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Analytic tools for identifying biomarkers of epileptogenesis after traumatic brain injury using multi-modal data and virtual reality to correct segmentation errors in MRI

Dominique Duncan
University of Southern California

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Abstract: The first part of my talk focuses on identifying biomarkers that can predict epileptogenesis after traumatic brain injury (TBI). This project, The Epilepsy Bioinformatics Study for Antiepileptogenic Therapy (EpiBioS4Rx), is a multi-site, international collaboration including a parallel study of humans and an animal model, collecting MRI, EEG, and blood samples. The development of epilepsy after TBI is a multifactorial process and crosses multiple modalities. Without a full understanding of the underlying biological effects, there are currently no cures for epilepsy. This study hopes to address both issues, calling upon data generated and collected at sites spread worldwide among different laboratories, clinical sites, in different formats, and across multicenter preclinical trials. Before these data can even be analyzed, a central platform is needed to standardize these data and provide tools for searching, viewing, annotating, and analyzing them. We have built a centralized data archive that will allow the broader research community to access these shared data in addition to analytic tools to identify and validate biomarkers of epileptogenesis in images and electrophysiology as well as in molecular, serological, and tissue studies.

The second part of this talk focuses on crowdsourcing manual validation of algorithmically-segmented brain volumes using virtual reality. One of our imaging workflow processes involves algorithmic segmentation of the scans into labeled anatomical regions using FreeSurfer software. Since this automation cannot yet achieve perfect accuracy, we are working on transforming the way this is accomplished using VR technology to deal with the volumes directly in 3D space, which has been shown to be more efficient and intuitive.

Bio: Dominique Duncan is an assistant professor of Neurology at the USC Stevens Neuroimaging and Informatics Institute in the Laboratory of Neuro Imaging (LONI). She began working at LONI in 2015 as a postdoctoral scholar with Dr. Arthur Toga. Dr. Duncan's background spans mathematics, engineering, and neuroscience. She double majored in Mathematics and Polish Literature as an undergraduate at the University of Chicago and minored in Computational Neuroscience. She earned her PhD in Electrical Engineering at Yale University. In her PhD thesis, she analyzed intracranial EEG data using nonlinear factor analysis to identify preseizure states of epilepsy patients. After graduation, she was a professor of Mathematics at Sichuan University in Chengdu, China for a summer program where she taught Calculus 2, Calculus 3, and Linear Algebra to undergraduate students. She then took a postdoctoral position in Neurology at the Stanford University School of Medicine as well as one in Mathematics at UC Davis, where she developed an algorithm based on diffusion maps to classify Alzheimer's patients using MRI. Her current projects include combining machine learning and crowdsourcing segmentation error corrections in neuroimaging data using virtual reality, developing analytic tools to identify biomarkers of epileptogenesis after traumatic brain injury, and building a multi-modal data repository for human invasive recordings.