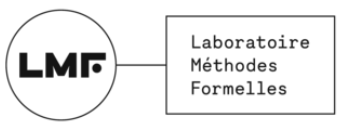
ANR CHAAT

Concurrency and Higher-dimensional Automata: Applications and Theory

Uli Fahrenberg

LMF, Université Paris-Saclay

Kickoff meeting, 19 October 2026



1 History

2 ANR CHAAT

In the Beginning there was Zoom



Initial Commit

```
uli@satie:~/Proj/HDLang$ git remote show origin|grep -v main|grep -v Remote|grep -v Local
* remote origin
  Fetch URL: git@github.com:christianUioJohansen/HDAandAlgebras.git
  Push  URL: git@github.com:christianUioJohansen/HDAandAlgebras.git
uli@satie:~/Proj/HDLang$ git log|tail -5
commit 2ab276bf61ce9814ccd218edcef4a747c38c6c32
Author: Christian Johansen <christian@johansenresearch.info>
Date:   Mon Nov 2 21:09:08 2020 +0100

    Initial commit
uli@satie:~/Proj/HDLang$
```

The First Generation: The Four Originals

- Generating Posets Beyond N [RAMiCS 2020]
- Languages of Higher-Dimensional Automata [Math.Struct.Comput.Sci. 2021]
- A Kleene Theorem for Higher-Dimensional Automata [CONCUR 2022]
- Posets with Interfaces as a Model for Concurrency [Inf.Comput. 2022]
- Kleene Theorem for Higher-Dimensional Automata [Log.Meth.Comput.Sci. 2024]

The Second Generation: The EPITA Era

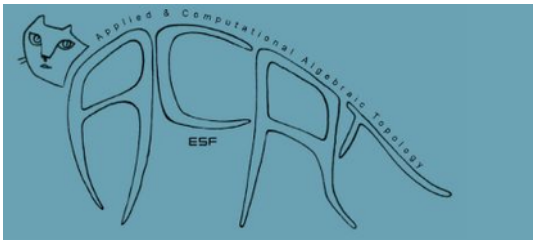
- A Myhill-Nerode Theorem for Higher-Dimensional Automata [PETRI NETS 2023]
- Closure and Decision Properties for Higher-Dimensional Automata [ICTAC 2023]
- Languages of Higher-Dimensional Timed Automata [PETRI NETS 2024]
- Presenting Interval Pomsets with Interfaces [RAMiCS 2024]
- Myhill-Nerode Theorem for Higher-Dimensional Automata [Fund.Inf. 2024]
- Closure and Decision Properties for Higher-Dimensional Automata [TCS 2025]
- Presheaf Automata [Ann.Pure Appl.Log. 2026]

The Third Generation: The Young Ones

- Logic and Languages of Higher-Dimensional Automata [DLT 2024]
- Bisimulations and Logics for Higher-Dimensional Automata [ICTAC 2024]
- Petri Nets and Higher-Dimensional Automata [PETRI NETS 2025]
- Higher-Dimensional Automata: Extension to Infinite Tracks [FSCD 2025]
- Towards an Efficient Conversion of Petri Nets into HDAs [MSR 2025]
- Kamp Theorem for Higher Dimensional Automata [CSL 2026]
- Interpreted HDAs for Concurrent Discrete-Event Control [WODES 2026]
- Forgetting Event Order in Higher-Dimensional Automata [LICS 2026]
- Algebraic Characterization of FO-definable Languages of HDAs [CONCUR 2026]
- Bisimulations and Modal Logics for HDAs [CONCUR 2026]

Prehistory

- van Glabbeek 1989
- Goubault-Jensen 1992/93
- GETCO 1999, 2000-06, 2010, 2015, 2018, 2022-23-24
  - Geometric and Topological Methods in Computer Science
- Directed topology
  - Algebraic Topology and Concurrency, TCS 2006
  - Directed Algebraic Topology and Concurrency, 2016 (book)
  - Fajstrup, Raussen, Dubut, Haucourt, Ledent, Mimram, ...



Highlights

- 2022 (Paris) – Uli
- 2023 (Kassel) – Amazigh
- 2024 (Bordeaux) – Uli, Emily
- 2025 (Saarbrücken) – Amazigh, Enzo
- 2026 (Vienna) – Emily, Aloÿs, Enzo, Kuba



Nice people

Augustin Albert, Amazigh Amrane, Hugo Bazille, Paul Brunet, Cameron Calk, Yorgo Chamoun, Emily Clement, Jérémy Dubut, Aloÿs Dufour, Sven Dziadek, Enzo Erlich, Gregory Faraut, Marie Fortin, Éric Goubault, Jakub (Kuba) Hajdas, Emmanuel Haucourt, Loïc Hélouët, Christian Johansen, Jérémy Ledent, Samuel Mimram, Philipp Schlehuber-Caissier, Georg Struth, Rob van Glabbeek, Krzysztof Ziemiański, Safa Zouari ...

https://ulifahrenberg.github.io/pomsetproject/

https://p-acts.github.io/

ANR CHAAT



- French national research project, October 2026 – September 2030
- Concurrency and Higher-dimensional Automata: Applications and Theory
- LMF, LRE, IRIF, LIX, SAMOVAR

Logo by Paul Brunet (LACL)

HIDAPNE

- small sister of the CHAAT (no logo, sadly)
- UPSaclay research project, October 2026 – September 2028
- HIgher-Dimensional Automata for Petri NEts
- Uli Fahrenberg, Thomas Chatain, Enzo Erlich, Stefan Haar, Philipp Schlehuber-Caissier, Stefan Schwoon

ANR CHAAT

1. The WORK
   - structure of tasks / “work packages”
   - planning (?)
2. The PEOPLE
   - WP leaders
   - other nice people
   - new people

This Meeting

- 9:30 This talk
- 10:30 Break
- 11:00 Scientific talks: Lory, Safia
- 12:00 Lunch
- 13:30 Detailed discussion of WPs / Break / Model checking

The Work

1. Languages, bisimulations and logics for higher-dimensional automata
2. Geometry and topology of higher-dimensional automata
3. Variants and extensions of higher-dimensional automata
4. Applications and tools

The Work

1. Languages, bisimulations and logics for higher-dimensional automata
   - "higher-dimensional automata theory"
   - on the language / linear logic side, already have Kleene, Myhill-Nerode, Büchi-ET, Kamp, Schützenberger: Enzo's PhD
   - languages of infinite ipomsets: less developed, (part of) Kuba's PhD
   - bisimulation / branching logic is less developed, and complicated; Safa's PhD
   - also, active learning: Safia's PhD
2. Geometry and topology of higher-dimensional automata
3. Variants and extensions of higher-dimensional automata
4. Applications and tools

The Work

1. Languages, bisimulations and logics for higher-dimensional automata
2. Geometry and topology of higher-dimensional automata
   - HDAs as objects of directed algebraic topology
   - homology, homotopy, geometry, covering theory, ...
   - some things exist already: Dubut-Kahl-Raussen-Ziemiański-...; but under-developed
   - some work by Augustin and Yorgo
3. Variants and extensions of higher-dimensional automata
4. Applications and tools

The Work

1. Languages, bisimulations and logics for higher-dimensional automata
2. Geometry and topology of higher-dimensional automata
3. Variants and extensions of higher-dimensional automata
   - partial / relational / etc. HDAs: first steps to be presented at ICTAC'26
   - timed and hybrid HDAs: already exist, and seem useful; but under-developed
   - HDAs as semantics of Petri nets, communicating automata, reaction systems, etc.
4. Applications and tools

The Work

1. Languages, bisimulations and logics for higher-dimensional automata
2. Geometry and topology of higher-dimensional automata
3. Variants and extensions of higher-dimensional automata
4. Applications and tools
   - Model checking HDAs: LTL and/or CTL; new algorithms to take concurrency into account
   - application to Petri net model checking
   - active learning; concurrent control
5. HIDAPNE

The Work

1. Languages, bisimulations and logics for higher-dimensional automata
2. Geometry and topology of higher-dimensional automata
3. Variants and extensions of higher-dimensional automata
4. Applications and tools
5. HIDAPNE
   - apply HDAs to model checking of Petri nets
   - max-cell HDAs; anonymous HDAs; etc.
   - transfer methods and tools from Petri net unfoldings

The People

1. Jérémy Ledent: WP1 lead, coordo IRIF
2. Jérémy Dubut: WP2 lead, coordo LIX
3. Amazigh Amrane: WP3 lead, coordo LRE
4. Philipp Schlehuber-Caissier: WP4 lead, coordo SAMOVAR
5. Uli Fahrenberg: BIG BOSS, coordo LMF

The People

1. Jérémy Ledent: WP1 lead, coordo IRIF
   - Marie Fortin, Jean Krivine, Emily Clement (LIPN)
   - Cameron Calk, postdoc CHAAT
2. Jérémy Dubut: WP2 lead, coordo LIX
3. Amazigh Amrane: WP3 lead, coordo LRE
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   - Éric Goubault, Emmanuel Haucourt, Samuel Mimram, Noam Zeilberger
   - Augustin Albert, Yorgo Chamoun, Louise Leclerc (PhDs)
   - Aloÿs Dufour, postdoc CHAAT
3. Amazigh Amrane: WP3 lead, coordo LRE
4. Philipp Schlehuber-Caissier: WP4 lead, coordo SAMOVAR
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   - Hugo Bazille, Laetitia Laversa, Adrien Pommellet
   - Enzo Erlich (PhD LRE/IRIF)
4. Philipp Schlehuber-Caissier: WP4 lead, coordo SAMOVAR
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   - Sven Dziadek, Natalia Kushik
   - Jakub (Kuba) Hajdas (PhD SAMOVAR/LMF)
   - Clément Borne, PhD CHAAT
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5. Uli Fahrenberg: BIG BOSS, coordo LMF
   - Thibaut Benjamin, Benedikt Bollig, Thomas Chatain, Gregory Faraut (LURPA)
   - Stefan Haar (HIDAPNE; Inria), Stefan Schwoon (HIDAPNE)
   - Safia Tehami (PhD LMF/LRE)
   - Evgenii (Jenya) Vinarskii, Postdoc HIDAPNE
   - Lory Soumphonphakdy, PhD CHAAT
6. Samy Abbes, Gio Bernardi, Paul Brunet, Loïc Hélouët, Paul-André Melliès, Sophie Pinchinat, Luigi Santocanale, ...

Scientific Advisory Board

- **Henning Basold**, Leiden University, The Netherlands
- **Christian Johansen**, Norwegian University of Science and Technology, Norway
- **Thomas Kahl**, University of Minho, Portugal
- **Georg Struth**, The University of Sheffield, UK
- **Tarmo Uustalu**, Reykjavik University, Iceland & Tallinn University of Technology, Estonia
- **Rob van Glabbeek**, University of Edinburgh, UK
- **Krzysztof Ziemiański**, University of Warsaw, Poland

New People

- Cameron Calk, Postdoc IRIF
- Aloÿs Dufour, Postdoc LIX
- Evgenii (Jenya) Vinarskii, Postdoc LMF

- Jakub (Kuba) Hajdas, PhD SAMOVAR since 1/26 (Natalia-Sven-Uli)
- Clément Borne, PhD SAMOVAR since 10/26 (Natalia-Philipp-Emily-Uli)
- Safia Tehami, PhD LMF since 10/26 (Amazigh-Adrien-Uli)
- Lory Soumphonphakdy, PhD LMF starting 1/27 (?)

- Alexandre Albessard, stage M1/2 LMF-LIX
- Emile Fourcin, stage M2 LMF starting 2/27 (?)
- Oussama Bouchnak, stage M2 starting 2/27 (?)