Duncan Bennett

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Research Interest

My research interests are in applications of machine learning and data science to medicine and public health. Recently, I have worked on data augmentation using Variational Autoencoders to train deep models for spectral pathogen detection. I have also worked on computer vision and NLP tasks to analyze kidney transplant forms to inform medical infrastructure.

Education

- **University of Arizona** — Tucson, AZ
  PhD in Mathematics; (in progress) — *Aug. 2019 – Present*

- **Western Washington University** — Bellingham, WA
  Master of Science in Mathematics; GPA: 3.94 — *Sept. 2016 – June. 2018*
  - MS Project : Classification of Finite Group Extensions and Group Cohomology

- **University of Puget Sounds** — Tacoma, WA
  Bachelor of Science in Mathematics; GPA: 3.44 — *Aug. 2015 – May. 2015*
  - Senior Thesis : Algebraic Topology

Research and Work Experience

- **Kidney Transplant Form OCR**
  Supervisor: ***Prof Marek Rychlik*** *University of Arizona* — *June 2022- present*
  - Implementation of computer vision algorithms such as PEARL to extract data from images of kidney transplant documents.
  - Develop foundation in the theory of Probablistic Graphical Models and Energy-based Models as it pertains to computer vision.
  - Implementation of NLP algorithsm such as tfidf and grammar induction for document classification applied to medical documents.
  - Written in MATLAB

- **Lightsense Technology Internship**
  Supervisor: ***Michael Stanley*** *Lightsense Technology* — *June 2022-Dec 2022*
  - Develop machine learning models to classify and unmix high dimensional spectral data.
  - Build and train variational autoencoders for data augmentation and outlier detection as part of a 2-class classification model.
  - Research and present on modern papers in the intersection of machine learning and chemometrics.
  - Collaborate with researchers in other fields of expertise.
  - Maintain python, keras and tensorflow code on github.

- **Response-guided Principal Component Classification**
  Supervisor: ***Prof Helen Zhang*** *University of Arizona* — *Aug. 2020-present*
  - The adaptation of response-guided principal component regression to logistic regression for binary classification.
  - Improvements to convergence, robustness compared to logistic regression by reformlating in terms of principal components. Improvement by factor of 10 to 100 in Kullback-Leibner divergence with respect to density estimation.
  - Continued research to generalize this method to generalized linear models to combined response-guided PCA with Poisson regression etc.
  - Written in R with glmnet, ggplot2 and original library

- **Scoliosis Medical Imaging**
  Supervisor: ***Prof Marek Rychlik*** *University of Arizona* — *July 2021-Dec. 2021*
  - Build and train CNN with up/down sampling to preform semantic segmentation of spine X-rays.

- From semantic segmentaion, train output layer for quadrilateral estimation of vertebra and calculation of Cobb angle using techniques from density estimation.
- Preliminary results show improvements in quadrilateral segmentation accuracy compared to tradiation regression approaches.
- Written in MATLAB with image processing and fuzzy logic toolkits.

- **Supervised Principal Component Regression**
  Supervisor: ***Prof Ning Hao*** *University of Arizona* *July 2021-Aug. 2021*
  - Developed dimension reduction methods that principal components based on the covariance of the predictors and variance of the response data.
  - Written in R with glmnet, ggplot2 and original library.

- **The Order Complex of Cyclic Groups and its Homotopy Type**
  Supervisor: ***Prof James Bernhard*** *Univeristy of Puget Sound* *May 2011-Oct. 2011*
  - The subgroup lattice functor distributes over direct products and thus for abelian groups, the question of homotopy type can be reduced down to that of the maximal p-subgroups. This results in the subgroup lattice is homotopy equivalent to a wedge of spheres of varying dimension.

Technical Skills

- **MATLAB**: Familiarity with MATLAB for machine learning and toolboxes such as Statistics and Machine Learingn, Deep Learning, Image Processing, Signal Processing, DSP System and Fuzzy Logic.
- **R**: Familiarity with R for statistical analysis and libraries such as dplyr, ggplot2, knitr, and glmnet.
- **Python**: Jupyter Notebooks, Keras, scikit-learn, pyplot, ...
- **Computer Skills**:
  - Git/Github
  - Linux (Ubuntu, Fedora)
  - Emacs
  - bash and terminal navigation

- **Relevant Coursework**: Statistical Machine Learning, Numerical Analysis and Algorithms, Experiment Design, Advanced Regression Analysis, Probability, Statistics, Natural Language Processing, Stochastic Processes, Probabilistics Graphical Models.

Presentations and Talks

- **R Tutorial: Basics for NLP** Tucson, AZ
  University of Arizona : DataFest 2023 *Mar 2023*
- **Variational Autoencoders** Tucson, AZ
  University of Arizona : Multilingual OCR Seminar *Sept 2022*
- **Variational Autoencoders and Data Augmentation** Tucson, AZ
  Lightsense Technology *July 2022*
- **Speech and Language Processing (Series)** Tucson, AZ
  Univeristy of Arizona : Multilingual OCR Seminar *Spring 2022*
- **Response-guided Principal Component Classification** Tucson, AZ
  Univeristy of Arizona : RTG Mini Conference *Dec 2020*
- **The Order Complex of Cyclic Groups and its Homotopy Type** Bellingham, WA
  Western Washington University : Western's Association of Mathematics (WαM) *May 2018*
- **The Cohomology of Finite Groups and Group Extensions** Bellingham, WA
  Western Washington University : Mathematics Department Colloquium *May 2018*
- **The Order Complex of Cyclic Groups and its Homotopy Type** Tacoma, WA
  University of Puget Sound : Math/CS Seminar *April 2016*

Awards

- **Galileo Circle Award**
  (University of Arizona) *August 2022*
- **Outstanding Masters Graduate Award**
  (Western Washington University) Academic Merit *May 2018*
- **Elias Bond Graduate Fellowship**
  (Western Washington University) Academic Merit *May 2017*
- **Richard Greene Graduate Scholarship**
  (Western Washington University) Academic Merit *May 2017*

Teaching

- **University of Arizona** Tucson, AZ
  Graduate Teaching Assistant *Aug. 2019 – Present*
  - Math 112 Algebra
  - Math 120R Pre-Calculus
- **Whatcom Community College** Bellingham, WA
  Adjunct Instructor *Sept. 2018 – June. 2019*
  - Math 97 Elementary Algebra I
  - Math 98 Elementary Albegra II
  - Math 141 Pre-Calculus I
  - Math 151 Calculus I
- **Western Washington University** Bellingham, WA
  Graduate Teaching Assistant *Sept. 2016 – June. 2018*
  - Math 112 Algebra
  - Math 114 Pre-Calculus I
  - Math 115 Pre-Calculus II

Extra Curricular

- **Pi Mu Epsilon (Math Honors Society)** Tacoma, WA
  Founding Member of University of Puget Sound chapter *2015*
- **Arizona ASA DataFest Mentor** Online/AZ
  Graduate Student Mentor *2021-present*
  - Mentored undergraduate competitors through fast-paced data competition using large datasets from industry.
  - Occurs over 3 days every spring.
  - Given tutorials on relevant skills in a short timeframe.