Quantifying Model Variation in Assessing Cardiac Function

Jain, Ishan (School: Mission San Jose High School)
Rattehalli, Neeraj (School: Menlo-Atherton High School)

Accurate assessment of ventricular volumes and cardiac function is essential for diagnosis and treatment of cardiovascular disease, screening for cardiotoxicity, and decisions regarding the clinical management of patients with a critical illness. However, the clinical workflow has many dependencies, unreliable assumptions in algorithmic calculation, and variability in accurate human assessment despite the years of training. Left ventricular ejection fraction (LVEF) by a transthoracic echocardiogram (TTE) is widely used for guiding medical decisions but is prone to variability because of errors from manual view acquisition and measurements. We developed an end-to-end deep learning model for evaluating cardiac function by 1) automated identification of end-systole and end-diastole, 2) segmentation of the left ventricle, and 3) algorithmic evaluation of the cardiac function. Using a video-based deep learning model, end-systole and end-diastole were accurately identified an average of within 4 and 7 ms from the human labels, respectively. From the determined frames, ventricular volumes were calculated. Even with the same ventricular tracing, slight clockwise rotational perturbations in the long axis position resulted in variance in the estimates of ventricular volume up to 0.9%. Over tracing and under tracing the left ventricular region by 10-15% varied ejection fraction by 9.2% and 8.0%, respectively. The ultimate calculated LVEF varied up to 2-3%. Even with precise identification of cardiac times and segmentation of cardiac structures, small variations can compound to significantly impact eventual evaluations of ventricular function, suggesting limitations in the precision of current clinical procedures for assessing cardiac function.