

ILYA O. RYZHOV

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Robert H. Smith School of Business
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Education

Ph.D. in Operations Research and Financial Engineering, Princeton University, Princeton NJ, 2011.
M.A. in Operations Research and Financial Engineering, Princeton University, Princeton NJ, 2008.
M.S. in Management Science and Engineering, Stanford University, Stanford CA, 2006.
M.Eng. in Operations Research and Industrial Engineering, Cornell University, Ithaca NY, 2005.
B.S. in Computer Science, Cornell University, Ithaca NY, 2004.

Research Interests

- Stochastic optimization; modeling and algorithms for multi-stage resource allocation problems
- Optimal learning; decision analysis; efficient information collection in stochastic optimization
- Applications in non-profit operations, dynamic pricing, transportation, business analytics

Employment

- Assistant Professor (Fall 2011-present)
Robert H. Smith School of Business, University of Maryland, College Park MD

Books

- Powell, W.B. & Ryzhov, I.O. (2012) *Optimal Learning*. John Wiley and Sons.

Working Papers (in various stages of review)

- Chen, Y. & Ryzhov, I.O. (2017) “Consistency analysis of sequential learning under approximate Bayesian inference.” Submitted to *Operations Research*.
- Chen, Y. & Ryzhov, I.O. (2017) “Rate-optimality of complete expected improvement.” Submitted to *Journal of Applied Probability*.
- Fan, Y., Ryzhov, I.O. & Liao, Y. (2017) “A dynamic screening algorithm for hierarchical binary marketing data.” Submitted to *Operations Research*.
- Gu, L., Ryzhov, I.O., Mankad, S. & Han, B. (2017) “Social behavior and user engagement in competitive online gaming: an empirical analysis.” Submitted to *Production and Operations Management*.
- Peng, Y., Chen, C.-H., Fu, M.C., Hu, J.-Q. & Ryzhov, I.O. (2017) “Efficient sampling allocation procedures for selecting the optimal quantile.” In revision at *INFORMS Journal on Computing*.
- Qu, H., Ryzhov, I.O., Fu, M.C., Bergerson, E. & Kurka, M. (2017) “Learning demand curves in B2B pricing: a new framework and case study.” In revision at *Production and Operations Management*.
- Ryzhov, I.O. (2017) “The local time method for targeting and selection.” In revision at *Operations Research*.
- Ryzhov, I.O., Mes, M.R.K., Powell, W.B. & van den Berg, G.A. (2017) “Bayesian exploration for approximate dynamic programming.” In revision at *Operations Research*.

Journal Papers

- Marković, N., Ryzhov, I.O. & Schonfeld, P. (2017) “Evasive flow capture: a multi-period stochastic facility location problem with independent demand.” *European Journal of Operational Research* **257**(2), 687-703.
- Ding, Z. & Ryzhov, I.O. (2016) “Optimal learning with non-Gaussian rewards.” *Advances in Applied Probability* **48**(1), 112-136.
- Han, B., Ryzhov, I.O. & Defourny, B. (2016) “Optimal learning in linear regression with combinatorial feature selection.” *INFORMS Journal on Computing* **28**(4), 721-735.
- Ryzhov, I.O. (2016) “On the convergence rates of expected improvement methods.” *Operations Research* **64**(6), 1515-1528.
- Ryzhov, I.O., Han, B. & Bradić, J. (2016) “Cultivating disaster donors using data analytics.” *Management Science* **62**(3), 849-866.
- Defourny, B., Ryzhov, I.O. & Powell, W.B. (2015) “Optimal information blending with measurements in the L2 sphere.” *Mathematics of Operations Research* **40**(4), 1060-1088.
- Marković, N., Ryzhov, I.O. & Schonfeld, P. (2015) “Evasive flow capture: optimal location of weigh-in-motion systems, tollbooths, and security checkpoints.” *Networks* **65**(1), 22-42.
- Qu, H., Ryzhov, I.O., Fu, M.C. & Ding, Z. (2015) “Sequential selection with unknown correlation structures.” *Operations Research* **63**(4), 931-948.
- Ryzhov, I.O., Frazier, P.I. & Powell, W.B. (2015) “A new optimal stepsize for approximate dynamic programming.” *IEEE Transactions on Automatic Control* **60**(3), 743-758.
- Ryzhov, I.O. & Powell, W.B. (2012) “Information collection for linear programs with uncertain objective coefficients.” *SIAM Journal on Optimization* **22**(4), 1344-1368.
- Ryzhov, I.O., Powell, W.B. & Frazier, P.I. (2012) “The knowledge gradient algorithm for a general class of online learning problems.” *Operations Research* **60**(1), 180-195.
- Ryzhov, I.O. & Powell, W.B. (2011) “Information collection on a graph.” *Operations Research* **59**(1), 188-201.

Conference Proceedings

- Chen, Y. & Ryzhov, I.O. (2016) “Approximate Bayesian inference as a form of stochastic approximation: a new consistency theory with applications.” Proceedings of the 2016 Winter Simulation Conference (eds: T.M.K. Roeder, P.I. Frazier, R. Szechtman, E. Zhou, T. Huschka, S.E. Chick), pp. 534-544.
- Ryzhov, I.O. (2015) “Expected improvement is equivalent to OCBA.” Proceedings of the 2015 Winter Simulation Conference (eds: L. Yilmaz, W.K.V. Chan, I. Moon, T.M.K. Roeder, C. Macal, M.D. Rossetti), pp. 3668-3677.
- Chau, M., Fu, M.C., Qu, H. & Ryzhov, I.O. (2014) “Simulation optimization: a tutorial overview and recent developments in gradient-based and sequential allocation methods.” Proceedings of the 2014 Winter Simulation Conference (eds: A. Tolk, S.Y. Diallo, I.O. Ryzhov, L. Yilmaz, S. Buckley, J.A. Miller), pp. 21-35.
- Fu, M.C., Bayraksan, G., Henderson, S.G., Nelson, B.L., Powell, W.B., Ryzhov, I.O. & Thengvall, B. (2014) “Simulation optimization: a panel on the state of the art in research and practice.” Proceedings of the 2014 Winter Simulation Conference (eds: A. Tolk, S.Y. Diallo, I.O. Ryzhov, L. Yilmaz, S. Buckley, J.A. Miller), pp. 3696-3706.
- Chau, M., Qu, H., Fu, M.C. & Ryzhov, I.O. (2013) “An empirical sensitivity analysis of the Kiefer-Wolfowitz algorithm and its variants.” Proceedings of the 2013 Winter Simulation Conference (eds: R. Pasupathy, S.-H. Kim, A. Tolk, R. Hill, M.E. Kuhl), pp. 945-956.
- Ding, Z. & Ryzhov, I.O. (2013) “Optimal learning with non-Gaussian rewards.” Proceedings of the 2013 Winter Simulation Conference (eds: R. Pasupathy, S.-H. Kim, A. Tolk, R. Hill, M.E. Kuhl), pp. 631-642.
- Han, B., Ryzhov, I.O. & Defourny, B. (2013) “Efficient learning of donor retention strategies for the American Red Cross.” Proceedings of the 2013 Winter Simulation Conference (eds: R. Pasupathy, S.-H. Kim, A. Tolk, R. Hill, M.E. Kuhl), pp. 17-28.
- Qu, H., Ryzhov, I.O. & Fu, M.C. (2013) “Learning logistic demand curves in business-to-business pricing.” Proceedings of the 2013 Winter Simulation Conference (eds: R. Pasupathy, S.-H. Kim, A. Tolk, R. Hill, M.E. Kuhl), pp. 29-40.

- Qu, H., Ryzhov, I.O. & Fu, M.C. (2012) “Ranking and selection with unknown correlation structures.” Proceedings of the 2012 Winter Simulation Conference (eds: C. Laroque, J. Himmelspach, R. Pasupathy, O. Rose, A. Uhrmacher), pp. 144-155.
- Ryzhov, I.O., Defourny, B. & Powell, W.B. (2012) “Ranking and selection meets robust optimization.” Proceedings of the 2012 Winter Simulation Conference (eds: C. Laroque, J. Himmelspach, R. Pasupathy, O. Rose, A. Uhrmacher), pp. 532-542.
- Ryzhov, I.O., Tariq, A. & Powell, W.B. (2011) “May the best man win: simulation optimization for match-making in e-sports.” Proceedings of the 2011 Winter Simulation Conference (eds: S. Jain, R.R. Creasey, J. Himmelspach, K.P. White, M. Fu), pp. 4239-4250.
- Ryzhov, I.O. & Powell, W.B. (2011) “The value of information in multi-armed bandits with exponentially distributed rewards.” Proceedings of the 2011 International Conference on Computational Science, pp. 1363-1372.
- Ryzhov, I.O. & Powell, W.B. (2011) “Bayesian active learning with basis functions.” Proceedings of the 2011 IEEE International Symposium on Adaptive Dynamic Programming and Reinforcement Learning, pp. 143-150.
- Ryzhov, I.O., Valdez-Vivas, M.R. & Powell, W.B. (2010) “Optimal learning of transition probabilities in the two-agent newsvendor problem.” Proceedings of the 2010 Winter Simulation Conference (eds: B. Johansson, S. Jain, J. Montoya-Torres, J. Huan, E. Yücesan), pp. 1088-1098.
- Ryzhov, I.O. & Powell, W.B. (2010) “Approximate dynamic programming with correlated Bayesian beliefs.” Proceedings of the 48th Allerton Conference on Communication, Control, and Computing, pp. 1360-1367.
- Ryzhov, I.O., Frazier, P.I. & Powell, W.B. (2010) “On the robustness of a one-period look-ahead policy in multi-armed bandit problems.” Proceedings of the 2010 International Conference on Computational Science, pp. 1629-1638.
- Ryzhov, I.O. & Powell, W.B. (2009) “A Monte Carlo knowledge gradient method for learning abatement potential of emissions reduction technologies.” Proceedings of the 2009 Winter Simulation Conference (eds: M.D. Rossetti, R.R. Hill, B. Johansson, A. Dunkin, R.G. Ingalls), pp. 1492-1502.
- Ryzhov, I.O. & Powell, W.B. (2009) “The knowledge gradient algorithm for online subset selection.” Proceedings of the 2009 IEEE International Symposium on Adaptive Dynamic Programming and Reinforcement Learning, pp. 137-144.

Book Chapters

- Ryzhov, I.O. (2015) “Approximate Bayesian inference for simulation and optimization.” In: *Modeling and Optimization: Theory and Applications* (eds. B. Defourny and T. Terlaky), pp. 1-28. Springer.
- Ryzhov, I.O. (2015) “Optimal learning for business decisions.” In: *Breakthroughs in Decision Science and Risk Analysis* (ed. L.A. Cox), pp. 83-122. John Wiley and Sons.
- Powell, W.B. & Ryzhov, I.O. (2012) “Optimal learning and approximate dynamic programming.” In: *Reinforcement Learning and Approximate Dynamic Programming for Feedback Control* (eds. F.L. Lewis and D. Liu), pp. 410-431. John Wiley and Sons.

Invited Talks and Seminars

- Institute for Systems Research, University of Maryland, 9/7/16.
- Statistical Sciences and Operations Research, Virginia Commonwealth University, 11/13/15.
- The Wharton School, San Francisco CA, 6/23/15.
- Systems Engineering and Operations Research, George Mason University, 2/13/15.
- Industrial and Systems Engineering, Lehigh University, 10/18/13.
- American Red Cross Headquarters, Washington DC, 1/25/13.
- The Wharton School, University of Pennsylvania, 12/4/12.
- Computer Science, University of Maryland, 2/29/12.
- Industrial Engineering and Management Sciences, Northwestern University, 2/10/11.
- Industrial and Operations Engineering, University of Michigan, 2/7/11.
- Leonard N. Stern School of Business, New York University, 1/31/11.

- Industrial and Systems Engineering, University of Minnesota, 1/21/11.
- Graduate School of Business, Stanford University, 1/5/11.
- Robert H. Smith School of Business, University of Maryland, 12/20/10.
- Industrial and Systems Engineering, University of Florida, 10/8/10.

Conference Presentations

- INFORMS Annual Meeting, Nashville TN, 11/15/16.
- Joint Statistical Meetings, Chicago IL, 8/1/16.
- 27th Annual POMS Conference, Orlando FL, 5/8/16.
- Winter Simulation Conference, Huntington Beach CA, 12/7/15.
- INFORMS Annual Meeting, Philadelphia PA, 11/1/15.
- 26th Annual POMS Conference, Washington DC, 5/9/15, 5/10/15.
- Winter Simulation Conference, Savannah GA, 12/8/14.
- INFORMS Annual Meeting, San Francisco CA, 11/9/14 (2 talks).
- Modeling and Optimization: Theory and Applications Conference, Lehigh University, 8/15/14 (2 talks).
- Manufacturing & Service Operations Management Conference, University of Washington, 6/20/14.
- INFORMS Annual Meeting, Minneapolis MN, 10/8/13.
- Manufacturing & Service Operations Management Conference, INSEAD, 7/29/13.
- Winter Simulation Conference, Berlin, Germany, 12/11/12.
- INFORMS Annual Meeting, Phoenix AZ, 10/16/12.
- Industrial and Systems Engineering Research Conference, 5/20/12.
- Winter Simulation Conference, Phoenix AZ, 12/14/11.
- INFORMS Annual Meeting, Charlotte NC, 11/13/11, 11/14/11, 11/15/11.
- INFORMS Healthcare Conference, Montreal, Canada, 6/20/11.
- 2nd International Workshop on Computational Stochastics, Singapore, 6/2/11.
- Optimization Days, Montreal, Canada, 5/2/11.
- IEEE International Symposium on Adaptive Dynamic Programming and Reinforcement Learning, Paris, France, 4/13/11.
- 12th INFORMS Computing Society Conference, Monterey CA, 1/9/11.
- Winter Simulation Conference, Baltimore MD, 12/6/10.
- INFORMS Annual Meeting, Austin TX, 11/8/10 (2 talks).
- 48th Allerton Conference on Communication, Control, and Computing, Monticello IL, 9/30/10.
- 12th International Conference on Stochastic Programming, Halifax, Canada, 8/17/10.
- 1st International Workshop on Computational Stochastics, Amsterdam, The Netherlands, 6/1/10.
- Winter Simulation Conference, Austin TX, 12/14/09.
- INFORMS Annual Meeting, San Diego CA, 10/11/09, 10/13/09.
- INFORMS NJ Chapter Meeting, Rutgers University, 9/17/09.
- 15th INFORMS Applied Probability Society Conference, Cornell University, 7/12/09.
- Graduate Student Research Conference, Operations Research and Financial Engineering, Princeton University, 5/7/09.
- IEEE International Symposium on Adaptive Dynamic Programming and Reinforcement Learning, Nashville TN, 4/1/09.
- INFORMS Annual Meeting, Washington DC, 10/12/08, 10/14/08.

Ph.D. Advising

- Han, B. (2015) “Statistical and optimal learning with applications in business analytics.” Department of Mathematics, University of Maryland.
 - Finalist, INFORMS Washington DC Chapter Student Excellence Award.
 - Winner, Ann G. Wylie Dissertation Fellowship, University of Maryland.
 - Winner, Phi Delta Gamma Graduate Fellowship, University of Maryland.
- Ding, Z. (2014) “Optimal learning with non-Gaussian rewards.” Department of Mathematics, University of Maryland.

- Qu, H. (2014) “Simulation optimization: new approaches and an application.” Department of Mathematics, University of Maryland.
 - Winner, INFORMS Computing Society Student Paper Award.

Ph.D. Committees

- Wang, X. (2016) “Vehicle routing problems that minimize the completion time: heuristics, worst-case analyses, and computational results.” Mathematics, University of Maryland.
- Zhu, W. (2016) “Essays on supply chain finance.” Robert H. Smith School of Business, University of Maryland.
- Chau, M. (2015) “Stochastic simulation: new stochastic approximation methods and sensitivity analyses.” Mathematics, University of Maryland.
- Chhabra, M. (2014) “Studies in the algorithmic pricing of information goods and services.” Computer Science, Virginia Tech.
- Price, S. (2014) “Applying operations research models to problems in health care.” Robert H. Smith School of Business, University of Maryland.
- Marković, N. (2013) “Evasive flow capture.” Civil and Environmental Engineering, University of Maryland.

Undergraduate Advising

- van den Berg, G.A. (2011) “Bayesian information collection in stochastic optimization: an aggregation-based approach.” Senior Thesis, Princeton University (co-advised with Warren Powell).
 - Ahmet S. Çakmak Prize for Innovative Research and an Exceptional Senior Thesis.
 - Program in Applied and Computational Mathematics Project Prize.
- Hsih, K.W. (2010) “Optimal dosing applied to glycemic control in type 2 diabetes.” Senior Thesis, Princeton University (co-advised with Warren Powell).
 - Ahmet S. Çakmak Prize for Innovative Research and an Exceptional Senior Thesis.
- Valdez-Vivas, M.R. (2009) “Optimal learning in the two-agent newsvendor problem.” Senior Thesis, Princeton University (co-advised with Warren Powell).
 - 2nd place, Princeton Undergraduate Research Symposium.

Teaching

Robert H. Smith School of Business, University of Maryland, College Park MD

- BMGT 838E: Stochastic Optimization (Fall 2012, Fall 2014, Spring 2017)
Doctoral course on stochastic optimization; covers stochastic search, dynamic programming, stochastic programming, and optimal learning.
- BMGT 834: Probabilistic Models (Fall 2011, Spring 2014)
Doctoral course on probability and stochastic processes; covers Markov chains, Poisson processes, martingales, and Brownian motion.
- BMGT 434: Introduction to Optimization (Spring 2012-Fall 2012, Fall 2013-Spring 2014)
Undergraduate course on optimization models; focuses on business scenarios, formulation of decision problems, and managerial insights.
- BUDT 758P: Decision Analytics (Spring 2015-Fall 2016)
Optimization elective for the MS in Information Systems program; focuses on methodology and applications of linear programming, network models, and simulation.
- BUDT 732: Decision Analytics (Spring 2013, Spring 2014, Fall 2015, Spring 2016)
MBA course on optimization and decision modeling; focuses on business applications of linear programming, network models, and simulation.

Operations Research and Financial Engineering, Princeton University, Princeton NJ

Co-designed OR&FE 418 (Optimal Learning) with Warren Powell and gave about 25% of course lectures (Spring 2010, Spring 2011). Also served as Teaching Assistant for OR&FE 307 (Linear Optimization) and OR&FE 309 (Probability and Stochastic Systems).

Management Science and Engineering, Stanford University, Stanford CA

Served as Teaching Assistant for MS&E 211 (Linear and Nonlinear Optimization), Autumn 2005.

Computer Science, Cornell University, Ithaca NY

Served as Undergraduate Consultant for COM S 100 (Introduction to Computer Programming), Fall 2002, Spring 2003, Fall 2003.

Industry Collaborations

- Vendavo, Inc. (2013)
- American Red Cross (2012)

Awards

Research awards:

- Finalist, Best Theoretical Paper, Winter Simulation Conference, 2016.
- Winner, Glover-Klingman Prize, 2015.
- Finalist, INFORMS Junior Faculty Forum Paper Competition, 2014.
- Winner, Best Theoretical Paper, Winter Simulation Conference, 2012.
- Winner, Best Paper, IEEE International Symposium on Adaptive Dynamic Programming and Reinforcement Learning, 2011.
- Outstanding Student Paper Travel Grant, IEEE Computational Intelligence Society, 2011.
- Finalist, Best Theoretical Paper, Winter Simulation Conference, 2009.
- Finalist, INFORMS New Jersey Chapter Student Contest, 2009.

Teaching awards:

- Teaching Award, Association of Princeton Graduate Alumni, 2009.
- 2 Excellence in Teaching Awards, School of Engineering and Applied Sciences, Princeton University, Spring/Fall 2008.

Service awards:

- Outstanding Reviewer Award, *IEEE Transactions on Automatic Control*, 2014.
- Meritorious Service Award, *Operations Research*, 2013.

Other:

- Honoree, Annual University-Wide Celebration of Scholarship and Research, University of Maryland, 2012-2013, 2015-2016.
- Research Opportunity, Wharton Customer Analytics Initiative, 2012, 2014.
- Summer Travel Fellowship, Association of Princeton Graduate Alumni, 2010.
- Francis Robbins Upton Fellowship, Princeton University, 2006.
- Honourable Mention, Silent Hoist and Crane Company Material Handling Award Competition, Cornell University, 2005.
- Pursglove Award, Cornell University, 2005.
- Knauss M. Eng. Scholarship, Cornell University, 2004.

Academic Service

Editorial service:

- Co-editor, Proceedings of the 2014 Winter Simulation Conference.

Reviewer for the following journals:

- *ACM Transactions on Modeling and Computer Simulation*, 2012, 2016.
- *Annals of Applied Probability*, 2017.
- *Annals of Operations Research*, 2015-2016.
- *Annals of Statistics*, 2015-2016.
- *Computational Optimization and Applications*, 2012-2013.
- *European Journal of Operational Research*, 2012-2016.
- *Expert Systems With Applications*, 2011.
- *IEEE Signal Processing Letters*, 2012.
- *IEEE Transactions on Automatic Control*, 2012-2016.
- *IEEE Transactions on Control of Network Systems*, 2017.
- *IEEE Transactions on Control Systems Technology*, 2015.
- *IEEE Transactions on Systems, Man and Cybernetics C*, 2011.
- *IIE Transactions*, 2009, 2011-2012, 2014-2015.
- *INFORMS Journal on Computing*, 2015-2017.
- *Journal of Applied Probability*, 2016.
- *Management Science*, 2012-2017.
- *Manufacturing & Service Operations Management*, 2011-2014.
- *Mathematical Programming B*, 2014.
- *Mathematics of Operations Research*, 2013-2016.
- *Operations Research*, 2012-2017.
- *Operations Research Letters*, 2012.
- *Probability in the Engineering and Informational Sciences*, 2016.
- *Production and Operations Management*, 2012, 2016.
- *SIAM Journal on Optimization*, 2014.

Reviewer for the following edited volumes:

- *Modeling and Optimization: Theory and Applications* (Springer Proceedings in Mathematics), 2011.

Reviewer for the following conferences:

- Hawaii International Conference on System Sciences, 2011, 2013.
- IEEE Conference on Decision and Control, 2012, 2014.
- IEEE International Conference on Automation Science and Engineering, 2015.
- IEEE International Conference on Cybernetics & Intelligent Systems, 2010.
- IEEE International Symposium on Adaptive Dynamic Programming and Reinforcement Learning, 2011.
- Industrial and Systems Engineering Research Conference, 2012-2014.
- International Conference on Computational Science, 2011.
- ISB-POMS Workshop on Socially Responsible Operations and Supply Chains, 2014.
- Winter Simulation Conference, 2011-2016.

Organizational work for the following conferences:

- Award Committee, Industrial and Systems Engineering Research Conference, 2012-2013.
- Award Committee, Winter Simulation Conference, 2013, 2015.
- Program Committee, International Workshop on Computational Stochastics, 2011.

- Program Committee, Winter Simulation Conference:
 - Analysis Methodology track, 2016.
 - Simulation for Decision Making track, 2013.
 - Simulation Optimization track, 2013, 2016-2017.
 - Poster track, 2016.
- Session Organizer, Industrial and Systems Engineering Research Conference, 2012.
- Session Organizer, INFORMS Annual Meeting, 2011-2015.
- Session Organizer, INFORMS Computing Society Conference, 2015.
- Session Organizer, Winter Simulation Conference, 2013.
- Track Chair, Winter Simulation Conference, 2014-2015.

Other service work:

- Award Committee, William P. Pierskalla Best Paper Prize, 2013-2014.
- Award Committee, George Nicholson Student Paper Competition, 2014-2015.
- Membership Committee, INFORMS Simulation Society, 2012-2015.
- Faculty Search Committee, University of Maryland, 2015.
- Organizer, Operations Management Seminar, University of Maryland, 2012-2015.
- Organizer, Research Interaction Team, Applied Mathematics, University of Maryland, 2012.
- Panelist, National Science Foundation, 2015.
- Ph.D. Admissions Committee, Applied Mathematics, University of Maryland, 2012.
- Graduate Student Committee, Princeton University, 2009-2011.
- Senior Thesis Writing Group, Princeton University, 2007-2009.

Press Coverage

- Chick, S.E. (2012) “Review of *Optimal Learning*.” In: Greenberg, H.J. (ed.), Book reviews, *INFORMS Journal on Computing* **24**(4).