Werner MÉRIAN

Mathematical logic

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28 Avril 1999 (25 years old)

Education

2024 - **Ph.D in mathematical logic**, *IMJ-PRG*, Paris (France)

2024 **Diploma from the École Normale Supérieure of Lyon**

2023 - 2024 **2nd year master program of mathematical logic and foundations of computer science (LMFI)**, *University Paris Cité (ex Paris-Diderot, ex Paris 7)*, Paris (France)

2022 - 2023 **2nd year master program of theoretical computer science**, *ENS of Lyon*, Lyon (France)

2021 - 2022 **1st year master program of theoretical computer science**, *ENS of Lyon*, Lyon (France)

2020 - 2021 **3rd year bachelor program of theoretical computer science**, *ENS of Lyon*, Lyon (France)

2017 - 2020 **Higher school preparatory classes ("classe prépa")**, *Lycée Janson de Sailly*, Paris (France), MPSI then MP then 5/2 MP

2017 **High school**, *Lycée Saint Michel de Picpus de Saint Mandé*, Paris (France)

Research

September 2024 - **PhD thesis: Enumeration problems and descriptive complexity**, *University Paris Cité (ex Paris-Diderot, ex Paris 7) (France)*, Institute of Mathematics of Jussieu-Paris Rive Gauche (IMJ-PRG), Supervisor: Arnaud Durand, co-supervisor: Yann Strozecki

The most studied computational problems are decision problems: for a given instance, *is there* a solution or not. On their side, enumeration problems are interested in *enumerating* all the solutions. Unlike decision or optimization problems, where complexity is generally measured in the size of the problem instance, complexity measures in enumeration must take into account the potentially exponential number of solutions to be enumerated. For this, several "tractable" complexity classes have been introduced: polynomial output time, polynomial incremental time, polynomial delay...

This thesis proposes to study the descriptive complexity of enumeration problems, by seeking logical characterizations for these classes. For polynomial output time, this would consist in exhibiting a logic $\mathcal{L}$ such that for any problem P (of graph for example): P is expressible in $\mathcal{L}$ if and only if P is enumerable in polynomial output time. Such results can be seen as algorithmic meta-theorems, in the sense that they automatically provide an algorithm (to decide, compute a solution of a problem or enumerate them all) from the expressions obtained in the logic.

Research internships

April 2024 - July 2024 **Team semantics and the flattening operator**, *University of Helsinki (Finlande)*, Department of Mathematics and Statistics, Supervisors : Juha Kontinen, Jouko Väänänen and Arnaud Durand

Team semantics was developed to describe the concepts of dependence and independence using formal logic. Over the formulas of first-order logic, this team semantics constitutes an extension of classical semantics, called Tarskian semantics. We can then study many types of dependencies: dependence, independence, inclusion, exclusion... The starting point of this internship was the introduction of an operator F called the *flattening operator*. The natural question that follows adding such an operator to a given team-based logic is how much the expressive power of the given logic has been increased. Initially, the goal was to understand the expressiveness of the dependence logic expanded with F, the inclusion logic expanded with F, etc. A second phase was to obtain translations towards SAT problems, in order to understand the difficulty in terms of complexity brought by the addition of this operator F.

February 2023 - July 2023 **Logical characterization of enumeration complexity classes**, *Paris-Diderot University (France)*, Institute of Mathematics of Jussieu-Paris Rive Gauche (IMJ-PRG), Supervisor: Arnaud Durand

Enumeration problems are problems for which one wishes to enumerate all the solutions associated with an input instance. During this internship, we were interested in characterizing each of the major complexity classes of enumeration (TotalP, IncP and DelayP) via certain logics. To achieve this, we had to develop fragments of third-order logic (mainly existential third-order Horn logic) to first of all succeed in expressing central problems, such as Max independent set or Sat, and then be able to capture enumeration complexity classes.

April 2022 - July 2022 **A characterization of the Hanf locality via an invariant elementary definability**, *University of Cambridge*, Cambridge (England), Supervisor : Anuj Dawar

The Hanf locality intuitively says that structures that locally look the same cannot be distinguished by first order sentences. In a 2017 publication, Lindell, Towsner and Weinstein showed that a class of bounded degree structures is Hanf local, under certain conditions. The goal of this interneship was to extend this result to classes of unbounded degree structures, in particular by focusing on bounded tree-width structures.

May 2021 - July 2021 **One-way cellular automata and undecidability**, *Fundamental Computer Science Laboratory of Orléans (LIFO) GAMoC team*, Orléans (France), Supervisors : Martin Delacourt and Nicolas Ollinger

The periodicity problem for cellular automata is known to be undecidable in the general case. It has been shown that even if we restrict ourselves to the case of dimension 1, the problem remains undecidable. However, the problem is still open for the case of one-way cellular automata, in other words 1D cellular automata which can "see" only on one side. During this internship, we were interested in the preservation of the periodic property of one-way cellular automata under a certain transformation: embedding.

Seminars

April 17, 2024 2h seminar given within the logic team of the University of Helsinki (Finland), entitled "Logical characterization of complexity classes for enumeration problems"

June 16, 2022 1h30 seminar given within the logic team at the University of Cambridge (England), entitled "Presentation of Lindell, Towsner and Weinstein's result about Hanf Locality and Invariant Elementary Definability"

Organization of events for research and popularization

May 12 to 13, 2025 — Organization of the annual days of the GT DAAL (Data, Automata, Algebra, and Logic) 2025 edition at the Gaspard-Monge Computer Science Laboratory (LIGM) of the Gustave Eiffel University (Champs-sur-Marne)

November 6, 2024 — Organization of the Masters-Doctoral Students meeting 2024 edition

Workshops

September 23 to 24, 2024 — Presentation as a guest at the workshop entitled "Enumeration complexity" and organized by Yann Strozecki at LaBRI in Bordeaux (France) following HighLights 2024 [`https://highlights-conference.org/2024/hcrw`].

Research Schools

March 31 to April 4, 2025 — Attended the winter school entitled "The kaleidoscope of complexity", organized at the CIRM in Luminy in Marseilles [`https://conferences.cirm-math.fr/3225.html`].

January 16 to 20, 2023 — Attended the winter school entitled "Discrete mathematics and logic: from mathematics to computer science", organized at the CIRM in Luminy in Marseilles [`https://conferences.cirm-math.fr/2758.html`].

Computer skills and programming languages

Computer science

Languages	C/C++ : Advanced notions Python : Advanced notions OCaml : Advanced notions Swift, ObjectiveC Brainf*ck, Piet bash, Makefile Haskell	Web	HTML et CSS JavaScript and PHP Apache servers DNS management SQL
OS	GNU/Linux : Ubuntu, Debian	Tools	TEX and LATEX (and expl3): expert Git, SVN SSH, FTP Trello, Jira
Proof assistant	Coq: Advanced notions Agda: Basic notions	Formal calculus	Maple

Projects

2024 — Certified compiler in coq: Micro-compiler Authenticated with Rigor via Theorems of High Elegancy M.A.R.T.H.E. (not to recall a famous English proof assistant...)

2022 — Combinatorial exploration to show the minimality of a set of 11 tiles for the aperiodic Wang tiling

2022 — Compiler of a fragment of C to RISC-V

2021 — C library and kernel module to simulate vcpus and uthreads

2021 — OCaml interpreter in OCaml (lexer, parser, evaluation, typing)

List of attended courses

For an exhaustive list of the courses that I was able to take at ENS of Lyon and at the LMFI, and their detailed content, see: [`https://www.wernermerian.fr/en/attended-courses.html`]

Spoken languages

French	Mother tongue	
English	C1 academic level	*Certificate in Advanced English (CAE): score 184*

Computer science contests

December 2023
December 2022
December 2021

CentralSupélec Intelligence and Analysis Tournament (TRACS), organised by the French intelligence agency (DGSE)

Sport

Sports performance

April 2023	Athletics : Marathon of Paris (3h51m33s)
March 2023	Athletics: Half-marathon (1h42m23s)
July 2021	Mountaineering: Ascent to the summit of Mont Blanc

Club sports

Sailing	Catamaran (Hobie Cat 16)
Combat sport	Savate (French boxing)

Other hobbies

2012- Annual participation to the Fleurance Astronomy Festival, in the Gers (France).