CV: Oliver Richardson

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SUMMARY

I am a PhD Candidate at Cornell University, in theory of AI and Progamming Languages, advised by Joe Halpern. Everything interests me! But especially mathematical foundations of agents, particularly knowledge representation, reasoning, and senses of naturality or aesthetic. I have an unusually broad academic background, and have a particular afinity for making pretty things out of code. Before getting into research, I made video games!

EDUCATION

Cornell University

Current PhD Candidate in the theory, machine learning, and programing languages groups.
Expected graduation: August 2024.

University of Cambridge

Master of Philosophy (MPhil) in Advanced Computer Science, 2018.

University of Utah

Honors BS in Computer Science.
BS in Mathematics.
BS in Biology (Cell & Molecular).
Minors in Chemistry, Physics, and Cognitive Science.

Cumulative GPA: 3.85
Graduated Spring 2017

SERVICE @CORNELL

- Computer Science Graduate Organization (CSGO) Secretary: 4 semesters.
- TA Hour Reporting System: Development and Maintenance.
- I organize Cornell's weekly computer science student seminar (9 semesters).
- PhD applicant reviewing.
- I review for AISTATS.

SELECTED LEAD-AUTHOR CONFERENCE PAPERS

Inference for Probabilistic Dependency Graphs [UAI'23]

Coauthors: Joseph Y Halpern and Christopher De Sa.

Polynomial inference algorithm for PDGs of bounded treewidth, through exponential conic programming. A linear reduction from PDG inference to the problem of approximating a PDG's degree of inconsistency.

Loss as the Inconsistency of a PDG:
Choose your Model, not your Loss Function [AISTATS'22]

Sole author. Among 10% accepted for oral presentation.

A universal loss function: just model the inconsistency of the the appropriate PDG. Yields a visual proof language for inequalities.

Probabilistic Dependency Graphs [AAAI'21]

Coauthor: Joseph Y Halpern.

A generalization of Baysian Networks and Factor Graphs, which can represent inconsistent belief states. Semantics allow for separation between qualitative and quantitative information; we argue they are a particualrly natural modeling tool.

ADDITIONAL RESEARCH PROJECTS

The Local Inconsistency Resolution Algorithm
[SPIGM / LLW WORKSHOPS ICML'23]

Sole Author. Introduce parameterized PDGs, and a generic algorithm for resolving inconsistency. Show how GANs, message passing, adversairal training, the EM algorithm and others, are all instances of a single algorithm for resolving inconsistency in parametrized PDGs.

Mixture Languages [LAFI WORKSHOP POPL'23]

Co-author: Jialu Bao. An alternate continuous-time notion of concurrency, and a programming language whose semantics are given in such terms.

[*Masters Thesis*] Diagrammatic Reasoning *with Mateja Jamnik* — 2017-2018

Title: *Shapes, Proofs, and Programs: A Unified Theory of Diagrammatic Reasoning.* Began as a web portal for `DIAMOND`, Mateja's diagrammatic reasoning system, but became a theoretical unification of several diagrammatic representations for proofs. I introduce "woven diagrams" as a mixed topological / geometric representation that can be interpreted as programs or proofs.

[*UGrad Thesis*] Trigonal Tropical Curves *with Aaron Bertram* — '15-'17

A tropical geometry project regarding hyperliptic and trigonal graphs and their divisors; classification of "general" such curves. Showed that the twist of a trigonal curve as a ruled surface is visible from its tropical graph.

[*UGrad Thesis*] Supersense Classification *with Vivek Srikumar* — '16-'17

Improvements upon state-of-the art preposition supersense classification by jointly predicting supersense labels for nouns and verbs; found joint encoding to inform features.

Effect of Representation on Recall *with Sen Cheng* — SUMMER 2016

DAAD RISE (German Exchange) Research Project: simulations regarding the interaction between episodic and semantic memory, in the Cheng Computational Neuroscience lab in Bochum.

Mathematical Neurobiology REU *with Sean Lawley* — 2014-2015

Looked at and made changes to a model of facilitated diffusion along microtubules; also improved upon a system of ODEs designed to capture precise timing in a neural network model, by generalizing it to a continuous neural field and removing the global inhibitory constraint.

Organic Chemistry Game *with Holly Sebahar* — 2014-2015

Java project to replace homework in ochem classes with an automated system. Everything in the game is made of particles, that come together to form different shapes. When objects are far away, they are 'delocalized', and appear like normal game objects, but then re-arrange to form molecules when the player approaches. Project was lost with a bent thumb drive.

Further Publications and Presentations

Complexity & Scale: Understanding the Creative [IACAP'14]

Sole-author student paper, presented at the International Association for Computing and Philosophy conference (IACAP) in Thesaloniki, Greece.

An approach to explaining novelty and creativity based on information theory: integrate (Kolmogorov) complexity of embeddings across scale.

Capitalization in the St. Petersburg Game PPE 2012

Mariam Thalos and Oliver Richardson. Published in Politics, Philosophy, and Economics. Presented at CiE 2012: Turing Centenary Conference in Cambridge.

Work and Volunteer Experience

CHAI/BAIR Research Collaborator Summer 2021

Exploring metrics for goal-directedness in reward functions, and looking into alternate foundations for reward-free reinforcement learning. Investigating stability of RL / IRL loops.

Senior Summer Camp Counselor Summer 2017

Developed and lead activities for a leadership-focused camp group at a Jewish Community Center. Content included voting mathematics, government simulations, and improv games

Application Engineer for Canyons School District Summer 2016

Maintained a variety of district webpages. Built some applications from scratch, and re-wrote others to simplify them. Also made form-building utilities to to simplifty the process of making a front-end portal, and a datatables view independently for each project. Learned both front and back-end web development. (HTML5, CSS, ColdFusion, interface with and set up databases, use JQuery and plugins (e.g. datatables).

Camp Einstein Volunteer Summer 2015

Teaching science to elementary students on the Navajo Reservation. We travel to the reservation for a week, and orchestrate hands-on science experiments using household items.

Science Cohort and Tutoring 2013-2016

I lived in a science community, where I thought people how to program, and provided help with a number of subjects, particularly math, physics, organic chemistry, and CS.

Lab Aide at the U of U NanoFab 2013-2014

Judgement Day Testing Suite for School Districts 2011

Complete software suite that serves as a test creator, administers tests, aggregates data, and has analysis tools. *Features complex question types: diagram drawing, matching, MAZE reading questions. Supports various levels of feedback, and anonymous peer grading.*

Programming Projects

- Swipe-based interface for a retroactive retroactive calendar and analytics with analytics
- Graphical Calendar and assignment organizing software / contact book
- 3D software renderer and Game Engine with Gouroud and textured pixel-by pixel shading
- Blender-style 3D stick figure animation creator for custom game engine
- Top-down RTS engine with A* path-finding, dynamic lights, fog of war, particle effects
- 3D Rigid body physics engine
- Computer Algebra System
- Reaction/Diffusion Morphogenesis simulations
- Many 2D games
  - Othello + AI
  - Evil Tetris
  - Nano-wars RTS clone
  - Tower defense games
  - . . .
- GameJam 2015: *Lingering* – what happens after you beat the final boss?

See repositories at http://gitlab.com/zaytuna and http://github.com/orichardson for code and a more complete listing

AWARDS AND SCHOLARSHIPS

March 2016	**DAAD RISE Award** *German Research Stipendium*
March 2016	**Putnam Award** *Highest Score on the Putnam Exam at the University of Utah*
March 2016	**Undergraduate Problem Solving Contest, first place** *Local Math Competition at the University of Utah*
September 2016	University of Utah Marshall Scholarship Endorsee
October 2016	University of Utah Churchill Scholarship Endorsee
October 2016	ACM-ICPC, Rocky Mountain regional — second place at site, sixth overall *The International Collegiate Programming Contest is a timed coding challenge with teams of three people. The Rocky Mountain includes the mountain time zone of US and Canada*
March 2015	Intermountain Math Contest, Second Place *Like the Putnam Exam, except slightly easier and local to Utah schools*
April 2015	College of Engineering Computing Faculty Scholarship
March 2015	Susan B. Christianson Memorial Mathematics Scholarship
April 2015	Mathematical Contest in Modeling (MCM) Honorable Mention *The MCM is a four-day-long competition with teams of three people, to write a 20-50 page paper in applied mathematics*
October 2015	ACM-ICPC, Rocky Mountain regional — second place at site, fifth overall
April 2015	College of Engineering Computing Faculty Scholarship
April 2014	Honors College Faculty Scholarship
April 2013	University of Utah Honors at Entrance Award *Awarded for academic achievement in high school, provides full tuition waivers for all 8 semesters at the University of Utah*
2012	Science Fair: First Place Symantec Software Award ($10000, SLVSEF)

Selected UGrad Coursework

Computer Science

5650 – Visual Perception in Graphics
5350 – Machine Learning
5300 – Artificial Intelligence
5340 – Natural Language Processing
5130 – Intro to Robotics
5110 – Formal Verification
5150 – Advanced Algorithms
6390 – `[graduate]` Information Extraction

Math

5320 – Intro to Modern Algebra (I and II)
5520 – Intro to Topology (I and II)
4200 – Complex Analysis
4800 – Algebraic/Tropical Geometry Research
5120 – Math Biology (I and II, focus on PDE's)
6520 – `[graduate]` Algebraic Topology

Other

`PHYS 4410` – Classical Mechanics
`PHYS 4420` – Electrodynamics
`PHYS 5650` – Quantum Mechanics
`PHYS 5110` – Particle Physics
`PHIL 5200` – Advanced Deductive Logic
`BIOL 5275` – Microbe Genome Evolution
`BIOL 5665` – Paleophysiology
`BIOL 5030` – Immunology
`LING 3160` – Language and Cognition

PhD Coursework

Societies and Engagement

Cornell University

Secretary for the CS Graduate Organization (4 terms).
Grad Seminar Organizer (4 terms).

University of Cambridge

Hack Cambridge
Trinity Math Society
Churchill College Football Team
Churchill College Frisbee Team
Cambridge Show Choir

University of Utah

Hack the U
ACM ICPC Programming Competition
U of U Undergrad Problem Solving Contest
Putnam Exam
Global Game Jam
Mathematical Contest in Modeling (MCM)
Philosophy Club
RoboUtes
The Utah Robotic Mining Project

Masters Coursework

Category Theory

An introduction to category theory, with emphasis on the connections to type theory, logic, and abstract interpretation. Covered distributive categories, natural transformations, representativity via Yoneda embeding, adjoint functors, toposes, and monads. As part of this course, each member of the class expanded on and typeset two lectures, which together form an introductory text.

Algebraic Path Problems / Applications to Routing

A formal exploration of semirings, and similar structures with relaxed axioms. How to build them with algebraic combinators, and prove their properties. Focused on representing routing protocols with algebra rather than algorithms — case studies of RIP, and BGP (algebraically: a non-distributive bi-semigroup) and examples where distributed Bellman Ford does not converge; how to fix this.

Computer Vision

Calibration, Tracking Features, Image Stitching, CNN's, Epipolar Geometry, etc.

Associated Research Project: Analysis of Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs) with respect to their ability to create training data for classifiers. Showed that style transfer is a more effective way of generating training data, but does not offer adversarial protection.

Affective Computing

Emotional models, facial action units, analysis of body expressions. Focus on network architectures for state-of-the-art systems, and impact of audio/visual feature fusion at different stages. Reinforcement learning and emergence of proto-emotions in autonomous robots.

Associated Research Project: Unsupervised extraction of the temporal structure of emotional plot arcs from anime, done with a bootstrapping technique using musical analysis, and network-generated facial and vocal features.

Advanced Functional Programming

Type theory, Abstraction and Paramatricity, the lambda cube, OCaml and Agda syntax and assignments, Curry-Howard correspondence, multi-stage programming, GADTs, semiring computation, monads and applicatives.

Technical Proficiencies

Programming Languages:
LaTeX ∗ python ∗ Scala ∗ Java ∗ C++ ∗ C# ∗ HTML/CSS/javascript ∗ OCaml ∗ Lisp

Libraries & Programs:
Git ∗ SQL ∗ numpy ∗ sklearn ∗ pytorch ∗ z3 ∗ emacs ∗ Gimp ∗ Blender

Assorted

Languages: English, French, German. Some Hindi, Japanese, Arabic.

Music: 16 years of formal piano traning, some Jazz piano. Novice guitarist.

Sports: Soccer, ultimate, racquetball, climbing, skiing, skating, squash, biking.