

**An explanation of any relevant background you have in category theory or any of the specific projects areas**

I am familiar with the use of category theory in natural language acquisition and processing (NLP) and TQFT and I am aware of its use in chemical reaction networks, causality, systems theory, etc. However, my research concerns applying category theory to biological neural networks (BNN) with the goal of writing an algorithm that models the self-assembling circuitry of BNN. This is why I am interested in Spivak's team.

Previously, I have developed the n-Morph category (a relaxed combination of n-Fold and Arrow categories) to model the structure of BNN. Last summer, I worked under Prof. Bob Coecke, formalizing the type rules of BNN based on the molecular sequences triggering synaptogenesis and pruning. Because end goal of my project is for the algorithm to be capable of NLP, I am interested in Sadrzadeh's team.

I have drawn a Toffoli gate with BNNs and am interested in seeing how my algorithm relates to quantum computing. For this reason, I am interested in Backens' team.

**The date you completed or expect to complete your Ph.D and a one-sentence summary of its subject matter.**

I am an undergraduate and expect to complete my Bachelor degree next year. I plan to go to graduate school after that.

**Order of project preference**

1. Toward a mathematical foundation for autopoiesis
2. Formal and experimental methods to reason about dialogue and discourse using categorical models of vector spaces
3. Simplifying quantum circuits using the ZX-calculus
4. Complexity classes, computation, and Turing categories
5. Partial evaluations, the bar construction, and second-order stochastic dominance
6. Traversal optics and profunctors

**To what extent can you commit to coming to Oxford (availability of funding is uncertain at this time)**

Over the next few weeks, I will be applying for funding for a summer internship, most likely somewhere in Europe. Once that is secured, I can commit to coming to Oxford.

**A brief statement (~300 words) on why you are interested in the ACT2019 School. Some prompts:**

**how can this school contribute to your research goals?**

**how can this school help in your career?**

I started research in biology but changed my major from chemistry to math. So background-wise, I am all over the place. As a result, most of my past research has been interdisciplinary and so is my current research in applied category theory. I hope to have a career in applied categories because it is flexibly interdisciplinary so I am always on the lookout for potential future project areas.

Of course, I can look up papers on my own but I am specifically interested in the school because I need more practice. In past category theory conferences, I have not been able to follow the talks as well as I would like to. I hope the detailed discussions in the ACT2019 school will help me to get the most from future conferences.

My experience in applied category is tailored to my project so I hope the school will help me to broaden my scope, particularly in understanding the abilities and limitations of categories by looking at how they are used in papers intersecting with disciplines other than my own. I am also looking forward to exchanging ideas with other students as it is difficult to find peers in applied category theory outside such programs. I want to observe others at work and see what their mathematical toolkit looks like so I know which tools to add to my own.

# Lyra H. Jung

lyra@alytra.com (718)-714-8319

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## EDUCATION

California Institute of Technology — B.S. Math, 2020

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## EXPERIENCE

\* = Started as an independent project.

### Research Experience, Independent — 2008–Present

Porphyrins for Optical Computing Memory Systems\*

Field: Organometallic and Physical Chemistry

### Research Assistant, University of Oxford — 2018

Categorical Representation of Semantic Information in the Brain\*

Mentor: Prof. Bob Coecke

Field: Applied Category Theory, Mathematics

### Research Assistant, University of California Los Angeles — 2017–Present

Categorification of Biological Neural Networks\*

Mentor: Prof. Mason Porter

Field: Applied Category Theory, Mathematics

### Research Assistant, California Institute of Technology — 2011–2012

Phospholipids as LOX-1 Inhibitors\*

Mentor: Prof. Douglas Rees

Field: Cardiovascular Drug Development

### Research Assistant, Columbia University — 2011–2012

Length dependence of the conductivity of single DNA molecules that bridge a carbon nanotube gap

Supervisor: Prof. James Hone

Field: Nanotechnology, Mechanical Engineering

### Research Assistant, Columbia University — 2010–2011

Development of Cyclopropanones as Broadly Useful Asymmetric Catalysts

Supervisor: Prof. Tristan Lambert

Field: Organic Chemistry

### Research Assistant, New York University — 2009–2010

Uptake of Sulfa Drugs from Aqueous Solutions by Marine Algae

Supervisor: Prof. Neville Kallenbach

Field: Environmental Biochemistry

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## **PUBLICATIONS**

Navarro, A.E., **Lim, H.**, Chang, E., Lee, Y., Manrique, A.S., “Uptake of Sulfa Drugs from Aqueous Solutions by Marine Algae.” Separation Science and Technology, vol. 49, no. 14, 2014, pp. 2175–2181., doi:10.1080/01496395.2014.926930.

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## **MANUSCRIPTS IN PREPARATION**

**Jung, L.H.**, Categorification of Biological Neural Networks

**Jung, L.H.**, Categorical Representation of Semantic Information in the Brain

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## **SKILLS**

Fluent: English, Korean

Intermediate: Python

Elementary: Spanish

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## **AWARDS**

Caltech Summer Undergraduate Research Fellowship — 2012  
Phospholipids as LOX-1 Inhibitors



DEPARTMENT OF  
**COMPUTER  
SCIENCE**

Head of Department: Professor Michael Wooldridge  
Direct Line Tel: +44 (0)1865 283503  
Email: [mjw@cs.ox.ac.uk](mailto:mjw@cs.ox.ac.uk)  
Departmental Administrator: Sharon Lloyd  
Direct Line Tel: +44 (0)1865 283668  
Email: [sharon.lloyd@cs.ox.ac.uk](mailto:sharon.lloyd@cs.ox.ac.uk)  
Academic Administrator: Shoshannah Holdom  
Direct Line Tel: +44 (0)1865 273863  
Email: [academic.admin@cs.ox.ac.uk](mailto:academic.admin@cs.ox.ac.uk)

Oxford, February, 2019.

**Letter of recommendation for Lyra Jung, ACT**

Last summer Lyra Jung visited our group, fully on her own initiative, and on her own money, to learn more about Applied Category Theory. Although still an undergraduate, she had put together a research proposal paving the foundations for categorical neuroscience. Lyra is clearly extremely motivated and wholeheartedly embraces ACT. She interacted well with the people here with a shared interest, and is clearly devoted to actual research, rather than merely being a student.

Lyra seems to be quite isolated at CalTech, so the ACT School would be a great opportunity for her to work with core people from the ACT community. I have no doubt that Lyra will progress to becoming a researcher, but she does need some guidance from the broader community.

Therefore I strongly recommend that she would be admitted to the ACT School.

Sincerely,

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