

LAB ACTIVITY 15

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DATE : 23/09/2025

DIGITAL ASSIGNMENT-4

TASK - 1: The Life Cycle of Matplotlib

```
In [5]: # Importing the necessary libraries
```

```
import pandas as pd
import matplotlib.pyplot as plt
```

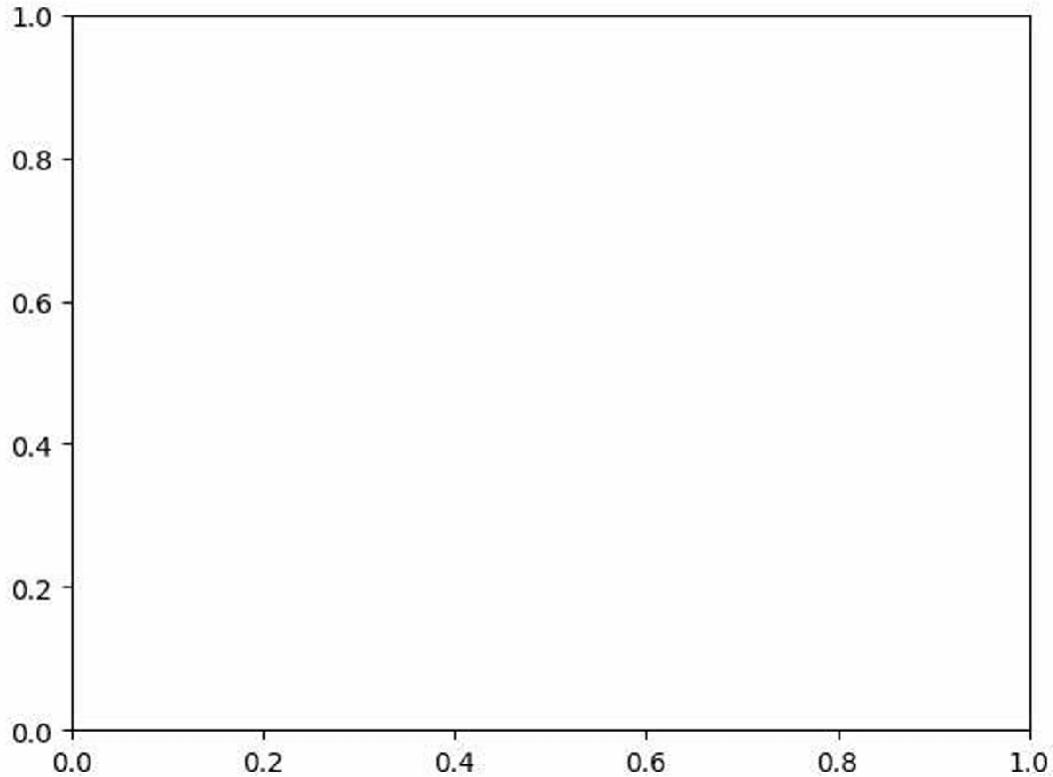
```
In [7]: # Loading the dataset using read_csv() from pandas library
```

```
data = pd.read_csv('Housing.csv')
print(data.head()) # displaying the first 5 rows
```

	price	area	bedrooms	bathrooms	stories	mainroad	guestroom	basement	\
0	13300000	7420	4	2	3	yes	no	no	
1	12250000	8960	4	4	4	yes	no	no	
2	12250000	9960	3	2	2	yes	no	yes	
3	12215000	7500	4	2	2	yes	no	yes	
4	11410000	7420	4	1	2	yes	yes	yes	

	hotwaterheating	airconditioning	parking	prefarea	furnishingstatus
0	no	yes	2	yes	furnished
1	no	yes	3	no	furnished
2	no	no	2	yes	semi-furnished
3	no	yes	3	yes	furnished
4	no	yes	2	no	furnished

```
In [9]: # Create a figure and axes (Object-Oriented Interface)
fig, ax = plt.subplots()
```



```
: fig, ax = plt.subplots()

# Plot data on axes

ax.plot(data["area"], data["price"], color="blue", marker="o", linestyle="-", label="Price vs
Area")

# Customize plot (labels, title, legend, grid)

ax.set_xlabel("Area (sq ft)")

ax.set_ylabel("Price (INR)")

ax.set_title("Housing Price vs Area") ax.legend() ax.grid(True)
```



```
In [15]: # Aggregate data for plotting
avg_price_by_furnishing = data.groupby('furnishingstatus')['price'].mean()
furnishing_categories = avg_price_by_furnishing.index
average_prices = avg_price_by_furnishing.values
```

```
In [17]: # Create the figure and axes objects
fig, ax = plt.subplots(figsize=(9, 7))

# Plot the data on the Axes
```

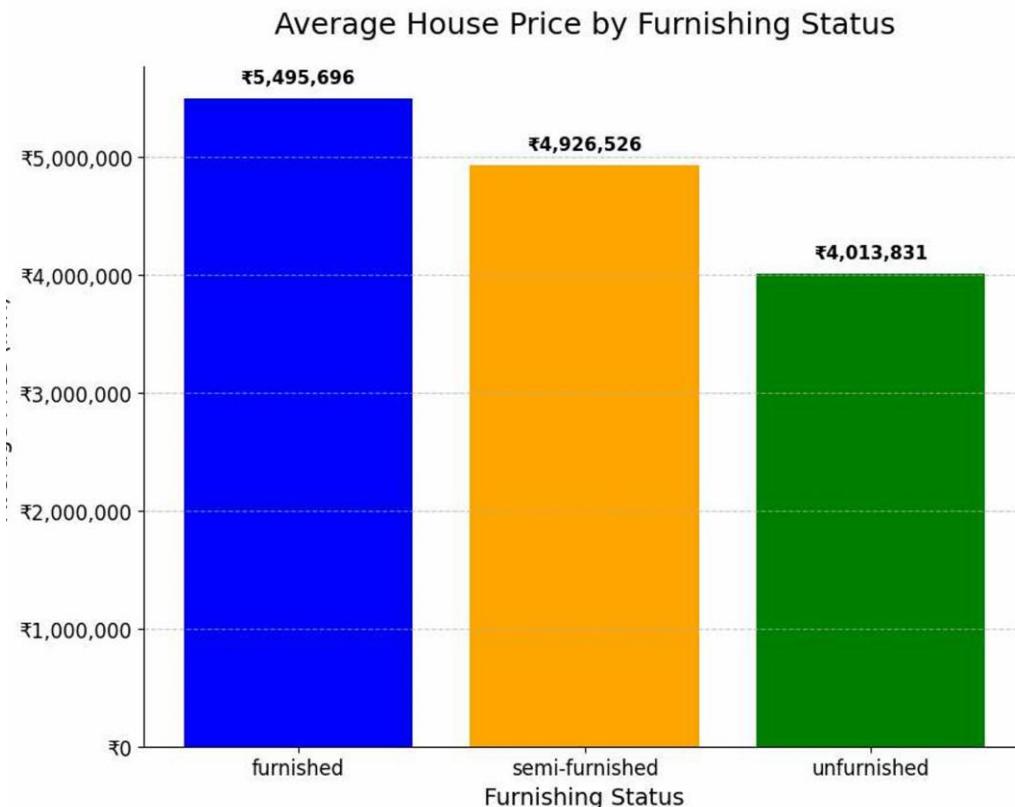
```
ax.bar(furnishing_categories, average_prices, color=['blue', 'orange', 'green'])

# Customize the title, labels, and tick marks
ax.set_title('Average House Price by Furnishing Status', fontsize=18, pad=20)
ax.set_xlabel('Furnishing Status', fontsize=14)
ax.set_ylabel('Average Price (INR)', fontsize=14)
ax.tick_params(axis='x', labelsize=12)
ax.tick_params(axis='y', labelsize=12)
ax.yaxis.set_major_formatter(plt.FuncFormatter(lambda x, p: f'₹{x:,.0f}'))

# Add data labels
for i, price in enumerate(average_prices):
    ax.text(i, price + 100000, f'₹{price:.0f}', ha='center', va='bottom', fontsize=11, fontweight='bold')

# Add a grid for better readability
ax.grid(axis='y', linestyle='--', alpha=0.7)
ax.spines['top'].set_visible(False)
ax.spines['right'].set_visible(False)

# display the figure
plt.tight_layout()
plt.show()
```



TASK - 2: Load the Image and change its characteristics (Brightness, hue, saturation)

```

import cv2
import matplotlib.pyplot as plt

# Load image (change path as needed)
image = cv2.imread("sample.jpg") # reads in BGR format
image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB) # convert to RGB for matplotlib

# --- Brightness Adjustment ---
def adjust_brightness(img, factor=1.2):
    hsv = cv2.cvtColor(img, cv2.COLOR_RGB2HSV).astype("float32")
    h, s, v = cv2.split(hsv)

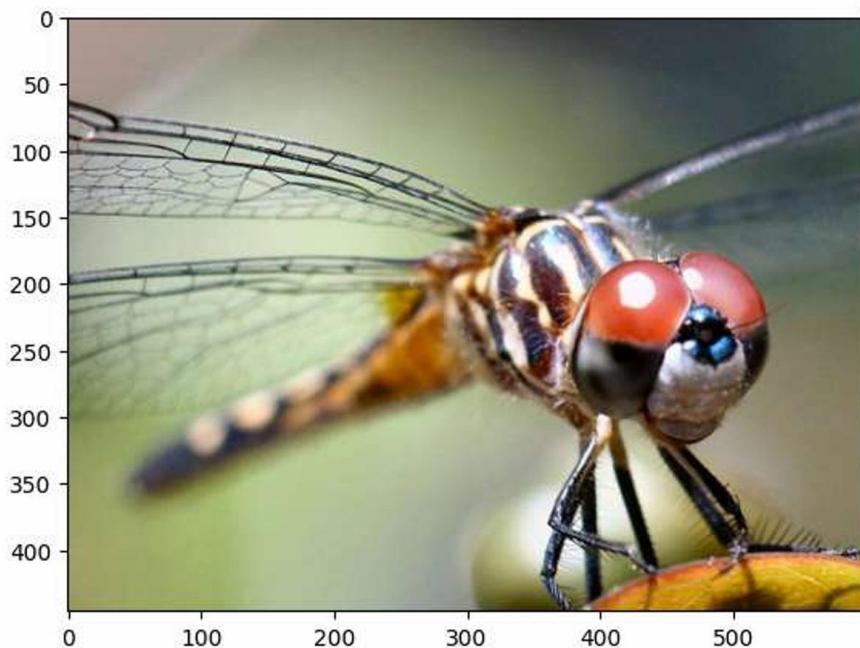
```

```
v = v * factor  
v = np.clip(v, 0, 255)  
hsv = cv2.merge([h, s, v])  
return cv2.cvtColor(hsv.astype("uint8"), cv2.COLOR_HSV2RGB)  
  
# --- Saturation Adjustment ---  
  
def adjust_saturation(img, factor=1.5):  
    hsv = cv2.cvtColor(img, cv2.COLOR_RGB2HSV).astype("float32")  
    h, s, v = cv2.split(hsv)  
    s = s * factor  
    s = np.clip(s, 0, 255)  
    hsv = cv2.merge([h, s, v])  
    return cv2.cvtColor(hsv.astype("uint8"), cv2.COLOR_HSV2RGB)  
  
# --- Hue Adjustment ---  
  
def adjust_hue(img, shift=30): # shift hue by 30 degrees  
    hsv = cv2.cvtColor(img, cv2.COLOR_RGB2HSV)  
    h, s, v = cv2.split(hsv)  
    h = (h.astype(int) + shift) % 180 # Hue range is [0,179]  
    hsv = cv2.merge([h.astype("uint8"), s, v])  
    return cv2.cvtColor(hsv, cv2.COLOR_HSV2RGB)  
  
# Apply transformations  
bright_img = adjust_brightness(image, 1.5)  
saturated_img = adjust_saturation(image, 1.8)  
hue_img = adjust_hue(image, 40)
```

```
# Show Results  
  
titles = ["Original", "Brightness", "Saturation", "Hue"]  
  
images = [image, bright_img, saturated_img, hue_img]  
  
  
plt.figure(figsize=(12,6))  
  
for i in range(4):  
  
    plt.subplot(1,4,i+1)  
  
    plt.imshow(images[i])  
  
    plt.title(titles[i])  
  
    plt.axis("off")  
  
plt.show()
```

```
[163, 124, 0]], dtype=uint8)
```

```
In [28]: # Plotting numpy arrays as images  
imgplot = plt.imshow(img)
```



APPLYING PSEUDO CODE:

```
import cv2

import matplotlib.pyplot as plt


# Load image in grayscale
gray_img = cv2.imread("sample.jpg", cv2.IMREAD_GRAYSCALE)

# Apply pseudocolor maps
color1 = cv2.applyColorMap(gray_img, cv2.COLORMAP_JET)      # Jet colormap (rainbow style)
color2 = cv2.applyColorMap(gray_img, cv2.COLORMAP_HOT)      # Hot colormap
color3 = cv2.applyColorMap(gray_img, cv2.COLORMAP_OCEAN)    # Ocean colormap

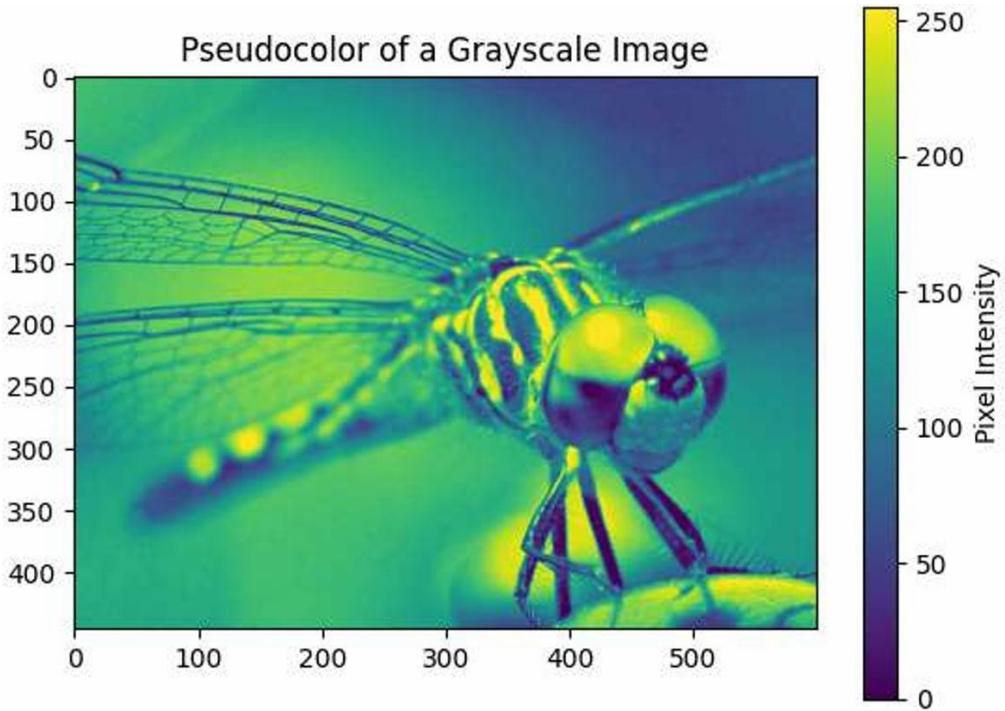
# Convert BGR (OpenCV default) to RGB for matplotlib
color1 = cv2.cvtColor(color1, cv2.COLOR_BGR2RGB)
color2 = cv2.cvtColor(color2, cv2.COLOR_BGR2RGB)
color3 = cv2.cvtColor(color3, cv2.COLOR_BGR2RGB)

# Display results
titles = ["Grayscale", "Pseudocolor: JET", "Pseudocolor: HOT", "Pseudocolor: OCEAN"]
images = [gray_img, color1, color2, color3]

plt.figure(figsize=(12,6))

for i in range(4):
    plt.subplot(1,4,i+1)
    if i==0:
        plt.imshow(images[i], cmap="gray")
    else:
```

```
plt.imshow(images[i])  
plt.title(titles[i])  
plt.axis("off")  
plt.show()
```



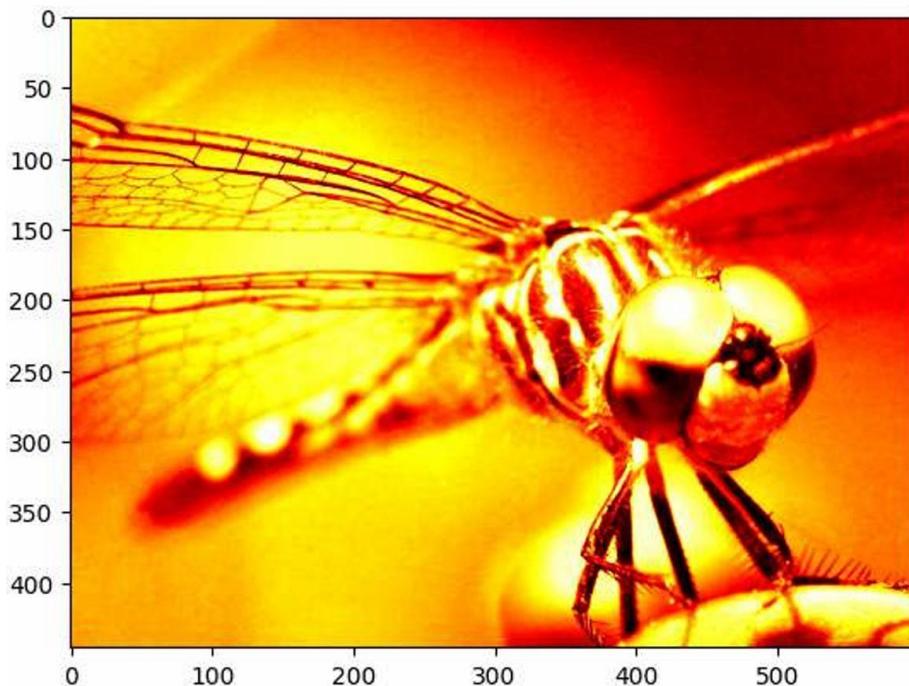
Explanation:

The original image (img) is a 3D NumPy matrix → [height, width, 3/4] (RGB).

```
# luminosity (2D, no color) image, the default is called viridis. There are plenty of others (ex:  
hot)
```

```
plt.imshow(lum_img, cmap="hot")
```

Out[66]



```
import cv2
import matplotlib.pyplot as plt

# Load grayscale image
gray_img = cv2.imread("sample.jpg", cv2.IMREAD_GRAYSCALE)

# List of all colormaps
colormaps = [
    cv2.COLORMAP_AUTUMN, cv2.COLORMAP_BONE, cv2.COLORMAP_JET,
    cv2.COLORMAP_WINTER, cv2.COLORMAP_RAINBOW, cv2.COLORMAP_OCEAN,
    cv2.COLORMAP_SUMMER, cv2.COLORMAP_SPRING, cv2.COLORMAP_COOL,
    cv2.COLORMAP_HSV, cv2.COLORMAP_PINK, cv2.COLORMAP_HOT,
    cv2.COLORMAP_PARULA, cv2.COLORMAP_MAGMA, cv2.COLORMAP_INFERNO,
    cv2.COLORMAP_PLASMA, cv2.COLORMAP_VIRIDIS, cv2.COLORMAP_CIVIDIS,
```

```
cv2.COLORMAP_TWILIGHT, cv2.COLORMAP_TWILIGHT_SHIFTED,
cv2.COLORMAP_TURBO, cv2.COLORMAP_DEEPGREEN

]

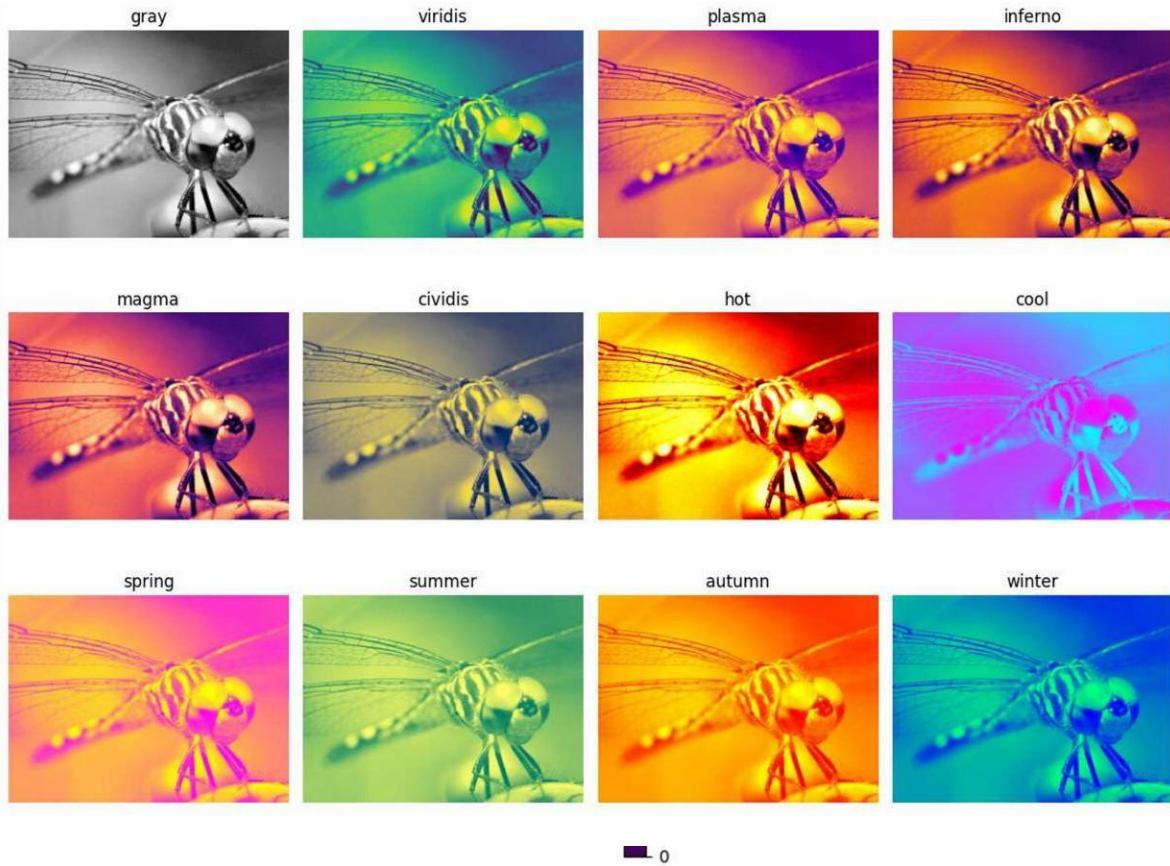
names = [
    "AUTUMN", "BONE", "JET", "WINTER", "RAINBOW", "OCEAN", "SUMMER",
    "SPRING", "COOL", "HSV", "PINK", "HOT", "PARULA", "MAGMA",
    "INFERNO", "PLASMA", "VIRIDIS", "CIVIDIS", "TWILIGHT",
    "TWILIGHT_SHIFTED", "TURBO", "DEEPGREEN"
]

plt.figure(figsize=(15,12))

for i, (cmap, name) in enumerate(zip(colormaps, names)):
    color_img = cv2.applyColorMap(gray_img, cmap)
    color_img = cv2.cvtColor(color_img, cv2.COLOR_BGR2RGB)

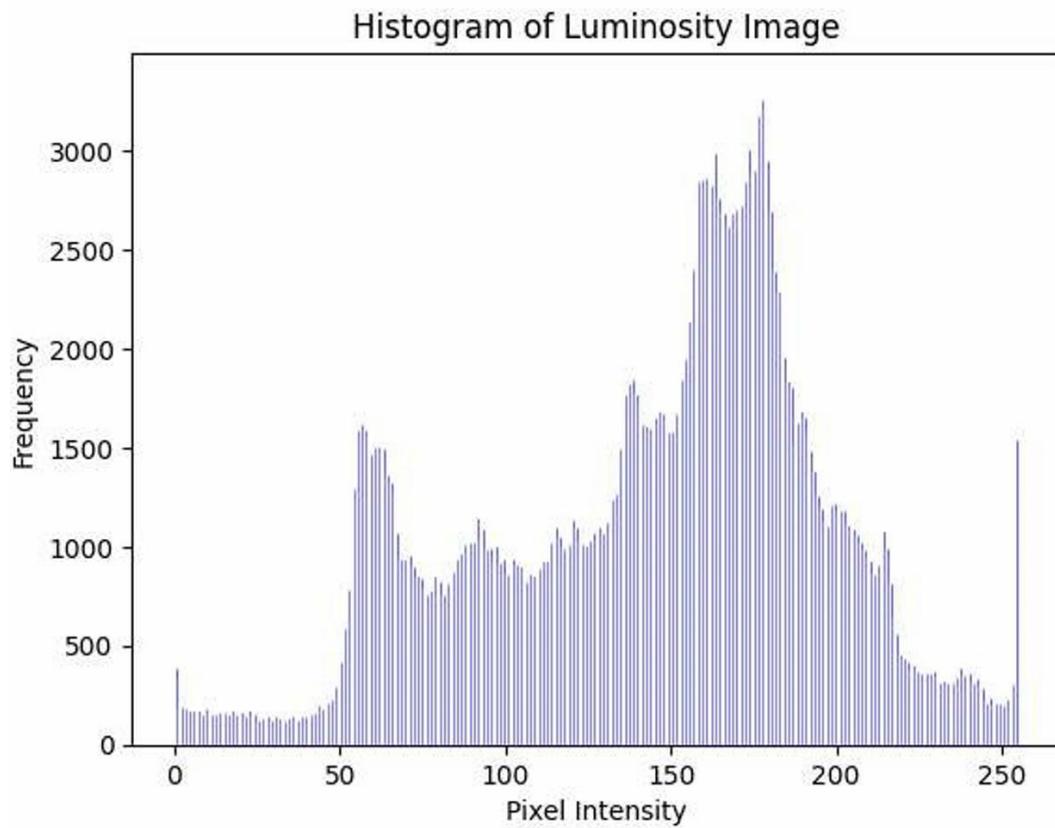
    plt.subplot(5,5,i+1)
    plt.imshow(color_img)
    plt.title(name)
    plt.axis("off")

plt.tight_layout()
plt.show()
```



— 0

```
In [87]: # Examining a specific data range
plt.hist(lum_img.ravel(), bins=range(256), fc='blue', ec='white') # bins Set the bins from 0 to 255 (the full range
# fc Set the face color (fc) of the histogram bars to bl
# ec Set the edge color (ec) of the histogram bars to wh
plt.title("Histogram of Luminosity Image")
plt.xlabel("Pixel Intensity")
plt.ylabel("Frequency")
plt.show()
```



TASK - 3: Finding the inverse of image (In Matrix of pixel values) and finding the negative image (inverted image)

```
In [119... # Load the image
      img = Image.open("dragonfly.png")
      img = img.convert("RGB")
      img_array = np.array(img)           # load image
                                         # ensure 3 channels
                                         # convert to NumPy array
```

```
In [128... print("Original Image array: ",img_array)
```

```
Original Image array: [[[177 148 144]
 [179 150 146]
 [181 152 148]
 ...
 [ 66  81  78]
 [ 64  80  77]
 [ 63  79  76]]]

[[[179 150 146]
 [180 151 147]
 [182 153 149]
 ...
 [ 65  80  77]
 [ 63  79  76]
 [ 62  78  75]]]

[[[180 152 148]
 [180 152 148]
 [181 153 149]
 ...
 [ 65  80  77]
 [ 63  79  76]
 [ 62  78  75]]]

...
[[[150 155  97]
 [150 155  97]
 [150 155  97]
 ...
 [174 137    7]
 [177 140    7]
 [180 144    8]]]

[[[150 155  97]
 [150 155  97]
 [150 155  97]
 ...
 [170 133    3]
 [171 132    1]
 [172 134    1]]]
```

```

[[ 76 131 255]
 [ 92 131 255]]]

In [125... # Display original and negative side by side
fig, axs = plt.subplots(1, 2, figsize=(10, 5))

axs[0].imshow(img_array)
axs[0].set_title("Original Image")
axs[0].axis("off")

axs[1].imshow(negative_img_array)
axs[1].set_title("Negative (Inverted) Image")
axs[1].axis("off")

plt.show()

```

Original Image



Negative (Inverted) Image



TASK - 4: Plotting numerical data, categorical data, text data (Word cloud), ordinal data, audio data and image data

```

In [169... import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns

# Load Housing dataset
data = pd.read_csv("Housing.csv")

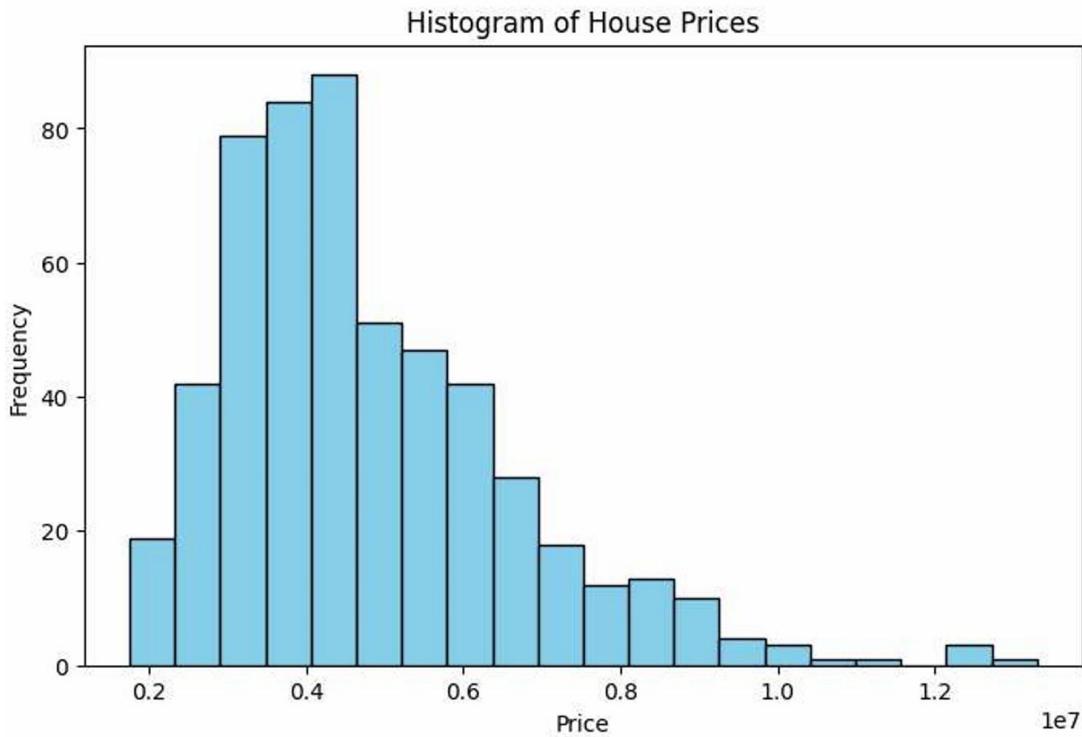
```

1. Numerical Data (price)

```

In [192... plt.figure(figsize=(8,5))
plt.hist(data['price'], bins=20, color='skyblue', edgecolor='black')
plt.title("Histogram of House Prices") # frequency of prices
plt.xlabel("Price")
plt.ylabel("Frequency")
plt.show()

```



LAB ACTIVITY 16

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REG NO : 22MID0136; COURSE CODE: CSI3007; LAB : L7+L8;

DATE : 30/09/2025

**MultIndex creation, indexing, slicing, swapping, alignment,
and advanced operations in Pandas.**

1. Creating a Series using pandas

```
In [7]: ## TASK-1
import pandas as pd    # Importing the pandas library and giving it the alias 'pd'

# Initializing a Series from a list
data = [10, 3.5, 'b', 7, 8]    # A mixed list with integer, float, string, and integer values
series_from_list = pd.Series(data) # Creating a Pandas Series from the list
print(series_from_list) # Printing the Series to see its index and values

0      10
1      3.5
2        b
3        7
4        8
dtype: object
```

2. Creating a DataFrame using a dictionary

```
In [9]: ## TASK-2
import pandas as pd    # Import pandas library for data manipulation

# Creating a DataFrame using a dictionary

data = {
    'Name': ['Kamesh', 'Sonali', 'Vedhika', 'Rithika'], # Column 'Name' with string values
    'Age': [26, 21, 23, 27],                            # Column 'Age' with integer values
    'Score': [88, 91, 80, 95]                          # Column 'Score' with integer values
}

df = pd.DataFrame(data)    # Converting dictionary into a DataFrame
print(df)                 # Printing the DataFrame to display rows and columns

      Name  Age  Score
0   Kamesh   26     88
1   Sonali   21     91
2  Vedhika   23     80
3  Rithika   27     95

]: ## TASK-3
import pandas as pd    # Import pandas library

# Creating first Series with custom indices
s1 = pd.Series([10, 20, 30], index=["x", "y", "z"])

# Creating second Series with overlapping and non-overlapping indices
s2 = pd.Series([40, 50, 60], index=["y", "z", "w"])

# Multiplying the two Series
print(s1 * s2)

w      NaN
x      NaN
y    800.0
z   1500.0
dtype: float64

]: ## TASK-4
import pandas as pd    # Import pandas library

# Creating first Series with default index [0, 1, 2]
series_a = pd.Series([10, 20, 30])

# Creating second Series with default index [0, 1, 2]
series_b = pd.Series([40, 50, 60])
```

```
# Adding the two Series element-wise (index-wise)
sum_series = series_a + series_b
```

```
# Printing the resulting Series
print(sum_series)
```

```
0    50
1    70
2    90
dtype: int64
```

3. Creating a MultiIndex Series in Different Ways

```
: ## TASK-5
```

```
import pandas as pd    # Import pandas library
```

```
# Defining two arrays that will act as hierarchical index levels
arrays = [
```

```
    ['X', 'X', 'Y', 'Y'],           # First level of index
    ['History', 'Geography', 'History', 'Geography'] # Second level of index
]
```

```
# Creating a MultiIndex object from the arrays with custom names
index = pd.MultiIndex.from_arrays(arrays, names=('Letter', 'Subject'))
```

```
# Creating a Series with the MultiIndex
```

```
multi_s = pd.Series([75, 82, 89, 95], index=index)
```

```
# Printing the MultiIndex Series
```

```
print(multi_s)
```

```
Letter  Subject
X      History    75
        Geography   82
Y      History    89
        Geography   95
dtype: int64
```

```
: ## TASK-6
```

```
import pandas as pd    # Import pandas library
```

```

# Defining list of tuples, each tuple represents one index pair
tuples = [
    ('C', 'History'),
    ('C', 'Geography'),
    ('D', 'History'),
    ('D', 'Geography')
]

# Creating MultiIndex from tuples with level names
index = pd.MultiIndex.from_tuples(tuples, names=('Letter', 'Subject'))

# Creating a Series with values mapped to the MultiIndex
multi_s = pd.Series([76, 82, 89, 94], index=index)

# Printing the MultiIndex Series
print(multi_s)

```

Letter	Subject	
C	History	76
	Geography	82
D	History	89
	Geography	94

dtype: int64

```

## TASK-7
# Creating MultiIndex from the Cartesian product of two lists
index = pd.MultiIndex.from_product(
    [['C', 'D'], ['History', 'Geography']],   # First list × Second list
    names=('Letter', 'Subject')                 # Naming index levels
)

# Creating a Series with values mapped to the MultiIndex
multi_s = pd.Series([70, 75, 88, 93], index=index)

# Printing the MultiIndex Series
print(multi_s)

```

```
Letter  Subject
C      History     70
       Geography   75
D      History     88
       Geography   93
dtype: int64
```

```
36... ## TASK-8
import numpy as np

# From product (Cartesian product of iterables)
iterables = [[ "C", "D"], [ "History", "Geography"]]
index = pd.MultiIndex.from_product(iterables, names=( "Letter", "Subject"))
multi_s = pd.Series(np.random.randint(60, 100, size=4), index=index) # Creating a Series with MultiIndex
print("MultiIndex Series from product:\n", multi_s3, "\n")
```

```
MultiIndex Series from product:
Letter  Subject
C      History     82
       Geography   99
D      History     98
       Geography   98
dtype: int32
```

```
38... ## TASK-9
# Creating a DataFrame that will be used to generate MultiIndex
df = pd.DataFrame({
    'Letter': [ 'C', 'C', 'D', 'D'], # First column for first-level index
    'Subject': [ 'History', 'Geography', 'History', 'Geography'] # Second column for second-level index
})

# Creating MultiIndex from the DataFrame
index = pd.MultiIndex.from_frame(df, names=( "Letter", "Subject"))

# Creating a Series with MultiIndex
multi_s = pd.Series([72, 81, 89, 96], index=index)

# Printing the MultiIndex Series
print(multi_s)
```

```
Letter  Subject
C      History    72
       Geography   81
D      History    89
       Geography   96
dtype: int64
```

4. Accessing and Indexing

```
.40... ## TASK-10
print("Access all subjects for 'C':\n", multi_s.loc["C"], "\n")
print("Access specific element (D, Geography):\n", multi_s.loc[("D", "Geography")], "\n")

Access all subjects for 'C':
Subject
History    72
Geography   81
dtype: int64

Access specific element (D, Geography):
96
```

5. Slicing in MultiIndex

```
.42... ## TASK-11
print("Slicing from C to D:\n", multi_s.loc["C":"D"], "\n")
print("Partial slice for all History:\n", multi_s.loc[:, "History"], "\n")
```

```

Slicing from C to D:
   Letter  Subject
C      History     72
          Geography  81
D      History     89
          Geography  96
dtype: int64

Partial slice for all History:
   Letter
C      72
D      89
dtype: int64

```

6. Swapping and Reordering Levels

```

134... ## TASK-12
print("Swapping levels:\n", multi_s.swaplevel(), "\n")
print("Reordering levels:\n", multi_s.reorder_levels(["Subject", "Let

```

Swapping levels:

Subject	Letter	
History	C	72
Geography	C	81
History	D	89
Geography	D	96

dtype: int64

Reordering levels:

Subject	Letter	
History	C	72
Geography	C	81
History	D	89
Geography	D	96

dtype: int64

7. Passing List of Arrays directly to Series / DataFrame

LAB ACTIVITY 17

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DATE : 03/10/2025

Essential Data Analysis Techniques in Python: DataFrames, indexing, grouping, merging, and pivot tables in Pandas.

1.Creating DataFrames (different ways)

```
import pandas as pd
```

```
# Create a DataFrame from dictionary
```

```
data = {  
    "Name": ["Alice", "Bob", "Charlie", "David"],  
    "Age": [24, 27, 22, 32],  
    "Department": ["HR", "IT", "Finance", "IT"],  
    "Salary": [45000, 54000, 50000, 60000]  
}  
  
df = pd.DataFrame(data)  
  
print(df)
```

Original DataFrame				
	Name	Age	Department	Salary
0	Alice	24	HR	45000
1	Bob	27	IT	54000
2	Charlie	22	Finance	50000
3	David	32	IT	60000

```
Mean salary by department (Series):  
Finance    70000.0  
IT          72500.0  
dtype: float64
```

```
[82]: # Grouping by department (no aggregation yet)  
  
# groupby returns a GroupBy object; actual aggregation not performed yet  
grouped_series = salary.groupby(department)  
print("Grouped Series (just groups, no aggregation):\n", grouped_series, "\n")  
  
Grouped Series (just groups, no aggregation):  
<pandas.core.groupby.generic.SeriesGroupBy object at 0x000001E2BB3B6270>
```

```
[84]: # Accessing a specific group  
  
# get_group retrieves all entries belonging to a specific group  
print("Finance group in Series:\n", grouped_series.get_group("Finance"), "\n")  
  
Finance group in Series:  
Sonali    72000  
Mahi      68000  
dtype: int64
```

```
[86]: #Aggregation Example  
  
# Aggregation on grouped Series  
# Compute mean salary per department  
aggregated_series = grouped_series.mean()  
print("Aggregated Series (mean salary per department):\n", aggregated_series, "\n")  
  
# Other aggregations  
print("Sum per department:\n", grouped_series.sum(), "\n")  
print("Max per department:\n", grouped_series.max(), "\n")
```

10. Generating Summary Tables

Summary table

- df.pivot_table(values='NumericColumn', index='RowCategory', columns='ColumnCategory', aggfunc='mean') values → numeric column to summarize
- index → row labels
- columns → column labels (optional)
- aggfunc → aggregation function (mean, sum, count, etc.)

```
]: ## TASK-18  
# Import pandas library  
import pandas as pd  
  
# Create a sample DataFrame with Department, Team, and Salary  
  
df = pd.DataFrame({  
    "Department": ["Finance", "Finance", "IT", "IT"],    # Two departments
```

```

    "Team": ["A", "B", "A", "B"],           # Two teams within each department
    "Salary": [70000, 72000, 65000, 67000]   # Salary values for each team
})

# Create a pivot table to summarize salaries
# values="Salary" → we are summarizing the Salary column
# index="Department" → Departments become row index
# columns="Team"      → Teams become column headers
# aggfunc="mean"       → average salary is calculated per group

summary = df.pivot_table(values="Salary", index="Department", columns="Team", aggfunc="mean")
# Print the summary table
print("Pivot Table Summary:\n", summary)

```

```

Pivot Table Summary:
Team          A      B
Department
Finance     70000.0 72000.0
IT          65000.0 67000.0

```

```

: ## TASK-19

# Import pandas library
import pandas as pd

# Create a DataFrame with Department, Team, and Salary
df = pd.DataFrame({
    "Department": ["Finance", "Finance", "IT", "IT", "Finance", "IT"], # Departments
    "Team": ["X", "Y", "X", "Y", "X", "Y"],                            # Teams inside each department
    "Salary": [70000, 72000, 65000, 67000, 71000, 68000]            # Salary values
})

# Create a pivot table to summarize the average Salary
# values="Salary" → we want to summarize the Salary column
# index="Department" → rows will be Departments
# columns="Team"      → columns will be Teams (X, Y)
# aggfunc="mean"       → average salary is calculated if multiple entries exist

summary_table = df.pivot_table(values="Salary", index="Department", columns="Team", aggfunc="mean")
# Print the summary pivot table
print("Summary Table (Average Salary):\n", summary_table)

```

```
Summary Table (Average Salary):
```

Team	X	Y
Department		
Finance	70500.0	72000.0
IT	65000.0	67500.0

```
]: ## TASK-20
# Pivot Table with Multiple Aggregation Functions

# applying more than one aggregation function at once using a list:
summary_table_multi = df.pivot_table(
    values="Salary",
    index="Department",
    columns="Team",
    aggfunc=["mean", "sum", "max"]
)
print("Pivot Table with Multiple Aggregations:\n", summary_table_multi)
```

```
Pivot Table with Multiple Aggregations:
```

Team	mean		sum		max	
	X	Y	X	Y	X	Y
Department						
Finance	70500.0	72000.0	141000	72000	71000	72000
IT	65000.0	67500.0	65000	135000	65000	68000

```
]: ## TASK-21

# Handling Missing Data
# Pivot tables automatically fill missing combinations with NaN.

# Replace missing values with fill_value
summary_table_fill = df.pivot_table(
    values="Salary",
    index="Department",
    columns="Team",
    aggfunc="mean",
    fill_value=0
)
print("Pivot Table with Missing Values Filled:\n", summary_table_fill)
```

Pivot Table with Missing Values Filled:

Team	X	Y
Department		
Finance	70500.0	72000.0
IT	65000.0	67500.0

```
]: ## TASK-22
```

```
# Grouping vs Pivot Tables
# Pivot tables are essentially groupby + aggregation + reshape in one step.
# They are easier to read when summarizing across two categorical variables.
```

```
# Equivalent using groupby
```

```
grouped = df.groupby(["Department", "Team"])["Salary"].mean().unstack()
print("Equivalent using groupby + unstack:\n", grouped)
```

Equivalent using groupby + unstack:

Team	X	Y
Department		
Finance	70500.0	72000.0
IT	65000.0	67500.0

```
]:
```