Reverse-Engineering Brain Structures in MRI with Deep Learning

Yan, Benjamin (School: Century High School)

Modern diagnosis of glioma tumors requires several MRI sequences of the brain, which can be costly, burdensome to the patient, and provide toxic risks due to the presence of metallic, often gadolinium, contrast agents. The bulk of literature to streamline MR imaging has focused on making the physical imaging more rapid and trimming the number of sequences used in diagnosis. This research proposes a new, machine learning-based approach termed BikeGAN, which allows the reversible translation of images between sequences. A single T1 weighted MRI can be used to reverse-engineer all other sequences for diagnosis, preserving a large wealth of diagnosis information while allowing streamlined treatment. BikeGAN involves training a forward and backward mapping of an image input to image output, for instance, T1 and T2 weighted images, through adversarial losses to encourage the production of realistic-looking MRI scans and cycle-consistency losses to ensure the semantic alignment of the forward and backward mappings. The architecture included a generator to create MRI images and a classifier network to evaluate them, with a novel min-max objective function used to encourage the steady learning of both networks and the increasingly more realistic production of MRI sequences. The deep learning tool was retrospectively tested on MRI scans and showcases its ability to preserve anatomical consistency while generating a diverse wealth of tissue contrast and diagnostic areas. It could significantly streamline patient treatment, trim imaging costs, and shore up MRI resources to help counter shortages in availability, elevating the standard of patient care.

Awards Won: