

Alexis TOUMI

EDUCATION

- 2018 – 2022 **DPhil Computer Science**, *University of Oxford*.
Oxford–DeepMind Graduate & Harrisson Scholarship for Quantum Foundations.
- 2016 – 2018 **MSc Mathematics & Foundations of Computer Science**, *University of Oxford*.
Categories, Proofs & Processes (99), Quantum Computer Science (95), Categorical Quantum Mechanics (70), Distributional Models of Meaning (82), Computational Game Theory (98).
- 2012 – 2015 **BSc Computer Science**, *University of Oxford*, (First-Class Honours).
Lambda Calculus, Computational Complexity, Learning Theory, Knowledge Representation.

RESEARCH

- DPhil Proposal: *Quantum Structures for Linguistics, Cognition and Artificial Intelligence*, under the supervision of Prof. Coecke and Dr. Marsden.
- o I'm responsible for the logistics of the [Wolfson Quantum Foundations](#) seminars.
 - o I help organising a seminar series on compositional cognitive models which involves computer scientists, linguists, physicists, neuroscientists and philosophers.
- MSc *Categorical Compositional Distributional Questions, Answers & Discourse Analysis*, supervised by Prof. Coecke. My talk presenting [1] at CAPNS 2018 is [available here](#). I gave a presentation of [2] at [L'agape, Workshop on the Foundations of Physics](#).
- BSc *Equilibrium Checking in Reactive Modules Games*, supervised by Dr. Gutierrez and Prof. Wooldridge. For a high-level presentation of equilibrium checking, see [3]. I gave a demonstration of [4] at ICTAC 2015 and participated in the summer school.

PUBLICATIONS

- [1] B. Coecke, G. de Felice, D. Marsden, and A. Toumi. "Towards Compositional Distributional Discourse Analysis". In: *Electronic Proceedings in Theoretical Computer Science* 283 (Nov. 2018), pp. 1–12. ISSN: 2075-2180. DOI: 10.4204/EPTCS.283.1.
- [2] B. Coecke, F. Genovese, M. Lewis, D. Marsden, and A. Toumi. "Generalized Relations in Linguistics & Cognition". In: *Theoretical Computer Science* (2018). ISSN: 0304-3975. DOI: 10.1016/j.tcs.2018.03.008.
- [3] M. Wooldridge, J. Gutierrez, P. Harrenstein, E. Marchioni, G. Perelli, and A. Toumi. "Rational Verification: From Model Checking to Equilibrium Checking". In: *Proceedings of the Thirtieth AAAI Conference on Artificial Intelligence, February 12-17, 2016, Phoenix, Arizona, USA*. 2016, pp. 4184–4191.

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- [4] A. Toumi, J. Gutierrez, and M. Wooldridge. "A Tool for the Automated Verification of Nash Equilibria in Concurrent Games". In: *Theoretical Aspects of Computing - ICTAC 2015 - 12th International Colloquium Cali, Colombia, October 29-31, 2015, Proceedings*. 2015, pp. 583–594. DOI: 10.1007/978-3-319-25150-9_34.

TEACHING

- 2019 **Computational Complexity**, *University of Oxford*, Class Tutor.
Turing machines, time and space complexity, randomisation, interactive proof systems.
- 2018 **Data Science with Python**, *ESILV Paris*, Teaching Assistant.
Feature extraction from images, clustering, classification. Methodology for model evaluation.

WORK EXPERIENCE

- 2017 – 2018 **Data Scientist**, *Institut de Recherche et d'Histoire des Textes – CNRS*, Paris.
Deep neural networks for the automated analysis of manuscripts from the Middle Ages.
Development of an integrated processing pipeline from document identifiers to visualisation.
- 2015 – 2016 **Data Scientist – R&D Intern**, *Tinyclues*, Paris.
Tensor factorisation on complex relational data: users, products, emails, clicks and sales.
Cluster analysis for catalog segmentation. Prediction of email targeting performance.
- 2014 – 2015 **Data Scientist – Summer Intern**, *Yonderlabs*, Berlin.
Probabilistic graphical models (HMM and CRF) applied to natural language processing.
Graphical analysis of the named-entity network extracted from a corpus of news articles.

PROGRAMMING SKILLS & LANGUAGES

- Languages Strong communication skills, verbal and written, in both English and French.
Basic German and beginner Arabic.
- Functional *Haskell, OCaml.* Python *numpy, pandas, sklearn, nltk.*
- OOP *Java, Scala.* Databases *SQL, RDF, OWL.*
- ML Deep neural network architecture and training. Distributional models for NLP.

OTHER INTERESTS

- Philosophy I am especially interested in Spinoza's ontology and its developments in Hegel, Bergson, Wittgenstein and Deleuze. I also like to delve into philosophy of mind, physics, language and mathematics.
- Literature Poetry (Rimbaud, Baudelaire), theatre (Camus, Ionesco), fiction (Kafka, Borges).
- Music I have been mixing electronic music, digital and vinyl, for 10 years.

Dear applied category theorist,

I'm a first-year DPhil student, my expected submission date is 2022. In one sentence, my thesis focuses on extending compositional distributional models of meaning beyond the sentence boundary to deal with language in context: from syntax through semantics to pragmatics. This happens to fit precisely with:

1. Mehrnoosh Sadrzadeh: *Formal and experimental methods to reason about dialogue and discourse using categorical models of vector spaces.*

I have already met Mehrnoosh to discuss problems of anaphora and references while working on [1]. Two other projects which would greatly contribute to my research (in order of preference):

2. Miriam Backens: *Simplifying quantum circuits using the ZX-calculus.*
3. David Spivak: *Toward a mathematical foundation for autopoiesis.*

I have had the occasion to work with the ZX calculus during my masters and celebrated its 10-year anniversary at the ZX Fest last year. More recently I studied regular logic, which models the conjunctive queries underlying the semantics of anaphora resolution as developed in [1].

Statement:

After a couple of years following attentively the recent developments in applications of category theory (e.g. in the blog posts of the n-category café, the talks of the Simon Institute's *Compositionality* workshop 2016 or of the previous ACT conference 2018) I believe that the adjoint school would be the ideal context in which to start playing a more active role in this thriving community.

My work so far has followed two parallel threads, which at first sight can appear as unrelated: foundations of quantum theory on one side, artificial intelligence and natural language processing on the other. I aim at unraveling the common points between these applications and unify them as part of the same conceptual framework: monoidal categories as compositional theories of processes.

Game theory is yet another application which has recently been given a categorical treatment, using tools from functional programming which relate to the project:

4. Bartosz Milewski: *Traversal optics and profunctors*

This is of particular interest to me, as it would allow to model pragmatics of natural language dialogue by formalising Wittgenstein's concept of *language games*, one example of such a game being the question and answers which have been the topic of my MSc thesis.

Furthermore, this would represent a significant step towards a bridge with my previous work on the complexity of equilibrium checking in multi-agent systems [3] [4]. Indeed, it would be highly valuable to tackle game complexity with a categorical approach, e.g. along the line of the project:

5. Pieter Hofstra: *Complexity classes, computation, and Turing categories*

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To conclude, the ACT conference and its associated summer school would allow me to make a meaningful contribution to the field, supervised by senior researchers; as well as developing my presentation skills while interacting with fellow students from a wide range of disciplines.

Categorically yours,

Alexis TOUMI

Attached: curriculum vitæ

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Oxford, February, 2019.

Letter of recommendation for Alexis Toumi, ACT

When Alexis Toumi applied for a PhD position here, he was one of the strongest (if not the strongest) applicants I have ever seen, and I have seen many! I consider him to be one of the two strongest PhD students I currently have (out of 20+, jointly with Giovanni de Felice, who also applied for the ACT school).

When he applied for a PhD position he already had four papers, spanning a broad range of disciplines: game theory, models of cognition, and practical natural language processing. His current work also includes quantum computational complexity. All of his marks in Oxford's prestigious MFoCS MSc program where a stellar +90%, with several close to 100%. At the same time, he has industry experience working with neural networks. Immediately when starting his MFoCS studies he engaged in two series of weekly research meetings, one on quantum calculi and one on NLP and cognition, and one on ZX calculus. His participation in the former resulted in two papers, the second of which him and Giovanni de Felice were the lead researchers.

Alexis is an Applied category Theorist in heart and soul, taking category theory to be his main language, and then applying it to practical real world problems, his core focus being in NLP and AI. He has a very broad knowledge on that field, at the level of what one would expect from an experienced researcher, and is super-passionate about science across a wide range of disciplines.

You may notice some parallel in this letter with the one for Giovanni de Felice, and that's because the two of them are a bit of a tandem. Besides their joint work, they do have their separate stands as well, with distinct teams of collaborators. Both of them are indeed great team players and hence would do particularly well at the ACT School. I put my strongest possible recommendation for the school behind these two applicants!

All together, I would say that this is a clear no-brainer...

Sincerely,

Bob Coecke
Head of the Quantum Group,
Professor of Quantum Foundations, Logics and Structures,
Department of Computer Science,
University of Oxford.