Nathan Grosshans

Ph.D. in Theoretical Computer Science

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Positions

09/2018 – 08/2019 **Temporary teaching and research position (ATER)**, *ENS Paris*, Paris (France).

Education

2014–2018 **Ph.D. in Computer Science**, *ENS Cachan & UdeM*, Cachan (France) & Montréal (Canada).
International joint Ph.D. between the École Normale Supérieure de Cachan and the Université de Montréal.

2013–2014 **M.Sc. in Computer Science (2nd year)**, *École Polytechnique*, Paris (France).
Parisian Master of Research in Computer Science (MPRI), jointly run with ENS Paris, ENS Cachan and Paris 7.

2012–2013 **M.Sc. in Computer Science (1st year)**, *École Polytechnique*, Palaiseau (France).
Thematic "Efficient algorithms".

2009–2012 **B.Sc. in Computer Science**, *Université de Strasbourg*, Strasbourg (France), With *High Honors*.
General Bachelor's degree in Computer Science, first year joint with the Bachelor's degree in Mathematics.

Scientific interests

Main Computational complexity theory, automata theory, logic.

Other Algorithms, computability, graph theory, algebra, geometry.

Distinctions

2017–2018 **Merit scholarship** from the **DIRO, Université de Montréal**.

2014–2017 **Doctoral stipend** from the Advanced Thematic Research Network (RTRA) **Digiteo**, project *BPLOW*.

2014–2017 **Doctoral contract** from **ENS Cachan**'s doctoral school. Declined.

2013–2014 **M.Sc. scholarship** from the **DigiCosme Labex** (excellence laboratory centre).

Research activities

September 2018 to August 2019 *1 year* **ATER position**, *Département d'Informatique de l'ENS (DIENS)*, Paris (France).

September 2014 to September 2018 *4 years* **Ph.D.**, *Laboratoire Spécification et Vérification (LSV) & Laboratoire d'Informatique Théorique et Quantique (LITQ)*, Cachan (France) & Montréal (Canada).

Subject: *The limits of Nečiporuk's method and the power of programs over monoids taken from small varieties of finite monoids.*

Thesis supervisors: Pierre McKenzie and Luc Segoufin.

Completion of the work about Nečiporuk's method. Study of the computational power of programs over monoids, a kind of restricted branching programs defined by Barrington and Thérien in the late 1980s and such that, when we restrict the monoids to come from some given variety of finite monoids and the programs to be of polynomial length, capture almost all known subclasses of NC^1. Though this gives a finite semigroup-theoretic viewpoint on most of the open questions about the internal structure of NC^1, this did not, for the moment, help to solve any of those. The following contributions of this work are very modest steps towards solutions to these questions through such a viewpoint.

- Definition of a notion of "tameness" of a variety of finite monoids entailing that polynomial-length programs over monoids taken from it cannot recognise much more regular languages than through morphism-recognition.
- Exact algebraic characterisation of the class of regular languages recognised by polynomial-length programs over monoids in $\mathbf{DA}$ and proof of some other properties of those.
- Partial results for the exact algebraic characterisation of the class of regular languages recognised by polynomial-length programs over monoids in $\mathbf{J}$ and proof of some other properties of those.

March to August 2014 *23 weeks*

Research internship, *Laboratoire Spécification et Vérification (LSV)*, Cachan (France).
Subject: *An abstract formulation of Nečiporuk's lower bound method*.
Internship supervisors: Pierre McKenzie and Luc Segoufin.
Study of Nečiporuk's lower bound method for Boolean function complexity measures. Though dating from 1966, this method still gives the best lower bounds known for the size of deterministic and non-deterministic branching programs. The limitations of the method — for these measures in particular — are well known, however, a priori, these results have never been generalised so as to be abstracted from any particular complexity measure, which was done in this work. The contributions made are the following.

- Suggestion of a formal generic definition of Nečiporuk's method based on previous works, abstracted from any particular complexity measure on Boolean functions.
- Statement and proof of some generic meta-results allowing to get, for a given complexity measure, limitation results for this lower bound method.
- Application to the known cases of the size of binary formulæ, of deterministic and non-deterministic branching programs, as well as to the new case of limited non-deterministic branching programs.

April to August 2013 *19 weeks*

Research internship, *Laboratoire d'Informatique de l'Ecole Polytechnique (LIX)*, Palaiseau (France).
Subject: *Complexité des contraintes semi-algébriques convexes*.
Internship supervisor: Manuel Bodirsky.
Study of the complexity of the constraint satisfaction problems (CSPs) on the set of reals where in addition to the usual linear relations (that is to say, the equality relations and the (large) inequality relations), one allows the use of some convex closed bounded semi-algebraic relations that are not linear (a simple example is the relation given by a constraint of the form $x^2 + y^2 \leq 1$). The work has in particular focused on the possibility to solve these problems in polynomial time thanks to the ellipsoid method, a theoretical tool well known to be adapted to this type of problems on convex sets. More precisely, the work done can be summarised through the following points.

- Study of the sufficient conditions for the use of the ellipsoid method and, to this purpose, introduction and proof of the equivalence of several properties concerning the class of sets that are definable by the non semi-linear relations for a given constraint satisfaction problem.
- Building on a generalisation of Liouville's Theorem in diophantine approximation, suggestion of a proof start to prove a conjecture stating that these properties are verified for the constraint satisfaction problems defined above (that was finally found to be false after the end of the internship) and study of some other conditions verified in this case.
- Presentation, without any other proof than this of correction, of an algorithm that allows to solve the simple problem given by the aforementioned particular example.

Teaching activities

2018–2019 *192 hours*

ATER position, *École Normale Supérieure de Paris*, Paris (France).
Teaching assistant for the following courses of the Computer Science Department.

- Formal languages, computability and complexity (1st year).
- Databases (1st year).

Secretary for the computer science oral examinations of the "X/ENS concours".

2016–2017 *64 hours*

Teaching mission, *École Normale Supérieure de Cachan*, Cachan (France).
Holder of a teaching mission for the following courses from the Computer Science Department.

- Databases project (1st year).
- Object-oriented programming project (1st year).
- Computer algebra practicals (preparation year for the "agrégation de mathématiques, option C").

2015–2016 *64 hours*

Teaching mission, *École Normale Supérieure de Cachan*, Cachan (France).
Holder of a teaching mission for the following courses from the Computer Science Department.

- Databases project (1st year).
- Computer algebra practicals (preparation year for the "agrégation de mathématiques, option C").

Summer 2015 *19 hours*

Teaching assistantship, *Université de Montréal*, Montréal (Canada).
Teaching assistant for the course "Introduction to Theoretical Computer Science" (undergraduate course).

2014–2015 *64 hours*

Teaching mission, *École Normale Supérieure de Cachan*, Cachan (France).
Holder of a teaching mission for the following courses from the Computer Science Department.

- Tutoring (1st year).
- Software engineering (2nd year).
- Computer algebra practicals (preparation year for the "agrégation de mathématiques, option C").

Publications

Nathan Grosshans, Pierre McKenzie, and Luc Segoufin. The power of programs over monoids in DA. In *42nd International Symposium on Mathematical Foundations of Computer Science, MFCS 2017, August 21-25, 2017 - Aalborg, Denmark*, pages 2:1–2:20, 2017.

Paul Beame, Nathan Grosshans, Pierre McKenzie, and Luc Segoufin. Nondeterminism and an abstract formulation of Nečiporuk's lower bound method. *ACM Trans. Comput. Theory*, 9(1):5:1–5:34, December 2016.

Participation to schools

2017	Swedish Summer School in Computer Science 2017	*KTH, Stockholm*
2015	Summer School on Lower Bounds 2015	*Charles University, Prague*

Participation to conferences and workshops

2017	42nd International Symposium on Mathematical Foundations of Computer Science	*Aalborg, Denmark*
2015	27th McGill Invitational Workshop on Computational Complexity	*Holetown, Barbados*

Other professional experience

June to July 2012 *5 weeks*

Seasonal job, *CETE de l'Est – Laboratoire Régional des Ponts et Chaussées*, Strasbourg (France).
Casual worker web developper for the Acoustics Unit.

- Realisation of the interfacing of a C++ library estimating the road noise emission with the Drupal CMS (coding of a PHP extension and a Drupal module).
- Exploration of the possible solutions to use Scilab code in a webpage.

May to August 2011 *10 weeks*

Internship, *Ready Business System (RBS)*, Entzheim (France).
Work on the ShoreTel unified communication platform.

- Exploration activities on the platform: installing, implementing and testing advanced features of the telephony system, as well as writing documentation (installation, operating and maintenance procedures).
- Work for clients: installation, advanced configuration and training.
- Preparation and realisation of presentations and demonstrations for prospective clients (pre-sale).

July to August 2010 *5 weeks*

Seasonal job, *Mott Metallwaren und Bühnenbau*, Tauberbischofsheim (Germany).
Manufacturing of wooden/metal goods.

- Assembly of different mobile stage elements models.
- Packing and preparation of pallets ready to be delivered.
- Preparation and pre-cut of the slabs intended to be incorporated into the stage elements.

August 2008 and April 2009 *1 month and 1 week*

Seasonal job, *Ready Business System (RBS)*, Entzheim (France).
IP telephony technician.

- Deployment of IP telephony platforms (VoIP): setup of the VoIP private branch exchange (Asterisk server on CentOS) and the IP phones, integration of those into the local network.
- Accompanying interventions for clients.
- Preparation and installation of VoIP private branch exchanges, configuration of those to meet clients' needs.

Linguistic ability

German	Read, written and spoken	*Mother tongue*
English	Read, written and spoken	*TOEFL ITP: 657/677*
French	Read, written and spoken	*Main language*

Computing skills

Languages	C, C++, Java, OCaml, assembly language (MIPS), bash, SQL, PL/SQL, PHP, HTML, Python, LaTeX.
OSes	Linux-based operating systems, MacOS, Windows.