

## William E. Byrd

<http://webyrd.net/>

Scientist  
Department of Computer Science  
&  
Hugh Kaul Precision Medicine Institute  
University of Alabama at Birmingham

### Work

115A Campbell Hall  
1300 University Boulevard  
Birmingham, AL 35294-1170  
[webyrd@uab.edu](mailto:webyrd@uab.edu)

### Residence

1508 4th Ave S  
Apt 223  
Birmingham, AL 35233  
(812) 320-8505 (mobile)  
[webyrd@gmail.com](mailto:webyrd@gmail.com)

## EDUCATION

Doctor of Philosophy in Computer Science, September 2009  
Indiana University, Bloomington, IN  
Specialty Area: Programming languages, with an emphasis on functional and logic programming.  
Committee: Daniel P. Friedman (Advisor), Amr Sabry, Christopher T. Haynes, Lawrence S. Moss.

Bachelor of Science in Computer Science, *cum laude*, May 1999  
University of Maryland, Baltimore County, Baltimore, MD

Bachelor of Science in Special Education, *magna cum laude*, December 1994  
College of Charleston, Charleston, SC

## RESEARCH INTERESTS

Relational programming, program synthesis, and combining symbolic artificial intelligence with machine learning and neural networks

Computational tools for precision medicine and biology/chemistry

Functional programming

## PUBLICATIONS

### Books

*The Reasoned Schemer, Second Edition*. Daniel P. Friedman, William E. Byrd, Oleg Kiselyov, and Jason Hemann. Foreword by Guy Lewis Steele Jr. and Gerald Jay Sussman. Afterword by Robert A. Kowalski. The MIT Press, Cambridge, MA, 2018. The second edition includes a greatly simplified logic language, a new implementation of the language, a new forward, afterword, and preface, and a complete rewrite of many chapters.

MIT Press web page: <https://mitpress.mit.edu/books/reasoned-schemer-second-edition>

Source code from the second edition: <https://github.com/TheReasonedSchemer2ndEd>

*The Reasoned Schemer*. Daniel P. Friedman, William E. Byrd, and Oleg Kiselyov. The MIT Press, Cambridge, MA, 2005. An introduction to relational (pure logic) programming using the miniKanren language. Includes the complete implementation of miniKanren.

MIT Press web page: <https://mitpress.mit.edu/books/reasoned-schemer>

Source code from the first edition: <https://github.com/miniKanren/TheReasonedSchemer>

## Theses

*Relational Programming in miniKanren: Techniques, Applications, and Implementations.*

William E. Byrd. Indiana University, Bloomington, IN, September 30, 2009.

Archival double-spaced version (open access): <https://search.proquest.com/docview/304903505>

Single-spaced version (CC BY 4.0): <https://github.com/webyrd/dissertation-single-spaced>

## Refereed Papers

William E. Byrd, Daniel P. Friedman, Ramana Kumar, and Joseph P. Near. A Shallow Scheme Embedding of  $\perp$ -Avoiding Streams. To appear in a special issue of *Higher-Order and Symbolic Computation*, in honor of Mitchell Wand's 60th birthday.

Preprint: <http://webyrd.net/frons/frons.pdf>

Lisa Zhang, Gregory Rosenblatt, Ethan Fetaya, Renjie Liao, William E. Byrd, Matthew Might, Raquel Urtasun, Richard Zemel. Neural Guided Constraint Logic Programming for Program Synthesis. In *Advances in Neural Information Processing Systems 31 (NeurIPS 2018)*, 2018.

Paper and poster: <https://neurips.cc/Conferences/2018/Schedule?showEvent=11187>

Full proceedings:

<https://papers.nips.cc/book/advances-in-neural-information-processing-systems-31-2018>

William E. Byrd, Michael Ballantyne, Greg Rosenblatt, and Matthew Might. Functional Pearl: A Unified Approach to Solving Seven Programming Problems. In *Proceedings of the ACM on Programming Languages (PACMPL)*, volume 1, ICFP, article 8, September 2017.

Paper (ACM Digital Library, Open Access):

<https://dl.acm.org/citation.cfm?doid=3136534.31110252>

Interactive web version of the paper, courtesy of Nada Amin:

<http://io.livecode.ch/learn/namin/icfp2017-artifact-auas7pp>

Complete code/executable artifact: <https://github.com/gregr/icfp2017-artifact-auas7pp>

Presentation:

<https://podcasts.ox.ac.uk/unified-approach-solving-seven-programming-problems-functional-pearl>

Christina M. Woo, Alejandra Felix, William E. Byrd, Devon K. Zuegel, Mayumi Ishihara, Parastoo Azadi, Anthony T. Iavarone, Sharon J. Pitteri, and Carolyn R. Bertozzi. *Development of IsoTaG, a Chemical Glycoproteomics Technique for Profiling Intact N- and O-Glycopeptides from Whole Cell Proteomes*. Journal of Proteome Research, 2017, 16(4), pp 1706–1718.

Paper (ACS Publications):

<https://pubsdc3.acs.org/doi/abs/10.1021/acs.jproteome.6b01053?journalCode=jprobs>

Jason Hemann, Dan Friedman, William E. Byrd, and Matthew Might. A Small Embedding of Logic Programming with a Simple Complete Search. In *Proceedings of the Dynamic Languages Symposium 2016 (DLS '16)*, Amsterdam, 2016.

Paper (ACM Digital Library): <https://dl.acm.org/citation.cfm?id=2989230>

Dakota Fisher, Matthew Hammer, William E. Byrd, and Matthew Might. miniAdapton: A Minimal Implementation of Incremental Computation in Scheme. In *Proceedings of the 2016 Workshop on Scheme and Functional Programming*, Nara, Japan, 2016.

Paper: <https://arxiv.org/abs/1609.05337>

Code: <https://github.com/fisherdj/miniAdapton>

Steven Lyde, Matthew Might, and William E. Byrd. Control-Flow Analysis of Dynamic Languages via Pointer Analysis. In *Proceedings of the Dynamic Languages Symposium 2015 (DLS '15)*, Pittsburgh, PA, 2015.

Paper: <http://matt.might.net/papers/lyde2015control.pdf>

William E. Byrd, Eric Holk, and Daniel P. Friedman. miniKanren, Live and Untagged: Quine Generation via Relational Interpreters (Programming Pearl). In *Proceedings of the 2012 Workshop on Scheme and Functional Programming*, Copenhagen, Denmark, 2012.

Paper: <http://webyrd.net/quines/quines.pdf>

Code: <https://github.com/webyrd/quines>

Claire E. Alvis, Jeremiah J. Willcock, Kyle M. Carter, William E. Byrd, and Daniel P. Friedman. cKanren: miniKanren with Constraints. In *Proceedings of the 2011 Workshop on Scheme and Functional Programming (Scheme '11)*, Portland, OR, 2011.

Paper: <http://www.schemeworkshop.org/2011/papers/Alvis2011.pdf>

Code (slightly updated): <https://github.com/calvis/cKanren/tree/nov2011>

Code (radically updated): <https://github.com/calvis/cKanren>

Eric Holk, William E. Byrd, Nilesh Mahajan, Jeremiah Willcock, Arun Chauhan, and Andrew Lumsdaine. Declarative Parallel Programming for GPUs. In *Proceedings of the International Conference on Parallel Computing (ParCo)*, Ghent, Belgium, 2011.

Paper:

<https://www.cs.indiana.edu/~achauhan/Publications/Pubs/2011-parco-holk-harlan.pdf>

Eric Holk, William E. Byrd, Jeremiah Willcock, Torsten Hoeffler, Arun Chauhan, and Andrew Lumsdaine. Kanor: A Declarative Language for Explicit Communication. In *Proceedings of the Thirteenth International Symposium on the Practical Aspects of Declarative Languages (PADL)*, Austin, TX, pp. 190–204, 2011.

Paper: <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.299.351>

Andrew W. Keep, Michael D. Adams, Lindsey Kuper, William E. Byrd, and Daniel P. Friedman.

A Pattern-matcher for miniKanren -or- How to Get into Trouble with CPS Macros.

In *Proceedings of the 2009 Workshop on Scheme and Functional Programming*, Cal Poly Technical Report CPSLO-CSC-09-03, pp. 37–45, 2009.

Full proceedings: <http://www.schemeworkshop.org/2009/scheme2009.pdf>

Joseph P. Near, William E. Byrd, and Daniel P. Friedman.  $\alpha$ leanTAP: A Declarative Theorem Prover for First-Order Classical Logic. In *Proceedings of the 2008 International Conference on Logic Programming (ICLP)*, LNCS vol. 5366, Springer-Verlag, Heidelberg, pp. 238–252, 2008.

Paper: <http://webyrd.net/alphaleantap/alphatap.pdf>

Code (.zip file containing  $R^6RS$ -compliant Scheme files, and Prolog files):

<http://webyrd.net/alphaleantap/alphaleantap.zip>

Oleg Kiselyov, William E. Byrd, Daniel Friedman, and Chung-chieh Shan. Pure, Declarative, and Constructive Arithmetic Relations (Declarative Pearl). In *Proceedings of the 2008 International Symposium on Functional and Logic Programming (FLOPS)*, LNCS vol. 4989, Springer-Verlag, Heidelberg, pp. 64–80, 2008.

Paper: <http://webyrd.net/arithm/arithm.pdf>

William E. Byrd and Daniel P. Friedman.  $\alpha$ Kanren: A Fresh Name in Nominal Logic Programming. In *Proceedings of the 2007 Workshop on Scheme and Functional Programming*, Université Laval Technical Report DIUL-RT-0701, pp. 79–90, 2007.

Paper: [http://webyrd.net/alphamk/alphamk\\_workshop.pdf](http://webyrd.net/alphamk/alphamk_workshop.pdf)

Authors' revised paper (recommended): <http://webyrd.net/alphamk/alphamk.pdf>

Revised code ( $R^5RS$ -compliant Scheme file): <http://webyrd.net/alphamk/alphamk.scm>

William E. Byrd and Daniel P. Friedman. From Variadic Functions to Variadic Relations: A miniKanren Perspective. In *Proceedings of the 2006 Scheme and Functional Programming Workshop*, University of Chicago Technical Report TR-2006-06, pp. 105–117, 2006.

Paper: <http://scheme2006.cs.uchicago.edu/12-byrd.pdf>

Alan T. Sherman, Brian O. Roberts, William E. Byrd, Matthew R. Baker, and John Simmons. Developing and Delivering Hands-on Information Assurance Exercises: Experiences with the Cyber Defense Lab at UMBC. In *Proceedings from the Fifth IEEE Systems, Man and Cybernetics Information Assurance Workshop*, West Point, NY, pp. 242–249, 2004.

Paper (IEEE Digital Library): <https://ieeexplore.ieee.org/document/1437823>

## Other Writings

William E. Byrd and Daniel P. Friedman. Towers of Little Languages. (Foreword to *The Joy of Clojure, Second Edition* by Michael Fogus and Chris Houser, Manning, 2014.)

Manning liveBook link to the foreword:

<https://livebook.manning.com/#!/book/the-joy-of-clojure-second-edition/foreword-to-the-second-edition/>

Manning web page for the book:

<https://www.manning.com/books/the-joy-of-clojure-second-edition>

## SCHOLARSHIPS

National Institute of General Medical Sciences (NIGMS) Scholarship (January, 2016)

Awarded \$2,235 towards tuition for the Cold Spring Harbor Laboratory synthetic biology course I attended in the summer of 2015.

## PROGRAMMING TOOLS DESIGNED

Barliman (in collaboration with Greg Rosenblatt)

Program editor that can perform synthesis of higher-order, recursive Scheme code.

<https://github.com/webyrd/Barliman>

Barliman, Mk II (in collaboration with [alphabetical order]: Michael Ballantyne, Greg Rosenblatt, Kanae Tsushima, and Rob Zinkov)

(*Still in early development.*) Extends Barliman's program synthesis with: guided search based on machine learning; type annotations/type inference; “design recipe”-style heuristics; templates; and other techniques to reduce the search space.

<https://github.com/webyrd/n-grams-for-synthesis>

mediKanren (in collaboration with Greg Rosenblatt and Matt Might)

Graphical interface to the mediKanren programming language/graph database, for use in the NIH NCATS Biomedical Data Translator Project.

<https://github.com/webyrd/mediKanren>

## PROGRAMMING LANGUAGES DESIGNED

miniKanren (in collaboration with Daniel P. Friedman, Oleg Kiselyov, and Chung-chieh Shan)  
A declarative applicative logic programming system.  
<http://miniKanren.org/>

mediKanren (in collaboration with Greg Rosenblatt and Matt Might)  
miniKanren extended with a graph database, for use in the NIH NCATS Biomedical Data Translator Project.  
<https://github.com/webyrd/mediKanren>

cKanren (in collaboration with Claire Alvis, Daniel P. Friedman, Jeremiah Willcock, and Kyle Carter; derived from miniKanren)  
A constraint logic programming framework.  
<https://github.com/calvis/cKanren>

$\alpha$ Kanren (in collaboration with Daniel P. Friedman; derived from miniKanren, and inspired by James Cheney and Christian Urban's  $\alpha$ Prolog)  
A nominal logic programming language.  
<http://www.cs.indiana.edu/~webyrd/#alphaKanren>

Harlan (in collaboration with Eric Holk, Claire Alvis, Jeremiah Willcock, Nilesh Mahajan, Ryan Newton, Arun Chauhan, and Andrew Lumsdaine)  
An experimental functional programming language for the GPU.  
<https://github.com/eholk/harlan>

Kanor (in collaboration with Eric Holk, Jeremiah Willcock, Nilesh Mahajan, Aaron Hsu, Arun Chauhan, and Andrew Lumsdaine)  
A declarative language for explicit communication.

## STEERING COMMITTEES

Scheme and Functional Programming Workshop Steering Committee (September 2015–present)

## PROGRAM COMMITTEES

1st miniKanren and Relational Programming Workshop (miniKanren 2019) (General Chair)  
August, 2019, Berlin, Germany. Co-located with the ACM SIGPLAN International Conference on Functional Programming (ICFP 2019).

International Symposium on Principles and Practice of Declarative Programming (PPDP 2019)  
October 7–9, 2019, Porto, Portugal. Co-located with the 3rd World Congress on Formal Methods (FM'19)

2018 Scheme and Functional Programming Workshop (Program Chair)  
September 28, 2018, St. Louis, MO. Co-located with the ACM SIGPLAN International Conference on Functional Programming (ICFP 2018).

Off the Beaten Track (OBT 2018)  
January 13, 2018, Los Angeles, CA. Co-located with the ACM SIGPLAN Symposium on Principles of Programming Languages (POPL 2018).

Selection Committee for the ICFP'17 Student Research Competition  
September 6, 2017, Oxford, UK. Part of ACM SIGPLAN International Conference on Functional Programming (ICFP 2017).

20th ACM SIGPLAN International Conference on Functional Programming (ICFP 2015)  
August 31–September 2, 2015, Vancouver, Canada.

2014 Scheme and Functional Programming Workshop  
November 19, 2014, Washington, DC. Co-located with Clojure/conj.

International Workshop on Functional and (Constraint) Logic Programming (WFLP 2014)  
September 15–17, 2014, Lutherstadt Wittenberg, Germany.

International Lisp Conference (ILC 2014)  
August 14–17, 2014, Université de Montréal, Montréal, Canada.

2013 Scheme and Functional Programming Workshop (Program Chair)  
November 13, 2013, Alexandria, VA. Co-located with Clojure/conj.

## EXTERNAL REVIEW COMMITTEES

23rd ACM SIGPLAN International Conference on Functional Programming (ICFP 2018)  
September 23–29, 2018, St. Louis, MO.

## ACADEMIC WORKSHOPS ORGANIZED

1st miniKanren and Relational Programming Workshop (miniKanren 2019) (co-organizer, with Nada Amin)  
August, 2019, Berlin, Germany. Co-located with the ACM SIGPLAN International Conference on Functional Programming (ICFP 2019).

2018 Scheme and Functional Programming Workshop (co-organizer, with John Clements)  
September 28, 2018, St. Louis, MO. Co-located with the ACM SIGPLAN International Conference on Functional Programming (ICFP 2018).

2013 Scheme and Functional Programming Workshop  
November 13, 2013, Alexandria, VA. Co-located with Clojure/conj.  
<http://webyrd.net/scheme-2013/>

## INVITED COURSES

*Relational Programming in miniKanren: an Interactive Tutorial* (arranged by Haochen Xie and Sics Society; hosted by Atsushi Igarashi) Kyoto, Japan, May 15–16, 2018.

Taught a two-day interactive mini-course on miniKanren and relational programming at the University of Kyoto.

Topics included: introduction to relational programming, translating functions to relations, relational interpreters in miniKanren, program synthesis via relational interpreter, and implementing microKanren.

*Summer School on Relational Programming* (sponsored by JetBrains; hosted by Dmitri Boulytchev) St. Petersburg, Russia, August 24–28, 2015.

Taught a one-week, 40-hour course on relational programming in miniKanren to 13 students from universities in St. Petersburg and from JetBrains.

Topics included: introduction to Scheme and Racket, introduction to relational programming, translating functions to relations, environment-passing interpreters in Scheme, relational interpreters in miniKanren, and implementing logic programming and constraint logic programming systems.

**INVITED TALKS**

*Lessons from Building an Interactive Biomedical Reasoning System* (hosted by Kanae Tsushima)  
National Institute of Informatics, Tokyo, Japan, December 18, 2018.

*Hygienic Scheme Macros & miniKanren* (hosted by Yasuaki Kudo)  
Tokyo Haskell Meetup, Tokyo, Japan, December 17, 2018.  
[https://www.meetup.com/ja-JP/Tokyo-Haskell-Meetup/?\\_cookie-check=6IX88Ng-xGsK06FK](https://www.meetup.com/ja-JP/Tokyo-Haskell-Meetup/?_cookie-check=6IX88Ng-xGsK06FK)

*Recent Research on miniKanren* (hosted by Dmitri Boulytchev)  
Boulytchev Lab, St. Petersburg State University, St. Petersburg, Russia, October 15, 2018.

*The Next 100,000 Notions of 'Variable'*  
Leetspeak 2018, Malmö, Sweden, October 13, 2018.  
<https://leetspeak.se/2018/speakers.html#speaker-3>

*Personal Data Preservation, Inspired by Ancient Writing*  
Clojure/SYNC 2018, New Orleans, LA, February 15, 2018.  
<https://clojuresync.com/will-byrd/>

*Implementing a Relational Programming Language in a Functional Language* (with Nada Amin)  
Cambridge NonDysFunctional Programmers Meetup, Cambridge, UK, January 23, 2018.  
<https://www.meetup.com/Cambridge-NonDysFunctional-Programmers/events/246603367/>

*Logic Programming, Semantics, and a Bit of Cleverness*  
Logic and Semantics Seminar, University of Cambridge, Cambridge, UK, January 23, 2018.

*Relational Programming and Program Synthesis in miniKanren*  
University of Oxford, Oxford, UK, January 18, 2018.

*Computer Science and My Life* (arranged by Haochen Xie and Sicss Society; hosted and translated by Haochen Xie)  
Keynote to open the Nagoya University Programming Seminar & Competition, Nagoya University, Nagoya, Japan, May 13, 2018.

*miniKanren: a Family of Languages for Relational Programming*  
Fourteenth International Symposium on Functional and Logic Programming (FLOPS 2018), Nagoya, Japan, May 9, 2018.  
<http://www.sqlab.jp/FLOPS2018/>

*miniKanren: a Family of Languages for Relational Programming* (arranged by Haochen Xie and Sicss Society; hosted by Yasuhiko Minamide)  
Tokyo Institute of Technology (Titech), Tokyo, Japan, May 7, 2018.

*Lessons from Building an Interactive Biomedical Reasoning System* (arranged by Haochen Xie and Sicss Society; hosted by Yoshihiro Imai/DWANGO; translation by Youyou Cong)  
Public Sicss Society Event, DWANGO Building, Tokyo, Japan, May 6, 2018.  
<https://sicss.connpass.com/event/83801/>

*Program Synthesis with miniKanren*  
Code Mesh 2017, London, England, November 8, 2017.  
<http://www.codemesh.io/>

*The Reasoned Racketeers* (keynote, with Daniel P. Friedman)  
RacketCon, Seattle, WA, October 7, 2017.  
<http://con.racket-lang.org/>

*The Most Beautiful Program Ever Written*  
Papers We Love, New York, NY, April 12, 2017.  
<https://www.meetup.com/papers-we-love/events/238718664/>

*Synthesis of Lisp Programs*  
LispNYC, New York, NY, April 11, 2017.  
<https://www.meetup.com/LispNYC/events/236903739/>

*Relational programming*  
KatsConf 2, Dublin, February 18, 2017.  
<http://www.katsconf.com/#nav-speakers>

*The Promise of Relational Programming*  
Partial Evaluation and Semantic-Based Program Manipulation (PEPM 2016), San Diego, CA, January 18, 2016.  
<http://conf.researchr.org/event/POPL-2016/pepm-2016-invited-invited-talk-william-byrd>

*A Vision for Relational Programming in miniKanren*  
Code Mesh 2015, London, England, November 4, 2015.  
<https://vimeo.com/146117469>

*The Promise of Relational Programming* (keynote)  
PolyConf, Poznań, Poland, July 2, 2015.  
<https://www.youtube.com/watch?v=eQL48qYDwp4>

*Relational Programming in miniKanren*  
The Computer Laboratory, University of Cambridge, Cambridge, England, December 6, 2013.  
<http://talks.cam.ac.uk/talk/index/49257>

*Meta-Programming in Logic Programming* (with Nada Amin)  
Code Mesh 2013, London, England, December 5, 2013.  
<http://codemesh.io/#william-byrd>

*Fun with Relational Interpreters in miniKanren* (keynote, with Daniel P. Friedman)  
flatMap, Oslo, Norway, May 14, 2013.  
<http://2013.flatmap.no/danwill.html>

*The Unreasonable Schemers* (guest of honor, with Daniel P. Friedman)  
miniKanren *Conf*<sup>o</sup> (associated with Clojure/West), Portland, OR, March 19, 2013.  
<http://clojurewest.org/schedule/>

*Relational Programming in miniKanren* (with Daniel P. Friedman)  
Strange Loop, St. Louis, MO, September 24, 2012.  
<http://www.infoq.com/presentations/miniKanren>



*3D Printing, Open Hardware, and the DIY Revolution*

CATALYST, Informatics and Computing Student Association, Indiana University, Bloomington, IN, February 18, 2012.

*3D Printing, Open Hardware, and the DIY Revolution*

Technology Management Club, Kelley School of Business, Indiana University, Bloomington, IN, February 7, 2012.

*3D Printing, Open Hardware, and the DIY Revolution*

Mechanical Engineering Technology (MET) Department, Purdue University, October 12, 2011. Talk led Purdue's MET Department to create an undergraduate digital fabrication club, and to purchase of five 3D printers and two CNC routers for the club.

**TALKS**

*CLP(SMT)* (talk written with Nada Amin, based on joint work)

Domain Specific Language Design & Implementation (DSLDI 2018), Boston, MA, November 6, 2018. Part of the ACM SIGPLAN conference on Systems, Programming, Languages and Applications: Software for Humanity (SPLASH 2018).

*Functional Pearl: A Unified Approach to Solving Seven Programming Problems* (presentation of paper written with Michael Ballantyne, Greg Rosenblatt, and Matthew Might)

ACM SIGPLAN International Conference on Functional Programming (ICFP 2017), Oxford, UK, September 4, 2017.

<https://podcasts.ox.ac.uk/unified-approach-solving-seven-programming-problems-functional-pearl>

*Barlman: Trying the Halting Problem Backwards, Blindfolded* (with Greg Rosenblatt)

Clojure/conj, Austin, TX, December 3, 2016.

[https://www.youtube.com/watch?v=er\\_1Lvkklsk](https://www.youtube.com/watch?v=er_1Lvkklsk)

*New Tools and Practices for Online Collaboration in Teaching, Learning, and Research of Programming Languages*

Off-the-Beaten Track (OBT 2016), St. Petersburg, FL, January 23, 2016. Co-located with the ACM SIGPLAN Symposium on Principles of Programming Languages (POPL 2016).

[http://conf.researchr.org/getImage/OBT-2016/orig/OBT\\_2016\\_paper\\_14.pdf](http://conf.researchr.org/getImage/OBT-2016/orig/OBT_2016_paper_14.pdf)

*miniKanren, a Language for Relational Programming* (CS242 guest lecture)

Stanford University, Stanford, CA, November 30, 2015.

*Concatenative Programming* (with Rob Martin)

Lambda Lounge Utah, Sandy, UT, May 12, 2015.

*We Need Real Tools for Generating Type Inference* (talk written with Nada Amin)

Off-the-Beaten Track (OBT 2014), San Diego, CA, January 25, 2014. Co-located with the ACM SIGPLAN Symposium on Principles of Programming Languages (POPL 2014).

*From Greek to Clojure!* (with Nada Amin)

Clojure/conj, Alexandria, VA, November 14, 2013.

<https://www.youtube.com/watch?v=7kPMFkNm2dw>

*A Relational Exploration of the Chomsky Hierarchy* (with Daniel P. Friedman)

Strange Loop, St. Louis, MO, September 18–20, 2013.

<http://www.infoq.com/presentations/chomsky-hierarchy>

*miniKanren Philosophy* (with Daniel P. Friedman)  
Clojure/conj, Raleigh, NC, November 16, 2012.  
<http://www.youtube.com/watch?v=fHK-uS-Iedc>

*miniKanren, Live and Untagged: Quine Generation via Relational Interpreters* (presentation of paper written with Eric Holk and Daniel P. Friedman)  
Scheme and Functional Programming Workshop, Copenhagen, Denmark, September 9, 2012.

*Declarative Parallel Programming*  
Computer Science Department, Colorado State University, Ft. Collins, CO, February 29, 2012.

*Generating Quines Using a Relational Interpreter*  
Indiana University Logic Seminar, Bloomington, IN, February 15, 2012.  
<http://www.math.indiana.edu/seminars/event.phtml?id=3355>

*miniKanren* (“Untalk”, with Daniel P. Friedman)  
Clojure/conj, Raleigh, NC, November 10, 2011.  
<http://blip.tv/clojure/dan-friedman-and-william-byrd-minikanren-5936333>

*Animatronic Kittens, 3D Printers, and Rogue Game Studios –or– Why Computer Science Education Should be Just-in-Time, not Just-in-Case, and Why (Epic) Failure Should Always be an Option*  
Indiana University Programming Languages Group, Bloomington, IN, April 15, 2011.  
<http://vimeo.com/23254348>

*From Variadic Functions to Variadic Relations: A miniKanren Perspective* (presentation of paper written with Daniel P. Friedman)  
Scheme and Functional Programming Workshop, Portland, OR, September 17, 2006.

## INVITED TUTORIALS

*Thinking About Recursion* (with Nada Amin)  
KatsConf 2, Dublin, February 18, 2017.  
<http://www.katsconf.com/#nav-speakers>

*Interpreting Scheme procedures as logic programs using miniKanren* (with Michael Ballantyne)  
Scheme and Functional Programming Workshop, Vancouver, Canada, September 4, 2015.  
<http://andykeep.com/SchemeWorkshop2015/>

*Write a Relational Scheme Interpreter in miniKanren*  
PolyConf, Poznań, Poland, July 2, 2015.  
<http://polyconf.com/>

*Logic Night*  
Lambda Lounge Utah, Sandy, UT, May 13, 2014.  
<http://www.meetup.com/Lambda-Lounge-Utah/events/164368252/>

*miniKanren Tutorial* (with Daniel P. Friedman)  
Practical Aspects of Declarative Languages (PADL 2014), San Diego, CA, January 23, 2014.  
<http://www.ist.unomaha.edu/padl2014/#invited>

*Electronic Voodoo Dolls* (e-Textiles Tutorial)  
ZOOM—Examining the Future of Craft, Indiana University, Bloomington, IN, October 19, 2013.  
<http://www.iub.edu/~zoom/>

## TUTORIALS

*One Weird Trick: Relational Interpreters for Program Synthesis* (with Gregory Rosenblatt and Daniel P. Friedman)

POPL 2018 TutorialFest, ACM SIGPLAN Symposium on Principles of Programming Languages (POPL), Los Angeles, CA, January 8, 2018.

*Concatenative Programming* (with Rob Martin)

Code Mesh 2015, London, England, November 2, 2015.

<http://www.codemesh.io/codemesh2015/william-e-byrd>

*Program Synthesis Using miniKanren* (with Daniel P. Friedman)

Strange Loop, St. Louis, MO, September 17, 2014.

<https://thestrangeloop.com/sessions/program-synthesis-using-minikanren>

*miniKanren Summer School* (with Daniel P. Friedman and Jason Hemann)

University of Utah, Salt Lake City, UT, May 27 and 29, 2014.

*Program Transformations* (with Nada Amin)

Lambda Jam, Chicago, IL, July 9, 2013.

<http://lambdajam.com/sessions#amin>

## ONLINE TUTORIALS (at <https://www.youtube.com/user/WilliamEByrd>)

miniKanren “uncourse” on Google+ Hangouts

<https://www.youtube.com/watch?v=iCuVTGWNU3s&index=1&list=PL04Tbom0dn2cks2n5PvifialL8kQwt0aW>

Older miniKanren Hangouts

<https://www.youtube.com/watch?v=vRrgaibcTYs&list=PL04Tbom0dn2eGFBHHZpwo2o82e8Tv6gI>

Google+ Functional & Logic Programming Tutorials

<https://www.youtube.com/watch?v=2GfFlfToBCo&list=PL04Tbom0dn2dD5HsavV0h1ZzZ37o73P3F>

## INTERVIEWS

*Mostly Erlang Episode 050 – miniKanren With William Byrd*

Recorded by Zachary Kessin, Thursday, November 13, 2014.

<http://mostlyerlang.com/2014/11/26/050-minikanren-with-william-byrd/>

*Functional Geekery Episode 9 – William E. Byrd*

Recorded by Proctor, Monday, April 21, 2014.

<http://www.functionalgeekery.com/episode-9-william-e-byrd/>

*William Byrd on Logic and Relational Programming, miniKanren*

Recorded by InfoQ at Code Mesh 2013, London, England, December, 2013.

<http://www.infoq.com/interviews/byrd-relational-programming-minikanren>

## UNDERGRADUATE PROJECTS SUPERVISED

miniAdapton: A Minimal Implementation of Incremental Computation in Scheme (2016)

Student: Dakota Fisher (co-advised with Matthew Hammer)

We created a minimal version of the Adapton system for incremental computation, and wrote a paper that was accepted to the 2016 Scheme Workshop in Nara, Japan.

Neurosymbolic computation in miniKanren (2014)

Student: Teyvn Bell

(Inspired by Pascal Hitzler’s work on combining neural networks and first-order logic.) Teyvn and I implemented a prototype relational simulator for feedforward neural networks.

Weaver: A system for developing interactive fiction based on rules and defeasible logic (2013)

Student: Brittany Ann Moore

(Inspired by previous work with Andrew “Zarf” Plotkin on rule-based interactive fiction.)

“Seg-bot” Arduino-controlled Rideable Segway Clone (2011–2013)

Student: Maria Khokhar

(Inspired by the Seg-bot project: <http://prototyperobotics.com/projects/the-seg-bot/>.) Maria and I took a welding class, sourced the parts, welded the steel frame, finished mechanical assembly, and wired the electronics. (Alas, I moved to University of Utah before we were able to complete final assembly and testing.)

Grammar-based Music Generation (summer 2012)

Students: Teyvn Bell, Emilie Mitchell, Brittany Ann Moore

(Inspired by Robert M. Keller’s Impro-Visor project: <http://www.cs.hmc.edu/~keller/jazz/improvisor/>.) An experiment in performing research with first-year undergraduates (Teyvn and Emilie). We were able to implement most, but not all, of the grammar-based parsing algorithm used in Impro-Visor. We spent much of our time implementing the languages and machines from Michael Sipser’s *Introduction to the Theory of Computation*, in both Scheme and miniKanren. We also discussed and implemented Scheme interpreters, memoization extensions to Scheme, CYK parsing, and grammar-related syntactic abstractions using hygienic macros.

## RESIDENCIES

Hacker in Residence, Hacker School (now “Recurse Center”), New York City

November 18–22, 2013

<https://www.recurse.com/residents#will-byrd>

Gave multiple talks and tutorials on relational programming. Worked with students on their projects, including a relational solver for propositional logic and an artificial intelligence system to play the real-time strategy game *StarCraft: Brood War*.

## EMPLOYMENT

**UNIVERSITY OF ALABAMA AT BIRMINGHAM**, Birmingham, AL

**Scientist**, Department of Computer Science & Hugh Kaul Precision Medicine Institute,

August 2017–present

<https://www.uab.edu/cas/computerscience/>

<https://www.uab.edu/medicine/pmi/>

Working with Matt Might, Greg Rosenblatt, and other members of the Hugh Kaul Precision Medicine Institute, along with many other members of the NIH NCATS Biomedical Data Translator Project, on applying computation and automated reasoning to precision medicine, biology, and biochemistry. Also working with colleagues at UAB, along with many other colleagues in the US, Canada, Japan, Russia, and the UK, on improving relational programming, especially in the context of program synthesis.

**UNIVERSITY OF UTAH**, Salt Lake City, UT

**Research Assistant Professor**, U Combinator Research Group,  
February 2017–July 2017

<http://www.ucombinator.org/>

**Research Associate**, U Combinator Research Group,

October–December 2012 (remote), January 2013–February 2017 (on-site)

<http://www.ucombinator.org/>

Worked with Matt Might and the members of the U Combinator programming languages research group on relational programming, interpreters, program synthesis, and static analysis.

**INDIANA UNIVERSITY**, Bloomington, IN

**Postdoctoral Researcher**, Center for Research in Extreme Scale Technologies (CREST)  
(formerly Open Systems Lab), March 2010–December 2012

Worked with Eric Holk, Andrew Lumsdaine, Arun Chauhan, and other members of the NSF-funded Declarative Parallel Programming project on the design, implementation, and assessment of two declarative programming languages for High-Performance Computing: *Kanor*, an embedded Domain-specific Language for message passing; and *Harlan*, a high-level language for general-purpose Graphics Processing Unit (GPGPU) programming. Worked with Nicole Jacquard, Andrew Lumsdaine, Craig Stewart, and Kylie Pepler towards the creation of an IU digital fabrication laboratory (Fab Lab).

**Course Instructor**, A290, Spring 2012

Course designer and inaugural instructor for A290, Tools for Computing: Arduino Development. Asked by the School of Informatics and Computing to design and teach a new 8-week course on physical computing using the Arduino microcontroller, based on previous success integrating Arduino into H211. Taught students how to solder, design and debug circuits, and program Arduino. Challenged students to design and implement their own unique physical computing capstone projects.

**Course Instructor**, H211, Fall 2010, Fall 2011

Course instructor for H211, Honors Introduction to Computer Science. Redesigned course to incorporate Arduino microcontroller/electronics art projects, 3D modeling, fractals, procedural music generation, and game design and implementation. Incorporated smart materials and Arduino-controlled electronic piano workshops from visiting researcher Catarina Mota. Started popular undergraduate Arduino and 3D Printing clubs at the request of former H211 students.

**Visiting Researcher**, August 2009–January 2010

Refined a novel distributed architecture for data privacy in smart rooms. Implemented and benchmarked a prototype system in Scheme, using OpenSSL and a custom version of the *ThreshSig* Java threshold cryptography library.

**Associate Instructor**, C311 and B521, September 2003–May 2009

<http://www.cs.indiana.edu/classes/c311/>    <http://www.cs.indiana.edu/classes/b521/>  
Co-taught IU's graduate and undergraduate introductory programming languages courses. Co-wrote *The Reasoned Schemer* (MIT Press, 2005), one of two textbooks used in C311 and B521. Co-designed the miniKanren logic programming language used in both courses. Wrote and delivered lectures on every topic in the course, including: environment-passing, continuation-passing, and store-passing interpreters; continuation-passing style, trampolining, registerization, and other correctness-preserving transformations; hygienic macro expansion; types and type inference; and functional and logic programming paradigms. Nominated for the department's *Associate Instructor of the Year* award.

**CAMP GREENTOP**, Sabillasville, MD**Director**, Summer 2002

Responsible for the safety and well-being of 200 campers and 65 staff at the nation's oldest residential summer camp for children and adults with physical and multiple disabilities. Interviewed and hired staff members, evaluated staff performance, and directly supervised the business manager, unit leaders, activities coordinator and nurses. Coordinated staff training, wrote the staff manual and created the camp web site. Ultimately responsible for all programs, activities, policies and procedures at camp. Previous positions held at Camp Greentop include:

**Activities Coordinator**, Summer 2000**Assistant Director**, Summer 1999**Unit Leader**, Summer 1995, Summer 1996**Cabin Leader**, Summer 1992, Summer 1993, Summer 1994**Counselor**, Summer 1991**THURMONT MIDDLE SCHOOL**, Thurmont, MD**Special Education Teacher**, August 1995–June 1997

Taught math and English to 7th and 8th grade students with learning disabilities and behavioral disorders. Created extra-curricular clubs for computer programming, chess, and American Sign Language. Co-wrote the Frederick County continuing education curriculum on basic and intermediate computer use in the classroom. Co-wrote Thurmont Middle School's technology grant proposal, resulting in the award of \$50,000 for computer and networking hardware. Designed and taught seminars on Internet use for middle school teachers.

**TEACHING CERTIFICATION**

Maryland Educator Certificate (valid 7/1/1995 to 6/30/1998)

Educator ID 4464, Standard Professional I/Generic Special Education 1–8

**CLUBS AND ACTIVITIES FOUNDED****University of Utah**

**Computer Science Department Weekly Grad Student Night**, September 2013–present  
Fridays, 6pm–10pm, Large Conference Room, Merrill Engineering Building. As of March 2014, sponsored and funded by the School of Computing.

My friend Andy Keep and I started these new groups at the University of Utah to encourage more interaction between graduate students (and post-docs). Now on its third generation of graduate-student leadership.

**Indiana University****Indiana University Arduino Electronics Club**, December 2010–November 2014

Fridays, 6pm–midnight, Lindley Hall 008

**Indiana University 3D Printing Club**, January 2011–November 2014

Sundays, 2pm–10pm, Lindley Hall 008

Created undergraduate Arduino/physical computing and 3D Printing/digital fabrication clubs at the request of former H211 students. Advised students on dozens of electronics and 3D printing projects. Supervised student assembly of three kit 3D printers and a 3D printed “EggBot” plotter. Developed Arduino projects for H211 and A290 courses.

## **OTHER COMPUTING-RELATED EDUCATIONAL ACTIVITIES**

### *The CS Education Zoo*

Computer Science education interview series, with co-host Steve Wolfman  
<http://webyrd.net/zoo.html>

Volunteer, Indiana Celebration of Women in Computing (InWIC)  
February 5/6, 2010 & February 11, 2012

Organizer, Teen Animatronics Club, July–August, 2010  
Boys & Girls Club of Bloomington, IN

Volunteer, Indiana University Tech Week, February, 2010  
Boys & Girls Club of Bloomington, IN

Organizer, TeenSIG Programming Club, October 2002–May 2003  
Washington Apple Pi Users Group, Rockville, MD

Organizer, Programming Club, Spring 1997  
Thurmont Middle School, Thurmont, MD

## **3D PRINTING DEMOS**

Indiana University booth, SuperComputing '12, Salt Lake City, UT, November 10–14, 2012.

Arlington Heights Elementary School Science Night, Bloomington, IN, October 23, 2012.

Minority Engineering Advancement Program (MEAP), IUPUI, Indianapolis, IN, June 22, 2012.

Hoosier Guitar-Building Workshop, Bloomington, IN, May 12, 2012.

Farmer's Market, Bloomington, IN, April 21, 2012.

Pervasive Technology Institute, Indiana University, Bloomington, IN, April 5, 2012.

CATALYST, Informatics and Computing Student Association, Indiana University, Bloomington, IN, February 18, 2012.

Summit Elementary School Science Night, Bloomington, IN, February 10, 2012.

Technology Management Club, Kelley School of Business, Indiana University, Bloomington, IN, February 7, 2012.

Mechanical Engineering Technology (MET) Department, Purdue University, October 12, 2011.

3rd Grade Class, Cumberland Elementary School, West Lafayette, IN, October 12, 2011.

World Maker Faire, New York Hall of Science, Queens, NY, September 17–18, 2011

Bloomington Boys & Girls Club, Bloomington, IN, early 2011.

## AWARDS

### **Benefitfocus.com “Medal of Honor”**

Benefitfocus.com, 2001

Inaugural recipient of Benefitfocus.com’s highest award, in recognition of exemplary work in porting the Benefitfocus application to the WebLogic J2EE application server. Award included a \$3,000 bonus.

### **AppNet Excellence Award**

AppNet, 2000

Awarded for developing, within a strict deadline, a complex XML Document Type Definition and BladeRunner configuration file that formed the foundation of a major document management system.

### **Outstanding Senior in Computer Science and Electrical Engineering**

University of Maryland, Baltimore County, 1999

One of a handful of seniors to receive this award for “highest academic achievement of graduating seniors majoring in computer science and electrical engineering.”

### **Director’s Award for Outstanding Staff Person**

Camp Greentop, 1993

Inaugural recipient of Camp Greentop’s highest award, given to the staff member who “most epitomizes Camp Greentop and performs above and beyond all reasonable expectations.”

## PROFESSIONAL PROGRAMMING EXPERIENCE

**Lyvegyde.com**, Bloomington, IN/Garrett Park, MD

*Co-founder and Lead Developer*, August 2008–May 2009

Co-designed and developed *lyvegyde*, a guide to live online events. Responsible for site architecture (Ruby on Rails, AJAX, MySQL, nginx web server, Mongrel application server, Ubuntu Linux), middleware and backend development, page caching and other optimizations, and site deployment (using the Capistrano deployment tool).

**Benefitfocus.com**, Charleston, SC

*Software Engineer*, February 2001–June 2002

Collaborated with other software engineers to port a multi-million dollar online benefits enrollment application from the Enhydra Java application server to BEA’s WebLogic Java 2 Enterprise Edition (J2EE) application server. Implemented the supplemental insurance, password authentication/account lockout and W4 subsystems of the application. Configured and tuned the production cluster of WebLogic J2EE application servers. Worked with other engineers to streamline and automate the application build process and integrate the JUnit Java unit testing framework into the application. Designed and implemented utility programs, including several generations of log parsers and a suite of Perl scripts to repair defects in Java Server Pages (JSP) and HTML source files.

**Commerce One/AppNet/Century Computing**, Laurel, MD

*Software Engineer*, August 1999–February 2001

*Intern*, October 1998–June 1999

Responsible for the XML-based form subsystem of ProcureZone.com, a multi-million dollar online procurement application for the construction industry. Designed and implemented custom software to validate the logic, layout and content of several thousand Extensible Form Description Language (XFDL) forms and trained subcontractors in the use of this validation software. Designed and implemented custom software to perform sophisticated transformations on over a million lines of XFDL code. Created the Document Type Definition for ProcureZone structured XML documents. Wrote a non-trivial context-free grammar for Interleaf’s BladeRunner software to allow users to convert ProcureZone documents between Microsoft Word and XML formats.



**Interactive Software Engineering** (now Eiffel Software), Goleta, CA

*Intern*, Summer 1998

Worked with Bertrand Meyer, creator of the Eiffel programming language, on the implementation of Simple Concurrent Object-Oriented Programming (SCOOP), an experimental concurrency mechanism for Eiffel. Presented an overview of SCOOP to a group of ISE's most valued customers at the Techniques of Object-Oriented Languages and Systems (TOOLS USA) conference.