

Giovanni de Felice

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EDUCATION

- 2017 – 2021 **DPHil Computer Science**, *University of Oxford*.
Oxford-Wolfson Marriott Graduate Scholarship in Computer Science
- 2016 – 2017 **MSc Mathematics & Foundations of Computer Science**, *University of Oxford*.
Categories, Proofs & Processes (96), Quantum Computer Science (94), Categorical Quantum Mechanics (86), Distributional Models of Meaning (79), Computational Game Theory (97).
- 2013 – 2016 **BSc Mathematics**, *Imperial College London*, (First-Class Honours).
Algebraic topology, Group theory, Galois theory, High performance computing.

RESEARCH

- DPHil Proposal: *Symmetry and Dynamics in Process Theories*, under the supervision of Prof. Coecke and Dr. Marsden. My research focuses on the interplay between categorical logic and representation theory, with the aim of developing a categorical framework for planar and braided process theories. This has found applications in quantum computer science [1] and natural language processing [2].
- MSc Thesis: *Hopf algebras in Quantum Computation*, supervised by Prof. Coecke, *MSc prize for excellence*. A string-diagrammatic treatment of the representation theory of Hopf algebras and their applications to topological quantum computation.
- UROP *Elliptic Curves and Group Cohomology*, supervised by Prof. Skorobogatov. Summer project funded by the department of Mathematics at Imperial College London. Related topics: galois theory, p-adic analysis, elliptic curves.
- BSc Group project: *Crystallographic Groups and Dunkl Analysis*, supervised by Prof. Zegarlinski. *Winton Capital prize* for best second year project. Related topics: symmetry, group theory, quantum mechanics.

PUBLICATIONS

- [1] A. Hadzihanovic, G. de Felice, and K. F. Ng. “A Diagrammatic Axiomatisation of Fermionic Quantum Circuits”. In: *3rd International Conference on Formal Structures for Computation and Deduction (FSCD 2018)*. Ed. by H. Kirchner. Vol. 108. Leibniz International Proceedings in Informatics (LIPIcs). Dagstuhl, Germany, 2018, 17:1–17:20. ISBN: 978-3-95977-077-4. DOI: 10.4230/LIPIcs.FSCD.2018.17.
- [2] 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. arXiv: 1811.03277.

TALKS

- Dec. 2018 **Universal quantum computation with fermionic linear optics**, *University of Oxford*, Quantum Lunch.
- July 2018 **A diagrammatic axiomatisation of fermionic quantum circuits**, *University of Oxford*, FSCD 2018.
- June 2018 **The fermionic ZW calculus**, *Dalhousie University*, QPL 2018.

TEACHING

- 2019 **Categorical Quantum Mechanics**, *University of Oxford*, Class Tutor.
Frobenius and Hopf algebras in monoidal categories, linear and dagger structures, complete positivity, introduction to higher categories
- 2018 **Quantum Computer Science**, *University of Oxford*, Class Tutor.
String diagrams, classical-quantum interaction, ZX calculus, quantum foundations.

WORK EXPERIENCE

- Sept 2016 **Market research**, *LVenture Group S.p.a*, Rome.
Market analysis for the start-up accelerator LUISS Enlabs.
- Summer 2016 **Voluntary work**, *World Wide Opportunities in Organic Farms*, Matera, Italy.
Volunteered in a farm focusing on sustainable agriculture.

PROGRAMMING SKILLS & LANGUAGES

- Languages: Fluent in English, French and Italian. Basic German.
- Programming: Python, C, Haskell, Matlab.
- Calculi: Lambda calculus, ZX calculus, ZW calculus.

INTERESTS

- Physics: I co-organise the Quantum Foundations seminar series at Wolfson College.
- Theatre: I acted in the movie "Diaz" by Daniele Vicary and in the theatre company Dynamis.

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ACT 2019

Adjoint School – Application

January 30, 2019

Dear applied category theorist,

I am a second-year PhD student and expect to graduate in 2021. I use functorial semantics and representation theory to study applications of braided and planar autonomous categories including linear optical and topological quantum computation, as well as natural language processing.

The Adjoint School would be a unique opportunity to play a role in the flourishing ACT community, working on cutting-edge applications of category theory supervised by leading researchers in the field.

Since I learned about the ZX calculus during my masters degree, I have been an active member of the ZX community. As a first-year DPhil, I started to work on the ZW calculus then on its relationship to ZX through dual-rail encodings (a long version of [1] is in preparation). The following project would be a great contribution to my research on this path.

1. Miriam Backens: *Simplifying quantum circuits using the ZX calculus.*

In parallel to my work on quantum computer science, I have been involved in the developments of the compositional distributional models of natural language. After fruitful discussions with Mernoosh Sadrzadeh and Ruth Kempson, my work in this direction has focused on modeling cross-sentence interaction through anaphoras and coreference [2].

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

Building on [2], I have studied relational databases and regular logic as a semantics for natural language discourse. It would be very interesting to see how these same structures can play a role in modeling a broader class of processes.

3. David Spivak: *Toward a mathematical foundation for autopoiesis.*

Motivated by the possibility to draw connections between different disciplines, I am always eager to extend my categorical toolbox. Interest in universal algebra has led me to study different variants of monads, including Hopf monads and the Girmonad which features in:

4. Tobias Fritz: *Partial evaluations, the bar construction and second-order stochastic dominance*

To conclude, the ACT summer school and conference would be a wonderful opportunity to interact with students from a variety of scientific fields and share my passion for category theory.

Yours fully faithfully,

Giovanni de Felice

Attached: curriculum vitæ



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**COMPUTER
SCIENCE**

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Oxford, February, 2019.

Letter of recommendation for Giovanni de Felice, ACT

I consider Giovanni de Felice to be one of the two strongest PhD students I currently have (out of 20+, jointly with Alexis Toumi, who also applied for the ACT school).

Although only one year in his PhD work he has already two published papers and two more ready for publication, spanning a broad range of disciplines: quantum computing, practical natural language processing, and quantum algebra. The first and the latter are particularly outstanding pieces of work, the 1st one being a completeness theory from the fermionic fragment of ZW-calculus, which was highly unexpected, and the second one being in collaboration with Shahn Majid, one of world-leading figures in the area of quantum algebra.

All of his marks in Oxford's prestigious MFoCS MSc program where a stellar +90%, with several close to 100%. 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 both resulted in two papers, one in each area. For the 1st him and Alexis Toumi were the lead researchers, and the second was a collaboration with two other PhD students.

Giovanni 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 as well as foundational physics and pure maths problems. He has a very broad knowledge of the fields in which he works, 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 Alexis, 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.