Daniel Carbonero

danny.carbonero@gmail.com
dannycarbonero.github.io

RESEARCH INTERESTS

I enjoy solving challenging biological and mathematical problems by crafting machine learning solutions backed by the implantation of massive data sets. My current research involves developing novel, and adapting existing, machine learning methods for analysis of large neuroscientific data sets to better understand the brain.

EDUCATION

PhD **Biomedical Engineering, Boston University** 2019 - Present
Dissertation: "Machine Learning Framework for Analyzing State-Dependent Neuronal Network Dynamics in Calcium Recordings"
Advisors: John A. White, PhD & Mark A. Kramer, PhD

MS **Biomedical Engineering, Boston University** 2019 - 2022

BS **Biomedical Engineering, University of Miami** 2015 - 2019
Cum Laude

PROFESSIONAL AND RESEARCH EXPERIENCE

Graduate Research Fellow March 2020-present
Neuronal Dynamics Laboratory (NDL), Department of Biomedical Engineering, Boston University
Advisor: John White, PhD

- Develop and adapt linear and manifold learning dimensionality reduction (DR) machine learning methods for unsupervised neuronal network dynamic analyses recorded with calcium imaging under unique neural contexts.
- Built constraining for non-negative matrix factorization DR to also allow semi-supervised analysis approaches to neuronal network dynamics.
- Integrated manifold learning initialization for linear matrix factor analyses to exploit manifold learning's simplicity in conjunction with factor analysis's interpretability.
- Develop and write software wrapper packages to make complex machine learning methods more easily accessible and implementable to end users.
- Collaborate with experimental lab scientists to best apply developed analytical methods to their collected data to answer groundbreaking, novel, and complex neurological questions.
- Design analysis pipeline for rigorously characterizing neuronal network dynamics under: increasing concentrations of anesthetic sedation, and natural and artificial memory recall.

Associate Engineer May 2019 – August 2019
Bio-Vitro Inc, Supervisor: Siddarth Rawal, MD

- Optimized design of previously constructed fluid handling platform for unattended, automated, cell culture and cell signaling analysis under physiological conditions for production and sending to collaborating labs to make organs-on-chips more technically accessible.
- Supported/troubleshot collaborators on use of produced platforms.

Undergraduate Research Assistant May 2018-August 2018
Research Experience for Undergraduates – Neurological Prosthesis Research Laboratory, Department of Biomedical Engineering, Duke University, Advisor: Warren Grill, PhD

- Modified and completely automated a fully computational, Deep Brain Stimulation, Parkinson's Disease (PD) Neurological model to simulate networks of neurons using experimentally recorded data as inputs.
- Modeled PD in rat brain using upstream, experimentally recorded, neuron firing as input to simulate, characterize, and analyze downstream Thalamus function and activity to assess effectiveness of Deep Brian Stimulation as treatment for PD.

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Undergraduate Research Assistant May 2017 – May 2019
Physiomimetic Microsystems Laboratory (PML), Department of Biomedical Engineering, University of Miami
Advisor: Ashutosh Agarwal, PhD

- Developed automated software pipelines for immunohistochemical fluorescent microscope image data acquisition, processing, and analysis for reproducible quantification of microphysiological systems
- Wrote front-end software packages to allow end users to easily and reproducibly process and analyze image data for various platforms (heart, neuro-muscular junction, metastasis).
- Designed, prototyped, and manufactured an integrated and completely automated platform for continuous cell culture and dynamic cell secretion analysis of these microphysiological systems.

Student Analyst January 2017 – May 2017
Department of Continuing International Education, University of Miami, Supervisor: Magaly Abreu

- Developed early iteration of real-time, self-updating student database to consolidate information and ease access..
- Created financial reports to visualize large volumes of financial data more clearly and concisely.

SKILLS

Machine Learning and Data Science: Linear Dimensionality Reduction, Matrix Decomposition, Manifold Learning, Clustering, Unsupervised/Semi-Supervised/Supervised Learning, Deep Learning (Artificial Neural-Networks) Time Series Analysis, Image Analysis
Data Science Software: Scikit-Learn, Scipy, Statsmodels, Pandas, Tensorflow, Numba
Programming: Highly Proficient in: Python, MATLAB
Comfortable with: HTML, CSS, R
Familiar with: C, C++, Java
High Performance Computing: Unix, Linux, Remote Super Computing Clusters, Code Parallelization (Python, MATLAB), GPU Computing, git Version Control
Engineering Design: CAD, SOLIDWORKS, Rapid Prototyping
Software: Arduino IDE, COMSOL Multiphysics, ImageJ
Document Preparation: Microsoft Office, Adobe Illustrator
Certifications: Six Sigma Green Belt
Languages: Native in Spanish, fluent in English

JOURNAL PUBLICATIONS

D Carbonero, J Noueihed, MA Kramer, JA White, "Linear Dimensionality Reduction Methods for Analyzing Neuronal Network Dynamics in Calcium Recordings" (in preparation)

J Noueihed, **D Carbonero**, FR Fernandez, JA White, "Balance of Excitation and Inhibition in the Primary Somatosensory Cortex Layer 2/3 Under Isoflurane Anesthesia" (in preparation)

J Noueihed, **D Carbonero**, FR Fernandez, JA White, "Multisession Processing of Multiphoton Calcium Imaging" (under review)

RR Besser, A Alassaf, **D Carbonero**, I Ortiz, R Maciel, M Saporta, A Agarwal, "A Compartmentalized Platform for In-Vitro Assembly of Neuromuscular Junctions and the Implications for Studying Charcot-Marie-Tooth Disease Type 2E" (under review)

RR Besser, A C Bowles, A Alassaf, **D Carbonero**, R Maciel, M Saporta, A Agarwal, "A Chemically Defined Media for Culture of C2C12 Skeletal Muscle and Human Induced Pluripotent Stem Cell Derived Spinal Spheroids" ***Cellular and Molecular Bioengineering***

RR Besser, R Maciel, **D Cabonero**, A Alassaf, I Claure, E Jones, J Reda, A Bowles, W Bachelor, N Ziebarth, R Rodriquez, A Khan, M Saporta, A Agarwal: "Enzymatically Crosslinked Gelatin-Laminin Hydrogels for Applications in Neuromuscular Tissue Engineering", ***Biomaterials Science*** , 8(2), 591-606 HIGHLIGHTED AS COVER ARTICLE

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A Alassaf, G Tansik, V Mayo, L Wubker, **D Carbonero**, A Agarwal: "Engineering Anisotropic Cardiac Monolayers on Microelectrode Arrays for Non-invasive Analyses of Electrophysiological Properties" ***Analyst***, 145(1), 139-140 *included in themed collection on bioanalytical tools for enabling precision medicine*

M Ishahak, L Birman, **D Carbonero**, J Hill, A Hernandez, S Rawal, A Agarwal: "Integrated platform for operating and interrogating organs-on-chips", ***Analytical Methods***, 11(43), 5645-5651 (2019) *highlighted in the Emerging Investigator Series*

RR Besser, M Ishahak, V Mayo, **D Carbonero**, I Claure, A Agarwal: "Engineered Microenvironments for Maturation of Stem Cell Derived Cardiac Myocytes", ***Theranostics***, 8(1), 124-140 (2018)

CONFERENCE PRESENTATIONS

D Carbonero. J Noueihed, MA Kramer, JA White, "Linear Dimensionality Reduction for Neuronal Network Analysis Under Isoflurane Sedation in Mice", Society for Neuroscientists 2022 Annual Meeting, San Diego CA, November 2022

D Carbonero, J Noueihed, MA Kramer, JA White, "Linear Dimensionality Reduction for Analyzing Calcium Recordings", Biomedical Engineering Society 2022 Annual Meeting, San Antonio TX, October 2022 **(Platform Oral Presentation)**

D Carbonero, J Noueihed, JA White, "Principal Component Analysis for Neuronal Network Analysis Under Isoflurane Sedation in Mice", Society for Neuroscientists 2021 Annual Meeting, November 2021

D Carbonero, J Noueihed, JA White, "Principal Component Analysis for Neuronal Network Analysis Under Isoflurane Sedation in Mice", Biomedical Engineering Society 2021Annual Meeting, Orlando FL, October 2021

R Besser, R Maciel, A Alassaf, **D Carbonero**, M Saporta, A Agarwal, "In Vitro Recapitulation of The Dysfunctional Neuromuscular Junction In Charcot-Marie-Tooth Disease", TERMIS 2019 Annual Conference & Exhibition, Orlando FL, December 2019

R Besser, **D Carbonero**, I Claure, A Alassaf, A Bowles, E Jones, J Reda, W Bachelor, R Rodriquez, A Khan, R Maciel, M Saporta, A Agarwal, "Enzymatically Crosslinked Gelatin-Laminin Hydrogels for Disease on Chip Applications", Society for Biomaterials 2019 Annual Meeting, Seattle WA, April 2019

D Carbonero, K Kumaravelu, W M Grill, "Computational Analysis of Neural Activity Recorded during Subthalamic Nucleus Deep Brain Stimulation in a Rat Model of Parkinson's Disease", Biomedical Engineering Society 2018 Annual Meeting, Atlanta GA, October 2018

R Besser, R Maciel, A Alassaf, **D Carbonero,** M Dvornik, I Claure, M Saporta, A Agarwal, "In Vitro Recapitulation of the dysfunctional neuromuscular junction in Charcot-Mari-Tooth disease", Biomedical Engineering Society 2018 Annual Meeting, Atlanta GA, October 2018

M Ishahak, L Alamda-Sabate, **D Carbonero**, S Rawal, A Agarwal, "Organ-on-Chip Platform with Integrated, Non-Invasive Oxygen Monitoring", Pittcon 2018, Orlando FL., February 2018.

D Carbonero, R Besser, A Agarwal, "TwitchRead: Analyzing Contraction in Engineered Skeletal Muscle Tissue Co-Cultured with Neurospheres", Biomedical Engineering Society 2017 Annual Meeting, Phoenix AZ., October 2017

INVITED TALKS

Boston University Neurophotonics Center Tech Talk Tutorial Series Boston MA, September 22, 2022
Linear Dimensionality Reduction for Analyzing Calcium Recordings (a toolbox)

- Seminar series to spread awareness on technologies under development to foster collaboration between labs

TEACHING EXPERIENCE

Graduate Teaching Fellow September 2021- December 2021
EK 381 – Probability, Statistics and Data Science for Engineers
Department of Mechanical Engineering, Boston University

Graduate Teaching Fellow September 2020- December 2020
EK 125 – Introduction to Programming for Engineers
Department of Mechanical Engineering, Boston University

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LEADERSHIP & MENTORING

Nucleate – Vice President of Communication, Boston Chapter **November 2022 – Present**

- Vice President of Communications of the Boston chapter of student-led organization aiming to facilitate venture creation in pioneering.
- Build automated email pipelines to ensure both chapter leadership, and venture teams are updated on all organizational information.
- Collaborate with the rest of the communications team, and leaders of other teams, to write and publish weekly newsletter.

Neuronal Dynamics Lab - 2021-2022 Senior Design Team Advisor **August 2021 – May 2022**

- Advised and mentored senior design team developing random forest and support vector machines machine learning depth of anesthesia classifiers using standard neural recordings.

Understanding the Brain: Neurophotonics Yearly Symposium, Session Chair **January 2022**

- Spearheaded planning of 5th annual student led symposium where innovators in the field, along with students, congregate to discuss new technologies, methods, analyses.
- Selected topic (Data Focused Neuroscientific Approaches: Taking a Deeper Look into Neural Networks), invited speakers, and chaired session.

AWARDS/HONORS

NSF Research Traineeship Program Understanding the Brain: Neurophotonics Trainee	2020
NIH Translational Research in Biomaterials Training Grant Trainee	2019
Boston University Biomedical Engineering Distinguished Fellowship	2019
University of Miami College of Engineering Senior Design Industry Impact Award	2019
Alpha Eta Mu Beta - National biomedical engineering honor society	2019
Omicron Delta Kappa Honor Society - National leadership honor society	2019
Tau Beta Pi Honor Society -National engineering honor society	2018
University of Miami President's Scholarship	2015