JAMES C. BOERKOEL JR.

Associate Professor, Computer Science Department Harvey Mudd College

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EDUCATION:

University of Michigan — Ann Arbor, MI
Ph.D. Computer Science and Engineering — July 2012
Distributed Methods for Solving Constraint-based Multiagent Selection and Scheduling Problems
Advisor: Professor Edmund H. Durfee

University of Michigan — Ann Arbor, MI
Master of Science, Computer Science and Engineering — August 2008

Hope College, *Summa Cum Laude* — Holland, MI
Bachelor of Science: Computer Science, Mathematics — December 2005

TEACHING EXPERIENCE:

Harvey Mudd College — Claremont, CA
Associate Professor — Fall 2013 - Current

CS 140: Algorithms, CS 151: Artificial Intelligence, CS124 Interaction Design, CS181O Human-Robot Interaction.

Principle instructor of the CS kernel Algorithms course, and elective Artificial Intelligence and Interaction Design courses. Human-Robot Interaction is a newly designed course offering. More information about all classes are available on my homepage.

Massachusetts Institute of Technology — Cambridge, MA
Instructor; 6.S092: Introduction to Programming in Java — January IAP 2013

Co-instructor for introductory software engineering course during MIT's Independent Activities Period. Responsible for designing and delivering lectures and homework, holding office hours, and grading.

University of Michigan — Ann Arbor, MI
Graduate Student Instructor; — Fall 2006; Winter 2007; 2011

EECS 545: Machine Learning, EECS 398: Practical Aspects of Software Development, EECS 381: Object Oriented and Advanced Programming

Designed and delivered review lectures, designed course homework, projects, and exams, and held office hours to assist students with questions.

University of Michigan — Ann Arbor, MI
Research Mentor — Summer 2009

Mentored an undergraduate student to design and implement a simulation engine for scheduling applications.

RESEARCH INTERESTS:

Human Robot Teamwork, Multiagent Coordination, Assistive Technology, Constraint-based Scheduling, AI Education, Robotics in Advanced Manufacturing

RESEARCH EXPERIENCE:

Human Experience and Agent Teamwork Lab (HEATlab) @ HMC   Claremont, CA
https://www.cs.hmc.edu/HEAT/
Founder, Principle Investigator   June 2014 – Current

The HEATlab focuses on using ideas from AI to automate the scheduling and coordination of multiple agents, including humans, virtual (computational) agents, and robots (embodied agents). We are motivated by the challenge of coordinating the actions of human-robot teams in environments that require explicit cooperation to be successful. A particular goal for human-robot teamwork is in planning solutions that recognize and exploit the relative strengths of humans and agents to accomplish what neither can achieve alone.

Lab members / alumni: Jeb Brooks ('14), Priya Donti ('15), Alex Gruver ('15) Jacob Rosenbloom ('15), Sam Echevarria ('16), Kari Linder (CMC '16), Scott Chow ('17), Sam Dietrich (Engineering '17), Kyle Lund (Robotics '17), Emilia Reed ('17), Brenda Castro ('18), Amy Huang ('18), Liam Lloyd ('18) Montana Roberts (Scripps '18), Hamzah Khan ('18), Jane Wu ('18), Jordan Abrahams ('19), Shyan Akmal ('19), Maggie Li ('19), Brenner Ryan ('19), Viva Ojha ('19), Savana Ammons ('20), Michael Gao ('20), Joon Lee ('20), Gretchen Rice (Olin College '20), Seth Isaacson ('21), Lindsay Popowski ('21)

Harvey Mudd College, Computer Science Department   Claremont, CA
Clinic Advisor   Fall 2013 – Current

Advised on the following senior capstone clinic projects:

- Accenture Labs. (2018-19): explores designing and developing a proof-of-concept augmented reality system for human workers teaming with warehouse robots.
- NASA Ames Research Center. (2017-18): explores reducing the communication overhead of current dynamic multirobot scheduling algorithms.
- Steelcase Inc. (2015-16): explores refining existing color classification system using machine learning to learn features that impact customer's perceptions about finish color.
- Steelcase Inc. (2014-15): explores designing algorithm for automatically classifying sheets of veneer at human-level performance into predefined color buckets.
- Qualcomm Inc. (2014-15): seeks to take an existing robotic platform and power it using the Snapdragon 600 so that it can localize in a known environment, navigate between goal locations, and provide tour guide functionality.
- Lockheed Martin (2013-14): investigates designing efficient, graph-theoretic algorithms to map real-world problems so that they can be solved by Lockheed's 512-qubit adiabatic quantum computer produced by D-Wave Systems.

Massachusetts Institute of Technology, Computer Science and AI Laboratory   Cambridge, MA
Postdoctoral Associate   Sept. 2012 – July 2013

Led a project funded by BMW that investigated developing and deploying mobile robot assistants in the final assembly of automotive manufacturing processes to increase the productivity, safety, and health of human workers.

University of Michigan, Computer Science Department   Ann Arbor, MI
Graduate Student Research Assistant, Prof. Edmund Durfee   May 2007 – August 2012

Developed foundational technology for scheduling agents that assist human users with selecting and scheduling activities to achieve their daily goals. This work extended traditional constraint-based scheduling representations and techniques to multiagent settings and developed distributed algorithms that exploit the weakly-coupled structure present in many multiagent scheduling problems.

Delft University of Technology, Algorithmics Group   Delft, Netherlands
NSF Extended European Lab Visit   June 2011 – July 2011

Collaborated with Léon Planken and Mathijs de Weerdt to develop efficient, distributed algorithms for incrementally responding to updates for multiagent scheduling problems.

LeanLogistics   Holland, MI
Research and Development   Feb. 2005 – Aug. 2006

Developed a new optimization engine using state-of-the-art constraint satisfaction approaches for a web-based transportation management application.

Hope College,   Holland, MI
Research Experience for Undergraduates   Summer 2003, 2004

Computer Science Department (2004): Developed and evaluated the eTextReader System, a textbook software tool for encouraging academic collaboration using tablet PCs. Presented research at HP Mobile Technology Conference 2004 and at SIGCSE in 2005.

Mathematics Department (2003): Researched and quantified an approach to conditioning ill-posed matrices.

PUBLICATIONS AND PRESENTATIONS (undergraduate coauthors highlighted):
https://www.cs.hmc.edu/HEAT/#publications

Journal Articles:

Mobile Robots to Moving-Floor Assembly Lines: Design, Evaluation and Deployment. Unhelkar, V., Dorr, S., Bubeck, A., **Perex, J.**, **Siu, H.**, Boerkoel, J., Tyroller, Q., Bix, J., Bartscher, S., and Shah, J. IEEE Robotics and Automation Magazine *IEEE Robotics & Automation Magazine* 1070, no. 9932/18 (2018).

Distributed Approaches for Summarizing and Decoupling Agents' Schedules in Multiagent Simple Temporal Networks. Boerkoel, J. and Durfee, E., *Journal of Artificial Intelligence Research (**JAIR**)*, Volume 47, pages 95-156, 2013.

Using Hybrid Scheduling for the Semi-autonomous Formation of Expert Teams. Durfee, E., Boerkoel, J. , and Sleight, J., *Future Generation Computer Systems (**FGCS**)*, 2013.

In Highly-Refereed Conferences with Archival Proceedings (Undergraduate coauthors highlighted):

Quantifying Degrees of Controllability in Temporal Networks with Uncertainty. **Akmal, S.**, **Ammons, S.**, **Li, H.**, and Boerkoel, J. In *Proc. 29th Int. Conf. on Automated Planning and Scheduling (**ICAPS-2019**)*. Presented July 2019 by **Akmal, S.**, **Ammons, S.**, and **Li, H.** in Berkeley, CA, USA.

DREAM: An Algorithm for Mitigating the Overhead of Robust Rescheduling. **Abrahams, J.**, **Chu Lasso, D.**, **Diehl, G.**, **Knittel, M.**, **Lin, J.**, **Lloyd, W.**, Boerkoel, J., and Frank, J. In *Proc. 29th Int. Conf. on Automated Planning and Scheduling (**ICAPS-2019**)*. Presented July 2019 by **Abrahams, J.**, in Berkeley, CA, USA.

Measuring and Optimizing Durability against Scheduling Disturbances. **Lee J.**, **Ojha, V.**, and Boerkoel, J. In *Proc. 29th Int. Conf. on Automated Planning and Scheduling (**ICAPS-2019**)*. Presented July 2019 by **Lee, J.**, and **Ojha V.** in Berkeley, CA, USA.

New Perspectives on Flexibility in Simple Temporal Planning. **Huang, A.**, **Lloyd, W.**, Omar, M. and Boerkoel, J. In *Proc. 28th Int. Conf. on Automated Planning and Scheduling (**ICAPS-2018**)*. Presented June 22, 2018 by **A. Huang** and **L. Lloyd** in Delft, Netherlands.

Who Takes the Lead? Automated Scheduling for Human-Robot Teams. **Castro, B.**, **Roberts, M.**, **Mena, K.**(high school student), and Boerkoel, J. In *Proc. of Artificial Intelligence in Human Robot Interaction AAAI Fall Symposium Series (**AI-HRI 2017**)*. Presented Nov. 10, 2017 by **M. Roberts** and **B. Castro** in Washington, DC.

Robust Execution of Probabilistic Temporal Plans. **Lund, K.**, **Dietrich, S.**, **Chow, S.**, and Boerkoel, J. In *Proc. 31st Conf. on Artificial Intelligence (**AAA-2017**)*. Presented Feb. 17, 2017 by **K. Lund** and **S. Chow** in San Francisco, CA.

Trust and Cooperation in Human-Robot Decision Making. **Wu, J.**, **Paeng, E.**, **Linder, L.**, Valdesolo, P., and Boerkoel, J. In *Proc. of Artificial Intelligence in Human Robot Interaction AAAI Fall Symposium Series (**AI-HRI 2016**)*. Presented Nov. 17, 2016 by **Wu, J.** in Washington, DC.

Robustness in Probabilistic Temporal Planning. **Brooks, J.**, **Reed, E.**, **Gruver, A.**, and Boerkoel, J. In *Proc. 29th Conf. on Artificial Intelligence (**AAA-2015**)*. Presented Jan. 27, 2015 by **J. Brooks** in Austin, TX.

Towards Control and Sensing for an Autonomous Mobile Robotic Assistant Navigating Assembly Lines. Unhelkar, V., **Perez, J.**, Boerkoel, J., Bix, J., Bartscher, S., Shah, J., *IEEE International Conference on Robotics and Automation (**ICRA 2014**)*. Presented June 3, 2014 by. V. Unhelkar in Hong Kong.

Distributed Algorithms for Incrementally Maintaining Multiagent Simple Temporal Networks. Boerkoel, J., Planken, L., Wilcox, R., and Shah, J., In *Proc. Of 23rd Int. Conf. on Automated Planning and Scheduling (**ICAPS 2013**)* pages 11-19, 2013. Presented June 13, 2013 in Rome, Italy.

Decoupling the Multiagent Disjunctive Temporal Problem. Boerkoel, J. and Durfee, E., In *Proc. 27th Conf. on Artificial Intelligence (**AAAI-2013**)* pages 123-129. Presented July 18, 2013 in Seattle, WA, USA.

 A Distributed Approach to Summarizing Spaces of Multiagent Schedules. Boerkoel, J. and Durfee, E., In *Proc. 26th Conf. on Artificial Intelligence (**AAAI-2012**)* pages 1742-1748, 2012. Presented July 24, 2012 in Toronto, Canada.

Distributed Algorithms for Solving the Multiagent Temporal Decoupling Problem. Boerkoel, J. and Durfee, E., In *Proc. of 10th Int. Conf. on Autonomous Agents and Multiagent Systems (**AAMAS 2011**)*, pages 141-148, 2011. Presented May 3, 2011 in Taipei, Taiwan.

A Comparison of Algorithms for Solving the Multiagent Simple Temporal Problem. Boerkoel, J. and Durfee, E., In *Proc. of 20th Int. Conf. on Automated Planning and Scheduling (**ICAPS 2010**)*, pages 26-33, 2010. Presented May 14, 2010 at a joint AAMAS/ICAPS session in Toronto, Canada.

Generalized Solution Techniques for Preference-Based Constrained Optimization with CP-nets. Boerkoel, J., Durfee, E., and Purrington, K., In *Proc. of 9th Int. Conf. on Autonomous Agents and Multiagent Systems (**AAMAS 2010**)*, May 13, 2010, Toronto, Canada, pages 291-298, 2010.

Evaluating Hybrid Constraint Tightening for Scheduling Agents. Boerkoel, J. and Durfee E., In *Proc.. of 8th Int. Conf. on Autonomous Agents and Multiagent Systems (**AAMAS 2009**)*, pages 673-680, 2009. Presented May 15, 2009 in Budapest, Hungary.

Hybrid Constraint Tightening for Hybrid Constraint Scheduling. Boerkoel, J. and Durfee, E., In *Proc. 23rd Conf. on Artificial Intelligence (**AAAI-2008**)*, pages 1446-1449, 2008. Presented (poster) July 16, 2008 in Chicago, IL.

Patents:

Heuristic Graph Embedding Methods for Adiabatic Quantum Computation Optimization Adachi, S. **Adair, T.,** Boerkoel, J., **Brent, T., Campbell, D.S.,** Boerkoel, J., and **Ornstein, J.** US Patent 10,282,674 filed August 20 2015 and issued May 7, 2019.

In Other Published Proceedings:

Trade-offs Between Communication, Rescheduling, and Success Rate in Uncertain Multi-Agent Schedules **Chu Lasso, D., Diehl, G., Knittel, M., Lin, J, Lloyd, W.,** Boerkoel, J., and Frank, J. 2018. The Integrated Planning, Acting and Execution Workshop (IntEx) at The 28th International Conference on Automated Planning and Scheduling. Presented by the team on June 20, in Delft NL.

Robust Multirobot Scheduling. **Lund, K., Dietrich, S.,** and Boerkoel, J. In Robotics: Science and Systems (RSS 2016) Workshop on On-line Decision-making in Multi-robot Coordination **(DERMUR-16)**. Presented June 19, 2016 in Ann Arbor, MI.

Exploring Human-Robot Trust and Cooperation. **Wu, J., Paeng, E.,** and Boerkoel, J. In *Robotics: Science and Systems (RSS 2016) Workshop on Social Trust in Autonomous Robots.* Presented June 19, 2016 in Ann Arbor, MI.

Robust Execution Strategies for Probabilistic Temporal Planning. **Lund, K., Dietrich, S.,** and Boerkoel, J. In *AAAI-2016 Student Abstract and Poster Program (AAAI-2016)*. Presented Feb. 15, 2016 by **K. Lund** in Phoenix, AZ.

Trust and Cooperation in Human-Robot Decision Making. **Paeng, E., Wu, J.,** and Boerkoel, J. In *AAAI-2016 Student Abstract and Poster Program (AAAI-2016)*. Presented Feb. 15, 2016 by **J. Wu** in Phoenix, AZ.

Robust Execution Strategies for Probabilistic Temporal Planning. **Lund, K., Dietrich, S.,** and Boerkoel, J. In *AAAI-2016 Student Abstract and Poster Program (AAAI-2016)*. Presented Feb. 15, 2016 by **K. Lund** in Phoenix, AZ.

Predicting the Quality of User Experiences to Improve Productivity and Wellness. **Donti, P., Rosenbloom, J., Gruver, A.,** and Boerkoel, J. In *AAAI-2015 Student Abstract and Poster Program (AAAI-2015)*. Presented Jan. 29, 2015 by **P. Donti, J. Rosenbloom, and A. Gruver** in Austin, TX.

Exploring Active and Passive Team-based Coordination. **Donti, P.,** and Boerkoel, J. In *Proc. AAAI Symposium on Human Robot Interaction (AI-HRI)*. Presented November 14, 2014 by **P. Donti** in Washington, DC.

Decoupling the Multiagent Disjunctive Temporal Problem (Extended Abstract). Boerkoel, J. and Durfee, E., In *Proc. of 9th Int. Conf. on Autonomous Agents and Multiagent Systems (AAMAS 2013)*.

Distributed Algorithms for Incrementally Maintaining Multiagent Simple Temporal Networks. Boerkoel, J. and Planken, L. In Proc. *2nd Workshop on Autonomous Robots and Multirobot Systems (ARMS 2012)* 2012.

Solving the Multiagent Selection and Scheduling Problem. Boerkoel, J. *In Proc. of the IJCAI Doctoral Consortium*, pages 2784-2785, 2011. Presented July 17, 2011 in Barcelona, Spain.

Challenges in Maintaining Minimal, Decomposable Disjunctive Temporal Problems. Boerkoel, J. and Durfee, E. In Proc. *2nd Workshop on Artificial Intelligence and Logistics (AILog-2011)* , pages 7-12, 2011. Presented July 16, 2011 in Barcelona, Spain.

Comparing Techniques for the Semi-Autonomous Formation of Expert Teams. Durfee, E., Boerkoel, J., and Sleight, J. In *Proc. Second International Workshop on Multi-Agent Systems and Collaborative Technologies (I-MASC'11)*, pages 351-358, 2011. Nominated for Best Paper Award.

Partitioning the Multiagent Simple Temporal Problem for Concurrency and Privacy (Extended Abstract). Boerkoel, J. and Durfee, E., In *Proc. of 9th Int. Conf. on Autonomous Agents and Multiagent Systems (AAMAS 2010)*, pages 1421-1422, 2010. Presented as a poster May 12, 2010 in Toronto, Canada.

Solving the Multiagent Selection and Scheduling Problem. Boerkoel, J. In *Proc. of the ICAPS Doctoral Consortium,* 2010. Presented May 12, 2010 in Toronto, Canada.

A Multiagent System for Solving the Activity Selection and Scheduling Coordination Problem. Boerkoel, J. In *Proc. of the AAAI/SIGART Doctoral Consortium*, pages 1-2, 2009. Presented July 12, 2009 in Pasadena, CA

Solving Decoupled Constraint Optimization Problems for Online Cognitive Orthotic Scheduling Agents. Purrington, K., Boerkoel, J., and Durfee, E., In *Working Notes of the IJCAI 2009 Workshop on Intelligent Systems for Assisted Cognition,* pages 89-96, 2009. Presented as a poster July 12, 2009 in Pasadena, CA.

Other Research Presentations:

"Better Together: The Advantages of Human-Robot Teamwork." Invited Talk, The University Club of Claremont. Claremont, CA. June 28, 2016.

"Temporal Planning for Robust Human-Robot Teamwork." Invited Talk, University of Southern California Intelligent Decision Making Group. Los Angeles, CA. February 22, 2015.

"Temporal Planning for Robust Human-Robot Teamwork." Invited Talk, Delft University of Technology. Delft, Netherlands. February 2, 2015.

"Designing Better Human-Robot Interactions." Invited Talk, Cal Poly Pomona, Computer Club. Pomona, CA. October 22, 2015.

"Distributed Algorithms for Solving the Multiagent Temporal Decoupling Problem." Invited Talk, Delft University of Technology. Delft, Netherlands. June 2011.

"Coordination Strategies for Multi-agent Scheduling." Invited Talk, Oberlin College, Oberlin. OH. March 2011.

"The Challenge of Coordinating Multiple Scheduling Agents: Solving the Multiagent Simple Temporal Problem." Invited Talk, Hope College. Holland, MI. February 2010.

HONORS AND AWARDS:
NSF Early Faculty CAREER Award, 2017 – 2022.
Citadel Scholars Program, 2015.
The Engman Research and Experiential Learning Award, 2015.
HMC Holen Fellowship, 2014.
Rose Hills Research Award, 2014.
University of Michigan Rackham Graduate School Predoctoral Fellow, 2011-2012.
NSF Extended European Lab Visit Scholarship, 2011.
Member of Phi Kappa Phi Academic Honor Society, 2011.
Honorable Mention – University of Michigan CSE Graduate Student Honors Competition, December 2010.
Russell J. Kraay Award for outstanding Junior in Computer Science at Hope College, 2005.
Conference Travel Grants Awarded: Rackham 2008, 2009, 2010, 2011, 2012; AAMAS 2009, 2010, 2011; IJCAI (DC) 2009; ICAPS (DC) 2010, and HRI-Pioneers 2013.

PROFESSIONAL SERVICE:

Doctoral Consortium, Int. Conf. for Automated Planning and Scheduling (ICAPS-18)   2018
Chair

National Science Foundation Partnerships for Innovation: Building Innovation Capacity   Feb. 2017
Panelist: Smart Manufacturing and Inventory Systems

AI Magazine – Special Issue on AI Education   Winter 2016
Co-Editor

TU Delft, Algorithmics Group PhD Defense: Michel Wilson   2016
Promoters / Advisors: Tomas Klos and Cees Witteveen
Doctoral Thesis Committee

AAAI Conference on Artificial Intelligence   2013,2015-16
Program Committee

ACM/IEEE International Conference on Human-Robot Interaction   2015-16
Program Committee

The Fifth Symposium on Educational Advances in Artificial Intelligence (EAAI-14) at AAAI   2014-16
Program Committee

Human-Robot Interaction Pioneers Workshop at HRI 2014   2014
Program Committee

Workshop on Human Robot Collaboration (HRC 2013) at RSS   2013
Co-organizer

Workshop on Autonomous Robots and Multirobot Systems (ARMS 2013) at AAMAS   2013
Co-organizer

Journal of Annals of Mathematics and Artificial Intelligence (AMAI)   2012-13
Reviewer

Journal of Autonomous Agents and Multiagent Systems (JAAMAS)   2012
Reviewer

ACM Transactions on Intelligent Systems and Technology (ACM TIST)   2012
Reviewer

Robotics and Autonomous Systems   2012
Reviewer