

MARTIN I. REIMAN

Department of Industrial Engineering and Operations Research, Columbia University
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EDUCATION:

Ph.D., Operations Research, Stanford University, 1977.
M.S., Statistics, Stanford University, 1977.
B.A., Mathematics and Physics, Cornell University, 1974.

RESEARCH INTERESTS:

Analysis, optimization and control of stochastic resource sharing systems: queueing systems, inventory systems, revenue management, stochastic networks. Approximations and asymptotics: diffusion processes, fluid and diffusion limit theorems, asymptotic optimality.

EMPLOYMENT HISTORY:

Professor, Department of Industrial Engineering and Operations Research, Columbia University, 2017-.
(At Columbia starting 2016)

Distinguished Member of Technical Staff, Mathematical Sciences Research Center, Bell Laboratories, Murray Hill, NJ 1998-2015.

Member of Technical Staff, Mathematical Sciences Research Center, Bell Laboratories, Murray Hill, NJ 1980-1998.

Member of Technical Staff, Data Communications Laboratory, Bell Laboratories, Holmdel, NJ, 1977-1980.

HONORS AND AWARDS:

1998 Marcel F. Neuts Best Paper Award, "Fluid and Diffusion Limits for Queues in Slowly Changing Random Environments," *Stochastic Models*, 1997 (with Gagan L. Choudhury, Avi Mandelbaum, and Ward Whitt)

1998 Distinguished Member of Technical Staff Award, Bell Labs, Lucent Technologies

1999 Bell Labs Research Affirmative Action Award

2001 Operations Research Society of Israel Best Paper Award, "Dimensioning Large Call Centers" (with Sem Borst and Avi Mandelbaum)

2001 INFORMS Applied Probability Society Best Publication Award, "Polling Systems with Zero Switchover Times: A Heavy Traffic Averaging Principle," *Annals of Applied Probability*, 1995, and "Polling Systems in Heavy Traffic: A Bessel Process Limit," *Mathematics of Operations Research*, 1998 (with Anatolii A. Puhalskii and Edward G. Coffman, Jr.)

2007 INFORMS Fellow Award

2016 INFORMS John von Neumann Award (joint with Ruth Williams)

2022 Member, National Academy of Engineering

PROFESSIONAL ACTIVITIES:

Editorial:

Associate Editor, Mathematics of Operations Research, 1987-1995.

Area Editor, Mathematics of Operations Research, 1995-2001.

Associate Editor, Annals of Applied Probability, 1997-2002, 2009-2012.

Program committee:

Conference on Applied Probability in Engineering, Computer, and Communication Sciences (Paris, June, 1993)

Third ORSA Telecommunications Conference (Boca Raton, March 1995)

Performance '96 (Lausanne, October 1996)

Fourth INFORMS Telecommunications Conference (Boca Raton, March 1998)

Tenth INFORMS Applied Probability Conference (Ulm, July 1999)

Performance 2002 (Rome, September 2002)

Twelfth INFORMS Applied Probability Conference (Beijing, June 2004)

Thirteenth INFORMS Applied Probability Conference (Ottawa, July 2005)

Program Committee Co-chair, Sixteenth INFORMS Applied Probability Conference (Stockholm, July 2011)

Performance 2017 (New York, November 2017)

Member/Fellow, Institute for Operations Research and the Management Sciences (INFORMS).

Member, Institute of Mathematical Statistics (IMS).

Member (elected) International Federation of Information Processing Working Group on System Modeling, Measurement and Evaluation (IFIP WG7.3)

Member, George B. Dantzig Dissertation Award Committee (INFORMS), 2005 and 2006

Vice-chair INFORMS Applied Probability Society, 2004-2006

Chair INFORMS Applied Probability Society, 2006-2008

Member, Lanchester Prize Committee (INFORMS), 2012 and 2013

Member, Nicholson Prize Committee (INFORMS), 2014 and 2015

PATENTS:

Arrangement for Equalizing Levels of Service Among Skills, U.S. Patent 6,052,460 issued April 18, 2000 (with T. S. Fisher and R. Jensen)

System for Automatically Routing Calls to Call Center Agents in an Agent Surplus Condition Based on Agent Occupancy, U.S. Patent 6,347,139 issued February 12, 2002 (with T. S. Fisher and R. Jensen)

Method of Routing Calls in an Automatic Call Distribution Network, U.S. Patent 6,366,668 issued April 2, 2002 (with S. C. Borst, A. D. Flockhart, F. C. Hymus, E. P. Mathews, J. B. Seery, and J. Z. Taylor)

System for Automatically Routing Calls to Call Center Agents in an Agent Surplus Condition Based on Delay Probabilities, U.S. Patent 6,510,221 issued January 21, 2003 (with T. S. Fisher and R. Jensen)

System for Automatically Routing Calls to Call Center Agents in an Agent Surplus Condition Based on Service Levels, U.S. Patent 6,535,600 issued March 18, 2003 (with T. S. Fisher and R. Jensen)

System for Automatically Predicting Call Center Agent Work Time in a Multi-Skilled Agent Environment, U.S. Patent 6,553,114 issued April 22, 2003 (with T. S. Fisher and R. Jensen)

Rate Allocation Method and Apparatus for Optimization of Adaptive Wireless Video Streaming, U.S. Patent 9,363,814 issued June 7, 2016 (with S.C. Borst and V. Joseph)

System and Method for Controlling an Operation of an Application, U.S. Patent 9,826,422 issued November 21, 2017 (with E. Grinshpun, D. Faucher, and Z. Sayeed)

System and Method for Cooperatively Controlling an Application, U.S. Patent 9,838,893 issued December 5, 2017 (with E. Grinshpun, D. Faucher, S. Sharma, and T. Sizer)

Pacing in Knowledge Worker Engagement, U.S. Patent 10,536,578 issued January 14, 2020 (with A. Stolyar, N. Korolev, V. Mezhibovsky, and H. Ristock)

PUBLICATIONS:

Reflected Brownian Motion on an Orthant. *Ann. Prob.*, 9:2 (April 1981), pp. 302-308 (with J. M. Harrison).

On the Distribution of Multidimensional Reflected Brownian Motion. *SIAM J. Appl. Math.*, 41:2 (October 1981), pp. 345-361 (with J. M. Harrison).

The Heavy Traffic Diffusion Approximation for Sojourn Times in Jackson Networks. *Applied Probability-Computer Science, The Interface*, R. L. Disney and T. J. Ott (editors), Birkhauser, Boston, II (1982), pp. 409-422.

Diffusion Approximations for Storage Processes in Computer Systems. *Proc. ACM SIGMETRICS Conf.*, 1983, pp. 93-117 (with E. G. Coffman, Jr.).

Diffusion Approximations for Computer-Communication Systems. *Mathematical Computer Performance and Reliability*, G. Iazeolla, P. J. Courtois and A. Hordijk (editors), Elsevier, North-Holland, 1984, pp. 33-53 (with E. G. Coffman, Jr.).

Some Diffusion Approximations with State Space Collapse. *Modelling and Performance Evaluation Methodology*, F. Baccelli and G. Fayolle (editors), Springer-Verlag, 1984, pp. 209-240.

Open Queueing Networks in Heavy Traffic. *Mathematics of Operations Research*, 9:3 (August 1984), pp. 441-458.

Sensitivity Analysis Via Likelihood Ratios, *Proceedings of the 1986 Winter Simulation Conference*, IEEE, 1986, pp. 285-289 (with A. Weiss).

Stability of a Queueing System with Concurrent Service and Locking, *SIAM Journal on Computing*, 16:1 (February 1987), pp. 169-178 (with C. A. Courcoubetis and B. Simon).

The Forwarding Index of Communication Networks, *IEEE Transactions on Information Theory*, 33:2 (March 1987), pp. 224-232 (with F. R. K. Chung, E. G. Coffman, Jr. and B. Simon).

Optimal Control of a Queueing System with Simultaneous Service Requirements, *IEEE Transactions on Automatic Control*, 32:8 (August 1987), pp. 717-727 (with C. A. Courcoubetis).

Construction of the Stationary Regime of Queues with Locking. *Stoch. Proc. Appl.*, 26:2 (November 1987), pp. 257-265 (with F. Baccelli and C. A. Courcoubetis).

Optimal Buffer Allocation in Light Traffic. *Proceedings of 26th Conference on Decision and Control*, IEEE, 1987, pp. 1499-1503.

Simterpolations: Estimating an Entire Queueing Function from a Single Sample Path. *Proceedings of the 1987 Winter Simulation Conference*, IEEE, 1987, pp. 358-363 (with B. Simon and J. S. Willie).

A Multiclass Feedback Queue in Heavy Traffic. *Advances in Applied Probability*, 20:1 (March 1988), pp. 179-207.

An Interpolation Approximation for Queueing Systems with Poisson Input. *Operations Research*, 36:3 (May-June 1988), pp. 454-469 (with B. Simon).

A Boundary Property of Semimartingale Reflecting Brownian Motions. *Prob. Th. and Rel. Fields*, 77:1 (1988), pp. 87-97 (with R. J. Williams).

Light Traffic Limits of Sojourn Time Distributions in Markovian Queueing Networks. *Commun. Statist.-Stochastic Models*, 4:2 (1988), pp. 191-233 (with B. Simon).

The Application of Likelihood Ratio Based Derivative Estimates in Interpolation Approximations for Queueing Systems. *Analysis and Optimization of Systems*, A. Bensousson and John Lions (editors), Springer-Verlag, 1988, pp. 919-924 (with B. Simon, A. Weiss and J. S. Willie).

Optimal Dynamic Allocation of Heterogeneous Servers Under the Condition of Total Overload: The Discounted Case. *Proceedings of 27th Conference on Decision and Control*, IEEE, 1988, pp. 634-639 (with C. A. Courcoubetis).

Open Queueing Systems in Light Traffic. *Mathematics of Operations Research*, 14:1 (February 1989), pp. 26-59 (with B. Simon).

Light Traffic Derivatives Via Likelihood Ratios. *IEEE Transactions on Information Theory*, 35:3 (May 1989), pp. 648-654 (with A. Weiss).

Sensitivity Analysis for Simulations Via Likelihood Ratios. *Oper. Res.*, 37:5 (September-October 1989), pp. 830-844 (with A. Weiss).

Asymptotically Optimal Trunk Reservation for Large Trunk Groups. *Proceedings of 28th Conference on Decision and Control*, IEEE, 1989, pp. 2536-2541.

A Network of Priority Queues in Heavy Traffic: One Bottleneck Station. *Queueing Systems*, 6:1 (1990), pp. 33-58 (with B. Simon).

Asymptotically Exact Decomposition Approximations for Open Queueing Networks. *Operations Research Letters*, 6, November 1990, pp. 363-370.

Optimal Control of a Heterogeneous Two Server Queue in Light Traffic. *Proceeding. of 1990 Conference on Information Sciences and Systems*, Princeton University, 1990, pp. 497-500.

Asymptotic Properties of a Recursive Procedure for Simultaneous Estimation. *Probability in the Engineering and Information Sciences*, 4:4 (1990), pp. 461-475.

Some Allocation Problems for Critically Loaded Loss Systems with Independent Links. *Proceedings of Performance '90*, P. J. B. King, I. Mitrani and R. J. Pooley (editors), North Holland, 1990, pp. 145-158.

Performance Analysis of Concurrent-Read Exclusive-Write. *Proceedings ACM Sigmetrics Conference*, 1991, pp. 168-177 (with P. E. Wright).

Optimal Trunk Reservation for a Critically Loaded Link. *Teletraffic and Datatrafic: In a Period of Change*, A. Jensen and V. B. Iverson (editors), North Holland, 1991, pp. 247-252.

Storage Limited Queues in Heavy Traffic. *Probability in the Engineering and Information Sciences*, 5:4 (1991), pp. 499-522 (with E. G. Coffman, Jr. and A. A. Puhalskii).

A Critically Loaded Multiclass Erlang Loss System. *Queueing Systems*, 9 (1991), pp. 65-82.

Simterpolation: A Simulation Based Interpolation Approximation for Queueing Systems. *Operations Research*, 40:4 (1992), pp. 706-723 (with B. Simon and J. S. Willie).

Variance Reduction for Sensitivity Estimates Obtained from Regenerative Simulation. *Operations Research Letters*, 14:1 (1993), pp. 9-18 (with P. V. Nguyen).

Sequential Bottleneck Decomposition: An Approximation Method for Generalized Jackson Networks. *Operations Research*, 42:1 (1994), pp. 119-136 (with J. G. Dai and V. Nguyen).

Processor Shared Buffers with Reneging. *Performance Evaluation*, 19 (1994), pp. 25-46 (with E. G. Coffman, Jr., A. A. Puhalskii and P. E. Wright).

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Optimality of Randomized Trunk Reservation. *Probability in the Engineering and Informational Sciences*, 8 (1994), pp. 463-489 (with E. A. Feinberg).

Polling Systems with Zero Switchover Times: A Heavy Traffic Averaging Principle, *Annals of Applied Probability*, 5:3 (1995), pp. 681-719 (with E. G. Coffman, Jr. and A. A. Puhalskii).

Dynamic Scheduling of a Two-Class Queue with Setups. *Operations Research*, 46:4 (July-August 1998), pp. 532-547 (with L. M. Wein).

Dynamic Call Admission Control of an ATM Multiplexer with On/Off Sources. *Proceedings of the 34th Conference on Decision and Control, IEEE*, 1995, pp. 1382-1388 (with D. Mitra and J. Wang).

The Stochastic Economic Lot Scheduling Problem: Heavy Traffic Analysis of Dynamic Cyclic Policies. *Operations Research*, 48:1 (January-February 2000), pp. 136-154 (with D. M. Markowitz and L. M. Wein).

Polling Systems in Heavy Traffic: A Bessel Process Limit. *Mathematics of Operations Research*, 23:2 (1998), pp. 257-304 (with E. G. Coffman, Jr. and A. A. Puhalskii).

Heavy Traffic Analysis of Polling Systems in Tandem. *Operations Research*, 47:4 (July-August 1999), pp. 524-534 (with L. M. Wein).

Fluid and Diffusion Limits for Queues in Slowly Changing Environments. *Commun. Statist.-Stochastic Models*, 13:1 (1997), pp. 121-146 (with G. L. Choudhury, A. Mandelbaum and W. Whitt).

Heavy Traffic Analysis of the Dynamic Stochastic Inventory-Routing Problem. *Transportation Science*, 33:4 (November 1999), pp. 361-380 (with R. Rubio and L. M. Wein).

On Pooling in Queueing Networks. *Management Science*, 44:7 (1998), pp. 971-981 (with A. Mandelbaum).

Robust Admission Control for Heterogeneous ATM Systems with Both Cell and Call QoS Requirements. *Teletraffic Contributions for the Information Age*, V. Ramaswami and P. Wirth (editors), Elsevier, 1997, pp. 1421-1432 (with D. Mitra and J. Wang).

A Critically Loaded Multirate Link with Trunk Reservation. *Queueing Systems*, 28 (1998), pp. 157-190 (with A. A. Puhalskii).

Robust Dynamic Admission Control for Unified Cell and Call QoS in Statistical Multiplexers. *IEEE J. Sel. Areas in Commun.*, 16:5 (1998), pp. 692-707 (with D. Mitra and J. Wang).

Strong Approximations for Markovian Service Networks. *Queueing Systems*, 30 (1998), pp. 149-201 (with A. Mandelbaum and W. A. Massey).

Call Admission: A New Approach to Quality of Service. *Queueing Systems*, 38 (2001), pp. 125-148 (with A. Shwartz).

Time Varying Multiserver Queues with Abandonment and Retrials. *Teletraffic Engineering in a Competitive World*, P. Key and D. Smith (editors), Elsevier, 1999, pp. 355-364 (with A. Mandelbaum, W. A. Massey and B. Rider).

Pricing in a Large Single Link Loss System. *Teletraffic Engineering in a Competitive World*, P. Key and D. Smith (editors), Elsevier, 1999, pp. 737-746 (with C. A. Courcoubetis).

Designing a Call Center with Impatient Customers. *Manufacturing and Service Operations Management*, 4 (2002), pp. 208-227 (with O. Garnett and A. Mandelbaum).

The Multiclass GI/PH/N Queue in the Halfin-Whitt Regime. *Advances in Applied Probability*, 32 (2000), pp. 564-595 (with A. A. Puhalskii).

Waiting Time Asymptotics for Time Varying Multiserver Queues with Abandonment and Retrials. *Thirty-seventh Annual Allerton Conference*, 1999, pp.1095-1104 (with A. Mandelbaum, W.A. Massey and A.L. Stolyar).

Queue Lengths and Waiting Times for Multiserver Queues with Abandonment and Retrials. *Telecommunication Systems*, 21 (2002), pp. 149-172 (with A. Mandelbaum, W.A. Massey, B. Rider, and A.L. Stolyar).

Dimensioning Large Call Centers. *Operations Research*, 52 (2004), pp. 17-34 (with S. Borst and A. Mandelbaum).

Providing Bandwidth Guarantees Over a Best-effort Network: Call Admission and Pricing. *IEEE INFOCOM 2001*, 2001 (with C.A. Courcoubetis and A. Dimakis).

Fluid and Heavy Traffic Diffusion Limits for a Generalized Processor Sharing Model. *Annals of Applied Probability*, 13 (2003), pp. 100-139 (with K. Ramanan).

A Brownian Control Problem for a Simple Queueing System in the Halfin-Whitt Regime. *Systems and Control Letters*, 51 (2004), pp. 269-275 (with R. Atar, A. Mandelbaum).

Scheduling a Multi-Class Queue with Many Exponential Servers: Asymptotic Optimality in Heavy-Traffic. *Annals of Applied Probability*, 14 (2004), pp. 1084-1134 (with R. Atar, A. Mandelbaum).

A New and Simple Policy for the Continuous Review Lost Sales Inventory Model, unpublished manuscript, 3/18/04 (Semantic Scholar, Corpus ID: 16270438)

An Asymptotically Optimal Policy for a Quantity-Based Network Revenue Management Problem, *Mathematics of Operations Research*, 33 (2008), pp. 257-282 (with Q. Wang).

The Heavy Traffic Limit of an Unbalanced Generalized Processor Sharing Model, *Annals of Applied Probability*, 18 (2008), pp. 22-58 (with K. Ramanan).

A Stochastic Programming Based Inventory Policy for Assemble-To-Order Systems with Application to the W Model, *Operations Research*, 58 (2010), pp. 849-864 (with M. Dogru and Q. Wang).

Optimal Server Scheduling in Hybrid P2P Networks, *Performance Evaluation*, 67 (2010), pp. 1259-1272 (with S.Borst and B. Zhang).

On the Core of Cooperative Queueing Games, *Operations Research Letters*, 39 (2011), pp. 385-389 (with U. Ozen and Q. Wang).

A Stochastic Program Based Lower Bound for Assemble-to-Order Inventory Systems, *Operations Research Letters*, 40 (2012), pp. 89-95 (with Q. Wang).

Asymptotically Optimal Dynamic Pricing for Network Revenue Management, *Stochastic Systems*, 2 (2012), pp. 232-276 (with R. Atar).

Economic Models of Sponsored Content in Wireless Networks with Uncertain Demand, *SDP 2013 – IEEE INFOCOM Workshop* (with M. Andrews, U. Ozen and Q. Wang).

Asymptotically Optimal Inventory Control for Assemble-to-Order Systems with Identical Lead Times, *Operations Research*, 63 (2015), pp. 716-732 (with Qiong Wang).

Optimal Rate Allocation for Adaptive Wireless Video Streaming in Networks with User Dynamics, *IEEE INFOCOM 2014* pp.406-414 (with V. Joseph and S. Borst).

Pricing Sponsored Content in Wireless Networks with Multiple Content Providers, *SDP 2015 -IEEE INFOCOM Workshop* (with M. Andrews and Y. Jin).

Optimal Rate Allocation for Video Streaming in Wireless Networks With User Dynamics, *IEEE/ACM Transactions on Networking*, 24 (2016), pp. 820-835 (with V. Joseph and S. Borst).

Assemble-to-Order Inventory Management via Stochastic Programming: Chained BOMs and the M System, *Production and Operations Management*, 26 (2017), pp. 446-468 (with M. Dogru and Q. Wang).

On the Use of Independent Base-Stock Policies in Assemble-to-Order Inventory Systems with Nonidentical Lead Times, *Operations Research Letters*, 44 (2016), pp. 436-442 (with H. Wan and Q. Wang).

A Truthful Pricing Mechanism for Sponsored Content in Wireless Networks, *IEEE INFOCOM 2016* (with M. Andrews and Y. Jin).

Asymptotically Optimal Inventory Control for Assemble-to-Order Systems, *Stochastic Systems*, Articles in Advance (with H. Wan and Q. Wang).

A Continuous-class Queueing Model with Proportional Hazards-based Routing, unpublished manuscript, SSRN 3390476 (with N. Master, C. Wang, and L. Wein).

A Survey of Recent Progress in the Asymptotic Analysis of Inventory Systems, *Production and Operations Management*, 30 (2021), pp. 1718-1750, (with D. A. Goldberg and Q. Wang).

Asymptotically Optimal Control of a Centralized Dynamic Matching Market with General Utilities, *Operations Research*, 70 (2022), pp.3355-3370 (with J. H. Blanchet, V. Shah, L. M. Wein, and L. Wu).

Parallel Server Systems in Extended Heavy Traffic, *Queueing Systems*, 100 (2022), pp. 277-279 (with R. Atar and E. Castiel).

Parallel Server Systems under an Extended Heavy Traffic Condition: A Lower Bound, submitted for publication (with R. Atar and E. Castiel).

Asymptotic Optimality of Switched Control Policies in a Simple Parallel Server System under an Extended Heavy Traffic Condition, submitted for publication (with R. Atar and E. Castiel).