U-Net for Neural Image Classification and Regression on MRI and PET Scans

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MRI and PET scan images have long provided a means of identifying disease in the human brain. However, identification of minute graphical details in these images is still difficult for trained doctors. Convolutional neural networks have made classification and segmentation of images in the medical field much quicker and more accurate. Using a dataset composed of MRI and PET scans, a three block convolutional neural network takes in MRI data, and then computes the difference between the output of the network and the corresponding PET data. After training the network successfully, we can use logistic regression to predict a PET image and disease classification of MRI images that do not have corresponding PET scans. Each block of the network is composed of two convolutional layers. In the down block, the convolutions down-sample the image. The bottom block uses two convolutions that keep the data the same size, and then the up block uses two transposed convolutional layers (“deconvolutional layers”) to return an image with the same dimensions as the input. The experimental setup includes three different up-sampling techniques: standard deconvolution and two types of “pixel” deconvolution. Additionally, a skip connection similar to those introduced in Microsoft Research’s *Deep Residual Learning for Image Recognition* is used between the down block and the up block to prevent a vanishing gradient during backpropagation. The data for training and testing comes from a set of single-channel, greyscale MRI images and a collection of PET scans that correspond to about half of the MRI set. The rest of the MRI data lacks corresponding PET scans, such that the trained network may predict the PET image instead.