Data Analysis on Scintillation Detector Data

By ,
Navaneeth P R
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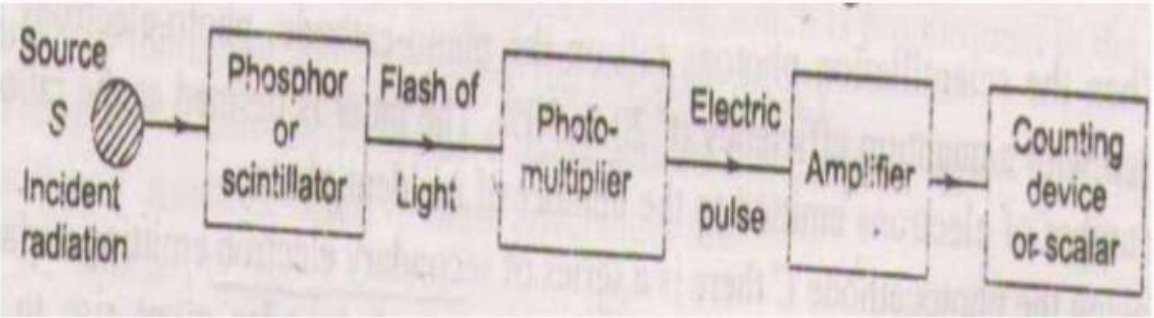
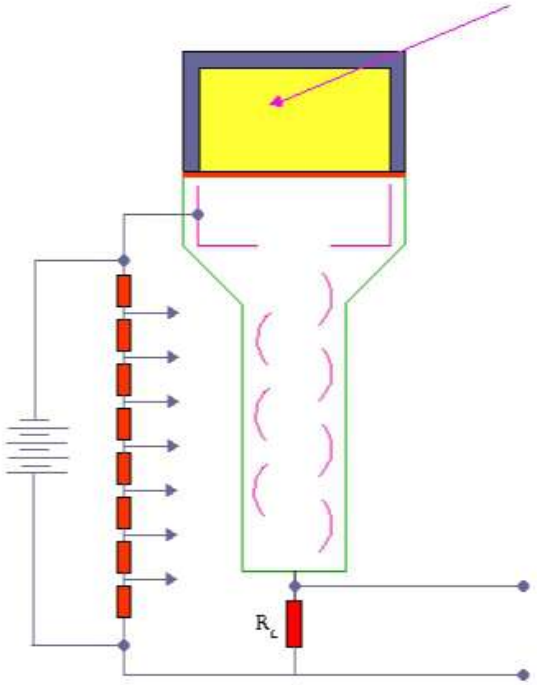
B-tech Engineering Physics

Contents

- Working of a scintillation detector.
- Analysis of data collected in the experiments.
- Fitting the collected data into models using machine learning and deep learning techniques.

Scintillation Detector





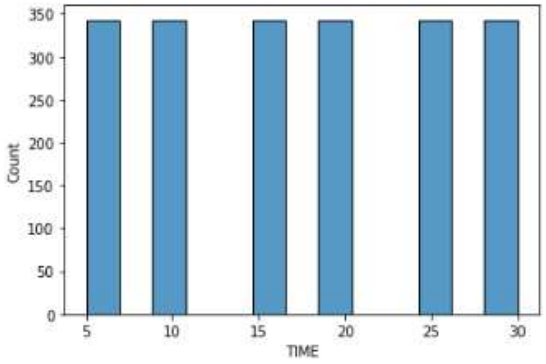
Analysis of data collected in the experiment

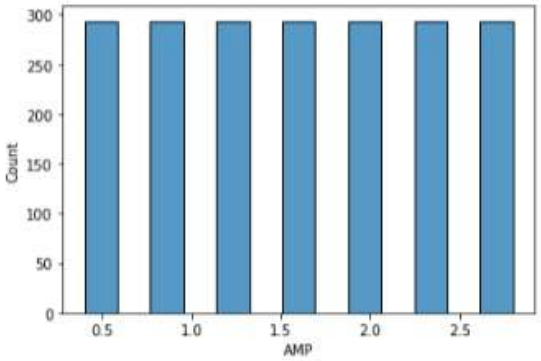
The experiment was performed and data was collected of variables like High Voltage (at the PMT), Amplifier Gain, Average time to count the radiation particles and Lower limit discrimination value (energy window) . These values were then used to statistically determine the optimal method and values for calibrating the detector.

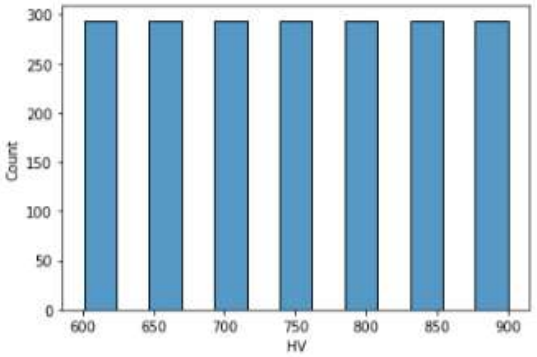
https://link.springer.com/article/10.1007%2Fs11265-021-01685-9

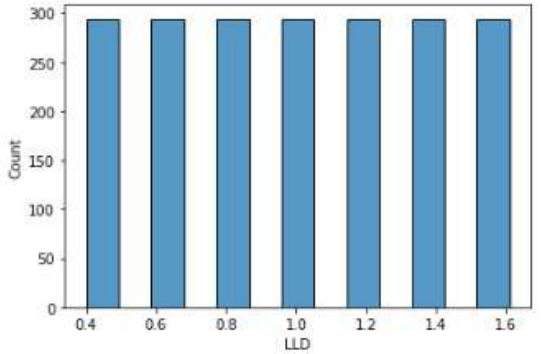
A set of raw data for the measurement of counts were given . A single variable was varied at a time and at a particular setting the measurement of counts were repeated many times . So for analysis, at a particular setting mean of the counts were taken . Histograms, Scatter, Box and Kernel Density estimation plots were used to visualize the data for insights and correlations were also calculated to understand the variable relationships.

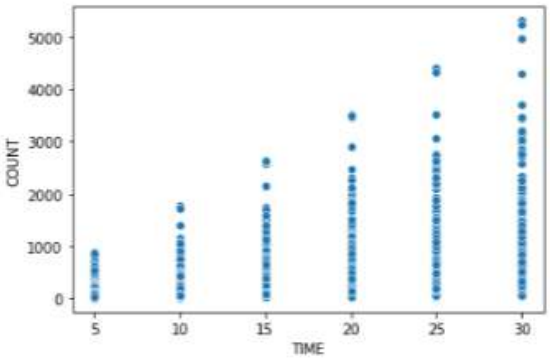
Histograms and scatter plot of independent variables

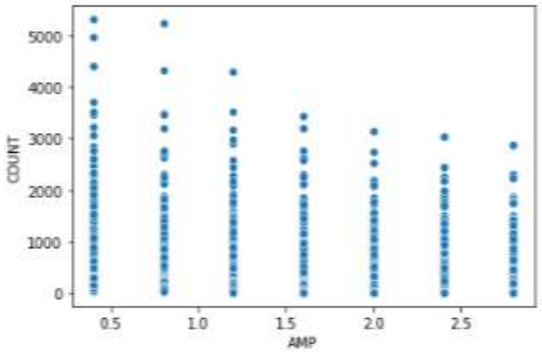


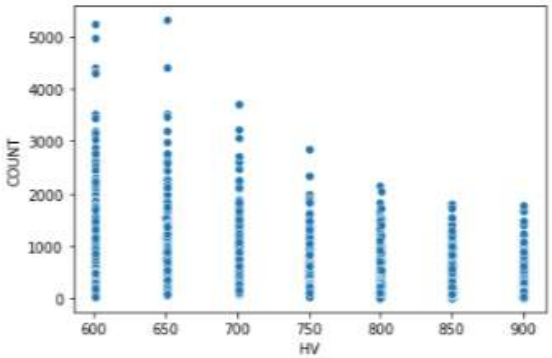


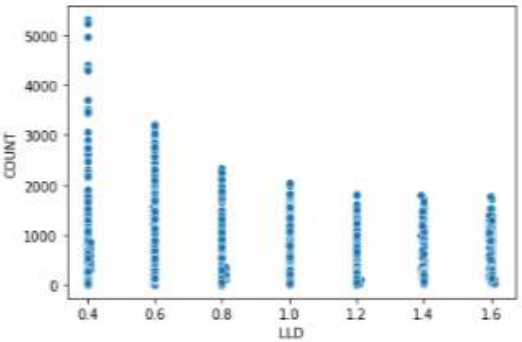




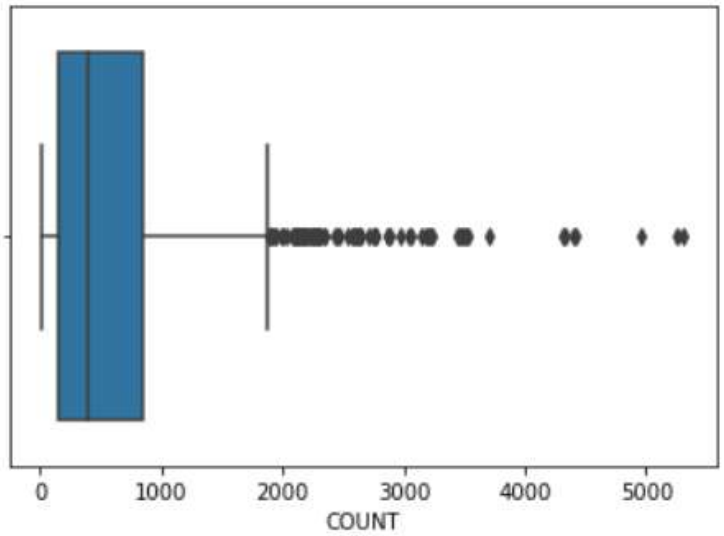


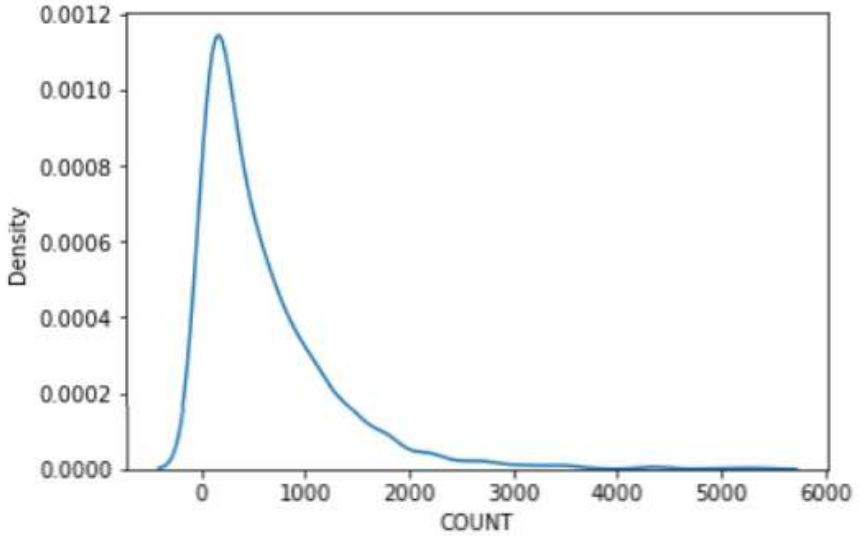






Box and KDE plot of dependent variable





Estimating correlations between independent and dependent variables

Since the independent variables exhibit a non-linear relationship with the dependent variable Spearman's Rank order correlation was used.

Independent Variable	Correlation Coefficient	p-value
Time	0.5064	1.733e-134
Amplifier Value	-0.326	3.66e-52
High Voltage	-0.5005	6.224e-131
LLD	-0.0118	0.5926

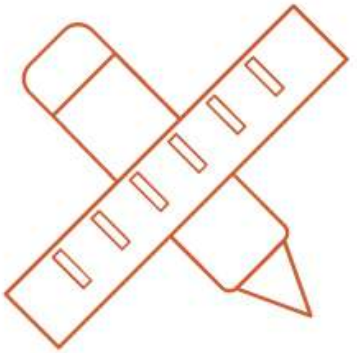
FITTING DATA USING ML AND DL

Scaling the data

$$X \longrightarrow (X-mean(X))/std.dev(X)$$

$$mean(X) = sum(X)/ count(X)$$

$$std.dev(X) = (sum(X-mean(X))^2/count(X))^(1/2)$$



Neural Network Model

Layers:

- Input layer- 4 neurons.
- Two Hidden layers- 5 neurons each.
- Output layer-1 neuron.

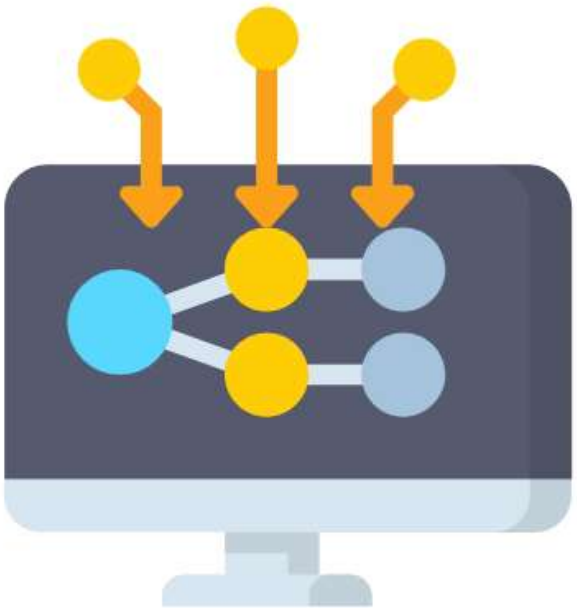
Optimizer : RMSprop

Loss Function: Mean Absolute Error

Learning Rate: Exponentially decaying

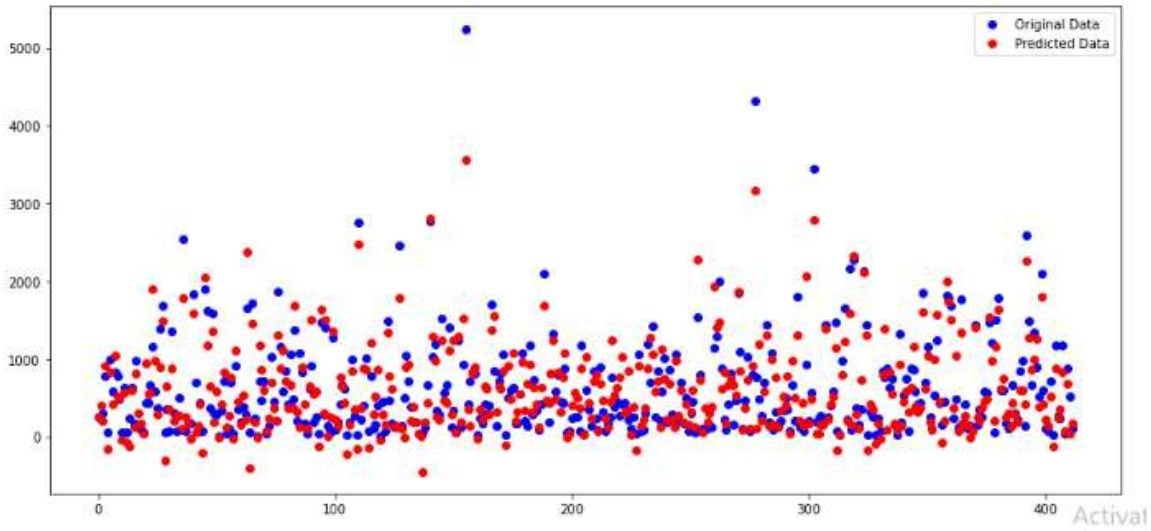
Epochs: 100

Error: 55%



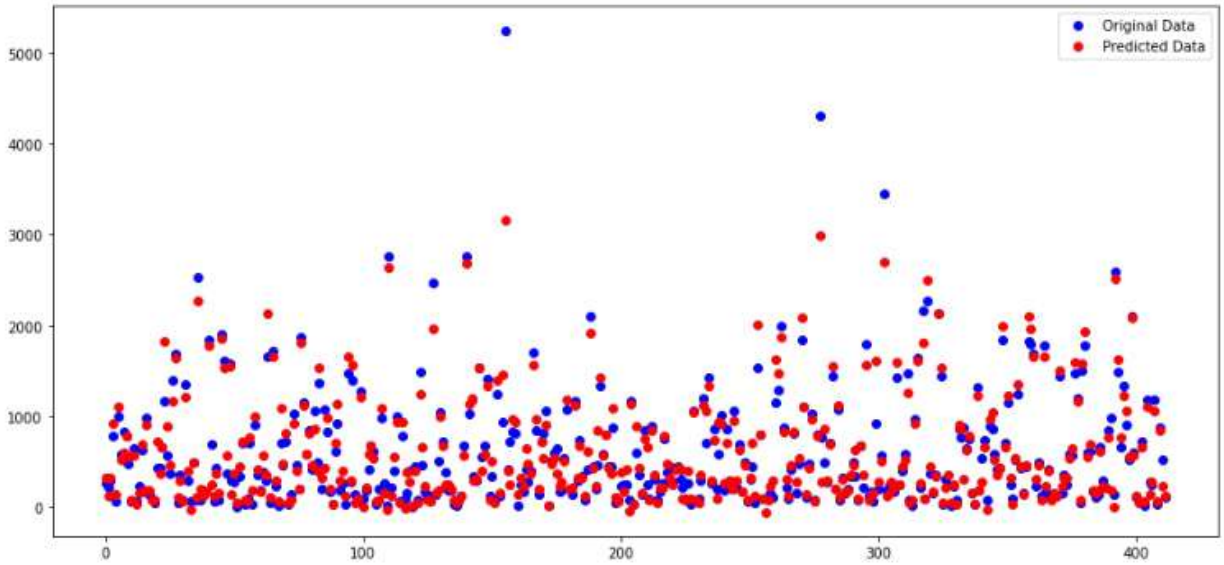
Multivariate Polynomial Regression

- Data fit into a non-linear polynomial.
- Maximum degree: 20



Support Vector Regression

Data was fitted using a SVR algorithm using a Gaussian RBF kernel.



More predicted points overlap with the origianl data points


THANK
YOU FOR
LISTENING