

# Nicholas A. Gabriel

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

## Education:

### **The George Washington University**

*Ph.D. Physics*

*M.S. Physics*

**Washington, DC**

*exp. 2024*

*2020*

### **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*

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

Implemented a framework for detecting foreign influence that combines data censorship, graph learning, and feature attribution to identify models and features that can generalize across influence operations.

- 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  $\approx 10,000$  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.
- Implemented several graph learning models (node2vec, GCN, message passing) in PyTorch with PyG.
- Compared graph learning models (graph embeddings and graph neural networks) 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 (accepted to Scientific Reports). [[paper](#)] [[github](#)]

#### **Graph-informed operator learning for complex systems:** (AFOSR: FA-9550-20-1-0383)

Proposed a multiscale operator learning framework for modelling a wide range of complex systems with hierarchical graph structure and unknown dynamics.

- Implemented a multiscale, graph-informed operator learning framework in JAX. [[github](#)]
- Developed a benchmark dataset consisting of interacting extremist groups on social media.
- Simulated a model systems for synchronized connectome dynamics.
- 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 of extremist communities.
- Demonstrated the efficacy of operator learning, hyperbolic graph learning, and inverse physics-informed learning for autoregressive forecasting of complex systems. [[slides](#)] [[video](#)]

#### **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 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*