Amateur Astro Engine

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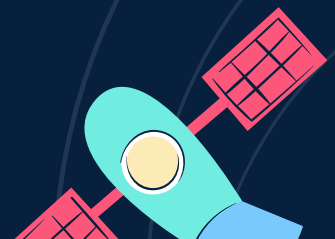
What's the project all About?
This is an engine for amateure astronomers by using it they can learn how to track celestial objects , predict astronomical events using previous data & filter astronomical images .

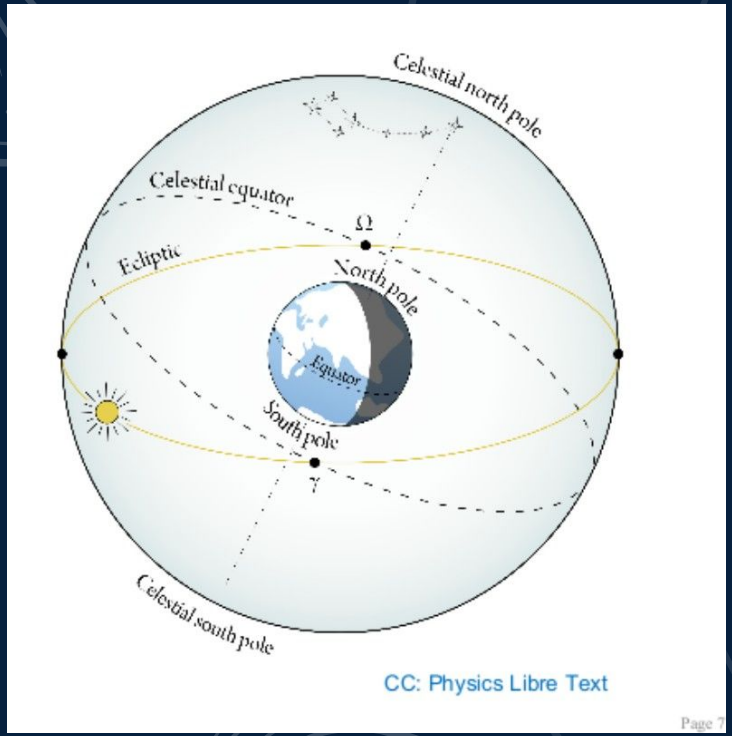
Project motivation : Computational astronomy is a rapidly expanding field. NASA, NRAO and numerous other institutes have begun to open-source their datasets for research purposes. However, astronomical data-analysis software can be quite complex for young learners . It's very challenging for them to understand and modify these tools for their use. In this project, I have implemented simplified algorithms to facilitate young learners' comprehension of how these systems function, enabling them to explore and learn about computational astronomy more easily.

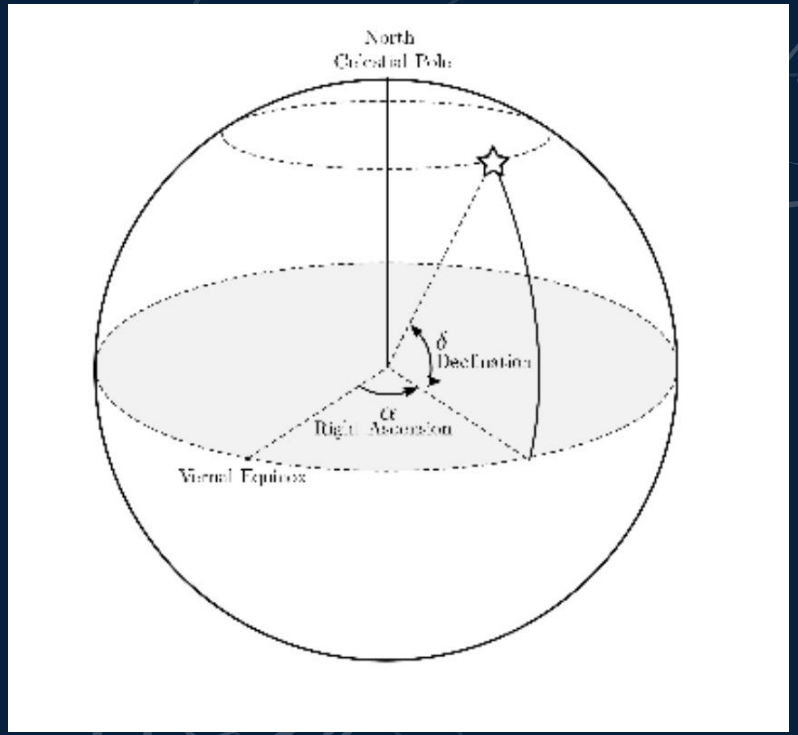


Key Features:

- Gradient descent
- Image Stacking
- Spherical coordinate Calculator

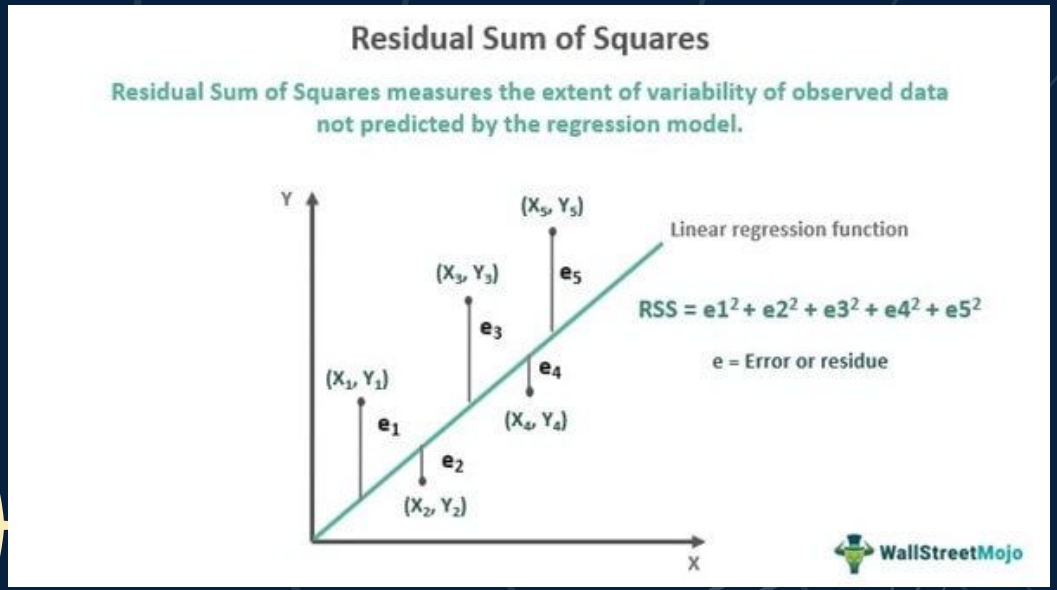
Coordinate Calculations in Celestial-sphere:





Regression: A regression is a statistical technique that relates a dependent variable to one or more independent (explanatory) variables

RSS: The residual sum of squares measures the level of variance in the error term, or residuals, of a regression model.



How can we get the best fit model?

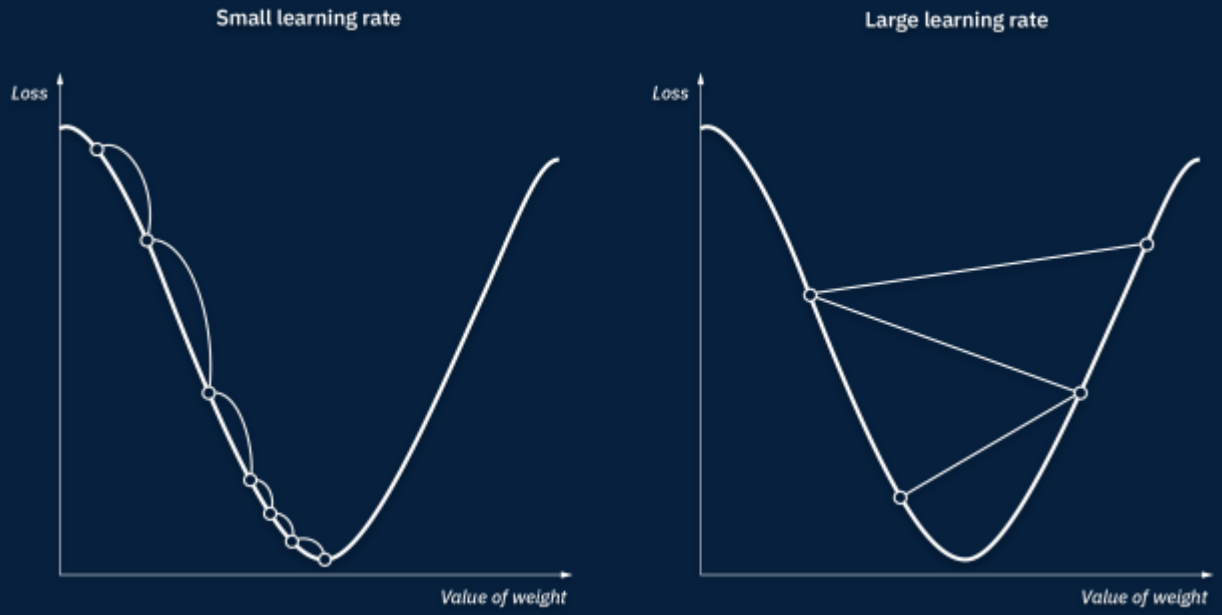
By picking the coefficients of the parameters for which RSS gives the minimum value.

Gradient Descent:

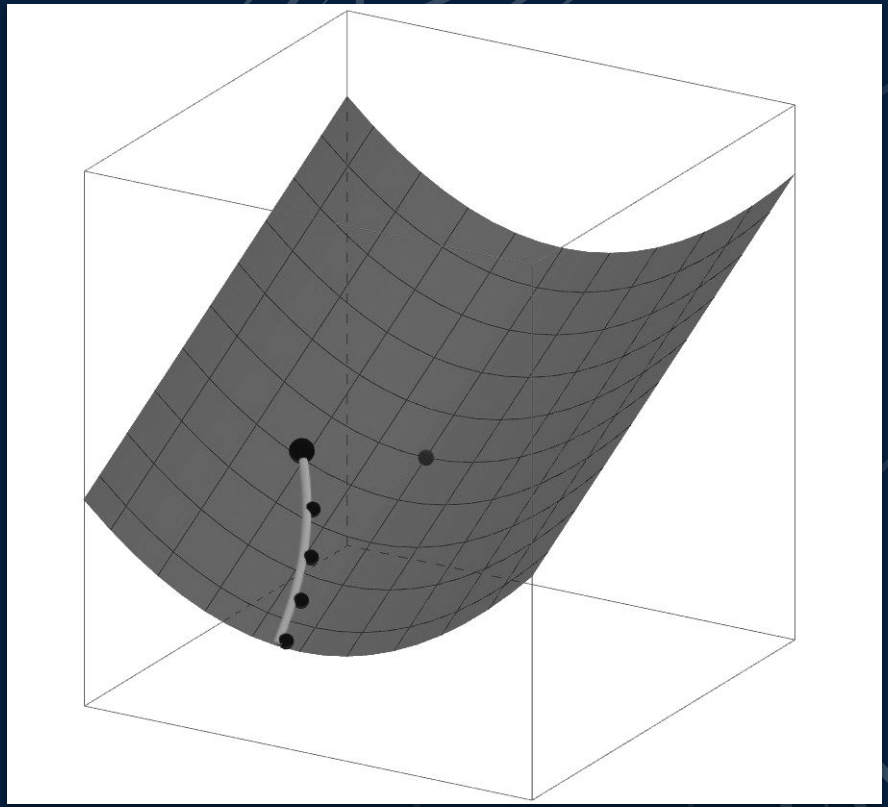
Gradient descent is an optimization algorithm that minimizes a function by iteratively adjusting the model parameters in the direction of the steepest decrease in the function's value.

$$\theta_j = \theta_j - \alpha \frac{\partial}{\partial \theta_j} J(\theta)$$

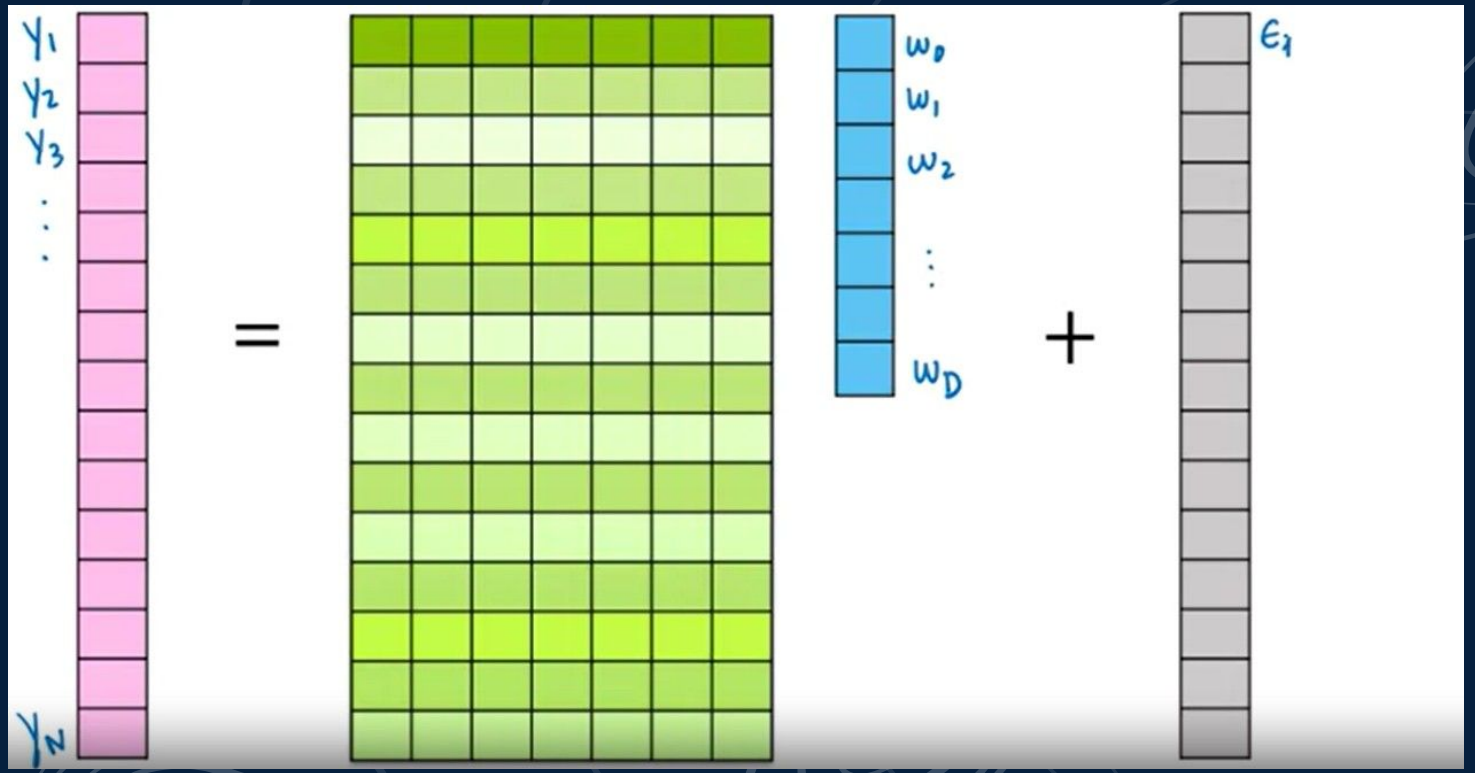
2D:


Small learning rate
Loss
Value of weight
Large learning rate
Loss
Value of weight

3D:



N-Dimensional:



Gradient of ND matrix form model:

$$\nabla RSS(\mathbf{w}) = \nabla[(\mathbf{y}-\mathbf{H}\mathbf{w})^T(\mathbf{y}-\mathbf{H}\mathbf{w})]$$

$$= -2\mathbf{H}^T(\mathbf{y}-\mathbf{H}\mathbf{w})$$

Algorithm:

Gradient descent algorithm

repeat until convergence {

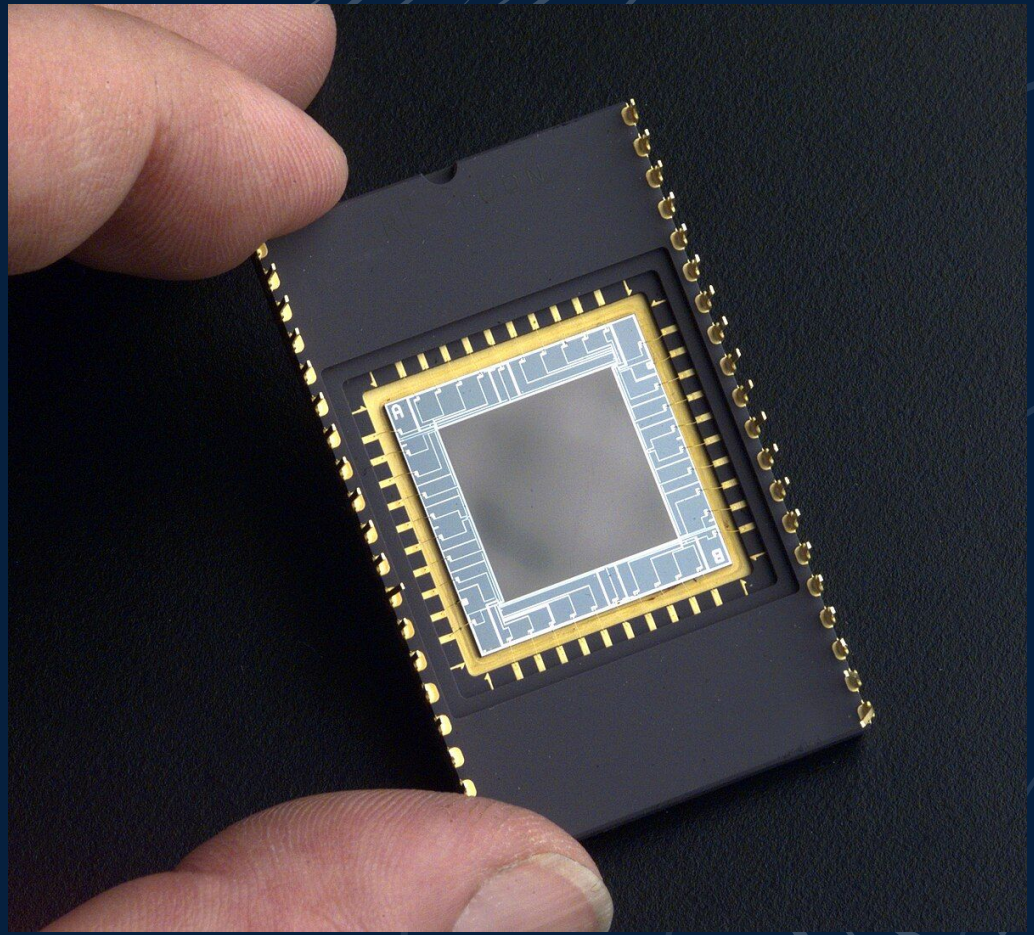
$$\theta_j := \theta_j - \alpha \frac{\partial}{\partial \theta_j} J(\theta_0, \theta_1)$$

(for $j = 1$ and $j = 0$)

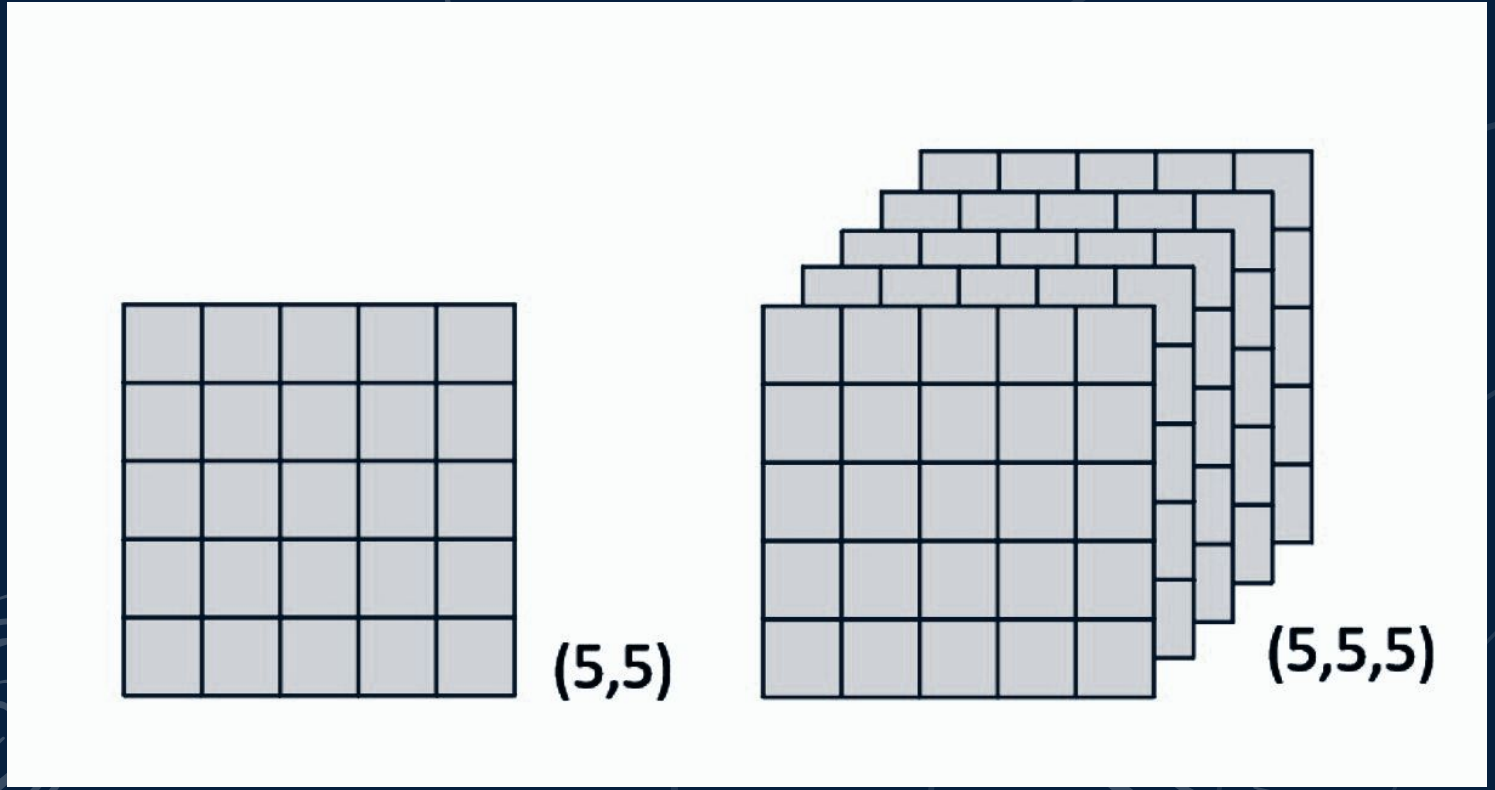
}

Image Stacking: Image stacking is a technique used in astrophotography and image processing to combine multiple photos of the same subject to reduce noise, enhance details, or create long-exposure effects.

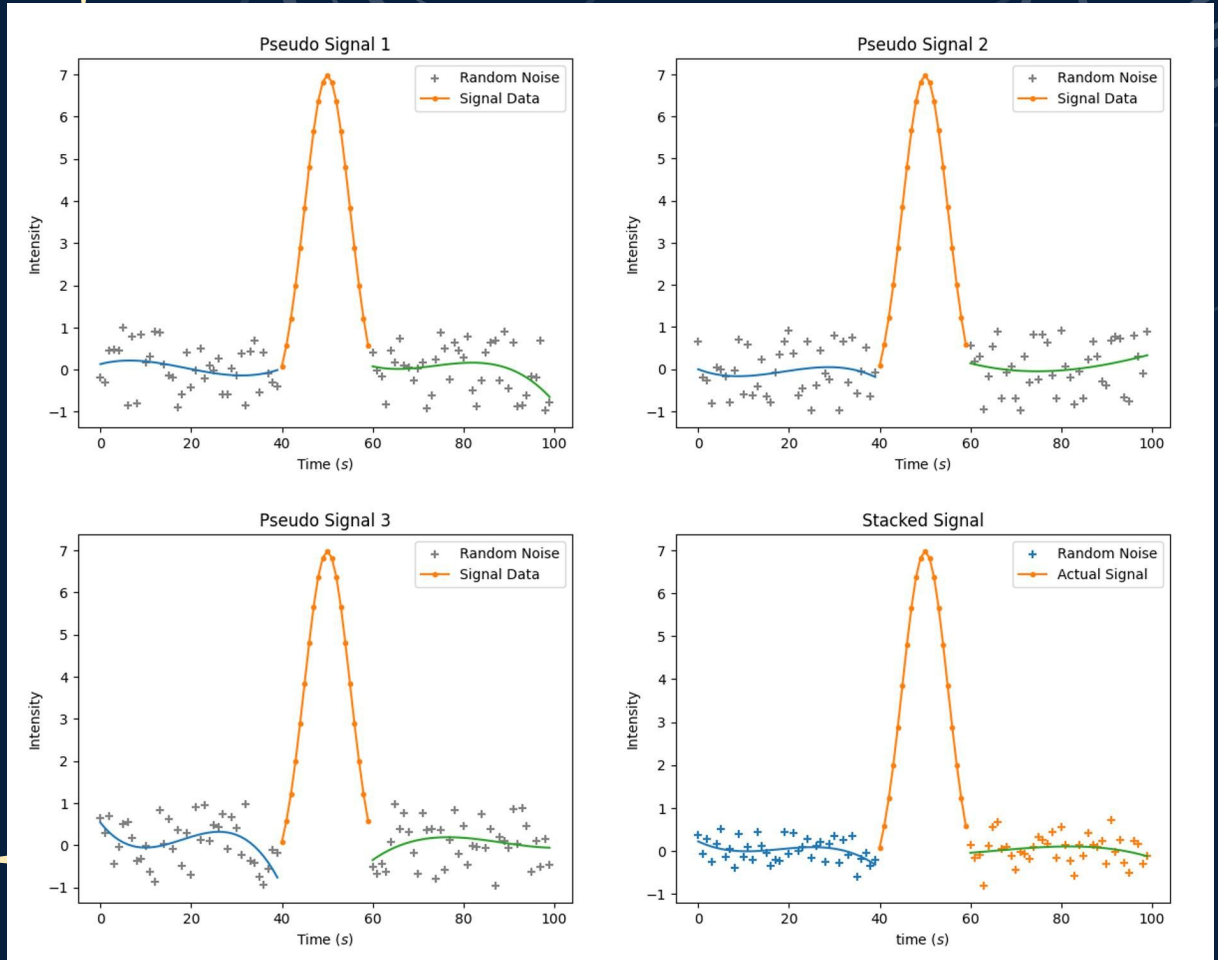
CCD:



Stacking grid of 5 images:



Analogy with signals:



Before Stacking

After Stacking

Future Feature Plan:

Principal Component Analysis

SPL Project's link:

https://github.com/hasin1415/SPL-01.git

Thank You!