Rafid Mahmood

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Ottawa, Ontario, Canada

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Employment

University of Ottawa, Telfer School of Management

Assistant Professor 2023–pres.

NVIDIA Corporation

Senior Research Scientist 2022–pres.

AI Resident Researcher 2020–2022

Education

University of Toronto, Mechanical and Industrial Engineering

Ph.D Industrial Engineering 2015–2020

Vector Institute for Artificial Intelligence Postgraduate Affiliate 2019–2020

University of Toronto, Electrical and Computer Engineering

M.A.Sc. Electrical Engineering 2013–2015

Honors B.A.Sc. Electrical Engineering 2008–2013

Publications [1]

Working Papers and Pre-Prints

1. **No Need to Sacrifice Data Quality for Quantity: Crowd-Informed Machine Annotation for Cost-Effective Understanding of Visual Data**
   C. Klugmann*, R. Mahmood, G. Hegde, A. Kale, and D. Kondermann
   working paper, 2024.

2. **AutoScale: Automatic Prediction of Compute-optimal Data Compositions for Training LLMs**
   F. Kang*, Y. Sun, B. Wen, S. Chen, D. Song, R. Mahmood, and R. Jia
   under review, 2024.

3. **Can Feedback Enhance Semantic Grounding in Large Vision-Language Models?**
   Y.-H. Liao*, R. Mahmood, S. Fidler, and D. Acuna
   under review, 2024.

4. **Deep Learning-Assisted Appointment Scheduling Under Uncertainty**
   A. Moosavi*†, O. Ozturk, R. Mahmood, and J. Patrick
   under review, 2024.

[1] Some articles (e.g., INFORMS journals) were published with alphabetical author ordering. The primary author is denoted with *. Supervised students are denoted with †.

5. **Optimizing Data Collection for Machine Learning**
   R. Mahmood*, J. Lucas, J. M. Alvarez, S. Fidler, and M. T. Law
   under review in Journal of Machine Learning Research (JMLR), 2023.
   - Preliminary version at NeurIPS 2022.
   - Presented at INFORMS 2023 Workshop on Data Science & Data Mining Workshop.

Published Journal Articles and Conference Proceedings

6. **Prospective Human Validation of Artificial Intelligence Interventions in Cardiology: A Scoping Review**
   A. Moosavi*, S. Huang*, M. Vahabi†, B. Motamedivafa, N. Tian, R. Mahmood, P. Liu, and C. L. F. Sun
   Journal of the American College of Cardiology (JACC): Advances, 2024.

7. **Learning to Optimize Contextually Constrained Problems for Real-Time Decision Generation**
   A. Babier, T. C. Y. Chan, A. Diamant, and R. Mahmood*
   accepted in Management Science (MS), 2024.

8. **Translating Labels to Solve Annotation Mismatches Across Object Detection Datasets**
   Y.-H. Liao*†, J. Lucas, R. Mahmood, V. Prabhu†, D. Acuna, and S. Fidler
   International Conference on Learning Representations (ICLR), 2024.

9. **Inverse Optimization: Theory and Applications**
   T. C. Y. Chan, R. Mahmood*, and I. Y. Zhu*
   accepted in Operations Research (OR), 2023.

10. **Got (Optimal) Milk? Pooling Donations in Human Milk Banks with Machine Learning and Optimization**
    T. C. Y. Chan, R. Mahmood, D. L. O'Connor, D. Stone, S. Unger, R. K. Wong*†, and I. Y. Zhu
    accepted in Manufacturing & Services Operations Management (M&SOM), 2023.
    - **First Place for Pierskalla Best Paper Award.**
    - **Finalist for MSOM 2023 Practice-Based Research Competition.**
    - **Runners' Up (second place) for POMS 2023 College of Healthcare Operations Management (CHOM) Best Paper Award.**
    - **Runners' Up (second place) for INFORMS 2024 Innovative Applications in Analytics Award (IAAA).**
    - **Finalist for INFORMS 2023 Public Sector Operations Research (PSOR) Best Video Award.**
    - **Honorable Mention (third place) for CORS 2023 Practice Prize Competition.**
    - Preliminary version at The Journal of Nutrition.
    - Presented at MSOM 2023 Healthcare SIG.

11. **Bridging the Sim2Real Gap with CARE: Supervised Detection Adaptation with Conditional Alignment and Reweighting**
    V. Prabhu*†, D. Acuna, Y.-H. Liao†, R. Mahmood, M. T. Law, J. Hoffman, S. Fidler, and J. Lucas
    Transactions on Machine Learning Research (TMLR), 2023.

12. **Optimizing Data Collection for Machine Learning**
    R. Mahmood*, J. Lucas, J. M. Alvarez, S. Fidler, and M. T. Law
    Neural Information Processing Systems (NeurIPS), 35, 29915–29928, 2022.

13. **How Much More Data Do I Need? Estimating Requirements for Downstream Tasks**
R. Mahmood*, J. Lucas, D. Acuna, D. Li, J. Philion, J. M. Alvarez, Z. Yu, S. Fidler, and M. T. Law
Computer Vision and Pattern Recognition (CVPR), 275–284, 2022.

14. **Low Budget Active Learning via Wasserstein Distance: An Integer Programming Approach**
R. Mahmood*, S. Fidler, and M. T. Law
International Conference on Learning Representations (ICLR), 2022.

15. **OpenKBP-Opt: An International and Reproducible Evaluation of 76 Knowledge-Based Planning Pipelines**
A. Babier*, R. Mahmood, B. Zhang, V. G. L. Alves, A. M. Barragán-Montero, J. Beaudry, C. E. Cardenas, Y. Chang, Z. Chen, J. Chun, K. Diaz, H. D. Eraso, E. Faustmann, S. Gaj, S. Gay, M. Gronberg, B. Guo, J. He, G. Heilemann, S. Hira, Y. Huang, F. Ji, D. Jiang, J. C. J. Giraldo, H. Lee, J. Lian, S. Liu, K. Liu, J. Marrugo, K. Miki, K. Nakamura, T. Netherton, D. Nguyen, H. Nourzadeh, A. F. I. Osman, Z. Peng, J. D. Q. Muñoz, C. Ramsl, D. J. Rhee, J. D. Rodriguez, H. Shan, J. V. Siebers, M. H. Soomro, K. Sun, A. U. Hoyos, C. Valderrama, R. Verbeek, E. Wang, S. Willems, Q. Wu, X. Xu, S. Yang, L. Yuan, S. Zhu, L. Zimmermann, K. L. Moore, T. G. Purdie, A. L. McNiven, and T. C. Y. Chan
Physics in Medicine & Biology, 67 (18), 2022.

16. **An Ensemble Learning Framework for Model Fitting and Evaluation in Inverse Linear Optimization**
A. Babier, T. C. Y. Chan, T. Lee, R. Mahmood*, and D. Terekhov
INFORMS Journal on Optimization (IJOO), 3 (2), 119–138, 2021.
    - Presented at CORS 2020 Canadian Healthcare Optimization Workshop.
    - **Honorable Mention (second place) for CORS 2018 Best Student Paper Competition.**

17. **Prediction of Protein and Fat Content in Human Donor Milk Using Machine Learning**
R. K. Wong*†, M. A. Pitino, R. Mahmood, I. Y. Zhu, D. Stone, S. Unger, D. L. O'Connor, and T. C. Y. Chan
The Journal of Nutrition, 2021.

18. **OpenKBP: The Open-access Knowledge-Based Planning Grand Challenge and Dataset**
A. Babier*, B. Zhang, R. Mahmood, K. Moore, T. Purdie, A. McNiven, and T. C. Y. Chan
Medical Physics, 48 (9), 5549–5561, 2021.

19. **Sampling from the Complement of a Polyhedron: An MCMC Algorithm for Data Augmentation**
T. C. Y. Chan, A. Diamant, and R. Mahmood*
Operations Research Letters (ORL), 48 (6), 744–751, 2020.

20. **The Importance of Evaluating the Complete Knowledge-Based Planning Pipeline**
A. Babier*, R. Mahmood, A. McNiven, A. Diamant, and T. C. Y. Chan
Physica Medica: European Journal of Medical Physics, 72, 73–79, 2020.
    - Preliminary version at ICCR 2019.

21. **AutoAudio: Deep Learning for Automatic Audiogram Interpretation**
M. J. Crowson*, A. Hamour, R. Mahmood, A. Babier, V. Lin, D. Tucci, and T. C. Y. Chan
Journal of Medical Systems, 44 (163), 2020.

22. **Predicting Post-Operative Cochlear Implant Performance Using Supervised Machine Learning**
M. J. Crowson*, P. Dixon, R. Mahmood, J. W. Lee, D. Shipp, T. Le, V. Lin, J. Chen, and T. C. Y. Chan
Otology & Neurotology, 41 (8), 1013–1023, 2020.

23. **The Importance of Evaluating the Complete Knowledge-based Automated Planning Pipeline**
A. Babier*, R. Mahmood, A. McNiven, A. Diamant, and T. C. Y. Chan
International Conference on the Use of Computers in Radiotherapy (ICCR), 2019.

24. **Knowledge-based Automated Treatment Planning with Three-dimensional Generative Adversarial Networks**
A. Babier*, R. Mahmood, A. McNiven, A. Diamant, and T. C. Y. Chan
Medical Physics, 47 (2), 297–306, 2019.

    – Presented at NeurIPS 2018 ML4H Workshop.

25. **Streaming Codes for Multiplicative-Matrix Channels with Burst Rank Loss**
R. Mahmood*, A. Badr, and A. Khisti
IEEE Transactions on Information Theory (IT), 64 (7), 5296–5311, 2018.

    – Preliminary version at ISIT 2016.

26. **Automated Treatment Planning in Radiation Therapy with Generative Adversarial Networks**
R. Mahmood*, A. Babier, A. McNiven, A. Diamant, and T. C. Y. Chan
Machine Learning for Healthcare (MLHC), PMLR 85, 484–499, 2018.

    – **Runners' Up (second place) for CORS 2019 Health Care Operations Research (HCOR) Student Presentation Competition.**

27. **Convolutional Codes with Maximum Column Sum Rank for Network Streaming**
R. Mahmood*, A. Badr, and A. Khisti
IEEE Transactions on Information Theory (IT), 62 (6), 3039–3052, 2016.

    – Preliminary version at ISIT 2015.

28. **Low Delay Network Streaming Under Burst Losses**
R. Mahmood*, A. Badr, and A. Khisti
IEEE International Symposium on Information Theory (ISIT), 2898–2902, 2016.

29. **Convolutional Codes with Maximum Column Sum Rank for Network Streaming**
R. Mahmood*, A. Badr, and A. Khisti
IEEE International Symposium on Information Theory (ISIT), 2271–2275, 2015.

30. **Embedded MDS Codes for Multicast Streaming**
A. Badr*, R. Mahmood, and A. Khisti
IEEE International Symposium on Information Theory (ISIT), 2276–2280, 2015.

Media Articles

31. **Optimizer for the 2021 NHL Expansion Draft**
M. Shin*, Y. Shalaby*, A. Loa*, B. Potter*, T. C. Y. Chan, and R. Mahmood
OR/MS Today, 48 (5), 52–54, 2021.

Patents

32. **Addressing Object Detection Annotation Biases Misalignment via Label Translation**
D. A. Marrero, R. Mahmood, J. Lucas, A. Liao, S. Fidler
US Patent Application Number 18/243612, filed September 2023.

33. **Translating Synthetic Image Labels to Improve Model Performance on Real-world Datasets and Applications**
A. Liao, D. A. Marrero, J. Lucas, R. Mahmood, S. Fidler, V. Prabhu
US Patent Application Number 18/366394, filed Aug 2023.

34. **Estimating Optimal Training Data Set Sizes For Machine Learning Model Systems And Applications**
R. Mahmood, J. Lucas, Z. Yu, J. M. Alvarez Lopez, S. Fidler, and M. T. Law
US Patent Number 2023/0376849 A1, published Nov 2023.

35. **Estimating Optimal Training Data Set Size For Machine Learning Model Systems And Applications**
R. Mahmood, J. Lucas, D. A. Marrero, D. Li, J. Philion, J. M. Alvarez Lopez, S. Fidler, and M. T. Law
US Patent Number 2023/0385687 A1, published Nov 2023.

36. **Optimized Active Learning Using Integer Programming**
R. Mahmood, S. Fidler, and M. T. Law
US Patent Number 2023/0244985 A1, published Aug 2023.

Presentations

Invited Seminars

ICCV Tutorial on Learning with Noisy and Unlabeled Data for Large Models beyond Categorization	2023
University of Toronto Rotman School of Management	2023
University of Ottawa Center for a Responsible Wealth Transition (CRWT)	2022
Wilfrid Laurier University Lazaridis School of Business and Economics	2022
University of Ottawa Telfer School of Management	2022
University of Hong Kong IMSE Department	2022
Rutgers University ISE Department	2021
University of North Carolina Kenan-Flagler Business School	2021
University of Cincinnati Lindner College of Business	2021
University of Iowa IE + EE Department	2021
University of Calgary CS Department	2021
University of Edinburgh Business School	2021
University of Alberta Alberta School of Business	2020
NVIDIA Toronto AI Lab	2020
University of Pittsburgh IE Department	2020
Université de Montréal GERAD	2019

Conferences[2]

Operations for New Machine Learning Products by Optimally Stopping Data Collection

– INFORMS Annual Meeting, Seattle, WA, USA 2024

Optimizing Data Collection for Machine Learning

– INFORMS Annual Meeting, Phoenix, AZ, USA 2023
– INFORMS Workshop on Data Science, Phoenix, AZ, USA 2023
– MSOM Conference, Montréal, QC, Canada 2023

Got (Optimal) Milk? Pooling Donations in Human Milk Banks with Machine Learning and Optimization

– MSOM Healthcare SIG Conference, Montréal, QC, Canada 2023
– POMS Conference, Orlando, FL, USA 2023

Low Budget Active Learning: An Integer Programming Approach

– CORS Annual Conference, Vancouver, BC, Canada 2022
– INFORMS Annual Meeting, Anaheim, CA, USA 2021

Learning to Optimize with Hidden Constraints

– POMS Conference, Orlando, FL, USA 2022
– CORS Annual Conference, Toronto, ON, Canada 2021
– INFORMS Annual Meeting, Washington, DC, USA 2020
– INFORMS Annual Meeting, Seattle, WA, USA 2019
– CORS Annual Conference, Saskatoon, SK, Canada 2019

An Ensemble Learning Framework for Inverse Linear Optimization

– INFORMS Health Care, Boston, MA, USA 2019
– CORS Annual Conference, Saskatoon, SK, Canada 2019
– CORS Annual Conference, Halifax, NS, Canada 2018
– INFORMS Annual Meeting, Houston, TX, USA 2017
– CORS Annual Conference, Quebec City, QC, Canada 2017
– INFORMS Annual Meeting, Nashville, TN, USA 2016

Automated Treatment Planning with Generative Adversarial Networks

– CORS Annual Conference, Saskatoon, SK, Canada 2019
– MLHC Conference, Palo Alto, CA, USA 2018

Convolutional Codes with Maximum Column Sum Rank for Network Streaming

– IEEE ISIT, Hong Kong, HK, China 2015

[2]Presentations are categorized by the abbreviated main paper discussed. Actual titles may vary.

Teaching

University of Ottawa

ADM 4307: Business Forecasting Analytics 2024

MGT 5301: Predictive Analytics 2023–2024

ADM 2304: Applications of Statistical Methods in Business 2023–2024

Students Supervised

University of Ottawa

1. Morteza Emadi, *MSc Advisor*, 2024–pres. Co-advised with Michael Mulvey.
2. Hammad Shakir, *MSc Advisor*, 2024
3. Hsuan-Wei Liao, *MSc Advisor*, 2024
4. Tulika Tahiliani, *MSc Advisor*, 2024–pres.
5. Maryam Vahabi, *PhD Advisor*, 2023–pres. Co-advised with Christopher Sun.
6. Shahryar Moradi, *PhD Committee Member*, 2023–pres.
7. Amirhossein Moosavi, *PhD Committee Member*, 2023

NVIDIA

8. Feiyang Kang, *Research Scientist Internship*, 2023. Co-mentored with Nadine Chang, Maying Shen, Marc T. Law, James Lucas, and Jose M. Alvarez.
9. Nikita Durasov, *Research Scientist Internship*, 2023. Co-mentored with Jiwoong Choi, Marc T. Law, James Lucas, and Jose M. Alvarez.
10. Andrew Yuan-Hong Liao, *Research Scientist Internship*, 2022–2023. Co-mentored with David Acuna, James Lucas, and Sanja Fidler.
11. Viraj Prabhu, *Research Scientist Internship*, 2022. Co-mentored with David Acuna, Marc T. Law, James Lucas, and Sanja Fidler.

Grants

1. CIHR Project Grant, Co-Investigator, 2024–2029 ($1 450 725).
2. SSHRC Insight Development Grant, Co-Investigator, 2024–2026 ($68 000).
3. NSERC Discovery Grant, Principal Investigator, 2023–2027 ($160 000).
4. NSERC Discovery Grant ECR Launch Supplement, Principal Investigator, 2023–2024 ($12 500).
5. University of Ottawa SEED Funding Opportunity, Principal Investigator, 2023 ($20 000).
6. Telfer School of Management Start-up Grant, Principal Investigator, 2023-2024 ($40 000).

Awards

1. Runners' Up, Innovative Applications in Analytics Award, INFORMS, 2024.
2. First Place, Pierskalla Best Paper Award, INFORMS, 2023.
3. Finalist, Public Sector Operations Research (PSOR) Best Video Award, INFORMS, 2023.
4. *(Declined)* Semi-Finalist, Wagner Prize Competition, INFORMS, 2023.
5. Finalist, Practice-Based Research Competition, MSOM, 2023.
6. Finalist, Practice Prize Award, CORS, 2023.
7. Runners' Up, College of Healthcare Operations Management (CHOM) Best Paper Prize, POMS, 2023 ($250).
8. University of Toronto Doctoral Completion Award, 2019–2020 ($8 000).
9. Runners' Up, Health Care Operations Research Student Presentation Competition, CORS, 2019.
10. Postgraduate Affiliate Award, Vector Institute for Artificial Intelligence, 2019 ($12 000).
11. Honourable Mention, Student Paper Competition: Open Category, CORS, 2018 ($100).
12. Postgraduate Doctoral Scholarship, NSERC, 2017 ($42 000).
13. First Place, Waterfront International Ltd. Quantathon, 2016 ($7 500).

Other Professional Experience

NHL Expansion Draft Optimizer 2017, 2021

`http://nhlexpansiondraft.com`

Back-end Software Developer (2017), Adviser (2021)

We deployed a web app simulating the 2017 and 2021 NHL Expansion Drafts. Our site was featured in *The Toronto Star*, *OR/MS Today*, and *The Seattle Times*.

OpenKBP Grand Challenge 2019–2020

`https://www.aapm.org/GrandChallenge/OpenKBP/`

Machine Learning Expert

We organized an international competition for automating radiation therapy dose treatments in head-and-neck cancer, featuring 28 teams of 195 participants. We also released the public-access OpenKBP Data Set containing 400 treatments.

Opus One Solutions, Toronto, ON, Canada 2019

Power Systems Optimization Expert (Consultant)

Service

Ad-hoc Referees

Grants

SSHRC Insight Grant (External Reviewer) 2024

Journals

Operations Research; INFORMS Journal on Computing; Computers and Operations Research; European Journal of Operational Research; Health Care Management Science; IEEE Transactions on Knowledge and Data Engineering; IEEE Transactions on Cybernetics; IISE Transactions

Conferences

NeurIPS 2020–2024; ICML 2021–2024; ICLR 2022–2024; IEEE ISIT 2017, 2022; ACM CHIL 2020–2021; NeurIPS ML4H Workshop 2019–2020

Committees

INFORMS HAS Pierskalla Award Committee Co-Chair	2023
Telfer Business Healthcare Society Faculty Advisor	2023–2024
University of Ottawa UCaaS Steering Committee Member	2022–2023

Personal

Languages: English (fluent), French (beginner)

Citizenship: Canadian