**Research Experiences**
(Listed chronologically)

**Project:** Summer Research Work (Prof. Michael Shiflett at Rutgers University)
**Date:** June 2012 – August 2012

**Abstract**
The purpose of this experiment was to determine whether an excess of neurons is a direct cause of the exhibition of autism in subjects. Autism has become a prevalent issue in the country, and its fundamental causes have yet to be understood by researchers. In case studies past, an excess of neurons was found to be correlated with the manifestation of autism, which was herein investigated to determine whether a third confounding variable is a common cause of the two correlated variables or whether the two share a causal relationship. By conducting experiments on the mice (*Mus musculus*) with mutations on the neuropilin (NRP2) gene, which resulted in the proliferation of a surplus of neurons, and conducting two-tailed, independent t-tests with an alpha of .05, p-values of $6.566 \times 10^{-6}$ and $8.904 \times 10^{-6}$ were determined for each social test, respectively. A significant difference was therefore concluded between the social activity of mutants as compared to that of the wild mice, establishing the excess neurons as a possible cause of autism.

**Invited Presentations**
*Upon the Effect of Excess Neurons on the Manifestation of Autism*, Monmouth Junior Science Symposium (2013, 1 of 6 in NJ).
*Upon the Effect of Excess Neurons on the Manifestation of Autism*, South Jersey Chapter Human Factors and Ergonomics Society Conference (2013, 1 in NJ).
*Upon the Effect of Excess Neurons on the Manifestation of Autism*, Institute of Electrical and Electronics Engineers (IEEE) Annual Research Conference (2013)

**Awards**
Delaware Valley Science Fair (DVSF): 1st Place Behavioral/Social Science (BSS), 1/10 considered for ISEF
Jersey Shore Science Fair (JSSF): 1st Place Behavioral/Social Science (BSS)
Selected MJSS (Monmouth Junior Science Symposium) Research Presenter (Six in NJ)
3rd Place and Student Choice Award
Regional Junior Science and Humanities Symposium (JSHS) Semifinalist
American Psychological Association: American Psychological Award Winner

**Research Experiences**
(Listed chronologically)

**Project:** Summer Research & Semester Mentorship (Profs. Ilya Dodin and Ammar Hakim at Princeton Plasma Physics Lab)
**Date:** June 2013 – January 2014

**Abstract**
As humans have mostly harnessed the power of nonrenewable energy sources in the past 50 years, the energy crisis has grown to unprecedented heights, leading to the need to adopt alternative energy sources. Despite the research that has been performed on nuclear fusion, there remains one large hindrance at hand: fusion currently requires greater input energy than is generated through the process itself, represented as $Q < 1$ ($Q$ being the ratio of the output to input energy). Most of the input energy goes towards the heating and confinement processes, which are herein explored. The research was concerned with magnetic confinement fusion systems, particularly with respect to the heating and confinement mechanisms of tokamaks. Cross-field cancellation and cutoff boundaries represent a large portion of the unnecessary energy expenditure in reactors, whose prevalence is partially due to a lack of understanding of such phenomena. Current models are inaccurate in their representation of plasma waves. Thus, a modified model of plasma waves is studied herein, whose greater accuracy is confirmed using novel numerical simulations, specifically a time-step RK4 algorithm to model the Moyal Bracket using C++ and Python.

**Invited Presentations**
*Implementation of Novel Magneto-Inertial Confinement Reactor Designs Towards Viable Confined Fusion*, Monmouth Junior Science Symposium (2014, 1 of 10 in NJ).

**Awards**
Siemens Westinghouse National Competition Semifinalist
Delaware Valley Science Fair (DVSF): 2nd Place Physics
Jersey Shore Science Fair (JSSF): 1st Place Physics
Selected MJSS (Monmouth Junior Science Symposium) Paper Presenter
Regional Junior Science and Humanities Symposium (JSHS) Finalist
Institute of Electrical and Electronics Engineers Award: 2nd Place

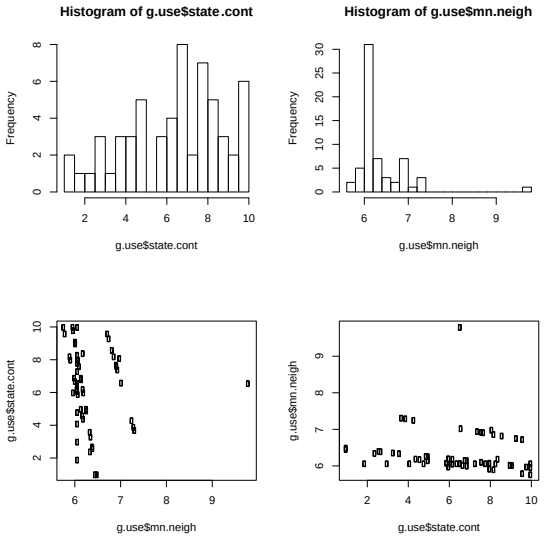
**Research Experiences**
(Listed chronologically)

**Project:** Summer Research Work (Prof. Abdulrahmen El-Sayed at Columbia University (Mailman School of Public Health))
**Date:** June 2015 – August 2015

## Abstract

*Is social network position associated with self-efficacy among elderly New Yorkers undergoing a wellness coaching intervention?*
We seek to understand the influence of the strength of social networks to improve self-efficacy among those undergoing a wellness coaching intervention. Prior to undergoing the wellness coaching intervention, all participants underwent the CDSMP, when information about the density and strength of their social relationships within an overall social network comprised of other participants were collected. We assessed whether higher density and strength of relationships was associated with self-efficacy throughout the course of the wellness coaching intervention. We used social network analytic techniques. Specifically, our initial approach is focused around building statistical models of the influence on participants of others' self-efficacy status. To this end, we will employ both relatively simple regression-based techniques (regressing participants' self-efficacy onto others' self-efficacy) and more advanced methods such as Markov random fields. The figure below shows our preliminary effects of others' self-efficacy onto participants' self-efficacy.

*Does social connectedness with wellness coaches improve the efficacy of a wellness coaching intervention among elderly New Yorkers?*
We seek to understand the influence of the strength of social connectedness to a wellness coach on the efficacy of a wellness coaching intervention to improve self-efficacy. Here, information about the strength of social relationships between coaches and participants in a wellness coaching intervention were collected at baseline and throughout the intervention period. We used social network analysis to understand differences in self-efficacy by strength of coach-participant relationships throughout the intervention.



**Research Experiences**
(Listed chronologically)

**Project:** Junior Independent Work (Prof. Matt Weinberg at Princeton University)
**Date:** January 2017 – May 2017

**Abstract**
Both the Bitcoin and Ethereum decentralized systems rely on the same distributed public Blockchain mining model of transmitting and recording history. Previous thought was that this system would be held in check through a balanced proof of work incentive system. However, previous studies have revealed an attack dubbed "selfish mining" whereby miners can exploit this incentive system to increase their expected rewards. Such models have further been applied to studying the transaction fee system that is expected to largely replace the block rewards system over the following years. Despite extensive study in the past, such models have failed to include the associated effects of these selfish mining attacks on exchange rates, which is of primary focus herein. These models are further extended to the context of the Ethereum network, which has not been studied with respect to selfish mining previously. In addition, this study sought to align and compare the current empirical status of the Bitcoin and Ethereum networks to the model results, to determine whether it is currently in the miners' economic interest to engage in selfish mining or not. In the end, the necessary devaluation was studied as a function of the attacker's hashrate, selfish mining (SM) hashrate proportion, SM engagement delay, and uncle block reward (Ethereum), and it was found that the current state of Bitcoin and Ethereum are highly conducive to selfish mining, making it of interest to find countermeasures thereof in future studies.

**Research Experiences**
(Listed chronologically)

**Project:** Senior Thesis (Profs. Matt Weinberg and Arvind Narayanan at Princeton University)
**Date:** September 2017 – May 2018

**Abstract**
Bitcoin has emerged from the fringes of technology to the mainstream recently. With speculation rampant, it has become more and more the subject of harsh criticism in ascertaining its use case. Unfortunately, much of Bitcoin's present use case is for transactions in online black markets. Towards that end, various studies have sought to partially deanonymize Bitcoin transactions, identifying wallets associated with major players in the space to help forensic analysis taint wallets involved with criminal activity. Relevant past studies, however, have rigidly enforced manually constructed heuristics to perform such deanonymization, paralleling an extensive union-find algorithm. We wish to extend this work by introducing many more heuristics than were previously considered by constructing a separate "heuristics graph" layered atop the transactions graph and performing a graph clustering on this heuristics graph. Towards that end, we explored the performance of various clustering algorithms on the SBM (stochastic block model) as a prototype of the heuristics graph and additionally tested graph preprocessing algorithms, specifically sparsification and coarsening to determine the extent they could speed up computation while retaining reasonable accuracies. We found hierarchical spectral clustering and METIS to have the best performance by the standard purity, NMI, and F-score clustering accuracy metrics. We also found sparsification and coarsening to result in little reduction in time with the former severely detracting from accuracies and the latter less so, suggesting the latter holds potential given implementation optimization in future studies. METIS was subsequently employed to cluster a subset of the full graph due to major time concerns with hierarchical spectral clustering. Several wallet clusters were identified as a result, though the accuracy of this could not be determined due to the limited ground truth available. Future extensions of this work should seek to refine the hierarchical spectral clustering algorithm for its time deficiencies and extend the ground truth available.