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Research Interests

My current research involves applying insights in nonlinear dynamical systems theory to the problems of cognition. My dissertation research explores the uses of aperiodic dynamics in forming perceptual, memory and goal structures for use in improved action selection mechanisms for autonomous agents. I have been particularly interested in the hierarchical formation of goal structures (valence systems) in biological and artificial organisms. My research has looked at how principles of self-organization in nonlinear dynamics are realized in neuronal groups, and especially how such principles are organized in the development of behavioral mechanisms. Areas of interest include:

- ◆ Complex adaptive systems
- ◆ Dynamical and embodied cognitive models
- ◆ Nonlinear brain dynamics
- ◆ Self-organizing systems
- ◆ Hierarchical and mesh dynamics
- ◆ Developmental and evolutionary systems

Education

Ph.D. in Computer Science, University of Memphis, 2004

Concentration: Artificial Intelligence, Cognition and Complex Adaptive Systems

Dissertation: *Towards a Model of Basic Intentional Systems: Chaotic Dynamics for Perception and Action in Autonomous Adaptive Agents*

Advisors: Dr. Robert Kozma, Dr. Stanley P. Franklin, Dunavant Professor

M.S. in Computer Science, Johns Hopkins University, 1994

Concentration: Artificial Intelligence

Graduated with honors

B.S. in Computer Science, Purdue University, 1990

Graduated with distinction

Research Positions

2001-current Self-Organizing Ontogenetic Development for Adaptive Systems (SODAS)

NASA Intelligent Systems Grant NCC-2-1244, University of Memphis

Co-investigator

Principal Investigator: Dr. Robert Kozma

Research scientist and coordinator of NASA intelligent systems grant. Coordinated interdisciplinary group of Psychology, Cognitive Science, Neuroscience and Artificial Intelligence researchers. Responsibilities include management of masters student's research projects, development of cluster computing systems, research and development of computational neurodynamical brain models, teaching, seminar organization and conference and journal publications.

2000-2001 Why2000: An Intelligent Tutoring System with Natural Language Dialog

Office of Naval Research MURI Grant (N00014-00-1-0600), U. of Memphis

Research Scientist, Consultant

Principal Investigator: Dr. Arthur C. Graesser

Consulted on Why 2000: An Intelligent Tutoring System with Natural Language Dialog for the Office of Naval Research Multi-University Research Initiative. Adapted AutoTutor intelligent tutoring system technology to new knowledge domains. Trained programmers and masters students in AutoTutor technology.

1997-2000 AutoTutor: Simulating Tutors with Natural Dialog and Pedagogical Strategies

National Science Foundation Grant (SBR 9720314), University of Memphis

Research Associate, Principal Programmer

Principal programmer National Science Foundation grant for the development of simulated tutors with natural language dialog and pedagogical tutoring strategies. Responsibilities included the design and development of simulated tutoring systems using statistical natural language processing techniques and animated talking head agents for student interaction. Organized and coordinated interdisciplinary team of scientists and programmers to translate theoretical positions on human tutoring into computer simulation. Developed and organized psychological experiments using AutoTutor. Helped streamline the collection and analysis of data. Produced conference and journal publications of scientific results.

Grants

2004-2006 Co-Investigator, NASA Research in Intelligent Systems, submitted.
SODAS II: Integrated Models of Self-Organizing Ontogenetic Development for Autonomous Adaptive Systems
Principal Investigator: Dr. Robert Kozma
Co-Investigators: Derek Harter, Dr. Walter J. Freeman, Péter Érdi
Submitted 3 year / \$1,000,000 extension to NASA for concrete implementations of aperiodic dynamics for perception and action in autonomous robotic agents.

2004-2006 Co-Investigator, NSF AI and Cognitive Science Program, submitted.

Nonlinear Dynamical Mechanisms for Goal Formation and Resource Allocation in Autonomous Agents

Principal Investigator: Dr. Robert Kozma

Co-Investigator: Derek Harter

Submitted 3 year / \$600,000 proposal to study goal-formation through aperiodic neurodynamics in the biological Midline Forebrain using the K-IV model.

2001-2003 **Co-Investigator**, NASA Research in Intelligent Systems, award \$1,000,000/3yr. *Models of Self-Organizing Ontogenetic Development for Autonomous Adaptive Systems (SODAS)*

Principal Investigator: Dr. Robert Kozma

Co-Investigators: Derek Harter, Dr. Stanley P. Franklin, Dr. Walter J. Freeman

Initiated, and wrote grant proposal and won 3 year/\$1,000,000 grant for biologically inspired approaches to building autonomous robotic agents.

2001 **Travel Grant**, Cognitive Science Society, \$500
NSF travel grant awarded for presentation at 23rd Annual Conference of the Cognitive Science Society, Edinburgh, Scotland.

2001 **Travel Grant**, CNS Society, \$750
Travel grant awarded for presentation at Fifth International Conference of Cognitive and Neural Systems (CNS2001), Boston, MA

Professional Experience

1994–1997 **MCImetro**, Reston, VA

Senior Software Engineer, Research and Development

Headed up national team of software engineers for the development of telecommunications provisioning system to provide private local phone service. Developed client/server provisioning application on NextStep platform using Objective-C and Oracle database. Led team to perform requirements, user analysis and system and database design using objected oriented analysis and design techniques. Coordinated and negotiated requirements with customers. Led graphical user interface design of system. Researched deployment of NextStep platform and objected oriented software methodologies for use in other MCI software projects.

1990–1994 **Hughes Network Systems**, Germantown, MD

Software Engineer

Responsible for developing and implementing features for client/server network management software for satellite based telecommunications systems. Performed maintenance, testing, design and development tasks in VAX Pascal system. Participated in object oriented analysis and design initiatives for the development of new projects. Organized and trained engineers in these techniques for projects. Participated in the development and maintenance of expert systems for diagnosing satellite network problems.

Teaching Experience

Instructor, CS3: Advanced Data and File Structures (undergraduate course), University of Memphis, Summer 2004

Instructor, Expert Systems and Prolog Programming (undergraduate/graduate course), University of Memphis, Spring 2004

Teaching Assistant, Neurodynamics (graduate course), University of Memphis, Spring 2004

Teaching Assistant, Artificial Intelligence (undergraduate course), University of Memphis, Fall 2003

Instructor, Dynamics of Memory and Cognition: How brains make up their minds (graduate seminar), University of Memphis, Fall 2001

Instructor, Computational Linguistics (undergraduate laboratory course), University of Memphis, Fall 2000

Seminar Organizer, Embodied and Dynamical Models of Cognition (graduate seminar), University of Memphis, Fall 1999

Instructor, Object Oriented Software Development (engineering seminar), Hughes Network Systems, 1993-1994

Editorial Work

2001–current Ad hoc reviewer to *Transactions in Neural Network*

2001 Reviewer for *Intelligent Systems Design and Applications (ISDA 2001)* conference.

Professional Service

2004 Organizing Chair, 2004 Symposia on Intentional Dynamic Systems, University of Memphis.

2001 Organizer, 2001 Symposia on the Dynamics of Memory, Perception and Consciousness, University of Memphis.

Professional Memberships

Association of Computing Machinery (ACM), since 1994

American Association of Artificial Intelligence (AAAI), since 1998

Cognitive Science Society, since 1998

Institute of Electrical and Electronics Engineers (IEEE), since 2003

Society of Adaptive Behavior, since 1999

Journal Publications

Harter, D., and Kozma, R. (under review). Chaotic neurodynamics for autonomous agents. *IEEE Transactions on Neural Networks*.

- Harter, D.**, and Kozma, R. (submitted). Neurodynamical conditions for general intelligent behavior. *Cognitive Science*.
- Harter, D.**, Kozma, R. and Achunala, S. (submitted). Constraints and the dynamic mechanisms of behavior generation. *Dynamical Psychology*.
- Harter, D.**, and Kozma, R. (in progress). Self-organization of cognitive maps in autonomous agents using an aperiodic neural population Model. *International Journal of Artificial Intelligence Technology*.
- Harter, D.**, and Kozma, R. (2001). Task environments for the dynamic development of behavior. *Lecture Notes in Computer Science*. 2074:300-306.
- Harter, D.**, Graesser, A. C. and Franklin, S. P. (2001). Bridging the gap: Dynamics as a unified view of cognition. *Behavioral and Brain Sciences*, 24(1):45-46.
- Graesser, A. C., VanLehn, K., Rosé, C., Jordan, P., **Harter, D.** (2001). Intelligent tutoring systems with conversational dialogue. *AI Magazine*. 22(4):39-51.
- Graesser, A.C., Person, N., **Harter, D.**, and the Tutoring Research Group (2000). Teaching tactics and dialog in AutoTutor. *International Journal of Artificial Intelligence in Education*. 12(3):257-279.
- Graesser, A. C., Wiemer-Hastings, P., Wiemer-Hastings, K., **Harter, D.**, Person, N., & the Tutoring Research Group. (2000). Using Latent Semantic Analysis to evaluate the contributions of students in AutoTutor. *Interactive Learning Environments*. 8(2):129-148.
- Wiemer-Hastings, P., Graesser, A.C., and **Harter, D.** (1998). The foundations and architecture of AutoTutor. *Lecture Notes in Computer Science*. 1452:334-340.

Conference Proceedings

- Harter, D.**, and Kozma, R. (2004). Aperiodic neurodynamics using a simplified K-set neural population model. Accepted in *Proceedings of the 2004 International Joint Conference on Neural Networks (IJCNN 2004)*.
- Harter, D.**, and Kozma, R. (2004). Biological Limbic Systems: A Bottom-Up Model for Deliberative Action. Accepted in *Proceedings of the 26th Annual Meeting of the Cognitive Science Society (CogSci 2004)*.
- Harter, D.**, and Kozma, R. (2004). Complex Systems Approaches to the Ontogenetic Development of Behavior. Accepted in *Proceedings of the 3rd Annual Technical Conference of the American Institute of Aeronautics and Astronautics Conference (AIAA 2004)*.
- Harter, D.**, and Kozma, R. (2004). Aperiodic dynamics for appetitive/aversive behavior in autonomous agents. *Proceedings of the 2004 IEEE International Conference on Robotics and Automation (ICRA'04)*, New Orleans, LA, April 2004, pp. 2147-2152.
- Harter, D.**, and Kozma, R. (2004). Navigation and cognitive map formation using aperiodic neurodynamics. Accepted in *Proceedings of the 8th International Conference on the Simulation of Adaptive Behavior (SAB'04)*.
- Harter, D.**, and Kozma, R. (2004). Aperiodic dynamics and the self-organization of cognitive maps in autonomous agents. *Proceedings of the 17th International FLAIRS Conference (FLAIRS'04)*, Miami, FL, May 2004, pp. 424-429.
- Harter, D.**, and Kozma, R. (2002). Simulating the principles of chaotic neurodynamics. In *Proceedings of the 6th World Multi-Conference on Systemics, Cybernetics and Informatics (SCI 2002)*, volume XIII, pages 598-603, Orlando, FL.

- Kozma, R., **Harter, D.** and Achunala, S. (2002). Action selection under constraints: Dynamic optimization of behavior in machines and humans. In *Proceedings of the IEEE/INNS/ENNS International Joint Conference on Neural Networks (IJCNN'02)*, pages 2574-2579, Washington, D.C.
- Harter, D.** (2001). Ontogenetic development of skills, strategies and goals for autonomously behaving systems. In *Proceedings of the 5th World Multi-Conference on Systemics, Cybernetics and Informatics (SCI 2001)*, pages 178-181, Orlando, FL.
- Harter, D.**, and Kozma, R. (2001). Models of ontogenetic development for autonomous adaptive systems. In *Proceedings of the 23rd Annual Conference of the Cognitive Science Society*, pages 405-410, Edinburgh, Scotland.
- Harter, D.**, and Kozma, R. (2001). Task environments for the dynamic development of behavior. In *Proceedings of the Intelligent Systems Design and Applications 2001 Workshop (ISDA 2001)*, pages 300-309, San Francisco, CA.
- Harter, D.**, and Kozma, R. (2001). Ontogenetic development of behavior for simple tasks. In *Proceedings of the Artificial Intelligence and Soft Computing Conference (ASC 2001)*, pages 401-407, Cancun, Mexico.
- Harter, D.**, Kozma, R. and Franklin S. P. (2001). Models of ontogenetic development: The dynamics of learning. In *Proceedings of the 2001 Learning Workshop*, page 37, Snowbird, UT.
- Harter, D.**, Kozma, R. and Franklin S. P. (2001). Ontogenetic development of skills, strategies and goals for autonomously behaving systems. In *Proceedings of the Fifth International Conference of Cognitive and Neural Systems (CNS2001)*, page 18, Boston, MA.
- Kozma, R., **Harter, D.** and Franklin S. P. (2001). Self-organizing ontogenetic development for autonomous adaptive systems (SODAS). In *Proceedings of the IEEE/INNS/ENNS International Joint Conference on Neural Networks (IJCNN'01)*, pages 633-637, Washington, D.C.
- Graesser, A.C., Person, N., **Harter, D.**, and the Tutoring Research Group (2000). Teaching tactics in AutoTutor. In *Proceedings of the Workshop on Tutorial Dialogue at the Intelligent Tutoring Systems 2000 Conference*. pages 49-57, University of Quebec, Canada.
- Marineau, J., Wiemer-Hastings, P., **Harter, D.**, Olde, B., Chipman, P., Karnavat, A., Pomeroy, V., Graesser, A.C., and the Tutoring Research Group (2000). Classification of speech acts in tutorial dialog. In *Proceedings of the Workshop on Tutorial Dialogue at the Intelligent Tutoring Systems 2000 Conference*.
- Wiemer-Hastings, P., Graesser, A. C., **Harter, D.**, & the Tutoring Research Group (1998). The foundations and architecture of AutoTutor. In *Proceedings of the 4th International Conference on Intelligent Tutoring Systems*, pages 334-343, Berlin Springer-Verlag.

Conference Presentations

- Harter, D.**, and Kozma, R. (2004). Aperiodic dynamics and the self-organization of cognitive maps in autonomous agents. Paper presented at the 17th International FLAIRS Conference (FLAIRS'04), Miami, FL, May 2004.
- Harter, D.**, and Kozma, R. (2004). Aperiodic dynamics and the self-organization of cognitive maps in autonomous agents. Paper presented at the 17th International FLAIRS Conference (FLAIRS'04), Miami, FL, May 2004.

- Harter, D.** (2004). Formation of perceptual patterns in autonomous agents using a discretized K-III model. Paper presented at the 2004 Intentional Dynamic Systems Conference (IDS'04), Memphis, TN, April 2004.
- Harter, D.**, and Kozma, R. (2002). Simulating the principles of chaotic neurodynamics. Paper presented at the 6th World Multi-Conference on Systemics, Cybernetics and Informatics (SCI 2002), Orlando, FL.
- Harter, D.** (2002). Computational neurodynamics at the University of Memphis. Paper presented at the 4th Annual Memphis Area Engineering and Science Conference (MAESC 2002), Memphis, TN.
- Harter, D.** (2002). Chaotic neurodynamics for behaviors in autonomous agents. Poster presented at the 2002 Symposia on the Dynamics of Memory, Perception and Consciousness (DPCM 2002), Memphis, TN.
- Harter, D.** (2001). Ontogenetic development of skills, strategies and goals for autonomously behaving systems. Paper presented at the 5th World Multi-Conference on Systemics, Cybernetics and Informatics (SCI 2001), Orlando, FL.
- Harter, D.**, and Kozma, R. (2001). Models of ontogenetic development for autonomous adaptive systems. Poster presented at the 23rd Annual Conference of the Cognitive Science Society, Edinburgh, Scotland.
- Harter, D.**, and Kozma, R. (2001). Ontogenetic development of behavior for simple tasks. Paper presented at the Artificial Intelligence and Soft Computing Conference (ASC 2001), Cancun, Mexico.
- Harter, D.**, Kozma, R. and Franklin S. P. (2001). Models of ontogenetic development: The dynamics of learning. Poster presented at the 2001 Learning Workshop, Snowbird, UT.
- Harter, D.**, Kozma, R. and Franklin S. P. (2001). Ontogenetic development of skills, strategies and goals for autonomously behaving systems. Poster presented at the Fifth International Conference of Cognitive and Neural Systems (CNS2001), Boston, MA.
- Graesser, A.C., Person, N., **Harter, D.**, & the Tutoring Research Group (2000, June). Teaching tactics in AutoTutor. Paper presented at the Workshop on Tutorial Dialogue at the Intelligent Tutoring Systems 2000 Conference, Montreal, Canada.
- Marineau, J., Wiemer-Hastings, P., **Harter, D.**, Olde, B., Chipman, P., Karnavat, A., Pomeroy, V., Graesser, A.C., and the Tutoring Research Group (2000, June). Classification of speech acts in tutorial dialog. Paper presented at the Workshop on Tutorial Dialogue at the Intelligent Tutoring Systems 2000 Conference, Montreal, Canada.
- Person, N., Graesser, A.C., **Harter, D.**, Mathews, E., and the Tutoring Research Group (2000, November). Dialog move generation and conversation management in AutoTutor. Paper presented at the AAAI Fall Symposium 2000 on Building Dialogue Systems for Tutorial Applications, Cape Code, MA.
- Person, N., Graesser, A.C., **Harter, D.**, and the Tutoring Research Group (2000, July). The dialog advancer network: A mechanism for improving AutoTutors conversational skills. Paper presented at the Meetings of the Society for Text and Discourse, Lyon, France.
- Rajan, S., **Harter, D.**, Graesser, A.C., and the Tutoring Research Group (2000, July). Back channel feedback in human and intelligent tutoring systems. Poster presented at the Meetings of the Society for Text and Discourse, Lyon, France.
- Graesser, A. C., Wiemer-Hastings, K., Wiemer-Hastings, P., **Harter, D.**, Person, N., and Kreuz, R. (1999). Latent semantic analysis can reliably evaluate student contributions in AutoTutor. Paper presented at the 40th Annual Meeting of the Psychonomic Society, Los Angeles, California.

Graesser, A.C., Franklin, S. P., and the Tutoring Research Group (1998, July). The goals and design of AutoTutor. Symposium presented at the 8th Annual Meeting of the Society for Text and Discourse, Madison, Wisconsin.

References

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