BENJAMIN JACK KUIPERS

University of Michigan
Computer Science and Engineering
2260 Hayward Street
Ann Arbor, Michigan 48109

kuipers@umich.edu
http://eecs.umich.edu/~kuipers/

EDUCATION

- Ph.D. (Mathematics), Massachusetts Institute of Technology, 1977.
  Thesis: Representing Knowledge of Large-Scale Space.
- B.A. with High Honors (Mathematics), Swarthmore College, 1970.
  Thesis: Topological Vector Spaces.

PROFESSIONAL EXPERIENCE

- **University of Michigan, Department of Electrical Engineering and Computer Science**
  - Professor Emeritus of Electrical Engineering and Computer Science, 2024-present.
    Professor of Computer Science and Engineering, 2009-2024.
- **University of Texas at Austin, Department of Computer Sciences**
  - Professor Emeritus, 2009-present.
    Endowed Professorship in Computer Sciences No. 3, 1997-2008.
    Department Chair, 1997-2001.
    David Bruton, Jr. Centennial Professor in Computer Sciences No. 1, 1992-97.
    Associate Professor of Computer Sciences, 1985-92.
  - Professor of Electrical and Computer Engineering, UT Austin, 2001-2008.
    Associate Professor of Medicine, The University of Texas Health Science Center at San Antonio (secondary appointment), 1988-91.
- **Massachusetts Institute of Technology, Laboratory for Computer Science**
  - Research Associate, Clinical Decision Making Group, 1984-85.
- **Tufts University, Department of Mathematics**
  - Assistant Professor of Mathematics, 1978-85 (on leave 1984-85).
  - Assistant Professor of Medicine, Tufts University School of Medicine, 1983-85.
- **Massachusetts Institute of Technology, graduate and post-doctoral work**
  - Research Associate, Division for Study and Research in Education, 1977-78.
  - Graduate Student, NSF Fellow, Danforth Fellow, Teaching Assistant and Research Assistant, Department of Mathematics and Artificial Intelligence Laboratory, 1972-77.
- **Harvard University, Department of Psychology**
  - Systems Programmer, Computer Based Laboratory, 1970-72.

PUBLICATIONS

Books

- B. J. Kuipers. *Qualitative Reasoning: Modeling and Simulation with Incomplete Knowledge*. Cambridge, MA: MIT Press, 1994.
- S. Winter, M. Duckham, L. Kulik, and B. Kuipers. *Spatial Information Theory: Proc. 8th Int. Conf. COSIT 2007.* Lecture Notes in Computer Science 4736. Berlin: Springer, 2007.

Articles

- Benjamin Kuipers, Ethical common sense for robots. In Johanna Seibt, Raul Hakli & Marco Nørskov (Eds.), *RoboPhilosophy – Philosophy of, for, and by Social Robotics*, MIT Press, to appear.
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- J. Juett and B. Kuipers. Learning to grasp by extending the peri-personal space graph. *IEEE/RSJ Conf. Intelligent Robots and Systems (IROS)*, 2018.
- B. Kuipers. How can we trust a robot? *Communications of the ACM (CACM)* **61**(3): 86–95, March 2018. doi:10.1145/3173087.
- C. Johnson and B. Kuipers. Socially-aware navigation using topological maps and social norm learning. *AAAI/ACM Conference on Artificial Intelligence, Ethics, and Society (AIES)*, 2018.
- Emanuelle Burton, Judy Goldsmith, Sven Koenig, Benjamin Kuipers, Nicholas Mattei & Toby Walsh. Ethical considerations in artificial intelligence courses. *AI Magazine* **38**(2): 22–34, Summer 2017.
- J. J. Park, S. Lee and B. Kuipers. Discrete-time dynamic modeling and calibration of differential-drive mobile robots with friction. *IEEE Int. Conf. on Robotics and Automation (ICRA)*, 2017.

- T. Williams, M. Scheutz, C. Johnson and B. Kuipers. A tale of two architectures: A dual-citizenship integration of natural language and the cognitive map. *Proc. Conf. Autonomous Agents and Multi-Agent Systems (AAMAS)*, 2017.
- B. Kuipers, E. A. Feigenbaum, P. E. Hart, N. J. Nilsson. Shakey: From conception to history. *AI Magazine* **38**(1): 88–103, Spring 2017.
- B. Kuipers. Why and how should robots behave ethically? In J. Seibt, M. Nørskov & S. S. Andersen (Eds.), *What Social Robots Can and Should Do*, Frontiers in Artificial Intelligence and Applications, vol. 290, IOS Press Ebooks, 2016, pages 15–18, doi:10.3233/978-1-61499-708-5-15.
- J. Juett and B. Kuipers. Learning to reach by building a representation of peri-personal space. *IEEE-RAS Int. Conf. on Humanoid Robots*, Cancun Mexico, 2016.
- B. Kuipers. Beyond Asimov: how to plan for ethical robots. https://theconversation.com/beyond-asimov-how-to-plan-for-ethical-robots-59725. Published 6-1-2016.
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- B. Kuipers. Human-like morality and ethics for robots. *AAAI-16 Workshop on AI, Ethics & Society*, AAAI, 2016.
- J. J. Park & B. Kuipers. Feedback motion planning via non-holonomic RRT* for mobile robots. *IEEE/RSJ Conf. Intelligent Robots and Systems (IROS)*, 2015.
- Xun Wang, Mary-Anne Williams, Peter Gardenfors, Jonathan Vitale, Shaukat Abidi, Benjamin Johnston, Benjamin Kuipers & Alan Huang. Directing human attention with pointing. *IEEE Int. Symp. on Robot and Human Interactive Communication (ROMAN)*, 2014.
- G. Tsai & B. Kuipers. Handling perceptual clutter for robot vision with partial model-based interpretations. *IEEE/RSJ Conf. Intelligent Robots and Systems (IROS)*, 2014.
- G. Tsai, C. Johnson & B. Kuipers. Semantic visual understanding of the indoor environment: from structures to opportunities for action. *Vision Meets Cognition Workshop*, CVPR, 2014.
- R. Mittelman, M. Sun. B. Kuipers & S. Savarese. A Bayesian generative model for learning semantic hierarchies. *Frontiers in Psychology: Hypothesis and Theory* **5**(417): 1–9, 2014.
- R. Mittelman, B. Kuipers, S. Savarese, H. Lee. Structured recurrent temporal Restricted Boltzmann Machines. *International Conference on Machine Learning (ICML)*, 2014.
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- R. Mittelman, H. Lee, B. Kuipers and S. Savarese. Weakly supervised learning of mid-level features with Beta-Bernoulli process restricted Boltzmann machines. In *IEEE Int. Conf. on Computer Vision and Pattern Recognition (CVPR)*, 2013, pages 476–483.
- P. Foster, Z. Sun, J. J. Park and B. Kuipers. VisAGGE: Visible angle grid for glass environments. In *IEEE Int. Conf. on Robotics and Automation (ICRA)*, 2013, pages 2213–2220.
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- C. Xu and B. Kuipers. Object detection using principal contour fragments. *Canadian Conf. Computer and Robot Vision (CRV-11)*, 2011.
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- J. Mugan and B. Kuipers. Autonomously learning an action hierarchy using a learned qualitative state representation. *International Joint Conference on Artificial Intelligence (IJCAI)*, 2009.
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- J. Mugan and B. Kuipers. Towards the application of reinforcement learning to undirected developmental learning. *International Conference on Epigenetic Robotics (EpiRob-08)*, 2008.
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- S. Gulati and B. Kuipers. High performance control for graceful motion of an intelligent wheelchair. *IEEE Int. Conf. Robotics and Automation (ICRA-08)*, 2008.
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- P. Beeson, M. MacMahon, J. Modayil, A. Murarka, B. Kuipers & B. Stankiewicz. Integrating multiple representations of spatial knowledge for mapping, navigation, and communication. In *Interaction Challenges for Intelligent Assistants*, AAAI Spring Symposium Series, 2007.

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- S. Ramamoorthy, B. Kuipers and L. Wenzel. 2006. Parametrization and computations in shape spaces with area and boundary invariants. *Proc. 16th Fall Workshop on Computational and Combinatorial Geometry*, Northampton MA, 10-11 November 2006.
- H. Subramanian, S. Ramamoorthy, P. Stone and B. J. Kuipers. Designing safe, profitable automated trading agents using evolutionary algorithms. In *Proc. Genetic and Evolutionary Computation Conference (GECCO-06)*, 2006, pages 1777–1784.
- M. MacMahon, B. Stankiewicz and B. Kuipers. 2006. Walk the talk: connecting language, knowledge, action in route instructions. *National Conference on Artificial Intelligence (AAAI-06)*, Boston, MA, 16-20 July 2006.
- B. J. Oommen, G. Raghunath and B. Kuipers. 2006. Learning from stochastic teachers and stochastic compulsive liars. *IEEE Trans. Systems, Man and Cybernetics, Part B: Cybernetics* **36**(4): 820–834.
- A. Murarka, J. Modayil and B. Kuipers. 2006. Building local safety maps for a wheelchair robot using vision and lasers. *Third Canadian Conference on Computer and Robot Vision*, Quebec City, Canada, 7-9 June 2006. (Best Student Paper Award)
- P. Beeson, A. Murarka and B. Kuipers. 2006. Adapting proposal distributions for accurate, efficient mobile robot localization. *IEEE Int. Conf. on Robotics and Automation (ICRA-06)*.
- J. Modayil and B. Kuipers. 2006. Autonomous shape model learning for object localization and recognition. *IEEE Int. Conf. on Robotics and Automation (ICRA-06)*.
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- D. Clancy and B. Kuipers. 2005. Time in qualitative simulation. In M. Fisher, D. Gabbay, & L. Vila (Eds.), *Handbook of Temporal Reasoning in Artificial Intelligence*, Elsevier Science, pages 655–664.
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- "Cognitive Representations of Medical Expertise." Tufts University Working Papers in Cognitive Science, No. 14, November 1979.
- "A Model of the Acquisition of Spatial Knowledge." Tufts University Working Papers in Cognitive Science, No. 11, February 1980.
- A. Stevens, D. Getty, B. Kuipers and C. Steinberg. "Studies of Human Spatial Information Processing." Final project report to the Defense Advanced Research Projects Agency. Cambridge, MA: Bolt Beranek and Newman, Inc. Report No. 3785. November, 1978.
- "Spatial Knowledge." MIT Artificial Intelligence Laboratory Memo 359, June 1976. Reprinted in *Artificial Intelligence Memoranda of MIT*. New York: Comtex Scientific Corporation, 1983.
- "Reactions to Weizenbaum's Book." *SIGART Newsletter* **58**: 4-5, June 1976.

- "CBL Report on the Software and Hardware Problems of University Computer Centers Serving Fast-Real-Time Users: 1969 - 1973." R. Walton with the assistance of W. Baum, S. Bradner, P. Clark, B. Kuipers, M. Novey, Y. Peduel, A. Razdow, R. Strom, and E. Wanner. Cambridge, MA: Computer Based Laboratory, Psychology Department, Harvard University, 1975.
- Review of E. Sandewall, "An approach to the frame problem, and its implementation." *Information and Control* **26**: 393-394, December 1974. (with B. C. Smith.)

DOCTORAL STUDENTS GRADUATED

1. Yung-Tai Byun, "Spatial learning mobile robots with a spatial semantic hierarchical model." Ph.D., Computer Science, University of Texas at Austin, May 1990. Professor, Department of Computer Science, Hongik University, Seoul, Korea.
2. James Crawford, "Access-limited logic: a language for knowledge representation." Ph.D., Computer Science, University of Texas at Austin, May 1991. CEO/Founder, Orbital Insight, Bay Area, California.
3. John Hartman, "Automatic control understanding for natural programs." Ph.D., Computer Science, University of Texas at Austin, May 1991.
4. Akira Hayashi, "Geometrical motion planning for highly redundant manipulators using a continuous manipulator model." Ph.D., Computer Science, University of Texas at Austin, May 1991. Professor of Information Sciences, Hiroshima City University, Japan.
5. David Throop, "Model-based diagnosis of complex, continuous mechanisms." Ph.D., Computer Science, University of Texas at Austin, August 1991. Research Scientist, Boeing Computer Services, Houston, Texas.
6. Daniel Berleant, "The use of partial quantitative knowledge with qualitative reasoning." Ph.D., Computer Science, University of Texas at Austin, December 1991. Professor, Department of Information Science, University of Arkansas at Little Rock.
7. Dan Dvorak, "Monitoring and diagnosis of continuous dynamic systems using semiquantitative simulation." Ph.D., Computer Science, University of Texas at Austin, May 1992. Jet Propulsion Laboratories, Pasadena, CA.
8. David Franke, "A theory of teleology." Ph.D., Computer Science, University of Texas at Austin, May 1992. Chief Scientist, Vast.com, Austin, Texas.
9. Wood Wai Lee, "A qualitative simulation based method to construct phase portraits." Ph.D., Computer Science, University of Texas at Austin, May 1993. Development Engineer, Dowell Schlumberger, Tulsa, Oklahoma.
10. Adam Farquhar, "Automated modeling of physical systems in the presence of incomplete knowledge." Ph.D., Computer Science, University of Texas at Austin, December 1993. Digital Lifecycle Management, UK.
11. Richard Froom, "High-speed navigation with approximate maps." Ph.D., Computer Science, University of Texas at Austin, May 1995. Valassis Digital, Austin, Texas

12. David Pierce, "Map learning with uninterpreted sensors and effectors." Ph.D., Computer Science, University of Texas at Austin, May 1995. CTO, Specific Energy, Georgetown, Texas.

13. Raman Rajagopalan, "Qualitative reasoning about dynamic change in the spatial properties of a physical system." Ph.D., Computer Science, University of Texas at Austin, December 1995. Principal Architect, Infosys Technologies, Dallas, Texas.

14. Bert Kay, "Refining imprecise models and their behaviors." Ph.D., Computer Science, University of Texas at Austin, December 1996. Deceased, June 1997.

15. Wan-Yik Lee, "Spatial semantic hierarchy for a physical mobile robot." Ph.D., Computer Science, University of Texas at Austin, December 1996. Development Scientist, Ascent Technology, Cambridge, Massachusetts.

16. Daniel J. Clancy. "Solving complexity and ambiguity problems within qualitative simulation." Ph.D., Computer Science, University of Texas at Austin, December 1997. Chief Product Officer, Twitch.

17. Micheal Hewett, "Computational perceptual attention." Ph.D., Computer Science, University of Texas at Austin, May 2001. Keeper Security.

18. Emilio Remolina, "A logical account of causal and topological maps." Ph.D., Computer Science, University of Texas at Austin, December 2001. Stottler-Henke Associates, Inc. (SHAI), San Mateo, CA.

19. Stacia Wyman, "Algorithms for the analysis of whole genomes." (Co-supervised with Robert Jansen, Integrative Biology.) Ph.D., Computer Science, University of Texas at Austin, August 2004. Senior Genomics Scientist, Innovative Genomics Institute, UC Berkeley.

20. Harold Chaput, "The constructivist learning architecture: a model of cognitive development for robust autonomous robots." (Co-supervised with Risto Miikkulainen.) Ph.D., Computer Science, University of Texas at Austin, August 2004. Electronic Arts, Belmont CA.

21. Mohan Sridharan, "Robust structure-based autonomous color learning on a mobile robot." (Co-supervised with Peter Stone.) Ph.D., Electrical and Computer Engineering, University of Texas at Austin, August 2007. Senior Lecturer, University of Birmingham, UK.

22. Matt MacMahon, "Following natural language route instructions." Ph.D., Electrical and Computer Engineering, University of Texas at Austin, August 2007. Google.

23. Subramanian Ramamoorthy, "Task encoding, motion planning and intelligent control using qualitative models." Ph.D. in ECE, August 2007. Professor of Robot Learning and Autonomy, University of Edinburgh.

24. Jefferson Provost, "Reinforcement learning in high-diameter, continuous environments." (Co-supervised with Risto Miikkulainen.) Ph.D., Computer Science, University of Texas at Austin, August 2007. Data Science Manager, Apple Computer, Austin TX.

25. Joseph Modayil, "Robot developmental learning of an object ontology grounded in sensorimotor experience." Ph.D., Computer Science, University of Texas at Austin, August 2007. Research Scientist, Google/DeepMind, London UK.

26. Patrick Foil Beeson, "Creating and utilizing hybrid representations of spatial knowledge using mobile robots." Ph.D., Computer Science, University of Texas at Austin, August 2008. Standard Bots, Houston TX.

27. Aniket Murarka, "Building safety maps using vision for safe local mobile robot navigation." Ph.D., Computer Science, University of Texas at Austin, August 2009. Oculus VR, Menlo Park, CA.

28. Jonathan Mugan, "Autonomous qualitative learning of distinctions and actions in a developing agent." Ph.D., Computer Science, University of Texas at Austin, August 2010. Principal Scientist, DeUmbra, Austin TX.

29. Shilpa Gulati, "A framework for characterization, planning, and evaluation of safe, comfortable and customizable motion of assistive mobile robots." Ph.D. in Mechanical Engineering (R. Longoria, co-advisor), August 2011, University of Texas at Austin. Head of Behavior Prediction, Waymo.

30. Changhai Xu, "Steps Towards the Object Semantic Hierarchy." (Kristen Grauman, co-advisor.) Ph.D., Computer Science, University of Texas at Austin, August 2011. Epic Systems, Madison WI.

31. Grace Tsai, "On-line, incremental visual scene understanding for an indoor navigating robot." Ph.D., Electrical Engineering: Systems, University of Michigan, August 2014. Staff Software Engineer, Google.

32. Jeremy Stober, "Sensorimotor embedding: A developmental approach to learning geometry." Ph.D., Computer Science, University of Texas at Austin, May 2015. Senior Machine Learning Manager, Apple, Austin TX.

33. Jong Jin Park, "Graceful navigation for mobile robots in dynamic and uncertain environments." (Art Kuo, co-advisor.) Ph.D., Mechanical Engineering, University of Michigan, April 2016. Robotics Senior Applied Scientist, Amazon Lab126.

34. Collin Johnson, "Topological mapping and navigation in real-world environments." Ph.D., Computer Science and Engineering, University of Michigan, April 2018. Lead Robotics Engineer, May Mobility, Ann Arbor, MI.

35. Jonathan Emerson Juett, "Towards learning the foundations of manipulation actions from unguided exploration." Ph.D., Computer Science and Engineering, University of Michigan, August 2021. Computer Science Instructor, Kirkland Community College, Iowa.

External Examiner

Barry D. Reich, University of Pennsylvania
Enrico Coeira, University of New South Wales, Australia
A. Sowmya, Indian Institute of Technology, Bombay, India
Pierre Fouché, Université de Technologie de Compiègne, Compiègne, France.
Raffaela Guglielmann, Universita di Milano, Italy, October 2000.
Luis E. Garza Castañón, Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM) Campus Monterrey, Mexico
Daniel Nikovsky, Carnegie-Mellon University, November 2001.
Bernhard Rinner, Habilitation, Technical University, Graz, Austria, January 2002.

Robert Sim, McGill University, Canada, November 2003.
Francesco Savelli, Universita degli Studi di Rome "La Sapienza", Italy, November 2004.
John Santore, University of Buffalo, December 2004.
Urs-Jakob Ruetschi, University of Zurich, Switzerland, April 2007.
Ananth Ranganathan, Georgia Institute of Technology, February 2008,
Jan Oliver Wallgrün, Universität Bremen, Germany, August 2008.
Elin Anna Top, KTH, Sweden, October 2008.
Christopher Crick, Yale University, October 2009.
Junaed Sattar, McGill University, Canada, September 2011.
Kira Mourao, University of Edinburgh, Scotland, May 2012.
Arren John Glover, Queensland University of Technology, Australia, December 2013.
Mikhail Alexander Frank, Università della Svizzera Italiana, Switzerland, October 2014.
Varun Raj Kompella, Università della Svizzera Italiana, Switzerland, December 2014.
Malika Meghjani, McGill University, Montreal, Canada, November 2016.
Malcolm Mielle, Örebro University, Örebro, Sweden, October 2019.

RESEARCH GRANTS

- Ford Motor Company, "Intelligent Wheelchair." (AWD011972). 1/1/2019 to 12/31/2021.
- National Science Foundation, Information and Intelligent Systems. "RI: Small: Robot developmental learning of skilled actions." (IIS-1421168), 9-1-2014 to 8-31-2020.
- National Science Foundation, Information and Intelligent Systems. "RI EAGER: Memory-based learning of effective actions." (IIS-1252987), 9-1-2012 to 8-31-2014.
- National Science Foundation, Information and Intelligent Systems. "HCC: Large: Collaborative Research: Human-Robot Dialog for Collaborative Navigation Tasks." (IIS-1111494), 8-15-2011 to 7-31-2016.
- TEMA-Toyota Technical Center. "Active sensing of the physical environment for autonomous systems." 1-1-2010 to 2-29-2012.
- National Science Foundation, Cyber-Physical Systems Program. "CPS: Medium: Learning to Sense Robustly and Act Effectively." (CPS-0931474) 9-1-2009 to 8-31-2014.
- Texas Higher Education Coordinating Board, Advanced Technology Program. "Developmental robotics: Learning hand-eye skills." (003658-0170-2007.) 5-15-2008 to 8-31-2010.
- National Science Foundation, Information and Intelligent Systems. "RI: Robot developmental learning of objects, actions, and tools." (IIS-0713150) 9-15-2007 to 8-31-2010.
- National Science Foundation, Information and Intelligent Systems. "SGER: A simulation platform for research on developmental robotics." (IIS-0750011) 9-1-2007 to 2-28-2009.
- National Science Foundation, Artificial Intelligence and Cognitive Sciences. "Artificial Intelligence: An Academic Genealogy." (IIS-0538927) 7-1-2005 to 6-30-2007.
- National Science Foundation, Artificial Intelligence and Cognitive Sciences. "Learning the Sensorimotor Foundation for Spatial Reasoning." (IIS-0413257) 1-1-2005 to 12-31-2008.

- National Institutes of Health, National Eye Institute. "Development of a Bayesian Low-Vision Navigation Aid" (1 R03 EY016089) (Co-PI. Brian J. Stankiewicz, PI), 12-1-2004 to 11-30-2007.
- IBM Faculty Research Award. "Enabling autonomic computing by building cognitive maps of complex computing systems." IBM Austin Center for Advanced Studies. 11-27-2002 to 12-31-2004.
- IBM Faculty Research Award. "Enabling autonomic computing by building cognitive maps of complex computing systems." Tivoli Center of Excellence and IBM Austin Center for Advanced Studies. 12-7-2001 to 4-17-2003.
- Texas Higher Education Coordinating Board, Advanced Technology Program. "Strategic Autonomy for Planetary Rovers." (003658-0656-2001.) 1-1-2002 to 8-31-2004.
- Tivoli Corporation. "Building a Cognitive Map of a Large-Scale Computing System." 4-18-2000 to 4-17-2003.
- Microsoft Corporation. "Elements of Computing" (equipment support). 6-15-2000 to 6-14-2003.
- Texas Higher Education Coordinating Board, Advanced Research Program. "Spatial Knowledge for Agents in the Physical World." (003658-347.) 1-1-1998 to 8-31-2000.
- National Science Foundation, CISE Research Instrumentation Program. "CISE Research Instrumentation: Robotics Equipment for Research on Assistive Intelligence." (CDA-9617327.) 2-1-1997 to 1-31-2001.
- National Aeronautics and Space Administration, Lyndon B. Johnson Space Center. "Spatial Reasoning for Scalable Distributed Mobile Robot Vision." (NAG 9-898.) 8-6-96 to 7-31-97.
- National Science Foundation, Knowledge Models and Cognitive Systems Program. "An Ontological Hierarchy for Spatial Knowledge." (IRI-9504138.) 12-1-1995 to 11-30-1999.
- Texas Higher Education Coordinating Board, Advanced Research Program. "A Modern, Access-Limited Knowledge Representation System." (003658-242.) 1-1-1996 to 12-31-1997.
- National Aeronautics and Space Administration, Ames Research Center. "Monitoring with Trackers Based on Semi-Quantitative Models." (NAG 2-994.) 8-15-1995 to 8-14-1996.
- National Aeronautics and Space Administration, Lyndon B. Johnson Space Center. "A Scalable Distributed Approach to Mobile Robot Vision." (NAG 9-828.) 9-1-95 to 8-31-96.
- Lower Colorado River Authority, Austin, Texas. "Development of Automated Stage/Discharge Relationship Generation Capabilities." 1994.
- Electric Power Research Institute, Palo Alto, California. "Qualitative Design and Verification of Heterogeneous Controllers." (RP8030-21.) 1994-96.
- National Science Foundation, Robotics and Machine Intelligence Program. "Qualitative Design and Verification of Heterogeneous Controllers." (IRI-9216584.) 1993-96.
- National Aeronautics and Space Administration, Lyndon B. Johnson Space Center. "Dynamic Modeling for Failure Analysis." (NAG 9-665.) 1993.

- National Aeronautics and Space Administration, Ames Research Center. "Self-Calibrating Models for Dynamic Monitoring and Diagnosis." (NCC 2-760.) 1992-94.
- National Science Foundation, Knowledge Models and Cognitive Systems Program. "Software Upgrade and Distribution Support for QSIM." (IRI-9017047.) 1991-93.
- California Institute of Technology, Jet Propulsion Laboratory (NASA). "A Study on Qualitative Reasoning." (JPL Contract No. 958788.) 1990-93.
- National Science Foundation, Robotics and Machine Intelligence Program. "Qualitative Methods for Robot Exploration." (IRI-8904454.) 1989-94. Extended to five years "for special creativity based on outstanding scientific/technical progress achieved to date under this grant."
- National Aeronautics and Space Administration, Lyndon B. Johnson Space Center. "Diagnosis and Model Building for Dynamic Systems." (NAG 9-512.) 1991-92.
- Texas Higher Education Coordinating Board, Advanced Research Program. "Access-Limited Logic as a Language for Knowledge Representation." (003658-175.) 1989-91.
- National Science Foundation, Knowledge Models and Cognitive Systems Program. "Qualitative Modeling and Simulation of Physical Systems." (IRI-8905494.) 1989-92.
- National Aeronautics and Space Administration, Ames Research Center. "System Monitoring and Diagnosis With Qualitative Models." (NAG2-507.) 1988-91.
- National Aeronautics and Space Administration, Lyndon B. Johnson Space Center. "A Qualitative Approach to Robot Exploration and Mapping." (NAG9-200.) 1987-89.
- National Science Foundation, Intelligent Systems Program. "Deep and Shallow Models in the Knowledge Base." (IRI-8602665.) 1986-89.
- National Science Foundation, Intelligent Systems Program. "Knowledge Representations for Expert Causal Models (Computer Research)." (MCS-8303640; DCR-8417934; DCR-8512779.) 1983-86.
- National Institutes of Health, National Library of Medicine. "Expert Causal Models in the Medical Knowledge Base." (R01 LM04125; R01 LM 04374; R01 LM04515.) 1983-86.
- National Institutes of Health, National Library of Medicine. "Cognitive Representations of Medical Expertise." (R23 LM03603) 1980-83.
- National Institutes of Health, National Library of Medicine. "Clinical Decision Analysis." (via subcontract through New England Medical Center Hospital). 1979-80.
- Advanced Research Projects Agency, Department of Defense. "Studies of Human Spatial Information Processing." (via subcontract through Bolt, Beranek and Newman, Inc.). 1977-78.

ACADEMIC HONORS

Herbert A. Simon Prize for Advances in Cognitive Systems, 2024.
Fellow, Asia-Pacific Artificial Intelligence Association (AAIA), 2022.
Herbert Kopf Service Excellence Award (University of Michigan College of Engineering), 2020-2021.
EECS Outstanding Achievement Award (University of Michigan College of Engineering), February 2015.
Fellow, American Association for the Advancement of Science (AAAS), 2012.
University of Texas at Austin, College of Natural Sciences Teaching Excellence Award, 2004.
Guest Professor, University of Science and Technology of China, Hefei, China, May 2002.
Fellow, Institute of Electrical and Electronics Engineers (IEEE), 1999.
Endowed Professorship in Computer Sciences (No. 3), 1997-2008.
David Bruton, Jr. Centennial Professorship in Computer Sciences (No. 1), 1992-97.
Fellow, American Association for Artificial Intelligence (AAAI), 1992.
NSF Creativity Award, 1992: "Qualitative Methods for Robot Exploration" (IRI-8904454). "This two-year extension for special creativity is based on outstanding scientific/technical progress achieved to date under this grant."
Computer Sciences Faculty Fellowship (No. 1), 1987-92.
Sigma Xi, student member 1970, full member 1976.
Phi Beta Kappa, Swarthmore College, 1970.
Danforth Graduate Fellowship, 1970.
National Science Foundation Graduate Fellowship, 1970.
National Merit Scholar, 1966.

2011 Best Student Paper Award for C. Xu, J. Liu and B. Kuipers, "Motion segmentation by learning homography matrices from motor signals." *Canadian Conf. Computer and Robot Vision (CRV-11)*.
2010 Best Educational Video Award, AAAI Video Competition (AIVC 2010), for J. Mugan and B. Kuipers, "The Qualitative Learner of Action and Perception, QLAP." Video available at: http://www.youtube.com/watch?v=xJ0g-NoerZ0
2008 ICRA Best Paper Award finalist (top 4) for S. Ramamoorthy and B. J. Kuipers, "Trajectory generation for dynamic bipedal walking through qualitative model based manifold learning."
2007 AAAI Classic Paper Award, Honorable Mention for "A robust, qualitative method for robot spatial learning" by Benjamin Kuipers and Yung-Tai Byun, as one of the most influential papers from the seventh National Conference on Artificial Intelligence, held in 1988.
2006 Best Student Paper Award for A. Murarka, J. Modayil and B. Kuipers, "Local safety maps for a wheelchair robot using vision and lasers." *Third Canadian Conference on Computer and Robot Vision (CRV-06)*.
Artificial Intelligence honored two papers (1984 and 1986) as among the 25 most cited papers in the first 50 volumes of the journal [*Artificial Intelligence* **59**, 1993].
Number of published papers reprinted in Readings volumes or other edited collections: 17.
1994 Best Paper Award in Machine Reasoning for R. Rajagopalan and B. Kuipers, "The Figure Understander: a system for integrating text and diagram input to a knowledge base." *Industrial and Engineering Applications of Artificial Intelligence and Expert Systems Conference (IEA/AIE)*, 1994.

1988 AAAI Best Paper Award nominee (top 10). B. J. Kuipers & Y.-T. Byun, "A robust qualitative method for spatial learning in unknown environments." *National Conference on Artificial Intelligence (AAAI)*, 1988.

CONSULTING

Leela AI, scientific advisor, 2020- .
Vicarious.com, scientific advisor, 2015-2017.
External expert reviewer, *Intrinsically Motivated Cumulative Learning Versatile Robots (IM_CLeVeR)*, EU funded project, 2010-2013.
Schlumberger Technology Committee, 2000-03.
Georgia Institute of Technology, College of Computing, Board of Regents Review Committee, 3-5 March 2002.
NASA Space Research and Technology Subcommittee (SRTS) of the Space Systems and Technology Advisory Committee (SSTAC), Human and Machine Operations Panel, appointed September 1992.
Peat Marwick Foundation, Montvale, New Jersey, 1989-90.
Microelectronics and Computer Technology Corporation, Austin, Texas, 1985-87.
U. S. Coast Guard Research and Development Center, Groton, Connecticut, 1986-87.
CISE, Milan, Italy, 1986-88.
NASA Systems Autonomy Demonstration Project, Houston, Texas, March 1987.

PROFESSIONAL ACTIVITIES

Professional Committee Service

Selection Committee, CIFellows Program, Computing Research Association (CRA), 2021.
Selection Committee, CIFellows Program, Computing Research Association (CRA), 2020.
AAAS Council Delegate (elected), representing the Section on Information, Computing, & Communication, 2020-2023.
AAAS Committee on Council Affairs (council executive committee, elected), 2021-2023.
Ethics Officer, ACM Special Interest Group on Artificial Intelligence (SIGAI), 2016-2019.
Member, Committee on Best Practices for Hiring, Promotion, and Scholarship, Computing Research Association (CRA), 2013-2014.
Member-at-large (elected), Section on Information, Computing, and Communication, American Association for the Advancement of Science (AAAS), 2008-2012.
Fellow Selection Committee, Association for the Advancement of Artificial Intelligence (AAAI), 2009-2012.
Elected member, Executive Council, American Association for Artificial Intelligence (AAAI), 1992-95.

Chair or Co-Chair

Program Co-Chair, AAAI / ACM Conference on Artificial Intelligence, Ethics, and Society (AIES-2021), 19-21 May 2021.

Shakey Celebration Chair, AAAI Conference on Artificial Intelligence (AAAI-15), 25-30 January 2015.
General Co-Chair, IEEE International Conference on Development and Learning (ICDL), 2010.
Program Co-Chair, Senior Member Track, National Conference on Artificial Intelligence (AAAI-08).
Program Co-Chair, Conference on Spatial Information Theory (COSIT), 2007.
Program Co-Chair, International Workshop on Qualitative Reasoning (QR-06), Dartmouth, 2006.
Program Co-Chair, National Conference on Artificial Intelligence (AAAI-97), Providence, RI, July 1997.
Program Co-Chair, Control of the Physical World by Intelligent Agents, AAAI Fall Symposium Series, New Orleans, 4-6 November 1994.
Program Chair, International Workshop on Qualitative Reasoning (QR-91), Austin, 1991.

Program Committees

AAAI/ACM Conf. on Artificial Intelligence, Ethics, & Society (AIES), 2023
Int. Conf. on Automated Planning and Scheduling (ICAPS), 2012
Machine Consciousness 2011 (part of AISB-11)
Inconsistency Robustness, 2011
Workshop on Computational Spatial Language Interpretation (CoSLI), 2010.
Robotics: Science and Systems, 2010.
Associate Editor, IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS), 2009
Control Mechanisms for Spatial Knowledge Processing in Cognitive/Intelligent Systems, AAAI Spring Symposium, 2007
Space Syntax & Spatial Cognition Workshop, Bremen, 2006
Integrated Intelligence Special Track at AAAI-07
Robotics: Science and Systems (RSS), 2006
Epigenetic Robotics Conference, 2006, 2007
International Conference on Development and Learning (ICDL-06, ICDL-07, ICDL-08, ICDL-09, ICDL-2010 (General Co-Chair), ICDL-EpiRob-2011)
International Joint Conference on Artificial Intelligence (IJCAI-05)
International Conference on Machine Learning (ICML-05)
GIScience 2004, 2006.
AAAI 2004 Spring Symposium on Knowledge Representation and Ontology for Autonomous Systems
Symposium on Hybrid Systems: Computation and Control (HSCC-03, HSCC-04)
International Conference on Spatial Information Theory: COSIT'95, COSIT'99, COSIT'01, COSIT'03
International Workshops on Qualitative Reasoning: QR-97, QR-98, QR-99, QR-00, QR-01, QR-02, QR-03, QR-04, QR-05, QR-07, QR-08, QR-09, QR-2010, QR-2011
RoboCup International Symposium 2001.
Special Track on Spatiotemporal Reasoning at FLAIRS 2001.
National Conferences on Artificial Intelligence, AAAI-83, AAAI-84, AAAI-87, AAAI-88, AAAI-90 (area chair), AAAI-92 (area chair), AAAI-93 (area chair), AAAI-94 (area chair),

AAAI-97 (program cochair), AAAI-2000, AAAI-04, AAAI-06, AAAI-07 (main program, nectar and integrated intelligence tracks).
Knowledge Representation and Reasoning: KR'91, KR'96.
AAAI96 Workshop on Theories of actions, planning and robot control, August 1996.
Common Sense Reasoning Symposium (Common Sense 96), Stanford, January 1996.
Seventh Portuguese Conference on Artificial Intelligence (EPIA'95), 1995.
Intelligent Systems in Process Engineering (ISPE'95), July 1995.
Second International Conference on Intelligent Systems Engineering, 1994.
Third IMACS/IFORS/IEEE Conference on Decision Support and Qualitative Reasoning, Barcelona, June 1993.
IEEE International Symposium on Intelligent Control, 1991.
IJCAI-91 (area cochair, Qualitative Physics).
IMACS Workshop on Decision Support Systems and Qualitative Reasoning, 1991.
Model-Based Reasoning Workshops, AAAI-90, AAAI-91.
Avignon'89, Avignon'90, Avignon'91. Second Generation Expert Systems, Avignon, France.
AAAI Spring Symposium on Robot Navigation, March 1989.
Qualitative Physics Workshop, 1988.
IEEE Conference on AI Applications, 1987.

Review Panels

NSF review panels (numerous).
Judge, Computer Science, Fifth Texas State Science & Engineering Fair, 12 April 1991.
System Requirements Review and Study Committee, NASA Systems Autonomy Demonstration Project, March 1987.
Project Site Visit Team, National Library of Medicine, Ohio State University, Columbus, Ohio, 8 October 1987.

Boards

Advisory Editor, *Spatial Cognition and Computation*, 1998- .
Editorial Board, *International Journal of Humanoid Robotics*, 2010-.
Editorial Board, *Journal of Artificial Intelligence and Consciousness*, 2019-2022.
Associate Editor, *IEEE Trans. Cognitive and Developmental Systems (TCDS)*, 2016-2019.
Associate Editor, *IEEE Trans. Autonomous Mental Development (TAMD)*, 2008-2015.
Editorial Board, *International Journal of Machine Consciousness*, 2008-2014.
Advisory Board, School of Interactive Computing, Georgia Insitute of Technology, 2009-2012.
Scientific Advisory Boards, EU funded projects:
Cognitive Systems for Cognitive Assistants (CoSy), 2005-2009
Bayesian Approach to Cognitive Systems (BACS), 2006-2010
Cognitive Systems that Self-Understand and Self-Extend (CogX), 2008-2012.
Robots Bootstrapped Through Learning from Experience (Xperience) 2011-2015.
Spatio-Temporal Representations and Activities for Cognitive Control in Long-Term Scenarios (STRANDS), 2013-2017.
Scientific Advisory Board, *Edubot* project, CMU, 2006-2010

Schlumberger Technology Committee, 2000-03.
Editorial Board, *Computational Intelligence*, 1992-2004.
Editorial Board, *Journal of Artificial Intelligence Research*, 1994-97.
Editorial Board, *The Knowledge Engineering Review*, 1994-96.
Member, IFIP Technical Committee 12, Working Group 12.3, 1993.
Associate Editor, *IEEE Expert*, 1991-95.
Editorial Board, *AI & Medicine: An International Journal for the Theory and Practice of Expert Systems in Medicine*, 1989-91.

Proposal and Manuscript Reviews, etc.

Air Force Office of Scientific Research
Canada Council for the Arts (Canada)
Eidgenössische Technische Hochschule Zürich (ETHZ) (Switzerland)
Fonds de Formation des Chercheurs et d'Action Concertée (Canada)
Fonds zur Förderung der wissenschaftlichen Forschung (Austria)
Heinz Foundation
Israel Science Foundation (Israel)
Israeli Ministry of Science and Technology (Israel)
Medical Research Council (UK)
National Institutes of Health
NSF Biophysics Program
NSF Computer Research Equipment
NSF Cyber-Physical Systems (CPS)
NSF Directorate for Computer and Information Science and Engineering (CISE)
NSF Division of Information Technology
NSF Geography and Regional Science Program
NSF Human Resource Development for Minorities in Science and Engineering
NSF Information & Intelligent Systems (IIS)
NSF Integrative Graduate Education and Research Traineeship Program (IGERT)
NSF Intelligent Systems Program
NSF Interactive Systems Program
NSF Knowledge and Database Systems Program
NSF Mechanical and Structural Systems/Structures and Building Systems Program
NSF National Robotics Initiative
NSF Robotics and Machine Intelligence Program
NSF Robust Intelligence Program
NSF Visiting Professorships for Women
NSF Division of International Programs
Schweizerischer Nationalfonds zur Förderung der wissenschaftlichen Forschung (Swiss)
Swedish Research Council for Engineering Sciences (Sweden)
U. S. Civilian Research and Development Foundation (CRDF)
University of Bremen (Germany)
Wiener Wissenschafts-, Forschungs-, und Technologiefonds (Austria)
Academic Press

Kluwer Academic Publishers
Morgan Kaufmann Publishers
MIT Press
Prentice-Hall Publishing Company
AI & Society: Knowledge, Culture and Communication
Annals of Mathematics and Artificial Intelligence
Applied Artificial Intelligence
Artificial Intelligence
Artificial Intelligence for Engineering Design, Analysis and Manufacturing (AIEDAM)
Artificial Intelligence in Medicine
Automatica
Autonomous Robots
Behavioral and Brain Sciences
Cognitive Psychology
Cognitive Science
Communications of the ACM, *CACM*
Computational Intelligence
Control and Intelligent Systems
Decision Support Systems
Engineering Applications of Artificial Intelligence
Environment and Behavior
Environmental Psychology
Ethics and Information Technology
European Journal of Control
European Journal of Plant Pathology
Frontiers in Neuroscience
Geographical Analysis
Geoinformatica
Heliyon
IEE Proceedings, Control Theory and Applications
IEEE Expert
IEEE International Conference on Robotics and Automation
IEEE Transactions on Automation Science and Engineering
IEEE Transactions on Autonomous Mental Development
IEEE Transactions on Cognitive and Developmental Systems
IEEE Transactions on Industrial Informatics
IEEE Transactions on Knowledge and Data Engineering
IEEE Transactions on Neural Networks
IEEE Transactions on Pattern Analysis and Machine Intelligence
IEEE Transactions on Robotics
IEEE Transactions on Robotics and Automation
IEEE Transactions on Systems, Man and Cybernetics
Information Journal
Information Sciences
Information Systems Research

International Joint Conferences on Artificial Intelligence (IJCAI)
International Journal of Computer Vision
International Journal of Intelligent Systems
International Journal of Robotics Research
ISA Transactions
iScience
Journal of Aerospace Information Systems
Journal of Environmental Psychology
Journal of Experimental Psychology: Applied
Journal of Field Robotics
Journal of Neuroengineering and Rehabilitation
Journal of Robotics
Journal of System Science and System Engineering
Journal of the Royal Society Interface
Journal of Web Semantics
Jurimetrics
Knowledge Engineering Review
Machine Learning
Mathematics and Computers in Simulation
Minds and Machines
Natural Computing
Neural Computation
New England Journal of Medicine
PLoS ONE
Psychological Research
Quarterly Journal of Experimental Psychology
Religions
Robotics and Autonomous Systems
Science
Science Robotics
Sensors
Spatial Cognition and Computation
ECCAI AI Dissertation Award, 2001
Kyoto Prizes, Inamori Foundation

Memberships

Fellow, American Association for the Advancement of Science (AAAS)
Fellow, Association for the Advancement of Artificial Intelligence (AAAI)
Fellow, Institute for Electrical and Electronic Engineers (IEEE)
Fellow, Society for Values in Higher Education (SVHE)
Association for Computing Machinery (ACM)

University and Departmental Service: University of Michigan

Chair, University of Michigan Committee for the Tanner Special Lecture on Artificial Intelligence and Human Values, 2019-2022. (Lecture: 2-3 November 2022.)
Member, College of Engineering Robotics Future Project, 2019-20.
Convener, UM ADVANCE Launch Committee, 2019-20.
Chair, Computer Science and Engineering Faculty Search Committee, 2017-20.
Chair, Computer Science and Engineering Graduate Program Committee, 2011-14.
Executive Committee (elected), Computer Science and Engineering, 2009-11, 2013-14.
Robotics Steering Committee, College of Engineering, 2012-15.
Robotics Institute Director Search Committee, College of Engineering, 2014-15.

University and Departmental Service: University of Texas at Austin

University Task Force on Curricular Reform, 2004-06.
University Research Policy Committee, 2002-2006, Chair, 2003-04, 2004-05.
Executive Council, Center for Perceptual Systems, 2002-2008.
Chairman, Computer Science Department, 1997-2001.
College of Natural Sciences Tenure and Promotion Committee, Member, 1994-95, 2002-03; Chair, 1995-96, 2003-04.

INVITED PRESENTATIONS

Media Coverage

- "Trust in Robotics." Interview on TrustTalk.com with Severin de Witt. Recorded 12 July 2022.
- "ROBOTS: Time to think about laws?" Panelist on Roundtable, a daily current affairs show on TRT World UK, London. 21 January 2020.

Plenary and Keynote Addresses

- "Final Remarks." Kuipers AI Symposium, University of Michigan, 27 April 2024.
- "What Can AI Ethics Tell Us About Corporations?" TTI Vanguard Conference on Computation & Application. Boston, MA, 3 March 2022.
- "Ethics and Trust for Robots and AIs." Workshop on Trustworthy AI for Multimedia Computing, ACM Multimedia 2021, Chengdu, China (online), 20 October 2021.
- "What can we count on? Evaluating ethical robots." IROS 2021 Workshop on Building and Evaluating Ethical Robotic Systems. Prague, The Czech Republic (online), 1 October 2021.
- "Acting, Learning, and Knowing in Large-Scale Space." RSS 2021 Workshop on Declarative and Neurosymbolic Representations in Robot Learning and Control. 15 July 2021.
- "Hunting for Unknown Unknowns: AI and Ethics in Society." R. L. Rabb Symposium on Embedding AI in Society, North Carolina State University, 19 February 2021.
- "AI Without Trust Endangers Our Society." 56^{th} Annual Warren Cook Health and Safety Discussional. University of Michigan, Ann Arbor, Michigan, 7 November 2019.

- "Learning about Space: Mapping and Navigation." CVPR-2019 Workshop on Habitat: Embodied Agents Challenge, Long Beach, CA, 16 June 2019.
- "Ethics as a Foundational Domain for Commonsense Knowledge." ISAT/DARPA Designing for Values, Interactivity, Contestability, & Ethics in Systems (DeVICES) Workshop, University of California, Berkeley, 2 April 2019.
- "How can we trust a robot?" TTI Vanguard Conference on Intelligence, Natural and Artificial. Brooklyn, NY, 12 June 2018.
- "Natural Communication for Human-Robot Collaboration." AAAI Fall Symposium on Natural Communication for Human-Robot Collaboration, Arlington, VA, 10 November 2017.
- "Morality and Trust for Robots: Questions and (a few) Answers." ICDL-EpiRob International Workshop on Ethical Issues of Open-Ended Learning in Autonomous Robots. IEEE Int. Conf. Development and Learning, and Epigenetic Robotics, Lisbon, Portugal, 18 September 2017.
- "How Can Robots Be Trustworthy?" Robotics: Science & Systems (RSS) Workshop on Morality and Social Trust in Autonomous Robots, Cambridge, MA, 16 July 2017.
- "Learning to Reach and Grasp: A Developmental Robotics Approach." Conference on Advances in Cognitive Systems, RPI, Troy, NY, 12 May 2017.
- "Why and How Should Robots Behave Ethically?" RoboPhilosophy 2016, Aarhus, Denmark, 21 October 2016.
- "QLAP: Learning and Action Hierarchy Starting from Observed Contingencies." ICDL-Epirob Workshop on Autonomous Perception: Sensorimotor Contingencies and Predictive Processing to Developmental Robotics. Cergy, Paris, France, 19 September 2016.
- "How Can We Trust a Robot?" Invited A-Talk, Softbank Robotics, Paris, France, 15 September 2016.
- "What is Spatial Reasoning for?" Spatial Cognition 2016, Philadelphia PA, 4 August 2016.
- "What is Trust, and How Can My Robot Get Some?" RSS Workshop on Social Trust in Autonomous Robots, Ann Arbor, Michigan, 19 June 2016.
- "Grounding Symbolic Knowledge in Continuous Experience." 36^{th} SOAR Workshop, Ann Arbor, Michigan, 9 June 2016.
- "The Journal of Computational Research Replication." Open Forum on Evaluation of Results, Replication of Experiments, and Benchmarking in Robotics Research, IROS-15 Workshop, Hamburg, Germany, 29 September 2015.
- "Actions and Affordances: Among the Foundations of Commonsense Knowledge." IROS Workshop on Semantic Policy and Action Representations for Autonomous Robots, Hamburg, Germany, 28 September 2015.
- "Can Robots Behave Well as Members of Society?" Public lecture, ESSENCE Summer School, Edinburgh, Scotland UK, 25 August 2015.

- "How Can Robots Behave Well in Society?" Workshop on Combining AI Reasoning and Cognitive Science with Robotics, Robotics: Science & Systems, Rome, Italy, 16 July 2015.
- "Space, Objects, and Actions." Workshop on Learning Reusable Concepts in Robotics, Robotics: Science & Systems, Rome, Italy, 16 July 2015.
- "Communication with Robots: Focus on Spatial Knowledge." Workshop on Model Learning for Human-Robot Communication, Robotics: Science & Systems, Rome, Italy, 16 July 2015.
- "Bootstrap Learning of Real-World Semantics." Workshop on Sensorimotor Learning. IEEE Int. Conf. on Robotics and Automation (ICRA), Seattle, Washington, 26 May 2015.
- "Research Issues at the Boundary of AI and Robotics." Workshop on Research Issues at the Boundary of AI and Robotics, AAAI Conference on Artificial Intelligence, 25 January 2015.
- "Making a Useful Intelligent Assistive Robot." AAAI Fall Symposium on Artificial Intelligence and Human-Robot Interaction. Arlington, Virginia, 14 November 2014.
- "Making a Useful Intelligent Assistive Robot." IROS-14 Workshop on Rehabilitation and Assistive Robots. Chicago, Illinois, 18 September 2014.
- "Vision Is For Agents." Vision Meets Cognition Workshop, IEEE Int. Conf. on Compuber Vision and Pattern Recognition (CVPR), Columbus, Ohio, 23 June 2014.
- "Spatial Knowledge: One of the Foundations of Commonsense Knowledge." International Spatial Cognition Summer Institute, University of California Santa Barbara, 12 August 2013.
- "Learning representations for space, objects, and actions." AAAI Workshop on Learning Rich Representations from Low-Level Sensors, Seattle, 15 July 2013.
- "Constructing the Foundations of Commonsense Knowledge." AISB/IACAP World Congress – Alan Turing 2012, Birmingham, UK, 6 July 2012.
- "What are the pieces to the puzzle? How do they fit together?" AAAI Spring Symposium, *Designing Intelligent Robots: Reinventing AI*. Stanford, California, 27 March 2012.
- "Rod and Me." Celebrating the Academic Work of Rodney Brooks. MIT, Cambridge, Massachusetts, 9 March 2012.
- "Autonomous learning of foundational knowledge: space, objects, actions." AAAI Workshop on *Lifelong Learning from Sensorimotor Experience*, San Francisco, California, 7 August 2011.
- "Multiple ontologies for spatial mapping and navigation." Cognitive Science 2011 symposium, *Finding your way: The cognitive science of navigation*, Boston MA, 21 July 2011.
- "The future of machine intelligence requires learning the foundations of knowledge." Future of Machine Intelligence, Oxford UK, 16 January 2011.
- "Multiple ontologies for spatial exploration and mapping." Second International Workshop on Indoor Spatial Awareness (ISA-2010), SIGSPATIAL GIS Conference, San Jose, CA, 2 November 2010.

- "How can a robot learn the foundations of knowledge?" Distinguished Lecture. School of Informatics, University of Edinburgh, Edinburgh, Scotland, 20 October 2010.
- "How shall we learn how to learn how to grasp?" Keynote address. Workshop on Grasping – Representations for object grasping and manipulation, IEEE International Conference on Robotics & Automation (ICRA-10), Anchorage, Alaska, 3 May 2010.
- "How can a robot learn the foundations of knowledge?" Keynote address, Fourth International Conference on Cognitive Systems (CogSys-10), ETH Zurich, Switzerland, 28 January 2010.
- "Evaluating the robot cognitive mapper." Keynote address, Performance Measurement for Intelligent Systems (PerMIS-09), NIST, Gaithersburg, MD, 22 September 2009.
- "Multiple spatial ontologies in humans and robots." *Modeling Spatial Cognition*, Scottsdale AZ, 15 May 2009.
- "Why don't I take military funding?" The INESPE Lecture Series on the Social Responsibility of Engineers and Scientists. Niels Bohr Institute, University of Copenhagen, 14 October 2008.
- "Navigation within the Hybrid Spatial Semantic Hierarchy." Invited talk, ICRA 2008 Workshop on Future Directions in Visual Navigation, Pasadena, CA, 19 May 2008.
- "The Robot Wheelchair." Technologies and Strategies for the Physical Transfer of Individuals with Motor Impairments. Interagency Committee on Disability Research. Arlington VA, 10 September 2007.
- "Where do concepts come from?" Invited talk, International Workshop on Natural and Artificial Cognition, Oxford, England, 25 June 2007
- "Learning the foundations for life-long learning." Invited talk, Special Session on Enabling Lifelong Human-Robot Interaction, International Conference on Development and Learning, London, 12 July 2007.
- "Can a Robot Have Knowledge of its Own?" From Sensors to Human Spatial Concepts: Geometric Approaches and Appearance-Based Approaches, Workshop at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS-06), Beijing, China, 10 October 2006.
- "The Intelligent Wheelchair." Summer Research Institute on Technology in Health Promotion Research for Underserved Populations, Center for Health Promotion and Disease Prevention Research in Underserved Populations (CHPR), The University of Texas at Austin School of Nursing, Austin, Texas, 19 June 2006.
- "Bayesian Reasoning in the Hybrid Spatial Semantic Hierarchy." Bayesian Cognition International Workshop, Paris, France, 16 January 2006.
- "What Building Robots Can Teach Us About the Mind." Lecture series, *The Human Edge: Technology, Mankind, and the Future*, Institute for the Humanities at Salado, Salado, Texas, 2 April 2005.
- "Spatial Navigation Research Results." Artificial Intelligence in Games, GameDev Workshop 2003, Austin, Texas, 22 August 2003.

- "Learning about Space, Qualitatively and Quantitatively." Fifteenth International Workshop on Qualitative Reasoning, San Antonio, Texas, 17 May 2001.
- "The Skeleton in the Cognitive Map." Third International Symposium on Space Syntax. Atlanta, Georgia, 10 May 2001.
- "The Hybrid Future of Qualitative Reasoning." VII Conferencia de la Asociacion Española para la Inteligencia Artificial (CAEPIA'97). Terremolinos, Spain, 13 November 1997.
- "The Spatial Semantic Hierarchy for Large-Scale and Visual Space." Herbstkolloquium 97 des DFG-Schwerpunktprogramms 'Raumkognition' in Trier. Trier, Germany, 29 September 1997.
- "Qualitative Reasoning Approaches the Millenium." IX International Symposium on Artificial Intelligence. Cancun, Mexico, 15 November 1996.
- "On Commonsense Knowledge of Space." Workshop on Formal Models of Common-Sense Geographical Worlds, National Center for Geographic Information and Analysis (NCGIA), Research Initiative 21. San Marcos, Texas, 31 October 1996.
- "Qualitative Reasoning for Monitoring and Control." Second International Conference on Intelligent Systems Engineering. Technical University of Hamburg-Harburg, Germany, 8 September 1994.
- "Spatial Learning and Navigation." International Conference GIS: From Space to Territory. Theories and Methods of Spatio-Temporal Reasoning. Pisa, Italy, 21 September 1992.
- "Qualitative Reasoning with Incomplete Knowledge." Workshop on Automation and Robotics. NASA Johnson Space Center, 12 March 1992.
- "Robot Exploration and the Symbol Grounding Problem." First U.S.-Japan Workshop on Integrated Systems in Multi-Media Environments. New Mexico State University, Las Cruces, NM, 12 December 1991.
- "Qualitative Simulation and Constraint Satisfaction." Constraint-Based Reasoning Workshop, AAAI 1991 Spring Symposium, Stanford University, 26 March 1991.
- "Qualitative Reasoning and Decision Support." IMACS International Workshop on Decision Support Systems and Qualitative Reasoning, Toulouse, France, 14 March 1991.
- "The Use of Qualitative Simulation in Support of Model-Based Reasoning." SPIE Applications of Artificial Intelligence VIII. Orlando, Florida, 17 April 1990.
- "Artificial intelligence: a new approach to modeling and control." Plenary lecture, First IFAC Symposium on Modelling and Control in Biomedical Systems, Venice, Italy, 8 April 1988.
- "Abstraction by time-scale in qualitative simulation for biomedical modeling." Invited lecture, First IFAC Symposium on Modelling and Control in Biomedical Systems, Venice, Italy, 8 April 1988.
- "Qualitative Reasoning with Causal Models in Medical Diagnosis." The Fifth Toyobo Biotechnology Foundation Symposium: Artificial Intelligence in Medicine, Tokyo, Japan, 22 August 1986.

- "Concepts of Qualitative Reasoning." Alvey Project Deep Knowledge Based Systems Workshop, University of Cambridge, Cambridge, England, 16 April 1986.
- "Expert Causal Models in the Medical Knowledge Base." Le Congrès Hippocrate 2001, Monte Carlo, Monaco, 5 November 1985.
- "Refuting the 'Map in the Head' Theory." SSRC Spatial Orientation Conference, Center for Research in Human Learning, University of Minnesota. Wayzata, Minnesota, 16 July 1980.

Tutorials

- "Learning from Experience about Different Aspects of Space." Cognitive Robotics Summer School, University of Southern California, Los Angeles, CA, 17 July 2019.
- "Multiple Spatial Ontologies in Humans and Robots" and "Bootstrap Learning of Real-World Semantics." Tutorial lectures at ESSENCE Summer School, Edinburgh, Scotland UK, 26 August 2015.
- "Autonomous robot learning of foundational representations." CoSy Summer Workshop on Multi-Sensory Modalities in Cognitive Science, Gerzensee, Switzerland, 28 August 2007.
- "Spatial Reasoning." International Conference GIS: From Space to Territory. Theories and Methods of Spatio-Temporal Reasoning. Pisa, Italy, 20 September 1992.
- "Qualitative Reasoning about Physical Systems." (with Elisha Sacks) Eighth National Conference on Artificial Intelligence (AAAI-90), Boston, Massachusetts, 1 August 1990.
- "Qualitative Reasoning: Modeling and Simulation with Incomplete Knowledge." Kansai Institute of Information Systems (Osaka, Japan) Study Group. Seventeen Japanese scientists visiting Austin, Texas, 31 October 1988.
- "Qualitative Simulation and Causal Models." (with Brian Williams) Seventh National Conference on Artificial Intelligence (AAAI-88), St. Paul, Minnesota, 22 August 1988.
- "Qualitative Simulation and Causal Models." (with Ramesh Patil) Sixth National Conference on Artificial Intelligence (AAAI-87), Seattle, Washington, 16 July 1987.
- "Qualitative Simulation and Causal Models." Fifth National Conference on Artificial Intelligence (AAAI-86), Philadelphia, Pennsylvania, 14 August 1986.

Lecture Series

- International Spatial Cognition Summer Institute, University of California Santa Barbara, 12-17 August 2013.

  "Cognitive Maps in Robots and Humans," 12 August 2013,
  "Using the HSSH as a Cognitive Map for a Robot," 13 August 2013,
  joint discussion with Christian Freksa, 17 August 2013.

- International Spatial Cognition Summer Institute, Bad Zwischenahn, Germany, 25-29 August 2003.

"The Spatial Semantic Hierarchy," 25 August 2003,
"A logical theory of the topological map," 26 August 2003,
"Metrical mapping: Integrating large- and small-scale space," 27 August 2003,
"Way-finding and the boundary relation hypothesis," 28 August 2003,
"Place recognition via bootstrap learning," 29 August 2003.

- University of Science and Technology of China, Hefei, Anhui, China, 28-31 May 2002.

  "Qualitative modeling and simulation," 29 May 2002,
  "Semi-quantitative reasoning in a qualitative framework," 29 May 2002,
  "Scaling up to large-scale problems," 30 May 2002,
  "Learning the cognitive map and its foundations," 30 May 2002.

- MONET Summer School on Model-Based Systems and Qualitative Reasoning, Bertinoro, Italy, 15-19 May 2000.

  "Modeling and simulation with incomplete knowledge," 18 May 2000,
  "Semi-quantitative simulation," 18 May 2000,
  "Tractability: abstraction and temporal logic," 18 May 2000,
  "Model-based reasoning for control tasks," 18 May 2000.

- Department of Geography, University of California, Santa Barbara, 11-13 January 1983.

  "Knowledge of Space I: Sensorimotor Representations," 11 January 1983,
  "Knowledge of Space II: Topological Representations," 12 January 1983,
  "Knowledge of Space III: Metrical Representations," 13 January 1983.

Panels

- "Ethics for AI and Robotics." Panel on Artificial Intelligence, at the International Association for Commercial Administrators (IACA), Detroit, Michigan, 21 May 2024.
- "Ethics for AI and Robotics." Panel: AI & Ethics, Kuipers AI Symposium, University of Michigan, 26 April 2024.
- "Do Lethal Autonomous Robots Pose a Dilemma?" Ethical and Legal Dilemmas of Autonomous Weapons in War and National Security, University of Pennsylvania, Philadelphia, Pennsylvania, 13 April 2024.
- "AI, Ethics, and the Future of Work." Ford+Munk Conference, Ford School of Public Policy, University of Michigan, Ann Arbor, Michigan, 15 March 2024.
- "Consciousness, Intelligence, and Theory of Mind in Generative AI." Friday Night AI Panel, Ann Arbor District Library, Ann Arbor, Michigan, 2 February 2024.
- Discussant panel for talk by Q. Vera Liao, Microsoft Research Montréal, "Human-Centered AI Transparency: Lessons Learned and Open Questions in the Age of LLMs." 7^{th} Summer School on Computational Interaction, University of Michigan, Ann Arbor, Michigan, 19 June 2023.

- "LSA Student Honor Council Speaker Honorarium." Michigan League, University of Michigan, Ann Arbor, Michigan, 6 February 2023.
- "GRASP Town Hall: Senior Roboticists Discuss Autonomous Weapons Systems and Navigating the Ethics, Funding, and Research Implications of their Work." GRASP Lab, University of Pennsylvania, Philadelphia, Pennsylvania, 21 January 2022.
- "Vulcan: An Intelligent Wheelchair." Working with Disability, Michigan Robotics Colloquium, University of Michigan, Ann Arbor, Michigan, 27 July 2021.
- "The Intelligent Wheelchair." AI & Health, Michigan AI Symposium, Ann Arbor, Michigan, 30 October 2020.
- "Ethics as a Technical Problem in AI." CCC Assured Autonomy Workshop #2, Phoenix, Arizona, 20 February 2020.
- "ROBOTS: Time to think about laws?" Panelist on Roundtable, a daily current affairs show on TRT World UK, London. 21 January 2020.
- "Ethics & AI." AI for Society, Michigan AI Symposium. Ann Arbor, MI, 19 October 2019.
- "Ethics & Self-driving Cars." Friday Night AI, A Michigan AI Event Series, Ann Arbor, MI. 24 May 2019.
- "Autonomy." Cinetopia Film Festival, Ann Arbor, MI, 19 May 2019.
- "The Ethics of Autonomous Vehicles." Humanities + Technology Lecture Series, Lawrence Technological University, Southfield, Michigan, 18 April 2019.
- "Ethics and Morality of Robotics." Public debate/panel, Federated Logic Conference (FLoC), Oxford Union, Oxford University, Oxford, UK, 16 July 2018.
- "The Future of AI and Technology – How Should Michigan's Workforce System Respond?" Governor's Talent Investment Board Panel, Michigan Works! Conference, Mt. Pleasant, Michigan, 11 September 2017.
- "Teaching Ethics in AI." Panel presentation and discussion in Educational Applications of Artificial Intelligence (EAAI), at AAAI-17, San Francisco, 6 February 2017.
- "Surprising Predictions for Robotics in the Next 3-5 Years." Panel at Robotics: Science and Systems (RSS-2016), Ann Arbor, Michigan, 22 June 2016.
- "Panel on AI & Robotics." Celebration of the 50th Anniversary of Shakey. IEEE Int. Conf. on Robotics and Automation (ICRA), Seattle, 27 May 2015.
- "Shakey Celebration" (organizer and moderator). AAAI Conference on Artificial Intelligence (AAAI-15). Austin, Texas, 27 January 2015.
- "AR&A in Temporal and Spatial Reasoning." Symposium on Abstraction, Reformulation and Approximation (SARA-2000). Horseshoe Bay, Texas, 29 July 2000.

- "Open Problems and Directions for Future Research in Adaptive Spatial Representations of Dynamic Environments." IJCAI-99 Workshop on Adaptive Spatial Representations of Dynamic Environments. Stockholm, Sweden, 1 August 1999.
- "Robot Action Planning — where are we? where are we going?" IJCAI-99 Workshop on Robot Action Planning. Stockholm, Sweden, 31 July 1999.
- "Common Sense." Society of Minds Symposium (Festschrift, Day Two), MIT Media Lab, Cambridge, Massachusetts, 19 October 1993.
- "What has Qualitative Reasoning Achieved, and Why?" Sixth International Workshop on Qualitative Reasoning about Physical Systems. Edinburgh, Scotland, 26 August 1992.
- "QR and the Frame (non?) Problem." IFIP Workshop on the Role of Knowledge Representation in Qualitative Reasoning. Islamorada, FL, 29 February 1992.
- "Open Issues – Needs, Expectations and Realities in Spatial Reasoning and Multisensor Fusion." 1987 Workshop on Spatial Reasoning and Multi-Sensor Fusion, St. Charles, Illinois, 7 October 1987.
- "Summary Panel." Conference on Social and Ethical Consequences of Designs for Medical Information Systems, Massachusetts Institute of Technology, 20 June 1986.
- "Expert Causal Reasoning and Explanation." Presented as part of a symposium entitled "Expert Systems and Cognitive Psychology: Implications for Medicine." American Educational Research Association Annual Meeting, Chicago, Illinois, 31 March 1985.
- "Deep Models, Qualitative Reasoning, Compiling From Deep Models, Anatomical and Physiological Reasoning." Artificial Intelligence in Medicine Workshop, Ohio State University, Columbus, Ohio, 2 June 1984.
- "Cognitive Psychology and AIM." Artificial Intelligence in Medicine Workshop, Ohio State University, Columbus, Ohio, 1 June 1984.
- "Computers and Education: A Technological Fix?" Tufts University All-University Forum, Medford, Massachusetts, 14 February 1984.
- "Expert Systems." Fifth Annual Conference of the Cognitive Science Society, Rochester, New York, 20 May 1983.
- "What Is a Number, That a Man May Know It?" (Moderator) Artificial Intelligence Society of New England, Storrs, Connecticut, 30 October 1982.

Research Seminars

- "Drinking from the Firehose of Experience." QuEST Meeting talk, Autonomy Capability Team (ACT3), Air Force Research Laboratory (AFRL), 7 June 2024.
- "Ethics helps our society prosper: What should we do about AI?" Good Systems Speaker Series, University of Texas at Austin, Austin, Texas, 12 April 2023.

- "AI, Ethics, Trust, Cooperation & Society." Guest lecture, EECS 496 (Professionalism), University of Michigan, 14 October 2022.
- "AI, Ethics, Trust, Cooperation & Society." AI Seminar, Computer Science & Engineering, University of Michigan, 4 October 2022.
- "Robot personhood" (joint with David Gunkel, Northern Illinois University). Tucson Hard-Science SF Writers Group, Tucson, Arizona, 1 October 2022.
- "AI, Common Sense, and Ethics." Physics and Astronomy Colloquium, University of Toledo, Toledo, Ohio, 15 September 2022.
- "Common sense and ethics for AI and robots." Tucson Hard-Science SF Writers Group, Tucson, Arizona, 6 August 2022.
- "My Journey, and Two Math Problems." Ann Arbor Math Olympiad Club, Ann Arbor, Michigan, 29 January 2022.
- "Ethics and Trust for Robots and AIs." Ford Motor Company, Robotics & Mobility EMM / SAR, Ann Arbor, Michigan, 28 October 2021.
- "Hunting for Unknown Unknowns: AI and Etthics in Society." GRASP Lab, University of Pennsylvania, Philadelphia PA, 24 February 2021.
- "Ethics as a Technical Problem in AI and Robotics." Michigan Student Artificial Intelligence Lab (MSAIL), Ann Arbor, MI, 11 March 2020.
- "Ethics, Self-Driving Cars, and the Deadly Dilemma". General Motors Research & Development Center, Warren, MI, 14 May 2019.
- "Robots in Science Fiction Movies: Selected Clips". University Commons, Ann Arbor, MI, 8 May 2019.
- "How do we make ethical robots?" AI Seminar Series, School of Computing, University of Utah, Salt Lake City, Utah, 8 November 2018.
- "How do we make ethical robots?" Nagpal Lab, Computer Science Department, School of Engineering and Applied Sciences, Harvard University, Cambridge, MA, 16 October 2018.
- "Robots, Society, Ethics, and Trust." Oxford Robotics Institute and Computer Science Department, Oxford UK, 17 July 2018
- "Robots, Society, Ethics, and Trust." Cognitive Robotics Group, Oxford Brookes University, Oxford UK, 16 July 2018
- "Robots: What are we worried about?" Google DeepMind, London UK, 20 June 2017
- "Robots: What are we worried about?" Oxford Robotics Institute and Computer Science Department, Oxford UK, 15 June 2017
- "How can we trust a robot?" Forum for Artificial Intelligence, University of Texas at Austin, Austin TX, 24 March 2017.

- "How can we trust a robot?" Robotics@MIT, MIT Stata Center, Cambridge MA, 30 January 2017.
- "How can we trust a robot?" Director's Seminar Series, National Institute of Occupational Safety and Health (NIOSH), Morgantown WV, 24 August 2016.
- "Learning the foundations of commonsense knowledge." Developmental Psychology Brown Bag, University of Michigan, Ann Arbor MI, 11 April 2016.
- "Can robots behave well as members of society?" Toyota AI Seminar, CSE, University of Michigan, Ann Arbor, MI, 17 November 2015.
- "An agenda for building an intelligent embodied agent." Vicarious, Union City, California, 23 October 2015.
- "Constructing the Foundations of Commonsense Knowlege." Google, Mountain View, California, 26 April 2013.
- "Constructing the Foundations of Commonsense Knowlege." Dagstuhl Seminar on Mechanisms of Ongoing Development in Cognitive Robotics, Schloss Dagstuhl, Germany, 10 February 2013.
- "Constructing the Foundations of Commonsense Knowledge." Electrical Engineering and Computer Science Department Seminar, Vanderbilt University, Nashville, Tennessee, 9 November 2012.
- "Constructing the Foundations of Commonsense Knowledge." School of Electrical Engineering and Computer Science, Queensland University of Technology, Brisbane, Australia, 30 July 2012.
- "Constructing the Foundations of Commonsense Knowledge." Dean's Leadership in Innovation Seminar Series, University of Technology, Sydney, Australia, 27 July 2012.
- "Qualitative reasoning: modeling and simulation with incomplete knowledge", and "How can a robot learn the foundations of knowledge?" CNO Strategic Study Group, Naval War College, Newport RI, 21 October 2011.
- "Learning the foundations of objects and actions in 3D." Institute of Perception, Action and Behavior, School of Informatics, University of Edinburgh Edinburgh, Scotland, 21 October 2010.
- "How can a robot learn the foundations of knowledge?" Robotics Group, Engineering Science Department, Oxford University, UK, 25 January 2010.
- "How can a robot learn the foundations of knowledge?" Cognitive Science Seminar, College of Computing, Georgia Institute of Technology, 15 January 2010.
- "Bootstrap learning of sensors, effectors, local space, objects and actions." Performance Measurement for Intelligent Systems (PerMIS-09), NIST, Gaithersburg, MD, 22 September 2009.
- "Autonomous robot learning of foundational representations." Computer Science and Engineering Colloquium, Michigan State University, East Lansing, Michigan, 17 April 2009.
- "Autonomous robot learning of foundational representations." Computer Science and Artificial Intelligence Laboratory, MIT, Cambridge MA, 16 March 2009.

- "Robot Navigation within the Hybrid Spatial Semantic Hierarchy." Controls Seminar, University of Michigan, Ann Arbor MI, 30 January 2009.
- "Navigation within the Hybrid Spatial Semantic Hierarchy." Robotics Institute, Carnegie-Mellon University, Pittsburgh, PA, 14 November 2008.
- "Autonomous robot learning of foundational representations." Center for Autonomous Systems, KTH, Stockholm, Sweden, 13 October 2008.
- "Autonomous robot learning of foundational representations." College of Computing, Georgia Institute of Technology, Atlanta, GA, 29 February 2008.
- "Autonomous robot learning of foundational representations." GRASP Lab, University of Pennsylvania, Philadelphia, PA, 15 February 2008.
- "Autonomous robot learning of foundational representations." Spatial Intelligence and Learning Center, Temple University, Philadelphia, PA, 14 February 2008.
- "The Hybrid Spatial Semantic Hierarchy: Factoring the Mapping Problem." ICRA Workshop on Cognitive Robots and Systems, Orlando, Florida, 19 May 2006.
- "Bootstrap Learning from Pixel Level to Object Level." Sony Computer Science Laboratory, Paris, France, 11 January 2006.
- "The Role of Spatial Cognition for Robotics." Dagstuhl Seminar on Spatial Cognition, Schloss Dagstuhl, Germany, 8 December 2005.
- "The Hybrid Spatial Semantic Hierarchy: Factoring the Mapping Problem." Center for Visual Science, University of Rochester, Rochester, NY, 4 November 2005.
- "Factoring the Mapping Problem." Information Technology Laboratory, National Institute of Standards and Technology, Gaithersburg, MD, 7 March 2005.
- "Qualitative Simulation for Design and Diagnosis." NI Week, Austin, Texas, 18 August 2004.
- "Factoring the Mapping Problem." Computer Science Department, Stanford University, Stanford CA, 29 June 2004.
- "Factoring the Mapping Problem." NASA Ames Research Center, Moffett Field, CA, 28 June 2004.
- "Qualitative Simulation for Design and Diagnosis." National Instruments, Austin, Texas, 13 May 2004.
- "Learning to Explore Space." UMIACS, University of Maryland, College Park MD, 10 December 2002.
- "Learning to Explore Space." NCARAI, Naval Research Laboratory, Washington DC, 9 December 2002.
- "Bootstrap Learning for Place Recognition" (with Patrick Beeson). Joint presentation for Center for Perceptual Systems and Cognition and Perception Forum, University of Texas at Austin, 7 October 2002.

- "Qualitative Simulation: Progress and Applications." Chinese Association for System Simulation, Beijing University of Aeronautics and Astronautics, Beijing, China, 7 June 2002.
- "Learning the Cognitive Map and its Foundations." Microsoft Research Asia, Beijing, China, 6 June 2002.
- "Learning the Cognitive Map and its Foundations." NSF VIGRE Program, Mathematics Department, University of Texas at Austin, Austin, Texas, 2 April 2002.
- "Learning the Cognitive Map and its Foundations." Institut für Technische Informatik, Technical University of Graz, Graz, Austria, 29 January 2002.
- "Learning the Cognitive Map and its Foundations." Cognitive Science Program, Georgia Institute of Technology, Atlanta, Georgia, 25 January 2002.
- "Learning the Cognitive Map and its Foundations." Center for Perceptual Systems, University of Texas at Austin, Austin, Texas, 30 November 2001.
- "Learning the Cognitive Map and its Foundations." AI Seminar, Robotics Institute, Carnegie Mellon University, Pittsburgh, PA, 26 November 2001.
- "The Spatial Semantic Hierarchy." Institut für Technische Informatik, Technical University of Graz, Graz, Austria, 22 May 2000.
- "The Spatial Semantic Hierarchy." Istituto Analisi Numerica - C.N.R., Pavia, Italy, 23 May 2000.
- "Spatial Knowledge and the Intelligent Wheelchair." Cognitive Neuroscience Colloquium Series, University of Minnesota, Minneapolis, Minnesota, 7 January 1999.
- "Exploration and Reasoning in Large-Scale and Visual Spaces." AI-Vision-Robotics Colloquium, Computer Science Department, Stanford University, Stanford, California, 16 April 1998.
- "Intelligent Systems for Model-Building and Simulation, and Applications to Monitoring and Control." Texas Institute for Computational and Applied Mathematics, Colloquium, Austin, Texas, 26 February 1998.
- "Academic/Industrial Interaction." R & D Group, Radian International, Austin, Texas, 12 December 1997.
- "Exploration and Reasoning in Large-Scale and Visual Space." Cognitive Science Program, Georgia Institute of Technology, Atlanta, Georgia, 5 December 1997.
- "The Spatial Semantic Hierarchy for Human and Robot Cognitive Maps." Workshop on Mental Representations in Navigation. Nissan Cambridge Basic Research Laboratory, Cambridge, Massachusetts, 25 June 1996.
- "The Spatial Semantic Hierarchy for Human and Robot Cognitive Maps." NCARAI, Naval Research Laboratory, Washington DC, 22 April 1996.
- "An Ontological Hierarchy for Spatial Knowledge." Department of Computer Science, University of Chicago, Chicago, Illinois, 14 February 1996.

- "An Ontological Hierarchy for Spatial Knowledge." Institute for Learning Sciences, Northwestern University, Evanston, Illinois, 13 February 1996.
- "Spatial Knowledge, Cognitive Maps, and the Spatial Semantic Hierarchy." *Spatial Orientation and Navigation*, ONR Meeting, NAS Study Center, Woods Hole, MA, 14 September 1995.
- "Qualitative Reasoning for Monitoring and Control." Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM), Monterrey, Mexico, 27 June 1995.
- "Qualitative Reasoning for Monitoring and Control." Department of Computer Science, University of Colorado, Boulder, 16 February 1995.
- "Robot Learning with the Spatial Semantic Hierarchy." Nara Institute for Science and Technology, Nara, Japan, 13 June 1994.
- "Robot Learning with the Spatial Semantic Hierarchy." Keihanna Interaction Corp., Nara, Japan, 10 June 1994.
- "Robot Learning with the Spatial Semantic Hierarchy." Department of Computer Science, Texas A & M University, College Station, Texas, 11 April 1994.
- "Robot Learning with the Spatial Semantic Hierarchy." Introspection Series, Department of Computer Sciences, University of Texas at Austin, 18 February 1994.
- "Robot Learning with the Spatial Semantic Hierarchy." Robotics Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, 31 January 1994.
- "Self-Calibrating Models for Dynamic Monitoring and Diagnosis." Space Operations, Applications, and Research Symposium (SOAR'93), NASA Johnson Space Center, Houston, Texas, 4 August 1993.
- "The Semantic Hierarchy in Robot Spatial Learning" College of Computer Science, Georgia Institute of Technology, Atlanta, Georgia, 7 March 1993.
- "The Semantic Hierarchy in Robot Spatial Learning" Knowledge Systems Laboratory, Stanford University, Stanford, California, 26 February 1993.
- "Progress in Qualitative and Semi-Quantitative Simulation." Istituto di Analisi Numerica del Cosiglio Nazionale delle Ricerche, Universita degli Studi di Pavia, Pavia, Italy, 18 September 1992.
- "Model-Based Reasoning with Incomplete Knowledge." Texas Instruments Central Research Laboratory, Dallas TX, 4 March 1992.
- "Symbolic Representations for Metric Spaces." IFIP Workshop on the Role of Knowledge Representation in Qualitative Reasoning. Islamorada, FL, 28 February 1992.
- "Model-Based Reasoning with Incomplete Knowledge." AT&T Bell Laboratories, Murray Hill, NJ, 21 November 1991.
- "Model-Based Reasoning with Incomplete Knowledge." Computer Science Department, Princeton University, Princeton, NJ, 20 November 1991.

- "Cognitive Maps of Control Domains." Robot Skills Research Seminar, Artificial Intelligence Laboratory, Massachusetts Institute of Technology, 3 July 1991.
- "The Composition of Heterogeneous Control Laws." Control Theory Research Seminar, Laboratory for Computer Science, Massachusetts Institute of Technology, 25 July 1991.
- "Robot Mapping and Exploration." The Quark Club, University of Texas at Austin, 26 September 1990.
- "Qualitative Simulation: Model-Based Reasoning with Incomplete Knowledge." Computer Science Department, University of Chicago, Chicago, Illinois, 7 February 1990.
- "Qualitative Simulation: Model-Based Reasoning with Incomplete Knowledge." Institute for Learning Science, Northwestern University, Evanston, Illinois, 8 February 1990.
- "Qualitative Reasoning." Computer Science Research Review, Department of Computer Science, University of Texas at Austin, 16 October 1989.
- "Qualitative Reasoning: Modeling and Simulation with Incomplete Knowledge." Laboratory for Computer Science, Massachusetts Institute of Technology, Cambridge, Massachusetts, 16 June 1989.
- "Robot Exploration Based on a Spatial Semantic Hierarchy." Center for Cognitive Science, University of Texas at Austin, 20 April 1989.
- "Qualitative Reasoning: Modeling and Simulation with Incomplete Knowledge." Computer Science Department, University of Toronto, Ontario, 23 February 1989.
- "Qualitative Reasoning: Modeling and Simulation with Incomplete Knowledge." Microelectronics and Computer Technology Corporation, Austin, Texas, 11 January 1989.
- "A Robust, Qualitative Method for Robot Exploration." MIT Artificial Intelligence Laboratory Revolving Seminar, Cambridge, MA, 8 November 1988.
- "Qualitative Reasoning: Modeling and Simulation with Incomplete Knowledge." IBM T. J. Watson Research Center, Hawthorne, NY, 28 October 1988.
- "Qualitative Model-Based Reasoning." Istituto di Analisi Numerica del Cosiglio Nazionale delle Ricerche, Universita degli Studi di Pavia, Pavia, Italy, 11 April 1988.
- "Advances in Qualitative Simulation." CSL Lecture Series, Texas Instruments Research Laboratories, Dallas, Texas, 13 November 1987.
- "Qualitative Reasoning about Mechanisms." CSL Lecture Series, Texas Instruments Research Laboratories, Dallas, Texas, 7 November 1986.
- "Aspects of Qualitative Reasoning About Mechanisms." First World Congress on Computational Mechanics, Austin, Texas, 22 September 1986.
- "Qualitative Reasoning with Causal Models in Medical Diagnosis." Electrotechnical Laboratory, Tsukuba, Japan, 21 August 1986.

- "Qualitative Reasoning with Causal Models in Medical Diagnosis." Institute for New Generation Computer Technology (ICOT), Tokyo, Japan, 20 August 1986.
- "Comments on Decision Support Systems." Recent Developments in Medical Information Systems: Available and Forthcoming Choices. Massachusetts Institute of Technology, Cambridge, Massachusetts, 19 June 1986.
- "Concepts of Qualitative Reasoning." Hewlett-Packard Research Laboratories, Bristol, England, 18 April 1986.
- "Learning from Exploration in Large-Scale Space." Graduate Group in Cognitive Science, University at Buffalo (SUNY), Buffalo, New York, 21 November 1985.
- "Qualitative Simulation of Mechanisms." Joint Research Centre, Commission of the European Communities, Ispra, Italy, 8 November 1985.
- "Qualitative Simulation of Mechanisms and Causal Models in Medical Diagnosis." Austin Chapter, ACM SIGART, Austin, Texas, 2 October 1985.
- "Artificial Intelligence Approaches to Clinical Reasoning." Combined Renal Conference, University of Texas Health Science Center, San Antonio, Texas, 18 September 1985.
- "Qualitative Causal Reasoning in Diagnosis." MIT Artificial Intelligence Laboratory Revolving Seminar, Cambridge, Massachusetts, 14 May 1985.
- "Qualitative Causal Reasoning in Diagnosis." Microelectronics and Computer Technology Corporation, Austin, Texas, 24 April 1985.
- "Causal Reasoning and Qualitative Simulation." Artificial Intelligence Symposium, Department of Computer Science, Columbia University, New York, New York, 12 April 1985.
- "Qualitative Simulation of Mechanisms." Computer Science Colloquium, University of Texas, Austin, Texas, 18 September 1984.
- "Qualitative Causal Reasoning for Second-Generation Medical Diagnosis Programs." Department of Computer Science, Boston University, Boston, Massachusetts, 20 April 1984.
- "Qualitative Causal Reasoning for Second-Generation Medical Diagnosis Programs." Department of Electrical Engineering and Computer Science, University of California at San Diego, La Jolla, California, 18 April 1984.
- "Qualitative Causal Reasoning for Second-Generation Medical Diagnosis Programs." Department of Computer Science, University of Texas, Austin, Texas, 16 April 1984.
- "Qualitative Causal Reasoning for Second-Generation Medical Diagnosis Programs." Department of Computer and Information Science, University of Massachusetts, Amherst, Massachusetts, 12 April 1984.
- "Qualitative Causal Reasoning for Second-Generation Medical Diagnosis Programs." School of Computer and Information Sciences, Georgia Institute of Technology, Atlanta, Georgia, 5 April 1984.

- "Qualitative Causal Reasoning for Second-Generation Medical Diagnosis Programs." University of Minnesota Computer Science Department, Minneapolis, Minnesota, 30 March 1984.
- "Studying Experts To Learn About Qualitative Causal Reasoning." Stanford University Computer Science Department, Stanford, California, 24 February 1984.
- "Knowledge Representations for Causal Reasoning." MIT Center for Policy Alternatives and Technology and Policy Program, Cambridge, Massachusetts, 28 October 1983.
- "Commonsense Knowledge of Large-Scale Space." Massachusetts Computer Associates, Wakefield, Massachusetts, 19 April 1983.
- "Modeling Spatial Knowledge." Cognitive Science Research Colloquium, University of California, Santa Barbara, 14 January 1983.
- "Commonsense Reasoning About Causal Systems." Department of Computer Science, University of Texas. Austin, Texas, 23 April 1982.
- "Commonsense Reasoning About Causal Systems." Computer Science Laboratory Seminar, Texas Instruments. Dallas, Texas, 22 April 1982.
- "The Structure of Causal Reasoning." Clinical Decision Making Seminar, Tufts-New England Medical Center Hospital. Boston, Massachusetts, 1 March 1982.
- "Causal Reasoning About Feedback Processes." Center for Research on Human Learning, Department of Computer Science, and Department of Management Sciences, University of Minnesota. Minneapolis, Minnesota, 2 October 1981.
- "Explorations of Cognitive Space." COINS Seminar, Department of Computer and Information Science, University of Massachusetts at Amherst. Amherst, Massachusetts, 6 April 1981.
- "New Explorations of Space." University of New Hampshire Computer Science Colloquium. Durham, New Hampshire, 5 November 1979.
- "New Explorations of Space." University of Maryland Computer Science Colloquium. College Park, Maryland, 15 October 1979.
- "Commonsense Knowledge of Space." Yale University Computer Science Colloquium. New Haven, Connecticut, 4 April 1979.
- "Progress in Human Spatial Information Processing." Advanced Research Projects Agency (DARPA) Contractors Meeting. New Orleans, Louisiana, 13 December 1977.
- "Cognitive Modeling of the Map User." First International Advanced Study Symposium on Topological Data Structures for Geographical Information Systems. Dedham, Massachusetts, 18 October 1977.
- "Representing Spatial Knowledge." Electrical Engineering and Computer Science Symposium, Massachusetts Institute of Technology. Cambridge, Massachusetts, 28 February 1977.

- "The TOUR Model of Spatial Cognition." Center for Human Information Processing, University of California, San Diego. LaJolla, California, 5 November 1976.
- "The TOUR Model of Spatial Cognition." ARPA Workshop on Psychology and Cartography. San Francisco, California, 30 October 1976.
- "Representing Spatial Knowledge." Center for Human Information Processing, University of California, San Diego. La Jolla, California, 15 December 1975.
- "Mental Maps." Artificial Intelligence Laboratory, Stanford University. Palo Alto, California, 29 January 1975.
- "Mental Maps." Xerox Palo Alto Research Center. Palo Alto, California, 13 January 1975.

Other Presentations

- "Ethics, Trust, and Autonomous Vehicles", guest lecture at the University of Michigan Law School. (Dan Crane's class, Connected and Automated Vehicles – Algorithmic Discrimination) Ann Arbor, Michigan, 29 September 2020.
- "How do we make ethical robots?" SoarTech AI Seminar, University of Michigan Computer Science & Engineering, Ann Arbor, 9 October 2018.
- "Thinking about Ethics for Self-Driving Cars." Problem-Solving Initiative, University of Michigan Law School, Ann Arbor, 18 September 2018.
- "The Origin of Meaning in Visual Experience." Midwest Workshop in Computer Vision 2011, Ann Arbor, 6 May 2011.
- "Why don't I take military funding?" Workshop on Teaching Ethics and Peace to Science and Engineering Students, University of Hamburg, 17 October 2008.
- "Spatial Reasoning and Robotics." The ACM Seminar Series. Computer Science Department, University of Texas at Austin, 12 October 1998.
- "The Spatial Semantic Hierarchy for Human and Robotic Cognitive Maps." Symposium on Cognitive Mapping, Development and Representation, Association of American Geographers, 93rd Annual Meeting, Fort Worth, Texas, 1 April 1997.
- "Robot Exploration and Mapping Strategy." RoboFest 7. Austin, Texas, 14 September 1996.
- "Truth, Beauty, and Power." Mrs. Zunker's eighth grade honors algebra class, Grisham Middle School, Round Rock Independent School District, 9 November 1994.
- "How a Robot Can Understand Its World." RoboFest 5. Austin, Texas, 26 March 1994.
- "Building Intelligent Agents." Computer Science Industrial Forum, Department of Computer Sciences, University of Texas at Austin, 7 February 1994.
- "Why Build Robots, Anyway?" RoboFest 4. Austin, Texas, 22 May 1993.

- "Qualitative Reasoning About Physical Systems." Demonstration and discussion, Computer Science Industrial Forum, Department of Computer Sciences, University of Texas at Austin, 18 February 1991.

MISCELLANY

- Developed the first symbolic differential equation solver. 1972. Cited in J. P. Golden, MACSYMA's Symbolic Ordinary Differential Equation Solver, *Proceedings of the Macsyma Users Conference*, 1977.

  Also cited (as MIT-ML disk files!) in David R. Stoutemyer, Computer Algebraic Manipulation for the Calculus of Variations, the Maximum Principle, and Automatic Control. University of Hawaii Aloha System TR A74-5, November 1974.

- Choreographed "He Built A Crooked House," a Scottish country dance. In *A Yankee Sampler*, Cambridge, Mass: Royal Scottish Country Dance Society, Boston Branch, 1976.

- Cited along with D. E. Knuth for independent discovery of a key improvement to their string searching algorithm, in R. S. Boyer and J S. Moore, A fast string searching algorithm, *Communications of the ACM* **20**: 762 - 772, 1977.

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