Alexander M. Duda

Curriculum Vitæ

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Research Interests

Theory: Complex Systems, Networks, Nonlinear Dynamics, Signal Processing, Systems Science

Application: {Bio, Cog, Neuro}-Inspired Computing, Developmental Embodied Systems, Human-Machine Integration/Interaction, Machine {Creativity, Curiosity, Improvisation, Learning}, Soft Computing, Swarm Intelligence

Organizational: Collective (Human, Animal, Machine, etc.) Organisms, Developing/Nurturing Creative Ecosystems

Education

2015 **Ph.D., Electrical and Computer Engineering**, University of Illinois at Urbana-Champaign

2009 **M.S., Applied Mathematics**, University of Illinois at Urbana-Champaign

2006 **B.S., Engineering Physics**, University of Illinois at Urbana-Champaign

Selected Awards and Honors

20(14 - 17) Future Technical Leaders (FTL) Program at Northrop Grumman Corporation

2013 F - Eta Kappa Nu (HKN) Electrical and Computer Engineering Honor Society, Alpha Chapter

2011 Su Intern. Conf. on Complex Systems Best Poster Award Winner

2010 W IEEE Intern. Conf. on Machine Learning and Applications Best Poster Award Nominee

20(09, 10) F List of Teachers Ranked as Excellent by their Students

2010 Su New England Complex Systems Institute Summer School Scholarship Recipient

Selected Work Experience

20(16 - 17) **FTL Systems Engineer**. Northrop Grumman Electronic Systems, Linthicum, MD.
- Completing third FTL rotation (08/08/16 - present) in Advanced Concepts & Technologies Division
- Primarily supporting shaping, capture, proposal, on multiple DARPA efforts
- Technical areas focused on next-generation machine learning, stochastic computing, and context-sensitive adaptive edge perception/computation/control
- Helped to recruit/nominate PhD FTL Program candidates from UIUC; 3 given FTL offers; 3 accepted

20(15 - 16) **FTL Systems Engineer**. Northrop Grumman Aerospace Systems, Space Park, CA.
- Completed second FTL rotation (07/20/15 - 07/29/16) in *NG Next* Basic Research supporting the Biologically-Inspired Processing and Sensing (BIPS) group
- Contributed to founding whitepaper for BIPS group
- Provided tours/demos for *NG Next* Lab to various NGC personnel, across a wide range of backgrounds including corporate directors, engineers, executives, and R&D managers
- Conducted neurorobotics basic research that included SNNs with plastic synapses
- Developed and nurtured academic collaborations
- Helped to propose and supported topic area at Telluride Neuromorphic Cognition Engr. Workshop 2016
- Represented *NG Next* BIPS group at Design & Emergent Systems Sidebar at *NGC* TechExpo

20(14 - 15) **FTL Systems Engineer**. Northrop Grumman Information Systems, Annapolis Junction, MD.
- Completed first FTL rotation (09/15/14 - 07/19/15) in Cyber Division - IR&D Big Data 2020
- Conducted tech strategy research covering academic, industrial, and government literature
- Drafted whitepaper focused on hardware trends for future big data processing systems
- Completed state-of-the-art trade study on streaming and in-memory engines
- Provided technical writing support and innovation ideas for business proposal tech volume

20(11 - 14) **Graduate Researcher**. University of Illinois at Urbana-Champaign.
- Worked on *Computational Models of Neural Population Dynamics*, funded in part by Sandia
- Designed canonical cellular-resolution SNN with learning
- Implemented SNN with plastic synapses
- Empirically studied extent to which summary statistics were information-preserving
- Explored techniques to establish similarity measures between phase portraits
- Used emergent dynamics of SNNs as basis for multi-sensory associative memory model
- Examined methods of processing high-throughput data with finite resources
- Employed visualization techniques for high-dimensional systems

2012 Su **Research Intern**. Sandia National Laboratories.
- Completed summer internship at Computer Science Research Institute, Albuquerque, NM
- Worked on dissertation, which included NeuroXyce development
- Identified important features in conductance-based learning-enabled synapse model
- Adapted spike-timing dependent plasticity (STDP) model for NeuroXyce synapse device
- Simulated, tuned, and debugged NeuroXyce synapse device

20(10 - 11) **Graduate Researcher**. University of Illinois at Urbana-Champaign.
- Contributed to project *The Role of Sensorimotor Function, Associative Memory and Reinforcement Learning in Automatic Acquisition of Spoken Language by an Autonomous Robot*, NRL supported
- Conducted scholarly research on use of SNNs for sensory integration
- Determined required features of canonical cellular-resolution SNN
- Explored possible ways to use dynamics of SNNs as basis for associative memory

2010 (S - Su) **Graduate Researcher**. University of Illinois at Urbana-Champaign.
- Worked on project *Mathematical Models of Neocortical Circuits*, Sandia supported
- Integrated Hodgkin-Huxley neuron model; explored variety of nonlinear behaviors
- Investigated methods to create reduced-order models of SNNs
- Implemented small-scale SNN (25+ neurons, 120+ synapses) without learning

Selected Computer Skills

Languages: C, C++, Python

Applications: LaTeX, MATLAB, NeuroXyce, STELLA

Operating Systems: Win, Mac, Linux

Selected Publications

[9] **BIPS Group Founding Whitepaper**. Written with A. Cobb, D. Flynn, S. Kelly, J. Shepanski, and G. Tseng. *NG Next* Basic Research Whitepaper, 2015.

[8] **Towards a Streaming Analytics Platform: Hardware Considerations, Predictions, and Recommendations**. NGC IR&D Big Data 2020 Whitepaper, 2015.

[7] **Towards a Neocortically-Inspired Ab Initio Cellular Model of Associative Memory**. Ph.D. Dissertation, *University of Illinois Press*, 2015.

[6] **Information-Preserving Transforms: Two Graph Metrics for Simulated Spiking Neural Networks**. Written with S. Levinson. Procedia Computer Science 20, pp. 14–21, 2013

[5] **Simulating neural systems with Xyce**. Written with Richard L. Schiek, Christy E. Warrender, Corinne Teeter, James Bradley Aimone, Heidi Thornquist, and Ting Mei. *SANDIA Report*, 2012.

[4] **Complex Networks of Spiking Neurons: Collective Behavior Characterization**. Written with S. Levinson. *Proc. of The Intern. Conf. on Complex Systems.* NECSI Knowledge Press, pp.1627–1629, 2011. (Best Poster Award Winner)

[3] **Characterizing Populations of Spiking Neurons.** Written with S. Levinson. *Proc. of The Intern. Conf. on Cognitive and Neural Systems.* NSF, pp.87, 2011.

[2] **Nonlinear Dynamical Multi-Scale Model of Associative Memory**. Written with S. Levinson. *IEEE Proc. of Intern. Conf. on Machine Learning and App.* IEEE Comp. Soc., pp. 867–872, 2010. (Best Poster Award Nominee)

[1] **Integrating Language and Motor Function on a Humanoid Robot**. Written with L. Majure, L. Niehaus, A. Silver, L. Wendt, and S. Levinson. *RobotCub Workshop at IEEE/RSJ IROS,* 2010.

Selected Presentations

2016 July 14 ***NG/Next* BIPS Group Demo**. Telluride Neuromorphic Cognition Engineering Workshop, Telluride, CO

2016 June 24 ***NG/Next* All Minds Meeting**. Manhattan Beach, CA

2016 June 7/8 ***NG/Next* Basic Research BIPS group Demo/Talk**. NGC TechExpo, McLean, VA

2016 March 21 **Embodied Adaptive Spiking Neural Networks: Emergent Weighted Directed Graph Structure and its Applicability to Novelty Detection**. *NG/Next* Basic Research Series, Redondo Beach, CA

2016 March 10 **MUNDANE: Multisensory Adaptive Data Experience Technology**. NGC FTL/SEA Spring Learning Forum, Baltimore, MD

2015 June 16 **Memristors in Big Data**. NGC Cyber Division Operations Webinar Series, AJ, MD

2015 June 9/10 **NGC IR&D Big Data 2020 Demo/Talk**. NGC TechExpo, McLean, VA

2015 April 23 **Towards a Streaming Analytics Platform: Hardware Focus**. AJ, MD

2015 Feb 20 **IEEE Big Data Conference 2014 Overview**. NGC Cyber Analytics & Research Department Webinar Series, AJ, MD

2014 Sept 05 **Ph.D. Final Examination**. Urbana, IL

2013 Dec 02 MIT Lincoln Laboratory, Lexington, MA.

2013 Nov 21 **Graduate School Advice Talk**. HKN ECE Honor Society, Urbana, IL.

2013 Nov 13 **Information-Preserving Transforms: Two Graph Metrics for Simulated Spiking Neural Networks**. Complex Adaptive Systems Conference, Baltimore, MD

2013 March 08 **LAR Group Demo/Talk**. Beckman Institute Open House, Urbana, IL.

2013 March 07 **Ph.D. Preliminary Examination**. Urbana, IL.

2011 June 30 **Complex Networks of Spiking Neurons: Collective Behavior Characterization**. International Conference on Complex Systems, Boston, MA.

2011 May 14 **Characterizing Populations of Spiking Neurons**. Conf. on Cog. and Neural Systems, Boston, MA.

2011 March 11 **LAR Group Demo/Talk**. Beckman Institute Open House, Urbana, IL.

2010 Dec 12 **Nonlinear Dynamical Multi-Scale Model of Associative Memory**. International Conference on Machine Learning and Applications, Washington DC.

2010 Nov 18 Neuroengineering IGERT @ Illinois Seminar Series, Urbana, IL.

2010 Oct 13 Beckman Graduate Student Seminar, Urbana, IL.

2010 June 24 **Nonlinear Dynamical Models of Associative Memory**. Computer Science Research Institute Seminar at Sandia, Albuquerque, NM.

2010 June 18 New England Complex Systems Institute Summer School at MIT, Cambridge, MA.

Selected Leadership Experience

2016 Su **Founder**. *NG/Next* All Minds Meeting; designed and implemented a special, collaborative, "brainstorming" all hands meeting

2016(S - Su) **Mentor**. Ph.D. student, research intern in BIPS group at *NG Next*

20(14, 15) **Reviewer**. Complex Adaptive Systems Conference, Procedia Computer Science

2015 Su **Mentor**. Ph.D. student, summer research intern at NGC Cyber Division

2015 S - 2016 S **Founder**. Monthly **Cyber Analytics & Research Department Webinar Series** at NGC; established scope; invited speakers; arranged schedule; advertised series

20(13 Su - 14 F) **Founder**. Weekly **Big Ideas Meeting** at Illinois; recruited members; established mission

20(13 Su - 13 S) **Mentor**. CS Illinois Senior Thesis: *Controlling an Autonomous Car with a SNN*

20(10 F - 11 S) **Mentor**. ECE Illinois Senior Thesis: *Analysis of an Ab Initio Model of Associative Memory*

Selected Teaching Experience

20(13 F, 14 S) **Teaching Assistant**. ECE 110 Lab: Introduction to ECE.

2013 S **Teaching Assistant**. ECE 101: Exploring Digital Information Technology.

20(09, 10) F **Teaching Assistant**. COE/LAS Honors Calculus II Project.

2008 F **Teaching Assistant**. Introductory Control Systems Lab.

20(06 - 08) **Tutor**. Department of Mathematics.

20(05 - 07) **Tutor**. Department of Physics.

Memberships

2016- INCOSE {Complex Systems; Systems Science} Committees/Working Groups

2013- IEEE {Computational Intelligence; Information Theory; Signal Processing} Society

Selected Personal Interests

Music

- Composition, songwriting, arrangement, improvisation
- Capturing/communicating a concept, an emotion, a mood in/through music
- Production, recording
- Experimenting with a variety of acoustic, electronic, and software instruments, processing chains, and sound design approaches
- Project management of tracks, EPs, LPs, etc.
- Creative direction for a variety of music projects
- Design/Implementation of machine intelligence for any of the above

Version

2017 May 02