Sandia National Laboratories

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To Whom It May Concern:

I am writing to recommend Kirk Landin to you for the 2019 Applied Category Theory workshop in Oxford. I am leading a team of 12+ researchers investigating the application of various academic programming analysis techniques to real-world applications. The areas we're investigating range across abstract interpretation, symbolic execution, property-directed reachability, human factors, and more. I first met Kirk as he was co-leading an internal class on using Coq to prove program properties. Based on those interactions, I asked Kirk to join our team approximately six months ago. Kirk has already introduced aspects of category theory into our dialog as a team, based on classes he took at university, regarding how elements of our analyses might be composed together. I believe that attending the 2019 Applied Category Theory workshop would help Kirk deepen his understanding of category theory and give him some valuable insights into its application to the area of software analysis.

Sincerely,
Dr. Douglas Ghormley

Kirk Landin

Education

2014 **Masters of Science: Electrical and Computer Engineering**, *University of Illinois at Urbana-Champaign*, 3.8 GPA.
Thesis: *2-D Radio Imaging of Equatorial Ionospheric Plasma Depletions with the C/NOFS Satellite: Algorithms and Results*

2012 **Bachelor of Science: Computer Engineering**, *University of Illinois at Urbana-Champaign*, 3.9 GPA.

2012 **Bachelor of Music: Jazz Performance**, *University of Illinois at Urbana-Champaign*, 3.9 GPA.

Work Experience

2012-Present **Sandia National Laboratories**, *Albuquerque, NM*, Member of Technical Staff. Research & Development. Computer Science.

2011 **Riverbed Technology**, *Champaign, IL*, Software Development Intern.
Helped develop a 10 Gigabit Ethernet Driver for Linux using a novel architecture

Relevant Project Experience

2018-2019 **Languge Independent Semantic Analysis**.
Investigate how to develop abstract interpretation and other related analyses on software in a manner that is largely independent of the software's language of implementation.

2018-2019 **BlueNile**.
Use static software analysis to infer network protocols used by programs.

2018-2019 **High Performance Graph Analytics**.
Develop, Maintain, and Improve a highly-generic C++ library of graph algorithms that is portable between CUDA, OpenMP, and serial computation models. Work with the Kokkos library and programming model for high performance applications.

2015-2016 **Signal Classifiers**.
Upgrade, verify/validate signal classifiers, configure data fusion algorithms, and deploy to a real-time imaging system, built in C++.

2016 **Hidden Markov Model Target Tracking**.
Hidden Markov Models for pixel-space target tracking in video.

2017 **Orbital Mechanics Simulator**.
C++ template techniques to create generic Python bindings, increase multi-threaded performance, help define software architecture.

Presentations/Lectures

4/27/2016 Templates in Modern C++: A Primer

(505) 284 0814 • ktlandi@sandia.gov •

8/10/2016 Functional Design Patterns, the Stuff They Never Taught You in School

8/17/2016 Functional Design Patterns, Part 2

Multiple The Probabilistic Fusion Algorithm: What it is and How it Works

7/5/2017 Generic Programming in C++: Polymorphism Without All of the Bloat

8/30/2017 Generic Programming in C++: Part 2

Multiple Building Good Functions: Effective Small-Scale Code Design

Reading Groups

2018-Present **Software Analysis Reading Group**.
Assorted papers from all areas of software analysis

2018 **Software Foundations Reading Group**, *Software Foundations by Benjamin Pierce et al*.
Automatic Theorem Proving, Semantic Modeling of Languages, Certified Software, Formal Methods, Type Theory, etc.

2017 **Parallel Algorithms Reading Group**, *Parallel Algorithms by Casanova, Legrand, & Robert*.
Shared-Memory Parallelism, Sorting Networks, Communications Strategies, Ring Algorithms, Grid Algorithms, Heterogeneous Load Balancing, Basic & Advanced Scheduling

Relevant Skills

- Haskell
- Coq
- C++
- Racket
- Automatic Theorem Proving
- Type Theory
- Category Theory
- Symbolic Execution
- Formal Language Semantics
- Functional Programming
- GPU Programming
- Linux
- Statistical Signal Processing
- Signal Reconstruction
- Inverse Problems
- Software Architecture
- Perl
- SQL
- Kernel Programming
- Image Processing
- Scala
- OCaml
- C
- Modern C++ & Template Techniques
- Abstract Interprtation
- Formal Logic
- Programming Language Theory & Design
- Binary Software Analysis
- Compilers & Optimization
- Object Oriented Programming
- Parallel & Concurrent Programming
- Numerical Linear Algebra
- Signal Detection and Estimation
- Tomography
- Signal Classification
- Stochastic Processes
- Python
- Embedded & System Software
- Assembly Languages

** Background on Category Theory, project preference My main intellectual area is Computer Science, in Programming Languages and Formal Methods, I am quite comfortable working with mathematics, and I work as a scientist doing R&D in Automated Software Analysis and Verification. In these past five years I have taught myself Category Theory. I have a good understanding of and can can manipulate many of the important categorical structures. What I lack is some of the formal aspects and more advanced parts of Category Theory, and I'm hoping that this course can help fill that gap.

The project that aligns best with my background and goals is Bartoz Milewski's project on "Traversal Optics and Profunctors". I have a deep understanding of Functional Programming, its structures, and how they relate to Category Theory. I have briefly encountered optics in the past, and there may be good opportunities in the future to use the logic of optics in my future work.

Order of Project Preference:
1. Milewski: "Traversal Optics and Profunctors"
2. Hofstra: "Complexity Classes, Computation, and Turing Categories"

I received my Master's Degree in Electrical and Computer Engineering from the University of Illinois at Urbana-Champaign in May 2014. My Thesis title was "2-D Radio Imaging of Equatorial Ionospheric Plasma Depletions with the C/NOFS Satellite: Algorithms and Results". I currently work as a scientist at Sandia National Laboratories in Albuquerque, New Mexico, USA. I am currently not pursuing a PhD.

I am currently working on securing the appropriate travel approvals from my job. As long as they come through, which I expect will happen, I will be fully funded and able to come out to Oxford in July.

** Why I'm Interested in the School As mentioned before, I work as a scientist doing R&D in automated software analysis. In short, my main job is to develop computer algorithms that are able to take software in some form (source code, compiled binaries, etc.) and analyze this software without running it to provide insight into how the software behaves. These insights could be things such as: "Does the program have particular security holes?", or "Will the program lock up because of incorrect concurrent programming?", or "Could this program leak private user data?"

Category Theory has been instrumental in the way that I understand and can reason about the structure of both software and computation in general. It is also used more and more by the software analysis and formal logic communities to push the state of the art in this field. Right now I have a great intuitive understanding of Categorical structures, however there are three things that I'm looking to improve in: 1. Become much better at understanding literature that goes deep into category theory 2. Gain some competence in doing formal derivations/proofs in category theory 3. Understand more of the advanced

structures in category theory.

I believe that the Adjoint school will help me improve in all three of these facets.

As for my career, many new advancements in the field of software analysis use Category Theory. The ability to ingest, reason about, and use these advances will certainly move my career forward. I am also one of the main experts in Category Theory at my place of work, so my continued improvement in the understanding of this subject will allow me to understand software analysis in new and better ways. A better personal understanding of Category Theory will also improve my ability to teach its concepts to my coworkers, and that will certainly help in the continued success and growth of our software analysis program.