

# Nathan GROSSHANS

*Student in Theoretical Computer Science*

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## Education

- 2014–Present **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.S. in Computer Science (2<sup>nd</sup> 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.S. in Computer Science (1<sup>st</sup> year)**, *École Polytechnique*, Palaiseau (France).  
Thematic “Efficient algorithms”.
- 2009–2012 **B.S. 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

- 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.S. scholarship** from the **DigiCosme Labex** (excellence laboratory centre).

## Research activities

- September 2014 to March 2018 **Ph.D.**, *Laboratoire Spécification et Vérification (LSV) & Laboratoire d’Informatique Théorique et Quantique (LITQ)*, Cachan (France) & Montréal (Canada).  
2018 Subject: *Applications and limits of recent branching program lower bounds*.  
3 years and 6 months (expected) Thesis supervisors: Pierre MCKENZIE and Luc SEGOUFIN.  
Computational complexity aims at classifying computational problems according to the amounts of resources needed for solving these problems. The challenge that arises is often the lower bounds issue: given a problem and an apparently optimal solution strategy for it, back the intuition up with a formal mathematical proof that no better strategy exists. A flurry of recent work has focused on the branching program computation model. The goal of this project is
1. to push these results further,
  2. to explain the limits of these methods and
  3. to cross-breed these methods (in particular those that pertain to the tree evaluation problem) with the techniques developed over the course of a decade to capture the power of tree automata models and their precise logical characterisations.
- March to August 2014 **Research internship**, *Laboratoire Spécification et Vérification (LSV)*, Cachan (France).  
23 weeks 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 **Research internship**, *Laboratoire d'Informatique de l'Ecole Polytechnique (LIX)*, Palaiseau (France).  
Subject: *Complexité des contraintes semi-algébriques convexes*.  
19 weeks 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

2016–2017 **Teaching mission**, *École Normale Supérieure de Cachan*, Cachan (France).

64 hours Holder of a teaching mission for the following courses from the Computer Science Department.

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

2015–2016 **Teaching mission**, *École Normale Supérieure de Cachan*, Cachan (France).

64 hours Holder of a teaching mission for the following courses from the Computer Science Department.

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

Summer 2015 **Teaching assistantship**, *Université de Montréal*, Montréal (Canada).

19 hours Teaching assistant for the course "Introduction to Theoretical Computer Science" (undergraduate course).

2014–2015 **Teaching mission**, *École Normale Supérieure de Cachan*, Cachan (France).

64 hours Holder of a teaching mission for the following courses from the Computer Science Department.

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

## Publications

[BGMS16] Beame, Paul, 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, ISSN 1942-3454. <http://doi.acm.org/10.1145/3013516>.

## Other professional experience

June to July 2012 **Seasonal job**, *CETE de l'Est – Laboratoire Régional des Ponts et Chaussées*, Strasbourg (France).

5 weeks Casual worker web developer 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 **Internship**, *Ready Business System (RBS)*, Entzheim (France).

10 weeks 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 **Seasonal job**, *Mott Metallwaren und Bühnenbau*, Tauberbischofsheim (Germany).

5 weeks 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 **Seasonal job**, *Ready Business System (RBS)*, Entzheim (France).  
and April 2009 IP telephony technician.

- 1 month and 1 week*
- 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.

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## Linguistic ability

German Read, written and spoken  
English Read, written and spoken  
French Read, written and spoken

*Mother tongue*

*TOEFL ITP: 657/677*

*Main language*

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## 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.