Identifying Glitches in a Gravitational Wave Detector Through CNNs

Agrawal, Ananya (School: Blue Valley West High School)

Gravitational waves (GW) are primarily emitted when compact binary objects collide while orbiting each other. Another possible mechanism is a stellar explosion resulting in a supernova formation. However, several noise transients (glitches) are often found in the detector data which can be confused with astrophysical (or real) signals. We need advanced methods to identify such noises in GW detector data streams. I propose a method of identifying glitches (blip glitches) versus Binary Black Hole (BBH) signals, using a Convolutional Neural Network (CNN) trained on images of time-evolution graphs in both the above categories. My novel approach is to transform the data before entering into the CNN through a process called Singular Value Decomposition (SVD). After the image undergoes SVD, the original data is reduced into multiple bases making it easier for the computer to process. Using the CNN, I ultimately perform a binary classification where the input data is a time evolution graph of the individual weighted bases; and the output labels are of two types: BBH signal or a glitch. The BBH and glitch data are based on the LIGO detector outputs, simulated through a Python library called Gengli. My CNN is trained using the Pytorch library (torch.nn module). This model can be potentially used in real-time identification of noisy data in the detectors, which is a primary requirement of any reliable GW data analysis pipeline.

Awards Won: