

Nicholas A. Gabriel

[\[website\]](#) [\[github\]](#)

Education:

The George Washington University

Ph.D. Physics

M.S. Physics

Washington, DC

exp. 2024

2020

Thesis: "Neural Operators for Many-Body Complex Systems"

University of Mary Washington

B.S. Mathematics (with honors), B.S. Physics

Thesis: "Maxwell's Equations, Gauge Fields, and Yang-Mills Theory" [\[thesis\]](#)

Fredericksburg, VA

2017

Research and Work Experience:

The George Washington University

Research Assistant, Advisor: Dr. Neil Johnson

Washington, DC

January 2019 - present

Neural Operators for many-body complex systems: (AFOSR: FA-9550-20-1-0383)

Proposed a novel operator learning framework for modeling many-body complex systems, combining advanced architectures for graph neural networks and neural operators, and demonstrating performance on large scale systems with millions of nodes. [\[github\]](#)

- Developed a neural coarse graining procedure to learn multiscale dynamics based on state-of-the-art renormalization methods for complex systems.
- Demonstrated the utility for neural coarse graining in learning effective dynamics and forecasting the evolution of complex systems with millions of nodes directly from data.
- Implemented and tested several advanced graph neural network architectures including hyperbolic convolutional layers, edge convolution, and message passing.
- Designed a novel variant of the Transformer architecture to learn multiscale interactions, improving operator learning performance by up to an order of magnitude.

Graph learning for foreign influence detection: (AFOSR: FA-9550-20-1-0382)

Implemented a framework for detecting foreign influence on social media using graph learning and feature attribution to identify models and features that can generalize across influence operation campaigns.

- Investigated detection methods for inauthentic users on Twitter originating from Russia, China, and Iran.
- Implemented several graph learning models (node2vec, GCN, message passing) in PyTorch with PyG.
- Compared graph learning models (graph embeddings and graph neural networks) and augmented feature sets on several cross-campaign benchmarks.
- Determined the most effective content-based and graph-based indicators for identifying IO accounts using Integrated Gradients (IG) with an empirically derived neutral IG baseline.
- Analyzed coordinated link-sharing behavior across IO campaigns and baseline Twitter accounts.
- Reported hundreds of URL domains that were useful for detecting IO activity, as well as domains that were misleading.
- Detailed findings in a 31 page manuscript available on arXiv. [\[paper\]](#) [\[github\]](#)

Data Collection/Web Scraping:

Led data collection efforts for social media tracking of foreign influence and extremist communities.

- Wrote data collection tools for social media using Python Selenium, BeautifulSoup, and Gmail API. [\[github\]](#)
- Parsed and cleaned text data using SpaCy and NLTK.
- Integrated data sources from different platforms (Twitter, Facebook, Instagram, Gab) into a single dataset using Pandas.
- Collected more than 12M tweets related to foreign influence using the Twitter API. [\[github\]](#)

Brookhaven National Laboratory

Intern, Advisor: Dr. David Jaffe

Upton, NY

June 2016 - August 2016

Developed software for simulation and statistical analysis of radioactive sources considered for mass calibration of the PROSPECT experiment antineutrino detector.

Primary deliverables:

- Bash scripts to run batch parallel Monte Carlo simulations of alpha particle transport in SRIM.
- NumPy and SciPy code to adaptively resample the detector geometry.
- CERN ROOT modules for interpolation of Monte Carlo data and calculation of alpha energy deposition spectrum.
- Two presentation given to PROSPECT collaborators detailing feasibility and accuracy of volumetric calibration using alpha particle sources. [[report](#)]

Massachusetts General Hospital

AAPM Undergraduate Fellow, Advisor: Dr. Alexei Trofimov

Boston, MA

June 2015 - August 2015

Prototyped a gaze tracking interface for use in proton radiotherapy treatment of ocular melanoma:

- Performed calibration of optical and infrared sensors for gaze tracking.
- Developed computer vision software for segmentation and pupil tracking using OpenCV
- Embedded gaze tracking sessions in a PyQt GUI which allows a physician to easily view and modify pupil segmentation parameters, view deviations from treatment plan in real time, and automatically save raw optical and segmented data.
- Worked with physicians and medical physicists to guide the design of the application.
- Wrote documentation and instructions for use of the GUI.

Technical Skills:

Languages/Libraries: Python, C, Bash, BLAS, TeX, CUDA C, MATLAB, Mathematica

Software:

Python: Pandas/Dask, NumPy, PyTorch, JAX, PyG, Jraph, scikit-learn, statsmodels, SpaCy, NLTK, Gensim, Selenium, Beautiful Soup

Linux/SWE/HPC: Git, SSH, Vim, Conda, Slurm, SQL, Elasticsearch

Mathematics/Statistics: Differential Geometry, Numerical Analysis, Functional Analysis, Partial Differential Equations, Timeseries Analysis, Graph Theory

Invited Presentations:

1. **The George Washington University** (ENIGMA seminar, 45m presentation) [[slides](#)]
"Multiscale Operator Learning for complex social systems", 10/4/2023
2. **Brown University** (CRUNCH group meeting, 40m presentation) [[slides](#)] [[video](#)]
"Multiscale Operator Learning for complex social systems", 9/15/2023
3. **IC2S2 2022** (Conference talk, 15m presentation) [[slides](#)]
"Automated Detection of Information Operations Using Graph Neural Networks", 7/21/2022
4. **Brookhaven National Laboratory** (PROSPECT group meeting, 20m presentation) [[report](#)]
"Mass calibration for PROSPECT", 8/10/2016