BRENDAN T. CRABB

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EDUCATION

Doctor of Medicine   Expected May 2023
Spencer Fox Eccles School of Medicine at the University of Utah, Salt Lake City, UT

Bachelor of Science in Physics   May 2017
Point Loma Nazarene University, San Diego, CA

AWARDS, HONORS, GRANTS

- **Young Investigator Award, 1st Prize.** North American Society for Cardiovascular Imaging.   2022
- **James B. Bassingthwaighte Best Poster Award.** International Cardiac Physiome Workshop 2021.   2021
- **Sarnoff Cardiovascular Research Foundation Fellowship**. $42,000 research grant.   2021 – 2022
- **AΩA Carolyn L. Kuckein Student Research Fellowship Award**. $6,000 research grant.   2020 – 2021
- **RSNA Research and Education Foundation's Medical Student Research Grant.** $6,000 research grant.   2019
- **NIH Ruth L. Kirschstein National Research Service Award**. $5,000 research grant.   2019
- **PLNU Outstanding STEM Senior Award.** Faculty-voted top STEM senior.   2017
- **PLNU Valedictorian.** Highest academic achievement in graduating class.   2017
- **Graduate Summa Cum Laude.** Highest academic distinction.   2017

RESEARCH EXPERIENCE

University of Utah School of Medicine   Dec. 2021 – Present
Department of Radiology and Imaging Sciences, Salt Lake City, UT
Research Associate
Advisor: Megan Mills, MD

Evaluating the Impact of Contextual Interference in Human and Machine Learning
- Modeled the impact of contextual interference and interleaved (non-blocked) training schedules in radiology resident curriculums by using multi-task deep neural networks.
- This project resulted in an accepted poster presentation at the 2022 Imaging Elevated: Utah Symposium for Emerging Investigators and a manuscript in preparation for submission to Academic Radiology.

University of California San Diego   Jul. 2021 – Jul. 2022
Departments of Radiology and Bioengineering, La Jolla, CA
Sarnoff Cardiovascular Research Fellow
Advisors: Andrew D. McCulloch, Ph.D. and Albert Hsiao M.D, Ph.D.

Deep Learning Analysis and Unsupervised Clustering of Left Ventricular Mechanics in Tetralogy of Fallot
- Investigated left ventricular mechanics in a multi-institutional, international cohort of patients with repaired tetralogy of Fallot using a deep learning-based approach.
- Aspects of this work were accepted for oral presentations at the Radiological Society of North America 2022 Annual Meeting and the North American Society for Cardiovascular Imaging 2022 Annual Meeting. Manuscript currently in preparation.

Towards Fully Automated Cardiac Statistical Modeling: A Deep-Learning Based MRI Approach
- Addressed critical bottlenecks in the development of biventricular statistical shape models by automating MRI view classification, short-axis slice selection, phase selection, and landmark localization.
- Resulted in a James B. Bassingthwaighte Best Poster Award at the 2021 Cardiac Physiome Workshop and a manuscript in preparation for submission to *Journal of Cardiovascular Magnetic Resonance*.

Biventricular Statistical Shape Atlas of Unloaded Reference Geometries: A Novel Method to Control for Hemodynamic Variations in End-Diastolic Pressure
- Developed an unsupervised machine learning approach to minimize geometric shape differences secondary to hemodynamic loading in biventricular statistical atlases, providing a more accurate characterization of underlying ventricular structure.
- Accepted for an oral presentation and conference manuscript at the American Society for Mechanical Engineer's 2022 International Mechanical Engineering Congress and Exposition.

University of Utah School of Medicine   March. 2020 – Jul. 2020
Department of Cardiology, Salt Lake City, UT
Research Assistant
Advisors: Rashmee Shah, M.D.

Electronic Medical Record Review of Patients with Symptoms of Coronavirus Disease 2019
- Designed study, performed statistical analysis, and wrote manuscript comparing the performance of fever, cough, and dyspnea-specific ICD-10 codes with medical record review among patients tested for COVID-19.
- Resulted in a first-author manuscript publication in *JAMA Network Open.*

University of Utah School of Medicine   May. 2020 – Present
Department of Neurological Surgery, Salt Lake City, UT
Research Assistant
Advisors: William T. Couldwell, MD, PhD and Michael Karsy, MD, PhD

Predicting Readmission Following Pituitary Adenoma Resection using Machine Learning
- Built automated python scripts that process NSQIP data, optimize machine learning models using Bayesian parameter optimization, and run a comparative performance and permutation analysis.
- Resulted in an abstract at the 2020 Weill Cornell Medicine Medical Student Neurological Surgery Research Symposium, abstract at the 2021 Congress of Neurological Surgeons Annual Meeting, and a first-author manuscript in *Neurosurgery*.

High-grade Glioma Imaging Volumes and Survival Analysis using Intraoperative MRI
- Conducted a multivariate regression and survival analysis for patients with high-grade gliomas based on intraoperative MRI volumes, tumor genetics, patient demographics, and clinical features.
- Resulted in a manuscript currently in review in the *Journal of Neuro-Oncology.*

University of Utah School of Medicine   Aug. 2018 – Present
Department of Radiology, Salt Lake City, UT
Research Assistant
Advisors: Gabriel Fine, M.D. and Frederic Noo, Ph.D.

Motion Correction in Digital Subtraction Angiography Using Generative Adversarial Networks
- Developed a generative adversarial network (GAN) that reliably eliminates motion artifacts in visceral angiograms.

- Received the Radiological Society of North America (RSNA) Research and Education Foundation's Medical Student Research Grant, the National Institute of Health (NIH) Ruth L. Kirschstein National Research Service Award Institutional Training Grant, and the AΩA Carolyn L. Kuckein Student Research Fellowship Award.
- Resulted in an accepted abstract to the 2019 Radiological Society of North America conference, an oral presentation at the 2020 Society of Interventional Radiology conference, a manuscript forthcoming in the *Journal of Vascular and Interventional Radiology*, and an international patent pending (WO2021113235A1).

United States Navy   Sept. 2017 – Jul. 2018
Space and Naval Warfare Systems Command, San Diego, CA
Civilian Research Assistant / Engineering Contractor
Advisors: Josh Harguess, Ph.D., Katie Rainey, Ph.D., and Niels Olson, MD

Whole Slide Image Processing for Deep Learning in Digital Pathology
- Wrote a Python module (SlideSeg) that produces image patches and annotation masks from whole slide images for deep learning in digital pathology.
- Made this tool open-source and publicly available at *github.com/btcrabb/slideseg*. It has been used by hundreds of researchers across the globe—from the NIH to India.

Synthetic Data Generation for Machine Learning in Domains with Sparse Data
- Researched, built, trained, and deployed generative adversarial networks (GANs) to produce photorealistic synthetic imagery for multiple Department of Defense sponsored projects.

Semantic Segmentation of Integrated Circuits in Printed Circuit Boards
- Combined the convolutional neural network architecture, u-net, with a recurrent neural network approximation to a conditional random field to produce a novel network that achieved state-of-the-art results at integrated circuit detection and segmentation.
- Made a custom version of the Caffe deep learning framework that supported the implementation of conditional random fields as a neural network layer and could be built with Microsoft Visual Studio 2017 and CMake on a Windows 10 machine.
- Integrated multiple trained neural network models into C++ software applications.

Image Super Resolution Using Convolutional Neural Networks
- Analyzed the performance of the super-resolution convolutional neural network (SRCNN) at single image super-resolution using multiple image quality assessments.

Point Loma Nazarene University   May 2015 – May 2017
Department of Inorganic Chemistry, San Diego, CA
Undergraduate Research Assistant
Advisor: Laurance Beauvais, Ph.D.

Organocatalysis using N-heterocyclic Carbene Containing Metal-Organic Frameworks
- Designed and performed experiments with a variety of metal-organic frameworks in inert conditions.
- Resulted in an accepted manuscript to the journal *Polyhedron*.

Exploratory Coordination Chemistry: Metal Nitride Nanoclusters with Cobalt, Bismuth, and Titanium Species
- Designed new synthetic routes to titanium and bismuth nanoparticles using metal nitride nanoclusters.
- Resulted in a manuscript and oral presentation at the 2017 Point Loma Nazarene University Honors Scholars Conference.

PROFESSIONAL EXPERIENCE

Sarnoff Cardiovascular Research Fellow 2021-2022
University of California San Diego, La Jolla, CA
- Fully funded, one year research fellowship at an institution of my choosing through the Sarnoff Cardiovascular Research Foundation, designed to train the next generation of leaders in cardiovascular innovation, research, and medicine.
- Selected to study under the co-mentorship of Dr. Albert Hsiao, associate professor of Radiology, and Dr. Andrew McCulloch, the Shu Chien Chancellor's Endowed Chair in Engineering and Medicine and director of the Institute for Engineering in Medicine, at the University of California San Diego.

Course Instructor 2017-2018
Eduonix Learning Solutions
- Designed and developed multiple online courses on machine learning, including recorded lectures, programming projects, and quizzes. To date, over 25,000 students worldwide have enrolled in these courses.
- Courses included "Machine Learning for Absolute Beginners", "Projects in Machine Learning: Beginner to Professional", "Mathematical Foundations for Machine Learning and AI", and "Applied Machine Learning for Healthcare".

Electrical Engineering Contractor 2017-2018
Space and Naval Warfare Systems Command, U.S. Navy, San Diego, CA
- Full time electrical engineering contractor for the U.S. Navy, hired due to my performance as an intern through the Naval Research Enterprise Internship Program.
- Tasked with researching and applying deep learning, including image super-resolution, generative adversarial networks, and semantic segmentation, to several Department of Defense sponsored projects.

Naval Research Enterprise Intern 2017
Office of Naval Research, U.S. Navy, San Diego, CA
- Summer internship studying Naval applications of computer vision and artificial intelligence.
- Personally recruited due to my performance in my undergraduate mathematics courses.

Chemistry Research Assistant 2015-2017
Point Loma Nazarene University, San Diego, CA
- Undergraduate research under Dr. Laurance Beauvais in inorganic chemistry.

University Physics I and II Teaching Assistant 2015-2017
Point Loma Nazarene University, San Diego, CA
- Facilitated lab experiences and graded problem sets for several undergraduate physics courses.

Math and Physics Tutor 2013-2017
Point Loma Nazarene University, San Diego, CA
- Tutored and assisted individual and groups of students over a broad range of math and physics concepts through the Math Learning Center.

LEADERSHIP AND COMMUNITY INVOLVEMENT

Co-President 2019 – 2021
Neurosurgery Student Interest Group
- Organized lunch talks with faculty and host clinical skills workshops with the neurosurgery residents.

Medical Volunteer 2019 – 2020
Junior League Community Assistance and Resource Event (CARE) Fair, Salt Lake City, UT
- Obtained histories and performed physical exams at the CARE Fair, which is an annual two-day event that provides underserved members of the community with routine medical, dental, and vision services.

Medical Volunteer 2018 – 2019
Midvale Community Clinic, Salt Lake City, UT
- Obtained histories and performed physical exams at the Midvale student-run clinic.

Mentor and Tutor 2015 – 2017
Reality Changers Tutoring Ministries, City Heights San Diego, CA
- Mentored and tutored underserved high school students in the inner city of San Diego on a weekly basis.

PATENTS

Crabb, B.T., Noo, F., Fine, G.C. Medical Image Synthesis for Motion Correction Using Generative Adversarial Networks. International Patent Application No. WO 2021/113235 A1, filed December 02, 2019, published June 10, 2021.

PEER REVIEWED JOURNAL ARTICLES

- Crabb, B. T., Govil, S., Deng, Y., et al. "A Deep Learning Approach for Fully Automated Cardiac Shape Modeling in Tetralogy of Fallot." *Journal of Cardiovascular Magnetic Resonance*. (In Review) 2022
- Gamboa, N. T., **Crabb, B. T.**, Henson, J. C., et al. "High-grade glioma imaging volumes and survival: A single-institution analysis of 101 patients after resection using intraoperative MRI." *Journal of Neuro-Oncology*. (In Review) 2022
- **Crabb, B. T.**, Hammrick, F., Richards, T., et al. "Subtraction-related Artifact Reduction in Visceral Digital Subtraction Angiography Using Generative Adversarial Networks." *Journal of Vascular and Interventional Radiology*. (In Review) 2022
- **Crabb B. T.**, Govil, S., Hegde, S., et al. "Biventricular Statistical Shape Atlas of Unloaded Reference Geometries: A Novel Method to Control for Hemodynamic Variations in End-Diastolic Pressure." *Proc. ASME 2022 International Mechanical Engineering Congress and Exposition.* (Accepted). 2022
- **Crabb, B. T.**, Hamrick, F., Campbell, J., et al. "Machine Learning-Based Analysis and Prediction of Unplanned 30-Day Readmissions after Pituitary Adenoma Resection: A Multi-Institutional Retrospective Study with External Validation." *Neurosurgery* (2022): 10-1227; doi: 10.1227/neu.0000000000001967 2022
- **Crabb, B. T.**, Lyons A., Bale M., et al. "Comparison of International Classification of Diseases and Related Health Problems, Tenth Revision Codes with Electronic Medical Records Among Patients with Symptoms of Coronavirus Disease 2019." *JAMA Network Open*. 2020;3(8). doi:10.1001/jamanetworkopen.2020.17703 2020
- **Crabb, B. T.**, Olson, N. H. "SlideSeg: A Python module for the creation of annotated image repositories from whole slide images", *Proc. SPIE, Medical Imaging 2018: Digital Pathology*, Volume 10581, 12 Feb. 2018. 2018

- Ward, C. M., Harguess, J., **Crabb, B. T.**, Parameswaran, S. "Image quality assessment for determining efficacy and limitations of Super-Resolution Convolutional Neural Network (SRCNN)", *Proc. SPIE 10396, Applications of Digital Image Processing XL, 1039605*, 19 September 2017; doi: 10.1117/12.2275157 — 2017
- Schumacher, W. T., Matthews, M. J. Larson, S. A., Lemmon, C. E., Campbell, K. A., **Crabb, B. T.**, Chicoine, B. J., Beauvais, L. G., Perry, M. C. "Organocatalysis by site-isolated N-heterocyclic carbenes doped into the UIO-67 framework." *Polyhedron*, Volume 114, 16 August 2016, Pages 422-427 — 2016

PEER REVIEWED ABSTRACTS

- **Crabb, B. T.**, Chandrupatla, R., Masutani, E., et al. "Deep Learning Left Ventricular Mechanical Analysis – Sensing Bi-Ventricular Dysfunction in Tetralogy of Fallot" *Radiological Society of North America 2022 Annual Scientific Meeting,* 29 November 2022 (Accepted for Oral Presentation). — 2022
- Chandrupatla, R., **Crabb, B. T.**, Masutani, E., et al. "Deep Learning Visualization and Quantification of Mechanical Dyssynchrony in Cardiac MRI" *Radiological Society of North America 2022 Annual Scientific Meeting,* 29 November 2022 (Accepted for Oral Presentation). — 2021
- **Crabb, B. T.**, Noo, F., and Fine, G. C. "Image synthesis for motion correction in digital subtraction angiography using a generative adversarial network (GAN)." *Journal of Vascular and Interventional Radiology* 31.3 (2020): S135. — 2020
- Schumacher, W., Mathews, M., Larson, S., Lemmon, C., Campbell, K., **Crabb, B. T.**, Chicoine, B., Beauvais, L., Perry, M. (2016, March). "Synthesis and characterization of MOF-supported NHC catalysts" In *Abstracts of Papers of the American Chemical Society* (Vol. 251). — 2016

ORAL PRESENTATIONS

- **Crabb, B. T.**, Chandrupatla, R., Masutani, E., et al. (2022, Sept). "Deep Learning Analysis and Unsupervised Clustering of Left Ventricular Mechanics in Tetralogy of Fallot" *North American Society for Cardiovascular Imaging 2022 Annual Scientific Meeting*, Cleveland, OH. — 2022
- **Crabb B. T.** (2022, June). Quantitative Analysis of Cardiac MRI: From Deep Learning Synthetic Strain to Bi-Ventricular Computational Modeling. Oral presentation at the *42nd annual Sarnoff Cardiovascular Research Foundation Scientific Meeting*, Arlington, VA. — 2022
- **Crabb B. T.**, Hamrick, F., Campbell, J., et al. (2021, Oct). Machine Learning-Based Analysis and Prediction of Unplanned 30-Day Readmissions after Pituitary Adenoma Resection: A Multi-Institutional Retrospective Study with External Validation. Oral presentation at the *2021 Congress of Neurological Surgeons Annual Meeting*, Austin, TX. — 2021
- **Crabb, B. T.**, Noo, F., Fine, G. C., (2020, April). Image Synthesis for Motion Correction in Digital Subtraction Angiography (DSA) Using a Generative Adversarial Network (GAN). Oral presentation at the *Society of Interventional Radiology's 2020 Annual Scientific Meeting*. — 2020
- **Crabb, B. T.**, Hamrick, F., Campbell, J. et al. (2020, Jan) Predicting Readmission Following Pituitary Adenoma Resection: A Machine Learning Approach. Oral presentation at the *Weill Cornell Medicine Medical Student Neurological Surgery Research Symposium*. — 2020
- **Crabb, B. T.**, Olpin, J., Fine, G. C., (2019, Sept). A Case of Budd-Chiari Syndrome. Clinical case presentation at the *Imaging Elevated: Utah Symposium for Emerging Investigators*, Salt Lake City, UT. — 2019

- **Crabb, B. T.**, Shoukry, M., Beauvais, L., Bennett, M. V., (2017, May). Exploratory Coordination Chemistry: Metal Nitride Nanoclusters with Cobalt, Bismuth, and Titanium Species. Oral presentation at the *2017 Point Loma Nazarene University Honors Scholars Conference*, San Diego, CA.   2017

POSTER PRESENTATIONS

- **Crabb, B.T.,** Chandrupatla, R., Masutani, E.M., et al. (2022, Apr). Deep Learning Left Ventricular Mechanical Analysis – Sensing Bi-Ventricular Dysfunction in Tetralogy of Fallot. Poster presented at the Rady Children's Hospital San Diego Pediatrics Research Symposium.   2022
- **Crabb, B.T.,** Govil, S., Young, A.A., et al. (2021, Nov). Towards Fully Automated Cardiac Statistical Shape Modeling: A Deep-Learning Based MRI View and Phase Selection Tool. Poster presented at the 2021 Cardiac Physiome Workshop.   2021
- **Crabb, B. T.**, Noo, F., and Fine, G. C. (2021, Nov). Motion Correction in Digital Subtraction Angiography using Generative Adversarial Networks: An Implementation and Evaluation of the Gradient-Consistency Loss Function. Poster presented at the 2021 Radiological Society of North America Annual Scientific Meeting, Chicago, IL.   2021
- Cogman, A., Eastaway, A., Fine, C., Smith, T., Weintraub, M., Kaufman, C., Quencer, K., **Crabb, B. T**, Quigley, E. (2019, Dec). Creation of a Haptic 3D Printed Simulator for TIPS Training in Augmented and Virtual Reality. Poster presentation at the Radiological Society of North America's 2019 Annual Scientific Meeting, Chicago, IL.   2019
- **Crabb, B. T.**, Fine, G. C., (2019, Dec). Motion Correction in Digital Subtraction Angiography Using Machine Learning. Poster presented at the Radiological Society of North America's 2019 Annual Scientific Meeting, Chicago, IL.   2019
- **Crabb, B. T.**, Olson, N. H., (2018, Feb). SlideSeg: A Python module for the creation of annotated image repositories from whole slide images, Poster presented at SPIE, Medical Imaging 2018: Digital Pathology.   2018
- **Crabb, B. T.**, Ward, C., (2018, Feb). Improving Semantic Segmentation Results using a CRF-RNN. Poster presented at the SPAWAR Naval Applications of Machine Learning Workshop, San Diego, CA.   2018
- **Crabb, B. T.**, Campbell, K., (2017, April). Preparation of metal-organic frameworks containing N-heterocylic carbene catalysts. Poster at the 253rd ACS National Meeting and Exposition, San Francisco, CA   2017

ONLINE PUBLICATIONS

- **Crabb, B. T.**, Karsy, M., Roper, S., Still, M., Vega, R. (2022, July). "Machine Learning–based Analysis and Prediction of Unplanned 30-Day Readmissions", Congress of Neurological Surgeons Journal Club Podcast. https://www.cns.org/publications/journal-club-podcasts/podcast-detail/august-2022-machine-learning-based-analysis-predic   2022

MANUSCRIPT REVIEWS

Ad hoc peer reviewer for manuscripts and proposals submitted to:
- Mitacs Accelerate   2022
- IEEE Journal of Biomedical and Health Informatics   2021

PROFESSIONAL AFFILIATIONS AND CERTIFICATIONS

American Heart Association (AHA)   2021 – Present
Advanced Wilderness Life Support (AWLS) certification   2020 – Present
Society of Interventional Radiology (SIR)   2018 – Present
Radiological Society of North America (RSNA)   2018 – Present
Secret-level security clearance, United States Government, active   2017 – Present