BRINNAE BENT

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EDUCATION

2021 | PhD Biomedical Engineering, Duke University (Durham, NC)

Thesis: Discovering Digital Biomarkers of Glycemic Health from Wearable Sensors (PI: Dr. Jessilyn Dunn)

~Certificate in College Teaching (CCT)

2018 | M.S. Biomedical Engineering, Duke University (Durham, NC)

Thesis: Developing a Closed Loop Feedback System for Spinal Cord Stimulation using Evoked Compound Action Potentials as a Biomarker (PI: Dr. Jonathan Viventi)

2016 | B.S. Biomedical Engineering, North Carolina State University (Raleigh, NC)

Bioinstrumentation Emphasis | Nanotechnology and Biological Sciences Minors | University Scholar, Magna Cum Laude

RESEARCH EXPERIENCE

2020-present | Lead Developer, Digital Biomarker Discovery Pipeline

Co-established the DBDP (dbdp.org), an open source software platform for the development of digital biomarkers using mHealth and wearables. My role has been to lead the development of this OSS tool (compiling 50+ functions across 10 modules), lead integration with Open mHealth JSON data schemas and MD2k Cerebral Cortex using Apache/PySpark, and handle day-to-day operations and maintenance. Helped secure funding through the Chan-Zuckerberg Initiative for Open Source Science. Currently leading three teams focusing on different components of the DBDP, including the DBDP Data Compression Toolbox.

2019-present | Data Scientist/Graduate Research Associate, BIG IDEAS Lab, Duke University

Developing tools and infrastructure using biomedical and health data for early detection, intervention, and prevention of disease. Technical experience with data analytics, health informatics, machine learning, and clinical trials.

Accomplishments:

- Led projects establishing best practices for wearable sensor validation, investigating wearable sensor device inaccuracy, optimizing sampling rate and data compression of wearable sensors, and using wearable sensors for human activity recognition.
- Coordinated clinical research in the Duke Endocrinology and Lipids Clinic.
- Employed statistical models and machine learning algorithms for digital bi0omarker development.

2019-2020 | Project Manager, Data+ Rhodes Information Initiative

2019- Led project using machine learning to determine injury risk for Duke student athletes in the Michael W. Krzyzewski Human Performance Laboratory (K-Lab).

2020- Established and led project using deep learning methods for human activity recognition with wearable sensors.

2016-2019 | Graduate Research Associate, Viventi Laboratory, Duke University

Developing flexible electronics for recording at a higher resolution and over a larger area of the brain than currently possible using existing technologies. Technical experience with animal work, surgical techniques, Altium circuit design, and clinical trials.

Accomplishments:

- Developed IRB and protocol for clinical research of spinal cord stimulation (SCS) and dorsal root ganglion (DRG) stimulation in order to develop a feed-forward recording-stimulation system, which will improve therapy for chronic pain
- Sole individual facilitating long-term (chronic) animal (rat) studies (including establishing new anesthesia and surgical protocols, performing brain surgeries, post-operative care, weekly recordings, and signal analysis)
- Developed new testing methods for *in vivo* recordings

- Prototyped behavioral training to determine if learned behavior affects signal decoding accuracy
- Developed protocols for clinical trials of intraoperative brain mapping using uEcoG, tested electrodes and equipment prior to experiments, executed experiments in the operating room, and performed data collection

2015-2016 | Senior Capstone, Joint UNC-NC State Biomedical Engineering Department

Following the Stanford BIODESIGN model, working with a team of three UNC students, three NC State students, and three neurosurgeons at Duke Medical Hospital to assess needs and develop feasible medical solutions while forming a start-up entrepreneurial research venture, Triangle Medical Innovations.

Summer 2015 | Research Fellow, Kopelman Lab: University of Michigan Biomedical Engineering Department

Characterized micelles for application in Nanoscale Electrochemical Voltage Sensors used in brain tumor imaging. Technical experience with pipetting, nanoparticle synthesis, dynamic light scattering, freeze-drying

2014-2016 | Undergraduate Research Fellow, NSF Nanosystems Engineering Research Center (NERC) for Advanced Self Powered Systems of Integrated Sensors and Technologies (ASSIST)

Designing intelligent power management for battery-free sensing, computation, and wireless communication. Developed and fabricated photoplethysmograph probe for heart and respiratory monitoring in a health and environment monitoring medical device system with applications in asthma analysis.

2014-2016 | Undergraduate Research Assistant, Integrated Bionic Microsystems Laboratory (iBionicS): NC State University

Implemented electroencephalography (EEG) and functional near-infrared spectroscopy (fNIRS) into a sleep monitoring device designed to replace traditional polysomnography. Improved injectable biophotonic sensor for physiological monitoring of animals using a rat model. Technical experience with Solidworks, EAGLE-CAD, PCB manufacturing, LABVIEW, soldering, 3D printing, epoxy, packaging

TEACHING EXPERIENCE

Fall 2019 | Department of Biomedical Engineering, Duke University

Lab instructor and teaching assistant for Biomedical Data Science (undergraduate/Masters data science course). Designed and led recitations on data science and machine learning.

Fall 2018 | Department of Biomedical Engineering, Duke University

Lab instructor and teaching assistant for Fundamentals of Biomedical Design (undergraduate/Masters design course). Taught lectures on electronics-CAD (Eagle and Altium Designer).

Spring 2017, Spring 2018 | Department of Biomedical Engineering, Duke University

Lab instructor for Biomedical Engineering instrumentation course, Introduction to Biomedical Instrumentation (BME 354), which focused on the basic principles of biomedical electronics with an emphasis on transducers, instruments, micro-controller and PC based systems for data acquisition and processing. Taught laboratories on measurements, circuit design, and Arduino.

Spring 2018-Fall 2020 | Mindspire Test Prep STEM Tutoring, Mindspire™ Test Prep

Tutor for middle school, high school, and college students. Taught a variety of subjects including Statistics, Physics (AP/SAT II), Chemistry (AP/SAT II), Computer Science, Writing, and ACT/SAT test prep. Designed and taught course at Durham Middle College High School on ACT prep. Taught workshops on test preparation at workshops and schools.

Spring 2016-Spring 2018 | North Carolina School of Science and Mathematics

Substitute teacher for engineering curriculum. Taught lectures and labs on mechanical engineering, biomechanics, and biomedical engineering.

Summer 2017 | Duke Summer Academy for High School Students, Duke University

Teaching lab staff for Duke Summer Academy laboratory. Aided in the ground-up design and facilitation of a lab teaching high school students Arduino programming and device design. Taught students engineering skills to build a pedometer with an interactive user interface.

Spring 2017 | Osher Lifelong Learning Institute, Duke University

Primary instructor and developer of entire 6-week curriculum focused on biomedical engineering. Developed lectures on bioelectronics, biomechanics, and medical devices in addition to a laboratory component including ECG, EMG, and EMG robotics.

Fall 2015, Spring 2016 | Department of Biomedical Engineering, Joint UNC-NC State Biomedical Engineering Department

Lab instructor for introductory Biomedical Engineering course, Biomedical Measurements (BME 204), which introduces students to modern topics in biomedical engineering and areas of emphasis in the biomedical engineering curriculum through the study and use of biomedical measurement tools. Taught labs on EKG, pulse oximetry, blood pressure, Doppler, pressure sensors, coulter counter, temperature sensors, and AFM/SEM. Developed and implemented new labs, setup labs, and taught fellow TA's how to implement the labs.

Fall 2014, Fall 2015 | College of Engineering, North Carolina State University

Engineering 101 is a course designed to help incoming freshman explore the college of engineering, understand the Engineering Grand Challenges, and provide professional development opportunities. In addition to typical grading duties, ran course Moodle site, taught some lectures, regularly assisted with in-class and out of class projects, arranged speakers for class, and hosted a resume help session.

Spring 2015, Spring 2016 | College of Engineering, North Carolina State University

Pioneered Teaching Assistant position for Engineering Academic Success (E122), a course created to provide strategies for academic, professional, and personal success for students at-risk in the College of Engineering.

PUBLICATIONS AND PRESENTATIONS

*Peer-Reviewed Publications under Review/in Revisions (*indicates journal publications):*

***B. Bent,** B. Lu, J. Kim, J.P. Dunn. "Biosignal Compression Toolbox for Digital Biomarker Discovery". *In revisions.*

***B. Bent**, P. Cho, A. Wittman, M. Snyder, M. Crowley, M. Feinglos, J.P. Dunn. "Non-invasive Wearables to Monitor Glycemic Health". *In revisions.*

***B. Bent**, J.P. Dunn. "cgmquantify: A Python package for comprehensive analysis of interstitial glucose and glycemic variability from continuous glucose monitor data". *In review*.

E. Grzesiak, **B. Bent**, M. McClain, C. Woods, E. Tsalik, B. Nicholson, T. Veldman, T. Burke, C. Nix, S. Evans, Z. Gardener, E. Bergstrom, R. Turner, C. Chiu, P.M. Doraiswamy, A. Hero, R. Henao, G.S. Ginsburg, J.P. Dunn. "Detecting Influenza and the Common Cold Before Symptom Onset with Noninvasive Wearable Sensors".

*Peer-Reviewed Publications (*indicates journal publications,* †indicates conference publications*):*

***B. Bent**, I. Sim, J.P. Dunn. "Digital Medicine Community Perspectives and Challenges: Survey Study". JMIR MHealth and Uhealth. (2020). Accepted.

***B. Bent**, J.P. Dunn. "Wearables in a Pandemic: What are They Good For?" JMIR Mhealth Uhealth. (2020).

†**B. Bent**, J.P. Dunn. "Personalized Machine Learning Models for Noninvasive Glucose Prediction Using Wearables". NeurIPS Machine Learning for Mobile Health Workshop. (2020).

*M. Trumpis, C.H. Chiang, A. Osborn, **B. Bent**, J. Li, J.A. Rogers, B. Pesaran, G. Cogan, J. Viventi. "Sufficient Sampling for Kriging Prediction of Cortical Potential in Rat, Monkey, and Human, uECoG". Journal of Neural Engineering. (2020).

*M. Henriquez, J. Sumner, M. Faherty, T. Sell, ****B. Bent**. "Machine Learning to Predict Lower Extremity Musculoskeletal Injury Risk in Student Athletes". frontiers: Sports Science, Technology, and Engineering. (2020) *(**corresponding, senior author with funding responsibilities)*

***B. Bent**, J.P. Dunn. "Optimizing Sampling Rate of Wrist-worn Optical Sensors for Physiologic Monitoring". Journal of Clinical and Translational Science. (2020)

*__B. Bent__, K. Wang, E. Gerzesiak, C. Jiang, Y. Qi, Y. Jiang, P. Cho, K. Zingler, F. Ogbeide, A. Zhao, I. Sim, J. Dunn. “Digital Biomarker Discovery Pipeline: An open source software platform for the development of digital biomarkers using mHealth and wearables.” Journal of Clinical and Translational Science. (2020)

Y. Jiang, Y. Qi, K. Wang, __B. Bent__, R. Avram, J. Olgin, J. Dunn. “EventDTW: An Improved Dynamic Time Warping Algorithm for Aligning Biomedical Signals of Uneven Sampling Frequencies.” Sensors. (2020)

*J.C. Goldsack, A. Coravos, J. Bakker, __B. Bent__, A. Dowling, C. Fitzer-Attas, A. Godfrey, J.G. Godino, N. Gujar, E. Ismailova, C. Manta, B, Peterson, B. Vandendressche, W. Wood, W. Wang, J. Dunn. “Verification, Analytical Validation, and Clinical Validation (V3): The Foundation of Determining Fit-for-Purpose for Biometric Monitoring Technologies (BioMeTs)”. Nature Digital Medicine. (2020).

*__B. Bent__, B.A. Goldstein, W.A. Kibbe, J.P. Dunn. “Investigating Sources of Inaccuracy in Wearable Optical Heart Rate Sensors.” Nature Digital Medicine. (2020)

*CH. Chiang, S. Won, A. Orsborn, KJ. Yu, M. Trumpis, __B. Bent__, C. Wang, Y. Xue, S. Min, V. Woods, C. Yu, BH. Kim, SB Kim, R. Huq, J. Li, KJ. Seo, F. Vitale, H. Fang, Y. Huang, K. Shepard, B. Pesaran, JA Rogers, J. Viventi. “Actively-powered, Flexible, Kiloscale Devices for Long-term, High-resolution Brain Recording”. Science Translational Medicine. (2020).

†__B. Bent,__ CH. Chiang, C. Wang, N. Lad, A. Kent, J. Viventi. “Simultaneous Recording and Stimulation Instrumentation for Closed Loop Spinal Cord Stimulation.” IEEE Neural Engineering Conference Proceedings. (2019).

†__B. Bent__, A.J. Williams, R. Bolick, K. Chiang, M. Trumpis, J. Viventi. “3D Printed Cranial Window System for Chronic µECoG Recording.” IEEE Engineering Medicine and Biology Conference Proceedings. (2018).

†A.J. Williams, M. Trumpis, __B. Bent,__ K. Chiang, J. Viventi. “A Novel µECoG Electrode Interface for Comparison of Local and Common Averaged Referenced Signals.” IEEE Engineering Medicine and Biology Conference Proceedings. (2018).

*V. Woods, M. Trumpis, __B. Bent__, C.H. Chiang, K. Palopoli-Trojani, C. Wang, M. Insanally, R.C. Froemke, and J. Viventi, “Long-term recording reliability of liquid crystal polymer µECoG arrays.” Journal of Neural Engineering. (2018).

†M. Sahraee Ardakan, M. Emami, AK Fletcher, M. Trumpis, __B. Bent__, J. Viventi. “Learning Nonlinear Dynamical Networks in Neural Systems”. Conference on Cognitive Computational Neuroscience Proceedings. (2017).

*J. Dieffenderfer, H. Goodell, S. Mills, M. McKnight, S. Yao, F. Lin, E. Beppler, __B. Bent__, V. Misra, Y. Zhu, O. Oralkan, J. Strohmaier, J. Muth, D. Peden, and A. Bozkurt. “Low Power Wearable Systems for Continuous Monitoring of Environment and Health for Chronic Respiratory Disease.” Journal of Biomedical and Health Informatics (2016).

†Laura Gonzales, Katherine Walker, Sindhuja Challa, __Brinnae Bent__. “Monitoring a Skipped Heartbeat: A Real-time Premature Ventricular Contraction (PVC) Monitor”. IEEE Virtual Conference on Applications of Commercial Sensors (2016).

__*Bent, Brinnae__, Dr. Alper Bozkurt. “Miniaturizing Plethysmography for use in a Multifunctional Health Monitoring Device with Applications for Asthma Analysis.” State of North Carolina Undergraduate Research Journal: Explorations Vol. X (2015).

†Dieffenderfer, James P., Henry Goodell, __Brinnae Bent__, Eric Beppler, Rochana Jayakumar, Murat Yokus, Dr. Jesse S. Jur, and Dr. Alper Bozkurt. "Wearable Wireless Sensors for Chronic Respiratory Disease Monitoring." IEEE Body Sensor Networks (2015).

Conference Presentations (first author):

1. Banff International Research Station Workshop Use of Wearable & Implantable Devices in Health Research, February 2020, (Banff, Canada), Oral: "Open-source digital biomarker development".

2. National Biomedical Engineering Society Symposium (BMES), October 2019, (Philadelphia, PA) Poster: “Determining the Optimal Sampling Frequency of Photoplethysmography from Wearables for Heart Rate Variability".

3. North American Neuromodulation Society Conference (NANS), January 2019, (Las Vegas, NV), Poster: “Simultaneous Recording and Stimulation Instrumentation for Closed Loop Spinal Cord Stimulation”

4. Engineering, Medicine, and Biology Conference, July 2018, (Honolulu, HI), Oral: “3D Printed Cranial Window System for Chronic µECoG Recording”

5. Neural Interfaces Conference, June 2018, (Minneapolis, MN), Poster: “3D Printed Cranial Window System for Chronic µECoG Recording”

6. Regional BMES Symposium, December 2017, (Durham, NC), Oral: “Flexible, High-density µECoG Electrodes for in vivo Applications”, co-presented with A. Williams.

7. National Biomedical Engineering Society Symposium (BMES), October 2017, (Phoenix, AZ) Poster: “In Vivo Evaluation of Chronic Reliability of High Resolution, Low-cost µECoG Arrays”.

8. Abrams Research Fellowship Final Symposium, May 2016, (Raleigh, NC), Oral: “Quantifying Sleep Quality with Smartband Technology”

9. National Conference on Undergraduate Research (NCUR) April 2016, (Asheville, NC) Poster: “Miniaturizing Photoplethysmography for use in a Multifunctional Health Monitoring Device with Applications in Asthma Analysis”

10. State of North Carolina Undergraduate Research Symposium (SNCURS) November 2015, (High Point, NC) Poster: “Miniaturizing Photoplethysmography for use in a Multifunctional Health Monitoring Device with Applications in Asthma Analysis”

11. Society of Women Engineers Annual Conference (WE15), October 2015, (Nashville, TN) Poster: “Miniaturizing Photoplethysmography for use in a Multifunctional Health Monitoring Device with Applications in Asthma Analysis”

12. National Biomedical Engineering Society Symposium (BMES), October 2015, (Tampa, FL) Poster: “Miniaturizing Photoplethysmography for use in a Multifunctional Health Monitoring Device with Applications in Asthma Analysis”

13. UNC-NC STATE BME Research Retreat, September 2015, (Chapel Hill, NC) Poster: “Miniaturizing Photoplethysmography for use in a Multifunctional Health Monitoring Device with Applications in Asthma Analysis”

14. University of Michigan Summer Research Symposium, July 2015 (Ann Arbor, MI) Poster and Oral: “Characterizing Micelles for Application in Nanoscale Electrochemical Voltage Sensors”

15. National Conference on Undergraduate Research (NCUR) April 2015, (Spokane, WA) Poster: “Quantifying Sleep Quality with Smartband Technology”

16. NC State Undergraduate Research Symposium (URS) April 2015, (Raleigh, NC) Poster: “Miniaturizing Photoplethysmography for use in a Multifunctional Health Monitoring Device with Applications in Asthma Analysis”

17. Triangle Biomedical Engineering Symposium (NC-BMES) March 2015, (Durham, NC) Poster: “Quantifying Sleep Quality with Sleepiband”

18. State of North Carolina Undergraduate Research Symposium (SNCURS) November 2014, (Raleigh, NC) Poster: “Quantifying Sleep Quality with Sleepiband”

OTHER EXPERIENCES & INVOLVEMENTS

2014-2016 | Biomedical Engineering Ambassador, Joint UNC-NC State Biomedical Engineering Department

2014- 2016 | Engineering Ambassador, North Carolina State University College of Engineering

2013- 2016 | Engineering Career Fair Coordinator (Inventory), North Carolina State University College of Engineering

Summer 2014 | Ergonomics Research & Development Intern, Oshkosh Corporation (Oshkosh, WI)

PROFESSIONAL AFFILIATIONS

2015-present | Biomedical Engineering Society

2015-present | Society of Women Engineers

2015-present | Institute of Electrical and Electronics Engineers (IEEE) Student Member

2015-present | IEEE Sensors Council

2015-present | IEEE Engineering in Medicine and Biology Society

2013-present | Engineering World Health

HONORS, AWARDS & FELLOWSHIPS

2020 | Featured Woman in STEM, 1MWIS

2020 | Invited Speaker, Digital Medicine Society Webinar Series

2020 | Participant & Speaker, Banff International Research Station Workshop Use of Wearable & Implantable Devices in Health Research

2020 | Invited Speaker, Duke Center for Health Informatics Seminar Series [Link]

2019 | BMES Career Award, Biomedical Engineering Society (BMES)

2019 | BMES Travel Award, Duke University Biomedical Engineering Department

2019 | FHIR DevDays Global Hackathon Winner (developed mobile app with interoperability standards), HL7 FHIR

2019 | Forge Pre-doctoral Fellowship (3+ year competitive fellowship), Duke Forge

2018 | Neural Interfaces Conference Student Travel Award, Neural Interfaces Conference 2018

2018 | Broader Impacts Seminar Student Talk Competition Finalist and Award Recipient, Duke University

2017 | Steven W. Smith Fellowship, Duke University

2017 | BMES Travel Award, Duke University Biomedical Engineering Department

2016 | NIH-IMSD Biosciences Collaborative for Research Engagement (BioCoRE) Graduate Fellowship

2016 | Biomedical Engineering Scholar Award Fellowship, Duke University

2016 | Abrams Scholar 'Researcher of the Year' Award, North Carolina State University

2016 | Biomedical Engineering Citizenship and Service Award (Joint UNC-NC State Biomedical Engineering Department)

2016 | i4 Pitch Finalist

2015 | i4 Pitch Award Recipient

2015 | Abrams Scholars Research Fellowship, North Carolina State University

2015 | RiOT Hackathon Honorable Mention

2015 | Society of Women Engineers National Technical Poster Competition Finalist

2015 | IEEE Body Sensor Networks Best Paper Award

2015 | University of Michigan Summer Research Fellowship

2015 | Outstanding Biomedical Engineering Junior 2015 (Joint UNC-NC State Biomedical Engineering Department)

2014 | NSF Undergraduate Research Fellowship