

# CARL WILLIAM HARRIS

117 Centre St. Concord, NH 03301 • (603) 540-1783 • carlwharris1@gmail.com

## 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*
- High honors in neuroscience major
- Dartmouth rowing varsity letter winner
- Dartmouth Economics Research Scholar (additional mentoring for students with high research potential; 2019-2021)
- Neukom Scholar (grant for development of novel computational techniques; 2020)
- David C. Hodgson Undergraduate Research Award (leave-term award for cognitive neuroscience research; 2020)
- James O. Freedman Presidential Scholar (two-term paid assistantship with Dr. Erzo Luttmer (economics); 2019)
- Academic citations for meritorious performance (exceptional performance in class) 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 demographic, clinical, and weekly activity data.
- 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 neural encoding, relative to a 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 to facilitate storage of holographic photostimulation data. Integrated NWB into existing two-photon microscopy processing packages, automated importation of acquisition data into NWB files, and a created standardized preprocessing pipeline. Wrote successful grant application to fund effort (Kavli Foundation, \$15,457).
- Created pipeline to track 3D macaque pose in video using the NIH Biowulf cluster. Developed tool to segment animal movement in video by fitting stochastically-observable keypoints 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 classifying animal behavior in video, using a recurrent neural network classifier trained using features extracted from raw video frames by a pretrained 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.
- Applied stereo vision techniques and semantic segmentation to create 3D reconstructions of octopus bodies from simultaneously recorded video. 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 a probabilistic reversal learning task. 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 examined 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**

*Volunteer*

**May 2022 –**

**Present**

- Wrote grant applications to support program's mission of engaging middle school students in high-poverty areas with hands-on technology projects and promoting early college awareness.
- Researched process to copyright program's classroom materials, with the aim of diversifying fundraising sources by marketing lesson plans to schools and other nonprofit programs.

## **TECHNICAL SKILLS**

- MATLAB, Python, Java

## **PUBLICATIONS**

### **Journal articles**

- [[Link](#)] **Harris, C.**, Finn, K. R., Kieseler, M. L., Maechler, M. R., & Tse, P. U. (2023). DeepAction: a MATLAB toolbox for automated classification of animal behavior in video. *Scientific Reports*, 13(1), 2688.
- [[Link](#)] **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**

- [[Link](#)] **Harris, C.**, Farmer, C., Atlas, L. Y., Gibbons, A., Shaw, J. D., Chung, J., & Pereira, F. (2022). *Prediction of mental well-being from individual characteristics and circumstances during the COVID-19 pandemic*. PsyArXiv.
- [[Link](#)] Yenho, C., **Harris, C.**, Ma, X., Li, Z., Pereira, F., Zheng, C. (2022). *Testing for context-dependent changes in neural encoding in naturalistic experiments*. arXiv.
- [[Link](#)] 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.

### **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**

- Spitmaan, M., **Harris, C.**, Khorsand, P., & Soltani, A. (in prep.). *Taming Synaptic Heterogeneity for Adaptive Learning*.

\* Denotes co-first authorship.

## **REFERENCES**

Available on request.