Short Assignment 0

1. Classification is to classify some distinct values such as male or female, white or black, true or false, etc. However, regression is a way to predict a continuous string of value, such as brightness, temperature, price, etc.

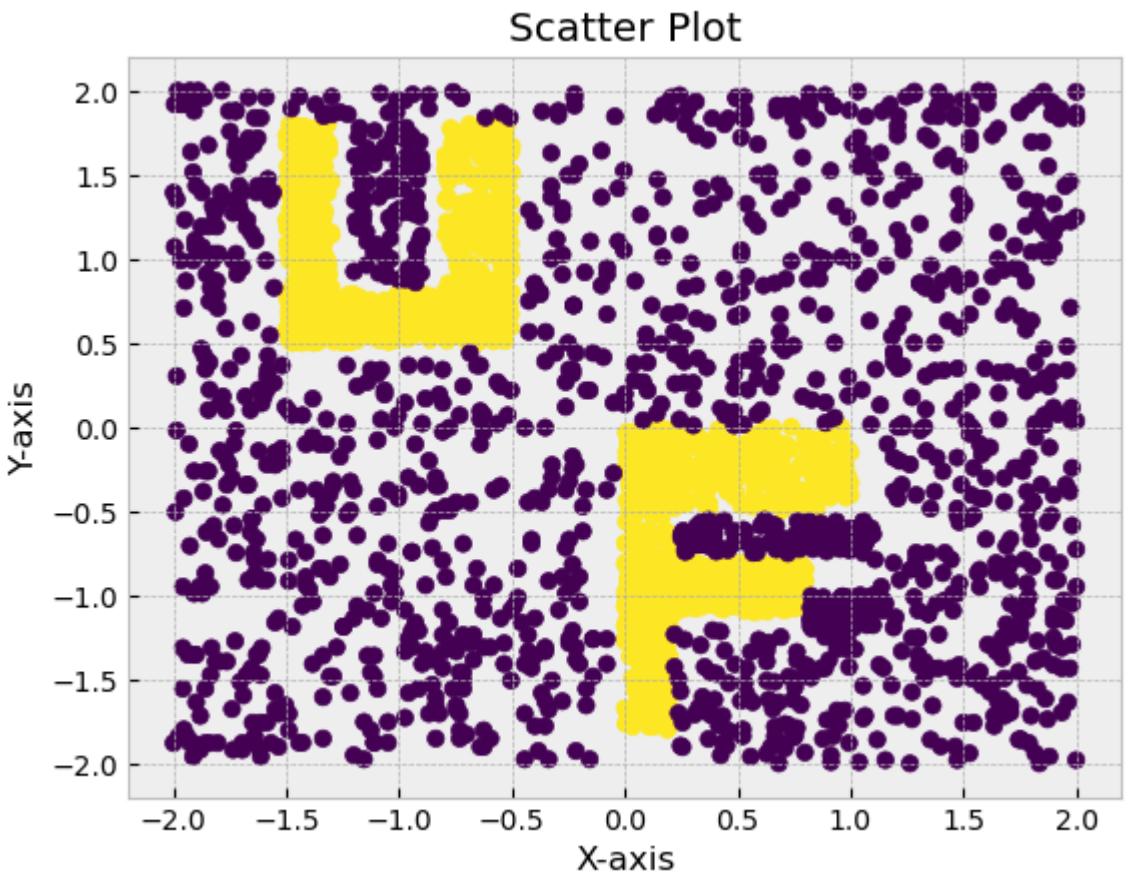
2. Both classification and regression tasks are under the branch of machine learning tasks. More specifically, they are both supervised learning tasks.

3. (1)Classification task example: given the pictures of two different breeds of cats, telling them from each other.Given a group of answer data from a Turing Test, having a judgement on whether the testing object is a human or not.(2)Regression task example: given the birth rate data of Gainesville area for the past 10 years, predicting the same value of next 5 years. Given a group of performance data of a laptop series which changes over years, predicting the performance change for future years.

In [29]:
```
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
plt.style.use('bmh')
data = np.load('dataset.npy')
```

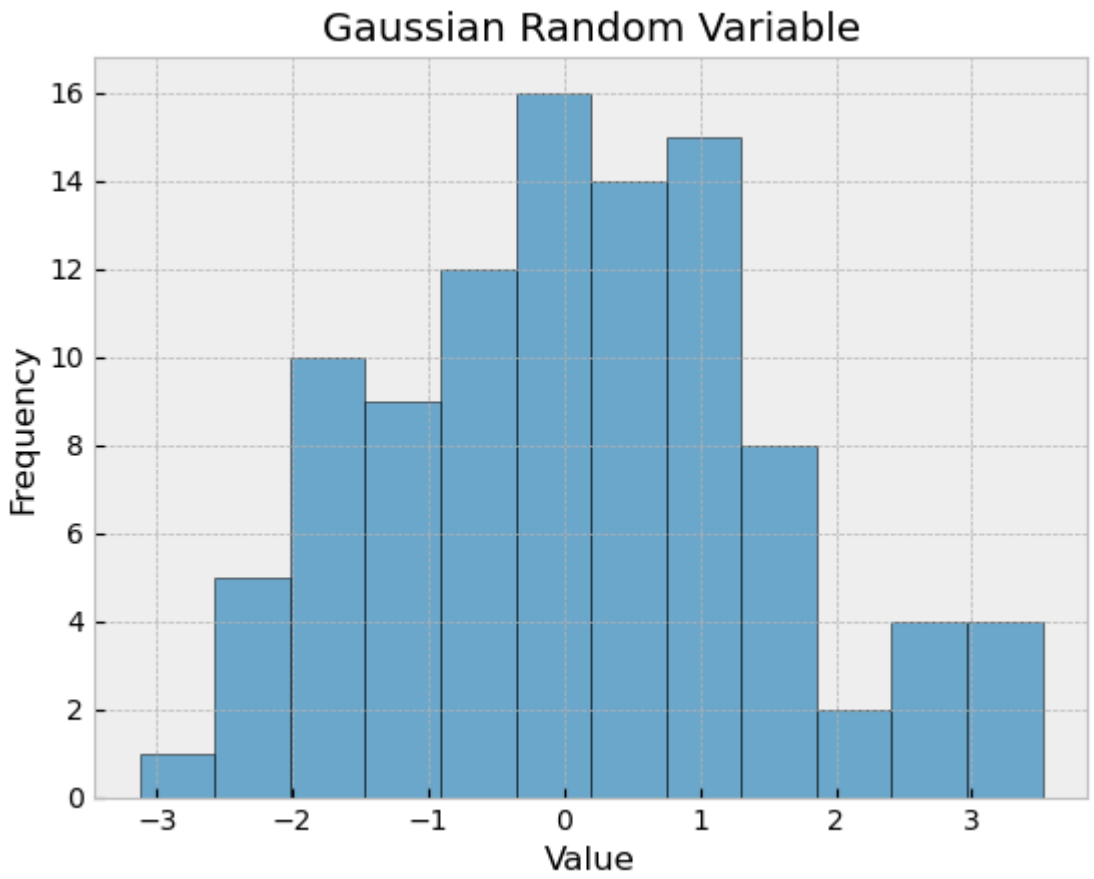
Actually, it is hard to tell what's the shape of this dateset now.

In [17]:
```
x = data[:, 0]
y = data[:, 1]
labels = data[:, 2]
plt.scatter(x, y, c=labels)
plt.title('Scatter Plot')
plt.xlabel('X-axis')
plt.ylabel('Y-axis')
plt.show()
```

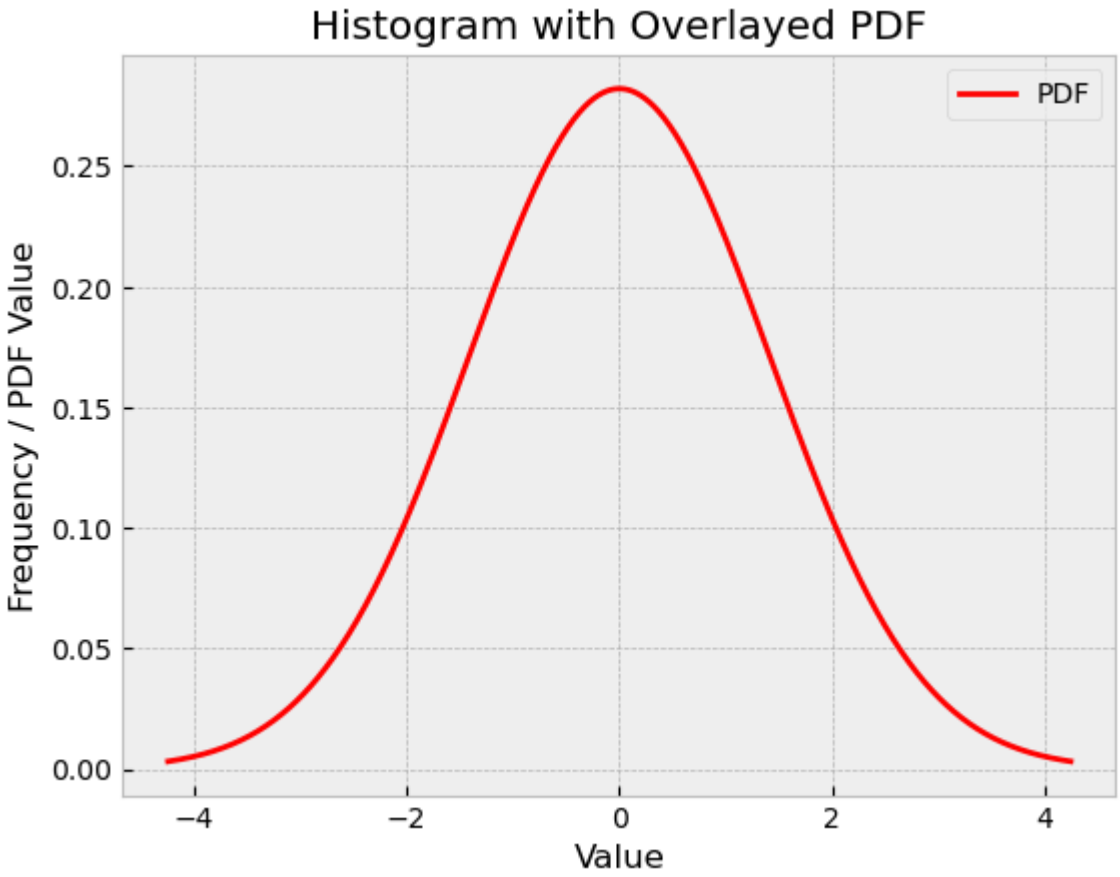


Now, after drawing the scatter plot, it is easy to see it shows a sign of 'UF' :)

In [27]:
```
import scipy.stats as stats
mean = 0
var = 2

rv = stats.norm(loc=mean, scale=np.sqrt(var))

sample_size = 100
sample = rv.rvs(size=sample_size)

plt.hist(sample, bins=12, edgecolor='k', alpha=0.7)

plt.title('Gaussian Random Variable')
plt.xlabel('Value')
plt.ylabel('Frequency')

plt.show()
```



In [28]:
```
# Create a range of values for the x-axis
x = np.linspace(mean - 3 * np.sqrt(variance), mean + 3 * np.sqrt(variance), 1000)

# Calculate the PDF values for the given range
pdf_values = rv.pdf(x)

# Plot the PDF over the histogram
plt.plot(x, pdf_values, 'r-', label='PDF')

# Customize the plot
plt.title('Histogram with Overlayed PDF')
plt.xlabel('Value')
plt.ylabel('Frequency / PDF Value')
plt.legend()

# Show the plot
plt.show()
```



I have to say, for Question D, I have referenced the way how ChatGPT solve it. I think it's really beyond my knowledge storage for now, and I have tried my best on it.

Course Policies

1. Our communation channels are Canvas discussion boards, office hours, email and Slack.
2. Generally we need to follow all deadlines, but if we have troubles, we should communicate with our instructor in advance to avoid losing on-time points.
3. I should discuss this with the instructor within a week of grades being posted.
4. Discussing and explaining general course material; discussing assignments for better understanding; aiding for general programming and debugging issues. If another student contribute a lot to my work, then I should cite her/him to let TAs and my instrctor know.
5. When I am finishing this assignments, I found that some issues may have some different answering ways like different format and steps because of the difference of students' education background. Therefore, I hope I will be informed if my personal answer significantly influences my grade. Thank you.

Prerequisites Review

1、Chain rules:

if: $f(x) = \phi(g(x))$

then: $f'(x) = \phi'(g(x)) \cdot g'(x)$.

$$\frac{\partial f}{\partial x} = \frac{1}{2}\phi'(wx+b)\cdot(wx)'$$

$$= \frac{1}{2}\cdot 2\cdot(wx+b)\cdot w$$

$$= (wx+b)\cdot w$$

2、assume that:

$$ax_1+bx_2+cx_3=y. \rightarrow a\begin{bmatrix}1\\1\\1\end{bmatrix}+b\begin{bmatrix}1\\2\\3\end{bmatrix}+c\begin{bmatrix}2\\-1\\1\end{bmatrix}=\begin{bmatrix}1\\-2\\5\end{bmatrix}$$

then:

$$\begin{cases} a+b+2c=1 & \cdots ① \\ a+2b-c=-2 & \cdots ② \\ a+3+c=5 & \cdots ③ \end{cases}$$

②+③: $2a+5b=3 \cdots ④$

①+2.②: $3a+5b=-3 \cdots ⑤$ ④-⑤ → $a=-6$

$a=-6 \rightarrow$ ④: $-12+5b=3 \rightarrow b=3$ $c=2$

$\therefore -6x_1+3x_2+2x_3=y.$

3. The rank of a matrix means the number of its linearly independet rows/columns.

A is already in a row echelon form,

so $r(A) = 2$.

$$B = \begin{bmatrix} 1 & 2 & 1 \\ -2 & -3 & 1 \\ 3 & 5 & 0 \end{bmatrix}$$

row 2 + 2 row 1 $\rightarrow$ $\begin{bmatrix} 1 & 2 & 1 \\ 0 & 1 & 3 \\ 3 & 5 & 0 \end{bmatrix}$

row 3 − 3 row 1 $\rightarrow$ $\begin{bmatrix} 1 & 2 & 1 \\ 0 & 1 & 3 \\ 0 & -1 & -3 \end{bmatrix}$

row 3 + row 2 $\rightarrow$ $\begin{bmatrix} 1 & 2 & 1 \\ 0 & 1 & 3 \\ 0 & 0 & 0 \end{bmatrix}$

$r(B) = 2$

4.

Y \ X	x_1	x_2	x_3	x_4	x_5
y_1	0.01	0.02	0.03	0.1	0.1
y_2	0.05	0.1	0.05	0.07	0.2
y_3	0.1	0.05	0.03	0.05	0.04

A. $P(x_1) = P(x_1, y_1) + P(x_1, y_2) + P(x_1, y_3)$

$= 0.01 + 0.05 + 0.1 = 0.16$.

we can calculate the others in a same way.

$P(x_2) = 0.17$ $\quad P(y_1) = 0.26$

$P(x_3) = 0.11$ $\quad P(y_2) = 0.47$

$P(x_4) = 0.22$ $\quad P(y_3) = 0.27$.

$P(x_5) = 0.34$.

B.

$$P(x_1 | Y = y_1) = \frac{P(x_1, y_1)}{P(y_1)} = \frac{0.01}{0.01 + 0.02 + 0.03 + 0.1 + 0.1} = \frac{1}{26}$$

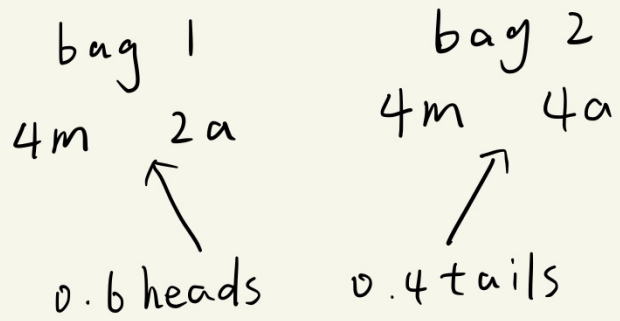
$P(x_2 | Y = y_1) = \frac{1}{13}$ $\quad P(x_3 | Y = y_1) = \frac{3}{26}$

$P(x_4 | Y = y_1) = \frac{5}{13}$ $\quad P(x_5 | Y = y_1) = \frac{5}{13}$

$$P(y_1|X=x_3) = \frac{P(y_1, x_3)}{P(x_3)} = \frac{0.03}{0.03+0.05+0.03} = \frac{3}{11}$$

$$P(y_2|X=x_3) = \frac{5}{11} \qquad P(y_3|X=x_3) = \frac{3}{11}$$

5.



assume:

event B : get a mango

event A : the coin shows "tails" and pick a fruit from bag 2.

$$P(A|B) = \frac{P(A)P(B|A)}{P(B)}$$

$$P(A) = 0.4 \qquad P(B) = 0.6 \times \frac{4}{4+2} + 0.4 \times \frac{4}{4+4} = 0.6$$

$$P(B|A) = \frac{4}{4+4} = \frac{1}{2}$$

$$\therefore P(A|B) = \frac{0.4 \times \frac{1}{2}}{0.6} = \frac{1}{3}.$$

In [ ]: