Emily Heavner

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EDUCATION

Doctor of Philosophy in Mathematics   December 2022
Colorado State University (CSU)   Fort Collins, CO
Advisor: Dr. Jennifer Mueller
Thesis: *An Inverse Problem and Multi-Compartment Lung Model for the Estimation of Lung Airway Resistance throughout the Bronchial Tree*

Master of Science in Mathematics   May 2019
Colorado State University   Fort Collins, CO
Advisor: Dr. Jennifer Mueller
Thesis: *Introduction and Numerical Simulation of a Dynamical System Lung Model*

Bachelor of Science in Mathematics   December 2016
Christopher Newport University (CNU)   Newport News, VA

WORK EXPERIENCE

Principal Algorithm Specialist – Alvaria, Remote   November 2022 – Present
- Developed and implemented a predictive modeling module that considers both external requirements and seasonality using multiple linear regression
- Investigated third party and company developed options for machine learning algorithm product development
- Designed UI and UX of new module for volume forecast
- Enhanced pre-existing schedule algorithms to account for longer handle time scenarios
- Collaborated with customers to develop and enhance models suited for their needs in industries like cloud computing, media, and technology
- Maintained and documented Delphi legacy code
- Researched contact center solution algorithms including Erlang formulas

Graduate Teaching Assistant - CSU, Fort Collins, CO   August 2017 – July 2022
- Instructed, lesson planned, and gave feedback through exams and homework for classes of 35 students for *Calculus for Biological Scientists I*, *Mathematical Algorithms for MATLAB I*, *Calculus for Physical Scientists I and II*, and *Math in the Social Sciences*
- Designed and wrote homework and exams for students in *Mathematical Algorithms for MATLAB I*, *Calculus for Physical Scientists I and II*, and *Math in the Social Sciences*
- Worked with students one-on-one and in group settings during office hours

Graduate Research Assistant - CSU, Fort Collins, CO May 2021 – January 2022, July 2022 – October 2022
- Collaborated with colleagues from multiple fields including medical professionals and biomedical engineers with a diverse background to collect, process, and analyze electrical impedance tomography (EIT) data and mechanical ventilator data from the ICU
- Developed and solved a multi-compartment asymmetric flow lung model using an inverse problem and MATLAB to determine airway resistance in each generation of the lung for real patients on mechanical ventilation

- Established an experiment and mathematical model from the ground up including data collection and analysis as well as evaluation and implementation of model

Calculus Center Assistant Director - CSU, Fort Collins, CO   May 2020 – May 2021
- Scheduled and assigned office hour and workshops for 3 semesters for an average of 44 instructors and 10 tutors over 5 different courses
- Communicated regularly via email to all 54 calculus center workers
- Managed workshops and developed hands-on curriculum for *Calculus I, II,* and *III*

Mathematical Sciences Graduate Intern – USDA, Fort Collins, CO June 2020 – August 2020
- Designed a flow chart for merging six biologic records and their laboratory results from over 1,000 goat operations or farms
- Identified and made decisions questionable and conflicting data
- Planned, validated, and merged biologic collection records and their laboratory results for over 10,000 goats for the National Animal Health Monitoring System 2019 Goat Study using Excel

Arguing About Safety Intern – NASA, Hampton, VA   January 2017 – May 2017
- Discovered and implemented new ways to write safety assurance cases that comply with Federal Aviation Administration regulations
- Developed algorithm to translate safety cases from goal structuring notation to prose-like notation

Inventory Management Intern – Spartan Nash, Norfolk, VA   May 2016 – March 2017
- Forecasted and modeled demand of products using self-created algorithms in Excel
- Published weekly reports to buyers, managers, and customers on product movement and analysis of current on hand product level
- Analyzed data to determine why product level is too high or too low and presented it to executives at the end of the internship

Mathematics Tutor – CNU, Newport News, VA   September 2014 - December 2016
- Aided college students in understanding theories and concepts in classes ranging from College Algebra to Differential Equations
- Advised students both one-on-one and in groups on better study habits such as how and when to start studying

PROGRAMMING LANGUAGES

Skilled: Excel, LaTeX, Mathematica, MATLAB
Intermediate: Delphi
Beginner: HTML, Java, Python, SQL

COURSES AND PROJECTS

Courses:
Public Speaking, Elementary Statistics, Applied Probability, Computer Ethics, Mathematical Modeling, Stochastic Modeling, Operations Research, Numerical Methods in Science and Engineering, Numerical Analysis, Linear and Nonlinear Programming, Linear Algebra, Topics in Mathematics: Introduction to Inverse Problems - a Data Science Perspective, Topics in Mathematics: Radar and Signal Processing, Ordinary and Partial Differential Equations, Dynamical Systems

Multiple Linear Regression Forecast Volume Model   July 2023 – Present
- Collaborated with customers to meet custom requirements

- Designed complete multiple linear regression algorithm with seasonality for Delphi
- Constructed algorithm to verify correct use of model and model assumptions
- Validated model using historical test data provided by customers

Determining Airway Resistance Values in the Lung   May 2019 – December 2022
- Collaborated with medical doctors to collect electrical impedance tomography (EIT) data, mechanical ventilator, and jet ventilation data in the ICU and the operating room
- Developed an asymmetric multi-compartment lung model based on relationship between electrical circuit and human lung
- Solved an inverse problem using MATLAB `fmincon` function to determine airway resistance in each generation of the lung for patients on mechanical ventilation and jet ventilation
- Tested inverse problem using an inverse crime and verified model set up through simulated data
- Produced Python script that maps image pixel locations to scaled time and volume vectors
- Validated lung volume information from EIT data with true lung volume information from mechanical ventilation

Numerical Simulation of a Dynamical System Lung Model   Summer 2019
- Updated dynamical system lung model which describes the lung volume in each lung compartment at a given time by adding conservation of mass properties to the model
- Verified model by using multiple numerical simulation

Image Deblurring   Fall 2019
- Reconstructed original images from blurred, noisy images using Tikhonov regularization and Kronecker products
- Computed regularization parameter using L-curve method

Finite Element Methods Project   Spring 2017
- Worked with a partner to find the numerical solution to a two-dimensional elliptic PDE described on a rectangle with Dirichlet boundary conditions
- Programmed own version of Finite Element Methods from scratch using MATLAB

Independent Research in Stochastic Modeling   September 2016 – December 2016
- Designed and developed research project and data collection with one other team member
- Collected traffic data of Hampton Roads area through Virginia Department of Transportation cameras and sitting in traffic
- Led and communicated data collection with one other team member
- Created stochastic model using MATLAB which predicted average drive times over a 20 mile span for a given time period

Independent Research in Nonlinear Dynamics   January 2016 – April 2016
- Modeled Lotka Volterra equations which predicted the number of competitive predators and their relationships using computer language NetLogo
- Demonstrated knowledge of chaotic systems by presenting discoveries on the Lorenz Attractor
- Presented work to faculty members at CNU

PUBLIC SPEAKING

Publications

- Heavner, Emily; Mueller, Jennifer L.;McFann, Kim; Dunn, Julie; Alnachoukati, Omar; Mohnike, Corey: *Estimation of airway resistance throughout the bronchial tree from mechanical ventilation output data*, Applied Mathematics for Modern Challenges (AMMC), [Manuscript accepted for publication], 2024

- Heavner, Emily *An inverse problem and multi-compartment lung model for the estimation of lung airway resistance throughout the bronchial tree*, Colorado State University Libraries, December 2022.

- Heavner, Emily; Holloway, C. Michael: *Assurance Arguments for the Non–graphically–inclined: Two Approaches*, NASA/TM–2017–219650, July 2017.

Instructor of Record

- *Calculus for Biological Scientists*, Spring 2022
- *Mathematical Algorithms in MATLAB I*, Spring 2022
- *Calculus for Physical Scientists I – Online*, Spring 2020
- *Calculus for Physical Scientists II – Online*, Spring 2020
- *Calculus for Physical Scientists II*, Fall 2019
- *Math in the Social Sciences*, Summer 2019
- *Calculus for Physical Scientists I*, Fall 2018, Spring 2019

Posters

- *Computational Estimation of Airway Resistance Throughout the Bronchial Tree*, Joint Mathematics Meetings, Virtual, April 2022.

- *Investigating Airway Resistance Values in the Alveolar Tree using an Inverse Problem and a Dynamical System Lung Model*, Conference on Modern Challenges in Imaging In the Footsteps of Allan MacLeod Cormack On the Fortieth Anniversary of his Nobel Prize, Tufts University, August 2019.

Talks:

- *An Inverse Problem and Multi-Compartment Lung Model for the Estimation of Lung Airway Resistance throughout the Bronchial Tree*, Public Thesis Defense, CSU, October 2022.

- *Estimating Airway Resistance in the Bronchial Tree Using an Inverse Problem and an Asymmetric Multi-Compartment Lung Model*, Guest Lecture in Math 676: Inverse Problems – a Data Science Perspective, CSU, April 2022.

- *Estimation of Airway Resistance Throughout the Bronchial Tree using an Inverse Problem and an Asymmetric Multi-Compartment Lung Model*, Joint Mathematics Meeting, Virtual, April 2022.

- *Introduction to an Asymmetric Multi-compartment Lung Model and Parameter Estimation*, Greenslopes Seminar, CSU, April 2022.

- *Estimation of airway resistance throughout the bronchial tree from mechanical ventilation output data*, Society for Mathematical Biology Annual Meeting, Virtual, June 2021.

- *Introduction to Inverse Problems and Their Application in the Medical Field*, Greenslopes Seminar, CSU, March 2020.

- *What is Regularization and Why Do We Care?*, Data Science Seminar, CSU, November 2019.

- *Inverse Problems and their Applications*, Solving Problems in Applied Math (SPAM) Lab, CSU, November 2019.

- *Derivation of the Shallow Water Equations*, Solving Problems in Applied Math (SPAM) Lab, CSU, March 2019.
- *Introduction and Numerical Simulation of a Dynamical System Lung Model*, SIAM[1] Front Range Applied Math Conference, University of Colorado Denver, March 2019.
- *Lung Model Using Switched Dynamical System and EIT*, Greenslopes Graduate Student Seminar, CSU, October 2018.
- *Stochastic Traffic Flow Model Based on Hampton Roads, VA*, CNU, December 2016.
- *Species Competition in a Lotka Volterra Model Using Netlogo*, CNU, March 2016.

LEADERSHIP EXPERIENCE

Greenslopes Seminar Co-organizer	Math Circles Summer Camp Organizer
Graduate Student Liaison	Secretary of SIAM at CSU
Graduate Student Break Room Committee	Expanding Your Horizons Activity Organizer
Mentor for AWM[2] at CSU	Interim President for AWM at CSU
Calculus Center Assistant Director	President for Mathematics Society at CNU
President of AWM at CSU	Secretary for Pi Mu Epsilon Virginia Mu Chapter
Vice President of SIAM at CSU	Student Advisor for Natural & Behavioral Science
Treasurer of SIAM at CSU	Secretary for Mathematics Society at CNU
Graduate Student Liaison for AWM at CSU	High School Mathematics Competition Volunteer
Kid College Coordinator	Crittenden Middle School Volunteer Tutor

PROFESSIONAL SOCIETIES

- Society for Industrial and Applied Mathematics — July 2017 – Present
- Omicron Delta Kappa — December 2016 – Present
- Pi Mu Epsilon — March 2016 – Present
- Association for Women in Mathematics — September 2014 – Present

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[1] Society for Industrial and Applied Mathematics
[2] Association for Women in Mathematics