
Statistical Methods for Neuroimaging – BSTA 7510
Course Schedule for Fall 2022

Module 1: An Introduction to Biomedical Imaging

August 30, 2022 – A Window Into the Brain and its Utility in the Clinic

- Structural and Functional Neuroanatomy
- Brief overview of neuroimaging technology and its use in medicine
- Neurological and psychiatric disorders and imaging presentations

September 1, 2022 – Image Processing in R

- Load and visualize imaging files in R
- State-of-the-art in image processing pipelines for structural and functional MRI
- Neuroconductor as an open-source central repository for R packages to imaging analysis

Module 2: Image Processing and Feature Extraction

September 6, 2022 – Intensity Normalization and Inhomogeneity Correction

- The state-of-the-art in image processing software packages, and interfaces with R
- N3 and N4 bias field correction methods
- Histogram matching and related methods
- Z-scoring and statistical intensity normalization
- Metrics for assessing intensity normalization

September 8, 2022 – Linear and Nonlinear Image Registration

- Linear image registration methods
- Nonlinear image registration methods
- Pitfalls of registration and interpolation-related artifacts
- Longitudinal methods for image registration

September 13, 2022 – Image Segmentation

- Brain extraction techniques
- Intensity-based image segmentation methods
- Mixture Modeling via Expectation-Maximization
- Deep learning for segmentation

Module 3: Structural Magnetic Resonance Imaging

September 15, 2022 – Atlas-based Segmentation of Complex Structures (Shinohara)

- Single-atlas segmentation methods
- Multi-atlas label fusion methods

Note – **September 20, 2022** is the Penn Conference on Big Data in Population Health Sciences <https://www.dbei.med.upenn.edu/big-data>, and class is cancelled. We encourage you to consider attending the conference.

September 22, 2022 – Multiple Comparison Corrections

Simon Vandekar, PhD

Assistant Professor of Biostatistics

Vanderbilt University

September 27, 2022 – Voxel-based Morphometry

- Voxel-based morphometry
- Region of interest analyses
- Lesion mapping
- Confounding in VBM

September 29, 2022 – Assessing the Cortical Mantle

- Methods for measuring cortical morphometry
- Coupling analysis of cortical changes
- Pathology in the cortex

October 4, 2022 – Fall Break

Module 3: Functional Magnetic Resonance Imaging

October 6, 2022 – Technologies for Measuring Brain Function

- Electroencephalography
- Magnetoencephalography
- Functional near-infrared spectroscopy
- Functional magnetic resonance imaging (fMRI)

October 11, 2022 – Overview of Task and Resting-State fMRI

- Overview of task-based and resting-state fMRI and their data structures
- Spatial and temporal decency in the data
- Generalized linear models

October 13, 2022 – Multimodal Measures of Tissue Damage

- Multichannel statistical segmentation methods
- Multimodal longitudinal biomarkers in multiple sclerosis

October 18, 2022 – The Complementary Value of Multimodal Imaging

- Contrast-enhanced MRI and analytical frameworks
- Image synthesis methods
- Image prediction techniques and performance assessment

October 20, 2022 – Dimension Reduction and Multi-View Data

- Multivariate pattern analysis (MVPA)
- Principal component analysis (PCA) and independent component analysis (ICA)
- Overview of cutting-edge development on joint analysis with multimodal imaging data

October 25, 2022 – Image Reliability Analysis

Haochang Shou, PhD

*Assistant Professor at the Penn Statistical Imaging and Visualization Endeavor
Department of Biostatistics, Epidemiology, and Informatics*

October 27, 2022 – Confounding and Generalizability in MVPA

Kristin Linn, PhD

*Assistant Professor at the Penn Statistical Imaging and Visualization Endeavor
Department of Biostatistics, Epidemiology, and Informatics*

October 29, 2022 - Inter-scanner Image Harmonization

- Multi-scanner study designs and biases
- Statistical approaches to image harmonization

Module 4: Lecture Series on “The Cutting Edge in Imaging Science”

November 1, 2022 – Neuroimaging Statistics in Multiple Sclerosis

Elizabeth Sweeney, PhD

*Assistant Professor at the Penn Statistical Imaging and Visualization Endeavor
Department of Biostatistics, Epidemiology, and Informatics*

November 3, 2022 – Imaging Informatics

Li Shen, PhD, FAIMBE

Professor of Informatics

Department of Biostatistics, Epidemiology, and Informatics

November 8, 2022 – Structural Connectivity Studies

Ragini Verma, PhD

Professor in the Section of Biomedical Image Analysis

Department of Radiology

November 10, 2022 – Modern Problems in Neuroimaging Science

Ruben C. Gur, PhD

Professor and Director of Neuropsychology and the Brain Behavior Laboratory

Department of Psychiatry

November 15, 2022 – Imaging Genetics

Aaron Alexander-Bloch, MD, PhD

Assistant Professor and Director of the Brain-Gene-Development Laboratory

Department of Psychiatry

November 17, 2022 – Imaging Blood Flow using MRI

John A. Detre, MD

Director of Center for Functional Neuroimaging

Co-Director of the Center for Advanced Magnetic Resonance and Spectroscopy

Vice-Chair for Research in Neurology

Professor of Neurology and Radiology

Department of Neurology

November 22-24, 2022 – Class Cancelled for Thanksgiving

November 29, 2022 – Network Modeling of Connectivity

Dani Bassett, PhD

J Peter Skirkanich Professor of Bioengineering, Physics and Astronomy, Electrical and Systems Engineering, Neurology, and Psychiatry

Department of Bioengineering

December 1, 2022 – Subject Motion in Functional Imaging Studies

Theodore D. Satterthwaite, MD, MA

Assistant Professor and Director of Image Analysis at the Brain Behavior Laboratory

Department of Psychiatry

December 6, 2022 – Biomarkers from Multivariate Pattern Analysis

Christos Davatzikos, PhD

Wallace T. Miller Sr. Professor of Radiology and Electrical and Systems Engineering and

Director of the Center for Biomedical Image Computing and Analytics

Department of Radiology

December 8, 2019 – In Class Presentations