

DAVID B. KNOESTER

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RESEARCH INTERESTS

- **Distributed systems:** Multi-agent systems, embedded systems, mobile networks, wireless sensor networks, parallel processing, and distributed control.
- **Artificial Intelligence:** Evolutionary computation, digital evolution, neuroevolution, distributed problem solving, dynamic optimization, and evolutionary robotics.
- **Biology:** Artificial life, computational biology, and the evolution of cooperation and self-organization.

EDUCATION

- Ph.D., Dual-major Computer Science and Ecology, Evolutionary Biology, & Behavior
May 2011, Michigan State University, East Lansing, Michigan.
 - Doctoral Advisor: Dr. Philip K. McKinley
 - Thesis title: Evolution of Distributed Behavior
 - Research description: This research focuses on the evolution of distributed behavior, where evolutionary computation is used to discover behaviors for groups of interacting and communicating agents. In some cases, this research has resulted in the discovery of novel distributed algorithms, while in others, the evolved algorithms have (re-)discovered mathematical models of behavior in biology.
- M.S., Computer Science & Engineering, May 2004, Michigan State University, East Lansing, Michigan.
- B.S., Computer Engineering, May 2000, University of Michigan, Ann Arbor, Michigan.

PROFESSIONAL EXPERIENCE

- **Identity Management Systems Programmer (2006–Present)**
Academic Computing and Network Services, Michigan State University, East Lansing, Michigan
 - Lead architect and developer of a web-services based identity management system for low-assurance users. Currently in use to provide access to electronic resources at MSU for thousands of guest users.
 - Jointly responsible for maintenance and support of MSU's identity management infrastructure, currently used for authentication and authorization of approx. 120,000 users.
- **Research Assistant (Aug. 2005–Present)**
Digital Evolution Laboratory, Michigan State University, East Lansing, Michigan
Software Engineering and Network Systems Lab, Michigan State University, East Lansing, Michigan
 - Currently conducting research into harnessing evolutionary computation for the design and development of complex distributed systems.
 - Applying tools developed for evolving distributed systems to improve our understanding of evolution in biological systems.
- **Software Development and Validation Engineer (2004–2006)**
Software Vehicle Innovation Program / Powertrain, General Motors Corporation, Detroit, Michigan
 - Sole development engineer for validation infrastructure, including hardware- and software-in-the-loop systems, instrumentation interfaces, calibration support, and software build integration.
 - Lead validation engineer for an embedded fuel system controller. Responsible for designing and implementing validation tests of both hardware and software system components, in both vehicle and laboratory environments. Controller was successfully released to production for MY2007, and can now be found on most GM vehicles.
 - Lead validation and build support engineer for an integrated trailer-brake controller. Responsible for software validation and component integration in both vehicle and laboratory environments. Controller was successfully released to production for MY2007.

- **Research Assistant** (2001–2004)
Software Engineering and Network Systems Lab, Michigan State University, East Lansing, Michigan
 - Conducted research into the application of developmental learning (a form of machine-learning) to network security. This approach is general enough to leverage existing intrusion detection methods, while providing a solid mathematical foundation for identifying anomalies in network traffic. Experimental results have demonstrated that this approach can detect a high percentage of network attacks with low false-positive rate.
- **Software Engineer** (2000–2002)
System Architecture Group, FactSet Research Systems, Inc., Stamford, Connecticut
 - Sole developer of a clustered, shared-disk database engine. Currently in use as a state database for a web-services platform for financial research software, used daily by portfolio managers, investment bankers, and analysts. Researched the use of cluster-global memory-mapped files to improve legacy database performance, and assisted in debugging OpenVMS operating system upgrades.

TEACHING EXPERIENCE

All of the following teaching experience was acquired in the Dept. of Computer Science & Engineering, Michigan State University, East Lansing, Michigan.

- **Guest Lecture: “Consensus.”** (April 2010)
CSE 812 (Advanced Operating Systems)
- **Guest Lecture: “Avida and Distributed Problem Solving.”** (January 2010)
CSE 910 (Computer Networks and Distributed Systems)
- **Guest Lecture: “Using Avida to Evolve Distributed Problem Solvers.”** (April 2009)
CSE 891 (Selected Topics)
- **Teaching Assistant, CSE 422 (Computer Networks)** (Spring semester, 2003)
 - Developed complete laboratory curriculum, where assignments focused on providing students with a practical understanding of computer networks, including DNS, TCP/IP, socket handling, and benchmarking. The final project was an FEC-encoding HTTP proxy, which students were able to test with a commercial web browser.
- **Teaching Assistant, CSE 410 (Operating Systems)** (Fall semester, 2002)
 - Presented laboratory lectures and assisted students on practical operating systems concepts, including synchronization, process handling, and multithreading.
- **Teaching Assistant, CSE 101 (Introduction to Databases)** (Spring semester, 2002)
 - Responsible for grading and assisting students with laboratory and homework assignments.

AWARDS

- **Outstanding Graduate Student**, Department of Computer Science and Engineering, Michigan State University, March 2011.
- **Best paper nomination**: “Evolution of Robust Data Distribution Among Digital Organisms.” Proceedings of the Genetic and Evolutionary Computation Conference (GECCO), July 2009.
- **Best student paper award**: “Applying Genetic Algorithms to Decision Making in Autonomic Computing Systems.” Proceedings of the IEEE International Conference on Autonomic Computing (ICAC), June 2009.
- **Best student paper award**: “Digital Evolution of Behavioral Models for Autonomic Systems.” Proceedings of the IEEE International Conference on Autonomic Computing (ICAC), June 2008.

POPULAR PRESS

- Wired (Science): Digital Creatures Evolve Firefly Flashing
<http://www.wired.com/wiredscience/2010/11/digital-organism-evolution>
This article is based on my work with the evolution of synchronization, where we evolved digital organisms that synchronize their behavior, much like fireflies in biology.

- **David B. Knoester** and Philip K. McKinley. “Neuroevolution of Controllers for Self-Organizing Mobile Ad Hoc Networks.” Proceedings of the IEEE International Conference on Self-Adaptive and Self-Organizing Systems (SASO), October 2011. (*To appear.*)
- **David B. Knoester** and Philip K. McKinley. “Evolution of Synchronization and Desynchronization in Digital Organisms.” Journal of Artificial Life, 17(1), Winter 2011.
- Andres J. Ramirez, **David B. Knoester**, Betty H.C. Cheng, and Philip K. McKinley. “Plato: A Genetic Algorithm Approach to Run-Time Reconfiguration in Autonomic Computing Systems.” Journal of Cluster Computing, March 2010.
- **David B. Knoester**, Heather J. Goldsby, and Philip K. McKinley. “Neuroevolution of Mobile Ad Hoc Networks.” Proceedings of the Genetic and Evolutionary Computation Conference (GECCO), July 2010.
- Heather J. Goldsby, **David B. Knoester**, and Charles Ofria. “Evolution of Division of Labor in Genetically Homogenous Groups.” Proceedings of the Genetic and Evolutionary Computation Conference (GECCO), July 2010.
- **David B. Knoester** and Philip K. McKinley. “Evolution of Probabilistic Consensus in Digital Organisms.” Proceedings of the IEEE International Conference on Self-Adaptive and Self-Organizing Systems (SASO), September 2009.
- **David B. Knoester** and Philip K. McKinley. “Evolving Virtual Fireflies.” Proceedings of the European Conference on Artificial Life (ECAL), September 2009.
- Heather J. Goldsby, **David B. Knoester**, Jeff Clune, Philip K. McKinley, and Charles Ofria. “The Evolution of Division of Labor.” Proceedings of the European Conference on Artificial Life (ECAL), September 2009.
- Benjamin E. Beckmann, Philip K. McKinley and **David B. Knoester**. “Effects of Communication Impairments on Quorum Sensing.” Proceedings of the IEEE International Conference on Self-Adaptive and Self-Organizing Systems (SASO), September 2009. (Poster.)
- **David B. Knoester**, Andres J. Ramirez, Philip K. McKinley, and Betty H.C. Cheng. “Evolution of Robust Data Distribution Among Digital Organisms.” Proceedings of the Genetic and Evolutionary Computation Conference (GECCO), July 2009. **Nominated for best paper award, artificial life track.**
- Andres J. Ramirez, **David B. Knoester**, Betty H.C. Cheng, Philip K. McKinley. “Applying Genetic Algorithms to Decision Making in Autonomic Computing Systems.” Proceedings of the IEEE International Conference on Autonomic Computing (ICAC), June 2009. **Received best student paper award.**
- **David B. Knoester**, Philip K. McKinley. “Cooperative Network Construction Using Digital Germlines.” Proceedings of the Genetic and Evolutionary Computation Conference (GECCO), July 2008.
- Heather J. Goldsby, Betty H.C. Cheng, Philip K. McKinley, **David B. Knoester**, and Charles Ofria. “Digital Evolution of Behavioral Models for Autonomic Systems.” Proceedings of the IEEE International Conference on Autonomic Computing (ICAC), June 2008. **Received best student paper award.**
- Philip K. McKinley, Betty H.C. Cheng, Charles Ofria, David Knoester, Benjamin Beckmann, and Heather Goldsby. “Harnessing Digital Evolution.” IEEE Computer, 41(1), January 2008.
- **David B. Knoester**, Philip K. McKinley, Benjamin Beckmann, and Charles Ofria. “Directed Evolution of Communication and Cooperation in Digital Organisms.” Proceedings of the European Conference on Artificial Life (ECAL), September 2007.
- **David B. Knoester**, Philip K. McKinley, and Charles Ofria. “Using Group Selection to Evolve Leadership in Populations of Self-Replicating Digital Organisms.” Proceedings of the Genetic and Evolutionary Computation Conference (GECCO), July 2007.
- Benjamin Beckmann, Philip K. McKinley, **David B. Knoester**, and Charles Ofria. “Evolution of Cooperative Information Gathering in Self-Replicating Digital Organisms.” Proceedings of the IEEE International Conference on Self-Adaptive and Self-Organizing Systems (SASO), July 2007.
- Heather J. Goldsby, **David B. Knoester**, Betty H.C. Cheng, Philip K. McKinley, and Charles Ofria. “Digitally Evolving Models for Dynamically Adaptive Systems.” Proceedings of the ICSE Workshop on Software Engineering for Adaptive and Self-Managing Systems (SEAMS), May 2007.

PUBLISHED SOFTWARE

Open-source projects to which I have contributed substantial amounts of time, code, or both:

- Avida: A Platform for Digital Life
<http://avida.devosoft.org>
Avida is a platform for digital evolution, where populations of individual computer programs self-replicate, undergo mutation, and compete for resources. Avida is commonly used to help us understand the process of evolution in biology, and is increasingly used for applied research.
- Breseq: Bacterial Genome Resequencing
<http://barricklab.org/breseq>
Breseq is a genome analysis pipeline that focuses on identifying putative mutations in bacterial genomes.

PRESENTATIONS

- “Neuroevolution of Mobile Ad Hoc Networks.” Genetic and Evolutionary Computation Conference (GECCO), July 2010, Portland, OR, USA.
- “Controlling Robotic Swarms.” **Invited talk**, November 2009, Hope College, Holland, MI, USA.
- “Evolution of Probabilistic Consensus in Digital Organisms.” Self-Adaptive and Self-Organizing Systems conference (SASO), September 2009, San Francisco, CA, USA.
- “Evolution of Robust Data Distribution Among Digital Organisms.” Genetic and Evolutionary Computation Conference (GECCO), July 2009, Montréal, QC, Canada.
- “Using Avida to Evolve Distributed Problem Solvers.” Guest lecture, MSU CSE 891, April 2009.
- “Cooperative Network Construction Using Digital Germlines.” Genetic and Evolutionary Computation Conference (GECCO), July 2008, Atlanta, GA, USA.
- “Using Group Selection to Evolve Leadership in Populations of Self-Replicating Digital Organisms.” Genetic and Evolutionary Computation Conference (GECCO), July 2007, London, UK.

RESEARCH GRANT PARTICIPATION

Results of my research were included as preliminary studies in the following proposals:

- National Science Foundation, “II-EN: Evolution Park An Evolutionary Robotics Habitat for the Study of Crawling, Swimming, and Flying Creatures,” PI: P. McKinley (**Funded: 2011-2013, \$305,000**).
- National Science Foundation, “BEACON: An NSF Center for the Study of Evolution in Action,” PI: E. Goodman (**Funded: 2010-2015, \$24,999,147**).
- National Science Foundation, “TEAMS: Transplanting Artificial Life Behaviors to Mobile Robots,” Computing Systems Research Program, PI: P. McKinley (**Funded: 2009-2012, \$494,364**).
- Army Research Office, “AWARE: Adaptive Software Monitoring and Dynamic Reconfiguration for Critical,” Infrastructure Protection, PI: P. McKinley, Co-PI: B. Cheng (**Funded: 2008-2011, \$315,000**).
- National Science Foundation, “A Testbed for Evolving Adaptive and Cooperative Behavior Among Autonomous Systems,” Computing Research Infrastructure Program, PI: P. McKinley, Co-PIs: B. Cheng, C. Ofria, R. Pennock and X. Tan (**Funded: 2008-2010, \$188,110**).
- National Science Foundation, “ORCHID: Harnessing Digital Evolution to Design High-Assurance Adaptive Systems,” Software for Real-World Systems Program, PI: B. Cheng, Co-PIs: P. McKinley, C. Ofria, and X. Tan (**Funded: 2008-2011, \$600,000**).
- National Science Foundation, “Applying Digital Evolution to Behavioral Models,” Small Grants for Exploratory Research Program, PI: B. Cheng, Co-PIs: P. McKinley, C. Ofria, and R. Lenski (**Funded: 2007-2008, \$100,000**).

PROFESSIONAL ACTIVITIES & SERVICE

Conference committees:

- Poster Chair, IEEE International Conference on Self-Adaptive and Self-Organizing Systems (SASO), 2011.

Reviewer for the following conferences:

- European Conference on Artificial Life (ECAL), Budapest, Hungary, September 2009.
- European Symposium on Algorithms (ESA), Eilat, Israel, October 2007.
- ACM/IFIP/USENIX 7th International Middleware Conference (MIDDLEWARE), Melbourne, Australia, November 2006.
- IEEE International Conference on Distributed Computing Systems (ICDCS), Lisboa, Portugal, July 2006.
- International Symposium on Distributed Objects and Applications (DOA), Agia Napa, Cyprus, October 2005.
- IEEE International Workshop on Future Trends in Distributed Computing Systems (FTDCS), Suzhou, China, May 2004.
- IEEE International Conference on Pervasive Computing and Communication (PerCom), Orlando, Florida, USA, March 2004.

Affiliations:

- BEACON: An NSF Center for the Study of Evolution in Action.
<http://beacon-center.org/>
BEACON is a multi-university consortium founded with the mission of illuminating and harnessing the power of evolution in action to advance science and technology and benefit society.
- DevoLab: The Digital Evolution Laboratory at Michigan State University.
- SENS: The Software Engineering and Network Systems Laboratory at Michigan State University.
- HAS: High-Assurance Computing Systems Initiative at Michigan State University.
- Student member of IEEE, ACM, and SIGEvo.

SKILLS

• Software development:

- I have ten years of industrial software development experience in a variety of languages, including: C, C++, Perl, Python, Matlab (incl. Simulink), SQL, and Java (SE & EE).
- I am experienced in the use of various development tools and environments, including: Boost, UML, NetBeans, Eclipse, Visual Studio, XCode, I-Logix Rhapsody, shell scripting, web services, XML, SCMs, and the GNU autotools.

• Embedded systems:

- I have extensive experience developing and debugging embedded control systems, both in laboratory and target environments. This includes root-cause analysis, developing patches for both application and operating system software (OSEK/VDX), and identification of hardware faults. I have also used the dSPACE MicroAutobox for rapid prototyping, and as part of my academic research I have developed embedded controllers for mobile robots.
- Properly validating embedded systems is a challenging problem, as both software algorithm and/or hardware implementations could be at fault. I have developed Software-in-the-Loop (SIL) and Hardware-in-the-Loop (HIL) validation systems, using a combination of Matlab, Simulink, Pi Autosim, and dSPACE simulators.
- *In situ* testing, where an embedded system is monitored in its target environment, requires still different techniques for validation. I have experience using CANoe, CANalyzer, ETAS Inca for *in situ* validation.
- Automated testing of embedded systems is required if regressions are to be identified in a timely manner. I have developed test harnesses (still in use as of 2010) for both the Pi Autosim and dSPACE simulators that enabled automated white-box testing of embedded systems using CCP.

- **Enterprise systems:**

- There are many aspects to enterprise-scale identity management, including identity issuance and vetting, authorization, authentication, and federated identity. I have developed systems that address these challenges for low-assurance populations using Apache Tomcat, Glassfish (a J2EE application server), MIT Kerberos, MySQL, and OpenDS (LDAP). I am also familiar with Shibboleth, ESBs, and BPEL.
- In today’s increasingly service-oriented environment, reliable and fast storage of state information, e.g., session state in web servers, is required. I have developed a distributed (shared-disk) database engine optimized for this purpose on OpenVMS TruClusters.

- **High-performance computing:**

- I have experience with high-performance computing for artificial life simulations as both a user (Moab, Torque) and software developer. Among my contributions to Avida (see “Published software,” above) is an extension to support large-scale parallel simulations across thousands of compute nodes using OpenMPI.

- **Statistical analysis:**

- Much of my academic research has benefitted from the use of various statistical analyses. My experience is primarily with frequentist methods for hypothesis testing, including (non-)parametric tests and multiple comparisons.