Tate McCartney

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Education

University of British Columbia *2021 – Present*
BASc in Engineering Physics (4th Year) *GPA: 4.33*

- **Coursework:** Convex Optimization (graduate level), Machine Learning, Real/Complex Analysis, Probability & Statistics, Linear Algebra, Differential Equations, General Relativity, Quantum Mechanics, Electromagnetism, Signal Processing, Experimental Techniques, Instrument Design.
- **Awards:** Dean's Honour List recipient (1st, 2nd, and 3rd years), UBC Engineering Alumni Division Award, Walter H. Gage Award, Roberts Memorial Award in Engineering.

Experience

Machine Learning Researcher (USRA Recipient) *Vancouver, BC*
UCSBC (Supervisor: Christos Thrampoulidis) *May 2024 – Present*

- **Lead author on forthcoming publication** that bridges token co-occurrence statistics and grammar learning by autoregressive (AR) language models, with planned submission to COLM 2025.
- Researched and experimentally validated State Space Models (SSMs) across synthetic datasets, comparing them to Transformers w.r.t. phenomena such as grokking, hierarchical learning, and embedding geometry.
- Designed experiments training Transformers on hierarchical data via AR and last-token-prediction (LTP), demonstrating that both approaches share comparable sample complexities for learning language syntax.
- Built and deployed a **large-scale HPC experimentation pipeline (SLURM + WandB)** to visualize AR vs. LTP convergence across training set size, grammar complexity, and data entropy.

HLA App Developer for e-Linac's Beam Envelope Measurements *Vancouver, BC*
TRIUMF, Canada's particle accelerator facility *Jan 2022 – April 2022*

- For the High-Level Application (HLA) framework, implemented from scratch a Python library to facilitate beam envelope measurements of TRIUMF's electron linear accelerator (e-Linac).
- Designed a routine to extract beam envelope characteristics from raw images, employing CV techniques to correct overexposure, reduce noise, and dynamically remove "false" electron emission.
- Incorporated statistical methods such as Mahalanobis distance to optimize pixel thresholding. This data-driven algorithm ensured minimal damage to data, **improving phase coordinates accuracy by** $\sim 70\%$.

Projects

State Space Models as Dynamical System Solvers *Dec 2024*
Report, *Repository*

- Investigated SSM-based approaches for modelling PDE-driven dynamical systems, motivated by SSMs' subquadratic scaling, infinite context window, and theoretical connection to dynamical functions.
- Designed two novel architectures to integrate spatial information with SSMs' long-range memory via CNN layers or input patching—**outperforming SOTA models** that seldom use temporal information.
- Benchmarked with Dynabench's Advection equation dataset ($\sim$ 30k timesteps), demonstrating SSMs' potential for modeling high-dimensional dynamical systems without knowledge of the underlying PDE.

Technologies & Trades

Languages: Python, Java, C/C++, JavaScript/TypeScript, React, MATLAB, Corvid, LaTeX

Tools: PyTorch, Keras, CUDA, ROS, Gazebo, Git, VirtualBox, Odin, Team Win Recovery Project (TWRP)

Experience with: Language modelling, reinforcement learning, computer vision, circuit design, Arduino, soldering, 3D printing, laser cutting, lathing, suspension systems, Onshape, primary literature

Ask me about: Plasma dynamics & nuclear fusion, mentoring students with disabilities, drumming