Abhishek Kumar Umrawal, Ph.D.

✍ Room 3054 ECE Building, Mail Code: 702 | 306 N. Wright St., Urbana, IL 61801

☎ (315) 504-5658 ✉ aumrawal@illinois.edu ☞ ece.illinois.edu/about/directory/faculty/aumrawal

Research Interests

Artificial Intelligence (AI) – Generative AI and Causal AI

Machine Learning (ML) – Statistical Learning and Reinforcement Learning

Theory and Algorithms – Combinatorial Optimization and Approximation Algorithms

Applications – Social Networks, Product Recommendations, and Intelligent Transportation

Academic Appointments

Teaching Assistant Professor Aug. 2023 - Present
Department of Electrical and Computer Engineering
University of Illinois Urbana-Champaign, Urbana, IL

- Collins Scholar 2023-2024
- Grainger Engineers Accelerating Research (GEAR) Scholar 2023-2024

Visiting Lecturer Aug. 2022 - June 2023
Department of Computer Science and Electrical Engineering
University of Maryland, Baltimore County, Baltimore, MD

Education

Purdue University Aug. 2023
College of Engineering
Doctor of Philosophy, Industrial Engineering
Area of Research: Operations Research
Concentration: Computational Engineering
Dissertation: Machine Learning Algorithms for Influence Maximization on Social Networks
Advisors: Dr. Vaneet Aggarwal (Purdue IE and ECE) and Dr. Christopher J. Quinn (Iowa State CS)
Honors: Bilsland Dissertation Fellow (2022) and Trailblazers in Engineering Fellow (2021)

Purdue University May 2021
Mitch E. Daniels, Jr. School of Business
Master of Science, Economics

Indian Institute of Technology (IIT) Kanpur May 2011
Department of Mathematics and Statistics
Master of Science, Statistics

Research Experience

University of Illinois Urbana-Champaign, Urbana, IL

Synergies between Generative AI and Causal AI Jan. 2024 - Present

- Working on understanding how Generative AI can help to achieve the objectives of Causal AI, and vice versa.

Reinforcement Learning-based Taxation Mechanisms to reduce Information Overload Sep. 2023 - Present

- Designing tax mechanisms to reduce information overload using reinforcement learning, and examining them theoretically and empirically.

Machine Learning for Influence Maximization on Social Networks Aug. 2023 - Present

- Improving the implementation of network diffusion models for runtime gains.
- Exploring new community-based strategies for influence maximization on social networks to account for inter-community influence.
- Developing new approximation algorithms for maximizing the spread of influence through a social network under partial incentives with a non-uniform (across users) linear relation between discount and adoption likelihood.

Multi-Armed Bandits and Online Learning Aug. 2023 - Present

- Designing new exploration vs. exploitation strategies for reinforcement learning, and examining them theoretically and empirically.

Purdue University, West Lafayette, IN

Machine Learning for Influence Maximization on Social Networks Aug. 2017 - Aug. 2023

- Developed a community-aware divide-and-conquer framework (SIGMETRICS 2022, TETCI 2023) for maximizing the spread of influence through a social network.
- Developed an approximation algorithm (CDC 2023) for maximizing the spread of influence through a social network under partial incentives.

Multi-Armed Bandits and Online Learning Aug. 2017 - Aug. 2023

- Developed algorithms with improved time, space, and sample complexity for top-k subset selection with non-linear full-bandit feedback (ALT 2021, AAAI 2021, TDS 2022) with applications to online influence maximization.
- Developed a combinatorial-bandit algorithm for n choose k subset selection with submodular full-bandit feedback (UAI 2022) with applications to product recommendation and online influence maximization.

Causal Artificial Intelligence for Randomized Experiments Aug. 2017 - May 2023

- Developed a causality-based graphical test for obtaining an optimal blocking set for randomized experiments (CLeaR 2023).

Machine Learning for Statistical Power Analysis Jan. 2021 - Dec. 2022

- Developed a genetic algorithm-based solution (IMPS 2022) for learning the statistical power surface for problems involving high-dimensional parameter space.

Deep Reinforcement Learning for Efficient and Intelligent Transportation Jan. 2020 - Jan. 2021

- Developed deep reinforcement learning algorithms for shared passengers and goods delivery with multi-hop ride-sharing (T-ITS 2021) and package delivery with multi-transfer freight delivery (ICAPS 2021).

Publications

Key citation metrics based on Google Scholar as of May 1, 2024: Citations: 134 and h-index: 6.

Peer-Reviewed Journals

J3. Umrawal, A. K., Quinn, C. J., and Aggarwal, V. (2023). A Community-Aware Framework for Social Influence Maximization. *IEEE Transactions on Emerging Topics in Computational Intelligence (TETCI), 7(4), 1253-1262.* (Impact Factor: 4.851.)

J2. Agarwal, M., Aggarwal, V., Umrawal, A. K., and Quinn, C. J. (2022). Stochastic Top-k Subset Bandits with Linear Space and Non-Linear Feedback with Applications to Social Influence Maximization. *ACM/IMS Transactions on Data Science (TDS), 2(4), 1–39.* (Impact Factor: 1.720.)

J1. Manchella, K., Umrawal, A. K., and Aggarwal, V. (2021). FlexPool: A Distributed Model-Free Deep Reinforcement Learning Algorithm for Shared Passengers and Goods Delivery. *IEEE Transactions on Intelligent Transportation Systems (T-ITS), 22(4), 2035-2047.* (Impact Factor: 9.551.)

Peer-Reviewed Conferences

C8. Umrawal, A. K., Aggarwal, V. and Quinn, C. J. (2023). Fractional Budget Allocation for Influence Maximization. *Proceedings of the 62nd IEEE Conference on Decision and Control (CDC), 4327-4332.*

C7. Umrawal, A. K. (2023). Leveraging Causal Graphs for Blocking in Randomized Experiments. *Proceedings of the 2nd Conference on Causal Learning and Reasoning (CLeaR), 213, 1-21.* (Acceptance rate: 45%.)

C6. Nie, G., Agarwal, M., Umrawal, A. K., Aggarwal, V., and Quinn, C. J. (2022). An Explore-then-Commit Algorithm for Submodular Maximization under Full-bandit Feedback. *Proceedings of the 38th Conference on Uncertainty in Artificial Intelligence (UAI), 1541-1551.* (Acceptance rate: 32%.)

C5. Umrawal, A. K., Lane, S. P., and Hennes, E. P. (2022). GeneticPower: A Genetic Algorithm-Based Framework for Learning Statistical Power Manifold. *Quantitative Psychology: Proceedings of the 87th Annual International Meeting of the Psychometric Society (IMPS), 422, 187-196.* (Received the Psychometric Society Travel Award.)

C4. Umrawal, A. K. and Aggarwal, V. (2022). Leveraging the Community Structure of a Social Network for Maximizing the Spread of Influence. *Proceedings of the ACM SIGMETRICS/IFIP PERFORMANCE Joint International Conference on Measurement and Modeling of Computer Systems Poster Presentations – ACM SIGMETRICS Performance Evaluation Review (PER), 50(4), 17-19.* (Received the SIGMETRICS Travel Award.)

C3. Chen, J., Umrawal, A. K., Lan, T., and Aggarwal, V. (2021). DeepFreight: A Model-Free Deep-Reinforcement-Learning-Based Algorithm for Multi-Transfer Freight Delivery. *Proceedings of the 31st International Conference on Automated Planning and Scheduling (ICAPS), 31, 510-518.* (Acceptance rate: 29%).

C2. Agarwal, M., Aggarwal, V., Quinn, C. J., and Umrawal, A. K. (2021). DART: aDaptive Accept RejecT Algorithm for Non-Linear Combinatorial Bandits. *Proceedings of the 35th AAAI Conference on Artificial Intelligence (AAAI), 35(8), 6557-6565.* (Acceptance rate: 21%.)

C1. Agarwal, M., Aggarwal, V., Quinn, C. J., and Umrawal, A. K. (2021). Stochastic Top-k Subset Bandits with Linear Space and Non-Linear Feedback. *Proceedings of the 32nd International Conference on Algorithmic Learning Theory (ALT), 306-339.* (Acceptance rate: 21%.)

Peer-Reviewed Workshops

W4. Umrawal, A. K., and Aggarwal, V. (2022). Community-IM: A Community-Based Algorithm for Social Influence Maximization. *AAAI Workshop on Graphs and Other Complex Structures for Learning and Reasoning (GCLR).*

W3. Umrawal, A. K. (2021). A Causality-Based Graphical Test to Obtain an Optimal Blocking Set for Randomized Experiments. *NeurIPS Workshop on Causal Inference Challenges in Sequential Decision Making: Bridging Theory and Practice (CSDNeurIPS).*

W2. Umrawal, A. K., and Chan, J. C. C. (2021). On Parameter Estimation in Unobserved Components Models subject to Linear Inequality Constraints. *NeurIPS Workshop on Machine Learning meets Econometrics (MLECON).*

W1. Manchella, K., Umrawal, A. K., and Aggarwal, V. (2020). FlexPool: A Distributed Model-Free Deep Reinforcement Learning Algorithm for Shared Passengers and Goods Delivery. *ACM Computer Science in Cars Symposium (CSCS).*

Under Review

R3. Robson, E., Reddy, D., and Umrawal, A. K. (2024). CyNetDiff: A Python Library for Accelerated Implementation of Network Diffusion Models. *Under review for International Conference on Very Large Data Bases (VLDB).*

R2. Umrawal, A. K., Aggarwal, V., and Quinn, C. J. (2023). Maximizing the Spread of Influence through a Social Network using Partial Incentives. *Under review for Journal of Artificial Intelligence Research (JAIR).*

R1. Agarwal, M., Aggarwal, V., Quinn, C. J., and Umrawal, A. K. (2023). DART: aDaptive Accept RejecT for Non-Linear Top-k Subset Identification. *Under review for the Journal of Machine Learning Research (JMLR), 2nd Round.*

Teaching Experience

Teaching Assistant Professor of Electrical and Computer Engineering Aug. 2023 - Present
University of Illinois Urbana-Champaign, Urbana, IL

CS/ECE 374 Introduction to Algorithms and Models of Computation.

Visiting Lecturer of Computer Science Aug. 2022 - June 2023
University of Maryland, Baltimore County, Baltimore, MD

CMSC 451 Automata Theory and Formal Languages, CMSC 471 Introduction to Artificial Intelligence, CMSC 478 Introduction to Machine Learning, and CMSC 447 Software Engineering - I.

Graduate Instructor of Mathematics Aug. 2020 - Dec. 2020
Purdue University, West Lafayette, IN

Recitation Instructor for MA 162 Plane Analytic Geometry and Calculus II.

Graduate Teaching Assistant Aug. 2017 - May 2020
Purdue University, West Lafayette, IN

IE 335 Operations Research - Optimization, IE 546 Economic Decisions in Engineering, IE 330 Probability and Statistics in Engineering II, NCN URE Summer 2018, ENGR 133 Transforming Ideas to Innovation EPICS, ENGR 132 Transforming Ideas to Innovation II, and ENGR 131 Transforming Ideas to Innovation I.

Instructor of Mathematics and Economics June 2019 - Aug. 2019
Johns Hopkins University, Baltimore, MD

Designed and instructed an advanced course titled Game Theory and Economics (GMTH) to academically gifted students for the Johns Hopkins Center for Talented Youth at the University of California Santa Cruz site.

Instructor of Statistics Jan. 2013 - Aug. 2017
University of Delhi, New Delhi, India

Paper 401 Econometrics and Time Series Analysis, Paper 404-406 (vi) Advanced Statistical Computing and Data Mining, Paper 102 Probability Theory, and Lab Courses in SPSS, R, MATLAB, and C.

Visiting Instructor of Business Analytics April 2015 - July 2017
Bridge School of Management, New Delhi, India

Module 2 Modeling Methods, Module 3 Advanced Modeling Methods, and Module 4 Analytics Communication and Management, in collaboration with Northwestern University.

Visiting Instructor of R Programming Dec. 2015 - Aug. 2016
WeekendR, New Delhi, India

Conceived, designed, and delivered the invited training program Programming and Predictive Modeling using R for aspiring and currently working analytics and management professionals.

Industry Experience

Marketing Analyst June 2011 - Nov. 2012
Accenture Management Consulting, Gurugram, India

Worked on promotional marketing, pricing strategy, and sales forecasting for clients from retail, finance, and telecom using SAS, VBA, and MS Excel.

Certifications

Deep Learning Specialization offered by deeplearning.ai, Feb. 2018 - Aug. 2018.

Probabilistic Graphical Models Specialization offered by Stanford University, Nov. 2017 - Feb. 2018.

Managerial Economics and Business Analysis Specialization offered by UIUC, July 2016 - Jan. 2017.

Data Science Specialization offered by Johns Hopkins University, May 2014 - May 2015.

Software Skills

Python - TensorFlow, PyTorch, R, SAS, MATLAB, SPSS, Tableau, MS-Excel, VBA, C, BASIC, LaTeX

Invited Talks, Lectures, and Workshops

'Fractional Budget Allocation for Influence Maximization on Social Networks'. Department of Computer Science and Engineering, Indian Institute of Technology Delhi, Jan. 08, 2024.

'Fractional Budget Allocation for Influence Maximization on Social Networks'. School of Computing, National University of Singapore, Dec. 13, 2023.

'Fractional Budget Allocation for Influence Maximization on Social Networks'. Signals, Inference, and Networks (SINE) Group Seminar, University of Illinois Urbana-Champaign, Sep. 18, 2023.

'A Genetic Algorithm-based framework for learning Statistical Power Manifold'. Mathematical and Computational Psychology (MCP) Colloquium, Department of Psychological Sciences, Purdue University, Nov. 1, 2021.

'Introduction to Economics and Finance for Engineering Undergraduates'. Purdue Society of Professional Engineers (PSPE), Purdue University, Feb. 18, 2019.

'Skill Training in Data Analytics'. Center for Science Education and Communication (CSEC), University of Delhi, India, June 20 - June 24, 2017.

'Introduction to SAS and SAS Analytics'. Bridge School of Management, India, Sep. 26 - Nov. 14, 2016.

'Market Basket Analysis using R'. FORE School of Management, India, Aug. 28, 2016.

'Programming and Predictive Modeling using R'. Weekendr Innovation Labs, India, April 02 - April 30; June 03 - July 03; and July 10 - Aug. 06, 2016.

'SPSS Winter Training'. Weekendr Innovation Labs, India, Dec. 20, 2015 - Jan. 09, 2016.

'Visual Analytics through R'. Bridge School of Management, India, Oct. 10, 2015.

'Econometric Modeling and Statistical Simulation using SPSS'. IIS University, India, March 18 - March 19, 2014.

Grants, Fellowships, and Awards

'Research Travel Grant' by the IEEE Control Society, Sep. 2023. [$944]

'Research Travel Grant' by the College of Engineering, Purdue University, Feb. 2023. [$500]

'Grad-Track Mentorship' by the College of Engineering, Purdue University, May 2022. [$1000]

'Student Travel Grant' by ACM SIGMETRICS, May 2022. [$1617]

'Bilsland Dissertation Fellowship' by the Graduate School, Purdue University, May 2022. [$64,272]

'Certificate of Excellence in Research' by the Office of Interdisciplinary Graduate Programs (OIGP), Purdue University, May 2022.

'Student Travel Award for International Meeting' by Psychometric Society, April 2022. [$1000]

'Winner in Poster Competition' by ABE Grad Student Association, Purdue University, March 2022. [$100]

'Trailblazers in Engineering (TBE) Fellowship' by the College of Engineering, Purdue University, Oct. 2021. [$500]

'Grad-Track Mentorship' by the College of Engineering, Purdue University, Aug. 2021. [$1000]

'Runner-up in Poster Competition' by ABE Graduate Student Association, Purdue University, Feb. 2021. [$25]

'Summer Project Mentor' by the School of Industrial Engineering, Purdue University, May 2020. [$1000]

'Graduate Mentor Award' by Vertically Integrated Projects (VIP), Purdue University, April 2020. [$250]

'OSG User School Travel Grant' by Open Science Grid (OSG), April 2019, April 2020.

'Cum Laude for INFORMS Student Chapter' by INFORMS, Oct. 2019.

'Faculty Excellence Award' by Bridge School of Management, Dec. 2015.

'Management Consulting Rockstar Sales Award' by Accenture, June 2012.

'Ranked 5th in Master Degree' at IIT Kanpur, 2011.

'Junior Research Fellowship (JRF)' in Joint CSIR-UGC National Eligibility Test (NET), Dec. 2010.

Academic Service

'Reviewer' for International Conference on Machine Learning (ICML), March 2024.

'Reviewer' for Conference on Uncertainty in Artificial Intelligence (UAI), Jan. 2024.

'Reviewer' for Conference on Causal Learning and Reasoning (CLeaR), Sep. 2023.

'Reviewer' for Conference on Uncertainty in Artificial Intelligence (UAI), Jan. 2023.

'Reviewer' for Pacific Asia Conference on Knowledge Discovery in Data Mining (PAKDD), Dec. 2022.

'Reviewer' for Workshop on Graphs and Other Complex Structures for Learning and Reasoning (GCLR), Association for Advancement in Artificial Intelligence (AAAI), Nov. 2022.

'Reviewer' for IEEE Transactions on Intelligent Transportation (T-ITS), Nov. 2022, Jan. 2023.

'Reviewer' for European Conference of Machine Learning (ECML), April 2022.

'Volunteer' for Neural Information Processing Systems (NeurIPS), Dec. 2021.

'Reviewer' for Springer Transportation Research Part E: Logistics and Transportation Review, Aug. 2021.

'Reviewer' for IEEE/ACM Transactions on Networking, Oct. 2020, Feb. 2021.

'Reviewer' for AISTATS - International Conference on Artificial Intelligence and Statistics, Oct. 2020.

Professional Memberships

'Member' of the Institute of Electrical and Electronics Engineers (IEEE).

'Member' of the IEEE Computational Intelligence Society (CIS).

'Member' of the IEEE Control Systems Society (CSS).

Leadership Experience

'President' at INFORMS Student Chapter, Purdue University, May 2019 - Aug. 2022.

'Computational Interdisciplinary Graduate Program (CIGP) Representative' at Interdisciplinary Graduate Program Student Advisory (IGPSA) Board, Purdue University, May 2019 - Aug. 2023.

'Treasurer' at INFORMS Student Chapter, Purdue University, Aug. 2018 - May 2019.

'Academic Affairs Chair' at IE Grad Student Organization (IEGSO), Purdue University, Aug. 2018 - May 2019.

'Social Events Chair' at IE Grad Student Organization (IEGSO), Purdue University, Nov. 2017 - May 2019.

'Volunteer Manager - Jashn-e-Rekhta 2017' at Rekhta Foundation, Feb. 2017.

'Faculty Coordinator' at Udaan, Department of Statistics, University of Delhi, Aug. 2016 - Aug. 2017.

In the News

My work on causal artificial intelligence was tweeted by Prof. Judea Pearl. Links: 1, 2.

Last updated on May 1, 2024.