

Mor Harchol-Balter

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RESEARCH AREAS

Design and performance analysis of computer systems including both theory and implementation:

Theoretical work: Queueing behavior and stochastic analysis of resource allocation in distributed computer systems. Load sharing policies, routing policies, cycle stealing, threshold policies, and multi-class prioritization. Fairness metrics in scheduling. Analysis using heavy-tailed workloads.

Systems implementation end: Kernel-level connection scheduling in Web servers. Solutions for coping with transient overload in Web servers. QoS for e-commerce applications involving the backend database. Prioritization mechanisms for OLTP transactions in database servers involving lock-queue reordering. Job scheduling in supercomputing centers and auction-based scheduling for the TeraGrid. Power management in server farms.

Workload characterization: Statistical characterization of workload including web, OLTP, and supercomputing workloads. Effects of heavy tails in workloads. Characterization of power usage of applications.

EMPLOYMENT

2008 - pres Associate Department Head for Graduate Education.

Computer Science Department, Carnegie Mellon University.

2004 - 2008 McCandless Associate Professor. Computer Science Department. Carnegie Mellon University.

1999-2004 McCandless Assistant Professor. Computer Science Department. Carnegie Mellon University.

1996-1999 NSF Postdoctoral Fellow. Massachusetts Institute of Technology.

Funded by: NSF Postdoctoral Fellowship in the Mathematical Sciences. Mentor: Prof. Tom Leighton.

EDUCATION

1990-1996 University of California, Berkeley.

Ph.D. in Computer Science, August 1996.

Thesis: *Network Analysis without Exponentiality Assumptions*.

Advisor: Prof. Manuel Blum. Committee: Manuel Blum, Sheldon Ross, Venkat Anantharam.

1984-1988 Brandeis University, Waltham, Massachusetts.

B.A. in Computer Science and Mathematics, May 1988.

Thesis: *Evaluation of Data Encryption Standard Using Walsh-Hadamard Matrix Factorization*.

Advisor: Prof. Martin Cohn.

HONORS

2009 Invited Speaker: Columbia Applied Probability Day 2009.

2008 Keynote Speaker: MASCOTS 2008.

2008 Keynote Speaker: SIPEW 2008.
 2007 Program co-Chair ACM SIGMETRICS 2007.
 2007 Program co-Chair QEST 2007.
 2007 Plenary Speaker: Annual Lunteren Conference.
 2007 Keynote Speaker: ORSIS 2007.
 2006 Plenary Speaker at Carnegie Mellon 50 Year Anniversary Symposium.
 2005-2007 Elected Secretary/Treasurer of ACM Sigmetrics.
 2005 Invited to IFIP 7.3 WG on Computer Performance Modeling and Analysis.
 2003 Herbert A. Simon Award for Teaching Excellence, Carnegie Mellon University.
 2003 ACM SIGMETRICS Best Student Paper Award.
 2003 International Teletraffic Congress Best Student Paper Award.
 2001 NSF CAREER Award.
 2001-2008 Anna McCandless Chair for Career Development, Carnegie Mellon University.
 1996-1999 NSF Mathematical Sciences Postdoctoral Fellowship.
 1996 ACM SIGMETRICS Best Paper Award for Integrating Systems and Theory.
 1990-1996 6-year National Physical Science Consortium Fellowship for Women and Minorities.
 1995 Demetri Angelakos Altruism Award, U.C. Berkeley.
 1994 Outstanding Graduate Student Instructor Award, Campus-Wide, U.C. Berkeley.
 1994 EECS Graduate Student Instructor of the Year Award, U.C. Berkeley.
 1994 Teaching Effectiveness Award, Campus-Wide, U.C. Berkeley.
 1990 Awarded National Science Foundation Graduate Fellowship.
 1990 Awarded Office of Naval Research Graduate Fellowship.
 1988 Mitchom Prize in Computer Science, Brandeis University.
 1988 Graduated Summa Cum Laude, Brandeis University.
 1988 Undergraduate Thesis Highest Honors, Brandeis University.
 1987 Phi Beta Kappa.
 1984-1988 Brandeis University 4-year Merit Scholarship.
 1984-1988 Lulu T. Briggs 4-year Scholarship.
 1984 Valedictorian South Brunswick High School, New Jersey.

PUBLICATIONS

Books in progress

[01] Mor Harchol-Balter. "Performance Analysis and Design of Computer Systems." *Based on Lecture Notes from 15-849a,b classes at Carnegie Mellon University*. These notes are available on the web by password access. Over 2000 researchers world-wide have requested access.

Thesis

[96] Mor Harchol-Balter. "Network Analysis without Exponentiality Assumptions." *Ph.D. Thesis*. University of California, Berkeley, December 1996.

Guest Editor

[07] Mor Harchol-Balter. "New Perspectives on Scheduling." *ACM Performance Evaluation Review, Special Issue*, vol. 34, no. 4, March 2007. Guest editor: Mor Harchol-Balter.

Chapters in Books

- [99] Mor Harchol-Balter and Allen Downey. “Exploiting Process Lifetime Distributions for Load Balancing.” Book chapter in *Mobility: Processes, Computers and Agents (ACM Press Series)*, edited by Dejan Milojicic, Fred Douglass, and Richard Wheeler. Addison-Wesley Publishing Company and the ACM Press, April 1999, pp. 229-259.
- [97] Earlier version appeared in: *ACM Transactions on Computer Systems*, vol. 15, no. 3, August 1997, pp. 253-285.
- [96] Earlier version appeared in: *Proceedings of ACM SIGMETRICS '96 Conference on Measurement and Modeling of Computer Systems*, May 1996, Philadelphia, PA, pp. 13-24. Winner of **Best Paper Award for Integrating Systems and Theory**.
- [95] Much earlier version appeared in: *Fifteenth ACM Symposium on Operating Systems Principles (SOSP) Poster Session*, Copper Mountain, CO, December 1995.

Refereed Journal Papers

- [09] Varun Gupta, Mor Harchol-Balter, Jim Dai, and Bert Zwart. “On the Inapproximability of M/G/k: Why Two Moments of Job Size Distribution are Not Enough.” To appear in *Queueing Systems: Theory and Applications*, 2009.
- [09] Harchol-Balter. “Queueing Disciplines.” *Wiley Encyclopedia Of Operations Research and Management Science*, 2009.
- [08] Atul Bhandari, Alan Scheller-Wolf, and Mor Harchol-Balter. “An Exact and Efficient Algorithm for the Constrained Dynamic Operator Staffing Problem for Call Centers.” *Management Science*, vol. 54, no. 2, February 2008.
- [07] Varun Gupta, Mor Harchol-Balter, Karl Sigman, and Ward Whitt. “Analysis of Join-the-Shortest-Queue Routing for Web Server Farms.” *Performance Evaluation*, vol. 64, no. 9-12, October 2007.
- [07] Earlier version appeared in *IFIP 7.3 International Symposium on Computer Performance, Modeling, Measurements, and Evaluation (Performance 2007)*, Cologne, Germany, October 2007.
- [06] Robert C. Hampshire, Mor Harchol-Balter, and William A. Massey. “Fluid and Diffusion Limits for Transient Sojourn Times of Processor Sharing Queues with Time Varying Rates.” *Queueing Systems: Theory and Applications journal (QUESTA)*, vol. 53, no. 1/2, June 2006, pp. 19 - 30.
- [06] Takayuki Osogami and Mor Harchol-Balter. “Closed Form Solutions for Mapping General Distributions to Quasi-Minimal PH Distributions.” *Performance Evaluation*, vol. 63(6), pp. 524-552 (2006). (Special Issue for best papers of Tools03).
- [03] Earlier version appeared as: “A Closed-Form Solution for Mapping General Distributions to Minimal PH Distributions.” *Lecture Notes in Computer Science 2794: The 13th International Conference on Modeling Techniques and Tools for Computer Performance Evaluation (Tools 03)*. Urbana, Illinois, September 2003, pp. 200 - 217. **Selected as one of best papers**.
- [06] Bianca Schroeder and Mor Harchol-Balter. “Web Servers under Overload: How Scheduling can Help.” *ACM Transactions on Internet Technologies*, vol. 6, no. 1, February, 2006, pp. 20-52.
- [03] Earlier version appeared in *Teletraffic Science and Engineering: Providing QoS in Heterogeneous Environments*, Elsevier publisher, vol. 5a, 2003. Based on *Proceedings of the 18th International Teletraffic Congress*, Berlin, Germany, September, 2003, pp. 171-180. Winner of **International Teletraffic Congress Best Student Paper Award**.
- [06] Adam Wierman, Takayuki Osogami, Mor Harchol-Balter, Alan Scheller-Wolf. “How Many Servers are Best in a Dual-Priority M/PH/k System?” *Performance Evaluation*, vol. 63, no. 12, 2006, pp. 1253-1272.

- [05] Mor Harchol-Balter, Takayuki Osogami, Alan Scheller-Wolf, and Adam Wierman. “Multi-Server Queuing Systems with Multiple Priority Classes.” *Queueing Systems: Theory and Applications journal (QUESTA)*, vol. 51, no.3-4, 2005, pp. 331-360.
- [05] Takayuki Osogami, Mor Harchol-Balter, and Alan Scheller-Wolf. “Analysis of Cycle Stealing with Switching Cost and Thresholds.” *Performance Evaluation*, vol. 61, no. 4, 2005, pp. 347-369.
- [03] Earlier version appeared as: “Analysis of Cycle Stealing with Switching Cost.” *Proceedings of ACM Sigmetrics 2003 Conference on Measurement and Modeling of Computer Systems*. San Diego, CA. June 2003, pp. 184-195.
- [04] Bianca Schroeder and Mor Harchol-Balter. “Evaluation of Task Assignment Policies for Supercomputing Servers: The Case for Load Unbalancing and Fairness.” Invited to *Cluster Computing*, vol. 7, no. 2, April 2004, pp. 151-161.
- [00] Earlier version appeared in: *Proceedings of 9th IEEE Symposium on High Performance Distributed Computing (HPDC '00)*, Pittsburgh, PA, August 2000.
- [04] Adam Wierman, Nikhil Bansal, Mor Harchol-Balter. “A Note on Comparing Response Times in M/GI/1/FB and M/GI/1/PS Queues.” *Operations Research Letters*, vol. 32, no. 1, January 2004, pp. 73-76.
- [03] Mor Harchol-Balter, Bianca Schroeder, Nikhil Bansal, and Mukesh Agrawal. “Size-based Scheduling to Improve Web Performance.” *ACM Transactions on Computer Systems*, vol. 21, no. 2, May 2003, pp. 207-233.
- [02] Mor Harchol-Balter. “Task Assignment with Unknown Duration.” *Journal of the ACM*, vol. 49, no. 2, March 2002, pp. 260-288.
- [00] Earlier version appeared in: *20th International Conference on Distributed Computing Systems (ICDCS '00)* Taipei, Taiwan, April 2000, pp. 214-223.
- [02] Mor Harchol-Balter, Karl Sigman, and Adam Wierman. “Asymptotic Convergence of Scheduling Policies with Respect to Slowdown.” *Performance Evaluation*, vol. 49, no. 1-4, 2002, pp. 241-256.
- [02] Earlier version appeared in: *IFIP 7.3 International Symposium on Computer Performance, Modeling, Measurements, and Evaluation (Performance 2002)*, Rome, Italy, September 2002.
- [00] Matthew Andrews, Antonio Fernandez, Mor Harchol-Balter, Tom Leighton, Lisa Zhang. “General Dynamic Routing with Per-Packet Delay Guarantees of $O(\text{distance} + 1/\text{session rate})$.” *SIAM Journal on Computing*, vol. 30, no. 5, 2000, pp. 1594-1623.
- [97] Earlier version appeared in: *Proceedings of the 38th IEEE Symposium on Foundations of Computer Science (FOCS 97)*, Miami, FL, October 1997, pp. 294-303.
- [99] Mor Harchol-Balter, Mark Crovella, Cristina Murta. “On Choosing a Task Assignment Policy for a Distributed Server System.” *IEEE Journal of Parallel and Distributed Computing*, vol. 59, 1999, pp. 204-228.
- [98] Earlier version appeared in: *Lecture Notes in Computer Science, No. 1469: 10th International Conference on Modeling Techniques and Tools for Computer Performance Evaluation*, September 1998, pp. 231-242.

Refereed Conference Papers (not overlapping with above)

- [09] Anshul Gandhi, Mor Harchol-Balter, Rajarshi Das, Jeff Kephart, and Charles Lefurgy. “Power Capping Via Forced Idleness.” *Workshop on Energy-Efficient Design (WEED 09)*, Austin, Texas, June 2009.
- [09] Mor Harchol-Balter, Alan Scheller-Wolf, and Andrew Young. “Surprising Results on Task Assignment in Server Farms with High-Variability Workloads.” *Proceedings of ACM Sigmetrics 2009 Conference on Measurement and Modeling of Computer Systems*, Seattle, WA. June 2009.

- [09] Anshul Gandhi, Mor Harchol-Balter, Rajarshi Das, and Charles Lefurgy. "Optimal Power Allocation in Server Farms." *Proceedings of ACM Sigmetrics 2009 Conference on Measurement and Modeling of Computer Systems*, Seattle, WA. June 2009.
- [09] Varun Gupta and Mor Harchol-Balter. "Self-Adaptive Admission Control Policies for Resource-Sharing Systems." *Proceedings of ACM Sigmetrics 2009 Conference on Measurement and Modeling of Computer Systems*, Seattle, WA. June 2009.
- [06] Chang Woo Yang, Adam Wierman, Sanjay Shakkottai, and Mor Harchol-Balter. "Tail Asymptotics for Policies Favoring Short Jobs in a Many-Flows Regime." *Proceedings of ACM Sigmetrics 2006 Conference on Measurement and Modeling of Computer Systems*, Saint Malo, France. June 2006, pp. 97-108.
- [06] Varun Gupta, Mor Harchol-Balter, Alan Scheller-Wolf, and Uri Yechiali. "Fundamental Characteristics of Queues with Fluctuating Load." *Proceedings of ACM Sigmetrics 2006 Conference on Measurement and Modeling of Computer Systems*, Saint Malo, France. June 2006, pp. 203-215.
- [06] Bianca Schroeder, Adam Wierman, and Mor Harchol-Balter. "Closed versus Open System Models: a Cautionary Tale." *Proceedings of Networked Systems Design and Implementation (NSDI 2006)*, San Jose, CA. May 2006. pp. 239-252.
- [06] Bianca Schroeder, Mor Harchol-Balter, Arun Iyengar, Erich Nahum, and Adam Wierman. "How to Determine a Good Multi-Programming Level for External Scheduling." *22nd International Conference on Data Engineering (ICDE 2006)*, Atlanta, Georgia, April 2006.
- [06] Bianca Schroeder, Mor Harchol-Balter, Arun Iyengar, Erich Nahum. "Achieving Class-Based QoS for Transactional Workloads." Poster paper in *22nd International Conference on Data Engineering (ICDE 2006)*, Atlanta, Georgia, April 2006.
- [05] Adam Wierman, Mor Harchol-Balter, and Takayuki Osogami. "Nearly Insensitive Bounds on SMART Scheduling." *Proceedings of ACM Sigmetrics 2005 Conference on Measurement and Modeling of Computer Systems (SIGMETRICS 05)*, Banff, Canada, June 2005, pp. 205-216.
- [04] Earlier version appeared in: Adam Wierman and Mor Harchol-Balter. "Formalizing SMART Scheduling." *6th Workshop on Mathematical Performance Modeling and Analysis (MAMA 2004)*, New York City, June 2004.
- [05] Adam Wierman and Mor Harchol-Balter. "Classifying Scheduling Policies with Respect to Higher Moments of Conditional Response Time." *Proceedings of ACM Sigmetrics 2005 Conference on Measurement and Modeling of Computer Systems (SIGMETRICS 05)*, Banff, Canada, June 2005, pp. 229-240.
- [05] Mor Harchol-Balter, Takayuki Osogami, and Alan Scheller-Wolf. "Robustness of Threshold Policies in Beneficiary-Donor Model." *ACM Performance Evaluation Review*, vol. 33, no.2, 2005.
- [05] David McWherter, Bianca Schroeder, Natassa Ailamaki, and Mor Harchol-Balter. "Improving Preemptive Prioritization via Statistical Characterization of OLTP Locking." *Proceedings of the 21st International Conference on Data Engineering (ICDE 2005)*, San Francisco, CA, April 2005.
- [04] Takayuki Osogami, Mor Harchol-Balter, Alan Scheller-Wolf, and Li Zhang. "Exploring Threshold-based Policies for Load Sharing." *Forty-second Annual Allerton Conference on Communication, Control, and Computing*, University of Illinois, Urbana-Champaign, October, 2004, pp. 1012-1021.
- [04] Takayuki Osogami, Adam Wierman, Mor Harchol-Balter, Alan Scheller-Wolf. "A Recursive Analysis Technique for Multi-Dimensionally infinite Markov Chains." *ACM Performance Evaluation Review*, vol. 32, no. 2, 2004.
- [04] David McWherter, Bianca Schroeder, Natassa Ailamaki, and Mor Harchol-Balter. "Priority Mechanisms for OLTP and Transactional Web Applications." *20th International Conference on Data Engineering (ICDE 2004)*, Boston, MA, April 2004, pp. 535-546.

- [03] Takayuki Osogami and Mor Harchol-Balter. "Necessary and Sufficient Conditions for Representing General Distributions by Coxians." *Lecture Notes in Computer Science 2794. 13th International Conference on Modeling Techniques and Tools for Computer Performance Evaluation (Tools 03)*, Urbana, Illinois, September 2003, pp. 182-199. **Selected as one of best papers.**
- [03] Mor Harchol-Balter, Cuihong Li, Takayuki Osogami, Alan Scheller-Wolf, and Mark Squillante. "Cycle Stealing under Immediate Dispatch Task Assignment." *Fifteenth ACM Annual Symposium on Parallel Algorithms and Architectures*, San Diego, CA, June, 2003, pp. 274-285.
- [03] Adam Wierman and Mor Harchol-Balter. "Classifying Scheduling Policies with respect to Unfairness in an M/GI/1." *Proceedings of ACM Sigmetrics 2003 Conference on Measurement and Modeling of Computer Systems*, San Diego, CA. June 2003, pp. 238-249. Winner of **Sigmetrics Best Student Paper Award.**
- [03] Mor Harchol-Balter, Cuihong Li, Takayuki Osogami, Alan Scheller-Wolf, Mark Squillante. "Task Assignment with Cycle Stealing under Central Queue." *23rd International Conference on Distributed Computing Systems (ICDCS '03)*, Providence, RI, May 2003, pp. 628 - 637.
- [01] Nikhil Bansal and Mor Harchol-Balter. "Analysis of SRPT Scheduling: Investigating Unfairness." *Proceedings of ACM Sigmetrics '01 Conference on Measurement and Modeling of Computer Systems (SIGMETRICS '01)*, June 2001, Cambridge, MA, pp. 279-290.
- [01] Mor Harchol-Balter. "Job Placement with Unknown Duration and No Preemption" *ACM Performance Evaluation Review*, vol. 28, no. 4, March 2001. Invited paper.
- [01] Nikhil Bansal and Mor Harchol-Balter. "Approximate Analysis of M/G/1/PS and M/G/1/SRPT under Transient Overload." *ACM Performance Evaluation Review*, vol 29, no. 3, December, 2001. Extended version available as Technical report Number CMU-CS-01-134.
- [01] Mor Harchol-Balter, Nikhil Bansal, Bianca Schroeder. "SRPT Scheduling for Web Servers." (invited paper) *Lecture Notes in Computer Science, No. 2221. 7th International Workshop, Job Scheduling Strategies for Parallel Processing*, Cambridge, MA, June 2001, pp. 11-20.
- [99] Mark Crovella, Bob Frangioso, and Mor Harchol-Balter. "Connection Scheduling in Web Servers." *USENIX Symposium on Internet Technologies and Systems (USITS '99)*, Boulder, Colorado, October 1999, pp. 243-254.
- [99] Mor Harchol-Balter, Tom Leighton, and Daniel Lewin. "Resource Discovery in Distributed Networks." *18th Annual ACM SIGACT-SIGOPS Symposium on Principles of Distributed Computing (PODC '99)*, Atlanta, May 1999, pp. 229-238.
- [99] Mor Harchol-Balter. "The Effect of Heavy-Tailed Job Size Distributions on Computer System Design." *Proceedings of the ASA-IMS Conference on Applications of Heavy Tailed Distributions in Economics, Engineering and Statistics*, Washington, DC, June 1999.
- [98] Mark Crovella, Mor Harchol-Balter, Cristina Murta. "Task Assignment in a Distributed System: Improving Performance by Unbalancing Load." *Proceedings of ACM Sigmetrics '98 Conference on Measurement and Modeling of Computer Systems (SIGMETRICS) Poster Session*, June 1998, Madison, WI, pp. 268-269.
- [95] Mor Harchol-Balter and David Wolfe. "Bounding Delays in Packet-Routing Networks." *Proceedings of the 27th Annual ACM Symposium on the Theory of Computation*, Las Vegas, May 1995, pp. 248-275.
- [94] Peter Gemmel and Mor Harchol. "Tight Bounds on Expected Time to Add Correctly and Add Mostly Correctly." *Information Processing Letters*, vol.49, January 1994, pp. 77-83.
- [94] Micah Adler, Peter Gemmel, Mor Harchol-Balter, Richard M. Karp, Claire Kenyon. "Selection in the Presence of Noise: The Design of Playoff Systems." *Proceedings of the Fifth Annual ACM-SIAM Symposium on Discrete Algorithms*, Arlington, VA, January 1994, pp. 564-572.

- [94] Mor Harchol-Balter and Paul E. Black. "Queueing analysis of oblivious packet-routing algorithms." *Proceedings of the Fifth Annual ACM-SIAM Symposium on Discrete Algorithms*, Arlington, VA, January 1994, pp. 583-592.

Technical reports (not overlapping with above)

- [98] Mor Harchol-Balter, Mark Crovella, SungSim Park. "The Case for SRPT Scheduling in Web Servers." MIT-LCS-TR-767, October 1998.
- [97] Mor Harchol-Balter, Mark Crovella, Cristina Murta. "To Queue or Not to Queue: When Queueing is Better Than Timesharing in a Distributed System." BUCS-TR-1997-017, October 1997.
- [95] Mor Harchol-Balter. "Bounding Delays in Packet-Routing Networks with Light Traffic." University of California at Berkeley Computer Science Division Tech Report Number UCB/CSD-95-885. October 1995.
- [95] Allen Downey and Mor Harchol-Balter. "A Note on 'The Limited Performance Benefits of Migrating Active Processes for Load Balancing'." University of California at Berkeley Computer Science Division Tech Report Number UCB/CSD-95-888, November 1995.
- [94] Mor Harchol-Balter and David Wolfe. "In Network of Queues, M/M/1 Can Outperform M/D/1." University of California at Berkeley Computer Science Division Tech Report Number UCB/CSD-94-841, November 1994.

Patents Issued

- [01] Mor Harchol-Balter and Mark Crovella. "Method and Apparatus for Assigning Tasks in a Distributed Server System." U.S. Patent Serial No. 6/223/205. Issued January, 2001.

Patents Pending

- [05] Arun Iyengar, Erich Nahum, Bianca Schroeder, and Mor Harchol-Balter. "Method and Apparatus for Dynamically Scheduling Requests." U.S. patent application Serial No. 10/804,516, filed on March 19, 2004, and executed on February 16, 2005.
- [01] Mor Harchol-Balter and Tom Leighton and Daniel Lewin. "Resource Discovery in Distributed Networks." U.S. Patent Pending No. 60/135/473, filed May 1999. *Licensed to Akamai Technologies, Inc.*

TALKS

- Sep 2009 "Why Segregating Short Jobs From Long Ones Under High Variability Is Not Always a Win." Allerton 2009 Conference talk, Urbana, Illinois.
- July 2009 "Surprising Results on Task Assignment with High-Variability Workloads." INFORMS Applied Probability Society, Ithaca, NY.
- July 2009 "Surprising Results on Task Assignment with High-Variability Workloads." Columbia Applied Probability Day, Columbia University, NY. Invited by: Karl Sigman.
- June 2009 "Surprising Results on Task Assignment with High-Variability Workloads." SIGMETRICS 2009 conference talk.
- Sep 2008 "Scheduling for Server Farms: Approaches and Open Problems." Keynote talk, MASCOTS 2008, Baltimore, MD. Invited by: Carey Williamson and Ethan Miller.
- Jul 2008 "Immigration and Emigration at CMU." CRA-Snowbird conference. Invited by: Kim Bruce and Hank Korth.
- Jun 2008 "Scheduling for Server Farms: Approaches and Open Problems." Keynote talk, SIPEW 2008, Darmstadt, Germany. Invited by: Kai Sachs.

- May 2008 “Analysis of Join-the-Shortest-Queue Scheduling.” Hisashi Kobayashi Retirement Workshop. Princeton University. Invited by: Brian Mark.
- Oct 2007 “What Performance Modeling Teaches us About Computer System Design.”
Craw Distinguished Lecture Series Speaker. Ohio State University. Host: Bettina Bair.
- Jun 2007 “Analysis of Scheduling in Server Farms.”
Mathematics Department, University of San Diego. Host: Ruth Williams.
- May 2007 “Analysis of Scheduling in Server Farms.”
Keynote Speaker, Operations Research Society of Israel (ORSIS) Conference.
- Apr 2007 “Analyzing Multi-Server Systems with Dependencies:
Cycle Stealing, Priority Queueing, Affinity Scheduling, and More.”
Computer Science Department, Stanford University. Host: Balaji Prabhakar.
- Apr 2007 “Analysis of Web Server Farms with Join-the-Shortest-Queue Routing.”
Operations Research Group, Stanford University. Host: Balaji Prabhakar.
- Mar 2007 “Auction-Based Scheduling of the TeraGrid.”
CMU/Pitt/Intel Workshop on Next-Generation Computing. Host: Peter Lee.
- Jan 2007 “Analysis of Scheduling in Server Farms.”
Plenary Speaker, Lunteren Conference, Netherlands.
- Jan 2007 “Works-in-Progress: From Web Server Farms to Limited Resource Sharing.”
EURANDOM, Netherlands. Host: Onno Boxma.
- Sep 2006 “What Performance Modeling Teaches Us About Computer Systems Design.”
CMU Student Theory Lunch.
- Aug 2006 “Analysis of Scheduling in Server Farms.”
Invited talk. IBM Watson Research Labs. Hosts: Asser Tantawi and Mark Squillante.
- Jul 2006 “What Performance Modeling Teaches us about Computer Systems Design.”
Invited talk. Microsoft Research, Redmond, WA. Hosts: Jennifer Chayes and Ken Church.
- Jun 2006 “Analysis of Scheduling in Server Farms.”
Invited tutorial. Sigmetrics 2006, San Malo, France. Host: Thomas Bonald.
- May 2006 “Nearly Insensitive Bounds on SMART Scheduling.”
Invited talk at Uri Yechiali’s retirement workshop, Shefayim, Israel.
- Apr 2006 “Task Assignment for Server Farms.”
Guest lecturer in Satya’s class, CMU.
- Apr 2006 “What Performance Modeling Teaches Us About Computer Systems Design.”
CS 50 Anniversary Celebration, CMU.
- May 2006 “Dimensionality Reduction Analysis of Cycle Stealing, Priority Queueing and More.”
Microsoft, Cambridge, England. Host: Dushyanth Narayanan.
- Mar 2006 “Dimensionality Reduction Analysis of Cycle Stealing, Threshold Policies and More.”
Imperial College, London, England. Host: Peter Harrison.
- Jan 2006 “Dimensionality Reduction Analysis of Cycle Stealing, Threshold Policies and More.”
University of California, Berkeley. Host: Rhonda Righter.
- Sep 2005 “Scheduling Your Network Connections (the SYNC Project).”
Polytechnic University, NYC. Host: Keith Ross and Torsten Suel.
- Jul 2005 “Nearly Insensitive Bounds on SMART Scheduling.”
INFORMS Applied Probability conference, Ottawa, Canada.
- June 2005 “Robustness of Threshold Policies in Beneficiary-Donor Model.”
MAMA Workshop, Banff, Canada.
- Jun 2005 “Nearly Insensitive Bounds on SMART Scheduling.”
ACM Sigmetrics Conference, Banff, Canada.
- Feb 2005 “Recursive Dimensionality Reduction Applied to the Analysis of Multiserver Scheduling.”
Lehigh University. Host: Andrew Ross.
- Feb 2005 “New Recursive Dimensionality Reduction Techniques Applied to the Analysis of Multiserver Scheduling.”
Columbia University – Industrial Engineering and Operations Research department. Host: Cliff Stein.
- Feb 2005 “Scheduling Your Network Connections (the SYNC Project).”
Columbia University – CS department. Host: Vishal Misra.
- Feb 2005 “Recursive Dimensionality Reduction Applid to the Analysis of Multiserver Scheduling.”

- University of Pittsburgh – Industrial Engineering and Operations Research department. Host: Jay Rajgopal.
- Dec 2004 “New Recursive Dimensionality Reduction Techniques Applied to the Analysis of Multiserver Scheduling.”
Tel Aviv University – Mathematics department. Host: Uri Yechiali.
- Dec 2004 “Scheduling Your Network Connections (the SYNC Project).”
Tel Aviv University – CS department. Host: Hanoch Levy.
- Jul 2004 “New Recursive Dimensionality Reduction Techniques Applied to the Analysis of Multiserver Scheduling including Cycle Stealing, Priority Queueing, and Threshold Policies”
Invited speaker. Stochastic Networks Conference, Montreal, Canada.
- Jul 2004 “New Recursive Dimensionality Reduction Techniques Applied to the Analysis of Multiserver Scheduling including Cycle Stealing, Priority Queueing, and Threshold Policies.”
MIT – EECS and LIDS departments. Host: Charles Leiserson.
- Jul 2004 “Scheduling Your Network Connections (the SYNC Project).”
MIT – EECS and LIDS departments. Host: Dina Katabi.
- Jun 2004 “New Recursive Dimensionality Reduction Techniques Applied to the Analysis of Multiserver Scheduling including Cycle Stealing, Priority Queueing, and Threshold Policies.”
Invited talk. EURANDOM. Eindhoven, Netherlands. Host: Onno Boxma.
- Jun 2004 “Exact closed-form analysis of Queues with Fluctuating Load.”
Invited talk. EURANDOM. Eindhoven, Netherlands. Host: Geert-jan van Houtum.
- Nov 2003 “Scheduling Static and Dynamic Web Requests.”
Invited talk. Microsoft Research. Host: John Dunagan.
- Nov 2003 “Scheduling Your Network Connections (the SYNC Project).”
Invited talk. University of Washington. Host: Susan Eggers.
- Nov 2003 “Task Assignment Policies for Server Farms: Including New Analysis of Cycle Stealing.”
Invited talk. University of Washington. Host: Susan Eggers.
- Oct 2003 “Scheduling Your Network Connections (the SYNC Project).”
Invited talk. Brown University. Host: Anna Lysyanskaya.
- Oct 2003 “Task Assignment Policies for Server Farms: Including New Analysis of Cycle Stealing.”
Invited talk. Brown University. Host: Anna Lysanskaya.
- Jul 2003 “Scheduling in Multiserver Systems.”
Talk at Aladdin SITE Review.
- Jun 2003 “Applying to Graduate School in Computer Science.”
Talk at Aladdin first College Workshop.
- May 2003 “Task Assignment Policies for Server Farms: Including New Analysis of Cycle Stealing.”
Invited talk. EMC² Corporation. Hosts: Peter Lauterbach, Ric Wheeler.
- Apr 2003 “Scheduling Static and Dynamic Web Requests.”
Invited talk. IBM T.J. Watson Research Lab. Host: Arun Iyengar.
- Nov 2002 “Load balancing algorithms in Networks of Workstations.”
Invited talk. Carnegie Mellon, Concert Group Meeting. Host: Karl Crary.
- Oct 2002 “Reduction of 2D-infinite Markov Chains to 1D-infinite Markov Chains.”
Invited talk. Carnegie Mellon, Aladdin Meeting. Host: Guy Blelloch.
- Jun 2002 “Task Assignment with Immediate Dispatch.”
SPAA 03 Conference.
- May 2002 “Task Assignment with Cycle Stealing under Central Queue.”
ICDCS 03 Conference.
- Jul 2002 “Investigating Unfairness in Scheduling Algorithms.”
Invited talk. Conference on Stochastic Networks. Stanford University.
- Jul 2002 “Scheduling Your Network Connections.”
Invited talk. Computer Science Seminar. University of California Berkeley. Host: Matt Welsh.
- Nov 2001 “Scheduling Your Network Connections.”
Invited talk. Computer Networking Seminar. Caltech University. Host: Steven Low.
- Sep 2001 “Scheduling Your Network Connections.”
Invited talk. Computer Systems Seminar. University of Illinois Urbana-Champaign. Host: Michael Loui.
- Sep 2001 “Scheduling Solutions for Coping with Transient Overload.”
Invited talk. Communications Seminar. University of Illinois Urbana-Champaign. Host: Michael Loui.

- Jun 2001 “Scheduling Your Network Connections.”
LIRMM – Laboratoire d’Informatique, de Robotique et de Microelectronique de Montpellier, France.
Host: Alain Jean-Marie.
- Jun 2001 “Scheduling Your Network Connections.”
Invited talk. Instituto Superior Tecnico, Lisbon. Host: Carlos Filipe Gomes Bisbo.
- Jun 2001 “Task Assignment with Unknown Duration.”
Invited talk. Instituto Superior Tecnico, Lisbon. Host: Carlos Filipe Gomes Bisbo.
- Jun 2001 “Analysis of M/G/1/PS and M/G/1/SRPT under Transient Overload.”
Invited talk at 3rd Workshop on Mathematical performance Modeling and Analysis (MAMA 2001).
Invited by: Mark Squillante.
- Jun 2001 “Scheduling Your Network Connections.”
M.I.T. Lab for Computer Science. Hosts: Vincent Chen and John Guttag.
- Jun 2001 “How Heavy Tails Impact Job Scheduling.”
Invited talk at Job Scheduling Strategies for Parallel Processing Workshop. Cambridge, MA.
Invited by: Larry Rudolph.
- May 2001 “Scheduling Your Network Connections.”
Invited talk. IBM Corporation T.J. Watson Research Lab.
- Mar 2001 “Scheduling Your Network Connections.” Invited talk at DIMACS Workshop on Resource Management and Scheduling in Next Generation Networks. Invited by: Rajmohan
- Mar 2001 “Scheduling Your Network Connections.” Duke University. Host: Ron Parr.
- Jan 2001 “Scheduling Your Network Connections.” Invited talk. HP Labs. Host: John Wilkes.
- Jan 2001 “Scheduling Your Network Connections.” Invited talk. Stanford University. Host: Mary Baker.
- Jun 2000 “Task Assignment with Unknown Duration.”
Invited talk at 2nd Workshop on Mathematical performance Modeling and Analysis (MAMA 2000).
Invited by: Mark Squillante.
- Oct 1999 “Connection Scheduling in Web Servers.”
Presented at USITS ’99.
- Jun 1999 “The Case for SRPT Scheduling in Web Servers.”
End-to-End Research Group Meeting. MIT Lab for Computer Science. Host: David Clark.
- Jun 1999 “Task Assignment with Unknown Duration.”
Invited paper at ASA-IMS Conference on Applications of Heavy Tailed Distributions in Economics, Engineering and Statistics. Washington DC.
- Apr 1999 “The Effect of Heavy-Tailed Job Size Distributions on System Design.”
Interview talk: Carnegie Mellon University. Host: Hui Zhang.
- Apr 1999 “The Effect of Heavy-Tailed Job Size Distributions on System Design.”
Interview talk: Caltech Institute of Technology. Host: Mani Chandy.
- Mar 1999 “The Effect of Heavy-Tailed Job Size Distributions on System Design.”
Interview talk: AT&T Research Labs. Host: Jennifer Rexford.
- Mar 1999 “The Effect of Heavy-Tailed Job Size Distributions on System Design.”
Interview talk: Johns Hopkins. Host: Gerald Mason.
- Mar 1999 “The Effect of Heavy-Tailed Job Size Distributions on System Design.”
Interview talk: Massachusetts Institute of Technology. Host: Charles Leiserson.
- Mar 1999 “The Effect of Heavy-Tailed Job Size Distributions on System Design.”
Interview talk: University of Texas, Austin. Host: Mike Dahlin.
- Mar 1999 “The Effect of Heavy-Tailed Job Size Distributions on System Design.”
Interview talk: New York University. Host: Richard Cole.
- Mar 1999 “The Effect of Heavy-Tailed Job Size Distributions on System Design.”
Interview talk: UMASS-Amherst. Host: Don Towsley.
- Feb 1999 “Task Assignment in a Distributed Server System.”
Brandeis University. Host: Liuba Shrira.
- Jan 1999 “Task Assignment in a Distributed Server System.”
Invited talk. University of California, Berkeley. Host: Manuel Blum.
- Oct 1998 “Task Assignment in a Distributed Server System.”
M.I.T., Theory Group. Host: Tom Leighton.

- Sep 1998 "Task Assignment in a Distributed Server System." Presented at the 10th International Conference on Modeling Techniques and Tools for Computer Performance Evaluation.
- Mar 1998 "Task Assignment in a Distributed Web Server." Cisco Systems.
- Mar 1998 "Task Assignment in a Distributed Supercomputing Server." MIT Xolas Supercomputing Group. Host: Charles Leiserson.
- Mar 1998 "Task Assignment in a Distributed Web Server." Lucent Technologies.
- Feb 1998 "Task Assignment in a Distributed Web Server." Arrowpoint Communications.
- Feb 1998 "Task Assignment for a Distributed Supercomputing Server." Cornell University. Host: Sid Resnick.
- Feb 1998 "Task Assignment in a Distributed Server System." IBM.
- Jan 1998 "Task Assignment in a Distributed Server System." Bay Networks.
- Jun 1997 "The Impact of Heavy-Tailed Distributions on Load Balancing in Web Servers." Invited to the INFORMS Applied Probability Conference, Cambridge, MA. Invited by Mark Crovella.
- Jan 1997 "Exploiting Process Lifetime Distributions for Dynamic Load Balancing." AT&T Research Lab. Host: Gisli Hjalmtysson.
- Oct 1996 "Exploiting Process Lifetime Distributions for Dynamic Load Balancing." Boston University. Host: Murad Taqqu.
- May 1996 "Exploiting Process Lifetime Distributions for Dynamic Load Balancing." Presented at the ACM SIGMETRICS Conference on Measurement and Modeling of Computer Systems.
- May 1996 "Exploiting Process Lifetime Distributions for Dynamic Load Balancing." University of California, San Diego. Hosts: Fran Berman and Russell Impagliazzo.
- Jan 1996 "Bounding Delays in Packet-Routing Networks." IBM Almaden. Host: Eli Upfal.
- May 1995 "Bounding Delays in Packet-Routing Networks." Presented at the 27th Annual Symposium Theory of Computing.
- Jan 1994 "Queueing Analysis of Oblivious Packet-Routing Networks." Presented at the Fifth Annual ACM-SIAM Symposium on Discrete Algorithms.

PROFESSIONAL SERVICE

Program co-Chair:

- 2007 Program co-Chair SIGMETRICS 2007.
- 2007 Program co-Chair QEST 2007.
- 2005 Co-Chair CMU/Eindhoven Collaborative Workshop on Queueing '05.
See www.aladdin.cs.cmu.edu/workshops/eindhoven/.
- 2004 Co-Chair WORKshop on Multiserver Scheduling (WORMS04).
See www.cs.cmu.edu/~harchol/WORMS04/.

SIG Officer:

- 2005-2007 Secretary/Treasurer ACM SIGMETRICS.

Editor:

- 2008 - pres Associate Editor *Performance Evaluation* journal.
- 2007 Guest Editor Performance Evaluation Review, Special Issue on Scheduling, March 2007.

Technical Program Committee and Related:

- 2009 Technical Program Committees: SIGMETRICS '09, MAMA '09, HotPower '09.
- 2009 Sigmetrics Rising Star Award Committee.

2008 Sigmetrics Rising Star Award Committee.
 2008 Technical Program Committees: SIGMETRICS '08, SIPEW '08, HotPower '08, MAMA '08.
 2007 Technical Program Committees: SIGMETRICS '07, QEST '07, MAMA '07.
 2006 Technical Program Committees: SIGMETRICS '06, WWW '06, QEST '06.
 2005 Technical Program Committees: SIGMETRICS '05, WWW '05.
 2004 Technical Program Committees: SIGMETRICS '04, WWW '04.
 2003 Technical Program Committee: SIGMETRICS '03.
 2002 Technical Program Committees: SIGMETRICS '02, Performance '02.
 2002 Publicity Chair: Performance '02.
 2001 Tutorial Chair: SIGMETRICS '01.
 2000 Technical Program Committee: SIGMETRICS '00.

Member of:

ACM, Informs, IEEE, IFIP W.G. 7.3.

Panelist:

Jan 2002 NSF CCR-Operating Systems and Compilers Panel. Headed by Randy Chow.
 Feb 2000 NSF ITR Panel. Headed by Darlene Fisher.

UNIVERSITY SERVICE

2008 - Pres Associate Department Head for Graduate Education, Computer Science. Primary responsibilities include:
 – Structuring Computer Science PhD Program;
 – Management of Graduate Admissions;
 – Graduate Recruiting & Open House;
 – Immigration and Emigration;
 – Running Black Friday meetings;
 – Assignment of graduate students to faculty;
 – Mentoring of graduate students and meeting to discuss problems.
 – Managing Doctoral Review Committee.

2003-2008 Doctoral Review Committee (DRC).
 Spr 2008 CSD Retreat Planning Committee.
 Jan 2008 Exam questioner/grading for Tepper School qualifiers.
 Fall 2007 CSD Finances committee.
 2006-2007 Gates classroom committee.
 Jun 2007 Speaker at Breakfast for Volunteer Alumni Leaders.
 Jan 2007 Exam questioner/grading for Tepper School qualifiers.
 Nov 2006 Presentation to 100 undergraduates on “Applying to Grad School.”
 Aug 2006 Host IC party.
 Apr 2006 Presentation to 100 undergraduates on “Applying to Grad School.”
 Apr 2006 Speaker at Carnegie Mellon 50 Year Anniversary Symposium.
 Jan 2006 Exam questioner/grading for Tepper School qualifiers.
 2005-2006 Supervised undergraduate researcher, Gwendolyn Stockman.
 Apr 2005 Chaired committee for Allen Newell Graduate Teaching Award.
 Apr 2005 Chaired committee for Herbert A. Simon Award.
 Apr 2005 Presentation to 100 undergraduates on “Applying to Grad School.”
 Mar 2005 Presentation at Open House Graduate Student Recruiting.
 Spr 2005 CS hiring committee: Performance evaluation area.
 2004-2005 Instrumenting SCS Perlis Teaching Assistant Award.
 Jan 2005 Exam questioner/grading for Tepper School qualifiers.
 Dec 2004 Undergraduate math colloquium speaker. Host: Deborah Brandon.
 Sep 2004 Women in SCS Road Show.

Aug 2004 Host IC party.
 May 2004 Judge for Herbert A. Simon Award.
 Apr 2004 Presentation to 100 undergraduates on "Applying to Grad School."
 Jan 2004 Exam questioner/grading for Tepper School qualifiers. Also, reader on some summer papers.
 Aug 2003 Host IC party.
 May 2003 Judge for Newell Award.
 Apr 2003 Presentation to 100 undergraduates on "Applying to Grad School."
 Apr 2003 Heavy involvement in faculty recruiting. Host parties.
 Jan 2003 Exam questioner/grading for Tepper School qualifiers.
 Nov 2002 Presentation to 100 undergraduates on "Applying to Grad School."
 Aug 2002 Host IC party.
 Aug 2002 Provide interview for undergraduate recruitment tape.
 July 2002 Committee to evaluate department chair position.
 May 2002 Joined SCS Web advisory committee.
 May 2002 Heavy involvement in faculty recruiting. Host parties.
 Apr 2002 Presentation to 150 undergraduates on "Applying to Grad School."
 Mar 2002 Presentation at Open House Graduate Student Recruiting.
 Jan 2002 Exam questioner/grading for Tepper School qualifiers.
 Nov 2001 Sent letters to top 130 CMU alumni encouraging them to apply to grad school at CMU.
 Nov 2001 Presentation to CMU Women Graduate Organization on "Advising and Being Advised."
 Aug 2001 Host IC party.
 Aug 2001 Presentation at Andrews Leap to High School students.
 Apr 2001 Heavy involvement in faculty recruiting. Host parties/candidates.
 Mar 2001 Presentation at Open House Graduate Student Recruiting.
 Nov 2000 Presentation at Freshman IC.
 Nov 2000 Led Pannel at CS Immigration Course titled
 "How to be a Great Advisor/ How to be a Great Grad Student."
 Nov 2000 Sent letters to top 40 CMU alumni encouraging them to apply to grad school at CMU.
 Aug 2000 Host IC party.
 July 2000 Presentation at Andrews Leap to High School students.
 Apr 2000 Presentation to prospective undergraduates at Undergrad Open House.
 Mar 2000 Presentation at Open House Graduate Student Recruiting.
 2000-2001 Supervised undergraduate researcher, Sonesh Surana.
 Oct 1999 Presentation to Women in SCS group on "Getting the Most Out of a Conference."
 Aug 1999 Presentation at Andrews Leap to High School students.

COMMUNITY SERVICE

2008-pres Creating first-ever Western PA American Regional Mathematics League (ARML) team.
 Includes high schoolers from all over Western PA.
 Team practices, lesson plans, and general organization of students and teachers.

2004-2005 Volunteer teacher of Elementary School National Math Olympiad Contest at Winchester-Thurston school.
 Teach every Monday afternoon.

2002-2004 Volunteer math teacher at Winchester-Thurston School, Pittsburgh, PA.
 Teach advanced mathematics to 2nd graders. Wednesday mornings, every other week.

1988-1990 Volunteer Teacher at City Year, Stilling St., Boston, MA.
 Volunteer Teacher Boston Partners in Education.
 Teach math to disadvantaged students one evening per week.

CONTRACT AND GRANT SUPPORT

Current:

Title: Optimizing Server Farm Performance in Power-Constrained Environments.
PI : Mor Harchol-Balter.
Agency: The Technology Collaborative of Pittsburgh.
Duration: January '09 - January '10.
Amount: \$124,000.
Support: 66%SU.
Award No: 1010970

Title: Optimizing Server Farm Performance in Power-Constrained Environments.
PI : Mor Harchol-Balter.
Agency: Matching funds (in kind) from Project Olympus and the Idea Foundry, Pittsburgh.
Duration: January '09 - January '10.
Amount: \$30,000.

Title: Efficient Power Management by Alternating Between "Extreme" Power States.
PI : Mor Harchol-Balter.
Agency: CMU Technology Transfer Center & Project Olympus.
Duration: January '09 - January '10.
Amount: \$40,000.
Support: 33%SU.
Award No: 2001801

Title: SMA/PDOS Collaborative Research: Design, Analysis, and Control of Adaptive Sharing Mechanisms.
co-PI : Mor Harchol-Balter (with Vishal Misra, Dan Rubenstein, Ed Coffman, and Predrag Jelenkovic).
Agency: NSF.
Grant No: NSF CCR-0615262. Division of Computer and Network Systems. Computer Systems.
Duration: August '06 - July '09.
Amount: \$1,000,000.
Support: 33%SU.
Center No: 15653.1.1120828.

Pending:

Title: Collaborative Research: Scheduling the TeraGrid: Auction-based Scheduling Meets Supercomputing
PI : Mor Harchol-Balter (with Alan Scheller-Wolf, Dave O'Hallaron, Avrim Blum, Sergiu Sanielevici
Vincent Chan, Co-PIs).
Agency: NSF.
Proposal No: NSF OCI-0751403. Office Cyber-Infrastructure.
Duration: August '07 - July '11.
Amount: \$1,722,630.
Support: 33%SU.

Past:

Title: SGER: Collaborative Research: CSR-SMA:
New Breakthrough in Analyzing Limited Resource Sharing Systems.
PI : Mor Harchol-Balter (with Jim Dai and Bert Zwart).
Agency: NSF.
Grant No: NSF CNS-0719106.
Duration: August '07 - August '08.
Amount: \$100,000.
Support: 33%SU.
Center No: 17666.1.1121054

Title: Scheduling the TeraGrid.
PI : Mor Harchol-Balter
Company: Microsoft Research. Award Number: 16101.
Duration: May '07 - May '08.
Amount: \$75,000.
Support: Winner of Microsoft Breakthrough Research Grant. Unrestricted Gift.

Title: CAREER: The Impact of Resource Scheduling on Improving Server Performance.
PI : Mor Harchol-Balter.
Agency: NSF.
Grant No: NSF CCR-0133077. CAREER Award. Division of Computer and Network Systems. Distributed Systems.
Duration: March '02 - February '08.
Amount: \$350,000.
Support: 33%SU.
Center No: 8061.1.1120231.

Title: ITR: Improving the Performance of Web Servers under Overload.
PI : Mor Harchol-Balter.
Agency: NSF.
Grant No: ITR-0313148. Division of Computer and Communication Foundations.
Duration: August '03 - July '07.
Amount: \$280,000.
Support: 8%SU.
Center No: 10575.1.1120449.

Title: Siebel Fellowship.
PI : Adam Wierman (my graduate student).
Duration: September '06 - September '07.

Title: External QoS Management System for Backend Database Servers.
PI : Mor Harchol-Balter.
Agency: The Technology Collaborative of Pittsburgh.
Duration: August '05 - August '06.
Amount: \$188,550.
Support: 33%SU.

Center No: 13821.1a.1010629.

Title: Analysis of Cycle Stealing and other Problems via new Dimensionality Reduction Approach.
PI : Mor Harchol-Balter.
Agency: NSF.
Grant No: CCR-0311383. Division of Computer and Communication Foundations. Theory of Computing.
Duration: July '03 - July '06.
Amount: \$150,000.
Support: 25%SU.
Center No: 10372.1.1120427.

Title: NSF PhD Graduate Fellowship for Student.
PI : Adam Wierman (my graduate student).
Agency: NSF.
Duration: July '03 - July '06.
Amount: 3 years graduate student support.

Title: QOS for Online Shopping: Providing Priority by Scheduling the Database.
PI : Mor Harchol-Balter (with Natassa Ailamaki, Co-PI)
Agency: Pittsburgh Digital Greenhouse.
Duration: August '03 - August '05.
Amount: \$265,192.
Support: 33%SU.
Center No: 10363.1.1010366.

Title: IBM PhD Graduate Fellowship for Student.
PI : Bianca Schroeder (my graduate student).
Agency: IBM.
Duration: September '03 - September '05.
Amount: 2 years graduate student support.

Title: ITR: Exploiting Remote Infrastructure for Mobile Information Access.
PI : M. Satyanarayanan (Mor Harchol-Balter, Co-PI).
Agency: NSF.
Grant No: ITR ANI-0081396. Division of Computer and Network Systems.
Duration: September '00 - September '05.
Amount: \$448,820.
Support: 33%SU.
Center No: 6748.1.1120092.

Title: Running Web Servers under Overload.
PI : Mor Harchol-Balter.
Agency: Pittsburgh Digital Greenhouse.
Duration: August '01 - August '02.
Amount: \$200,500.
Support: 50-100%AY.
Center No: 6737.1.1010099.

Title: Connection Scheduling in Web Servers.
PI : Mor Harchol-Balter.
Agency: Pittsburgh Digital Greenhouse.
Duration: August '00 - August '01.
Amount: \$200,075.
Support: 67-100%SU.
Center No: 4737.1.1010099.

Title: Gift.
PI : Mor Harchol-Balter.
Agency: EMC² Corporation.
Duration: April '01 - March '04.
Amount: \$100,000.
Support: 0-22%AY.
Center No: 8236.1.1010272.

Title: IBM PhD Graduate Fellowship for Student.
PI : Nikhil Bansal (my graduate student).
Agency: IBM.
Duration: September '01 - September '03.
Amount: 2 years graduate student support.

Title: Postdoctoral Fellowship Mathematical Sciences.
PI : Mor Harchol-Balter.
Agency: NSF.
Grant No: 9627445.
Duration: September '96 - August '00.
Support: Postdoctoral Research Fellowship Stipend.

INDUSTRY EXPERIENCE

- 2008 - 2009 Working with Intel Research Lab, Pittsburgh, on optimal power management.
- 2007 - 2008 Working with IBM T. J. Watson Lab researchers on optimal power management for server farms.
- 2005 - 2006 Supported by IBM Corporation, Seagate Technologies, Spinnaker Networks, Maya Design, and Cisco Technologies through TTC (The Technology Collaborative of Pittsburgh) grant. Quarterly meetings.
- 2003 - 2005 Supported by IBM Corp. and Seagate Technologies through PDG (Pittsburgh Digital Greenhouse) grant. Quarterly meetings.
- 2001 - 2003 Supported by Spinnaker Networks, Inc. through PDG grant. Quarterly Meetings.
- 2001 - 2003 Supported by gift from EMC² Corporation. Contacts: Peter Lauterbach, Ric Wheeler.

- 2001 - 2005 My students supported by IBM graduate fellowships.
Collaborate with many people at IBM on research.
- 2000 - 2001 Supported by Cisco Systems, through PDG grant. Contact: John Wakerley. Quarterly meetings.
- 1990 - 1991 Employed at NASA Ames Research Center, Moffit Field, CA.
Used Newton's Method for Fractal Approximation to generate Iterated Function System (IFS) for piecewise linear graphs. Developed rotation and size invariant filters for image recognition using simulated annealing.
- 1988 - 1990 Employed at GTE Government Systems, Needham, MA.
Mathematician for Advanced Machine Intelligence Technology group. Responsible for theory, design, and implementation of the Intelahedron™, a pattern classification system based on linear and non-linear frame-of-reference transformations. Work experience included:
1. Researching and developing eigendecomposition transformations to force separation of classes, reduce dimensionality, and identify the characteristic features of a class.
 2. Researching fast algorithms for obtaining the eigensystem of an autocorrelation matrix for a class of input signals.
 3. Applying the Intelahedron™ to: seismic data classification, underground oil detection, recognition of mixed signals with noise, decision making in a tactical battlefield.
- Co-authored with Dr. Angel DeCegama several hundred page report, *The Intelahedron™* (GTE Proprietary), detailing mathematical theory, algorithms, and implementation.
- Summer 87 Employed at AT&T Bell Laboratories, Murray Hill, NJ.
Developed object-oriented software tools in SCHEME for constraint-based propagation networks, including graphics and debugging tools.

TEACHING EXPERIENCE (Links to classes are available from my web page.)

- 15-441 **Undergraduate Computer Networking**
Course emphasizes basic performance and engineering tradeoffs in the design and implementation of computer networks. To make the issues more concrete, the class includes several multi-week projects requiring significant design and implementation. The goal is for students to learn not only what computer networks are and how they work today, but also why they are designed the way they are and how they are likely to evolve in the future. Examples are drawn from the Internet. Topics include: congestion/flow/error control, routing, addressing, naming, multi-casting, switching, internetworking, and network security.
Spring 2001 – co-taught with Peter Steenkiste. Reviews averaged 4.59 out of 5.0.
Spring 2002 – co-taught with Peter Steenkiste. Reviews averaged 4.83 out of 5.0.
Fall 2002 – co-taught with Srinu Seshan. Reviews averaged 4.8 out of 5.0.
- 15-849a **Performance Analysis and Design of Computer Systems**
Highly-intensive graduate class for computer systems students. The course emphasizes techniques to help one quickly make design decisions, such as: Which device is worth speeding-up? Is it better to use one fast machine or several slow ones? How should the machines be configured? Which load balancing algorithm will maximize throughput? Which task assignment policy will minimize delays? For minimizing packet loss, should we increase the buffer size, or buy a faster device? How do various scheduling policies compare? Techniques taught include: back-of-the-envelope analysis, Markov chains, networks of queues, queueing theory basics

measurement of systems, creating models from measurements, confidence intervals, simulation techniques, working with heavy-tailed distributions, as well as task assignment policies and scheduling for server farms. Student reviews write: "Take this class at all cost!"

Fall 1998 – I developed this class at MIT and passed out my hand-written lecture notes.

Reviews averaged over 6.6 out of 7.0.

Highest rating out of the 134 EECS classes taught at MIT during the past year.

Fall 1999 – First time taught at CMU. I produced 24 latexed lectures, each 15-20 pages.

Produced 7 latexed homeworks (each 10 problems) with complete solutions.

All materials are available on my web page, and are used by 2000 students and faculty worldwide. I also answer people's questions daily regarding the notes.

Reviews averaged 5.0 out of 5.0 in every category.

Fall 2000 – Reviews averaged 4.8 out of 5.0.

Fall 2002 – Reviews averaged 4.8 out of 5.0.

Course adopted as REQUIREMENT for all Tepper School OM students.

15-857a **Fall 2006** – 15-849a class changes name to 15-857a.

Reviews averaged 4.8 out of 5.0.

Fall 2007 – 17 students reviewing. Reviews averaged 4.9 out of 5.0.

15-849b **Theory of Performance Modeling.**

More theoretical version of 15-849a, geared towards students wishing to do research in queueing theory. The goal of queueing theory has always been to improve the design/performance of systems, e.g. networks, servers, memory, distributed systems, etc., by finding smarter schemes for allocating resources to jobs. In this class we will study the beautiful mathematical techniques used in queueing theory, including stochastic analysis, discrete-time and continuous-time Markov chains, renewal theory, BCMP product-form, Laplace transforms, supplementary random variables, fluid theory, virtual work, intensive scheduling theory, matrix-geometric techniques, and more. Throughout we emphasize realistic workloads, in particular heavy-tailed workloads. The techniques studied in this class are useful to students in Computer Science, Mathematics, ACO, OR, Statistics and Engineering. This course is packed with open problems – problems which if solved are not just interesting theoretically, but which have huge applicability to the design of computer systems today.

Fall 2001 – First introduction of this class. Created new set of 24 lectures,

with about 50% overlap to 15-849a. Lecture notes are on web page and are used by researchers world-wide. Course reviews averaged 4.8 out of 5.0.

Fall 2003 – Reviews averaged 5.0 out of 5.0.

Spring 2005 – Reviews averaged 4.7 out of 5.0.

15-858a **Advanced Topics in Stochastic Processes**

Intended to be offered every other year, with changing topics.

Advanced topics include: Stochastic Orderings, Heavy-tailed Workloads, Rate Conservation Law, Transform-based Analysis of Queueing Theory, Scheduling Theory, Fluid Analysis, Tail Behaviors, Matrix-Analytic Methods, and more.

Spring 2007 – Co-taught with Alan Scheller-Wolf (Tepper School). Reviews: 5.0 out of 5.0.

15-359 **Probability and Computing**

NEW Undergraduate class in probability for computer science majors.

Probability theory has become indispensable in computer science. In areas such as artificial intelligence and computer science theory, probabilistic methods and ideas based on randomization are central. In other areas such as networks and systems, probability is becoming an increasingly useful framework for handling uncertainty and modeling the patterns of data that occur in complex systems. This course gives an introduction to probability as it is

used in computer science theory and practice, drawing on applications and current research developments as motivation and context. Topics include combinatorial probability and random graphs, heavy tail distributions, concentration inequalities, various randomized algorithms, sampling random variables and computer simulation, the “probabilistic method” applied to graph theory problems, and Markov chains and their many applications, from Web search engines to models of network protocols.

Fall 2004 – Co-taught with John Lafferty. Reviews averaged 4.7 out of 5.0.

Spring 2006 – Co-taught with John Lafferty. Reviews averaged 4.8 out of 5.0.

Fall 2007 – Co-taught with Ryan O’Donnell. Reviews averaged 4.9 out of 5.0.

Fall 2008 – Co-taught with Ryan O’Donnell. Reviews averaged 4.9 out of 5.0.

15-820b **SQUALL Seminar – Scheduling and QUEueing Around Lunchtime**

Graduate-level research seminar on topics in scheduling theory. Students read and present recent papers as well as their own research results.

Taught for the benefit of graduate students, so that they can get feedback on their speaking skills.

Attended by students, multiple faculty, and postdocs.

Fall 2002, Spring 2003, Fall 2003, Spring 2004, Fall 2004, Spring 2005, Spring 2006, Fall 2007, Spring 2008, Fall 2008, Spring 2009.

TEACHING ASSISTANT EXPERIENCE

Fall 1993 Graduate Student Instructor, U.C. Berkeley.

Undergraduate Computer Science Algorithms

All reviews available upon request. Reviews averaged 5.0 out of 5.0.

Winner 3 teaching awards.

Fall 1987 Teaching Assistant, Brandeis University.

Undergraduate Theory of Computation.

All reviews available upon request. Reviews averaged 5.0 out of 5.0.

STUDENT ADVISING

My Ph.D. Students:

1. **Bianca Schroeder** – entered Fall 1999. Proposed May 2003. Graduated December 2005. *Accepted assistant professor position at University of Toronto, Computer Science Department.*
2. **Takayuki Osogami** – entered Fall 2001. Proposed April 2004. Graduated August 2005. *Accepted research position at IBM Tokyo Research Labs.*
3. **Adam Wierman** – entered Fall 2001. Proposed Feb 2005. Graduated May 2007. *Accepted assistant professor position at Caltech, Computer Science Department. Winner of 2007 CMU SCS Distinguished Dissertation Award.*
4. **David McWherter** – entered Fall 2001. Proposed April 2006. Graduated Aug 2008. *Accepted research position at Google, Seattle Lab.*
5. **Varun Gupta** – entered Fall 2004.
6. **Anshul Gandhi** – entered Fall 2007.

7. **Yi Zhuang** – entered Fall 2008.

Ph.D. Thesis Committee Member:

1. Chris Lumb – Graduated 2004 – ECE.
2. Atul Bhandari – Graduated 2006 – Tepper School (Operations Management).
3. Eno Thereska – Graduated 2007 – ECE.
4. Carol Frieze – Graduated 2007 – CS.