# Anuj Mahajan

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## Research Interests

Reinforcement Learning, Multi-Agent Systems, AI & Generalization, Computational Learning Theory, Game Theory, Continual Learning, Representation Learning, Safety & Alignment in AI, Large-scale AI, Probability & ML, Optimization

## Education

2017–Current **Doctor of Philosophy in Computer Science**, *University of Oxford*, U.K., Supervisor: Prof. Shimon Whiteson.

2011–2016 **Master of Technology in Computer Science & Engg (Dual degree)**, *Indian Institute of Technology*, Delhi, **Thesis** : Exploring new techniques for MAP Inference in Markov Random Fields.

2011–2016 **Bachelor of Technology in Computer Science & Engg (Dual degree)**, *Indian Institute of Technology*, Delhi.

## Publications[+]

### Conference/Journals

Anuj Mahajan, Mikayel Samvelyan, Lei Mao, Viktor Makoviychuk, Animesh Garg, Jean Kossaifi, Shimon Whiteson, Yuke Zhu, and A Anandkumar. TESSERACT: Tensorised actors for multi-agent reinforcement learning. In *Thirty-eighth International Conference on Machine Learning*. 2021 **[ICML]**.

Tarun Gupta, Anuj Mahajan, Bei Peng, Wendelin Boehmer, and Shimon Whiteson. UNEVEN: Universal value exploration for multi-agent reinforcement learning. In *Thirty-eighth International Conference on Machine Learning*. 2021 **[ICML]**.

Adam Stooke, Anuj Mahajan, Catarina Barros, Charlie Deck, Jakob Bauer, Jakub Sygnowski, Maja Trebacz, Max Jaderberg, Michael Mathieu, Nat McAleese, Nathalie Bradley-Schmieg, Nathaniel Wong, Nicolas Porcel, Roberta Raileanu, Steph Hughes-Fitt, Valentin Dalibard, and Wojciech Marian Czarnecki. Open-ended learning leads to generally capable agents. 2021 **[DeepMind Tech report]**.

Tonghan Wang, Tarun Gupta, Anuj Mahajan, Bei Peng, Shimon Whiteson, and Chongjie Zhang. Rode: Learning roles to decompose multi-agent tasks. In *Ninth International Conference on Learning Representations*. 2021 **[ICLR]**.

Anuj Mahajan, Tabish Rashid, Mikayel Samvelyan, and Shimon Whiteson. MAVEN: Multi-agent variational exploration. In *Thirty-third Conference on Neural Information Processing Systems*. 2019 **[NeurIPS]**.

Anuj Mahajan*, Matthew Fellows*, Tim GJ Rudner, and Shimon Whiteson. VIREL: A variational inference framework for reinforcement learning. In *Thirty-third Conference on Neural Information Processing Systems*. 2019 **[Spotlight, NeurIPS]**.

[+] Full updated list available at Google Scholar: Here
* Equal contribution

Anuj Mahajan and Theja Tulabandhula. Symmetry detection and exploitation for function approximation in deep RL. In *Proceedings of the 16th Conference on Autonomous Agents and MultiAgent Systems*. International Foundation for Autonomous Agents and Multiagent Systems, 2017 **[AAMAS]**.

Happy Mittal, Anuj Mahajan, Vibhav G Gogate, and Parag Singla. Lifted inference rules with constraints. In *Advances in Neural Information Processing Systems 28*, pages 3501–3509. Curran Associates, Inc., 2015 **[NeurIPS]**.

Anuj Mahajan, Sharmistha Jat, and Shourya Roy. Feature selection for short text classification using wavelet packet transform. In *Proceedings of the Nineteenth Conference on Computational Natural Language Learning*, pages 321–326. Association for Computational Linguistics, 2015 **[CoNLL]**.

### Preprints

Anuj Mahajan, Mikayel Samvelyan, Tarun Gupta, Benjamin Ellis, Mingfei Sun, Tim Rocktäschel, and Shimon Whiteson. Generalization in cooperative multi-agent systems. 2022 **[arXiv]**.

Benjamin Ellis, Skander Moalla, Mikayel Samvelyan, Mingfei Sun, Anuj Mahajan, Jakob Foerster, and Shimon Whiteson. Smacv2: A new benchmark for cooperative multi-agent reinforcement learning. 2022 **[OpenReview]**.

Mingfei Sun, Anuj Mahajan, Katja Hofmann, and Shimon Whiteson. Softdice for imitation learning: Rethinking off-policy distribution matching. 2021 **[arXiv]**.

Anuj Mahajan and Theja Tulabandhula. Symmetry learning for function approximation in reinforcement learning. 2017 **[arXiv]**.

### Workshops

Anuj Mahajan, Mikayel Samvelyan, Lei Mao, Viktor Makoviychuk, Animesh Garg, Jean Kossaifi, Shimon Whiteson, Yuke Zhu, and A Anandkumar. Reinforcement learning in factored action spaces using tensor decompositions. In *Quantum Tensor Networks in Machine Learning Workshop*. 2021 **[NeurIPS]**.

Pascal Van Der Vaart, Anuj Mahajan, and Shimon Whiteson. Model based multi-agent reinforcement learning with tensor decompositions. In *Quantum Tensor Networks in Machine Learning Workshop*. 2021 **[NeurIPS]**.

Luisa Zintgraf, Maximilian Igl, Kyriacos Shiarlis, Anuj Mahajan, Katja Hofmann, and Shimon Whiteson. Variational task embeddings for fast adaptation in deep reinforcement learning. In *Structure & Priors in RL Workshop*. 2019 **[ICLR]**.

Anuj Mahajan and Theja Tulabandhula. Discovering symmetries for sample efficient reinforcement learning. In *The Multi-disciplinary Conference on Reinforcement Learning and Decision Making*. 2017 **[RLDM]**.

## Patents

USA Method and system for predicting requirements of a user for resources over a computer network, Number: US010417578B2

USA Personalizing application interfaces based on usage, Number: US011112950B2

## Work Experience

### Industrial

2021 **Research Scientist Intern**, *DeepMind*, London, UK.
Open Ended Learning Systems

2020-2021 **Research Intern**, *J.P. Morgan Chase*, London, UK.
Safe Reinforcement Learning for long term decision making with constraints.

2019-2020 **Research Intern**, *NVIDIA*, Santa Clara, USA.
Multi-Agent Reinforcement Learning using tensorised function approximations.

2016-2017 **Research Scientist**, *Xerox Research Centre*.
Worked in the Machine Learning and Statistics Group in the following areas:
- Deep Reinforcement Learning
- Probabilistic Graphical Models
- Ranking for Duelling Bandits

2014 **Research Intern**, *Xerox Research Centre*.
Feature selection methods using Wavelet Packet transforms, published in CoNLL 2015.

### Teaching

2019 **Tutor**.
Tutor for Machine learning for Computer Science & Philosophy undergrads, Trinity term, Hertford College, University of Oxford.

2019 **Teaching Assistant**.
TA for Reinforcement Learning, Hilary term, Autonomous Intelligent Machines and Systems (AIMS), University of Oxford.

2015-2016 **Teaching Assistant**.
TA for the following courses at IIT, Delhi:
- Machine Learning (COL774) Spring semester 2015-16.
- Computer Networks (COL334) Fall semester 2015-16.

### Reviewing & Program Committee

**NeurIPS** Neural Information Processing Systems, 2019, 2020, 2021, 2022
**ICML** International Conference on Machine Learning, 2021
**AISTATS** Artificial Intelligence and Statistics, 2021
**ICLR** International Conference on Learning Representations, 2021, 2023
**JMLR** Journal of Machine Learning Research, 2020
**AAAI** Association for the Advancement of Artificial Intelligence, 2022, 2023
**IEEE** IEEE Transactions on Neural Networks and Learning Systems, 2022
**ELEC** Electronic Commerce Research, Springer, 2018, 2022
**TMLR** Transactions on Machine Learning Research, 2022

## Technical skills

Python, Java, C/C++, Prolog, SQL, Ocaml, Assembly

Pytorch, Tensor Flow, Jax, Docker, Matlab, Android, Eigen, AWS

## Relevant Courses

Advanced Machine Learning, Computational Learning theory, Machine Learning, Probabilistic Graphical Models, Adv. Algorithms, Data Mining, Computer Vision, Theory of Computation, Computational Biology, Molecular Cell Biology

## Scholarships

- Awarded J.P. Morgan AI fellowship 2020.
- Awarded IBM PhD fellowship 2020 (declined).
- Awarded Google Deepmind Scholarship 2017-20 for doctoral studies at University of Oxford.
- Awarded Drapers Hertford graduate Scholarship 2017-20 for doctoral studies at University of Oxford.
- Awarded Microsoft Student Travel Grant for presenting research paper at CoNLL 2015, Beijing, China.
- Awarded Microsoft Student Travel Grant for presenting research paper at NeurIPS 2015, Montreal, Canada.
- Kishore Vaigyanic Protsahan Yojana(KVPY) fellowship awarded by the Department of Science and Technology, Government of India.(**Given to 200 fellows chosen from around one million applicants**)

- Awarded Indian National Association of Engineers (INAE) grant 2015.
- National Talent Search Examination(NTSE) fellowship awarded by NCERT, Department of Education, Government of India.(**500 scholars chosen from around one million applicants**)

## Awards & Achievements

- Uber AI resident 2020 (Program rescinded due to covid19)
- Indian Institute of Technology, Delhi, Institute Merit Award : Received the prestigious IITD merit award given to **top 5% students in the institute**.
- Winner, Microsoft 'code.fun.do' : Programming event organized by Microsoft on 16-17/02/2013
- Won the Award of Excellence in Australian National Chemistry Quiz(ANCQ) for securing **All India Rank - 1** for three consecutive years (2006-08)
- Represented the state at Indian National Mathematics Olympiad and Astronomy Olympiad.
- Secured 8th position in the Regional Mathematical Olympiad, 2008 organized by NBHM, Government of India.
- Best Research Poster award at the Xerox open house 2014 poster presentation event.

## Media

- MIT Technology Review on Open Ended Learning: Link
- DeepMind blog on Generally Capable Agents: Link
- AI plays catch, Two Minute Papers: Link
- Multi-Agent Perspective to AI, talk at GoodAI: Link