Anthony B. Costa, Ph.D.

Contact Information

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Personal Statement

Proven leader in biomedical technologies, data science, and AI. As Founding Director of Sinai BioDesign and Chief Operating Officer for AISINAI, I have built and led successful teams focused on improving outcomes in medicine through a needs-based approach to device development and machine intelligence. I am a passionate educator and committed to the advancement of medicine through technology innovation. I have leveraged my extensive experience in computing, entrepreneurship, and medicine to enable unique multidisciplinary efforts, defining and executing strategy that successfully integrates physicians, hospital systems, and technical domain experts.

Current Appointments

Icahn School of Medicine at Mount Sinai, New York, NY, USA

Primary Appointment: Director, Sinai BioDesign	2017 to Present
Secondary Appointment: Chief Operating Officer, AISINAI	2017 to Present
Academic Appointment: Assistant Professor*†, Neurosurgery	2015 to Present

- Developed Sinai BioDesign and its team from the ground up, a first-of-its-kind innovation research group focused on early-stage medical device and software development, working directly with physicians and researchers to turn their needs and fledgling ideas into commercially-viable inventions.
- Overall portfolio includes leadership of neurosurgery computational research and infrastructure, software and device development, commercialization, an expansive innovation portfolio in medical technologies, and system-wide data science and engineering strategy and education.

Past Appointments

Monogram Orthopaedics, New York, NY, USA

Co-Founder	2016

- Orthopedic device startup company co-founded by Mount Sinai inventors.
- Contribution includes the development of novel computational image and geometry processing methods for the design, manufacturing, and robotically-assisted placement of novel orthopedic implants, as well as service as CSO during the company's formation.

*Co-Director, Masters in Biomedical Data Science
†Scientific Director, Neurosurgery Simulation Core

Icahn School of Medicine at Mount Sinai, New York, NY, USA
Computational Scientist, Scientific Computing 2013 to 2015

- Application of high-performance computing to computational genomics, structural and chemical biology, and basic clinical research and development efforts.
- Studied, designed, tested, and implemented massively parallel hardware and software resources in support of basic research on petascale data sets in life sciences research.
- Projects included performance optimization of next-generation-sequencing pipelines, molecular dynamics simulation for novel hardware architectures, and multiscale analysis and predictive modeling of unstructured clinical data.

Education

Northwestern University, Evanston, IL, USA
Postdoctoral Fellow 2010 to 2013

- Advised by Dr. Igal Szleifer.
- Department of Energy's Energy Frontier Research Center's Program.
- Non-Equilibrium Energy Research Center.
- Departments of Biomedical Engineering, Chemistry.

- Primary author of high-performance software for heterogeneous architectures used to study chaos in Hamiltonian dynamical systems. These tools provide an extensive toolkit for the study of deterministic chaos in the largest yet-simulated atomic and molecular systems.
- Software used to measure the importance of microscopic degrees of freedom during transient non-equilibrium processes. Demonstrated for the first time that a reduced statistical description of dissipation was possible by considering the dynamical entropy of the dissipative system only, without considering its surroundings.

Purdue University, West Lafayette, Indiana, USA
Ph.D., Magna Cum Laude, Chemistry 2010

- Advised by Dr. R. Graham Cooks.
- Thesis Topic: *Theory and Statistics of Ambient Mass Spectrometry.*
- Candidacy Exam: *Treanor Pumping Vibrational Transport on Hydrogen-Passivated Silicon Surfaces.*

- Developed general dimensionality reduction methods for imaging mass spectrometry applied to the determination of disease state in biological tissue. Real-time classification of tissue regions into an image giving the likelihood of cancer outperformed expert-analyzed histological staining. Method currently being applied *in vivo* during surgery.
- Identified, for the first time, a mechanism that explains the chiral selectivity and magic-number clustering of serine using a hierarchy of classical enhanced sampling methods and density functional theory. Serine clusters are implicated as one possible mechanism leading to the origin of biological homochirality.
- Used multi-phase and discrete particle computational fluid dynamics simulations to study droplet impact on surfaces and transport of progeny droplets. Demonstrated that momentum-transfer events explain the behavior of desorption-based ambient ionization methods in mass spectrometry. This mechanism is now widely accepted in the literature and used as the basis for the development of new ambient ionization methods.

Bowdoin College, Brunswick, Maine, USA
B.A., Music, Chemistry with Honors, Minor in Mathematics 2005

- Advised by Dr. Elizabeth A. Stemmler.
- Thesis Topic: *Fragmentation of N-Terminal Derivatives of Polyalanine Peptides by Sustained Off-Resonance Irradiation Fourier Transform Mass Spectrometry.*

Publications

D. Grinberg, A. Bruhat, M. Q. Lee, D. H. Adams, J. F. Obadia, A. B. Costa, P.-J. Cottinet, *Outils innovants pour guider la rparation mitrale: mthodes et perspectives*, Bulletin de lAcadmie Nationale de Mdecine (2020), In Press. doi:10.1016/j.banm.2020.02.010.

D. Ranti, K. Hanss, S. Zhao, V. Arvind, J. Titano, **A. B. Costa**, E. K. Oermann, *The Utility of General Domain Transfer Learning for Medical Language Tasks*, arXiv [cs.CL] (2020). arxiv:2002.06670.

D. Grinberg, A. Bruhat, P.-J. Cottinet, M. Q. Le, D. H. Adams, **A. B. Costa**, *Mitral Valve Repair Based on Physical Characterization of Coaptation Forces*, J. Thorac. Cardiovasc. Surg. (2020). In Press. doi:10.1016/j.jtcvs.2019.07.097.

J. Zeiger, **A. B. Costa**, J. Bederson, R. K. Shrivatava, A. M.-C. Iloreta, *Use of Mixed Reality Visualization in Endoscopic Endonasal Skull Base Surgery*, Operative Neurosurgery (2020). In Press. doi:10.1093/ons/opz355.

K. Nael, J. Drummond, **A. B. Costa**, R. De Leacy, M. Fung, J Mocco, *Differential Subsampling with Cartesian Ordering for Ultrafast High-Resolution MRA in the Assessment of Intracranial Aneurysms*, J. Neuroimaging 30 (2020) 40-44. doi:10.1111/jon.12677.

K. Yaeger, A. Iserson, P. Singh, T. Oxley, E. Vidal, **A. B. Costa**, J. Fifi, *A Technical Comparison of Thrombectomy Vacuum Aspiration Systems*, J. Neurointerventional Surg. 12 (2020) 72-76. doi:10.1136/neurintsurg-2019-014929.

K. A. Yaeger, M. Martini, G. Yaniv, E. K. Oermann, **A. B. Costa**, *United States Regulatory Approval of Medical Devices and Software Applications Enhanced by Artificial Intelligence*, Health Policy and Technology 8 (2019) 192-197. doi:10.1016/j.hlpt.2019.05.006.

B. Marinelli, M. Kang, M. Martini, J. Zech, J. Titano, S. Cho, **A. B. Costa**, E. K. Oermann, *Combination of Active Transfer Learning and Natural Language Processing To Improve Liver Volumetry Using Surrogate Metrics with Deep Learning*, Radiology Artificial Intelligence, 1 (2019), e180019. doi:10.1148/ryai.2019180019.

J. Steinberger, L. Schlachter, H. Oemke, D. Nistal, **A. B. Costa**, J. Bederson, *A Virtual Reality 360 Degree Fly-through of an Arteriovenous Malformation*, Operative Neurosurgery 18 (2019) E11. doi:10.1093/ons/opz062.

D. A. Kaji, J. R. Zech, J. S. Kim, S. K. Cho, N. S. Dangayach, **A. B. Costa**, E. K. Oermann, *An attention based deep learning model of clinical events in the intensive care unit*, PLOS Biomedical Engineering, 14 (2019) e0211057. doi:10.1371/journal.pone.0211057.

K. Yaeger, M. Martini, J. Rasouli, **A. B. Costa**, *Emerging Blockchain Technology Solutions for Modern Healthcare Infrastructure*, Journal of Scientific Innovation in Medicine, 1 (2019) 1. doi:10.29024/jsim.7.

J. Loewenstern, A. Aggarwal, M. Pain, E. Barthlemy, **A. B. Costa**, J. Bederson, R. K. Shrivastava, 2018, *Peritumoral Edema Relative to Meningioma Size Predicts Functional Outcomes after Resection in Older Patients*, Operative Neurosurgery, (2019). doi:10.1093/ons/opy107.

A. Camara, S. Ghatan, F. Panov, **A. B. Costa**, *Robotic surgical rehearsal on patient specific 3D printed skull models for stereoelectroencephalography (SEEG)*, Int. J. Comput. Assist. Radiol. Surg., 14 (2019) 139-145. doi:10.1007/s11548-018-1885-5.

J. J. Titano, M. Badgeley, J. Schefflein, M. Pain, A. Su, M. Cai, N. Swinburne, J. Zech, J. Kim, J. Bederson, J Mocco, B. Drayer, J. Lehar, S. Cho, **A. B. Costa**, E. K. Oermann, *Automated deep-neural-network surveillance of cranial images for acute neurologic events*, Nature Medicine, 24 (2018) 1337-1341. doi:10.1038/s41591-018-0147-y.

J. Zech, M. A. Badgeley, M. Liu, **A. B. Costa**, J. J. Titano, E. K. Oermann, *Variable Generalization Performance of Radiological Deep Learning Models: A Cross-Sectional Study*, PLOS Medicine, 11 (2018), e1002683. doi:10.1371/journal.pmed.1002683.

J. Zech, J. Forde, J. Titano, D. Kaji, **A. B. Costa**, E. K. Oermann, *Detecting Insertion, Substitution, and Deletion Errors in Radiology Reports Using Neural Sequence-to-Sequence Models*, Annals of Translational Medicine, (2018). doi:10.21037/atm.2018.08.11.

J. Zech, M. Pain, J. Titano, M. Badgeley, J. Schefflein, A. Su, **A. B. Costa**, J. B. Bederson, J. Lehr, E. K. Oermann, *Natural Language Based Machine Learning Models for the Annotation of Clinical Radiology Reports*, Radiology, 287 (2018) 570-580. doi:10.1148/radiol.2018171093.

J. Mascitelli, L. Schlachter, H. Oemke, A. G. Chartrain, J. Gillian, **A. B. Costa**, R. K. Shrivastava, J. B. Bederson, *Navigation-Linked Heads-Up Display in Intracranial Surgery: Accuracy and Utility*, Operative Neurosurgery, 15 (2018) 184-193. doi:10.1093/ons/opx205.

R. Feng, J. Loewenstern, A. Aggarwal, P. Pawha, A. Gilani, A. M. Iloreta, R. Bakst, B. Miles, J. B. Bederson. **A. B. Costa**, V. Gupta, R. K. Shrivastava, *Cerebral Radiation Necrosis: An Analysis of Clinical and Quantitative Imaging and Volumetric Features*, World Neurosurgery, 111 (2018) 48594. doi:10.1016/j.wneu.2017.12.104.

V. Arvind, **A. B. Costa**, M. Madgeley, S. Cho, E. K. Oermann, *Wide and Deep Volumetric Residual Networks for Volumetric Image Classification*, arXiv [cs.CV] (2017). arxiv:1710.01217.

E. K. Oermann, J. S. Multani, J. Mascitelli, K. Nicol, J. Titano, B. Skovrlj, M. Pain, J. D. Mocco, **A. B. Costa**, R. Shrivastava, *Quantitative Computed Tomography Ventriculography for Assessment and Monitoring of Hydrocephalus: A Pilot Study and Description of Method in Subarachnoid Hemorrhage*, World Neurosurgery, 104 (2017) 136-141. doi:10.1016/j.wneu.2017.04.107.

M. Das, **A. B. Costa**, J. Green, *Extensivity and Additivity of the Kolmogorov-Sinai Entropy for Simple Fluids*, Phys. Rev. E, 92 (2017) 022102. doi:10.1103/PhysRevE.95.022102.

S. Sarkiss, S. Philemond, J. Lee, S. Sobotka, T. D. Holloway, M. Moore, **A. B. Costa**, E. Gordon, J. B. Bederson, *Neurosurgical Skill Assessment: Measuring Technical Proficiency in Neurosurgery Residents through Intraoperative Video Evaluations*, World Neurosurgery, 89 (2016) 1-8. doi:10.1016/j.wneu.2015.12.052.

S. Sultana, J. E. Blatt, Y. Lee, M. Ewend, J. S. Cetas, **A. B. Costa**, M. Audette, *Patient-Specific Cranial Nerve Identification Using a Discrete Deformable Contour Model for Skull Base Neurosurgery Planning and Simulation*, Lecture Notes in Computer Science, 4901 (2016) 36-44. doi:10.1007/978-3-319-31808-0_5.

P. Kovatch, **A. B. Costa**, Z. Giles, E. Fluder, H. M. Cho, S. Mazurkova, *Big Omics Data Experience*, SC '15, 39 (2015). doi:10.1145/2807591.2807595.

T. Holloway, Z. S. Lorsch, M. A. Chary, S. Sobotka, M. M. Moore, **A. B. Costa**, R. F. Del Maestro, J. Bederson, *Operator Experience Determines Performance in a Simulated Computer-Based Brain Tumor Resection Task*, Int. J. CARS, 10 (2015) 1853-1862. doi:10.1007/s11548-015-1160-y.

R. G. Brook, A. Heinecke, **A. B. Costa**, P. Peltz, Jr., M. Bader, V. C. Betro, T. Baer, R. C. Hulguin, P. Dubey, *Beacon: Exploring the Application of Intel Xeon Phi Coprocessors to Scientific Computing*, Computing in Science & Engineering 17, (2015) 65-72. doi:10.1109/MCSE.2014.113.

J. R. Green, **A. B. Costa**[‡], B. A. Grzybowski, I. Szleifer, *Relationship Between Dynamical Entropy and Energy Dissipation far from Thermodynamic Equilibrium*, PNAS, 110 (2013) 16339-16343. doi:10.1073/pnas.1312165110.

A. B. Costa, J. R. Green, *Extending the Length and Time Scales of Gram-Schmidt Lyapunov Vector Computations*, J. Comput. Phys., 246 (2013) 113-122. doi:10.1016/j.jcp.2013.03.051.

A. L. Dill, L. S. Eberlin, **A. B. Costa**, D. R. Ifa, R. G. Cooks, *Data Quality in Tissue Analysis using Desorption Electrospray Ionization*, Anal. Bioanal. Chem., 401 (2011) 1949-1961. doi:10.1007/s00216-011-5249-z.

J. I. Zhang, **A. B. Costa**, W. A. Tao, R. G. Cooks, *Direct Detection of Fatty Acid Ethyl Esters using Low Temperature Plasma (LTP) Ambient Ionization Mass Spectrometry for Rapid Bacterial Differentiation*, Analyst, 136 (2011) 3091-3097. doi:10.1039/C0AN00940G.

A. B. Costa, R. G. Cooks, *Origin of Chiral Selectivity in Gas-Phase Serine Tetramers*, Phys. Chem. Chem. Phys., 13 (2011) 877-885. doi:10.1039/C0CP01402H.

A. L. Dill, L. S. Eberlin, **A. B. Costa**, C. Zheng, D. R. Ifa, L. Cheng, T. A. Masterson, M. O. Koch, O. Vitek, R. G. Cooks, *Multivariate Statistical Identification of Human Bladder Carcinomas using Ambient Ionization Imaging Mass Spectrometry*, Chem. A Euro. J., 17 (2011) 2897-2902. doi:10.1002/chem.201001692.

[‡]Indicates equal contribution to first author

R. G. Cooks, N. E. Manicke, A. L. Dill, D. R. Ifa, L. S. Eberlin, **A. B. Costa**, H. Wang, G. Huang, Z. Ouyang, *New Ionization Methods and Miniature Mass Spectrometers in Biomedicine: DESI Imaging for Cancer Diagnostics and Paper Spray Ionization for Therapeutic Drug Monitoring*, Faraday Discuss., 149 (2011) 247-267. doi:10.1039/c005327a.

J. I. Zhang, N. Talaty, **A. B. Costa**, Y. Xia, W. A. Tao. R. Bell, J. H. Callahan, R. G. Cooks, *Rapid Direct Lipid Profiling of Bacteria using Desorption Electrospray Ionization Mass Spectrometry*, Int. J. Mass Spectrom., 301 (2011) 37-44. doi:10.1016/j.ijms.2010.06.014.

A. L. Dill, L. S. Eberlin, C. Zheng, **A. B. Costa**, D. R. Ifa, L. Cheng, T. A. Masterson, M. O. Koch, O. Vitek, R. G. Cooks, *Multivariate Statistical Differentiation of Renal Cell Carcinomas Based on Lipidomic Analysis by Ambient Ionization Imaging Mass Spectrometry*, Anal. Bioanal. Chem., 398 (2010) 2969-2978. doi:10.1007/s00216-010-4259-6.

L. S. Eberlin, A. L. Dill, **A. B. Costa**, D. R. Ifa, L. Cheng, T. Masterson, M. Koch, T. L. Ratliff, R. G. Cooks, *Cholestoral Sulfate Imaging in Human Prostate Cancer Tissue by Desorption Electrospray Ionization Mass Spectrometry*, Anal. Chem., 82 (2010) 3430-3434. doi:10.1021/ac9029482.

A. L. Dill, D. R. Ifa, N. E. Manicke, **A. B. Costa**, D. W. Knapp, R. G. Cooks, *Lipid Profiles of Canine Transitional Cell Carcinoma and Adjacent Benign Tissue by Desorption Electrospray Ionization Imaging Mass Spectrometry*, Anal. Chem., 81 (2009) 8758-8764. doi:10.1021/ac901028b.

M. Fico, J. D. Maas, S. A. Smith, **A. B. Costa**, W. J. Chappell, R. G. Cooks, *Circular Arrays of Polymer-Based Miniature Rectilinear Ion Traps*, Analyst, 134 (2009) 1338-1347. doi:10.1039/b822140e.

A. B. Costa, R. G. Cooks, *Simulated Splashes: Elucidating the Mechanism of Desorption Electrospray Ionization*, Chem. Phys. Lett., 464 (2008) 1-8. doi:10.1016/j.cplett.2008.08.020.

A. B. Costa, R. G. Cooks, *Simulation of Atmospheric Transport and Droplet-Thin Film Collisions in Desorption Electrospray Ionization*, Chem. Commun., (2007) 3915-3917. doi:10.1039/b710511h.

Book Chapters

A. B. Costa, *3D Printing for Medical Models: Additive Manufacturing*, in *Imaging of the Spine, 2nd Edition*, Elsevier, In Press.

K. Riley, **A. B. Costa**, J. B. Bederson, R. Shrivastava, *Cranioplasty: The Role of Cranial Implants*, in *Digital Technologies in Craniomaxillofacial Surgery*, Springer, (2017).

Patents

T. Baker, **A. B. Costa**, P. Backeris, C. Kellner, H. Shoirah, *Detachable Cooling Apparatus, Associated System, and Method of Deployment*, Provisional Application Filed 2019.

P. Backeris, A. Bruhat, **A. B. Costa**, M. Palese, *Device for Retrieving a Foreign Object in a Body*, Provisional Application Filed 2019.

P. Backeris, K. Yaeger, **A. B. Costa**, T. Oxley, A. Berenstein, Y. J. Kwon, J. Borrello, *Detachable-Tip Balloon Microcatheter for Embolization of Vascular Malformations*, Provisional Application Filed 2019.

J. B. Bederson, **A. B. Costa**, P. Backeris, *Epidural/Subdural Minimally Invasive Access Tool*, Patent Pending. Provisional Application Filed 2018.

D. B. Unis, S. Somani, **A. B. Costa**, *Apparatus, Method and System for Providing Customizable Bone Implants*, Provisional Application Filed 2016. Patent Pending.

Invited Lectures

Training Biomedical & Clinical Language Models using BERT, GPU Technology Conference, San Jose, CA (2020).

Deep, Self-Supervised Learning for Patient-Specific Anomaly Detection in Stereoelectroencephalography, GPU Technology Conference, San Jose, CA (2020).

Digital Technologies in Neurosurgery: An End-to-End Case Series, MARCH Workshop on Statistical and Shape-Based Image Analysis with Applications in Medicine, Taipei, Taiwan (2019).

Advancing AI in Medicine: The Role of Law and Policy in Accelerating Medical Research, Brooklyn Law School, Brooklyn, NY (2019).

Institutional Initiatives for AI in Healthcare: What, Why, How?, Johns Hopkins Research Symposium on Engineering in Healthcare, Malone Center, Johns Hopkins University, Baltimore, MD (2019).

How GPU Computing Can Accelerate the Treatment of Neurological Disorders, GPU Technology Conference, San Jose, CA (2019).

Computer-Simulated Advances in Neurosurgical Research: Challenges, Successes, and Future Directions, InCHOIR Lecturship, Icahn School of Medicine at Mount Sinai, New York, NY (2018).

Big Omics Data Experience, SC '15, Austin, TX (2015).

High Field MRI for Modeling of Cranial Nerves and Small Caliber Vessels in Neurosimulation, World Federation of Neurosurgical Societies, Rome, Italy (2015).

What's Next for Haptic Neurosurgery Simulators?, European Congress of Neurosurgery, Prague, Czech Republic (2014).

Characterization and Benchmarking of NGS Workflow Methods on Various Platform Architectures, Bio-IT World Conference & Expo, Boston, MA (2014).

Measuring Dissipation in Very-Far-From-Equilibrium Processes, Chemistry Department Seminar Series, Bowdoin College, Brunswick, ME (2012).

Recent Theoretical and Experimental Results on Droplet Production and Transport in Desorption Electrospray Ionization, Ambient Surface Analysis, Bio-Surface Interaction and Nano-Biotechnology Conference, National Physical Laboratory, Teddington, UK (2008).

Notable Events

Visiting Professor, *National Taiwan University and National Center for Theoretical Sciences*, Taipei, Taiwan (2020).

Program Organizer, *Mount Sinai Health Hackathon: Artificial Intelligence*, Icahn School of Medicine at Mount Sinai, New York, NY (2018).

Program Co-Chair, *Medical AI Research Collaboration Hub*, National Taiwan University and the Icahn School of Medicine at Mount Sinai (2019).

Program Organizer, *Mount Sinai Health Hackathon: Rare Diseases*, Icahn School of Medicine at Mount Sinai, New York, NY (2018).

Program Co-Chair, *Artificial Intelligence, Advanced Digital Technologies, and Device Development in Neurosurgery*, Mount Sinai Hospital System, New York, NY (2018).

Program Co-Chair, *National Center for Theoretical Sciences Health Hackathon*, Taipei, Taiwan (2018).

Program Organizer, *Mount Sinai Health Hackathon: Cancer*, Icahn School of Medicine at Mount Sinai, New York, NY (2017).

Workshop Chair, *2nd Annual SC Workshop on Medical Image Analysis and Visualization Workshop (MIAV)*, SC '17, Denver, CO (2017).

Course Director, *Advanced Use of Digital Technologies for Intracranial Surgery*, American Association of Neurological Surgeons, Los Angeles, CA (2017).

Workshop Chair, *Taking Supercoming to the Clinic: Medical Image Analysis and Visualization*, SC '16, Salt Lake City, UT (2016).

Current Teaching

Course Director 2020 to Present
Regulation and Clinical Trials of Medical Devices
Icahn School of Medicine at Mount Sinai

Course Director and Instructor 2018 to Present
Introduction to Algorithms
Icahn School of Medicine at Mount Sinai

Past Teaching

Course Director and Instructor 2018 to 2019
Computer Systems
Icahn School of Medicine at Mount Sinai

Course Director and Instructor 2015 to 2018
Introduction to Scientific Computing
Icahn School of Medicine at Mount Sinai

Instructor 2016 to 2018
Summer School for Computational Genomics
Community Research Education and Engagement for Data Science (CREEDS)
Icahn School of Medicine at Mount Sinai

Instructor 2013 to 2015
Introduction to Scientific Computing
Icahn School of Medicine at Mount Sinai

Teaching Assistant 2005 to 2006
Introductory Chemistry for Engineers I, II
Purdue University