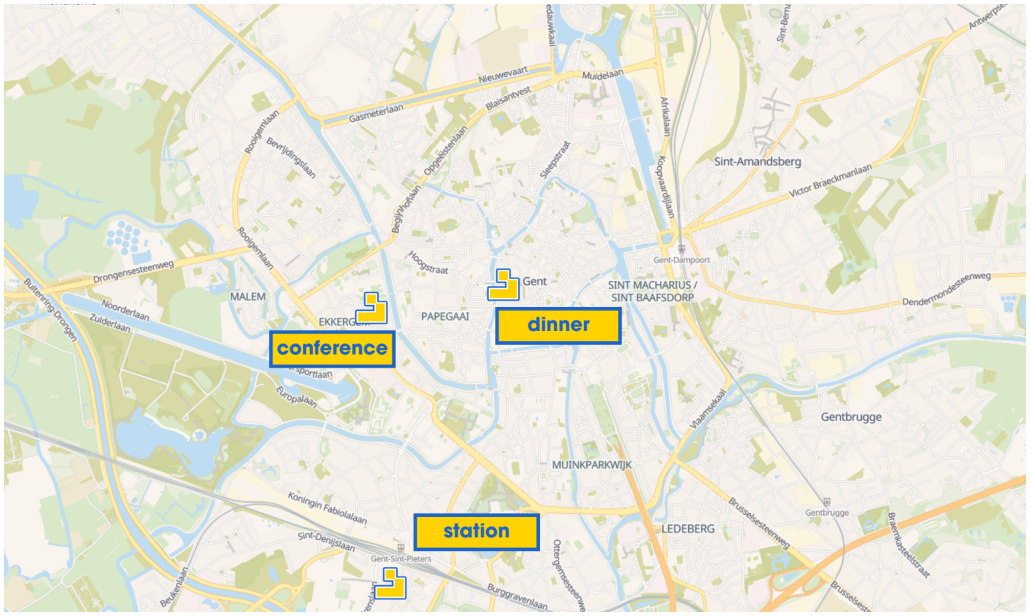
A diagram of the schedule is included on the next page for your convenience. We included the names of the invited speakers, and indications of lunch, welcome cocktails, and the conference dinner. The little icons represent the optimal moment to register upon arrival, moments reserved for group photos, and of course blocks for contributed talks.


AUTOMATA
ACRI
Mon 6
Tue 7
Wed 8
Thu 9
Fri 10
Anna Nenca
Cristian Spitoni
E. Pajouheshgar
A. Tsompanas
K. Wijnberg
Lunch
Hiroki Sayama
J. Carrasco-Barra
ACRI SC meeting
IFIP meeting
Dinner
19h30
22h00
09h00
10h00
11h00
12h00
13h00
14h00
15h00
16h00
17h00
18h00
19h00

iii Locations

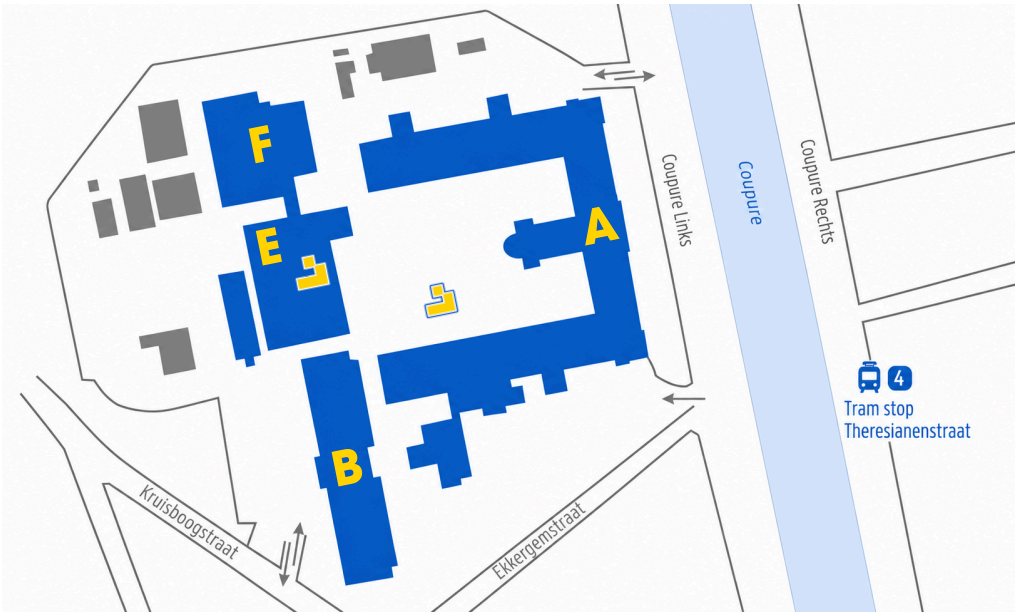
Three key locations in Ghent

You will probably arrive by train in the station of Gent-Sint-Pieters (“Gand-Saint-Pierre” in French) in the south of the city. The conference itself takes place at Ghent University’s faculty of Bioscience Engineering, at a twenty minute walk west from the middle of the city. The conference dinner is located in the historical centre. These locations are indicated with gliders in the map below.



Conference venue

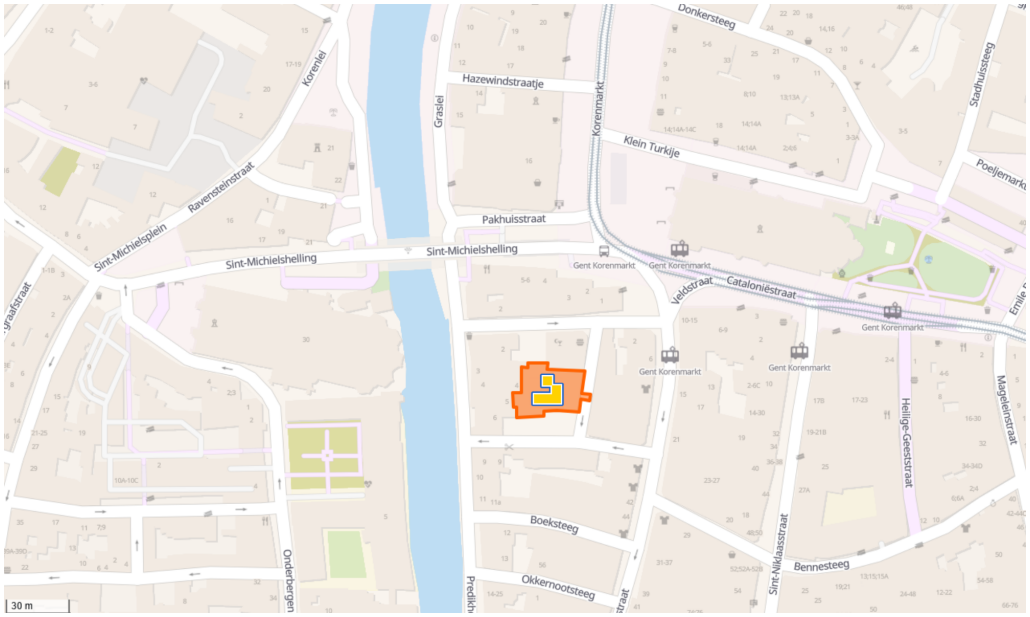
Registration, talks, coffee breaks, lunch, and the welcome cocktails will all take place in the same area at the faculty of Bioscience Engineering, Coupure Links 653, 9000 Ghent, Belgium.



All invited and contributed talks take place in *Auditorium E2* (room code E1.012), on the first floor on the northern side of Block E. Registrations, coffee breaks, lunch and the welcome cocktails take place in *Agora*, the large open space on the the ground floor of Building E. Weather permitting, we will also be found in the central garden enclosed by Blocks E and A.

Dinner venue

In case you registered for the conference dinner, we meet in the city centre on Wednesday evening at 19h30, in *Brasserie Pakhuis* (`www.pakhuis.be`). This unique restaurant is located in Schuurkenstraat 4, 9000 Ghent, between Saint Michael's Church and Saint Nicholas' Church, in the historical bull's eye of our medieval town. We indicated the location with a glider in the map below.



iv Food and drinks

Lunch and coffee breaks

We provide a *coffee break* in the morning and in the afternoon, and a *lunch* at noon, all included in your registration fee. Weather permitting, this is served in the faculty's central garden; otherwise we move to the ground floor of building E. Sweets and snacks during coffee breaks are provided by Patinnerie (`www.patinnerie.be`). Lunch is taken care of by Luncherie (`https://luncherie.be`). Please inform us of any allergies or other food restrictions.

Welcome cocktails

Cocktails – also included in your registration fee – will be served on Monday evening right after the final lecture and the group photo, scheduled at 17h15. Some welcoming drinks in (hopefully) the lovely evening sun will help us to wind down after an intense first day, to reconnect with old friends, and get to know inspiring new like-minded researchers. Power mixers Lisa and Mati prepared one type of non-alcoholic cocktail, and two alcoholic ones. The pop-up bar is open until 19h30.

Conference dinner

On Wednesday evening at 19h30, we convene at *Brasserie Pakhuis* in our antique city's historical centre. Note that the conference dinner is *not* included in the default registration; if you registered for the dinner, you will receive a token in your welcome bag, granting you access to the restaurant. In case you are curious about the Belgian cuisine, you may already take a look at their website, at `www.pakhuis.be`.

v Additional practical matters

Access to full papers

Accepted full papers for AUTOMATA and ACRI 2026 will be included in their respective proceedings published by Springer in the Lecture Notes in Computer Science series *after* the conference. Preprints of full papers, exploratory papers, and extended abstracts are available for downloading between the first and last day of the conference, using the links below and the password found in the printed version of this booklet. The QR codes on the next page link to `https://automataandacri2026.ugent.be/`*

*fullpapers-automata

*exp-and-ext-automata

*fullpapers-acri

*exp-and-ext-acri

Time management

Out of respect for other speakers, we ask that you keep to the assigned time slots. The session chair will visually remind you when you are nearing the end of your slot. Different contributions receive different time limits for the lecture and the subsequent Q&A, as listed below.

Type	Lecture time + Q&A time
Invited Speaker	50 + 10 minutes
Workshop	90 minutes (questions throughout)
Full Paper	25 + 5 minutes
Exploratory Paper	15 + 5 minutes
Extended Abstract	15 + 5 minutes

Website

You may find all information on the conference website. Go to `https://automataandacri2026.ugent.be`, or simply scan the QR code below.

Make your own Game of Life mosaics

Do you want to create your own Game of Life mosaic, the visual theme of this joint conference? Go to the web app via either the Art tab on the conference website, the Hugging Face app at tinyurl.com/gol-mosaics, or by scanning the QR code below. Upload an image (ideally without background) and download the still-life rendering of your favourite picture. Let us know what you think!

WiFi

If possible, please connect to `eduroam`. Otherwise, you may connect to the UGentGuest network. Login details are found in the printed version of this booklet, which you receive in your welcome bag when checking in.

Group photo

We would like to capture this unique happening by taking a number of group photos. We will snap a picture on *Monday evening* right before the welcome cocktails, in the faculty's central garden, around 17h15. Next, on *Wednesday right after lunch* (around 13h45). Please inform the Organising Committee if you are not comfortable with your photo being taken.

Tourist information

We highly recommend you pay a visit to the remarkable city centre of Ghent. Browse the tourism website `https://visit.gent.be/en` to get inspired, or download the official city guide by scanning the QR code below.

How about a visit to Gravensteen, the castle of the counts? Or a three-kilometre walk in the magical evening landscape? An ideal moment for that would be Tuesday evening or Thursday evening. We encourage you to go and discover the city together, so make sure to share your plans with fellow conference attendees. In doubt? Ask the Organising Committee for tips!

vi Sponsors

This conference would not be possible without our most valued sponsors, Jit Team and the Research Foundation Flanders (FWO).

Jit Team

Jit Team: *"We provide complete software development teams, who will take complex care of your software. We are experienced in building teams uniquely suited to the specific needs of our clients. One team - a range of skills, diverse personalities, and various approaches."*
⟶ Discover how they do so on `https://jit.team`.

fwo

FWO: *"The FWO aims to be the leading funding partner for researchers in Flanders. By offering financial support and promoting international cooperation, we create a favourable climate for world-class scientific research."*
⟶ Find out more on `www.fwo.be/en`.

vii Contact the organising committee

General

For general questions and requests, please contact `automataandacri2026@ugent.be`.

Organising committee

The Organising Committees of AUTOMATA & ACRI 2026 consist of the following members:

AUTOMATA (University of Gdańsk)	ACRI (Ghent University)
Barbara Wolnik	Jan Baetens
Anna Nenca	Timoteo Carletti (UNamur)
Dominik Falkiewicz	Michiel Rollier
Maciej Dziemiańczuk	Wouter Vervust
	Ruth Van den Driessche
	Jeroen Galle
	Timpe Vogelaers

Urgent

Please only use these modes of contact for delicate or urgent matters.

Contact	Number or email address
Jan Baetens (ACRI)	`jan.baetens@ugent.be`
	+32 9 264 58 66
Barbara Wolnik (AUTOMATA)	`barbara.wolnik@ug.edu.pl`
Michiel Rollier (local tips & tricks)	`michiel.rollier@ugent.be`
	+32 456 24 45 81
Emergency telephone number	112

AUTOMATA

1. Monday, July 6th

The registration desk will be open today from 08h30 to 13h00.

1.1 Morning: 09h00—10h00

Chair Bernard De Baets

1.1.1 AUTOMATA opening

09h00
09h10

The chair of this year's AUTOMATA Organising Committee, Barbara Wolnik, welcomes the attendees.

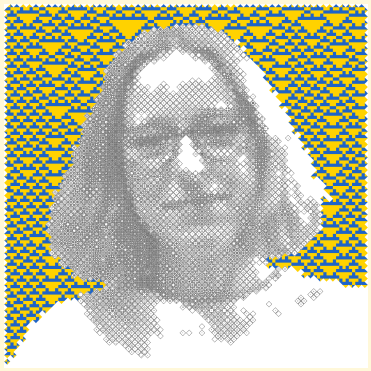
1.1.2 INVITED SPEAKER: Anna Nenca – *Exploring the rule space for the parity problem in cellular automata*

09h10
10h00

Type Invited Speaker (with full paper)
Authors Anna Nenca[1]
Affiliation [1]University of Gdańsk (Poland)

ABOUT THE SPEAKER

Dr. Nenca is a researcher at the University of Gdańsk (Poland), working within the Institute of Informatics at the Faculty of Mathematics, Physics and Informatics.



Keywords
Cellular automata · parity problem · discrete complex systems

Abstract
The parity problem explores whether a one-dimensional cellular automaton can determine if the number of ones in a configuration is even or odd, converging to a homogeneous final state of all zeros or all ones. Although simple in formulation, this problem highlights deep constraints on how local interactions can give rise to global computation. The talk will show how studying different neighborhood sizes helps understand the system's behavior, the spread of information, and the challenges of designing local rules that reliably lead to a homogeneous final configuration.

COFFEE BREAK

1.2 Morning: 10h30—13h00

Chair Franco Bagnoli

1.2.1 Harrison Fisher – *On a theorem of Marchetto and Richard*

10h30
11h00

Type Full Paper
Authors Harrison Fisher[1] & Matthew Macauley[1]
Affiliation [1]Clemson University (USA)

Keywords
Boolean network · fully coupled · forcing motif · interaction graph

Abstract
We prove that all 1.84×10^{19} Boolean networks on four variables, other than the identity and constant networks, are isomorphic to a network with a complete interaction graph. This resolves a question of Marchetto and Richard, who confirmed it for networks on three variables by brute force, and gave a uniform proof for networks on $n \geq 5$ variables.

1.2.2 Luidnel Maignan – *On the Quotient of the Space of Configurations*

11h00
11h30

Type Full Paper
Authors Luidnel Maignan[1] & Antoine Spicher[1]
Affiliation [1]Univ Paris Est Creteil (France)

Keywords
Space of Configurations · Grothendieck Topology · Site of Finite Words

Abstract
We investigate the quotient of the configuration space of cellular automata induced by the shift action. To overcome the limitation induced by a direct quotient of topological spaces (which fails to retain the relative positioning), we adopt a categorical perspective based on Grothendieck topologies and sites. In this framework, we introduce the site of *finite words* and show that its category of points is equivalent to the action groupoid of the shift. This equivalence provides a refined notion of quotient that preserves the full symmetry structure of configurations.

1.2.3 Nazim Fatès – *On Sisyphean cellular automata: rules with proper cycles and no shifting configuration*

11h30
12h00

Type Full Paper
Authors Nazim Fatès[1] & Anna Nenca[2]
Affiliation [1]Université de Lorraine (France), [2]University of Gdańsk (Poland)

Keywords
Cellular automata · shifts and cycles · homogenising rules

Abstract
We consider one-dimensional cellular automata rules with periodic boundary conditions. It is known that a binary rule with two non-quiescent states necessarily possesses a mixed (i.e., non-homogeneous) shifting configuration but what is the situation for the other cases? We ask if there are rules which do not contain any mixed shifting configuration and which nevertheless contain at least one proper cycle, that is, a cycle of length greater or equal to 2. Such shift-avoiding rules are called Sisyphean and are quite rare. We observe that there is no Sisyphean rule among the 256 elementary cellular automata but there are 11 candidates among the 16704 non-equivalent rules neighbourhood of size 4. We prove this property for ten rules and leave the case open for the eleventh rule.

1.2.4 Luca Mariot – *How to reconstruct (anonymously) a secret cellular automaton*

12h00
12h30

Type Full Paper
Authors Luca Mariot[1], Federico Mazzone[1], Luca Manzoni[2] & Alberto Leporati[3]
Affiliation [1]University of Twente (the Netherlands), [2]University of Trieste (Italy), [3]University of Milano-Bicocca (Italy)

Keywords
Cellular automata · anonymous secret sharing schemes · mutually orthogonal Latin squares · parallel classes · bipermutivity · de Bruijn graphs

Abstract
We consider threshold secret sharing schemes based on cellular automata (CA) that allow for anonymous reconstruction, meaning that the secret can be recovered only as a function of the shares, without knowing the participants' identities. To this end, we revisit the basic characterization of $(2,n)$ threshold schemes based on CA in terms of Mutually Orthogonal Latin Squares (MOLS), and redefine the secret space as the MOLS family itself, showing that the new resulting scheme enables anonymous reconstruction of secret CA rules. Finally, we discuss the trade-off between the number of secret CA that can be shared and the computational complexity of the recovery phase.

1.2.5 Buffer

12h30
13h00

An ample 30-minute buffer in case we are delayed, for checking your e-mails, or for expanding your network.

LUNCH BREAK

1.3 Afternoon: 14h00—15h30

Chair Kamalika Bhattacharjee

1.3.1 Rolf Hoffmann – *Evaluation of Update Rules for Parity Checking by Asynchronous Cellular Automata*

14h00
14h20

Type Exploratory Paper
Authors Gerhard Hasslinger[1], Ulrich Schachner[1] & Rolf Hoffmann[1]
Affiliation [1]TU Darmstadt (Germany)

Keywords
Asynchronous cellular automata · parity check · update rule · convergence process · Markov state model

Abstract
We investigate novel aspects of asynchronous Cellular Automata (CA) in a broad scope of rule variants for solving the parity problem. Given a one-dimensional binary vector, the task is to determine whether the parity over all bits is even or odd. Therefore, the convergence of an update process is studied with local updates on 2-, 3- or 4-bit neighborhood pattern following a uniform, parity preserving rule. We assume asynchronous random updates according to a Markov process, which is evaluated via simulation and analytical means. We compare and optimize rule variants regarding their convergence to two different final states, which indicate even versus odd parity. Beyond the all-one and all-zero configurations, we widen the scope to other final states and we include acyclic rule applications, which lead to promising convergence properties.

1.3.2 Barbora Hudcová – *Flavours of Self-Replication*

14h20
14h40

Type Extended Abstract
Authors Barbora Hudcová[1]
Affiliation [1]École Polytechnique Fédérale de Lausanne (Switzerland)

Keywords
Self-replication · Turing completeness · Cellular automata

Abstract
Kleene's recursion theorems imply that every Turing-complete language admits quines: programs that reproduce their own source code. Such programs have often served as a basis for examples of artificial self-replication. In contrast stands von Neumann's seminal construction of a non-trivial self-replicator in a cellular automaton, a result that anticipated

key abstract principles of biological replication before the discovery of DNA's structure and helped establish cellular automata as a widely studied family of dynamical systems. This dichotomy raises fundamental questions about the nature of self-replication: what conditions must be satisfied for self-replication to be non-trivial? Does every Turing-complete system satisfy them, and hence automatically facilitate non-trivial self-replication? And in what sense is von Neumann's self-replicator stronger than a quine? In this talk, I answer these questions based on joint work with Jordan Cotler and Clément Hongler on self-replication and computational universality.

1.3.3 Alejandro Vázquez-Aceves – *A categorical framework for cellular automata*

14h40
15h00

Type Extended Abstract
Authors Alejandro Vázquez-Aceves[1], Alonso Castillo-Ramirez[1] & Angel Zaldiva Corichi[1]
Affiliation [1]Universidad de Guadalajara (Mexico)

Keywords
Cellular automata · Generalized cellular automata · Category theory · Categorical product · Curtis-Hedlund-Lyndon theorem

Abstract
This paper proposes a generalized framework for cellular automata using the language of category theory, extending the classical definition beyond set-theoretic constraints. For an arbitrary category C with products, we define C-cellular automata as morphisms $\tau : A^G \to B^G$ in C, where the alphabets A and B are objects in C and the universe is a group G. We show that C-cellular automata form a subcategory of C closed under finite products, and that they satisfy a categorical version of the Curtis-Hedlund-Lyndon theorem. For two arbitrary group universes G and H, we extend our theory to define generalized C-cellular automata as morphisms $\tau : A^G \to B^H$ constructed via a group homomorphism $\phi : H \to G$. Finally, we prove that generalized C-cellular automata form a subcategory of C with a finite weak product involving the free product of the underlying group universes. This framework unifies existing concepts and provides purely categorical proofs of foundational results in the theory of cellular automata.

1.3.4 Jonas Mlinar – *Topological Entropy and Universal Cellular Automata*

15h00
15h20

Type Extended Abstract
Authors Jonas Mlinar[1] & Barbora Hudcová[1]
Affiliation [1]École Polytechnique Fédérale de Lausanne (Switzerland)

Keywords
Cellular Automata · Global Intrinsic and Local Universality · Topological Entropy

Abstract
Modern cellular automata theory distinguishes two genuinely different notions of computational capacity: local universality and global universality. The latter is known to be a strictly stronger property, as no reversible cellular automaton can be globally universal, whereas reversible locally universal cellular automata do exist. Our results further explore the gap between these fundamental computational classes, for which general structural results remain scarce. We introduce a new independent separation through topological entropy. We prove that, in dimension one, there exist locally universal cellular automata with zero topological entropy, while no globally universal cellular automaton can have zero topological entropy. In each dimension larger than one, every globally universal cellular automaton must even have infinite topological entropy. Topological entropy thus links an asymptotic property from topological dynamics with the computational-theoretic notions of universality for cellular automata.

1.3.5 Buffer

15h20
15h30

A modest 10-minute buffer in case we are delayed.

COFFEE BREAK

1.4 Afternoon: 16h00—17h15

Chair Luca Mariot

1.4.1 Dominik Falkiewicz – *Surprisingly complex number-conserving binary Moore neighborhood cellular automata*

16h00
16h20

Type Exploratory Paper
Authors Dominik Falkiewicz[1], Witold Bołt[2], Barbara Wolnik[1,3], Adam Rutkowski[1] & Bernard De Baets[3]
Affiliation [1]University of Gdańsk (Poland), [2]Jit Team (Poland), [3]Ghent University (Belgium)

Keywords
Cellular automata · Number conservation · Moore neighborhood

Abstract
Until recently, only few number-conserving binary Moore neighborhood cellular automata had been known. Last year we presented the (Ω,Λ) framework that allows one to generate hundreds of thousands of such rules, with the additional advantage of providing a simple and consistent way to interpret changes in the cellular space as movements of individually identifiable ones that could represent physical particles. Since then, using a recursive algorithm, we managed to generate all number-conserving binary 2-dimensional Moore neighborhood cellular automata. In this paper, we present examples of number-conserving rules that fall outside of the (Ω,Λ) framework and exhibit surprisingly complex behavior.

1.4.2 Akiko Fukuda – *Second-order three-neighbor number-conserving cellular automata*

16h20
16h40

Type Extended Abstract
Authors Akiko Fukuda[1], Sennosuke Watanabe[2], Yuki Nishida[3] & Junta Matsukidaira[4]
Affiliation [1]Shibaura Institute of Technology (Japan), [2]The University of Fukuchiyama (Japan), [3]Kyoto Prefectural University (Japan), [4]Ryukoku University (Japan)

Keywords
Second-order CA · Number-conserving · Discrete flux form

Abstract
In this study, number-conserving rules in second-order binary three-neighbor cellular automata are investigated. A polynomial representation of the local rules and its general expression are presented. Using this representation, the number-conservation condition is transformed into a system of linear equations. Solving this system under binary constraints reveals that 74 of the 2^{64} possible rules satisfy the number-conservation property. Furthermore, these rules are classified into 30 equivalence classes under standard equivalence relations. In addition, a necessary and sufficient condition for a cellular automaton to be number-conserving is derived.

1.4.3 Mikołaj Czyżak – *Dynamical complexity of state-conserving cellular automata with a four-cell neighborhood: the three-state case*

16h40
17h00

Type Extended Abstract
Authors Mikołaj Czyżak[1], Maciej Dziemiańczuk[1], Barbara Wolnik[1,2] & Bernard De Baets[2]
Affiliation [1]University of Gdańsk (Poland), [2]Ghent University (Belgium)

Keywords
Cellular automata · state conservation · four-cell neighborhood

Abstract
In the talk, we will present the first results of a broader program aimed at characterizing all one-dimensional state-conserving CAs with four-cell neighborhoods. As an initial step, we investigate in detail the case in which the state set consists of three elements. Particular attention will be devoted to the mathematical framework used in our analysis, especially techniques involving partially ordered sets and maximal independent sets of suitably defined graphs. We derive a concise structural characterization that not only explains the appearance of this number, but also clarifies several aspects of the global dynamics generated by these automata.

1.4.4 Buffer

17h00
17h15

A modest 15-minute buffer in case we are delayed.

After today's final speaker, two more activities take place: a group photo, followed by welcome cocktails. Cocktails are served in the central garden between 17h15—19h30. The group photo of all attendees and organisers is taken around 17h15 in the central garden.

2. Tuesday, July 7th

2.1 Morning: 09h00—10h00

Chair Nazim Fatès

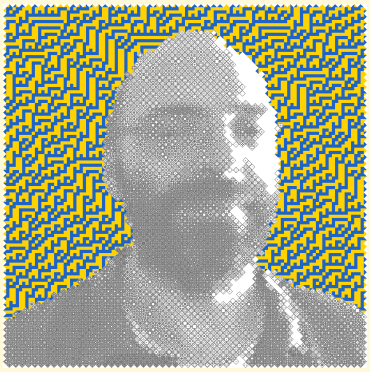
2.1.1 INVITED SPEAKER: Cristian Spitoni – *Topology, noise, and parallel updates in circular opinion dynamics*

09h00
10h00

Type Invited Speaker (with full paper)
Authors Wioletta M. Ruszel[1] & Cristian Spitoni[1]
Affiliation [1]Utrecht University (the Netherlands)

ABOUT THE SPEAKER

As a researcher at the Mathematical Department of Utrecht University (the Netherlands), Dr. Spitoni is engaged with the fundamental aspects of opinion dynamics.



Keywords
Opinion dynamics · Topological winding states · Bi-modal noise · Symmetry breaking

Abstract
We study a circular opinion dynamics model with local midpoint interactions, extended to allow parallel updates of multiple sites. On a ring, the dynamics admits twisted states associated with integer winding numbers. We investigate how bi-modal noise, which drives opinions toward two antipodal directions, affects these configurations. Numerically, we find that noise both destabilizes winding states and induces a spin–flop regime, characterized by macroscopic switching between preferred orientations. We introduce order parameters that distinguish topological trapping from symmetry breaking, providing a simple macroscopic description of the dynamics.

COFFEE BREAK

2.2 Morning: 10h30—13h00

Chair Anna Nenca

2.2.1 Kamalika Bhattacharjee – *Cellular Automata based Multi-Stream Parallel Combined Pseudo-Random Number Generators*

10h30
11h00

Type Full Paper
Authors Bhuvaneswari Arumugam[1] & Kamalika Bhattacharjee[2]
Affiliation [1]National Institute of Technology (India), [2]Indian Institute of Engineering Science and Technology (India)

Keywords

Combined CA-based PRNG · Multi-stream PRNG · Period · Maximal Equidistribution · Efficiency · jumping-ahead

Abstract

This work introduces multi-stream combined CAs-based PRNGs for the current 32-bit and 64-bit GPU architectures that generate pseudo-random numbers in a parallel manner using a multi-threading approach. The period of the PRNGs is close to maximal and is divided into s equal-length non-overlapping streams where all streams generate random numbers in parallel using jumping-ahead technique. We show that these PRNGs are extremely fast, have a small internal state to fit inside the GPUs and achieve uniformity in almost all possible dimensions which is not available in existing multi-stream PRNGs. These features make the proposed PRNGs well suited for high-performance computing.

2.2.2 Pablo Concha-Vega – *Non-Uniform and Weighted Crossing Gates in Two-Dimensional Sandpiles*

11h00
11h30

Type Full Paper
Authors Pablo Concha-Vega[1], Antonin Loubière[1,2] & Kévin Perrot[1]
Affiliation [1]Aix Marseille Université (France), [2]École normale supérieure Paris-Saclay (France)

Keywords

Sandpile models · Discrete dynamical systems · Computational complexity · Crossing gates

Abstract

Determining whether predicting two-dimensional sandpiles lies in *NC* or is P-complete has been open for decades. Moore and Nilsson proved P-completeness for the three dimensional case by encoding Boolean circuits into sandpiles, but this method fails in two dimension due to the impossibility of crossing gates. In this work, we study the existence of crossing gates on non-uniform and weighted grids. We establish an equivalence between uniform weighted crossing gates and a class of simple non-uniform crossing gates, which we call primal. We also exhibit a crossing gate that inherently requires more than one crossing, rather than a single crossing as in standard constructions. Finally, we show that the equivalence between uniform weighted and primal crossings breaks down in more general settings.

2.2.3 Sukanta Das – *A Study on Homo-Asynchronous Cellular Automata*

11h30
12h00

Type Full Paper
Authors Sukanta Das[1]
Affiliation [1]Indian Institute of Engineering Science and Technology (India)

Keywords

Cellular automata · Homogeneous configuration · Homogeneous component · Homo-asynchronism · Normal form · Convergence

Abstract

This work studies a new type of asynchronism, called *homo-asynchronism*, on cellular automata. A configuration of a one-dimensional cellular automaton can be decomposed into a number of homogeneous components. Homo-asynchronous refers to asynchronous update of the homogeneous components to evolve the automaton. In this study, we assume that exactly one homogeneous component is chosen uniformly and randomly for the update at each step. To identify the constituent homogeneous components of a configuration, this work introduces the *normal forms* of the configurations. Finally, the work reports a preliminary study on the convergence of homo-asynchronous cellular automata to fixed points.

2.2.4 Andrea Sportiello – *An Abelian process for random bicolourations of graphs*

12h00
12h30

Type Full Paper
Authors Andrea Sportiello[1]
Affiliation [1]Université Paris Nord (France)

Keywords
Abelian Processes · Rewriting Systems · Percolation Processes · Critical Phenomena

Abstract
We introduce a process on graphs equipped with a total ordering of the vertices, that at each step remove a local minimum, and its smallest neighbour, and modify the graph according to some rule. We identify a rule that makes the process abelian, that is, the order by which local minima are removed does not affect the outcome of the procedure (in this case, the list of vertices removed as minima, and its complement). On top of this, the modification of the graph can be encoded by an auxiliary structure (a matching) that is local. Several challenging algorithmic questions are in order: what is the worst-case complexity for determining the bicolouration? If a graph with $2n$ vertices, and a set of n minima, are given, how can we sample efficiently among the orderings such that the outcome has the prescribed set of minima? And, to start with, is the set of such orderings non-empty? We address these questions in this paper, and answer positively to the latter.

2.2.5 Buffer

12h30
13h00

An ample 30-minute buffer in case we are delayed, for checking your e-mails, or for expanding your network.

LUNCH BREAK

2.3 Afternoon: 14h00—15h30

Chair Barbora Hudcová

2.3.1 Bartosz Makuracki – *Simple representation of a large class of non-uniform cellular automata*

14h00
14h20

Type Extended Abstract
Authors Bartosz Makuracki[1], Barbara Wolnik[1,2], Maciej Dziemiańczuk[1] & Bernard De Baets[2]
Affiliation [1]University of Gdańsk (Poland), [2]Ghent University (Belgium)

Keywords
Non-uniform cellular automata · number conservation · finite grids

Abstract
We constructed a directed labeled graph with only 36 vertices that characterizes all number-conserving one-dimensional binary non-uniform cellular automata with the four-cell neighborhood, for all finite grids of length at least seven.

2.3.2 Katariina Paturi – *Minimality, transitivity and sensitivity of non-uniform cellular automata*

14h20
14h40

Type Extended Abstract
Authors Supreeti Kamilya[1], Jarkko Kari[2] & Katariina Paturi[2]
Affiliation [1]Birla Institute of Technology (India), [2]University of Turku (Finland)

Keywords
Non-uniform cellular automata · Odometer · Adding machine · Minimality · Sensitivity · Transitivity

Abstract
Every transitive cellular automaton (CA) is sensitive to initial conditions. We study this implication in the more general context of non-uniform cellular automata (NUCA) with finitely many different local update rules assigned to cells. We introduce an odometer NUCA on $\{0,1,2\}^{\mathbb{N}}$ which is nearly uniform in the sense that only the first cell uses a different local rule. This can be used to construct a two-dimensional NUCA that is minimal – and hence transitive – but that is not sensitive to initial conditions. Additionally we find that if the assignment of local rules in the cells is recurrent then transitivity implies sensitivity.

2.3.3 Pietro Di Lena – *Classifying Asynchronous Elementary Cellular Automata with the 0–1 Test for Chaos*

14h40
15h00

Type Exploratory Paper
Authors Pietro Di Lena[1] & Nicola Travaglini[1]
Affiliation [1]University of Bologna (Italy)

Keywords
Elementary Cellular Automata · Asynchronous Cellular Automata · 0–1 test for chaos · Chaotic Dynamics

Abstract
We investigate the effect of asynchronous updating on the dynamical behavior of elementary cellular automata (ECA) by means of the 0–1 test for chaos. While the classical theory of cellular automata is based on synchronous evolution, many natural systems are inherently asynchronous. It is therefore interesting to understand how asynchrony affects their qualitative dynamics, in particular whether it induces transitions from chaotic to regular behavior or vice versa. We adopt the experimental framework introduced in (Terry-Jack and O'Keefe, 2023) and extend it to fully asynchronous ECA (AECA): for each rule, we compute the 0–1 test statistic and compare the resulting classification with both its synchronous counterpart and Wolfram's empirical classification (Wolfram, 1984). Our results show that asynchronous updating can significantly alter the dynamical behavior of cellular automata. In particular, several rules that are regular in the synchronous setting exhibit chaotic behavior under asynchronous updates, while some chaotic rules become regular.

2.3.4 Franco Bagnoli – *Coarsening and Bifurcations in Wide-Range Two-Dimensional Totalistic Cellular Automata*

15h00
15h20

Type Exploratory Paper
Authors Franco Bagnoli[1] & Luca Mencarelli[1]
Affiliation [1]University of Florence (Italy)

Keywords
Totalistic cellular automata · coarsening dynamics · bifurcations and phase transitions

Abstract
We investigate Boolean, totalistic cellular automata with a majority or frustrated majority rule, and extended interaction range. These two models show a behavior which differs from the mean-field one. The majority model is characterized by the presence of absorbing states, and there is a related bifurcation according to the initial density, in agreement with the mean-field approximation. For initial density equal to 0.5, however, the dynamics is dominated by coarsening, until clusters with definite curvature radius are established. For the frustrated majority model, the mean-field approximation gives chaotic oscillations or a limit cycle. Instead, we observe active patterns, with stable density. Above a certain critical value for the interacting radius there is a bifurcation of the asymptotic density as a function of the initial one.

2.3.5 Buffer

15h20
15h30

A modest 10-minute buffer in case we are delayed.

COFFEE BREAK

2.4 Afternoon: 16h00—17h30

Chair Sukanta Das

2.4.1 Jose Pablo Llano – *From Unate to Uniform Boolean Networks via Switch Equivalence*

16h00
16h20

Type Extended Abstract
Authors Juan A. Aledo[1], Julio Aracena[2], Jose Pablo Llano[1], Lilian Salinas[2] & Jose C. Valverde[1]
Affiliation [1]Universidad de Castilla-La Mancha (Spain), [2]Universidad de Concepción (Chile)

Keywords
Uniform Boolean networks · Unate Boolean networks · Signed graphs · Switch equivalence · Dynamical isomorphism

Abstract
Unate Boolean networks (BN) can be represented by signed dependency graphs, where the sign of each arc encodes whether one variable has an increasing or decreasing influence on the update of another. Uniform BN are a subclass of

unate BN which includes well-studied families of BN, and which is characterized by a sign-uniformity condition. In this work, we use switch operations on signed graphs to characterize unate BN whose signed dependency graph can be transformed into that of a uniform BN. Since switching preserves dynamics up to isomorphism, the dynamics of such BN can be studied through their uniform (simpler) representatives. We apply our results to published BN models of genetic networks, showing that many heterogeneous models can be analyzed through uniform BN.

2.4.2 Armin Golesch – *Exploring strategies to streamline the development of cellular automata algorithms by reducing neighborhood-dependent calibration*

16h20
16h40

Type Extended Abstract
Authors Armin Golesch[1], Peter Raninger[1] & Thomas Antretter[2]
Affiliation [1]Materials Center Leoben (Austria), [2]Montanuniversität Leoben (Austria)

Keywords
cellular automata · frontal cellular automata · Cahn-Hilliard · neighborhood-dependence · neighborhood calibration · microstructure simulation · Finite Volume method · Monte Carlo transitions · Probabilistic Cellular automata · free-energy change

Abstract
In microstructure simulation using Cellular Automata (CA), the choice of neighborhood prominently influences the behavior of a generic implementation. Moore and von Neumann neighborhoods can yield diverging results, and directional bias may be reduced using pseudo-pentagonal or pseudo-hexagonal neighborhood patterns. The work of Łach and Svyetlichnyy (2024) demonstrates that not only basic implementations, but even advanced hybrid approaches show sensitivity to neighborhood choice. The need for calibration to mitigate numerical artifacts is common in CA literature and the desire to minimize this problem was emphasized by Zhi et al. (2024). This work aims to establish a Frontal Cellular Automata (FCA) framework with coupling to concentration fields via the Finite Volume Method (FVM), while maintaining high adaptability by avoiding reliance on a specific neighborhood type. The core concept is the development of a consistent neighborhood-interpretation scheme based on the Cahn-Hilliard equation. On-demand solutions of the Cahn-Hilliard equation are used for neighborhood interpretation, while relevant integrals are evaluated locally and results are stored for reuse to keep computational cost low. The dependence on neighborhood selection is minimized and a user-friendly system is established. The explicit representation of grain boundaries within a neighborhood enables a tailored evaluation of the free-energy change associated with defined cell transitions, which supports further advances in simulating anisotropic processes. A decoupled treatment of phase/grain pairings is utilized to reduce overall computational time through parallel execution on a HPC cluster. All information regarding specific pairings is computed locally on-demand and stored for reuse.

2.4.3 Marco Montalva-Medel – *Exploratory Results on Fixed Points of Freezing Automata Networks with (α,β)-Type Functions*

16h40
17h00

Type Exploratory Paper
Authors Felipe Chacana[1], Eric Goles[1], Marco Montalva-Medel[1] & Damir Vukicevic[2]
Affiliation [1]Universidad Adolfo Ibáñez (Chile), [2]University of Split (Croatia)

Keywords
Freezing automata network · Boolean network · Cellular automata · Extremal graph theory · Fixed points

Abstract
Freezing automata networks are discrete dynamical systems in which the local update rule permits only the transition from state 0 to state 1, making each activation irreversible. We study a parametric subfamily defined by two thresholds $\alpha,\beta \in \mathbb{N}_0$ with $\alpha \leq \beta$: an inactive vertex activates if and only if the number of its active neighbours lies in the closed interval $[\alpha,\beta]$. Using extremal graph theory, we establish tight upper bounds on the number of fixed points for all connected graphs, identifying complete graphs K_n as extremal for $\alpha \leq 1$ and star graphs S_n for $\alpha = 2$. For four canonical families—paths P_n, cycles C_n, stars S_n, and complete graphs K_n—we derive exact closed-form and recursive formulas, uncovering connections to the Fibonacci, Lucas, and Tribonacci sequences. We complement these results with lower bounds via a correspondence with dominating sets. Finally, we introduce a five-level complexity classification of the resulting formulas, based on the number of previously computed values required for their evaluation.

2.4.4 Jens Tandstad – *Exploration of Non-Local Cellular Automata and Emergent Particle Behaviors*

17h00
17h20

Type Exploratory Paper
Authors Jens Tandstad[1]
Affiliation [1]Independent (Norway)

Keywords
Cellular Automata · Particle · Physics · 3D · Emergence · Tangle · NAGA

Abstract
This exploratory paper investigates the emergent behaviors of a novel class of non-local, stochastic Cellular Automata (CA). The structural evolution is driven by a specialized execution rule, animating the system forward. We demonstrate that interactions between these automata, termed Nagas—including collisions—yield complex dynamic behaviors such as absorption path deflection. Notably, the underlying structures exhibit natural analogues to physical properties such as velocity, momentum, and elastic collisions. This class of systems demonstrates compelling emergent properties, enabling directional propagation at variable angles and velocities while strictly conserving both total cell counts and specific cell types, even during interactions.

2.4.5 Buffer

17h20
17h30

A modest 10-minute buffer in case we are delayed.

Members of IFIP convene in the lecture room between 17h30—18h15. Other attendees are encouraged to visit the beautiful city centre of Ghent!

3a. Wednesday, July 8th

3a.1 Morning: 09h00—10h00

Chair Eric Goles

3a.1.1 INVITED SPEAKER: Ehsan Pajouheshgar – *Learning Self-Organizing Dynamics with Neural Cellular Automata*

09h00
10h00

Type Invited Speaker (with full paper)
Authors Ehsan Pajouheshgar[1] & Sabine Süsstrunk[1]
Affiliation [1]School of Computer and Communication Sciences, EPFL (Switzerland)

ABOUT THE SPEAKER

Dr. Pajouheshgar is a postdoctoral researcher at EPFL Lausanne, working jointly with the Image and Visual Representation Laboratory (IVRL) and the Chair of Statistical Field Theory (CSFT). We highly recommend playing around with the various beautiful and intuitive web demos Dr. Pajouheshgar created to illustrate his work: DyNCA, NoiseNCA, Cells to Pixels, MemoryNCA, and MeshNCA.

Keywords
Neural Cellular Automata · Self-Organization · Pattern Formation · Morphogenesis · Texture Synthesis · Cellular Automata

Abstract
Patterns are configurations that admit descriptions shorter than themselves. A representation of a pattern is a program that reproduces it under a chosen way of comparing patterns. Different comparisons lead to different representations: a program may reproduce one configuration point by point, or it may reproduce the statistics of a pattern. Among the many possible representations of a pattern, self-organizing representations are special because they describe a formation process that builds structure through local interactions among many simple units (cells) that share an update rule and

evolve over time. This review presents Neural Cellular Automata (NCA) as a trainable self-organizing model of pattern formation. We introduce perception/adaptation as a general language for describing self-organizing representations: each cell first gathers local information from its neighborhood, then adapts its state according to that perception and a shared rule. This abstraction covers a wide range of self-organizing systems, from classical cellular automata to reaction-diffusion models. Neural Cellular Automata are a learned, differentiable instance of the same idea: instead of hand-designing the update rule, they make it possible to infer the rule from target patterns. The review follows this abstraction through three parts. The first two follow the two senses of pattern comparison: exact matching for a single target (morphogenesis) and distributional matching for a family of patterns (texture synthesis). The third part covers major extensions to the base NCA model, including generalizations beyond regular grids, changes to the output representation, and differentiable methods for learning discrete update rules.

COFFEE BREAK

3a.2 Morning: 10h30—13h00

Chair Rolf Hoffmann

3a.2.1 Noa Izsak – *A Generative View of Cellular Automata: Language Generators via Atomic Gliders*

10h30
10h50

Type Extended Abstract
Authors Noa Izsak[1]
Affiliation [1]CISPA Helmholtz Center for Information Security (Germany)

Keywords
Cellular Automata · Language Generation · Atomic Gliders · Expressiveness

Abstract
Cellular automata (CA) are traditionally studied as dynamical systems or as language recognizers. We consider a complementary perspective in which CA are viewed as language generators. In this setting, the evolution of a CA from finite initial configurations induces a formal language by reading the non-quiescent support of configurations along its orbit. We show how this generative behavior can be understood via atomic gliders—localized propagating patterns that emerge in the evolution and whose interactions determine the structure of the generated words. Even under regular initial configurations, the induced languages can exhibit nontrivial dependencies and go beyond classical regular behavior. This perspective provides a symbolic view of CA dynamics and suggests a connection to verification, enabling reasoning about system behavior through induced language.

3a.2.2 Taisei Nagashima – *Edge Detection Using Young's Reaction-Diffusion Cellular Automaton with Nonlinear Function*

10h50
11h10

Type Extended Abstract
Authors Taisei Nagashima[1] & Tadashi Tsubone[1]
Affiliation [1]Nagaoka University of Technology (Japan)

Keywords
Pattern Formation · Reaction-Diffusion System · Image Processing · Edge Detection

Abstract
The two-dimensional cellular automaton (CA) model proposed by D. A. Young is known to generate spotted and labyrinthine patterns. Our previous study extended this model and found that it can perform image processing tasks such as edge detection and skeletonization depending on the parameters. We also identified parameter conditions that enable edge detection, although this was limited to cases where a linear function controls the CA local rules. In this study, we hypothesized and verified that employing a nonlinear control function makes these conditions easier to satisfy. For comparison, we modified only a portion of the linear control function to make it nonlinear. As a result, we found that edge detection can be achieved with a nonlinear function even in cases where the original linear function fails.

3a.2.3 Kellie Evans – *Using Golly's Scripting Tools to Analyze Larger than Life's Jitterbugs*

11h10
11h30

Type Exploratory Paper
Authors Kellie Evans[1]
Affiliation [1]California State University (USA)

Keywords
Cellular automata · Game of Life · Larger than Life

Abstract
Larger than Life is a family of cellular automata proposed by David Griffeath that generalizes John Conway's celebrated Game of Life to large neighborhoods and update rules based on birth and survival intervals. Golly is an open source application for exploring the Game of Life and, more recently, Larger than Life. In this exploratory paper, we present new scripts for the Golly software that help identify and analyze the complex trajectories of certain viable patterns in Larger than Life, known as "jitterbugs," including the Game of Life's famous glider. We describe the scripts' limitations and ideas about how to surpass them.

3a.2.4 Eric Goles – *Parallel Flow Field Dynamics in the Sakoda Model of Social Interactions*

11h30
11h50

Type Exploratory Paper
Authors Katerin de la Hoz[1] & Eric Goles[2]
Affiliation [1]Universidad de Concepción (Chile), [2]Universidad Adolfo Ibáñez (Chile)

Keywords
Sakoda model · Cellular automata · Social dynamics

Abstract
We study a parallel flow field variant of the Sakoda model of social interactions, in which movement is local, synchronous, and constrained by a rotating directional field. We compare this dynamics with the sequential Sakoda rule across 35 interaction matrices with at least one attractive entry. In our experiments, the sequential dynamics reaches lower final energies in most paired simulations, while the parallel flow field dynamics produces higher energy states and a small number of atypical cases with a finite horizon. The results show how imposing local directional motion modifies the energy landscape explored by Sakoda-type social dynamics.

3a.2.5 Gabriel Istrate – *Conway's Army Percolation*

11h50
12h10

Type Extended Abstract
Authors Gabriel Istrate[1], Bogdan Dumitru[1,2] & Mihai Prunescu[1]
Affiliation [1]University of Bucharest (Romania), [2] Bitdefender (Romania)

Keywords
Conway's army · pagoda function · percolation · phase transitions

Abstract
We analyze a probabilistic version of Conway's soldiers puzzle: given a fixed constant $p \in [0,1]$, place checker pieces in the cells of an infinite checkerboard lying below the horizontal axis independently with probability p. A seminal result due to Conway is that one cannot reach line five. We prove rigorous lower and upper bounds on $D_k(p)$, the probability that one can reach a fixed cell on row k, $1 \leq k \leq 4$. We complement these rigorous results by empirical estimates (employing a SAT solver). These rigorous and empirical results suggest that $D_k(p)$ are smooth functions of p for all $k = 1,\ldots,4$. We then show that our results are connected to a percolation model on hypergraphs. Specifically, we define a dynamics that corresponds to Conway's army when the time is reversed. We define a notion of "percolation of safe configurations" for this dynamics and show that, for a k-uniform r-ary hypergraph analog $B_{k,r}$ of the Bethe lattice, the critical value for this percolation of valuable configurations on $B_{k,r}$ is $\frac{1}{(k-1)(r-1)}$. Interestingly, the proof of this result extends the original argument (based on branching processes) for percolation on the Bethe lattice.

3a.2.6 Buffer

12h10
13h00

An ample 50-minute buffer in case we are delayed, for checking your e-mails, or for expanding your network.

LUNCH BREAK

This concludes AUTOMATA. The second part of this joint conference, ACRI, starts today at 14h00. We will take a group photo around 13h45.

ACRI

3b. Wednesday, July 8th

The registration desk will be open today between 13h30—15h00. Today's lunch is included for everyone. A group photo is taken right after lunch, around 13h45.

3b.1 Afternoon: 14h00—15h45

Theme Theory
Chair Luca Mariot

3b.1.1 ACRI opening

14h00
14h15

The chair of this year's ACRI Organising Committee, Jan Baetens, welcomes the attendees.

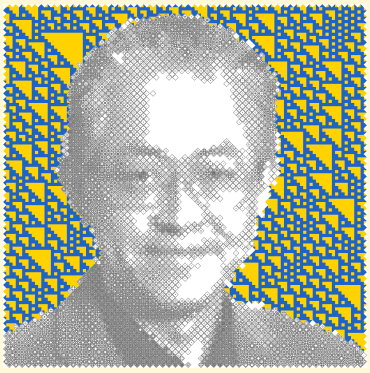
3b.1.2 INVITED SPEAKER: Hiroki Sayama – *Evolution and Complexity Growth of Artificial Life in Cellular Automata and Other Discrete Dynamical Systems*

14h15
15h15

Type Invited Speaker (lecture only)
Authors Hiroki Sayama[1]
Affiliation [1]Binghamton University, State University of New York (USA)

ABOUT THE SPEAKER

Prof. Sayama is the director of the Center for Collective Dynamics of Complex Systems (CoCo) at Binghamton University, State University of New York. He will provide an inspiring historical overview of the role of discrete dynamical systems in the study of artificial life.



Keywords
Artificial Life · History · Open-ended evolution · Generative Network Automata

Abstract
Since John von Neumann's early work on self-reproducing automata, discrete dynamical systems such as cellular automata (CA) have been extensively used in the field of Artificial Life as a mathematical/computational medium to represent various biological phenomena. While the traditional focus has been on implementing mechanisms for self-replication/self-reproduction, the core vision in von Neumann's work and much of its subsequent work has always been the evolution and complexity growth of biological systems. The "evolution" part of this vision was fully realized in deterministic CA in the late 1990s and early 2000s, whereas the "complexity growth" part remains quite difficult and elusive. In recent years, however, this topic has gained renewed attention in the Artificial Life community under the new term "open-ended evolution", utilizing various types of discrete dynamical systems that go beyond traditional CA. In this talk, I plan to provide a historical overview of this line of research and review several new developments that use variations of discrete dynamical systems, including Generative Network Automata and their applications for representation of open-ended artificial chemistry models and automated modeling acquisition of real biological developmental processes.

3b.1.3 Franco Bagnoli – *General control of linear cellular automata*

15h15
15h45

Type Full Paper
Authors Franco Bagnoli[1,2,4], Sara Dridi[3], Samira El Yacoubi[2], Amira Mouakher[2] & Bassem Sellami[2]
Affiliation [1]University of Florence (Italy), [2]University of Perpignan (France), [3]University of Setif 1 (Algeria), [4]INFN, Sect. Florence (Italy)

Keywords
Affine and linear cellular automata · controllability · control theory

Abstract
In mathematics and engineering, control theory deals with the behavior of dynamical systems through the application of suitable control inputs. One of the prominent themes in this theory is the controllability one. It concerns the existence of a control input that can steer a dynamical system from an initial state to a desired final state within a finite time horizon, possibly explicitly finding it. There is a general theory for controlling linear or linearizable system, but it cannot be applied to discrete systems like cellular automata, which is the problem of that we address in this paper. We develop a general theory for linear (and affine) cellular automata, and apply it to examples of one and two-dimensional Boolean cases. We introduce the concept of Boolean controllability matrix and show that controllability holds if and only if this matrix is invertible using Boolean operators.

COFFEE BREAK

3b.2 Afternoon: 16h15—17h30

Theme Theory
Chair Jan Baetens

3b.2.1 Souvik Roy – *Remark on the effect of non-local perturbation in Elementary Cellular Automata*

16h15
16h45

Type Full Paper (online presentation)
Authors Shrey Salvi[1], Sumit Adak[2] & Souvik Roy[1]
Affiliation [1]Ahmedabad University, Gujarat (India), [2]Technical University of Denmark (Denmark)

Keywords
Elementary Cellular Automata (ECA) · non-local Perturbation · Classification · Robust · rule min term (RMT)

Abstract
This study explores the effect of non-local θ-perturbation on elementary cellular automata (ECA) rules, where with θ probability, a cell (say i) randomly and uniformly selects any cell as its right neighbour, and with $1-\theta$ probability, a cell selects its right cell $(i+1)$ as its right neighbour. In the initial experimental study, for changing θ-perturbation rate, we classify the dynamics of ECA rules into robust, discontinuity, phase transition and class transition categories. Hereafter, we explore the reason behind these different rich behaviours by using the theoretical tool rule min term (RMT). Here, the microscopic analysis provides the roadmap towards concrete theory for ECA systems with the effect of θ perturbation.

3b.2.2 Ralph Willox – *A simple strategy for constructing ultradiscrete systems that exhibit the same dynamics as a given continuous model*

16h45
17h05

Type Exploratory Paper
Authors Ralph Willox[1]
Affiliation [1]The University of Tokyo (Japan)

Keywords
structure preserving ultradiscretisation · limit cycles · zero-radius cellular automata · ultradiscrete systems.

Abstract
Over the past 30 years, the special limiting procedure known as *ultradiscretisation* has become the tool of choice in the field of infinite dimensional integrable systems for constructing cellular automata that exhibit solitonic behaviour, as e.g. in the Korteweg-de Vries equation. A lesser known fact is that, in many cases, ultradiscretisation can also be used to construct cellular automata that retain the essential dynamical features (such as the existence of limit cycles etc.) of a dynamical system expressed in terms of ordinary differential equations (ODEs). In its standard application, the ultradiscretisation procedure relies on the prior construction of a 'good' discretisation of the dynamical system at hand, that shares the essential dynamical features of the ODE and which is sign-free, making it amenable to the ultradiscrete limit. In this paper we show, on a simple but generic model, that even if one starts from a discrete system with different dynamical features than the ODE one obtains as its continuum limit, the ultradiscrete limit can be tweaked such that the dynamics of the resulting cellular automaton is closer to that of the continuum limit than to that of the discrete model itself.

3b.2.3 Luca Mariot – *On the transversals of Latin squares generated by nonlinear bipermutive cellular automata*

17h05
17h25

Type Exploratory Paper
Authors Alberto Dennunzio[1], Maximilien Gadouleau[2] & Luca Mariot[3]
Affiliation [1]University of Milano-Bicocca (Italy), [2]Durham University (UK), [3]University of Twente (the Netherlands)

Keywords
cellular automata · Latin squares · bipermutivity · transversals · orthogonality

Abstract
In this short paper, we begin to investigate the conditions under which a generic Bipermutive Cellular Automaton (BCA) with no-boundary conditions of diameter d generates a Latin square of order $N = 2^{d-1}$ admitting an orthogonal mate, without relying on the linearity of the local rule. Since an orthogonal mate exists if and only if the Latin square can be partitioned into N disjoint transversals, we start by characterizing the subclass of BCA whose Latin squares have a transversal on the main diagonal. In particular, we prove that the main diagonal forms a transversal if and only if the generating function of the bipermutive local rule induces an invertible CA with periodic boundary conditions on a configuration of size $d-1$. We then perform exhaustive search experiments, showing that $d = 6$ is the smallest diameter for which there exist nonlinear bipermutive CA that generate Latin squares with a transversal on the main diagonal.

3b.2.4 Buffer

17h25
17h30

A modest 5-minute buffer in case we are delayed.

In case you registered for the conference dinner, we will see you tonight at 19h30 in Brasserie Pakhuis (`www.pakhuis.be`), in the centre of Ghent.

4. Thursday, July 9th

4.1 Morning: 09h00—10h30

Theme Unconventional Computing & Control
Chair Michiel Rollier

4.1.1 09h00 10h00 INVITED SPEAKER: Michail-Antisthenis Tsompanas – *Applications of Cellular Automata in Unconventional Computing*

Type Invited Speaker (lecture only)
Authors Michail-Antisthenis Tsompanas[1]
Affiliation [1]University of the West of England (UK)

ABOUT THE SPEAKER

Dr. Tsompanas is a Senior Lecturer at University of the West of England, associated with the Department of Computer Science and Creative Technologies, and involved with unconventional and bio-inspired computations.

Keywords
Chemical computing · Belousov–Zhabotinsky reaction · Memristive computing · Reaction–diffusion systems

Abstract
Cellular automata (CA) have long served as powerful computational models for simulating a variety of chemical, biological, and physical phenomena. Among the chemical systems modelled by CA, the Belousov–Zhabotinsky (BZ) reaction stands out as a characteristic example of nonlinear chemical oscillations and self-organization. These characteristics have inspired the use of BZ as a foundation for chemical computing. Building on insights from CA modelling, the underlying principles of such chemical processes have been transferred into electronic implementations,

most notably through memristor-based oscillators. These systems emulate reaction–diffusion dynamics in silico and have demonstrated the capability to perform multiple Boolean logic operations within the same architecture. This talk will explore how CA provide a conceptual and computational bridge between chemical computing and memristive electronic architectures, emphasizing their potential for enabling massively parallel, hardware-accelerated computational systems.

4.1.2 Eric Goles – *Complexity of Fungal Automaton Prediction*

10h00
10h30

Type Full Paper
Authors Enrico Formenti[1], Eric Goles[2], Kevin Perrot[3], Martín Ríos-Wilson[2] & Domingo Ruiz-Tala[4]
Affiliation [1]Université Côte d'Azur, Nice (France), [2]Universidad Adolfo Ibáñez, Santiago (Chile), [3]Aix Marseille Université, Marseille (France), [4]Universidad de Chile, Santiago (Chile)

Keywords
Cellular automata prediction · totalistic rule · fungal automata

Abstract
Fungal automata are a nature-inspired computational model in a two-dimensional grid, where a one-dimensional local rule is alternatively applied vertically and horizontally. In this work we study the computational complexity of predicting the dynamics of all fungal automata associated to freezing totalistic one-dimensional rules of radius 1, exhibiting various behaviors. Despite efficiently predictable in most cases (with non-deterministic logspace algorithms), a non-linear rule is left open to characterize. We further explore the freezing majority rule (which is totalistic), and prove that at radius 1.5 it becomes **P**-complete to predict.

COFFEE BREAK

4.2 Morning: 11h00—13h00

Theme Unconventional Computing & Control
Chair Eric Goles

4.2.1 Rolf Hoffmann – *Cellular Automata Rules Optimizing a Global Pattern Value*

11h00
11h30

Type Full Paper
Authors Rolf Hoffmann[1], Franciszek Seredyński[2] & Dominique Désérable[3]
Affiliation [1]Technical University Darmstadt (Germany), [2]University of Siedlce (Poland), [3]INSA Rennes (France)

Keywords
Pattern Optimization · Pattern Formation · Pattern Matching · Matching Templates · Tilings · Probabilistic Cellular Automata · Prisoner's Dilemma

Abstract
The objective is to find Cellular Automata (CA) rules that can evolve 2D patterns that are optimal with respect to a global value function. Here we define the global value as the sum of locally computed utilities. A utility, or local value function, assigns a score based on the states in the local neighborhood. The problem is solved in four steps: (0) defining the utility function, (1) finding optimal master patterns with a Genetic Algorithm, (2) extracting templates (local neighborhood configurations), (3) inserting the templates into a general CA rule. The constructed CA rules generate optimal or near-optimal patterns for both even and odd grid sizes. Optimal patterns of odd size contain exactly one thin spot, which is a 2×2 block of zeroes.

4.2.2 Franco Bagnoli – *Control of Cellular Automata by Mobile Agents with Reinforcement Learning*

11h30
12h00

Type Full Paper
Authors Franco Bagnoli[1,2,3], Samira El Yacoubi[2], Amira Mouakher[2] & Bassem Sellami[2]
Affiliation [1]University of Florence (Italy), [2]University of Perpignan (France), [3]INFN, Sect. Florence (Italy)

Keywords
Control of cellular automata · Reinforcement learning · Totalistic cellular automata

Abstract

In this work, we investigate the conditions under which mobile agents can learn intervention strategies to steer the global density of a two-dimensional Boolean cellular automaton towards a given target. Each agent observes only its Moore neighborhood and modifies the central cell according to a learned set of totalistic transition probabilities. We compare passive environments, where modifications are preserved, with active environments governed by outer-totalistic cellular automata such as the frustrated identity rules and the Game of Life. In passive environments, the proposed reinforcement-inspired update converges towards deterministic minority-like strategies that approximate the prescribed target density. In active environments, however, the same local learning heuristic often fails to reach arbitrary targets, because the environment dynamics restricts the reachable local configurations and may erase or transform local improvements before they translate into stable global density changes. This study provides a first step towards the understanding of how local learning agents can control discrete spatial dynamical systems under different environmental dynamics.

4.2.3 Sukanta Das – *Computing Shortest Path In-memory with Cellular Automata*

12h00
12h30

Type Full Paper
Authors Subrata Paul[1], Sukanta Das[1] & Biplab K Sikdar[1]
Affiliation [1]IIEST Shibpur, West Bengal (India)

Keywords

In-memory computing · Cellular automata · Cayley tree · Shortest path

Abstract

This work explores finite cellular automata (CAs) defined over a Cayley tree. Each cell of the CA is equipped with a memory unit and a tiny processing element. The computation paradigm of the proposed model leverages data-intensive computation within memory, thereby effectively realizing an in-memory computing (IMC) platform. The effectiveness of the proposed model is demonstrated while finding the shortest paths from a given source to all destinations in an arbitrary graph. The computation of the shortest path is completed in h steps, where h is the height of the Cayley tree.

4.2.4 Buffer

12h30
13h00

An ample 30-minute buffer in case we are delayed, for checking your e-mails, or for expanding your network.

LUNCH BREAK

4.3 Afternoon: 14h00—15h00

Theme Cryptography and Data Science
Chair Sukanta Das

4.3.1 Kamalika Bhattacharjee – *Generation of Isomorphic Cellular Automata with Application to Data Classification*

14h00
14h30

Type Full Paper
Authors Baby C. J.[1,2] & Kamalika Bhattacharjee[3]
Affiliation [1]NIT Tiruchirappalli, Tamil Nadu (India), [2]Government College of Engineering Kannur, Kerala (India), [3]IIEST Shibpur, West Bengal (India)

Keywords

Reversibility · Isomorphism · Template Based Representation · Transition Diagrams · Data Classification

Abstract

Isomorphism is an important property in finite cellular automata (CAs) that classifies the CAs into some equivalence classes where CAs belonging to the same class holds the same dynamics. This paper explores isomorphism in finite one-dimensional reversible non-uniform elementary cellular automata under null boundary condition. We introduce the notion of a *template* to represent a group of CAs. Some propositions are reported to identify templates that represent subclasses of isomorphic CA when the lattice size is 4. A scheme is reported to extend these CAs to any lattice size such that the extended CAs are also reversible and isomorphic to each other. This equivalence property of isomorphic CAs is crucial for applications where the elements may be unordered. As an application, the isomorphic CAs are utilized in data classification of machine learning where the ordering of the features can be changed.

4.3.2 Amit Sardar – *CA-Based Countermeasure for Ascon-128*

14h30
15h00

Type Full Paper (online presentation)
Authors Amit Sardar[1] & Dipanwita Roy Chowdhury[1]
Affiliation [1]IIT Kharagpur (India)

Keywords
Fault analysis · SSFA · Cellular Automata

Abstract
Ascon is a family of lightweight, NIST-standardized authenticated encryption with associated data (AEAD) algorithm designed for resource-constrained environments such as IoT and embedded systems. It was selected as the winner of the NIST Lightweight Cryptography competition (2019–2023) due to its efficiency, high performance, and resistance to side-channel attacks. However, such constrained devices remain vulnerable to implementation-based attacks, particularly fault injection attacks. Joshi and Mazumdar (2021) demonstrated the effectiveness of the Subset Fault Analysis (SSFA) attack on Ascon, showing that the key search space can be reduced from 2^{128} to 2^{64} under various bit-reset fault models. This result highlights Ascon's susceptibility to fault-based cryptanalysis. To address this issue, Ambili and Jose (2022) proposed a countermeasure based on a PRNG function constructed using linear cellular automata to enhance fault resistance. In this work, we show that the CA-based Ascon design proposed by Ambili and Jose (2022) remains vulnerable to SSFA attacks and does not completely eliminate the associated security risks. To overcome this limitation, we propose an improved cellular automata-based countermeasure that further strengthens the resistance of Ascon against SSFA attacks. Experimental evaluation using the FELICS framework demonstrates that the proposed approach achieves improved security with minimal overhead.

COFFEE BREAK

4.4 Afternoon: 15h30—17h00

Theme Applications
Chair N/A

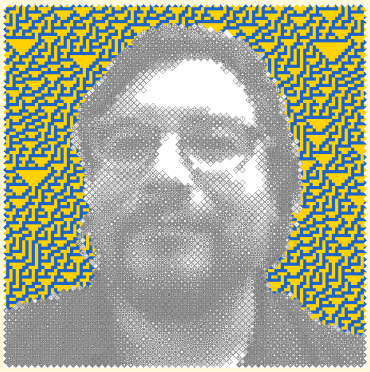
4.4.1 INVITED SPEAKER: Jaime Carrasco-Barra – *Hands-on Workshop on Recent Advances in Cellular Automata-Based Wildfire Simulation with Cell2Fire*

15h30
17h00

Type Workshop
Authors Jaime Carrasco-Barra
Affiliation Metropolitan Technological University & Complex Systems Engineering Institute, Santiago (Chile)

ABOUT THE SPEAKER

Dr. Carrasco-Barra is a senior scientist associated with the Metropolitan Technological University (UTEM) and the Complex Systems Engineering Institute (ISCI) in Santiago de Chile. He will guide a workshop on an exciting application of cellular automata in the context of wildfire models.



Keywords
Wildfire spread modelling · Spatial decision support · Fuel treatment optimization · Cell2Fire

Abstract
Spatial wildfire spread is a paradigmatic example of complex spatio-temporal dynamics that can be effectively represented using discrete and cellular automata-based models. This hands-on session presents Cell2Fire (C2F), a spatially explicit wildfire simulation framework grounded in cellular automata concepts, where landscape heterogeneity, fuel properties, topography, and weather conditions are encoded on regular grids, and local transition rules govern fire

propagation.

Originally developed in C++ for forest fuel management in Canadian landscapes, Cell2Fire has evolved into a flexible modeling framework supporting multiple fire behavior prediction systems, including the Canadian Forest Fire Behavior Prediction (FBP) System, KITRAL, and BehavePlus. These systems define fire spread transition rules that operate at the cell level, enabling the simulation of fire growth as an emergent phenomenon arising from local interactions.

Beyond fire spread simulation, Cell2Fire integrates spatial decision-making components that combine cellular automata outputs with optimization and multi-criteria analysis. Probabilistic ignitions, coupled with fire growth simulations, are used to generate prioritization metric maps based on user-defined landscape values (e.g., downstream protection value, DPV). These maps serve as inputs for resource-constrained optimization of fuel treatments and firebreak placement using mixed-integer programming, allowing the evaluation of intervention strategies through before-and-after comparisons.

The framework is distributed as an open-source, cross-platform QGIS Processing Toolbox plugin (AGPL-3.0), supporting both graphical user interfaces and script-based workflows in Python or Bash. Parallel computing is employed to efficiently execute large ensembles of stochastic simulations, enabling the analysis of uncertainty and variability inherent in wildfire dynamics. During the session, participants will interactively explore the theoretical foundations of cellular automata-based wildfire modeling while running Cell2Fire on their own computers, linking discrete modeling principles with real-world spatial applications.

Preparation

90 minutes is not a lot, so in order to make the most use of the time we are given, it is best to come prepared. Please install QGIS on your device via `www.qgis.org/download/`. Additionally, please browse through the C2F-W documentation on `github.com/fire2a/C2F-W` and the QGIS plugin documentation on github.com/fire2a/fire-analytics-qgis-processing-toolbox-plugin. During the workshop, we will be using Google Colab to avoid as much technical trouble as possible.

After today's workshop, members of the ACRI Steering Committee will convene in the lecture room between 17h15—18h00.

5. Friday, July 10th

5.1 Morning: 09h00—10h30

Theme Applications
Chair Wouter Vervust

5.1.1
09h00
10h00

INVITED SPEAKER: Kathelijne Wijnberg – *Linking Sand, Plants and People: a Cellular Automata Framework for Understanding the Dynamics of Managed Beaches*

Type Invited Speaker (lecture only)
Authors Kathelijne Wijnberg
Affiliation University of Twente (the Netherlands)

ABOUT THE SPEAKER

Prof. Wijnberg is the chair of Coastal Systems and Nature-based Engineering at University of Twente in the Netherlands. She will discuss her long-standing research on littoral morphology, highlighting how she applies cellular automata for modelling the Dutch shoreline.

Keywords

Coastal dune dynamics · Human impacts on beaches · Aeolian sand transport · Nature-based coastal protection

Abstract

With acceleration in rate of sea level rise, seaside towns on sandy shores will increasingly be impacted by coastal erosion. While sand nourishment offers a sustainable mitigation strategy, human use of the beach — such as recreational infrastructure on the beach and beach traffic — subtly impact on wind-driven sand dynamics and vegetation growth. On the long-term, these small-scale disturbances can cumulatively affect foredune development, which is critical for natural storm protection.

A Cellular Automata framework will be presented in which we add a human-use layer to a bio-physical Cellular Automata model that simulates the coupled dynamics of aeolian sand transport, vegetation evolution, and marine processes. The bio-physical part of the model captures self-organizing dune behaviour through local interaction rules governing sand movement and plant growth, while integrating episodic storm-driven erosion and fair-weather accretion. The human-use layer incorporates shore nourishment and simulates two-way interactions between recreational activities — including car and foot traffic, as well as infrastructure such as beach huts and pavilions — and the evolving beach-dune topography and vegetation cover.

5.1.2 Theodoros Chatzinikolaou – *Emergence of Least Resistance Transportation Networks from Memristor-Based Cellular Automata*

10h00
10h30

Type Full Paper
Authors G. Kleitsiotis[1], I. Dimopoulos[1], P. Fraidakis[1], I. K. Chatzipaschalis[1,2], I. Tompris[1], T. Chatzinikolaou[1], I.-A. Fyrigos[1], I. Vourkas[1] & G. Ch. Sirakoulis[1]
Affiliation [1]Democritus University of Thrace, Xanthi (Greece), [2]Universitat Politècnica de Catalunya, Barcelona (Spain)

Keywords

Memristors · Cellular Automata · Near-critical dynamics · Emergent Phenomena · Bio-inspired adaptive media · Artificial Neurons

Abstract

This work presents a decentralized cellular automaton (CA) for spatial optimization, realized as a two-dimensional (2D) lattice of locally coupled memristive relaxation oscillators. In this formulation, each CA cell acts as an adaptive unit that operates in a near-critical regime exhibiting input-dependent spiking behavior, and history-dependent transient dynamics through local CA neighborhood interactions. The proposed CA produces rich spatiotemporal activity patterns, including radially propagating excitation fronts and adaptive modulation of memristive conductances, resulting in emergent cell-to-cell dynamics that can be leveraged to address geospatial optimization problems without recourse to conventional graph-theoretic routing algorithms. Terrain elevation is encoded into the synaptic (inter-oscillator) landscape, and external stimulation is applied to nodes corresponding to urban centers. Under these conditions, the physical lattice spontaneously self-organizes into transport pathways that are highly efficient with respect to the imposed cost landscape. The proposed neuromorphic architecture is evaluated by reconstructing the principal topological features of the Greek National Transportation Network. The networks display hierarchical and fractal organization, in agreement with theoretical predictions for optimal transport networks and with empirical observations from biological adaptive systems. These findings support the viability of memristive CA as a physically inspired computational substrate for complex spatial optimization tasks.

COFFEE BREAK

5.2 Morning: 11h00—13h00

Theme Applications
Chair Barbara Wolnik

5.2.1 Michiel Rollier – *The MACCA-GW groundwater flow model: application to De Wilde Landen, the Netherlands*

11h00
11h30

Type Full Paper
Authors Michiel Rollier[1], Lotte Landuyt[1] & Jan M. Baetens[1]
Affiliation [1]Ghent University, Ghent (Belgium)

Keywords

Cellular automata · Groundwater modelling · Sensitivity analysis · Climate change · Water management

Abstract

We apply a macroscopic cellular automaton (CA) model to simulate two-dimensional groundwater flow in De Wilde Landen, a Dutch nature reserve where drinking water extraction and biodiversity conservation compete for the same resource. Building on the MACCA-GW framework of Ravazzani et al., we add vegetation-dependent evapotranspiration and site-specific boundary conditions, and calibrate the soil parameters against monitoring well data via Nelder-Mead optimisation. A Sobol' sensitivity analysis identifies the saturated hydraulic conductivity as the dominant uncertainty source, with a spatial gradient tied to the extraction infrastructure. We then simulate three IPCC climate scenarios

(SSP1-2.6/SSP2-4.5/SSP5-8.5) over 30 years and five pumping regime scenarios. All climate scenarios predict declining groundwater levels; reversing the extraction pattern (more in winter, less in summer) raises spring levels by up to 0.34 m, directly benefiting plant water availability during the growing season. We discuss model limitations, including numerical instability at low head values and incomplete boundary condition data.

5.2.2 Kenza Benjelloun – *A spatio-temporal RNN model for sea surface temperature forecasting*

11h30
12h00

Type Full Paper
Authors Kenza Benjelloun[1,2], Enrico Formenti[1] & Luca Manzoni[2]
Affiliation [1]Université Côte d'Azur, Nice (France), [2]Università degli Studi di Trieste, Trieste (Italy)

Keywords
Sea surface temperature forecasting · Recurrent neural networks · Data-driven modelling

Abstract
This paper presents a recurrent neural network (RNN) based spatio-temporal framework for learning cellular automata (CA) update rules for oceanographic modeling of sea surface temperature (SST). The classical RNN architecture is benchmarked against a neighborhood-averaging baseline and two gated variants, LSTM and GRU. All three recurrent architectures prove to be efficient next-step predictors, with gated architectures outperforming the vanilla RNN. This work establishes the superiority of GRU, achieving $\approx 32\%$ error reduction over the baseline. Deployed iteratively as a CA update rule, the GRU produces accurate auto-regressive simulations of SST evolution in the northern Adriatic sea over a 30-day forecast horizon, demonstrating that lightweight data-driven CA rules are a viable tool for short-to-medium term forecasting.

5.2.3 Meryem El Habbazi – *Modeling Dispersive Shallow Water Wave Propagation Using a Cellular Automaton Based on the Peregrine System*

12h00
12h30

Type Full Paper
Authors Meryem El Habbazi[1,2], Omar Jellouli[1], Latifa Boutat-Baddas[2], Mustapha Oudani[1] & Mohamed Boutayeb[1,2]
Affiliation [1]International University of Rabat (Morocco), [2]University of Lorraine, Nancy (France)

Keywords
Shallow water waves · Peregrine system · Boussinesq-type models · Cellular automata · Irregular bathymetry

Abstract
Surface wave propagation over shallow coastal regions with variable bathymetry involves complex phenomena such as refraction, shoaling, and nonlinear wave transformation. While classical shallow-water models are computationally efficient, they often neglect dispersive effects that are essential for realistic coastal-wave prediction. In contrast, Boussinesq-type models such as the Peregrine system capture both nonlinear and dispersive dynamics, but their numerical treatment is generally more demanding due to the operators involved. In this work, we develop a cellular automaton (CA) formulation of a simplified Peregrine system for dispersive shallow-water wave propagation over irregular bathymetry. The governing equations are recast into synchronous local transition rules on a structured grid, so that each cell is updated solely from nearest-neighbor interactions, without global solvers or matrix inversions. Numerical simulations show that the proposed model reproduces key coastal-wave phenomena, including propagation, refraction, and boundary-induced patterns, while preserving coherent wavefront dynamics on complex bathymetries. These results highlight the potential of cellular automata as a fully local and scalable framework for dispersive coastal-wave simulation.

5.2.4 Buffer

12h30
13h00

An ample 30-minute buffer in case we are delayed, for checking your e-mails, or for expanding your network.

LUNCH BREAK

5.3 Afternoon: 14h00—15h00

Theme Applications
Chair Nazim Fatès

5.3.1 Alonso Espinoza – *Parsimonious revision protocol for Boolean networks: Application to osteogenesis*

14h00
14h30

Type Full Paper

Authors Jacques Demongeot[1], Alonso Espinoza[2,3], Eric Goles[2,4], Marco Montalva-Medel[2], Sylvain Sené[3,5] & Laurent Tichit[3,5]

Affiliation [1]Université Grenoble-Alpes (France), [2]Universidad Adolfo Ibáñez, Santiago (Chile), [3]Université d'Aix-Marseille (France), [4]Millennium Nucleus SODAS, Santiago (Chile), [5]Université Publique, Marseille (France)

Keywords
Biological system modelling · Boolean networks · Discrete dynamical systems

Abstract
Boolean networks are powerful mathematical tools for modeling the qualitative dynamics of genetic regulation. Yet inferred models often generate spurious attractors that lack biological viability. In this paper, we propose a parsimonious computational framework to systematically refine Boolean network models by eliminating these non-biological asymptotic behaviors while strictly preserving known, biologically relevant attractors. Through an exhaustive exploration of local function substitutions, we generate a comprehensive set of candidate models. To identify the most biologically consistent networks, we implement an incremental pruning protocol that filters candidates based on structural interaction digraph similarity, attraction basin topological organization, trajectorial isomorphism, and the minimization of dynamical instability and frustration. We apply this methodology to a 9-node genetic control model of the osteogenesis regulation network. Our protocol effectively evaluates a syntactic search space of 51 138 potential networks, ultimately narrowing them down to a robust family of 6 parsimonious models that are fully compatible with current biological knowledge.

5.3.2 Hannelore Van De Putte – *A Center-Based Model Reveals that Cell Shape Variability Drives Cell Sorting in Spheroids*

14h30
14h50

Type Extended Abstract

Authors Hannelore Van De Putte[1], Jiří Pešek[2], Wouter Vervust[1] & Paul Van Liedekerke[1]

Affiliation [1]Ghent University (Belgium), [2]Inria Saclay Centre (France)

Keywords
Agent-Based Modelling · Multicellular Spheroids · Mechanobiology

Abstract
We present a center-based, agent-based model of multicellular spheroids, which are 3D spherical in vitro cell aggregates that recapitulate key features of solid tumours. The model is implemented within the CompuTiX framework, in which each cell is an agent whose motion is governed by the balance of cell-cell and cell-ECM forces. We use the model to investigate cell sorting in a mixed spheroid initialised with two intermingled, quiescent cell types. To this end, we test several biomechanical hypotheses for what drives segregation. We find that the hypotheses of differential adhesion, high heterotypic interfacial tension and added random cell motility each fail to produce the sorted final state. Instead, we introduced variation in cell shape by modelling each cell's volume as oscillating sinusoidally between cell nucleus volume and full-cell volume, with a random phase. We found that this latter hypothesis of cell shape variability causes the cells to cluster by type, reproducing the experimentally observed segregation both qualitatively and quantitatively. We conclude that the model is a promising tool for studying spheroid dynamics and intend to assess its ability to reproduce diverse spheroid phenotypes.

5.3.3 ACRI closing

14h50
15h00

Some closing words by the Organising Committee.

COFFEE BREAK

This concludes ACRI. This first joint conference, AUTOMATA & ACRI 2026, has now been completed. The Organising Committee wishes you a safe journey home.

Thank you for joining us in Ghent.

AUTOMATA & ACRI 2026 was organised by

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