

Ron Alterovitz, Ph.D.

Assistant Professor
Department of Computer Science
University of North Carolina at Chapel Hill

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RESEARCH INTERESTS

My research creates new software and algorithms to enable robots to safely and autonomously complete tasks in clinical and home environments. I focus on robot motion planning and physically-based simulation for medical and assistive robotics applications, including treatment planning, surgical assistance, medical image registration, physician training, and personal assistance.

EDUCATION

University of California, Berkeley

Ph.D., Industrial Engineering and Operations Research, 2006

Thesis: *Planning and Optimization Algorithms for Image-Guided Medical Procedures*

Committee: Ken Goldberg (Chair), James F. O'Brien, Alper Atamtürk, and Jean Pouliot

University of California, Berkeley

M.S., Industrial Engineering and Operations Research, 2003

California Institute of Technology (Caltech)

B.S. with Honors, Computer Science (Engineering and Applied Science), 2001

POSITIONS HELD

- 2009–present *Assistant Professor, University of North Carolina at Chapel Hill*, Department of Computer Science
- 2007–2008 *NIH Postdoctoral Research Fellow, University of California, San Francisco, UCSF Comprehensive Cancer Center, and University of California, Berkeley*, Department of Electrical Engineering and Computer Sciences
- 2006–2007 *Postdoctoral Research Fellow, LAAS-CNRS (National Center for Scientific Research)*, Toulouse, France, Robotics and Artificial Intelligence Group
- 2005 *Graduate Student Instructor, University of California, Berkeley*, Department of Electrical Engineering and Computer Sciences
- 2001–2006 *Graduate Student Researcher, University of California, Berkeley*, Berkeley Automation Sciences Laboratory
- 2000 *Software Developer, Oracle Corporation*
- 1999 *Software Developer, Netscape Communications*
- 1997, 1998 *Research Intern, NASA Glenn Research Center*

AWARDS AND HONORS

- 2010 UNC Computer Science Students Association (CSSA) Teaching Award
- 2009 “Highly Accessed” designation for article in BMC Bioinformatics journal
- 2009 Finalist for Intuitive Surgical Best Paper Award, IEEE International Conference on Robotics and Automation
- 2007 National Institutes of Health (NIH) Ruth L. Kirschstein National Research Service Award
- 2006 Department of Defense (DOD) Prostate Cancer Research Fellowship
- 2003 Best Paper Award Finalist, IEEE/RSJ International Conference on Intelligent Robots and Systems (one of 7 finalists/1,000+ submissions)
- 2003–2006 National Science Foundation (NSF) Graduate Research Fellowship
- 2001–2003 National Defense Science and Engineering Graduate (NDSEG) Fellowship
- 2000–2001 Caltech Upper Class Merit Award full tuition scholarship
- 2001 Sigma Xi, The Scientific Research Society
- 2000 Tau Beta Pi National Engineering Honor Society

PUBLICATIONS

BOOKS

1. Ron Alterovitz and Ken Goldberg, *Motion Planning in Medicine: Optimization and Simulation Algorithms for Image-Guided Procedures*, Springer Tracts in Advanced Robotics, Springer, 2008.

BOOK CHAPTERS

1. Noah J. Cowan, Ken Goldberg, Gregory S. Chirikjian, Gabor Fichtinger, Ron Alterovitz, Kyle B. Reed, Vinutha Kallem, Wooram Park, Sarthak Misra, and Allison M. Okamura, “Robotic Needle Steering: Design, Modeling, Planning, and Image Guidance,” in *Surgical Robotics: System Applications and Visions*, (J. Rosen, B. Hannaford, and R. M. Satava, eds.), ch. 23, pp. 557–582, Springer, 2011.

JOURNAL ARTICLES

1. Kyle B. Reed, Ann Majewicz, Vinutha Kallem, Ron Alterovitz, Ken Goldberg, Noah J. Cowan, Allison M. Okamura, “Robot-Assisted Needle Steering,” *IEEE Robotics and Automation Magazine*, 2011 (to appear).
2. Vincent Duindam, Jijie Xu, Ron Alterovitz, Shankar Sastry, and Ken Goldberg, “Three-dimensional Motion Planning Algorithms for Steerable Needles Using Inverse Kinematics,” *International Journal of Robotics Research*, vol. 29, no. 7, pp. 789–800, June 2010.
3. Nuttapong Chentanez, Ron Alterovitz, Daniel Ritchie, Jonha Cho, Kris Hauser, Ken Goldberg, Jonathan R. Shewchuk, and James F. O’Brien, “Interactive Simulation of Surgical Needle Insertion and Steering,” *ACM Transactions on Graphics (Proc. SIGGRAPH)*, vol. 28, no. 3, pp. 88:1–88:10, Aug. 2009.
(Image from article featured on back cover)

4. Ron Alterovitz, Aaron Arvey, Sriram Sankararaman, Carolina Dallett, Yoav Freund, and Kimmen Sjölander, “ResBoost: Characterizing and Predicting Catalytic Residues in Enzymes,” *BMC Bioinformatics*, vol. 10, no. 197, pp. 1–14, June 2009.
(Designated as “Highly accessed” by BMC Bioinformatics)
5. Ron Alterovitz and Jaydev P. Desai, “Surgical Robotics,” *IEEE Robotics and Automation Magazine*, vol. 16, no. 2, pp. 16–17, June 2009.
6. Ron Alterovitz, Ken Goldberg, Jean Pouliot, and I-Chow Hsu, “Sensorless Motion Planning for Medical Needle Insertion in Deformable Tissues,” *IEEE Trans. Information Technology in Biomedicine*, vol. 13, no. 2, pp. 217–225, Mar. 2009.
7. Ron Alterovitz, Michael Branicky, and Ken Goldberg, “Motion Planning Under Uncertainty for Image-Guided Medical Needle Steering,” *International Journal of Robotics Research*, vol. 27, no. 11–12, pp. 1361–1374, Nov. 2008.
8. Ron Alterovitz, Etienne Lessard, Jean Pouliot, I-Chow Hsu, James F. O’Brien, and Ken Goldberg, “Optimization of HDR Brachytherapy Dose distributions Using Linear Programming with Penalty Costs,” *Medical Physics*, vol. 33, no. 11, pp. 4012–4019, Nov. 2006.
9. Ron Alterovitz, Ken Goldberg, Jean Pouliot, I-Chow Hsu, Yongbok Kim, Susan Moyher Noworolski, and John Kurhanewicz, “Registration of MR Prostate Images with Biomechanical Modeling and Nonlinear Parameter Estimation,” *Medical Physics*, vol. 33, no. 2, pp. 446–454, Feb. 2006.

REFEREED CONFERENCE ARTICLES

1. Sachin Patil, Jur van den Berg, and Ron Alterovitz, “Motion Planning Under Uncertainty in Highly Deformable Environments,” in *Proc. Robotics: Science and Systems*, June 2011.
2. Edgar Lobaton, Jinghe Zhang, Sachin Patil, and Ron Alterovitz, “Planning Curvature-Constrained Paths to Multiple Goals Using Circle Sampling,” in *Proc. IEEE International Conference on Robotics and Automation (ICRA)*, May 2011, pp. 1463–1469.
3. Ron Alterovitz, Sachin Patil, and Anna Derbakova, “Rapidly-Exploring Roadmaps: Weighing Exploration vs. Refinement in Optimal Motion Planning,” in *Proc. IEEE International Conference on Robotics and Automation (ICRA)*, May 2011, pp. 3706–3712.
4. Jur van den Berg, Sachin Patil, Ron Alterovitz, Pieter Abbeel, and Ken Goldberg, “LQG-Based Planning, Sensing, and Control of Steerable Needles,” in *Algorithmic Foundation of Robotics IX (WAFR 2010)*, D. Hsu et al. (Eds.), STAR vol. 68, Springer-Verlag, 2010, pp. 373–389.
5. Sachin Patil and Ron Alterovitz, “Interactive Motion Planning for Steerable Needles in 3D Environments with Obstacles,” in *Proc. IEEE RAS/EMBS Int. Conf. Biomedical Robotics and Biomechatronics (BioRob)*, Sep. 2010, pp. 893–899.
6. Edgar J. Lobaton, Ramanarayan Vasudevan, Ruzena Bajcsy, and Ron Alterovitz, “Local Occlusion Detection Under Deformations Using Topological Invariants,” in *Proc. European Conference on Computer Vision (ECCV)*, Lecture Notes in Computer Science 6313, Sep. 2010, pp. 101–114.
(Selected for oral presentation)

7. Lisa A. Lyons, Robert J. Webster III, and Ron Alterovitz, “Planning Active Cannula Configurations Through Tubular Anatomy,” in *Proc. IEEE International Conference on Robotics and Automation (ICRA)*, May 2010, pp. 2082–2087.
8. Sachin Patil and Ron Alterovitz, “Toward Automated Tissue Retraction in Robot-Assisted Surgery,” in *Proc. IEEE International Conference on Robotics and Automation (ICRA)*, May 2010, pp. 2088–2094.
9. Lisa A. Lyons, Robert J. Webster III, and Ron Alterovitz, “Motion Planning for Active Cannulas,” in *Proc. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Oct. 2009, pp. 801–806.
10. Jijie Xu, Vincent Duindam, Ron Alterovitz, Jean Pouliot, J. Adam M. Cunha, I-Chow Hsu, and Ken Goldberg, “Planning Fireworks Trajectories for Steerable Medical Needles to Reduce Patient Trauma,” in *Proc. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Oct. 2009, pp. 4517–4522.
11. Kris Hauser, Ron Alterovitz, Nuttapon Chentanez, Allison Okamura, and Ken Goldberg, “Feedback Control for Steering Needles Through 3D Deformable Tissue Using Helical Paths,” in *Proc. Robotics: Science and Systems*, 2009.
12. Meysam Torabi, Kris Hauser, Ron Alterovitz, Vincent Duindam, and Ken Goldberg, “Guiding Medical Needles Using Single-Point Tissue Manipulation,” in *Proc. IEEE International Conference on Robotics and Automation (ICRA)*, May 2009, pp. 2705–2710.
(Finalist for Intuitive Surgical Best Paper Award)
13. Vincent Duindam, Jijie Xu, Ron Alterovitz, Shankar Sastry, and Ken Goldberg, “3D Motion Planning Algorithms for Steerable Needles Using Inverse Kinematics,” in *Algorithmic Foundation of Robotics VIII (WAFR 2009)*, G. S. Chirikjian et al. (Eds.), STAR vol. 57, Springer-Verlag, 2009, pp. 535–549.
14. Kyle B. Reed, Vinutha Kallem, Ron Alterovitz, Ken Goldberg, Allison M. Okamura, and Noah J. Cowan, “Integrated Planning and Image-Guided Control for Planar Needle Steering,” in *Proc. IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob)*, Oct. 2008, pp. 819–824.
15. Jeremy Schiff, Anand Kulkarni, Danny Bazo, Vincent Duindam, Ron Alterovitz, Dezhen Song, and Ken Goldberg, “Actuator Networks for Navigating an Unmonitored Mobile Robot,” in *Proc. IEEE International Conference on Automation Science and Engineering (CASE)*, Aug. 2008, pp. 53–60.
16. Jijie Xu, Vincent Duindam, Ron Alterovitz, and Ken Goldberg, “Motion Planning For Steerable Needles in 3D Environments with Obstacles Using Rapidly-Exploring Random Trees and Backchaining,” in *Proc. IEEE International Conference on Automation Science and Engineering (CASE)*, Aug. 2008, pp. 41–46.
17. Vincent Duindam, Ron Alterovitz, Shankar Sastry, and Ken Goldberg, “Screw-Based Motion Planning for Bevel-Tip Flexible Needles in 3D Environments with Obstacles,” in *Proc. IEEE International Conference on Robotics and Automation (ICRA)*, May 2008, pp. 2483–2488.
18. Ron Alterovitz, Thierry Siméon, and Ken Goldberg, “The Stochastic Motion Roadmap: A Sampling Framework for Planning with Markov Motion Uncertainty,” in *Robotics: Science and Systems III (Proc. RSS 2007)*, W. Burgard et al. (Eds.), MIT Press, 2008, pp. 233–241.

19. Ron Alterovitz, Michael Branicky, and Ken Goldberg, “Constant-Curvature Motion Planning Under Uncertainty with Applications in Image-Guided Medical Needle Steering,” in *Algorithmic Foundation of Robotics VII (WAFR 2006)*, S. Akella et al. (Eds.), STAR vol. 47, Springer-Verlag, 2008, pp. 319–334.
20. Ron Alterovitz, Andrew Lim, Ken Goldberg, Gregory S. Chirikjian, and Allison M. Okamura, “Steering Flexible Needles Under Markov Motion Uncertainty,” in *Proc. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Aug. 2005, pp. 120–125.
21. Ron Alterovitz, Ken Goldberg, and Allison M. Okamura, “Planning for Steerable Bevel-tip Needle Insertion Through 2D Soft Tissue with Obstacles,” in *Proc. IEEE International Conference on Robotics and Automation (ICRA)*, Apr. 2005, pp. 1652–1657.
22. Ron Alterovitz, Ken Goldberg, John Kurhanewicz, Jean Pouliot, I-Chow Hsu, “Image Registration for Prostate MR Spectroscopy Using Biomechanical Modeling and Optimization of Force and Stiffness Parameters,” in *Proc. 26th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBS)*, Sept. 2004, pp. 1722–1725.
23. Ron Alterovitz, Jean Pouliot, Richard Taschereau, I-Chow Hsu, and Ken Goldberg, “Sensorless Planning for Medical Needle Insertion Procedures,” in *Proc. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Oct. 2003, pp. 3337–3343.
(Best Paper Award Finalist)
24. Ron Alterovitz, Jean Pouliot, Richard Taschereau, I-Chow Hsu, and Ken Goldberg, “Needle Insertion and Radioactive Seed Implantation in Human Tissues: Simulation and Sensitivity Analysis,” in *Proc. IEEE International Conference on Robotics and Automation (ICRA)*, Sept. 2003, pp. 1793–1799.
25. James Moller, Mathew Carlson, Ron Alterovitz, and Joseph Swartz, “Post-ejection Cooling Behavior of Injection Molded Parts,” in *Proc. 56th Annual Technical Conference (ANTEC '98)*, vol. 1, Society of Plastics Engineers, Brookfield, CT, 1998, pp. 525–529.

CONFERENCE ABSTRACTS

1. Nuttapong Chentanez, Ron Alterovitz, Daniel Ritchie, Lita Cho, Kris K. Hauser, Ken Goldberg, Jonathan R. Shewchuk, James F. O’Brien, “Simulation of Needle Insertion and Tissue Deformation for Modeling Prostate Brachytherapy,” *American Brachytherapy Society (ABS) Annual Meeting*, Atlanta, GA, April 2010.
2. Sophie Barbe, Isabelle Andre, Juan Cortes, Ron Alterovitz, Vincent Lafaquiere, David Guieysse, Pierre Monsan, Magali Remaud-Simeon, and Thierry Simeon, “A Robotic-based Path Planning Approach for Computing Large-Amplitude Motions of Flexible Molecules,” *Fifteenth Meeting on Graphics and Molecular Modeling (GGMM)*, Grenoble, France, May 2007.
3. Michael Wehner, Ron Alterovitz, and Ken Goldberg, “Geometric Nonlinearity: Is it Important for Real-time FEM Surgical Simulation?,” *Medicine Meets Virtual Reality 14 (MMVR14)*, Long Beach, CA, Jan. 2006.
4. Ron Alterovitz, Etienne Lessard, Jean Pouliot, I-Chow Hsu, James F. O’Brien, and Ken Goldberg, “High-dose-rate Brachytherapy Dose Optimization for Prostate Cancer Using Linear Programming,” *Institute for Operations Research and the Management Sciences (INFORMS) Annual Meeting*, San Francisco, CA, Nov. 2005.

5. Ron Alterovitz, Yongbok Kim, John Kurhanewicz, Jean Pouliot, I-Chow Hsu, and Ken Goldberg, "Prostate MR Spectroscopy Image Registration Using Biomechanical Modeling of Tissue Deformations due to Endorectal Probe Insertion," *American Brachytherapy Society (ABS) 26th Annual Meeting*, San Francisco, CA, June 2005.
6. Ron Alterovitz, Ken Goldberg, John Kurhanewicz, Jean Pouliot, I-Chow Hsu, "Registering MR with MRS images for HDR prostate treatment using finite element modeling," *46th American Association of Physicists in Medicine (AAPM) Annual Meeting*, Pittsburgh, PA, July 2004.
7. Ron Alterovitz, Jean Pouliot, Richard Taschereau, I-Chow Hsu, and Ken Goldberg, "Modeling Seed Misplacement by Simulating Tissue Deformations," *American Brachytherapy Society (ABS) 24th Annual Meeting*, New York, NY, May 2003.
8. Ron Alterovitz, Jean Pouliot, Richard Taschereau, I-Chow Hsu, and Ken Goldberg, "Simulating Needle Insertion and Radioactive Seed Implantation for Prostate Brachytherapy," in *Medicine Meets Virtual Reality 11 (MMVR11)*, J.D. Westwood et al. (Eds.), IOS Press, Jan. 2003, pp. 19–25.

PATENTS

1. Robert J. Webster III, Allison M. Okamura, Noah J. Cowan, Gregory S. Chirikjian, Ken Goldberg, and Ron Alterovitz, "Distal bevel-tip needle control device and algorithm," United States Patent 7,822,458, Oct. 2010.

INVITED TALKS

1. *Case Western Reserve University*, Electrical Engineering and Computer Science Department, Cleveland, OH, Aug. 11, 2009.
2. *Carnegie Mellon University*, Robotics Institute, Pittsburgh, PA, June 17, 2008.
3. *Arizona State University*, Biomedical Informatics Department, Phoenix, AZ, May 22, 2008.
4. *Vanderbilt University*, Mechanical Engineering Department, Nashville, TN, Apr. 21, 2008.
5. *University of North Carolina at Chapel Hill*, Computer Science Department, Chapel Hill, NC, Mar. 17, 2008.
6. *Johns Hopkins University*, Center for Computer Integrated Surgical Systems and Technology Engineering Research (CISST ERC), Baltimore, MD, Mar. 5, 2008.
7. *University of California, Davis*, Center for Information Technology Research in the Interest of Society, Sacramento, CA, Jan. 18, 2008.
8. *Workshop on Algorithmic Motion Planning*, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), San Diego, CA, Oct. 29, 2007.
9. *University of California, Berkeley*, Electrical Engineering and Computer Sciences Department, Berkeley, CA, Oct. 11, 2007.
10. *LAAS-CNRS* (National Center for Scientific Research), Toulouse, France, Oct. 26, 2006.
11. *University of California, Irvine*, Computer Science Department, Irvine, CA, Apr. 25, 2006.

12. *University of California, Berkeley*, Industrial Engineering and Operations Research Department, Berkeley, CA, Oct. 28, 2005.
13. *Case Western Reserve University*, Electrical Engineering and Computer Science Department, Cleveland, OH, Aug. 18, 2005.
14. *Workshop on Medical Robotics and Welfare*, IEEE International Conference on Robotics and Automation (ICRA), Barcelona, Spain, Apr. 18, 2005.
15. *George Washington University*, Colloquium of the Institute for Biomedical Engineering, Washington, DC, Mar. 25, 2005.
16. *Johns Hopkins University*, Center for Computer Integrated Surgical Systems and Technology Engineering Research (CISST ERC), Baltimore, MD, Mar. 23, 2005.
17. *Workshop on Reality-Based Modeling of Tissues for Simulation and Robot-Assisted Surgery*, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Las Vegas, NV, Oct. 31, 2003.
18. *Workshop on Recent Advances in Medical Robotics*, IEEE International Conference on Robotics and Automation (ICRA), Taipei, Taiwan, Sept. 15, 2003.

PUBLICITY

1. "Teaching Medical Robots: Research aims to make robots smarter," *US News & World Report*, Nov. 2010. Available at: <http://www.usnews.com/science/articles/2010/11/22/teaching-medical-robots.html>

TEACHING AND COURSE DEVELOPMENT

Introduction to Robotics (COMP 590-099), Spring 2011. This new course provides undergraduate juniors and seniors with a hands-on introduction to robotics, with an emphasis on the computational and algorithmic aspects. Topics include robot kinematics, actuation, sensing, control, motion planning, and applications to personal assistance, autonomous vehicles, medical surgery, manufacturing, and other areas. In addition to traditional lectures, students have the opportunity to design, program, and test increasingly complex LEGO-based mobile robots, culminating in an end-of-semester robot contest.

Motion Planning in Real and Virtual Worlds (COMP 790-099), Spring 2010. This course introduces graduate students to the current state-of-the-art and challenges in computing motions for robots and characters in real and virtual worlds. Topics include path planning for autonomous agents/robots, computing motion policies in uncertain environments, the theoretical underpinnings of motion planning, and applications to surgical planning, autonomous vehicles, graphics, games, and other areas. The course includes lectures, discussions on current research challenges, mathematical problem sets, programming assignments, and a course project.

Robotics (COMP 790-099), Fall 2009, Fall 2010. This course introduces graduate students to the programming and control of robotic systems. Topics include kinematics, actuation, sensing, manipulation, control, and motion planning. We discuss applications including industrial, mobile, and medical robotics. The course includes lectures, mathematical problem sets, programming assignments, and a course project.

Recent Advances in Medical Robotics and Simulation (COMP 790-099), Spring 2009. This new graduate seminar covers recent research and open problems in medical robotics and physically-based simulation of medical procedures. Lectures discuss medical robotics systems, image-guided motion planning for medical devices, tissue modeling, and surgery simulation. In addition, students present recent papers and undertake projects in medical robotics and simulation.

PROFESSIONAL ACTIVITIES AND SERVICE

PROFESSIONAL ACTIVITIES

- 2010 *Co-Organizer*, Workshop on Medical Cyber-Physical Systems, collocated with the IEEE International Conference on Robotics and Automation (ICRA), Anchorage, AK. The workshop featured speakers from academia as well as industry (Intuitive Surgical, Inc.). Attended by over 50 international researchers.
- 2009-present *Co-Chair*, Technical Committee on Algorithms for Planning and Control of Robot Motion, IEEE Robotics and Automation Society
- 2008–2010 *Co-Chair*, Technical Committee on Surgical Robotics, IEEE Robotics and Automation Society
- 2008 *Co-organizer*, Workshop, Medical Needle Steering: Recent Results and Future Opportunities, selected for inclusion in the 11th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI), New York, NY
- 2008 *Invited Participant*, NSF / CCC / CRA Roadmapping for Robotics Workshop: A Research Roadmap for Medical and Healthcare Robotics, Arlington, VA. Results of this workshop were presented to US government agencies.
- 2008, 2011 *Program Committee*, Robotics: Science and Systems Conference (RSS)
- 2011 *Associate Editor*, IEEE International Conference on Robotics and Automation (ICRA)
- 2005–2010 *Associate Editor*, Medical Physics, the scientific journal of the American Association of Physicists in Medicine

TECHNICAL REVIEWS

- International Journal of Robotics Research (IJRR)
- IEEE Transactions on Robotics
- IEEE Transactions on Information Technology in Biomedicine
- IEEE Transactions on Biomedical Engineering
- IEEE/ASME Transactions on Mechatronics
- Mathematics of Operations Research
- Medical Image Analysis Journal
- Medical Physics
- Computer Aided Surgery
- Robotics: Science and Systems Conference (RSS)
- Workshop on the Algorithmic Foundations of Robotics (WAFR)

Second International Symposium on Medical Simulation
IEEE International Conference on Robotics and Automation (ICRA)
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
IEEE Visualization
Medical Image Computing and Computer Assisted Interventions Conference (MICCAI)

MEMBERSHIPS

IEEE Robotics and Automation Society, Sigma Xi, Tau Beta Pi

UNIVERSITY SERVICE

Facilities and Web Committee, Department of Computer Science, University of North Carolina, Chapel Hill, Fall 2009 – Spring 2011.

Faculty Search Committee, Curriculum in Applied Sciences and Engineering (CASE), University of North Carolina, Chapel Hill, Spring 2009.

Graduate Admissions Committee, Department of Computer Science, University of North Carolina, Chapel Hill, Spring 2009.

Graduate Study Committee, Advisor to the Dean of the College of Engineering on graduate programs and course changes, University of California, Berkeley, 2005–2006.