PETE B. RIGAS

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EDUCATION

CORNELL UNIVERSITY DEPARTMENT OF STATISTICAL SCIENCE, ITHACA, NY
Master of Professional Studies (MPS) in Applied Statistics (Option I), May 2020
GPA: 3.691

CORNELL UNIVERSITY, ITHACA, NY
B.S. in Mathematics, *summa cum laude*, May 2019
GPA: 3.541
Honors:Dean's List: Fall 2016, Fall 2017, Spring 2018, Spring 2019
Activities: Volunteer, Mathematics Club
Member, CNS Journal Club
Regular Attendee, Probability Seminar

Graduate Coursework: Real Analysis, Algebra I & II, Commutative Algebra, Probability Theory I & II, Homological Algebra, Complex Analysis, Differentiable Manifolds, Topics in Probability Theory (Statistical Mechanics, Percolation), Riemannian Geometry, Algebraic Number Theory, Genomics/Genetics, Topics in Probability Theory (Random Dispersive Equations), Databases & SAS HPC with DBMS, Statistical Computation with SAS, Probability Models & Inference

WORKING ARTICLES

P. Rigas & C. Kulkarni, *Modeling exponential decay in maximum capacitance across specified flight patterns in small aircraft* (https://github.com/peter-beep/NASA/blob/master/PHM2020_Pete%20(6).pdf), *abstract submitted for PHM conference*

X. Xu, P. Rigas, Y. Sun, C. Itoga, K. Lam, J. Delgado, E.M. Callaway, E. Kim, *Genetically modified rabies tracing of global circuit connections to corticotopin-releasing hormone neurons in the hypothalamic paraventricular nucleus* (https://github.com/peter-beep/xulab/blob/master/CRH_PVN_tracing_0426.docx.pdf)

TALKS

- Annual Conference of the Prognostics and Health Management Society
  - upcoming presentation at the end of September
- APS Physics March Meeting
  - presentation originally planned for March 2020
  - abstract available at https://meetings.aps.org/Meeting/MAR20/Session/S20.13

RESEARCH EXPERIENCE

Interests: Discrete Probability, Statistical Mechanics

Languages: Matlab, Python, familiarity with SAS and SQL

PHIL SOSOE, DEPARTMENT OF MATHEMATICS, CORNELL UNIVERSITY, ITHACA, NY
Research Assistant *in Probability*, Sept. 2018 –

- Statistical Mechanics I: Studied different types of percolation, configurations of physical systems, Poisson point processes.
    - Supervised reading on *Subcritical phase of d-dimensional Poisson-Boolean Percolation and its vacant set (2018)*, the *Existence of phase transition for percolation using the Gaussian Free Field (2018)*, and *Upper bound on the decay of correlations in a general class of O(N) symmetric models (2014)*.

GUILLAUME LAMBERT, SCHOOL OF APPLIED AND ENGINEERING PHYSICS, CORNELL UNIVERSITY, ITHACA, NY
Research Assistant *in Probability/Data Analysis*, Sept. 2019 –

- Statistical Mechanics II: Studied binding energies of the FnCas12a protein, developing generalizations of a thermodynamic model to predict binding energies for wider families of Cas proteins (https://github.com/peter-beep/Lambert-Lab)
    - Supervised reading on *Massively parallel CRISPRi arrays reveal concealed thermodynamic determinants of dCas12a binding (2018)*
    - Generalized work from aforementioned paper to compute 'randomized' partition functions for a thermodynamic model of Fn Cas12a binding, under simulations of random changes of DNA bases within the Hamming distance, from contributions of an exponential random variable.
    - Constructed rearrangements of bases surrounding binding sites of Fn Cas12a, leading to a formulation of an algorithm that sorts through binding energy data, by *(i)* ranking binding energies in increasing order, *(ii)* assigning Ising "spins" from DNA base pairs in gRNA and DNA sequences for base pairs from the guide and target sequences that are either in agreement or disagreement, *(iii)* determining whether agreement persists amongst DNA base pairs in gRNA and DNA sequences by assigning a value of +1 or -1 to the spins in the Hamiltonian, (*iv)* computing, amongst thousands of DNA sequences in parallel, transition probabilities for random walks whose transition probabilities at locations along the sequence, past an experimentally observed base pair mismatch at an earlier position, in order to determine the difference in the number of visits to the site of binding.
    - To analyze binding energies for a variety of proteins, *(i)* formulated, from expressions of the transition probabilities for agreeing and disagreeing DNA base pairs, a random term, which serves as a modification to the partition function normalization, that is dependent on the difference in the number of visits to the site of binding of random walks whose transition probabilities differ at sites of base pair mismatch, *(ii)* computed, from differences in the number of visits of distinct random walks, the probability of having a 99% chance of binding at an arbitrary site of target DNA sequences, by making use of a suitable upper bound and an appropriate probability measure.
    - Preliminarily to ensure that continuously varying the mismatch parameters introduced to the partition function exhibits a continuous phase transition, developed implementations to *(i)* plot changes in the Hamiltonian, based on the change in the number of visits to a fixed position of the DNA sequence, *(ii)* numerically quantifying, and discriminating, between the effect of different base pair mismatches on the expected number of visits for different positions along the target sequence, *(iii)* computed the change in energy, from experimentally recorded sequences, the change in binding energy at a common position of binding.

- Derived upper bounds by enforcing the criterion that the transition probabilities of the random walk strictly decrease across base pairs that are mismatches, insofar as guaranteeing that Hamiltonians, across thousands of binding sequences, can be calculated.

PETER MCMAHON, APPLIED AND ENGINEERING PHYSICS, CORNELL UNIVERSITY, ITHACA, NY
Research Assistant *in PDE, quantum variational algorithm, quantum computing, fluid mechanics*,

January 2020 –

- Solving PDEs with Quantum Computing: Formalized, and applied, quantum variational algorithm for solving non-linear problems in various PDEs, primarily focusing on the Navier-Stokes equations (https://github.com/peter-beep/McMahon-Lab).
    - Supervised reading on *Variational quantum algorithms for nonlinear problems*
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NASA AMES RESEARCH CENTER, MPS PROJECT, CORNELL UNIVERSITY, ITHACA, NY
Research Assistant to *Dr. Chetan Kulkarni*, in *battery fault detection*

January 2020 -

Modeling Battery Health: (https://github.com/peter-beep/NASA).

- Supervised reading on *Variational quantum algorithms for nonlinear problems*

SMITH LAB, CORNELL UNIVERSITY, ITHACA, NY
Research Assistant *in Behavioral Experiments and Matlab Analysis*, June 2018 – Dec. 2019

- Hippocampus & Retrosplenial Cortex Project: Explored the connection of the hippocampus with learning and memory (https://github.com/peter-beep/Smith-Lab).
    - Conducted various behavioral experiments, including white cylinder acclimations and Morris Water Maze, in collaboration with DREDD infused rats
    - Built micro-drives for surgical implantation in rodents, including glass and guide tubes, tetrodes, and molds
    - Spike-sorted neural signals from recorded data in behavioral experiments.
    - Developed implementations in Matlab to *(i)* view Dot plots, heatmaps, and place fields, *(ii)* calculate p-values, rate remapping indices, correlation values for left and right hemispheres in hippocampal recordings, and *(iii)* calculate the magnitude and direction of average velocities of rats in behavioral experiments
    - Processed hippocampal ripple data by *(i)* identifying beginning and ending times of sharp wave ripples, *(ii)* quantifying the number of spikes 3 seconds before the onset of each sharp wave ripple, *(iii)* identifying the maximum times of unique cell firing, *(iv)* approximating the final time of each sharp wave ripple
    - Dynamically modeled firing rates to study memory representations and formations in the hippocampus and retrosplenial cortex, by *(i)* computing different initial firing rates in the retrosplenial cortex, *(ii)* correlating initial rate of firing in the retrosplenial cortex to firing rates in the hippocampus, *(iii)* performing principal components analysis to determine whether representations in the hippocampus, on the neuronal ensemble level, are numerically correlated to firing rates in the retrosplenial cortex, *(iv)* computing durations of exposure in white box and black box environments, insofar as to construct ensemble firing rate vectors, in 250 ms time bins,

(vii) constructing matrices of ensemble firing rate vectors, *(viv)* bootstrapping the principal component analysis.
    - Arranged dotplots and heatmaps in Photoshop for analysis of firing rates of neurons
    - Interpreted neural data to determine how the hippocampal and retrosplenial cortex representations of memory influence different behaviors
    - Analyzed firing patterns of neurons to study characteristics of hippocampal place fields.
    - Performed T-maze acclimations, to ensure that rats achieve more than 80% accuracy, 32 out of 40, correct trials

GLENN HEALEY, UC IRVINE SAMUELI, IRVINE, CA
Research Assistant *in Probability*, June 2019 – Aug. 2019

- Statistical Mechanics III: Implemented Simulated Annealing (SA) algorithm for surface fitting.
    - Supervised reading on *Bayesian method for computing intrinsic pitch values (2018)*
    - Developed implementations in Matlab to *(i)* group velocities from 2014 MLB player data into groups based on numeric thresholds, *(ii)* compared relative energies of different pitches, from the initial and final velocities.
    - *(i)* Calculated different initial and final temperatures *T*, cooling factors, energy norms, *(ii)* generated smooth surfaces by cross correlating different groups of data points, *(iii)* empirically determined data of pitch values that minimized errors *E_i* , and *(iv)* plotted surfaces for intrinsic pitch values from the group of points that minimized *E_i*, in the normalized window of pitch values in the *x* and *z* directions, with speeds of 50 mph.
    - *(i)* Randomly generated 2-D array of samples, through a cross-validation scheme, by dividing pitch data into halves from which a smooth *F* was generated, based on day, *(ii)* determined the best input of parameters, corresponding to the smallest *E_i.*

KECK SCHOOL OF MEDICINE OF USC, LOS ANGELES, CA
Research Assistant *to Ophthalmologist Cheryl M. Craft*, June 2019 – Aug. 2019; May 2020 – Aug. 2020

- Clusterin Project: Studied whether injections of the clusterin protein impact the degeneration of eyesight in rats and mice, as a human model for studying ophthalmic disorders, in addition to other human models for lung and liver cancers (https://github.com/peter-beep/Craft-Lab).
    - Injected eyes of anesthetized mice and rats, 15 days after birth, with clusterin to study Retinitis Pigmentosa.
    - Performed electroretinograms (ERGs) on anesthetized rats and mice.
    - Measured action potentials, from rods and cones, of photoreceptors in the eye.
    - Developed implementations in Matlab to *(i)* detect, and count, dots representing nuclei of cells on the eyes of rats and mice, *(ii)* 'sketch,' and calculate, the area of Voronoi domains corresponding to nuclei, *(iii)* distributionally represent the area of Voronoi domains, *(iv)*, calculate, and compare, values of Clusterin coefficients for individual Voronoi domains.
    - Analyzed ERG data to *(i)* calculate mean Voronoi domain area, *(ii)* calculate clustering coefficients, *(iii)* construct Voronoi tessellations through colorings of Voronoi domains on the lattice.

XU LAB, UC IRVINE, IRVINE, CA
Research Assistant *in Optogenetics & Data Analysis*, Oct. 2013 – Aug. 2017

- SADDG-EGP Project: Made use of the retrograde SADDG-EGP virus, in addition to the CAV2-Cre adenovirus tracing to study connectivity between anterodorsal BNST (adBNST), and other areas of the brain.
    - Observed, and quantified, significant SADDG-EGP labeling.
    - Determined that a SADDG-EGP retrograde virus, in comparison to the canine adenovirus, labeled less neurons in the paraventricular, medial and lateral hypothalamus, cortical and lateral amygdale, and amygdale-hippocampal area.
    - Quantified labeling from the canine adenovirus in peripheral subregions including the subiculum, entorhinal cortex, medial, basolateral and basomedial amygdala.
    - Characterized inhibitory and exhibitory mechanisms of adBNST circuits, providing results that coincided with a previous 2009 work describing how glutamatergic inputs from the basolateral amygdala and central amygdala to adBNST regulate and sustain types of fear.
- BNST Project: Studied the mouse brain, including reprogramming neurons to remedy neural impairment
    - Cut, mounted, and counted fluorescent labeling in neurons from slices of the mouse brain.
    - Investigated the effect of a genetically modified virus from injections in ventral and lateral sub-regions of the medial and lateral bed nucleus of the stria terminalis (BNST).
    - Quantified more than 20,000 fluorescent labels of bodies sharing neural pathways with the central and medial amygdala, visual cortices, and brain stem from either the medial or lateral BNST. These findings suggest that circuit differences between the medial and lateral BNST exist.
    - Calculated the average number of fluorescent labels of neurons across different brain regions.
    - Organized data to compare differences in average fluorescent labeling across different brain regions in mice injected in the medial and lateral BNST.
- PVN Project: Investigated the effects of a Cre-dependent monosynaptic rabies tracing system on the paraventricular nuclei (PVN)
    - Determined that CRH neurons receive synaptic connections from more than 140 brain regions.
    - Enumerated regions that received significant input, which include the dorsomedial, ventromedial and lateral hypothalamus, lateral and medial preoptic nuclei, and arcuate nuclei.
    - Studied direction of global information flow directly impinged on CRH+ PVN neurons.
    - Identified excitatory and inhibitory neurons through antibody immunostaining.

BARTELS LAB, UC RIVERSIDE, RIVERSIDE, CA
Research Assistant *in Materials Science,* Oct. 2013 – May 2014

- Monolayer MOS2, WSe2 Growth: Conducted experiments to grow MOS2 film on wafer substrates.
    - Performed Raman Spectroscopy to analyze layered structure of transition metal dichalcogenides.
    - Conducted MOS2 and metal dichalcogenide growth experiments in vacuum, in order to gain insight on the structure of these compounds, in addition to the binding energies of reactants.
    - Analyze morphologies of MOS2 film to determine whether monolayer MOS2 film exists on experimentally ‘grown,’ molecular film substrates.
    - Computationally modeled systems with periodic boundary conditions.