Xnet: A Novel Machine Learning Model for Fast MRI Reconstruction

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The up to ninety-minute sessions that many patients spend in Magnetic Resonance Imaging machines, due to slow MRI data acquisition rates lead to blurry images, onsets of claustrophobia, hearing damage, and unwanted nerve stimulation. This work limits patient exposure by creating and implementing a novel Deep Learning Network which reconstructs MR images from a sub-sample of k-space data (the raw frequency data collected by the MRI machine). Due to the lack of sub-sampled k-space data available publicly, I simulated the following sub-sampled k-space scenarios (0.01%,0.05% 1%,2.5%, 5%, 25%, and 30%) by using their respective masks. This work proposes a bivariate generative adversarial network architecture called X-Net to generate a sharp MR image from two heavily sub-sampled MR images. This architecture uses convolutional auto-encoders, convolutional auto-decoders, and residual networks. It also contains a proprietary loss function and a novel abstraction of cross-pollination between tensorized information. Testing the framework on multiple sets of MR images (knee and brain) demonstrated a significant increase in reconstruction speed and PSNR (a quality metric). Furthermore, a set of three extensive experiments, each with different amounts of sub-sampled MR images as generator inputs, showed promising results for deployment into the medical industry. Nevertheless, this work is not limited to Medical Image Analysis. It is also highly applicable to the emerging studies of Data-Centric AI as it can make critical advancements in the last and arguably most crucial step in the Data-Centric AI pipeline: data augmentation.

Awards Won: