AMANDA LEE COLUNGA

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SKILLS

Programming – *MATLAB, Python, SQL*

Word processing & presentation software – *Microsoft Office, LaTeX*

Well-versed in the following mathematical techniques: *Local and global sensitivity analysis, parameter estimation/optimization, machine learning, uncertainty quantification: MCMC/DRAM, confidence/prediction intervals*

Bilingual native speaker – *English and Spanish*

EDUCATION

Ph.D., Applied Mathematics – *North Carolina State University* — **Expected July 2022**

- Thesis Project: Mathematically model the cardiovascular system in MATLAB to study cardiovascular function in patients with Pulmonary Hypertension.

M.S., Applied Mathematics – *North Carolina State University* — December 2018

- Coursework in Mathematical Modeling, Machine Learning (neural networks, classification and clustering, image processing), Data Visualization (MATLAB and Python), Numerical Methods, Differential Equations

B.S., Applied Mathematics – *Florida State University* — August 2016

- Coursework in Calculus, Numerical Analysis, Differential Equations, Statistics, and Matrix Algebra

POSITIONS AND EMPLOYMENT

Graduate Student Instructor – *North Carolina State University* — 2017 – January 2022

- Taught and assisted in mathematics courses while completing doctoral research

Graduate Student Intern – *Oak Ridge National Laboratory* — June - August 2019

- Develop a graphical user interface motivated by the level of uncertainty that exists in identifying a newly developed materials in a laboratory, to automate data analysis. Specific tasks included: synthetic data generation, weighted KNN classification algorithm, parameter optimization and uncertainty quantification confidence intervals.

Undergraduate Research Mentor – *North Carolina State University* — June - August 2020

- Mentored a group of 5 undergraduate students participating in an REU
- Specific tasks included: teaching the basics of MATLAB, high-performing computing, modeling the cardiovascular system, sensitivity analysis, subset selection, and parameter inference techniques

PUBLICATIONS & PREPRINTS

Colunga AL*, Kim KG*, Woodall NP*, Dardas TF, Gennari JH, Olufsen MS, Carlson BE. *Deep phenotyping of cardiac function in heart transplant patients using cardiovascular systems models*, *J Physiology,* doi.org/10.1113/JP279393, p. 1-20, 2020. (*contributed equally)

Colebank MJ*, **Colunga AL***, REU program, Olufsen MS. *Parameter inference in a computational model of hemodynamics in pulmonary hypertension*. (In Progress) (*contributed equally)

Colunga AL, Olufsen MS. *Modeling ventricular interaction.* (In Progress)

CONTRIBUTIONS TO SCIENCE

1. **Deep phenotyping of cardiac function in heart transplant patients using cardiovascular systems models**

   Longitudinal tracking and uncertainty quantification

   Goal: Identify heart transplant patients at risk for heart failure following a heart transplantation.

   a) Used a systems-level differential equations model analogous to an electrical circuit determining a set of identifiable parameters that were estimated, fitting the model to data.

   b) Longitudinally analyze patients throughout recovery by estimating left and right ventricular pressure-volume loops and power output

   c) Quantify the uncertainty of model predictions of left ventricular pressure and volume for two subsets of parameters via Markov Chain Monte Carlo simulations using the Delayed Rejection Adaptive Metropolis algorithm to predict parameter distributions. Sampling from the posterior distributions and compare the results to the estimated parameters.

   d) Results allowed us to distinguish patients with full recovery, and those at risk of organ rejection.

2. **Parameter inference in a computational model of hemodynamics in pulmonary hypertension**

   Modeling dynamic waveforms, data assimilation, and sensitivity analysis.

   Goal: Propose a lumped parameter model implementing local and global sensitivity analyses to estimate physiological parameters using both static systolic/diastolic data and time-series pressure waveforms.

   a) Local sensitivity analysis showed that the parameters associated with the timing of systole and diastole in the right ventricle and atria were most influential on model predictions.

   b) Global sensitivity analysis using Sobol' indices agreed with the local measures and revealed that there was a non-influential set of parameters that could be fixed.

   c) Apply information criterion to select the smallest parameter subset to that still provide accurate assimilations.

   d) Results from data assimilation show that inclusion of dynamic data not only changes the combinations of potential parameter subsets, but that we can also match the waveforms to model predictions. Model outcomes are consistent with physiological understanding of the disease.

3. **Modeling ventricular interaction**

   In depth model analysis and model comparison

   Goal: Ventricular interaction has been modeled using a nonlinear end-diastolic pressure volume relation which causes a differential algebraic equation that is difficult to solve under certain parameter regimes. We want to study whether a linearized model, much simpler to solve, provides similar results to the nonlinear model.

a) A parametric study guided towards a good set of nominal parameters for both models being compared

b) Simultaneously sampling all parameters within a 10% range indicated that the linear model reacts like the nonlinear model with minor differences in septal volume

c) *In progress:* Synthesize a data base of control and hypertensive patients, run sensitivity analyses and parameter inference on each dataset, utilize machine learning training a model to classify and cluster control and hypertensive patients based on biological markers and indicators of disease.

4. **Machine learning and graphical user interface**

Goal: Project at Oak Ridge National Laboratory. Develop a graphical user interface, motivated by the level of uncertainty that exists in identifying a newly developed materials in a laboratory, automating data analysis.

a) Use machine learning algorithms and mathematics to automate material classification.

b) Synthetic data generation of thousands of training data samples per model/classification

c) Apply weighted k-nearest neighbors to identify top four models/classifications for specific material data in question

d) Allow the user to change initial parameter values, optimize the parameters to the data, and generate confidence intervals bounds for with we are confident that the true parameter value lies

SERVICE & LEADERSHIP

Diversity, Equity, and Inclusion Committee: Graduate student representative — 2020 - Present

- Collaborate with department faculty and staff on improving the culture of the mathematics department, particularly as it relates to diversity, and using our influence to make the "pipeline" of mathematical talent more equitable.

Association for Women in Mathematics — Secretary: 2018-2019; Vice-President: 2019 - Present

- Sonia Kovalevsky Day event organizer/volunteer: Help organize and run age-appropriate mathematics workshops to empower young middle school girls and cultivate their enjoyment of mathematics into a passion

College of Science Outreach: presenter — Spring 2020, Fall 2020, Spring 2021

- College of Science effort to connect researchers with local middle and high schools
- Presented about my research and provided examples of how they could apply those ideas using their level of mathematical knowledge

AWARDS

Doctoral Dissertation Completion Grant – *North Carolina State University* — 2022

- Attend biweekly small group writing meetings, read and comment on other group members' drafts and share feedback

Graduate Education for Minorities *PhD Science Full Fellow* — 2019

- Work as a summer intern at sponsoring institution, maintain good academic standing, promote diversity in science and engineering

Diversity Enhancement Fellow – *North Carolina State University* — 2017, 2018, 2020, 2021, 2022

- Promote and contribute to diversity and inclusion at the graduate level

University Graduate Fellow – *North Carolina State University* — 2017

- One-year award providing competitive recruiting supplements for outstanding new doctoral students