

Professional Background

Expertise with Markov random fields and Belief Propagation, system design, and data analysis. In thesis and subsequent work, worked on the development of efficient algorithms for performing inference, reconstruction, and model estimation in Markov models, with particular emphasis in applying such algorithms to image compression. At Lincoln Laboratory, developed algorithms as well as modeling, simulation, and data analysis tools for the area of ballistic missile defense. In a short post-doctoral position, worked on machine learning applied to health care, with an emphasis on manipulating data labels to ask different prediction and classification questions. During a three-month stint with a very early-stage startup, gained experience writing a research proposal, coordinating the design of experimental data collection with the development of proposed algorithm capabilities, and forming a budget for prototype development. Consulted for a defense contractor on performance analysis of deep learning algorithms

Have been developing a reinforcement learning based approach to optimizing product preference on a social network. The work remains in its early stages, though traction is being gained as far as articulating interesting sub questions that will be able to recruit the interest and collaboration of technical researchers.

Education

- **University of Michigan, Ann Arbor, MI** Sept. 2010
Ph.D., EE:Systems, Signal Processing
 - Proved monotonicity relationships for entropy and divergence in Markov random fields in terms of exponential parameters; derived analytical solutions for combinatorial optimization of Ising model; developed nearly optimal lossless compression algorithms for MRFs.
 - Independently derived theoretical basis for Local Conditioning of Belief Propagation in undirected graphs.
- **University of Michigan, Ann Arbor, MI** 2007
M.S., EE:Systems, Signal Processing
 - Relevant courses: statistics, graph theory, signal processing, optimization, and information theory.
 - Developed novel sampling method as part of Master's thesis that became the basis for a National Science Foundation grant proposal.
 - Developed creative analytical solutions to a combinatorial optimization problem in the Ising model.
- **Wichita State University, Wichita, KS** 2005
M.S., Mathematics
 - Relevant courses: topology, analysis, partial differential equations, and dynamical systems.
 - Received commendation for the ability to communicate complex mathematical ideas in writing.
- **Wichita State University, Wichita, KS** 2003
B.S., Mathematics
 - Relevant courses: mathematics, chemistry, physics, computer science, economics, psychology.

Work History

- **Independent Researcher and Consultant**
Technergetics: Robert Harrod, Utica, NY October 2017 - May 2018
 - working on evaluation of image classification and detection algorithms
Personal Project: myself, Ann Arbor, MI January 2015 - present
 - working on data-driven theoretical model of consumer choice
- **Visiting Scholar** April 2015 - present
Advisor: David L. Neuhoff, EECS Department, University of Michigan, Ann Arbor, MI

- Submitting paper on minimum cut solution of a square grid graph from boundary information
- Analyzed tradeoffs between cutset width and spacing in lossless Reduced Cutset Coding. Conference paper to be presented at Internal Symposium on Information Theory, July 2016; full version posted to arxiv.
- Introduced concept of Minimum Conditional Description Length parameter estimation for Markov random fields. Conference paper presented at Information Theory and Applications workshop, February 2016.
- Writing paper on Local Conditioning, a variant of Belief Propagation for performing exact inference in cyclic graphs
- Writing follow-up paper on Reduced Cutset Coding exploring the benefit of using the conditional independence relations of a probability distribution in lossless compression

● **Chief Data Officer** March 2017 - June 2017

Supervisor: Andrew Kubik, President, ServaniX, Ann Arbor, MI

- designed development plan for machine learning algorithms for mental care
- collaborated on the writing of research proposals

● **Post-Doctoral Research Fellow** October 2016 - March 2017

Advisor: Jenna Wiens, EECS Department, University of Michigan, Ann Arbor, MI

- will be working on interpretable models for risk stratification in machine learning applied to healthcare
- will be working on design of human subject experiments

● **Technical Staff, Optical Systems Technology** Sept. 2010 - Dec. 2014

Group Leader: David Whited, MIT Lincoln Laboratory, Lexington, MA

- Developed software to command sensor to stars for stellar calibration of pointing knowledge; developed models for determining detectability of stars; developed modeling, simulation, and data analysis tools for cutting edge interceptor technology; developed and implemented algorithms for associating and fusing detections from multiple sensors.
- Assumed key role on alumni recruiting team for interviewing candidates.

● **Graduate Student Research Asst.** 2007-2009

Advisor: David L. Neuhoff, University of Michigan

Ann Arbor, MI

- Led reading group with lab team and advisor on message passing algorithms in graphical models.
- Supplied key ideas for and assisted advisor in writing National Science Foundation grant proposal.

● **Graduate Student Instructor, Discrete Mathematics** 2007-2008

EECS 203, University of Michigan

Ann Arbor, MI

- Led recitation discussions to elaborate key concepts in graph theory and combinatorics.
- Hosted office hours to provide further instruction for students preparing homework and for exams.

Awards

● **MIT Lincoln Lab Graduate Fellowship** 2009

- Awarded to a single graduate student at a small number of universities as a recruiting tool.

● **Innovative Signal Analysis (ISA) Fellowship** 2008

- Awarded to a single graduate student at a small number of universities as a recruiting tool.

● **Rackham Travel Award** 2007, 2009

- Awarded to a graduate student for the presentation of innovative research.

● **Rackham Engineering Award Fellowship** 2005-2010

- Fellowship covers all tuition, medical insurance, and provides a stipend for all graduate study.

● **Rackham Summer Institute Fellow** Summer 2005

– Summer fellowship providing an introduction to graduate studies at Michigan.

Publications

- Matthew G. Reyes, David L. Neuhoff, and Thrasos Pappas, *MAP Interpolation of an Ising Block*, accepted to Computer Vision Conference, Las Vegas, April 2019.
- Matthew G. Reyes, *A Marketing Game: a model for social media mining and manipulation*. accepted to Future of Information and Communication Conference, San Francisco, CA, March 2019.
- Matthew G. Reyes, *A Marketing Game: a rigorous model for strategic resource allocation*, ACM Workshop on Machine Learning and Graphs, London, August 2018.
- Matthew G. Reyes, *Local Conditioning: truly distributed exact inference for cyclic undirect networks*, accepted to Future Technologies Conference, Vancouverp, November 2018.
- Matthew G. Reyes and David L. Neuhoff, *Local Conditioning for Undirected Graphs*, Information Theory and Applications, San Diego, February 2017.
- Matthew G. Reyes and David L. Neuhoff, *Row-Centric Lossless Coding of Markov Images*, International Symposium on Information Theory, Aachen, June 2017.
- Matthew G. Reyes and David L. Neuhoff, *Minimum Conditional Description Length Estimation for Markov Random Fields*, Information Theory and Applications, San Diego, February 2016.
- Matthew G. Reyes and David L. Neuhoff, *Cutset Width and Spacing for Reduced Cutset Coding of Markov Random Fields*, International Symposium on Information Theory, Barcelona, July 2016.
- Matthew G. Reyes and David L. Neuhoff, *Cutset Width and Spacing for Reduced Cutset Coding of Markov Random Fields* (full version), online at <http://arxiv.org/abs/1602.04835>.
- Matthew G. Reyes, *A Marketing Game: Consumer Choice and the Ising Model*, Information Theory and Applications, San Diego, February 2015.
- Matthew G. Reyes, *Covariance and Entropy in Markov Random Fields*, ITA, San Diego, CA, February, 2013.
- Matthew G. Reyes, David L. Neuhoff, and Thrasos N. Pappas, *Lossy Cutset Coding of Bilevel Images Based on Markov Random Fields*, IEEE Transactions on Image Processing, January 2014.
- Ashish Farmer, Awlok Josan, Matthew Prelee, David L. Neuhoff, Matthew G. Reyes, and Thrasos N. Pappas, *Cutset Sampling and Reconstruction of Two-dimensional Data*, ITA, San Diego, February, 2011.
- Matthew G. Reyes, *Monotonicity and Positive Correlation in Markov Random Fields*, Information Theory and Applications, San Diego, February, 2012.
- Matthew G. Reyes, *Cutset Based Processing and Compression of Markov Random Fields*, Ph.D. thesis, University of Michigan, Ann Arbor, MI, 2011.
- Matthew G. Reyes and David L. Neuhoff, *Lossless Reduced-Cutset Coding of Markov Random Fields*, Data Compression Conference, Snowbird, March 2010.
- Matthew G. Reyes and David L. Neuhoff, *Entropy Bounds for a Markov Random Subfield*, Internatinoal Symposium on Information Theory, Seoul, July 2009.
- Matthew G. Reyes and David L. Neuhoff, *Arithmetic Encoding of Markov Random Fields*, International Symposium on Information Theory, Seoul, July 2009.
- Xiaonan Zhao, Matthew G. Reyes, Thrasos Pappas, and David L. Neuhoff, *Structural Texture Similarity Metrics for Retrieval Applications*, International Conference on Image Processing 2008, San Diego, CA.
- Matthew G. Reyes, Xiaonan Zhao, David L. Neuhoff, and Thrasos Pappas, *Structure-preserving Properties of Bilevel Image Compression*, Human Vision and Electronic Imaging, 2008, San Jose, CA.

- Matthew G. Reyes, Xiaonan Zhao, David L. Neuhoff, and Thrasyvoulas Pappas, *A Bilevel Image Coder Based on Markov Random Fields*, International Conference on Image Processing 2007, San Antonio, TX.

Presentations

- *Row-Centric Lossless Coding of Markov Random Fields*, ISIT, Aachen, Germany, June 2017.
- *Local Conditioning in Undirected Graphs*, ITA, San Diego, CA, February 2017.
- *Cutset Width and Spacing in Reduced Cutset Coding of Markov Random Fields*, ISIT, Barcelona, Spain, July 2016.
- *Minimum Conditional Description Length Estimation for Markov Random Fields*, ITA, San Diego, CA, February 2016.
- *A Marketing Game: Consumer Choice and the Ising Model*, ITA, San Diego, CA, February 2015.
- *Covariance and Monotonicity in Markov Random Fields*, ITA, San Diego, CA, February 2013.
- *Monotonicity and Positive Correlation in Markov Random Fields*, ITA, San Diego, CA, February 2012.
- *Cutset Based Processing and Compression of Markov Random Fields*, invited to talk to Stochastic Systems Group, MIT, November 10, 2010.
- *Cutset Based Processing and Compression of Markov Random Fields*, Thesis Defense, Ann Arbor, MI, September 10, 2010.
- *Lossless Reduced-Cutset Coding of Markov Random Fields*, DCC, Snowbird, Utah, March 2010.
- *Entropy Bounds for a Markov Random Subfield*, ISIT, Seoul, South Korea, July 2009.
- *Arithmetic Encoding of Markov Random Fields*, ISIT, Seoul, South Korea, July 2009.
- *Arithmetic Coding of Binary Markov Random Fields*, ITA, San Diego, CA, February 2009 (prepared presentation given by Prof. Dave Neuhoff).
- *Interpolation via Loopy Belief Propagation*, Statistics Interdisciplinary Seminar, University of Michigan, July 2008.
- *Structure-preserving Properties of Bilevel Image Compression*, HVEI, San Jose, CA, January, 2008 (prepared presentation given by Prof. Thrassos Pappas, Northwestern University).
- *Reconstruction of Markov Random Fields From Sparse Samples*, Graduate Student Symposium, University of Michigan, November 2007.
- *Bilevel Image Compression Based on Markov Random Fields*, ICIP, September 17, 2007.
- *A Binary Image Coder Based on Markov Random Fields*, ASEE Seminar Series, University of Michigan, August 22, 2007.

Workshops

- Second Annual School of Information Theory, Northwestern University, Aug. 10 - 13, 2009.
- First Annual School of Information Theory, Pennsylvania State University, June 1 - June 5, 2008.

Computing Skills

Languages: C, C++, BASH shell scripting, L^AT_EX, MatLab, Python, R

Operating Systems: Linux, MacOS X, Windows