Gabriel Ryan

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Education:

Columbia University Sep 2018 - Present
- PhD Candidate in Computer Science with research focus on deep learning for program analysis
- Co-advised by Professors Suman Jana and Salvatore Stolfo

Columbia University Sep 2016 - December 2017
- M.S. in Computer Science (GPA 3.97)
- Conducted research in modeling and simulating user behavior for Intrusion Detection Lab.
- Selected Coursework: Security, Deep Learning, Adv. Deep Learning, Data Analytics, Data Exploration Systems, Machine Learning, Natural Language Processing, Operating Systems, Compilers, High Perf. Computing

Swarthmore College June 2013
- B.S. Engineering, B.A. Computer Science (In Major GPA 3.83)
- Selected Coursework: Adv. Algorithms, Theory of Computation, Artificial Intelligence, Probabilistic Robotics, Computer Systems, Computer Languages, Applied Statistics, Optimization, Linear Systems Analysis

Research Experience:

Graduate Research Assistant, Columbia Security Lab Sep 2018 - Present
- Working with advisor Prof. Suman Jana using deep learning to develop new approaches to program analysis.
- Designed the *Continuous Logic Network* (CLN), a new neural architecture that directly models logic with SMT, and led a team of 3 students to implement a new loop invariant inference system (CLN2INV), that is the first to solve all 124 theoretically solvable loop invariant inference problems in the Code2Inv dataset. Published in ICLR 2020, follow up work on CLN Gating and Nonlinear Invariants published in PLDI 2020.
- Developed *Proximal Gradient Analysis* (PGA), a new method for dynamic software analysis that uses nonsmooth optimization methods to approximate gradients over a program. Implemented PGA as an LLVM pass and demonstrated it improved f1 accuracy by 33% over current methods in measuring dataflows to branches. Preprint on Arxiv.

MS Graduate Research Assistant, Columbia IDS Lab Fall 2016 - Fall 2017
- Working in Prof. Salvatore Stolfo's lab, developed novel method for modeling and generating user behavior data with neural networks. Designed architecture combining recurrent neural networks with multi task prediction to jointly model events and times and a real-time sequence. Implemented in Pytorch and Tensorflow.
- Conducted evaluation and modeling of Simulated User Bots (SUBs), and successfully simulated attacks against 3 user behavior models: Gaussian Mixtures, One Class SVMs, and Isolation Forests. Published in IEEE S&P Workshops 2018.

Seminar Research, Data Exploration Systems Spring 2017 - Spring 2018
- Working in Prof. Eugene Wu's lab, designed new method for measuring visual complexity in charts using approximate entropy. Published work in IEEE Infoviz 2018.
- Developed and conducted automated Amazon Mechanical Turk user studies demonstrating that users found comparison tasks more difficult on high entropy charts.

Research Fellow, Bryn Mawr Intelligent Systems Lab Summer 2013
- Developed tools using ROSJAVA package to run Java reinforcement learning algorithms on ROS robots and simulators.
- Implemented the HORDE reinforcement learning algorithm and successfully demonstrated that multitask learning outperforms HORDE for robotic sensor prediction.

Research Assistant, Woods Hole Oceanographic Institute January 2012

- Automated filtering and parsing of data from tow tank tests of a sub-Arctic current meter in MATLAB, setting research weeks ahead of schedule.
- Conducted frequency analysis of velocity data and developed burst sampling system that improved the signal to noise ratio by a factor of 3 while minimizing computation and radio usage.
- Published work in proceedings of Oceans 2012 conference.

Research Fellow, Swarthmore College Engineering Summer 2011

- Developed a wireless thermostat prototype around an MSP430 microcontroller and Zigbee radios that used low power event driven processing to achieve an estimated life expectancy of 5+ years on a coin cell battery.
- Wrote MATLAB Zigbee library to interface with Zigbee radios, allowing user to configure and use Zigbee radios through a simplified API.

Professional Experience:

Software Engineer, Allure Security Technology Sep 2015 - August 2018

- Developed web application for managing large scale deployments of User Behavior sensors and data loss detection using Java Spring Framework with AngularJS front end and Hibernate with Postgres and Mongodb databases. Designed and implement REST API using Swagger specification and Oauth2 authentication.
- Developed desktop client application for automated large scale document tracker injection using Electron and AngularJS.
- Designed and implemented new method for tracking document usage in the cloud using Google Drive API.
- Developed midstream network based document interception and tracking system using Squid Proxy and ICAP server to automatically inject trackers into suspicious documents.

Robotics Software Consultant, 3DDataLtd May 2015 - Aug 2015

- Developed a framework for 3d Simultaneous Localization and Mapping using the Lidar Odometry and Mapping algorthm. Modified algorithm to integrate IMU Sensor data using an Extended Kalman Filter. Implemented in C++ with PCL and ROS.

Radar Software Engineer, Raytheon Sep 2013 - April 2015

- Analyzed data from radar testing and provide software support for automated calibration, satellite tracking, antenna diagnostics, and maintenance prioritization software in Ada and C++.
- Developed additions to radar software in Ada and C++ for calibration and diagnostics.
- Earned team achievement award for completing new diagnostic capabilities ahead of schedule.

Publications:

Learning Nonlinear Loop Invariants with Gated Continuous Logic Networks Y. Jianan, G. Ryan, J. Wong, S. Jana, and R. Gu. Jana. PLDI 2020. `https://arxiv.org/abs/2003.07959`

CLN2INV: Learning Loop Invariants with Continuous Logic Networks. G. Ryan, J. Wong, Y. Jianan, R. Gu, and S. Jana. ICLR 2020. `https://arxiv.org/abs/1909.11542`

Fine Grained Dataflow Tracking with Proximal Gradients. G. Ryan, A. Shah, D. She, K. Bhat, and S. Jana. Preprint 2019. `https://arxiv.org/abs/1909.03461`

At a Glance: Pixel Approximate Entropy as a Measure of Line Chart Complexity. G. Ryan, A. Mosca, R. Chang, and E. Wu. IEEE Infovis 2018. `https://arxiv.org/abs/1811.03180`

Simulated User Bots: Real Time Testing of Insider Threat Detection Systems. P. Dutta, G. Ryan, A. Zieba, and S. Stolfo. IEEE Oakland S&P Workshops 2018. `https://ieeexplore.ieee.org/document/8424654`

Oversampling MAVS for reduction of vortex-shedding velocity-sensing noise. A. Williams, G. Ryan, and T. Thwaites. IEEE Oceans 2012. `https://ieeexplore.ieee.org/document/6404777`

Technical Summary:

Languages: Proficient in C/C++, Java, Javascript, Python, Matlab, and SQL.
Technologies: Linux, Git, AWS, MySQL, POSTGRES, MongoDb, PySpark, Pytorch, Tensorflow, ROS, LLVM