**Paper Title:** Improving Gravitational Wave Detection with 2D Convolutional Neural Networks

**Paper Link:** [https://ieeexplore.ieee.org/document/9412180](https://ieeexplore.ieee.org/document/9412180)

## 1 Summary

### 1.1 Motivation

Conventional techniques for detecting gravitational waves (GWs), such as matched filtering, frequently face difficulties with noise and real-time detection. This research suggests employing 2D convolutional neural networks (CNNs) for enhanced GW identification, especially for weak signals with low signal-to-noise ratios (SNRs), in order to overcome these limitations.

### 1.2 Contribution

The creation of a unique 2D CNN-based framework for GW detection is the main contribution. With the use of this architecture, 2D CNNs may learn the combined temporal and spectral properties of GW signals by converting time series data into 2D spectrograms using the Short-time Fourier Transform (STFT). Furthermore, for quick online detection, the paper suggests a two-stage 1D CNN design.

### 1.3 Methodology

The study introduces a 2D CNN system for detecting GW signals. It combines genuine LIGO background noise with synthetic GW signals to create a realistic training dataset. Training the network with binary cross-entropy loss involves using convolutional and fully-connected layers. Evaluation measures evaluate the model's performance, such as detection accuracy and the area under the ROC curve (AUC).

### 1.4 Conclusion

In summary, the findings demonstrate that, especially at low SNRs, the suggested 2D CNN framework consistently performs better at recognizing GW signals than 1D CNNs. This illustrates how capturing the time-frequency correlations explicitly helps to improve the accuracy of GW identification.

## 2 Limitations

### 2.1 First Limitation

Because the study uses simulated data, it may not accurately represent the intricacies of GW signals and noise in the real world. An assessment with greater rigor would come from testing on real LIGO data.

### 2.2 Second Limitation

The precise layout of the 2D CNN architecture and the pre-processing procedures may have an impact on how effective the suggested framework is. Further research into feature extraction methods and improved network designs may enhance performance even more.

## 3 Synthesis

This work sets the stage for improving GW detection through the application of sophisticated deep learning techniques such as 2D CNNs, which could result in greater sensitivity and the discovery of new astronomical events. By adding other data modalities or modifying the framework for real-time live detection, future study may be able to expand the field of gravitational wave astronomy.