



QUANTUM AI

Design Credit Project

IIT JODHPUR

PRESENTED BY

G Mukund (B21CS092)

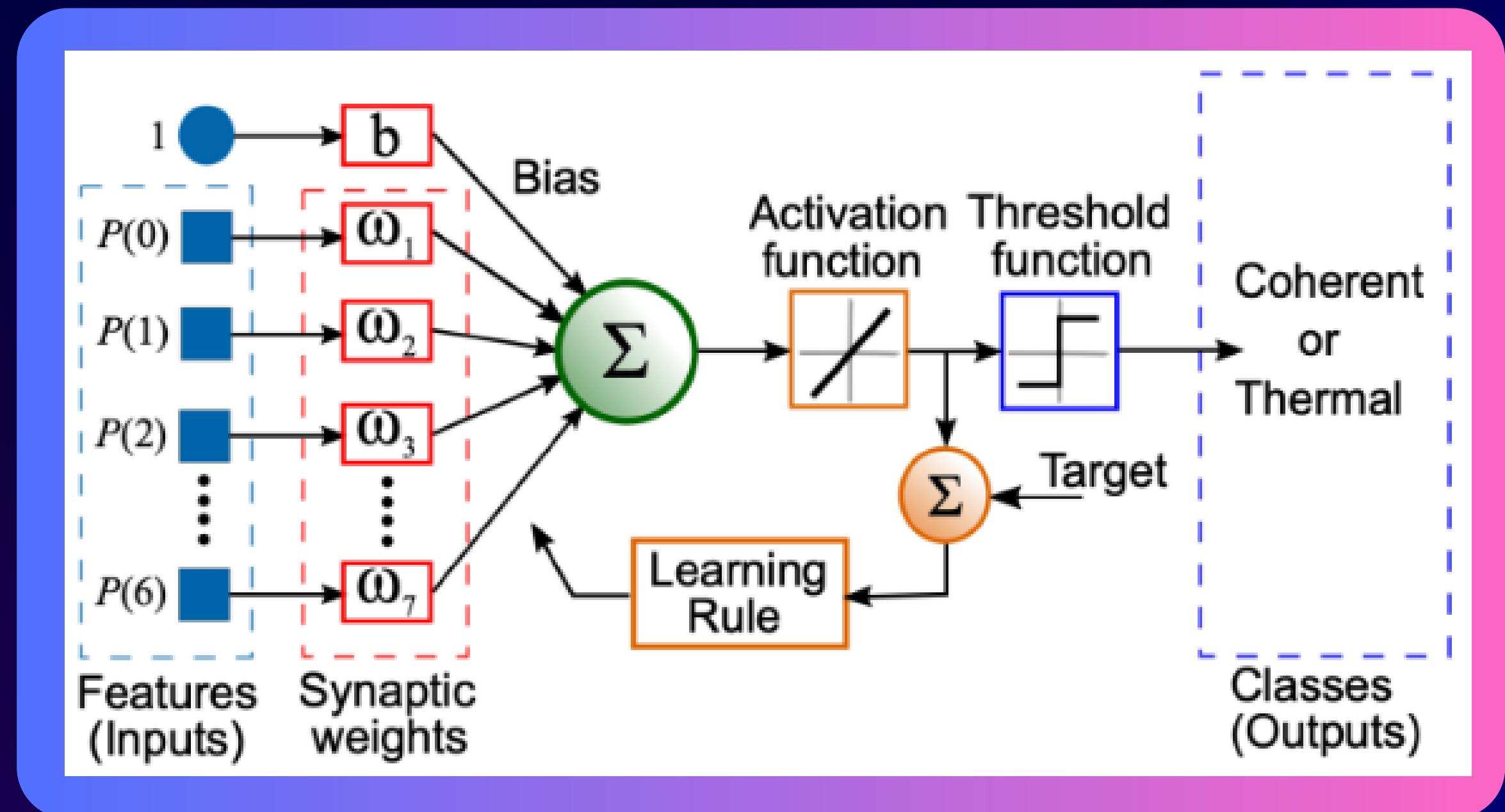
Pranav Pant (B21CS088)

Krishna Gaurang (B21EE086)



Objectives

Photon statistics estimation
of various light sources using
ML/ QML algorithms.





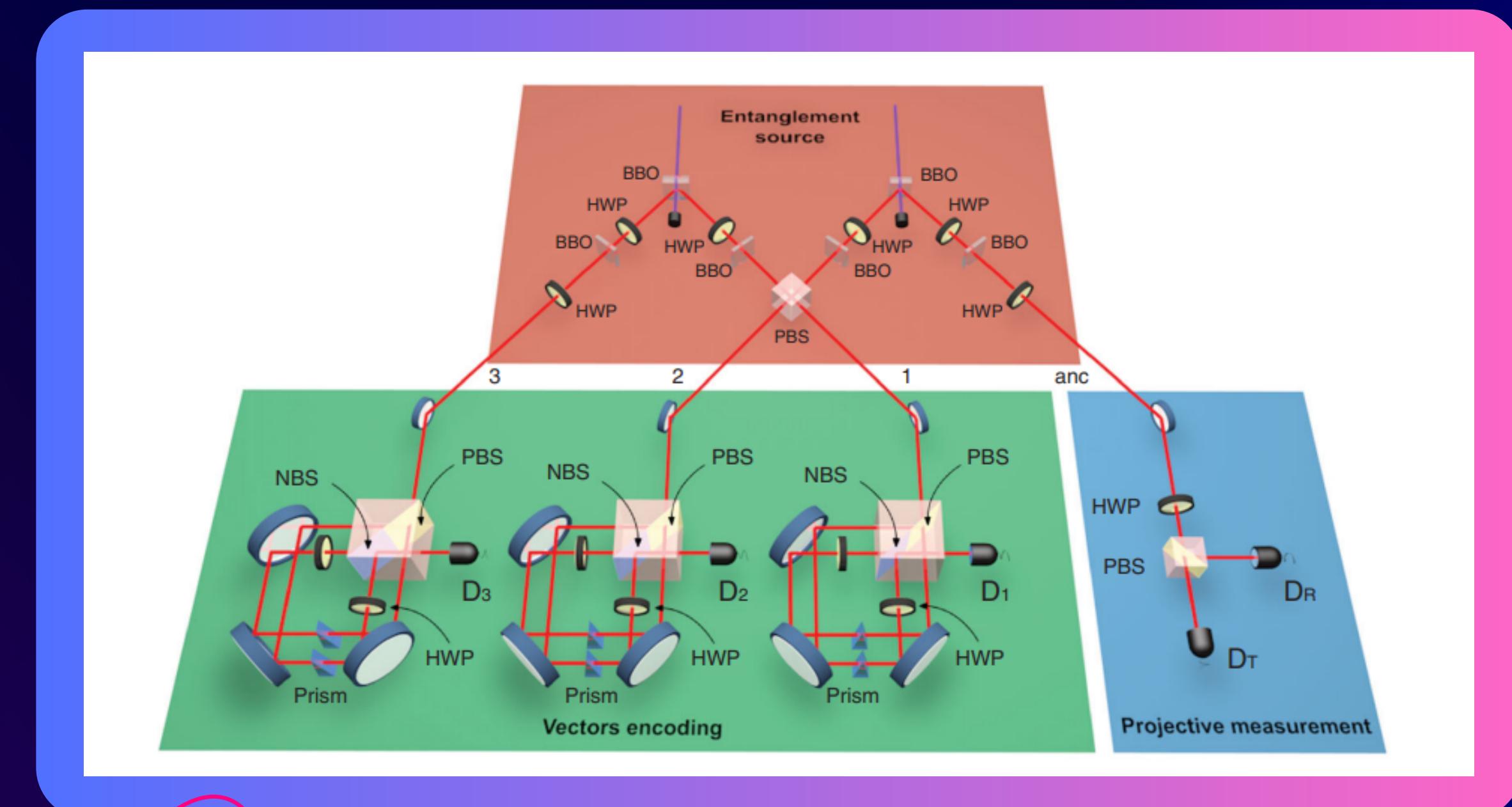
Flow of Project

- 1** Entanglement-based classification
- 2** Literature Review
- 3** Implementation of paper- Neural Networks and Photon Statistics
- 4** Applying our model on various new dataset
- 5** Uncover the dataset's inherent trends and distributional characteristics
- 6** Training a Final ML/ QML Model to test on random new datasets



Entanglement-based classification

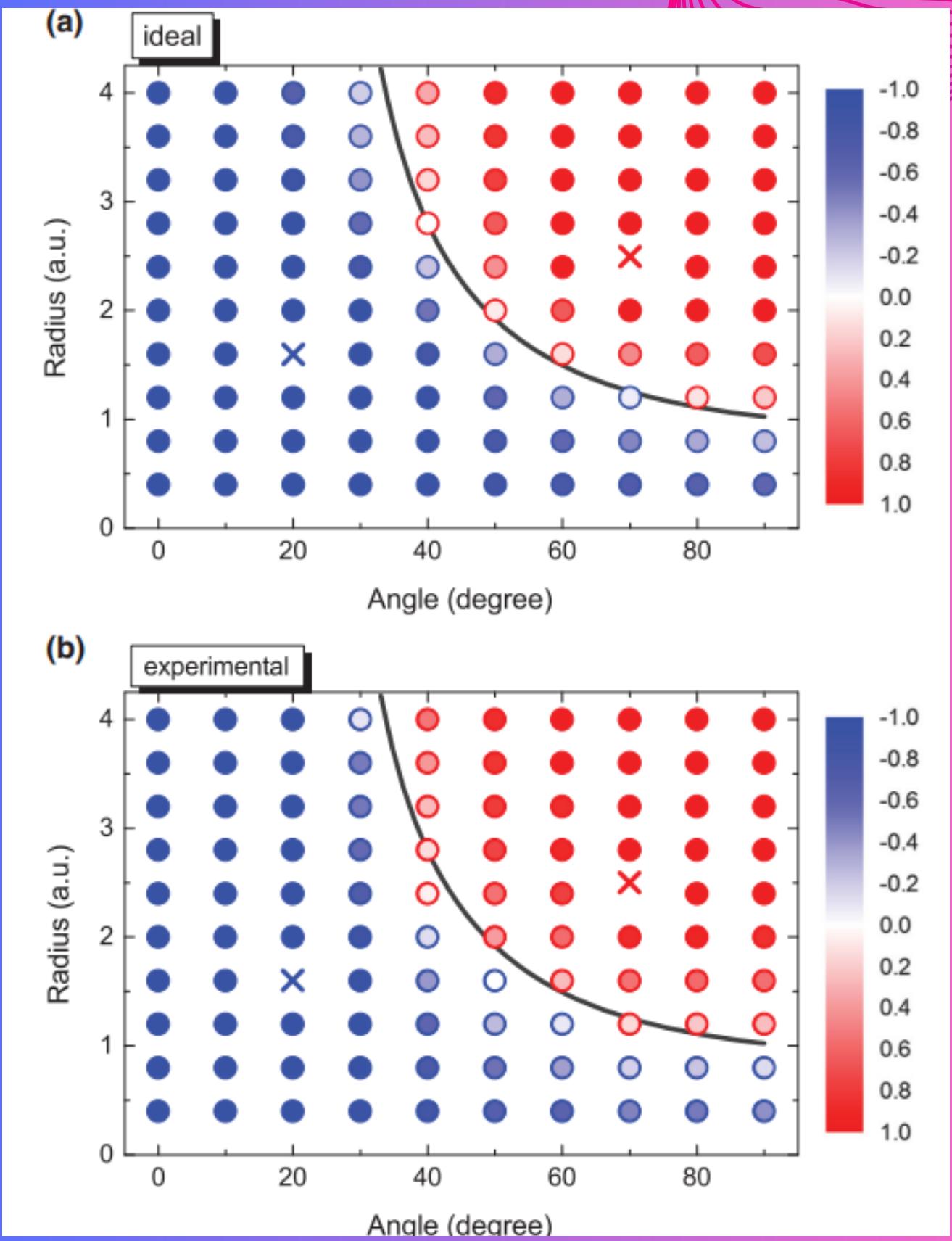
Entanglement-based classification of two-, four-, and eight-dimensional vectors to different clusters using a small-scale photonic quantum computer, which are then used to implement supervised and unsupervised machine learning.





K Means Clustering

It is an iterative process of assigning each data point to the groups and slowly data points get clustered based on similar features.





K Means Coded

We have written a code which can classify a given set of data points into k number of clusters.

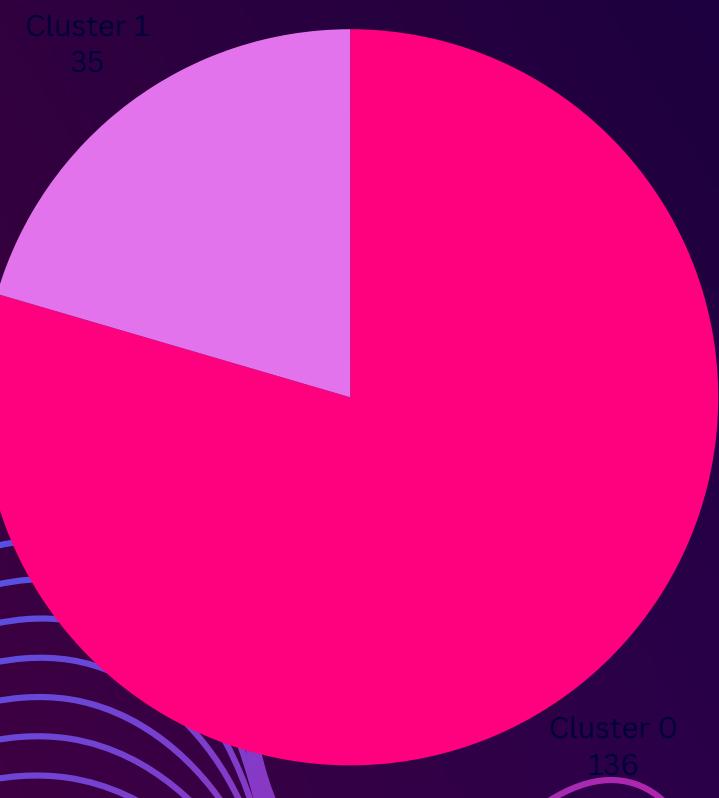
In the code we have taken a random dataset. If provided with the dataset for quantum states, then the code with some small modifications will classify the high dimensional vectors.

- 1 First we load the sample dataset and preprocess it so that it is ready for ML models to work on it.
- 2 We use a K-Means class from ML Library sklearn
- 3 Setting the number of clusters=2, we train the dataset for implementation.
- 4 Plotting the clusters, we see that we are divide the dataset into 2 clusters- yellow and violet.
- 5 Using elbow method, we confirm that the best classification for the taken sample dataset will be to divide into 2 clusters.
- 6 We were enthusiastic about doing extra work, so we decided to build everything ourselves instead of relying on the KMeans class from the ML library sklearn, which we had used previously. Therefore, we wrote the code from scratch and discovered that the results were identical to those obtained using the ML library.

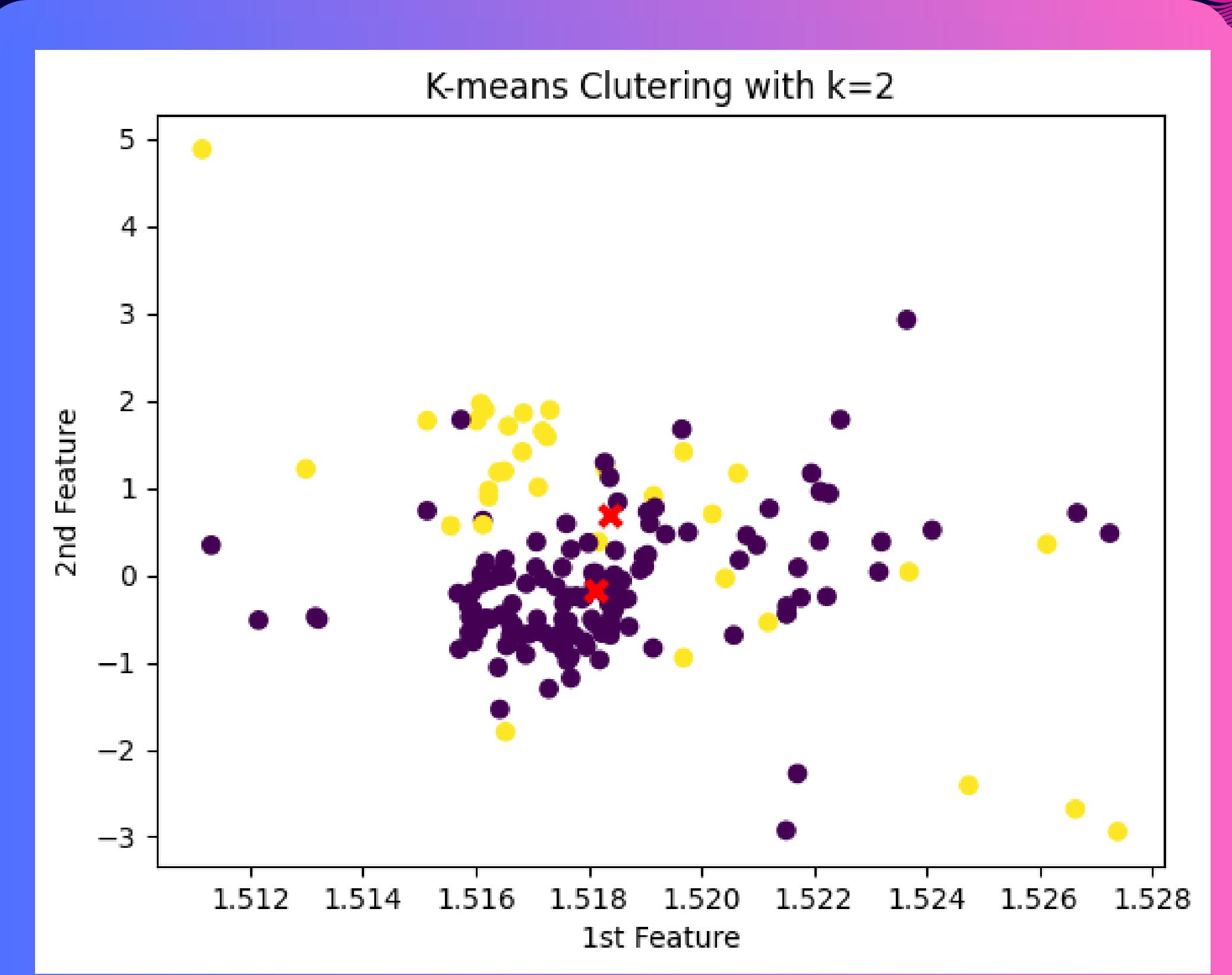


K Means Result

This is the how we divided the dataset into 2 clusters successfully.



- Cluster 0 - 136 points (Violet in graph)
- Cluster 1 - 35 points (Yellow in graph)

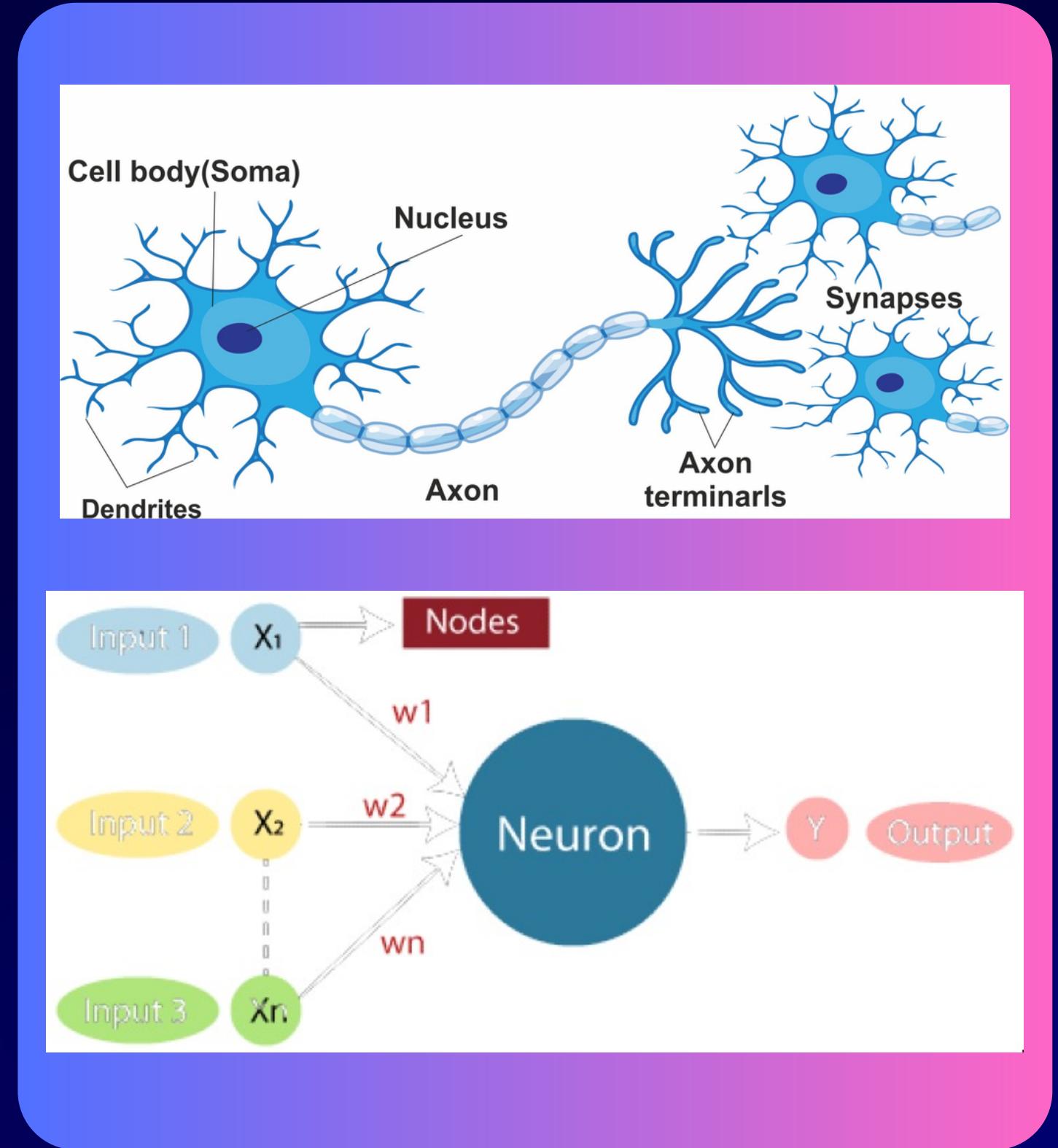




Neural Networks

Neural networks are a type of machine learning model inspired by the human brain's structure and functioning. They are used for solving complex problems by learning patterns and relationships from data.

Similar to the human brain that has neurons interconnected to one another, artificial neural networks also have neurons that are interconnected to one another in various layers of the networks.





Neural Net Coded

We have written a code which can identify the source of light for various photons.

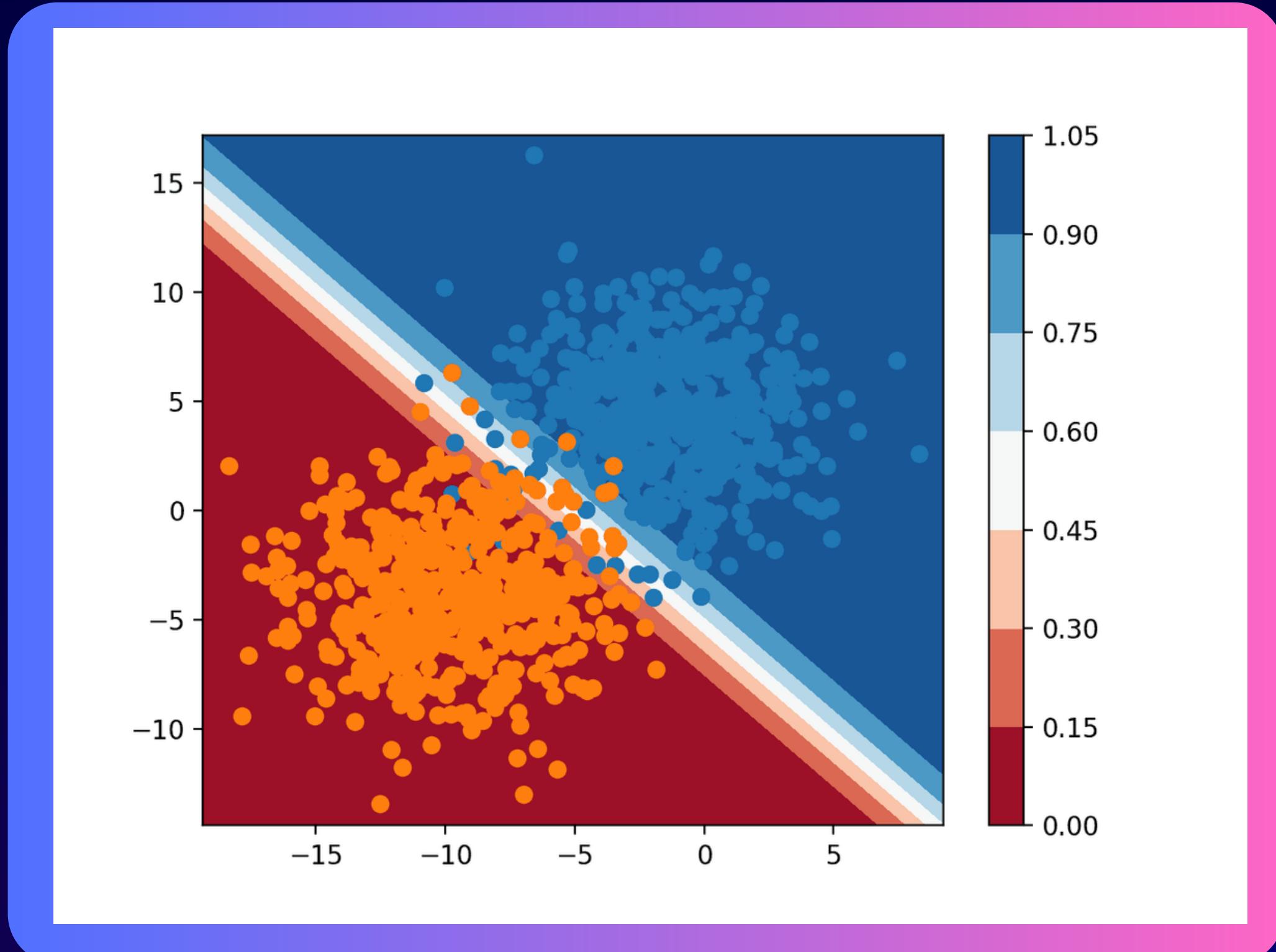
In the code we have used the dataset containing information of various photons.

- 1 First we load the dataset and preprocess it so that it is ready for ML models to work on it.
- 2 We create a sequential model which will encompass the different layers that we add to it at the later stages.
- 3 We add various hidden layers to the network with different pre defined hyperparameters.
- 4 Applying adam optimizer, we compile the model that we created.
- 5 Training the model on the dataset
- 6 Finally we run the model on the test dataset and analyse the performance of our model. It comes out to be around 71 percent.



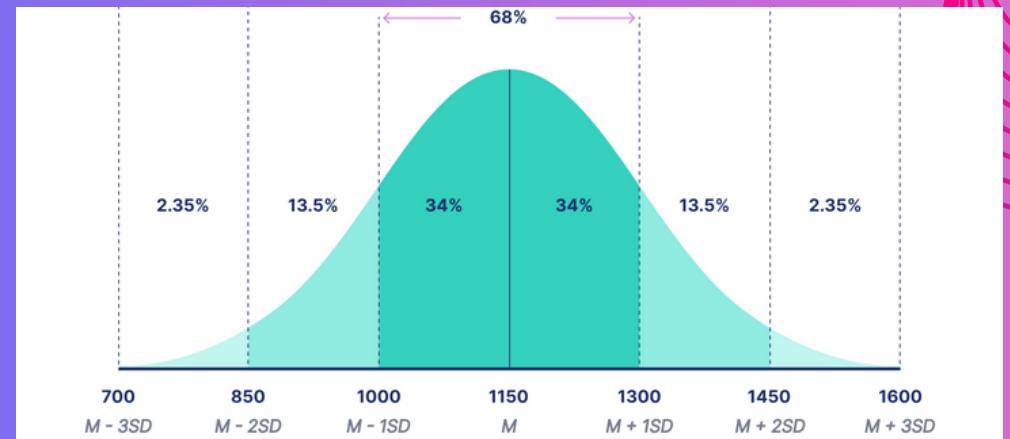
Neural Net Result

We have successfully categorized light sources and can predict the source of a new instance.

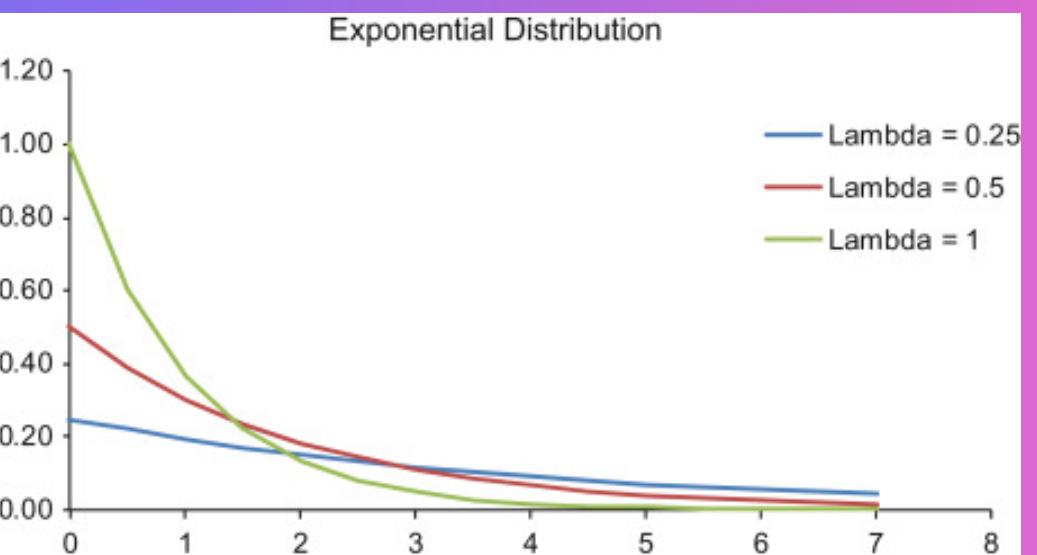
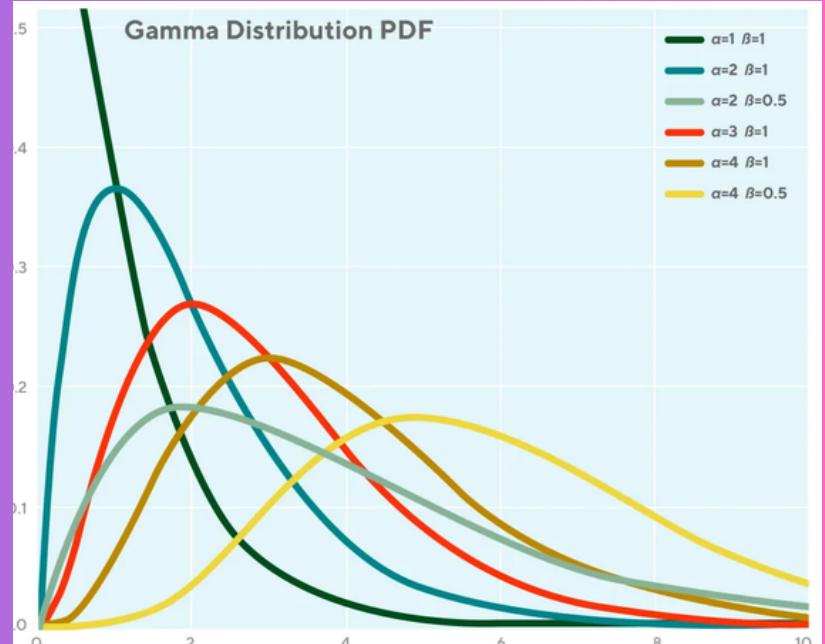
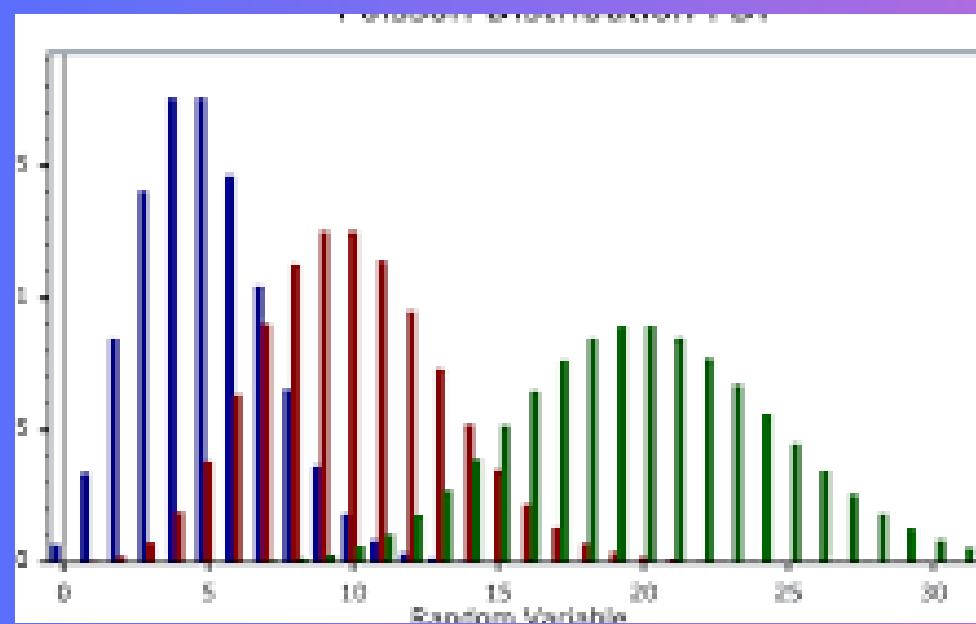




Uncovering dataset's inherent trends and distributional characteristics



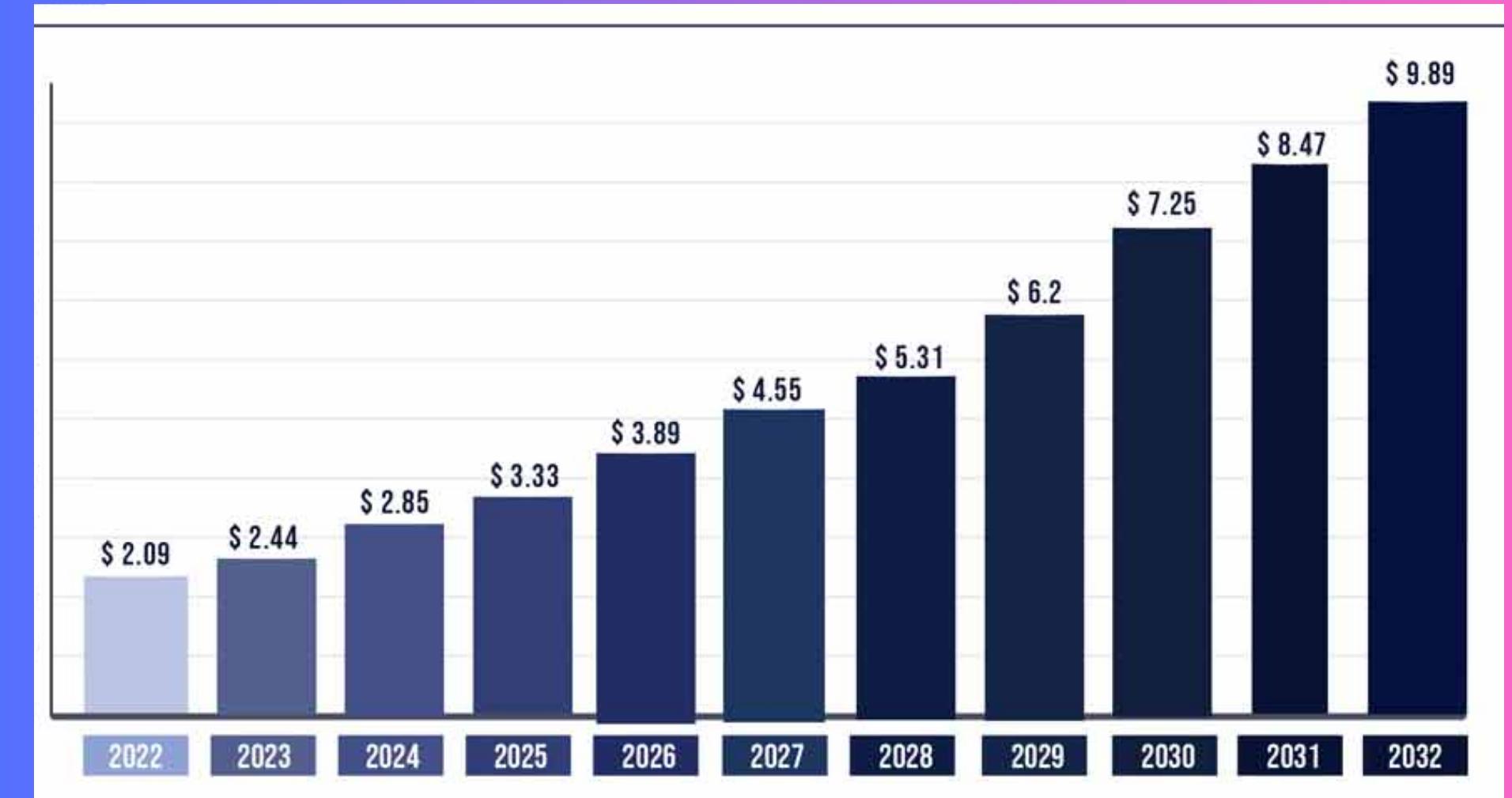
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Dataset's Trends

Unveiled the dataset's inherent trends and distributional features through statistical methodologies and visual tools. Each of these distributions has its own specific shape and characteristics, and visualizing them can provide insights into the underlying data distribution or probability density function.





Analysis Coded

We have written a code which can identify the source of light for various photons.

In the code we have used the dataset containing information of various photons.

Data Exploration and Visualization

- 1 Histograms, scatter plots, correlation analysis, density plots, cumulative distribution function (CDF), quantile-quantile (QQ) plot, and Gaussian distribution visualization.

Data Preprocessing Techniques

- 2 Data normalization using StandardScaler and MinMaxScaler to prepare the data for analysis.

Statistical Analysis

- 3 Statistical methods such as correlation analysis, CDF, QQ plot, and Gaussian distribution fitting

Visualization of Findings

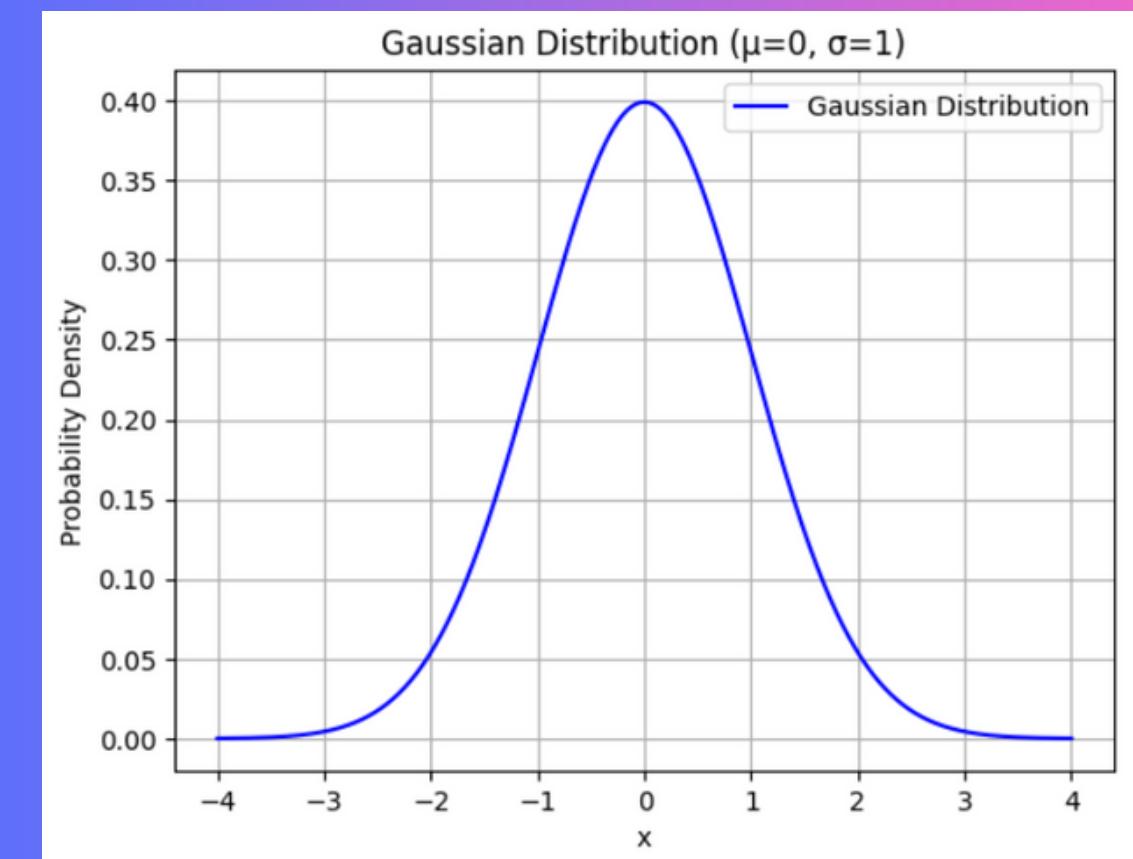
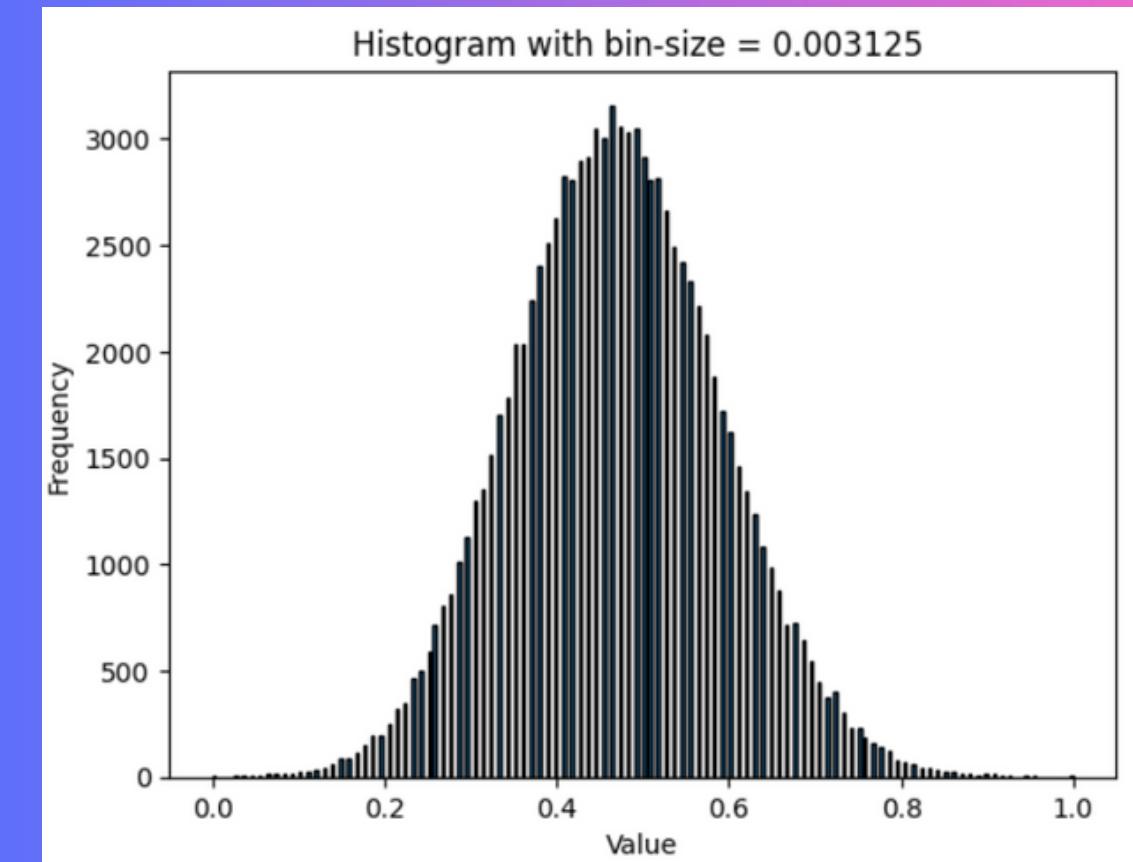
- 4 Visualizations and statistical analyses to comprehend the natural trend or distributional pattern in the data.



Dataset Wise Trends

2 1-filter and 1 lakh.csv

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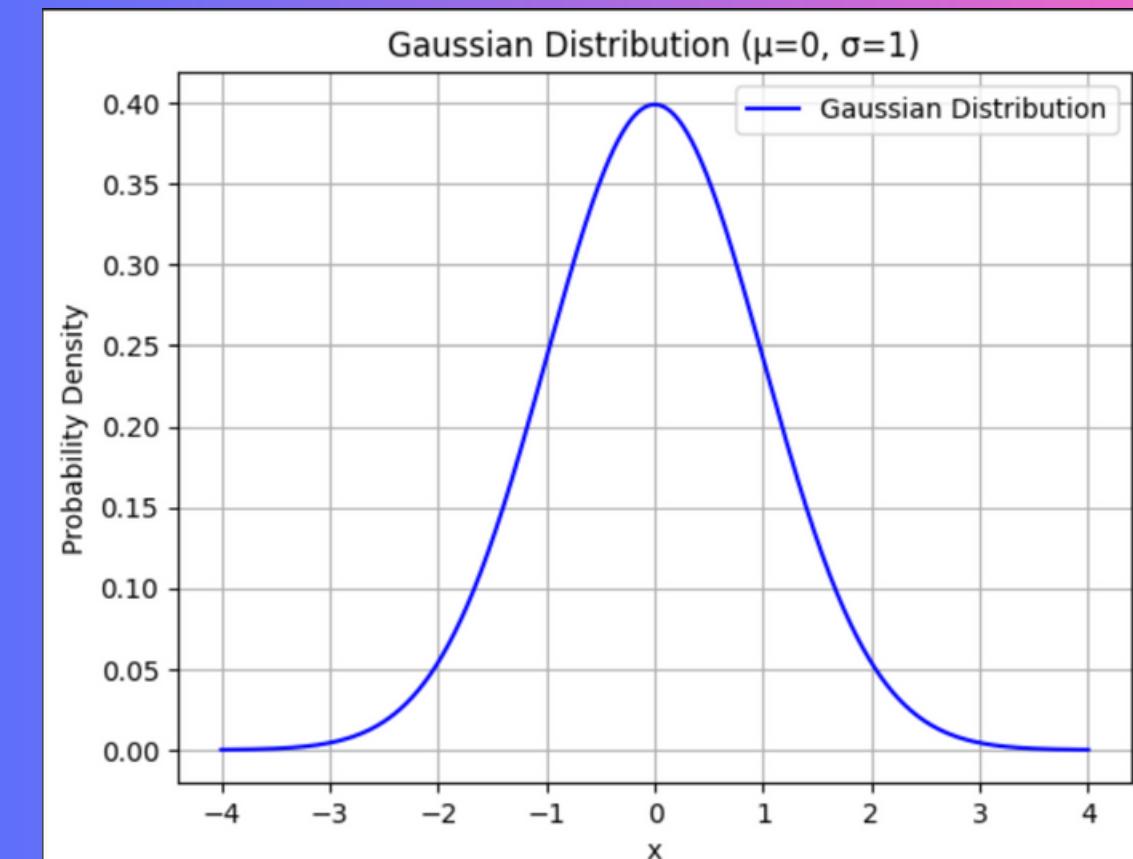
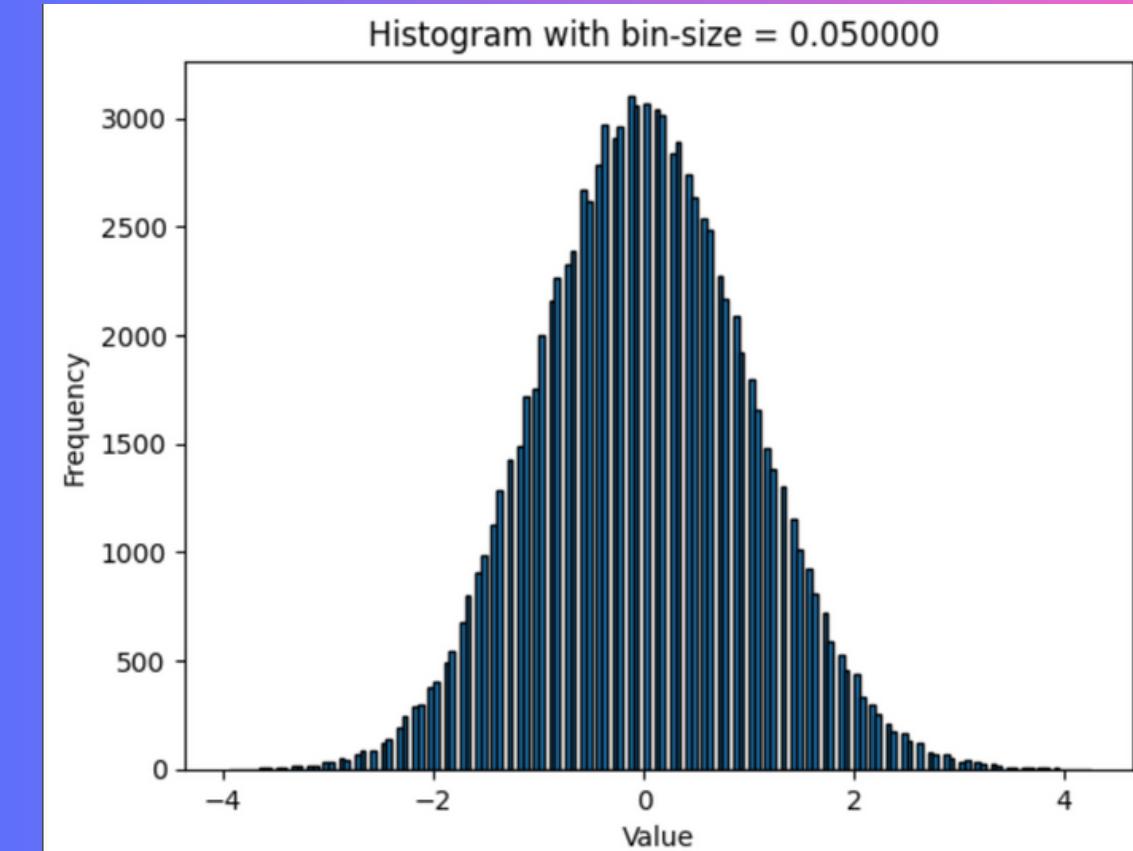




Dataset Wise Trends

3 1-filter and 1 lakh.csv

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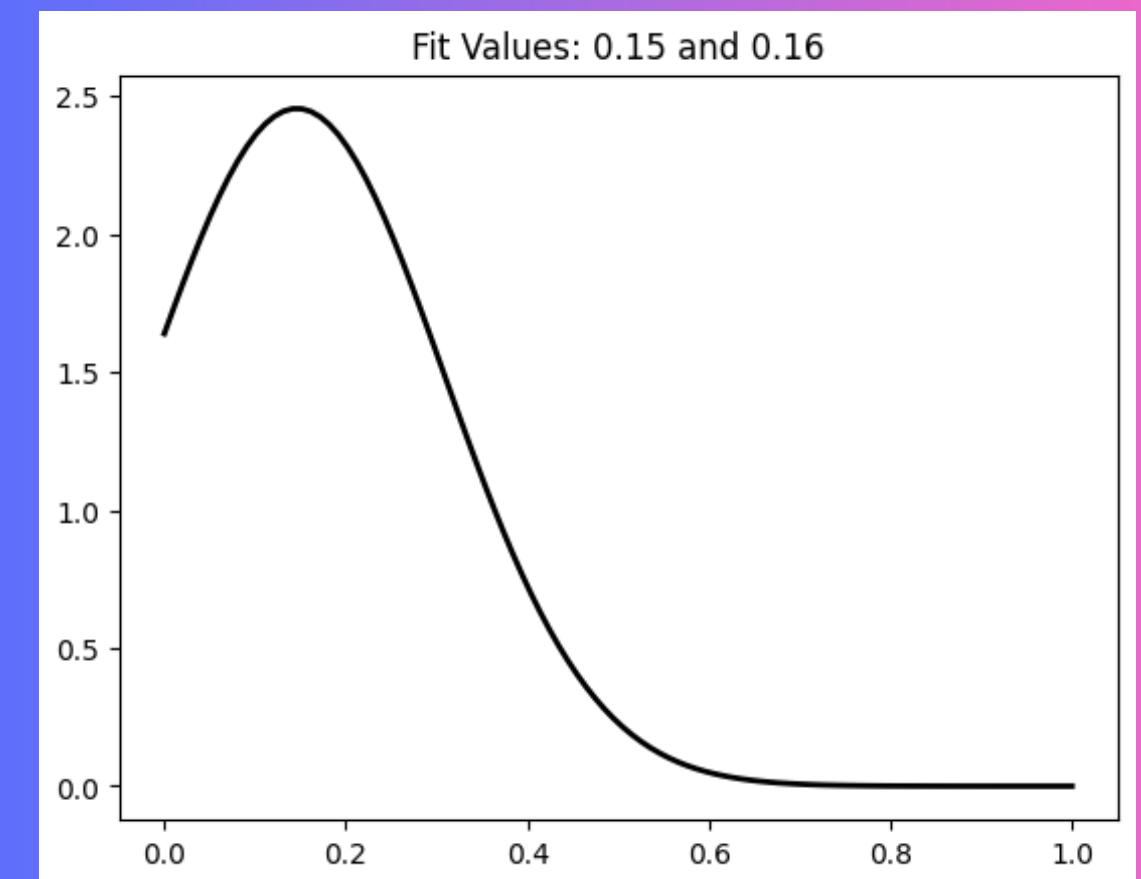
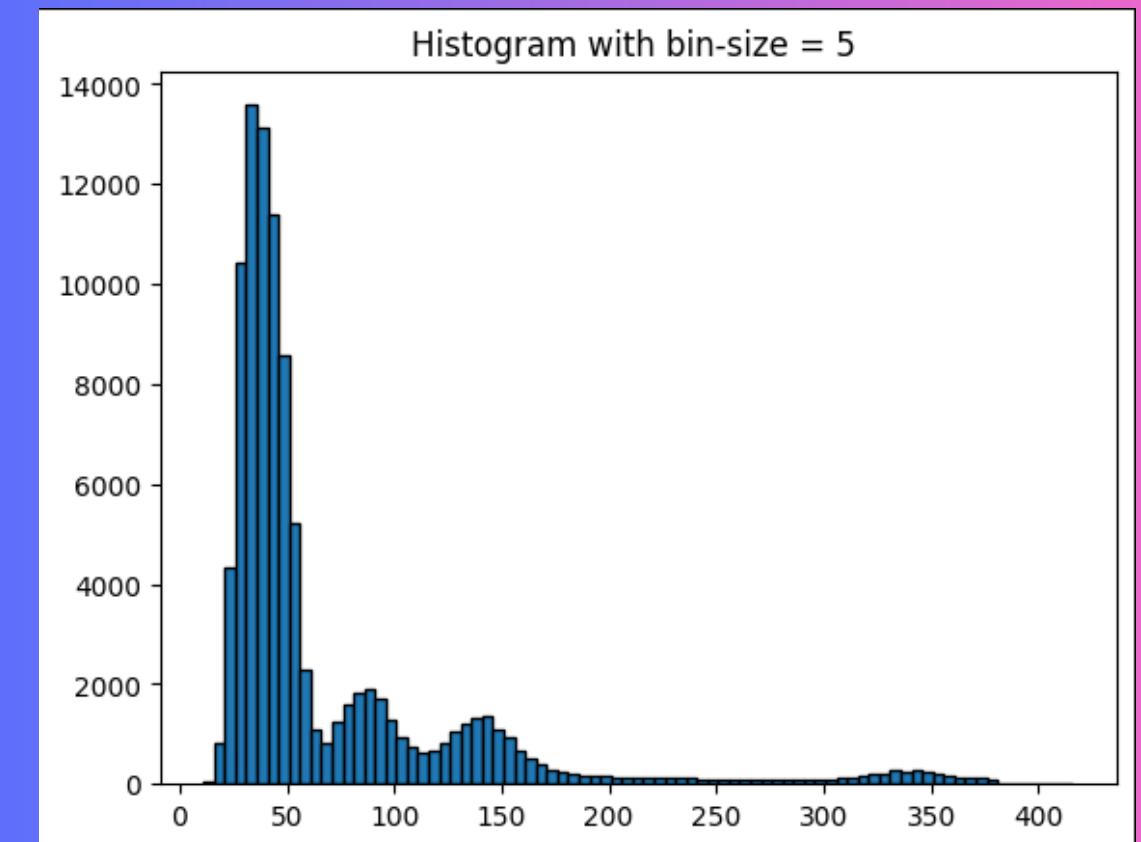




Dataset Wise Trends

1 filter and vn mobile.csv

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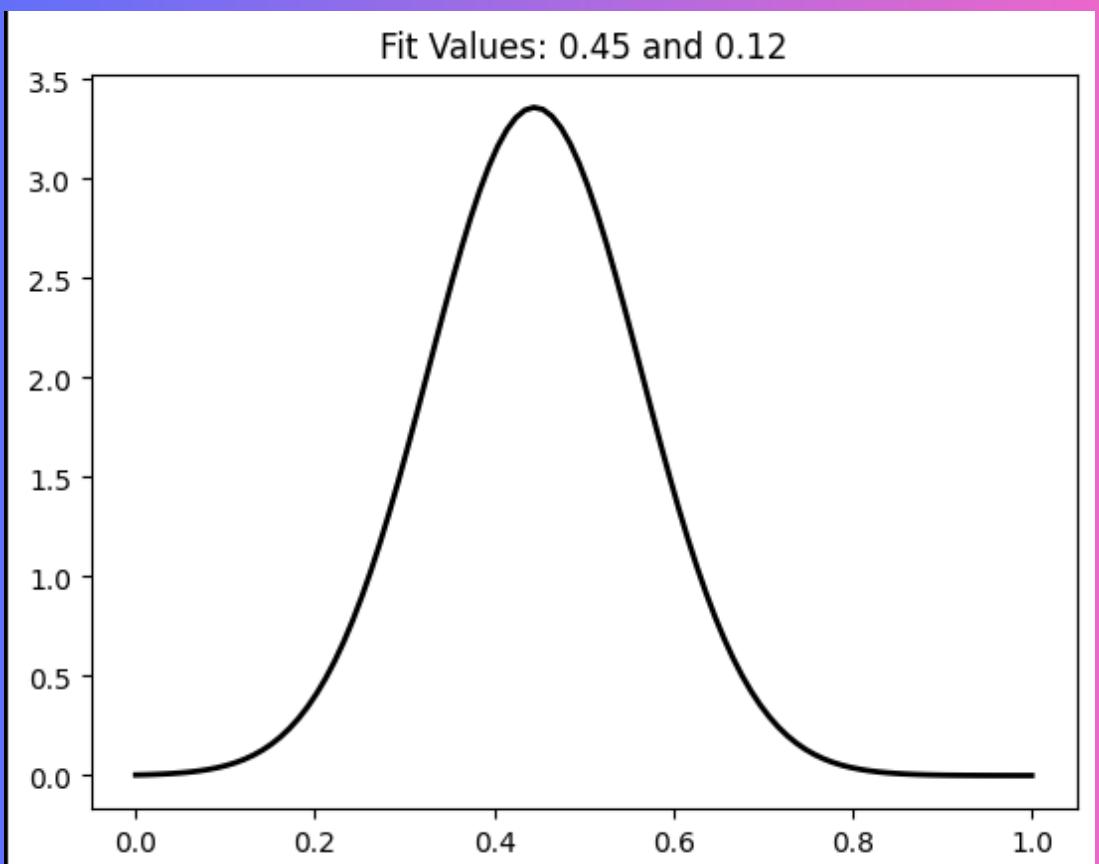
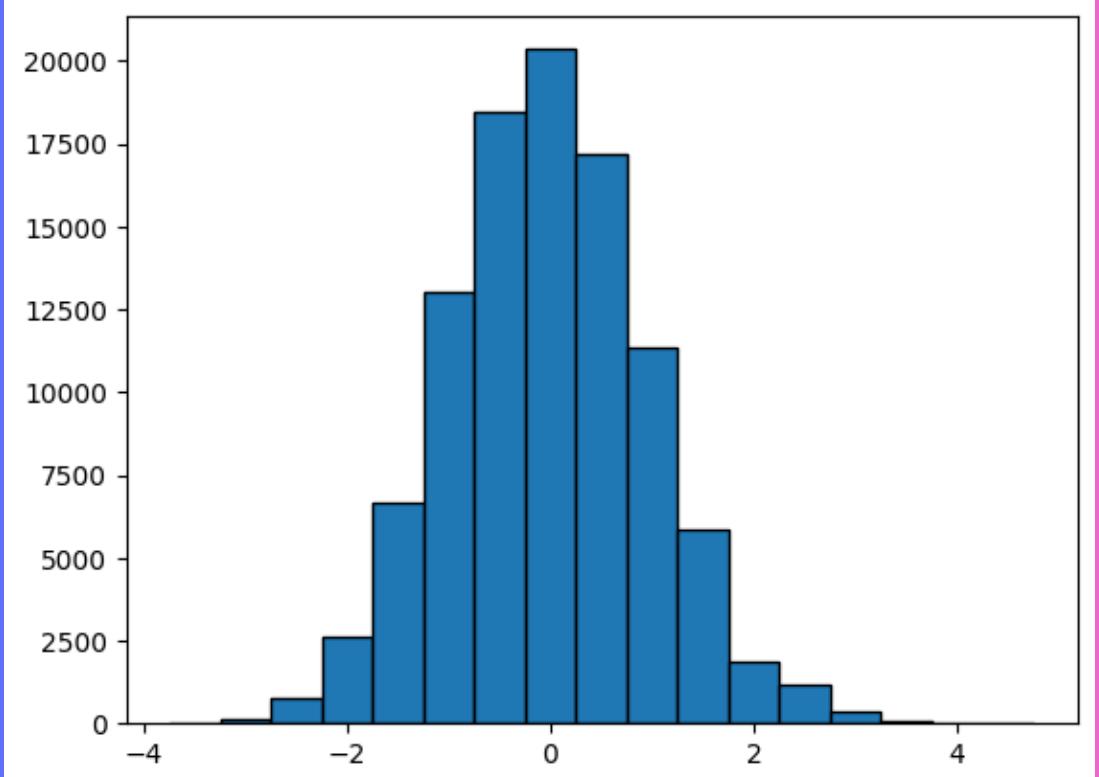




Dataset Wise Trends

with 2 ND FIKTER HENE OFF.xlsx

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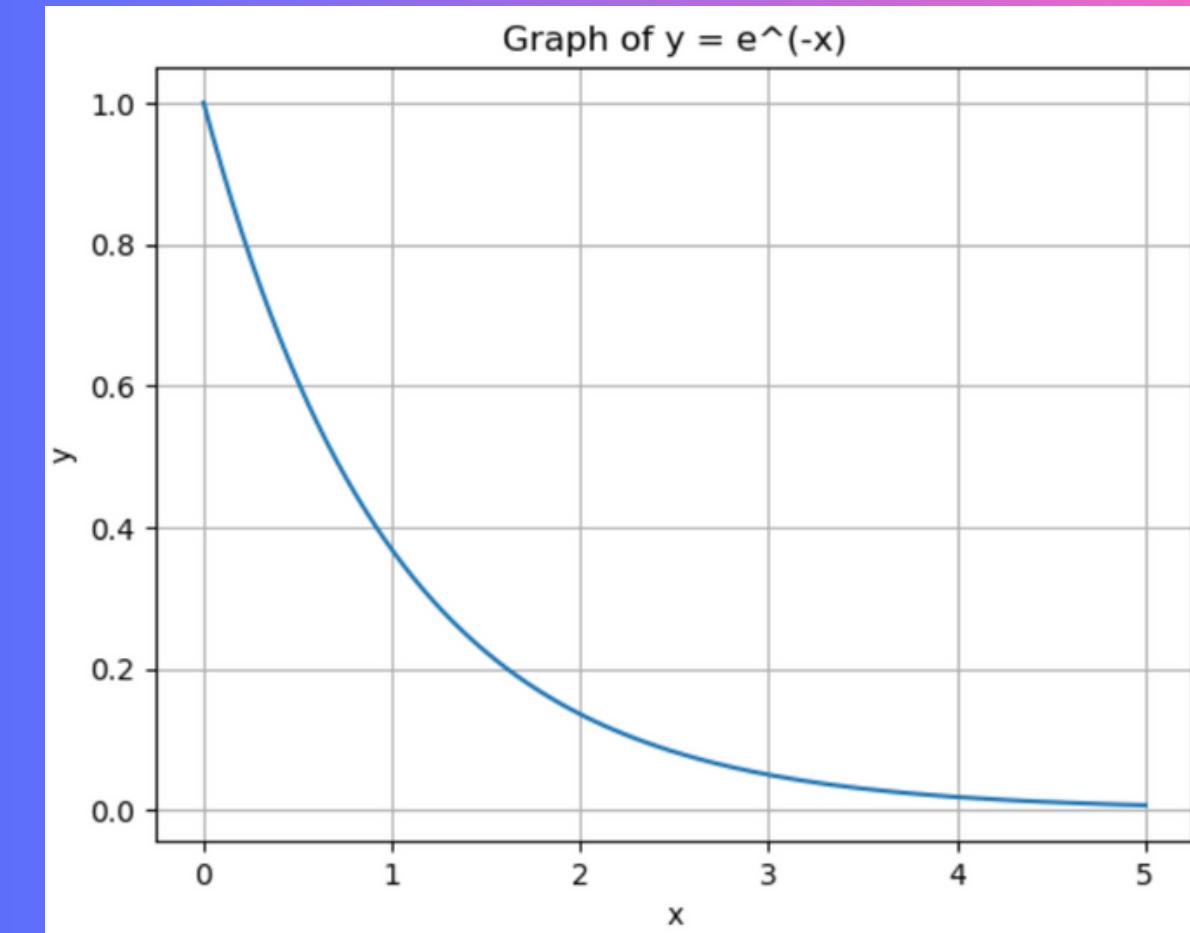
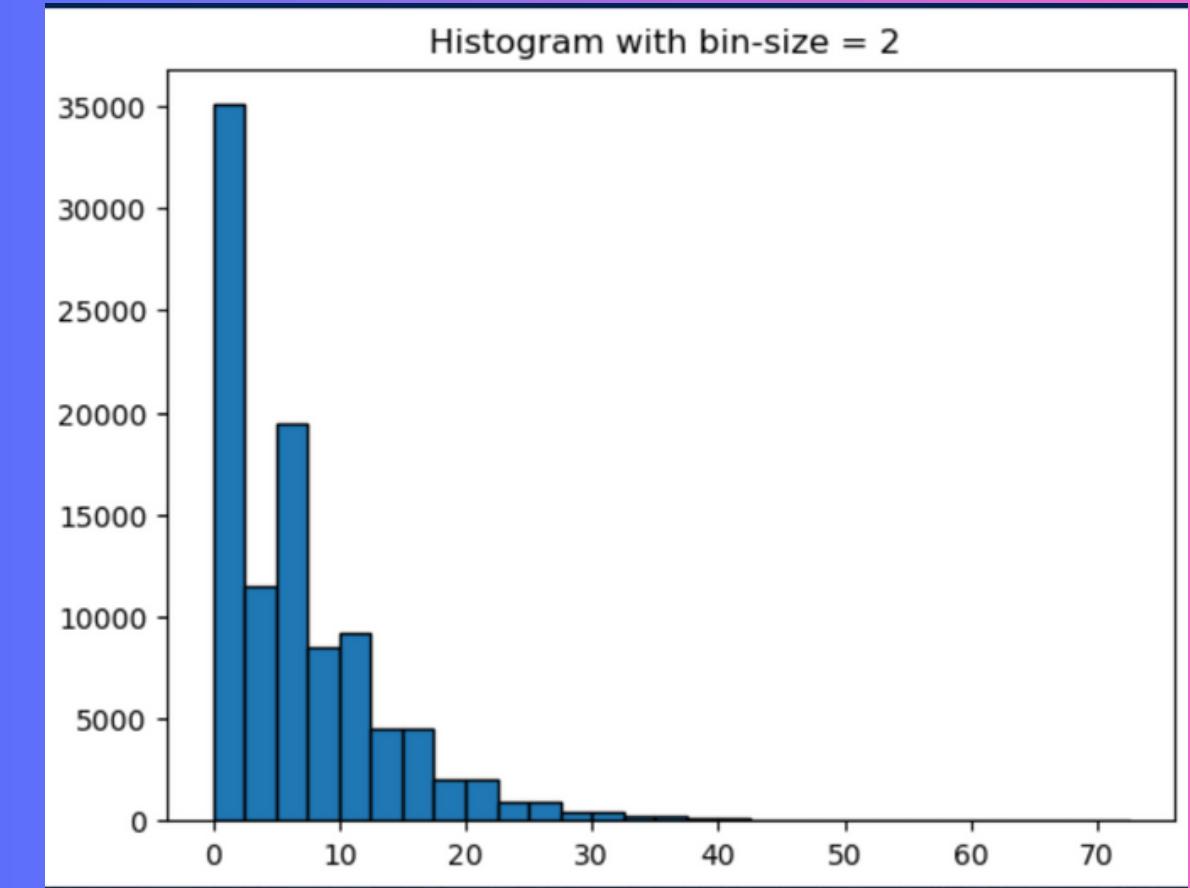




Dataset Wise Trends

abc 100 1 ms 1 Lakhs pmt on.csv

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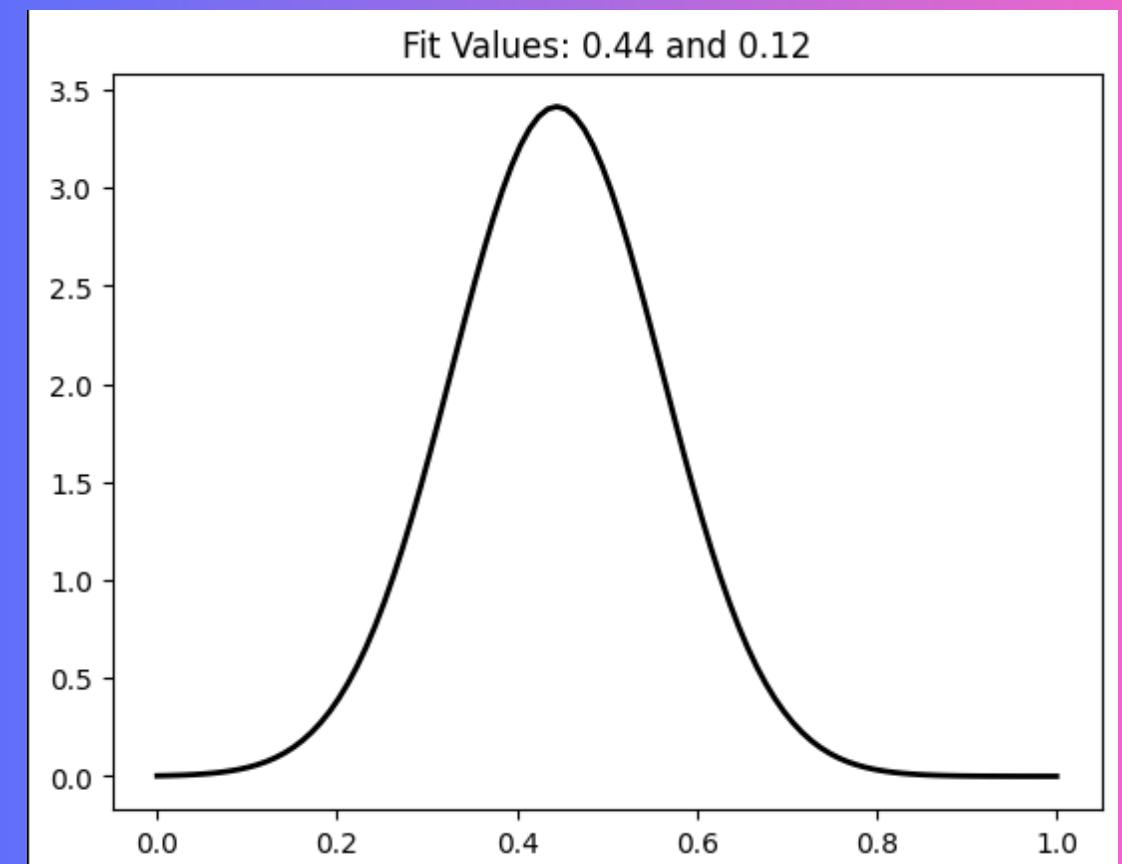
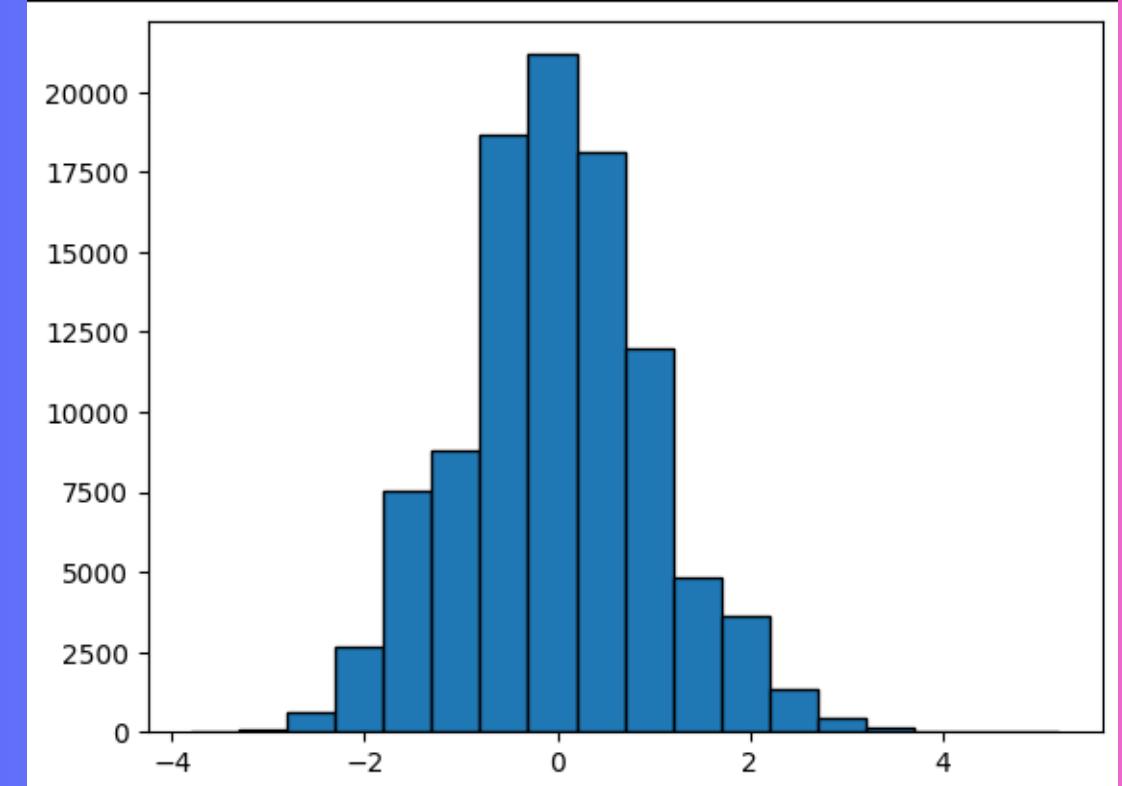




Dataset Wise Trends

with 2 ND FIKTER 500 MI 1L 50 SEC.xlsx

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usp=sharing&ouid=110746655111538115076
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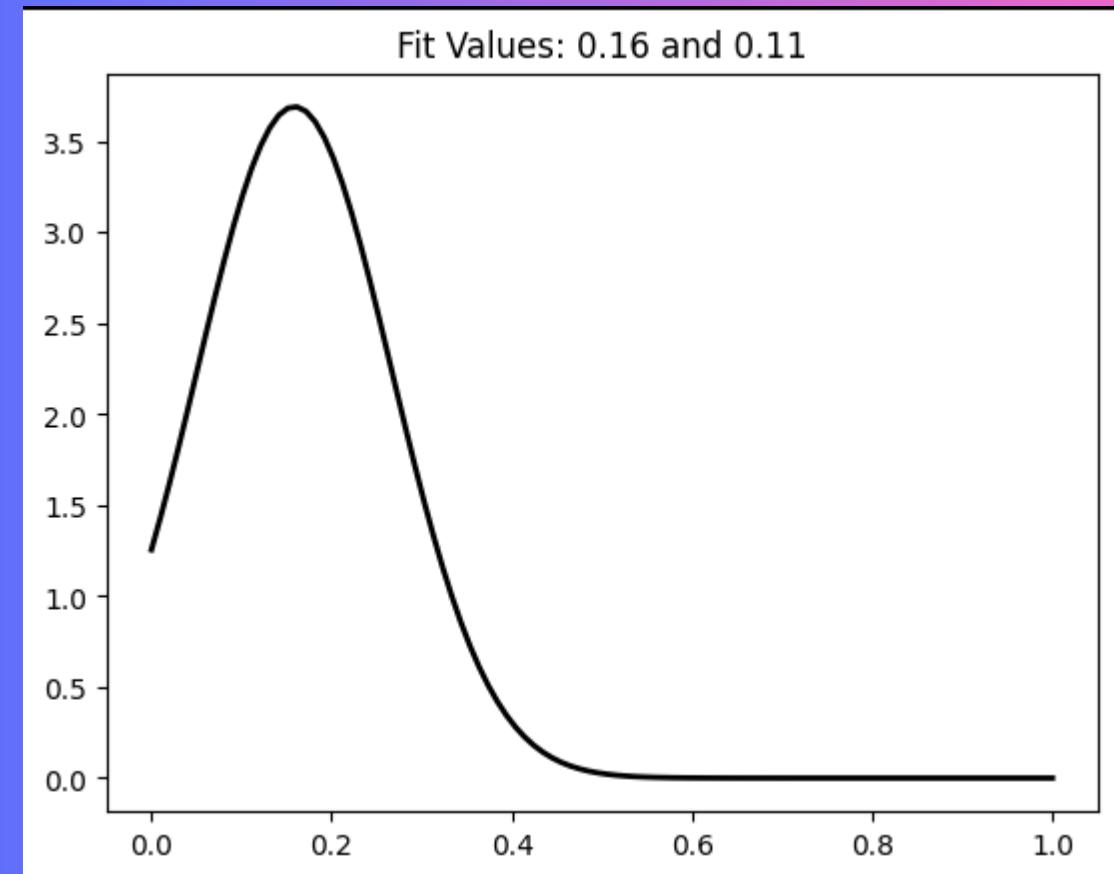
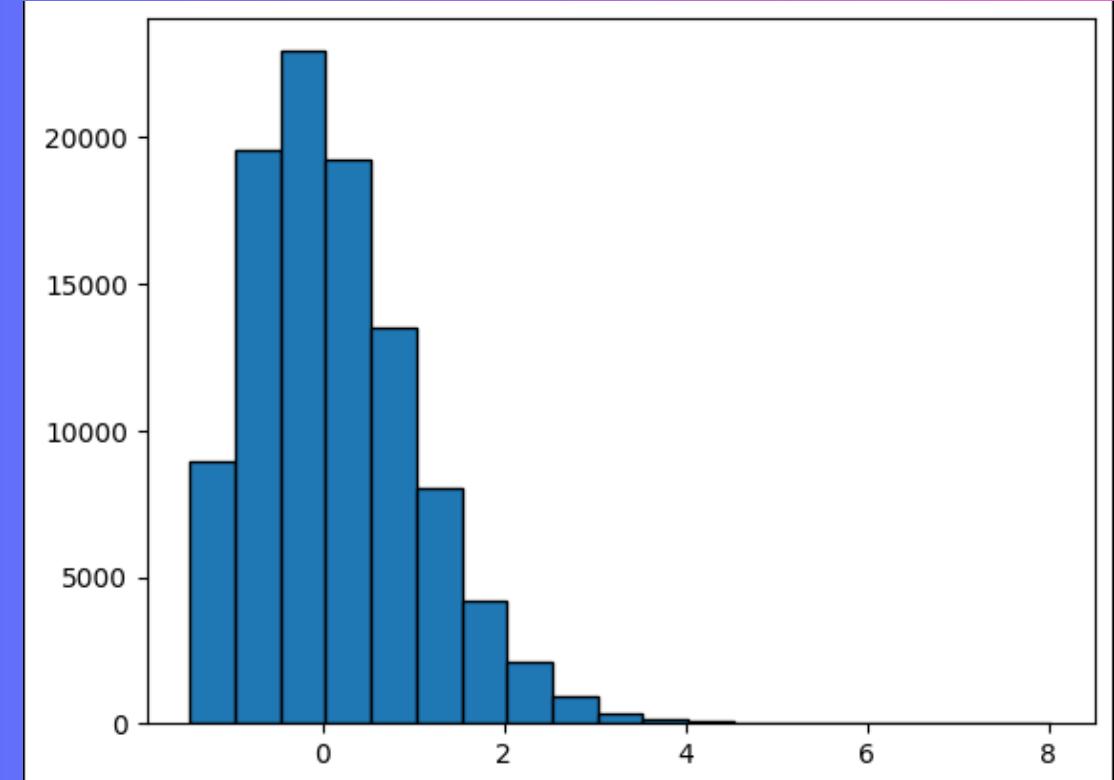




Dataset Wise Trends

4 bakgrnd.csv

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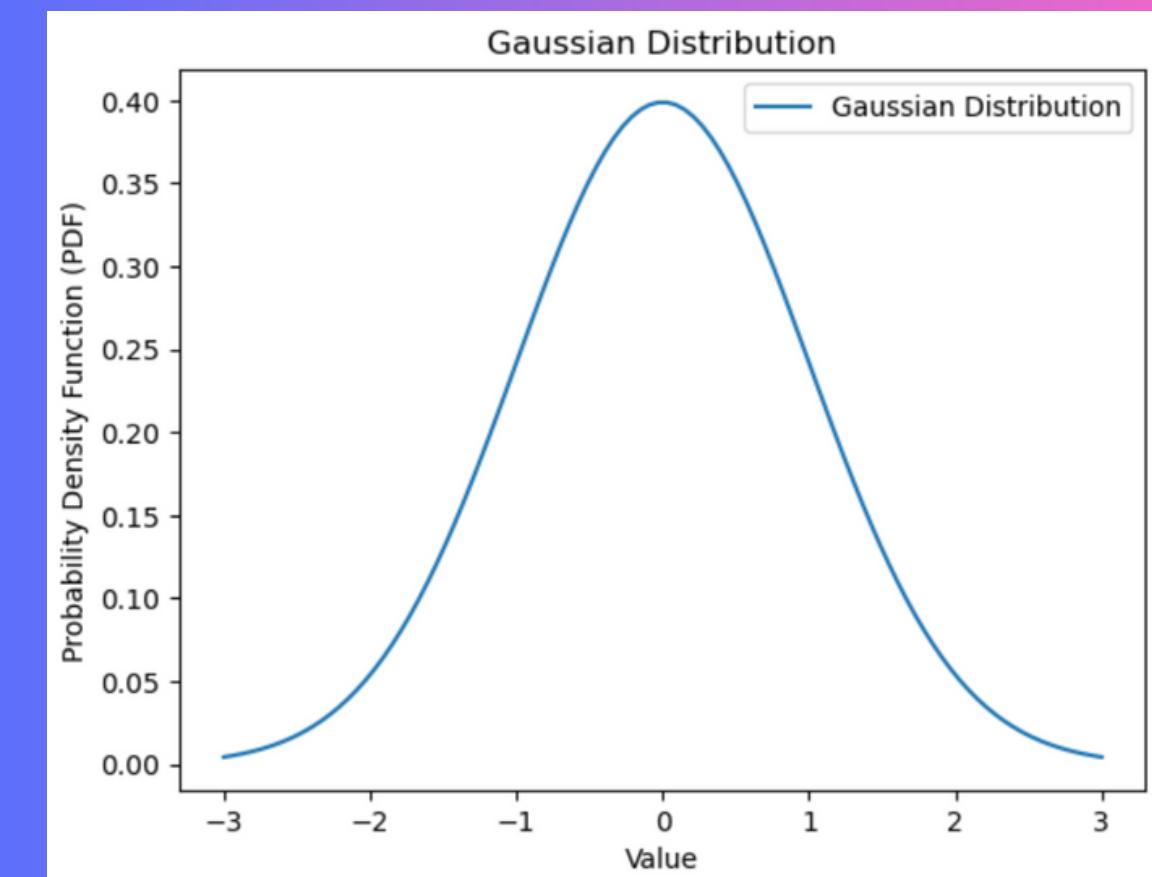
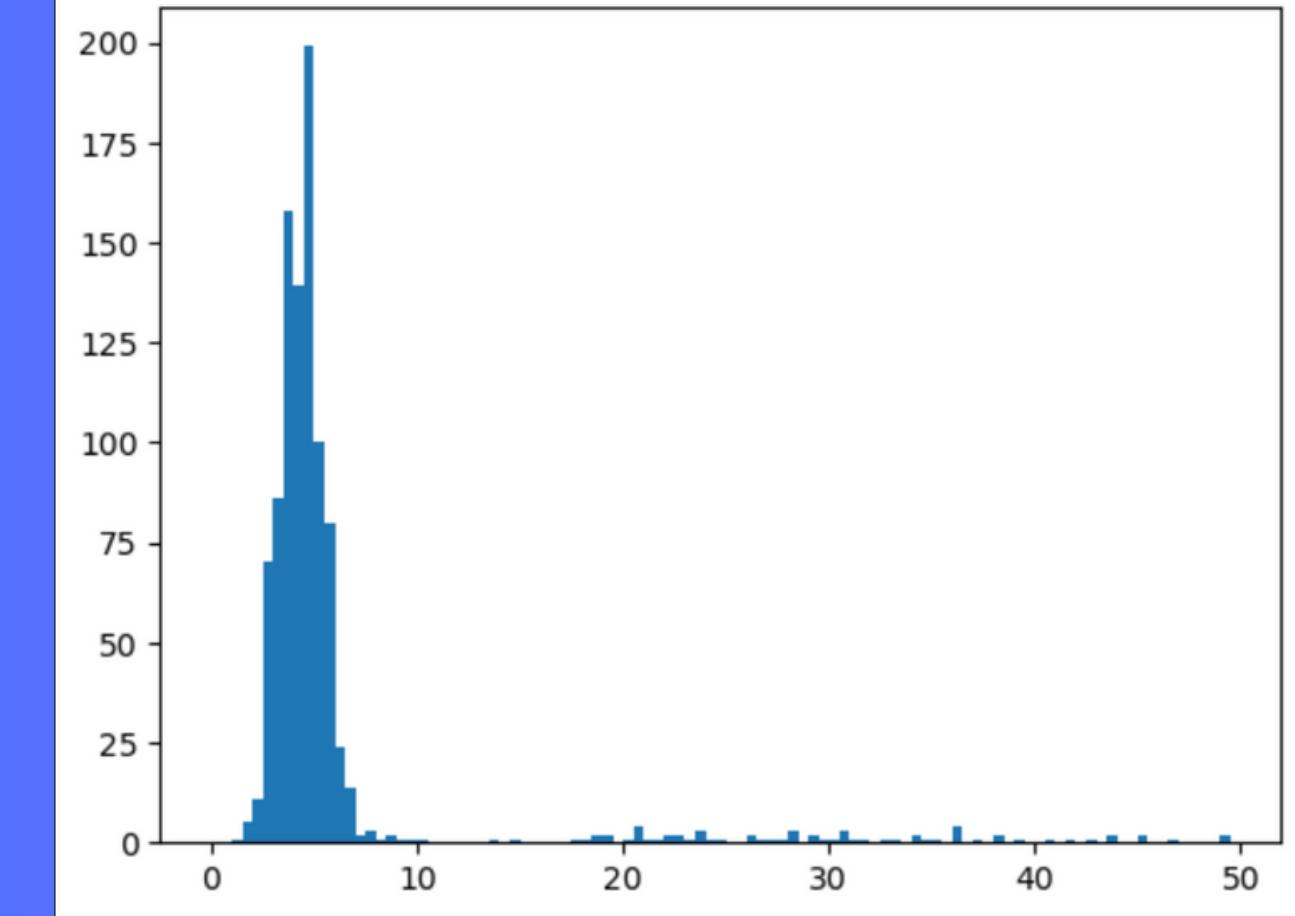




Dataset Wise Trends

s1 time decay both laser.txt

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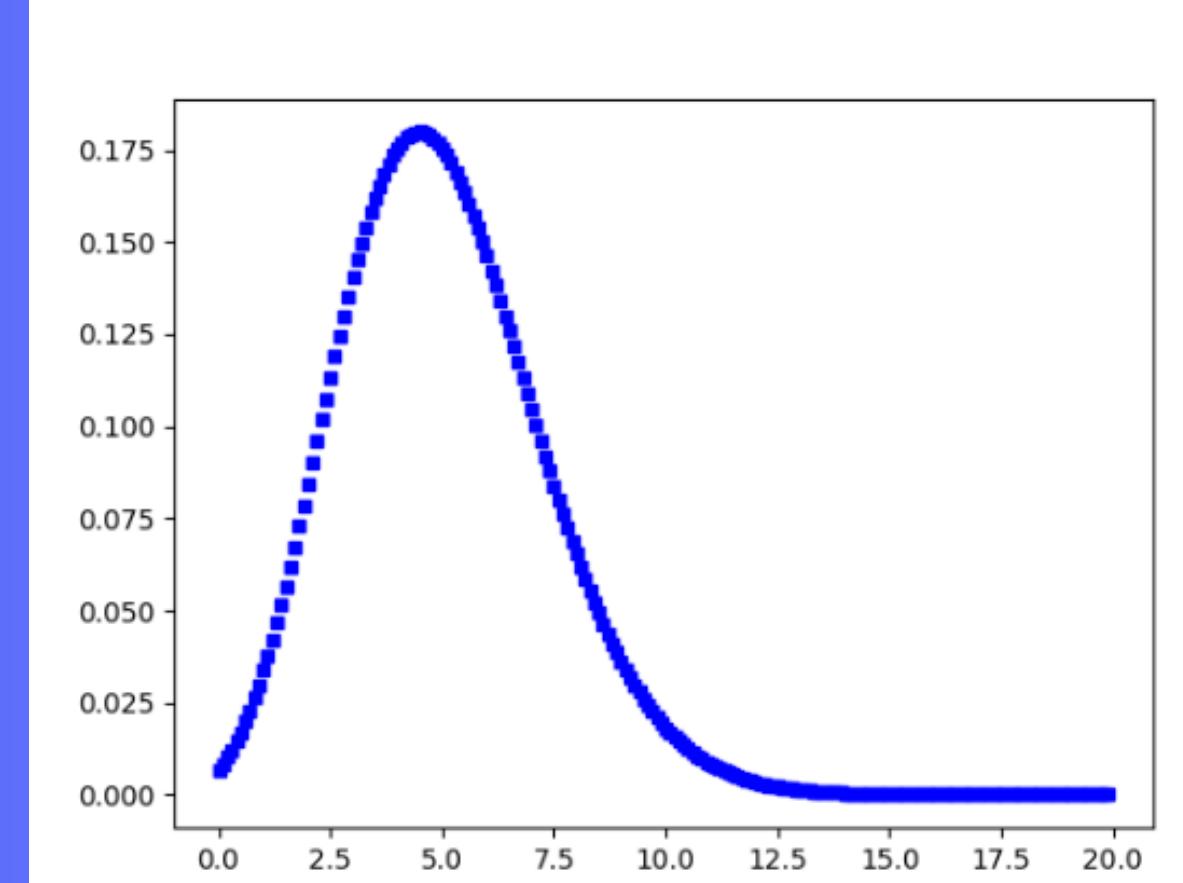
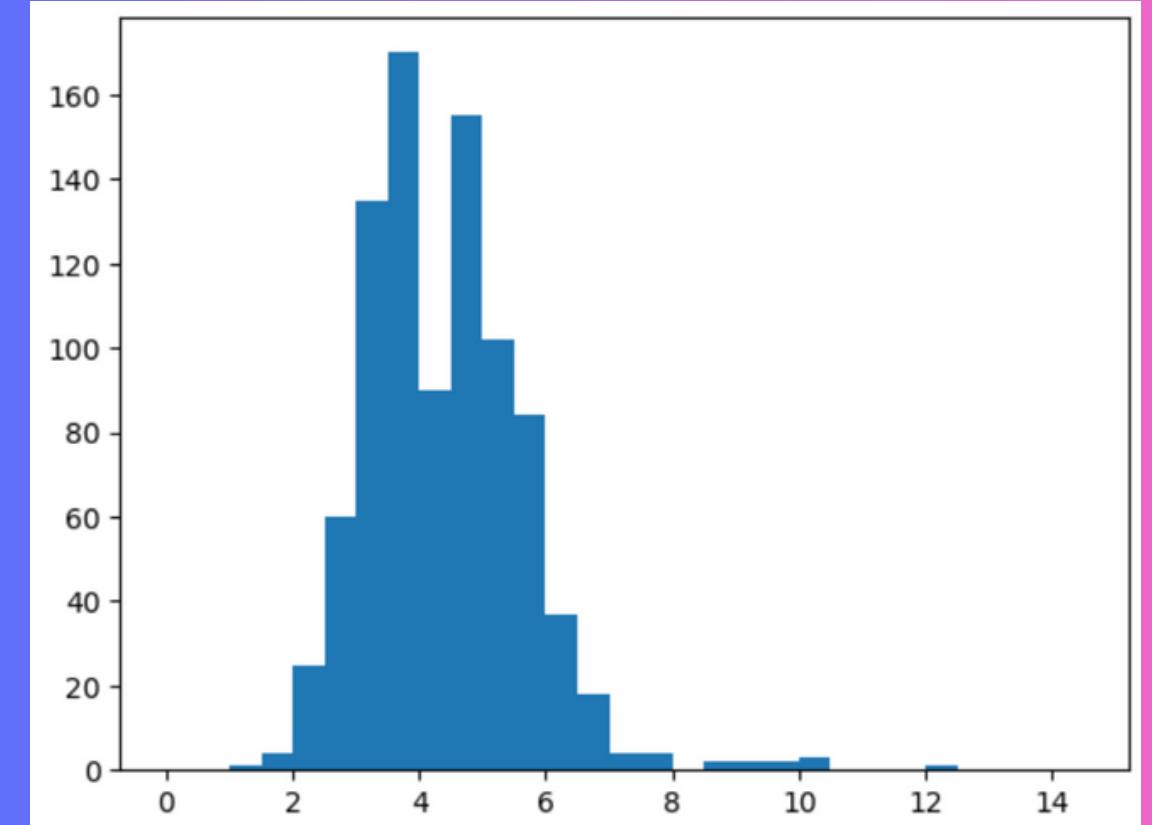




Dataset Wise Trends

s1 time decay both laser 2.txt

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Final Neural Net Model

Develop a neural network model using TensorFlow/Keras for 'y' prediction based on 'x' values from a dataset.

- 1 Developed a neural network model using TensorFlow/Keras for 'y' prediction based on 'x' values from a dataset.
- 2 Preprocessing: Initial data preprocessing involves scaling and normalizing the 'x' data for model training.
- 3 Model Architecture: The neural network consists of two hidden layers: one with 64 neurons and another with 32 neurons, followed by an output layer.
- 4 Loss Function: Utilizes mean squared error (MSE) as the loss function to optimize model performance during training.
- 5 Custom Metric: Incorporates a custom R-squared metric to evaluate the model's performance, measuring the proportion of variance in 'y' explained by 'x'.
- 6 Training Loop: The training loop executes for 50 epochs, continually evaluating R-squared values on the test set after each epoch.
- 7 Performance: The model achieves an impressive 95.7% R-squared score



Final Neural Net Model

Epoch 50: R-squared = 0.95768141746521

Develop a neural network model using TensorFlow/Keras achieving an impressive 95.7% R-squared score, signifying its capability to elucidate the variance in 'y' based on the input 'x'. This high R-squared value indicates a strong fit of the model to the data.



Summarizing our work

- Analyzed research papers and implemented them using machine learning technique of K-Means and Deep learning through neural networks achieving good accuracy on the dataset.
- Analyzed distributions of various data files and plotted their distributions after normalization and preprocessing of the data. After that, automated the process and created a neural network that can take the distribution points and predict the distribution of the data provided.



THANK YOU!

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