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May 27, 2020

Thank you for taking the time to consider my application for your Formal Verification Engineer position. As a software developer specializing in formal methods, I am confident that I will prove to be a valued addition to your team. My portfolio includes formally verified hardware designs, algorithms, and mathematical proofs. This work attests to my expertise in formal software verification, development, and theorem proving.

For the past year, I have been the principal developer for Kami Processor[1], a formally verified RISC-V processor. While at SiFive, I've made additional contributions to both Kami, a domain specific language for modeling digital circuits; developed Utila, a library of formally verified circuit components; and assisted with the verification of modules used within SiFive's S-series processors.

In addition to my professional activities, I have contributed proofs to the Coq Standard Library, and am a credited contributor to Coq.

I have over seven years of experience using Coq to formalize mathematical theorems and verify algorithms. Over this time, I have developed substantial libraries spanning dozens of modules and including hundreds of proofs.

A sample of this work can be found on my GitHub profile page. There you will find two of my contributions to the Coq Package Index.

The first, Functional Algebra[2], axiomatizes abstract algebra. Its theorems and definitions span the traditional algebraic hierarchy of monoids, groups, rings, and fields. It includes a formally verified algorithm capable of simplifying monoid and group expressions. The library encompasses over 700 definitions, proofs, and functions.

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[1]Kami Processor can be found here: https://github.com/sifive/ProcKami.

[2]The Functional Algebra library can be found here: `https://github.com/llee454/functional-algebra`.

The second, Incident Geometry[3], axiomatizes incident geometry and provides proofs of a few basic results. Beyond this, the library includes over 70 definitions, proofs, and functions for manipulating lists and simple sets.

Both are written in a functional style. This functional approach borrows heavily from Agda, and results in code that is clearer, easier to maintain, and compilationally more efficient than the traditional tactic oriented style commonly used in Coq. Moreover, both developments demonstrate programming best practices. For example, each contains substantial inline documentation and even include unittests to *validate* certain definitions. Together, these libraries evince my fluency in Gallina and my ability to produce substantial developments using Coq.

In addition to my demonstrable ability to prove complex theorems using Coq, I possess over a decade of professional programming experience. For over six years, I developed websites and mobile applications for Johns Hopkins University, where I served as the lead developer for Popline, the largest online repository of peer-reviewed journal articles concerning reproductive health.

In closing, my work attests to my abilities as a formal verification engineer. I am excited by the opportunity to join your team. If given the opportunity to serve in this capacity, I promise the highest level of professionalism and enthusiasm.

Thanks again,

Larry D. Lee Jr.

[3]The Incident Geometry library can be found here: `https://github.com/llee454/incident-geometry`.

Larry Darryl Lee Jr.

Last update on May 27, 2020

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Summary

An experienced software developer with a passion for mathematics, formal logic, and high quality software.

- Principal Developer for Kami Processor, the first open source RISC-V processor design formalized in Coq
- 7 years of experience using Coq to prove mathematical theorems and verify algorithms
- Over 10 years of professional programming experience
- Familiar with the principles of digital circuit design and computer architecture
- Deeply knowledgeable about theoretical computer science, mathematical logic, and higher-order type theory
- Fluent in Gallina, Agda, and Haskell.

Over the past year, I have worked at SiFive as the principal developer for Kami Processor, the first open-source RISC-V processor formalized in Coq. In addition, I have formally verified numerous algorithms embedded within SiFive's processor cores.

This work builds on over 7 years of Coq development experience, in which I have developed substantial Coq libraries spanning dozens of modules, hundreds of proofs, and thousands of lines of code. I have used Coq to define, prove, and verify **over 700** mathematical theorems and algorithms in abstract mathematics and practical engineering. I have submitted libraries to the Coq Package Index for inclusion, Contributed to the Coq Standard Library, and released substantial libraries to the open source community. My work, attests to my fluency in Gallina and my expertise in formal software verification.

Possessing over 10 years of professional software development experience, I have demonstrated my professionalism and expertise on numerous projects. I have served as lead developer for high visibility projects at Johns Hopkins University, and more recently at Elucid Solutions.

Experience

SiFive — San Mateo, California

Sr. Engineer *2018 – present*

- Working to develop the first formally verified, commercially available, RISC-V processor
- Principal developer for the open-source Kami Processor model
- Derived mathematical proofs verifying the correctness of components used within SiFive's S-series processors
- Mentored SiFive interns and developed training materials
- Contributed improvements to the Kami hardware modeling language
- Developed the Utila Kami library consisting of formally verified processor components

Elucid Solutions — Bethesda, Maryland

Sr. Programmer Analyst *2015 – 2018*

- Attained the highest Contractor Performance Assessment Reporting System (CPARS) rating for the ACHP.gov project - including "exceptional" ratings for "quality," "schedule," and "management"
- Was instrumental in attaining CMMI level 3 certification for Elucid Solutions' software development practice
- Laid the foundation for data-driven management and evidence-based practice at Elucid Solutions by standardizing performance metrics, data collection, and analysis
- Increased Productivity at Elucid Solutions by developing a comprehensive knowledge management system that was used successfully for over three years
- Lead Developer for Elucid Solutions.com, Elucid Solution's corporate website
- Lead Developer for Lucidity, an open-source content publishing system
- Lead Developer for ASK, a website providing interactive lessons, user guides, and training tutorials for the General Services Administration
- Lead Developer for Abandoned Mines.gov the Federal Mining Dialogue's public website
- Lead Developer for ACHP.gov the Advisory Council on Historic Preservation's agency website

Johns Hopkins University — Baltimore, Maryland
Sr. Programmer Analyst — *2009 – 2015*

- Improved the quality of code produced by the Knowledge for Health Program at the Johns Hopkins School of Public Health by advocating for and implementing systematic unit testing across software development projects
- Improved the maintainability of software produced by the Knowledge for Health Program by introducing version control and automated documentation generation
- Lead Drupal developer for Popline the largest online database of reproductive health research articles
- Lead Drupal developer for mHealth Evidence an online database of journal articles related to mobile health interventions
- Developed connectors for importing records from Pubmed, Google Scholar, Scopus, and other large scholarly databases
- Created mobile apps for both Android and iPhone using PhoneGap and native Android APIs
- Assisted in the maintenance and development of the Center for Communication Programs, Knowledge for Health, and Urban and Reproductive Health websites

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Skills

- Fluent in Gallina
- Knowledgeable about formal software verification
- Deeply knowledgeable about the theoretical foundations of Computer Science including Higher-Order Type Theory, Lambda Calculus, and formal logic
- Fluent in Haskell, Scheme, and other functional programming languages
- Experience using dependently typed programming languages, including Gallina and Agda
- Professional experience modeling digital circuit designs and deriving formal correctness proofs

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Education

Goucher College — Towson, Maryland
Bachelors of Arts — *2008*

References

"I was Larry's supervisor at SiFive. There, he was instrumental in bringing up a formal specification of the RISC-V processor in Kami, which is a framework in Coq to specify hardware circuits using transactional semantics. The task was pretty complex, given the enormity of the RISC-V specification and the ability to understand, Kami, a new framework completely, in order to write programs in that framework. Larry was a quick learner and was highly motivated to perform this task. He paid a lot of attention to detail and had excellent software engineering skills - always coming up with unit test cases even for the smallest change made or feature added to the code base. Overall, I enjoyed working with Larry."

Murali Vijayaraghavan
vmurali@csail.mit.edu

"Working with Larry for nearly two years at SiFive I have come to know him as a man with a efficient and effective proof writing technique. As evidenced by his work in the ProcKami repository, he also shows the great attention to detail and forward planning one associates with well-written COQ code."

Anthony Machado
tj.machado@gmail.com

"Larry Lee [has] great knowledge of theorem proving as well as the ProcKami Risc V processor. He was always the one I talked to when I had a question on how something worked in the ProcKami processor or a question on the Kami language semantics. It was really enjoyable working with Larry Lee while I was at SiFive."

Kenneth Roe
http://www.cs.jhu.edu/ roe/