Biological Spectroscopic Signal Denoising

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Abstract

Nuclear Magnetic Resonance (NMR) is a powerful technique used to identify the composition and concentration of individual compounds in a chemical mixture. One such application is the non-invasive monitoring of metabolites in the human body. However, NMR signals are inherently very weak due to the small nuclear magnetization and noise could overwhelm the signal if concentrations are low. For such NMR devices, the noise is composed of thermal and electrical noise as well as Radio Frequency Interference (RFI). At Synex, we developed a Machine Learning algorithm and a state-of-the-art signal acquisition system to recover high fidelity signal from a noisy input. First, we map the signal onto a high dimensional subspace, such that some of the noise is isolated from the signal. Inspired by image denoising techniques, we then use a deep Convolutional Neural Network (CNN) to denoise the high dimensional signal and map the denoised signal back to a 1D subspace. By employing adaptive noise estimation and dilated convolutions in the CNN, we reduced our error by 25%. We plan to incorporate additional information into our model to help us improve our denoising performance and achieve quantification accuracies that surpass industry standards.