Henry Bourne

Location: Bristol, United Kingdom

Website | GitHub | Email: hwbourne@gmail.com | Mobile: (+44) 7880757776

Me: A Computational Statistics and Data Science PhD Student

- Currently in the second year of my PhD. I am located at the University of Bristol in the Compass CDT and my supervisor is Dr. Rihuan Ke.
- My work leans towards computer vision with a focus on representation learning. In particular, contrastive self-supervised learning. More specifically looking at how to leverage density ratio estimation as a training objective to encourage the maximization of mutual information terms.
- This research has applications in multi-modal, multi-task and continual learning. Amongst other areas.

🧙 Technical Skills

(My best) Tools	:	Python, Pytorch, MLX, R.
Deep-Learning	:	Theory and implementation.
Statistics	:	Wide breadth and depth, more so in 'machine learning' areas.
Maths	:	Probability theory, optimization, linear algebra.
CS	:	Theory of computation, all the programming paradigms, small bits of all the other important stuff (architecture, algorithms, etc.).
Other	:	Know a fair bit of computational neuroscience. Some other tools I am proficient in using are Git, Github, Bash, SLURM and many other bits and pieces.

🧑‍🎓 Education

Masters at University of Bristol — Bristol, UK
Joint Mathematics and Computer Science degree (MEng), graduated with first class honors. — *2018 –- 2022*

Canford School — Dorset, UK
A Maths, A* (D2 Pre-U) Spanish, A Further Maths, A Physics, A EPQ (On CNN's in autonomous cars).* — *2016 –- 2018*

Canford School — Dorset, UK
5 A's, 4 A's, B.* — *2014 –- 2016*

Projects

Latent Representations and Catastrophic Forgetting (Supervised by Rihuan Ke) *Python, Pytorch, SLURM* Source Code

- Used the encoding portions of various networks to investigate the effect of latent representations on catastrophic forgetting [5, 7, 9] in a continual learning [2, 8] task.
- Used both frozen and trainable versions of the encoder to investigate the effect of fixed vs. flexible latent representations on catastrophic forgetting.
- Pretrained encoders using a mixture of classification and representation learning objectives to investigate their potential effect on catastrophic forgetting.
- Found immediate and complete forgetting in all networks bar the largest (Resnet50) when the encoder was frozen, suggesting using frozen feature extractors could somewhat help mitigate catastrophic forgetting.

Meta-Learning (Masters Diss., supervised by Song Liu) *Python, Numpy, Matplotlib, HIPS-autograd* Source Code

- Meta-learning [6] involves creating models able to "learn how best to learn", I investigated a particular subset of meta-learning which uses deep learning to infer a prior for the weights of a neural network.
- Using this prior as a starting point, it can then quickly learn new similar tasks using k-shot learning.
- Implemented the Model-Agnostic-Meta-Leaning (MAML) algorithm [4] with a fully connected network from scratch on a toy regression task.
- Showed improved performance and reduced computation compared to 'regular' deep learning.
- Augmented the MAML algorithm to work on temporal data.
- Created a novel extension of MAML called MATML which achieved better performance on temporal data.

Psychedelics and Vision (Bachelors Diss., supervised by Conor Houghton) *Python, Numpy, Matplotlib* Source Code

- Validated whether a field equation model for how visual hallucinations arise in the visual cortex [3] worked in a simulation of discrete spiking neurons.
- Simulated a spiking neural network of both excitatatory and inhibitory LIF neurons [1] using biologically plausible wiring from scratch.
- Created a tool for translating the activity from the simulated network into its corresponding retinal imagery.
- Found that increasing excitatory synapse strength lead to the appearence of hallucinatory patterns validating the claims of the field equation model.

Others... *Python, C++, SLURM, Github*

- **Slune**: A python package I've made for conducting blazing fast hyper-parameter tuning on SLURM powered computing clusters by taking advantage of the fact that it's embarrassingly parallel. Source Code
- **NeuralNetcpp**: A neural network I wrote from scratch in C++. I am also still working on this one. First larger project I've done with C++ so it is a little rough around the edges! Source Code
- **Hill Sprints App**: Currently developing an app in swift specifically for tracking and analysing sprint based interval training and for finding hills to sprint up.
- **Open Source Contributions**: Have contributed to the Ivy framework.

Work

Teaching assistant roles (2023-Present): Helped run the labs for the machine learning unit and currently teaching the mathematical programming unit.

Responsible Innovation Facilitator (2023-Present): In this role I help run responsible innovation workshops where we train PhD students across disciplines in how to engage in responsible and ethical research. As part of the role I have to run workshops, reflect on ethical practice in my own research and develop tailor made workshops for statistics PhD students.

🤷 Other

Extra information: Native English, Spanish to good proficiency, UK drivers license, Dual UK and NZ nationality.

Hobbies: Photography based art, poetry, running (doing a marathon this year!), callisthenics, MMA, reading and listening to podcasts (novels, philosophy, history, science, travel writing, etc.), seeing the 🌍!

References

[1] Larry F Abbott. "Lapicque's introduction of the integrate-and-fire model neuron (1907)". In: *Brain research bulletin* 50.5-6 (1999), pp. 303–304.

[2] Matthias De Lange et al. "A continual learning survey: Defying forgetting in classification tasks". In: *IEEE transactions on pattern analysis and machine intelligence* 44.7 (2021), pp. 3366–3385.

[3] G Bard Ermentrout and Jack D Cowan. "A mathematical theory of visual hallucination patterns". In: *Biological cybernetics* 34.3 (1979), pp. 137–150.

[4] Chelsea Finn, Pieter Abbeel, and Sergey Levine. "Model-agnostic meta-learning for fast adaptation of deep networks". In: *International conference on machine learning*. PMLR. 2017, pp. 1126–1135.

[5] Robert M French. "Catastrophic forgetting in connectionist networks". In: *Trends in cognitive sciences* 3.4 (1999), pp. 128–135.

[6] Timothy Hospedales et al. "Meta-learning in neural networks: A survey". In: *IEEE transactions on pattern analysis and machine intelligence* 44.9 (2021), pp. 5149–5169.

[7] Michael McCloskey and Neal J Cohen. "Catastrophic interference in connectionist networks: The sequential learning problem". In: *Psychology of learning and motivation*. Vol. 24. Elsevier, 1989, pp. 109–165.

[8] German I Parisi et al. "Continual lifelong learning with neural networks: A review". In: *Neural networks* 113 (2019), pp. 54–71.

[9] Roger Ratcliff. "Connectionist models of recognition memory: constraints imposed by learning and forgetting functions." In: *Psychological review* 97.2 (1990), p. 285.