Erik M. Ferragut, Ph.D.

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Research Interests

I am interested in applications of combinatorial and probabilistic modeling to the analysis of complex systems, especially those related to cybersecurity. Two main foci of recent research include (1) mathematical underpinnings of anomaly detection, and (2) scalable probabilistic algorithms. I have research and development experience in machine learning, probabilistic modeling, and theoretical and applied cryptology, including applications of probabilistic, combinatorial, group-theoretic, and computational methods.

Publications

Classified Papers

1. Authored 16 peer-reviewed classified papers in cryptology and related fields (1994–2005, 2007–2009). Received several competitive paper awards.

Refereed Journals

1. Czejdo, B., **Ferragut, E.**, Goodall, J., Laska, J., "Network Intrusion Detection and Visualization using Aggregations in a Cyber Security Data Warehouse," International Journal of Communications, Network and System Sciences (IJCNS), 5, 593–602, September, 2012.

Conference Proceedings

1. **Erik M. Ferragut**, Jason Laska, Robert A. Bridges, "A New, Principled Approach to Anomaly Detection," International Conference of Machine Learning Applications Special Session on Machine Learning in Information and System Security Issues, December 2012.

2. **Erik M. Ferragut**, Jason Laska, "Randomized Sampling for Large Data Applications of SVM," International Conference of Machine Learning Applications, December 2012.

3. **Erik M. Ferragut**, Jason Laska, Alex Melin, Bogdan Czejdo, "Addressing the Challenges of Anomaly Detection for Cyber Physical Energy Grid Systems," 8th Annual Cyber Security and Information Intelligence Research Workshop, October 2012.

4. Abercrombie, R., **Ferragut, E.**, Boone, S., "Hidden Markov Modeling for Weigh-In Motion Estimation," 6th International Conference on Weigh-In-Motion (ICWIM6), Dallas, Texas, June 2012.

5. **Erik M. Ferragut**, E. Nicole Braden, "System Log Summarization via Semi-Markov Models of Inter-Arrival Times," 7th Annual Cyber Security and Information Intelligence Research Workshop, October 2011.

6. Czejdo, B., **Ferragut, E**., "Time Analysis of Probabilistic Workflows," Proceedings of 2012 International Conference on Future Communication and Computer Technology (ICFCCT 2012), pp. 62–66.

7. Anita N. Zakrzewska, **Erik M. Ferragut**, "Enhanced Cyber Security Modeling Using an Extended Petri Net Formalism," IEEE Symposium on Computational Intelligence in Cyber Security (SSCI), April 2011.

8. David M. Darmon, **Erik M. Ferragut**, Stephen Kelly, Craig A. Shue, "Application of Latent Dirichlet Allocation to the Determination of Normal Client/Server Behavior and the Detection of Anomalies," IEEE Symposium on Computational Intelligence in Cyber Security (SSCI), April 2011.

9. R. K. Abercrombie, **E. M. Ferragut**, F. T. Sheldon, and M. R. Grimaila, "Addressing the Need for Independence in the CSE Model," IEEE Symposium on Computational Intelligence in Cyber Security (SSCI), April 2011.

10. Craig A. Shue, **Erik M. Ferragut**, "Dead Phish: An Examination of Deactivated Phishing Sites," Collaboration, Electronic Messaging, Anti-Abuse and Spam Conference (CEAS), July 2010.

11. **Erik M. Ferragut** 2009. "A dynamic erasure code for multicasting live data." In *Proceedings of the 5th Annual Workshop on Cyber Security and information intelligence Research: Cyber Security and Information Intelligence Challenges and Strategies* (Oak Ridge, Tennessee, April 13 - 15, 2009). F. Sheldon, G. Peterson, A. Krings, R. Abercrombie, and A. Mili, Eds. CSIIRW '09. ACM, New York, NY, 1-4.

Presentations

1. **Erik M. Ferragut**, "Probabilistic Schema Matching," Center for Intelligent Systems and Machine Learning Seminar, Knoxville, Tennessee, October 25, 2013.

2. **Erik M. Ferragut**, Jason Laska, Alex Melin, Seddik M. Djouadi, "Graph-Based Analysis of Cyber-Physical System Resiliency," American Mathematical Society Southeastern Sectional Meeting, Louisville, Kentucky, *pending approval* October 4–5, 2013.

3. A. Melin, **E. M. Ferragut**, J. A. Laska, D.L. Fugate and R. Kisner, "A Mathematical Framework for the Analysis of Cyber-Resilient Control Systems," 6th International Symposium on Resilient Control Systems, August 2013.

4. Robert Bridges, **Erik M. Ferragut**, Jason Laska, "A Principled Approach to Anomaly Detection," Congresso RSME, January 15, 2013.

5. **Erik M. Ferragut**, Jason Laska, Robert Bridges, "A Principled Approach to Anomaly Detection," Center for Intelligent Systems and Machine Learning Seminar, Knoxville, Tennessee, November 14, 2012.

Patents

1. "Weigh-In-Motion Estimation via Probabilistic Hidden Variable Modeling," R. K. Abercrombie and E. M. Ferragut, US Patent Pending, (May 2, 2012).

2. "Weight and Piece-Wise Analysis for Weigh-In-Motion," R. K. Abercrombie, E. M. Ferragut, and L. M. Hively, US Patent Pending, (May 3, 2012).

3. "Cyberspace Security Econometrics System (CSES) Expansion to Address Dependent Events," R. K. Abercrombie and E. M. Ferragut, U.S. Patent Pending (February 15, 2011).

Education

December 2003	Ph.D. in Mathematics University of Michigan, Ann Arbor Dissertation: "*Detection of Epistatic Effects in Genetic Data*" Advisor: Phil Hanlon
August 1999	M.S. in Mathematics University of Michigan, Ann Arbor
May 1997	B.S. in Mathematics, *Summa Cum Laude* Highest honors in Mathematics, Physics, and Philosophy Ursinus College, Collegeville, PA

Work Experience

- 6/2009 – Present: Oak Ridge National Laboratory (FFRDC). Cyber Security Research Scientist, Cyberspace Sciences and Information Intelligence Research Group.
- 8/2007 – 6/2009: Institute for Defense Analyses (FFRDC), Center for Communications Research, Princeton. Applied Research Mathematician.
- 8/2006 – 8/2007: Oak Ridge National Laboratory (FFRDC). Cyber Security Research Scientist, Cyberspace Sciences and Information Intelligence Research Group.
- 10/2005 – 8/2006: Johns Hopkins University, Applied Physics Laboratory (UARC). Applied Research Mathematician.
- 8/1993 – 10/2005: National Security Agency. Applied Research Mathematician.

Awards and Fellowships

- 2009, Honorable Mention, Theoretical Category, Crypto-Mathematics Institute
- 2003, Best Paper, KRYPTOS, First Prize
- 2003, Best Paper, Theoretical Category, Crypto-Mathematics Institute
- 2003, Honorable Mention, Theoretical Category, Crypto-Mathematics Institute
- 1997, Rackham Merit Fellowship, The University of Michigan, Rackham School of Graduate Studies
- 1997, National Science Foundation Minority Graduate Fellowship
- 1997, Ursinus College Faculty Prize in Mathematics
- 1997, Ursinus College Philip H. Fogel Memorial Prize (awarded to the student with the highest honors in Philosophy)
- 1997, Ursinus College Professor Evan S. Snyder Prize (awarded in for excellence in Physics)
- 1996, Phi Beta Kappa (academic honor society)
- 1996, Kappa Mu Epsilon (mathematics honor society)
- 1996, Sigma Xi (scientific research honor society)
- 1993, Undergraduate Training Program (now the Stokes Program) of the National Security Agency, a four-year full scholarship in return for national service

Professional Membership and Service

Memberships

- Member, American Mathematical Society (AMS)
- Member, Society for Industrial and Applied Mathematics (SIAM)
- Member, Latinos in Science and Engineering (MAES)

Service

- Organizer, Machine Learning Challenges in Cyber Security Applications, Special Session for the International Conference on Machine Learning Applications (ICMLA) 2013
- Reviewer, Cyber Security and Information Intelligence Research Workshop (CSIIRW) 2010–2012
- Reviewer, HICSS 2009
- Reviewer, IEEE Network Magazine
- Reviewer, ACM Transactions on Modeling and Computer Simulation Journal (ACM TOMACS)

Languages, Programming, and Clearances

- Fluent in English and Spanish
- Programming skills in Python, C, C++, PERL, Mathematica, Matlab, SAGE, and Magma
- Citizenship: USA
- Clearances: Q, TS//SI