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Ming Hsieh Institute Seminar Series

Medical Imaging

New Theory and Methods for Accelerated MRI Reconstruction

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Time: 10:00 AM - 11:00 AM
Room: EEB 248

Join Zoom:
https://usc.zoom.us/j/94607557250

** This talk is the public portion of a PhD dissertation defense **

Abstract: Magnetic resonance imaging (MRI) has revolutionized medicine by providing high-quality images of living tissue in a safe and noninvasive manner. However, the data-acquisition time can still be restrictively long in real applications. To accelerate this task, one popular alternative has been acquiring a reduced amount of data samples, and then using reconstruction methods to generate images out of the acquired undersampled data. In this talk we discuss novel contributions to improve the performance and efficiency of MRI reconstruction methods.

We start revisiting the shift-invariant linear predictability relationships that exist in the MRI data (k-space), and how they can be leveraged using structured low-rank modeling (SLM). Then, we propose novel reconstruction approaches based on SLM which additionally incorporate in-prior knowledge learned from previously acquired reference data. We show that this approach is particularly useful in the context of ghost-artifact correction in echo planar imaging (EPI), where we theoretically establish that in-prior knowledge is necessary in order to avoid ill-posedness when using SLM reconstruction methods. Next, we provide a robust and powerful SLM reconstruction method able to account for potential imperfections in the reference data.

In the last part of the talk, we show that linear predictability principles can also be used in the context of sensitivity map estimation in multichannel MRI. We start showing new theoretical results that provide a novel mathematical description for the estimation problem. Specifically, we show that sensitivity maps at particular locations belong to a nullspace of a matrix created from linear predictability relationships. Then, based on advanced signal processing techniques, we propose a set of computational methods which allow massive improvements in the computational complexity of sensitivity map estimation methods based on subspaces. We show cases where conventional estimation methods obtain a ~30-fold acceleration when combined with our proposed computational techniques. Notably, these improvements in computational time and memory usage are obtained without sacrificing estimation accuracy.

Biography: Rodrigo A. Lobos is a Ph.D candidate in Electrical and Computer Engineering at University of Southern California, supervised by Prof. Justin Haldar. He obtained his Bachelor's and Master's degree in Electrical Engineering at Universidad de Chile, where he received the Best Master's Thesis award in Electrical Engineering in 2015. During this time, The School of Engineers of Chile recognized Rodrigo as the best electrical engineer graduated from Universidad de Chile in 2015. He then joined Prof. Haldar's group at USC where his research has been focused on signal processing, computational imaging, and machine learning applied to medical imaging applications. Rodrigo's work has been recognized in distinguished medical imaging conferences, where he obtained a Best Paper Finalist award in IEEE ISBI 2020. At University of Southern California Rodrigo was selected as a Ming Hsieh Institute Ph.D Scholar.

Host: Justin Haldar