Nick Watters

PhD candidate, MIT Department of Brain and Cognitive Sciences
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Education & Employment

2019 - present **Doctor of Philosophy**, *Massachusetts Institute of Technology*, Cambridge MA
Department of Brain and Cognitive Sciences

2016 - 2019 **Research Engineer**, *Google Deepmind*, London UK

2012 - 2016 **Bachelor of Arts**, *Harvard College*, Cambridge, MA
Mathematics and Computer Science major, Neurobiology minor
Magna cum laude with highest honors

Research Experience

2019 - present **MIT Brain & Cognitive Sciences**
Graduate student, advised by Mehrdad Jazayeri & Joshua Tenenbaum

Primate neurophysiology and **cognitive science** research. Collected, analyzed, and modeled non-human primate neural data and human behavioral data.

Ongoing projects:
- Working memory of multiple objects in prefrontal cortex
- Kinematics prediction and intuitive physics in the brain
- Neural mechanisms of real-world scene understanding and object manipulation

2016 - 2019 **Google Deepmind**
Research engineer, neuroscience team

Machine learning research involving model-building, theory, and robotics. **Full stack software engineering** of production-level codebases.

Led research projects on:
- Few-shot learning and generalization in model-based reinforcement learning
- Variational autoencoders for learning disentangled visual representations
- Robust robotic control via unsupervised action space representations
- A relational neural physics engine for video prediction

2014 -2016 **Harvard University**
Undergraduate researcher

Senior thesis, advised by Dr. Shing-Tung Yau: Derived applications of information geometry to backpropagation and expectation-maximization algorithms

Harvard-Amgen Scholar, advised by Dr. Leslie Valiant: Developed neural network models of stable memory allocation in hippocampus. Derived theoretical bounds on model stability and continuity.

Research Intern, Olveczky Lab, Center for Brain Science: Inferred causality from zebra finch electrophysiology data to determine connectivity of brain areas.

2014 **Janelia Research Campus**
Janelia Undergraduate Scholar, advised by Dr. Shaul Druckmann

Theoretical neuroscience. Investigate theoretical derivations of random matrix eigenvalue distributions using statistical mechanics and computational modeling.

2011 - 2013 **The Rockefeller University**

Research Assistant, advised by Dr. George Reeke

Computational neuroscience. Developed novel model-based methods for neuronal spike train entropy estimation. Analyzed the effects of b-estradiol on mouse locomotor behavior and restlessness.

Technical Skills

Biological:

- Acute electrophysiology in nonhuman primates
- Neurosurgery in nonhuman primates
- Animal care and training of nonhuman primates

Computational and theoretical expertise:

- *Neuroscience:* Statistical methods for latent variable modeling in neural data
- *Machine learning:* Deep learning, reinforcement learning, generative modeling
- *Mathematics:* Algebraic topology, differential geometry, dynamical systems

Software engineering:

- Programming languages: Python, Java, Matlab, HTML, C++, C#,, Bash, OCAML
- Example software engineering project: Website, GitHub repo, and paper for Modular Object-Oriented Games library.

Fellowships & Awards

2020 - present National Science Foundation Graduate Research Fellow

2020 - present Computationally Enabled Integrative Neuroscience Training Program

2022 Angus McDonald Award for Excellence in Undergraduate Teaching, MIT

2020 - 2021 Brain and Cognitive Sciences Killian Graduate Fellowship

2020 Champions of the Brain Fellow, MIT

2019 Presidential Graduate Fellow, MIT

2016 Magna cum laude with highest honors, Harvard

2016 Navid Saheb Kashaf Mathematics Prize

2015 Herchel-Smith Undergraduate Research Fellow

Publications

Full publication list: https://scholar.google.com/citations?user=2OSq4Q0AAAAJ

2022 Li J, **Watters N**, et al. Modeling human eye movements with neural networks in a maze-solving task. *Proceedings of Machine Learning Research*, 2022.

2021 **Watters N**, et al. Modular object-oriented games: A task framework for reinforcement learning, psychology, and neuroscience. *arXiv*, 2021.

2019 Greff K, [and 6 others, including **Watters, N**]. Multi-object representation learning with iterative variational inference. *ICML*, 2019.

2019 **Watters N**, et al. Cobra: Data-efficient model-based RL through unsupervised object discovery and curiosity-driven exploration. *arXiv*, 2019.

2019 Burgess C, [and 6 others, including **Watters, N**]. Monet: Unsupervised scene decomposition

and representation. *arXiv*, 2019.

2019 **Watters N**, et al. Spatial broadcast decoder: A simple architecture for learning disentangled representations in VAEs. *arXiv*, 2019.

2019 Duan S, **Watters N**, et al. A heuristic for unsupervised model selection for variational disentangled representation learning. *arXiv*, 2019.

2018 Burgess C, [and 6 others, including **Watters, N**]. Understanding disentangling in β-VAE. *arXiv*, 2018.

2018 Achille A, [and 5 others, including **Watters, N**]. Life-long disentangled representation learning with cross-domain latent homologies. *NeurIPS*, 2018

2017 **Watters N**, et al. Visual interaction networks: Learning a physics simulator from video. *NeurIPS*, 2017.

2014 **Watters N**, et al. Neuronal spike train entropy estimation by history clustering. *Neural Computation*, 2014.

Conference Presentations & Invited Talks

06 / 2023 **McGill MountAIN** seminar. *Neural mechanisms of multi-object representation and prediction in the primate brain.*

03 / 2023 **COSYNE**. *Multi-object memory and prediction in the primate brain.*

11 / 2022 **Society for Neuroscience**. *Multi-object memory and prediction in the primate brain.*

09 / 2022 **Montreal Institute for Learning Algorithms** Neuro-AI seminar. *Multi-object memory and prediction in the primate brain.*

08 / 2022 **Conference on Cognitive Computational Neuroscience**. *Modeling human eye movements with neural networks in a maze-solving task.*

04 / 2022 **Simons Center for the Global Brain**. *Factorized representations for robust dynamics.*

01 / 2022 **BIRS Dynamical Principles of Biological & Artificial Neural Networks**. *Factorized representations for generalization.*

11 / 2019 **MIT Center for Brains, Minds, and Machines** colloquium, 2019. *Unsupervised learning and compositional representations.*

08 / 2019 **Hudson River Trading** research seminar, 2019. *Unsupervised learning and compositional representations.*

10 / 2019 **IBM Watson** research seminar, 2019. *Unsupervised learning and compositional representations.*

07 / 2019 **Max Planck Institute Tübingen** research seminar, 2018. *Unsupervised learning and compositional representations.*

Mentorship & Teaching

2021 - 2022 Mentored undergraduate researcher Jason Li. Co-authored publication and conference presentations.

2020 - 2021 Mentored undergraduate researcher Erica Chiu.

2021 Mentored summer undergraduate research fellow Dagim Belete.

2021 Teaching Assistant, 9.49 Neural Circuits for Cognition.

2020 Teaching Assistant, 9.014 Quantitative Methods in Neuroscience.

2015 Teaching Assistant, undergraduate and graduate applied algebra courses.