Nicholas A. Gabriel

[website] [github]

Education:

The George Washington University — **Washington, DC**
Ph.D. Physics — *exp. 2024*
M.S. Physics — *2020*

University of Mary Washington — **Fredericksburg, VA**
B.S. Mathematics (with honors), B.S. Physics — *2017*
Thesis: "Maxwell's Equations, Gauge Fields, and Yang-Mills Theory" [thesis]

Research and Work Experience:

The George Washington University — **Washington, DC**
Research Assistant, Advisor: Dr. Neil Johnson — *January 2019 - present*

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

- Collected data for >10,000 influence operations (IO) accounts released by Twitter across six separate campaigns originating from Russia, China, and Iran.
- Collected a comprehensive baseline of ≈10,000 high/low IO interaction accounts using the Twitter API.
- Extracted and expanded URLs from Tweets using the URLExpander library.
- Computed co-URLs from 12M tweets using Cython.
- Calculated graph-based and content-based indicators from co-URLs and URLs, respectively.
- Compared graph learning models and censorship thresholds 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 six IO campaigns and baseline Twitter accounts.
- Reported hundreds of URL domains which were removed or retained at the optimal censorship threshold.
- Detailed findings in a 31 page manuscript available on arXiv. [paper] [github]

Graph and operator learning for social dynamics: (AFOSR: FA-9550-20-1-0382 and FA-9550-20-1-0383)

- Implemented a framework for multiscale, graph-informed operator learning in JAX. [github]
- Ported code for hyperbolic graph network layers from PyTorch to JAX.
- Applied framework to concurrently learn reduced order dynamics of social systems, multiscale structure, and system evolution operators extremist communities.
- Demonstrated the efficacy of operator learning, hyperbolic graph learning, and inverse physics-informed learning for autoregressive forecasting of complex social systems. [slides] [video]

Data Collection/Web Scraping:

- Wrote data collection tools for social media using Python Selenium, Beautiful Soup, 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.

Brookhaven National Laboratory — **Upton, NY**
Intern, Advisor: Dr. David Jaffe — *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 parallel batch 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 **Boston, MA**
AAPM Undergraduate Fellow, Advisor: Dr. Alexei Trofimov *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 doctors 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