

CARL WILLIAM HARRIS

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EDUCATION

Dartmouth College, Hanover, NH

June 2021

B.A., Applied Mathematics and Neuroscience (High Honors), Economics Minor

GPA: 3.88/4.00

- *Honors Thesis*: “DeepAction: A MATLAB toolbox for automated classification of animal behavior in video”
- *Coursework*: Advanced topics in applied mathematics, discrete probability, applied computer science, graph theory, combinatorics, accelerated multivariable calculus, abstract algebra, complex analysis
- *Activities*: Men’s Division I varsity lightweight rowing, study group leader (economics and neuroscience)

AWARDS AND HONORS

Dartmouth College, Hanover, NH

- *Magna cum laude*
- Dartmouth Economics Research Scholar (2019-2021)
- Neukom Scholar (2020)
- David C. Hodgson Endowment for Undergraduate Research Award (2020)
- James O. Freedman Presidential Scholar (2019)
- Academic citations for meritorious performance in *The Price System* (2017), *Microeconomics* (2018), *Topics in Public Economics* (2021), and *Honors Neuroscience Research* (2021)

RESEARCH EXPERIENCE

National Institute of Mental Health, Bethesda, MD

July 2021 –

Postbaccalaureate IRTA, Machine Learning Team and Data Science & Sharing Team

Present

Advisors: Francisco Pereira and Adam Thomas

- Used regularized linear regression models and kernel regression techniques to predict longitudinal mental health outcomes during the COVID-19 pandemic from social, demographic, and behavioral survey responses and electronic health records.
- Implemented and ran simulations on NIH’s Biowulf HPC cluster to evaluate power and Type I error rate of classical two-sample hypothesis tests in detecting context-dependent changes in longitudinal neural recording data, relative to novel decoding approach based on cross-classification accuracy. Wrote corresponding sections of relevant manuscript.
- Led development of an extension to the Neurodata Without Borders (NWB) neurophysiology data standard for holographic photostimulation data. Integrated NWB standard into existing two-photon microscopy processing packages to promote reproducibility and data sharing. Wrote grant application to Kavli Foundation to support project.
- Created pipeline to track macaque pose in 3D from video. Developed tool to segment animal motion in video by fitting stochastically observable keypoints extracted from video to an autoregressive hidden semi-Markov model.

Tse Laboratory (Octopus Lab), Hanover, NH

May 2019 –

Undergraduate Researcher

June 2021

Advisor: Peter U. Tse

- Created MATLAB toolbox for the automated classification of animal behavior in video, using a recurrent neural network classifier trained using features extracted from raw video frames by a convolutional neural network. Includes a novel temperature scaling-based confidence measure to refer uncertain classifications for human review and GUI for video annotation.
- Set up lab’s video cameras to continuously record and upload footage to Dropbox, and integrated Dropbox with program running on Dartmouth’s HPC cluster to extract animal position data from more than 25 Tb of video. Implemented multi-object tracker with global nearest-neighbor assignment to segment individual animals’ movement trajectories.
- Used stereo vision and semantic segmentation to reconstruct octopuses’ bodies in 3D. Used non-rigid point cloud registration to model deformations in body contour over time.

Computational and Cognitive Neuroscience Laboratory, Hanover, NH

Mar. 2019 –

Undergraduate Researcher

June 2021

Advisor: Alireza Soltani

- Analyzed rats’ response to reward feedback in reversal learning task in environments with different reward probabilities. Used generalized linear models and novel information theory-based metrics to examine behavioral differences between discrimination and reversal learning. Fit choice behavior to a reinforcement learning model via MLE.
- Applied novel entropy measures to examine trial-by-trial changes in rats’ response to reward feedback in environments with different reward probability.
- Simulated reward probability estimation in populations of neurons following plastic and metaplastic learning rules in environments with varied uncertainty and volatility and compared their information encoding (i.e., mutual information) and decoding (via support vector machine) capacity.

Dartmouth Economics Department, Hanover, NH

Research Assistant

Advisor: Erzo F.P. Luttmer

Sep. 2018 –

Jan. 2020

- Responsible for the implementation of an online survey to examine the role of cognitive heuristics and biases on suboptimal annuity choice. Wrote HTML, CSS, and JavaScript code to generate questions and record results.
- Managed data from ~3,000 respondents, administered payments from the Dartmouth Economics Department, and created a project website to communicate with respondents.

VOLUNTEER EXPERIENCE

Passion for Learning, Silver Spring, MD

Research Assistant

May 2022 –

Present

- Wrote grant applications to support program's efforts to engage middle school students in high-poverty schools with hands-on technology projects and promote early college awareness.
- Researched process to copyright program's classroom materials to facilitate effort to diversify fundraising by selling lesson plans to schools and other nonprofit programs.

TECHNICAL SKILLS

- MATLAB, Python, Java

PUBLICATIONS

Journal articles

- **Harris, C.***, Aguirre, C.*, Kolli, S., Das, K., Izquierdo, A., & Soltani, A. (2021). Unique features of stimulus-based probabilistic reversal learning. *Behavioral Neuroscience*, 135(4), 550.

Manuscript preprints

- **Harris, C.**, Finn, K., Tse, P. (2022). DeepAction: A MATLAB toolbox for automated classification of animal behavior in video. *bioRxiv*. <https://doi.org/10.1101/2022.06.20.496909>
- Finn, K., **Harris, C.**, Marie-Luise, K., Atkisson, C., Maechler, M., Edelman, D., Tse, P. *Octopus biomaculoides'* activity depends on who their neighbor is. SSRN. <https://dx.doi.org/10.2139/ssrn.3802027>

Manuscripts under review

- Kieseler, M.L., Maechler, M., Hoffman, Z., Dhanoa, N., Fang, J., Gies, S., McHugh, J., **Harris, C.**, Valenti, J., Ram, M., Edelman, D., Duchaine, B., Missal, M., Tse, P. (in rev.). *Octopus bimaculoides* Learn to Take Shortcuts Toward Hidden Crabs Seen in a Mirror.

Manuscripts in preparation

- **Harris, C.**, Farmer, C., Chung, J., Atlas, L., & Pereira, F. (in prep.) Predicting longitudinal mental health outcomes during the COVID-19 pandemic from stable psychological traits and circumstances.
- Spitmaan, M., **Harris, C.**, Khorsand, P., & Soltani, A. (in prep.). Taming Synaptic Heterogeneity for Adaptive Learning.
- Yenho, C., **Harris, C.**, Ma, X., Li, Z., Zheng, C. (in prep.) Using classification accuracies to test for context-dependent change in neural code.

* Denotes co-first authorship.

REFERENCES

Available on request.