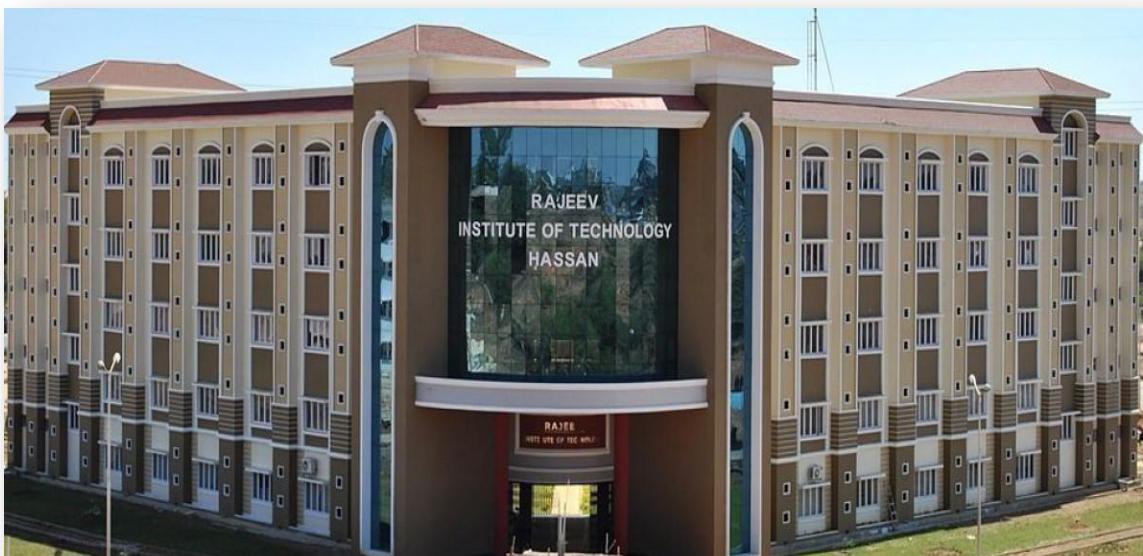


**RAJEEV INSTITUTE OF TECHNOLOGY
HASSAN-573201**



DATASTRUCTURES LABORATORY

(BCSL606)

As per VTU Syllabus/scheme for 6th Semester



**DEPARTMENT OF
COMPUTER SCIENCE & ENGINEERING**



VISION & MISSION OF THE INSTITUTE

VISION:

- ❖ To be an academic institution in vibrant social & economic environment, striving continuously for excellence in education, research and technological service to the society.

MISSION:

- ❖ To achieve academic excellence in engineering and management through dedication to duty, offering state of the art education and faith in human values.
- ❖ To create and endure a community of learning among students, develop outstanding professionals with high ethical standards.
- ❖ To provide academic ambience conducive to the development, needs and growth of society and the industry.

VISION & MISSION OF THE DEPARTMENT

VISION:

- ❖ To become an exemplary center for engineering education and research in the frontier areas of Computer Science and Engineering.

MISSION:

- ❖ Render quality education through best teaching learning process and modern educational tools to enable students for good careers.
- ❖ Impart essential skills to make students industry ready and future professional with social concern.
- ❖ Provide facilities and expertise in recent computer technology to promote research and innovations.



PROGRAM SPECIFIC OUTCOMES (PSO'S)

The graduates of Computer Science & engineering program of Rajeev Institute of Technology should be able to attain the following at the time of graduation.

PSO1: To apply software engineering principles and practices to design, develop and implement software solutions.

PSO2: To use recent software tools to solve and analyze a given problem.

PROGRAM EDUCATIONAL OBJECTIVES (PEO'S)

The program educational objectives are the statements that describe the expected achievements of graduates within first few years of their graduation from the program. The program educational objectives of Bachelor of Computer Science & Engineering at Rajeev Institute of Technology can be broadly defined as,

PEO1: Graduates will become software developers in diverse domains and/or pursue higher studies.

PEO2: Graduates will possess an agility to adapt to challenges in their profession.

PEO3: Graduates exhibit leadership qualities and will be a team player.

PEO4: Graduates will be able to communicate effectively and cultivate ethics.



PROGRAM OUTCOMES

Graduation students of Bachelor of Computer Science and Engineering program at Rajeev Institute of Technology will . attain the following program outcomes in the field of Computer Science and Engineering.

PO1-Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2-Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3-Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4-Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5-Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling to complex engineering activities, with an understanding of the limitations.

PO6-The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7-Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8-Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9-Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.



RAJEEV INSTITUTE OF TECHNOLOGY

HASSAN-573021, KARNATAKA

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING



PO10-Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11-Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environment.

PO12-Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.



DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

COURSE MODULES OF THE SUBJECT TAUGHT FOR THE SESSION AY:2024-25

Course Syllabus with CO's



Program 6: Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs

Program 7: Develop a program to demonstrate the working of Linear Regression and Polynomial Regression. Use Boston Housing Dataset for Linear Regression and Auto MPG Dataset (for vehicle fuel efficiency prediction) for Polynomial Regression.

Program 8: Develop a program to demonstrate the working of the decision tree algorithm. Use Breast Cancer Data set for building the decision tree and apply this knowledge to classify a new sample.

Program 9: Develop a program to implement the Naive Bayesian classifier considering Olivetti Face Data set for training. Compute the accuracy of the classifier, considering a few test data sets.

Program 10: Develop a program to implement k-means clustering using Wisconsin Breast Cancer data set and visualize the clustering result.

List of URLs, Text Books, Notes, Multimedia Content

Suggested Learning Resources:

1. S Sridhar and M Vijayalakshmi, "Machine Learning", Oxford University Press, 2021.
2. M N Murty and Ananthanarayana V S, "Machine Learning: Theory and Practice", Universities Press (India) Pvt. Limited, 2024.

Web links and Video Lectures (e-Resources):

- https://www.drssridhar.com/?page_id=1053
- <https://www.universitiespress.com/resources?id=9789393330697>
- https://onlinecourses.nptel.ac.in/noc23_cs18/preview

| | |
|------------------------|--|
| Course Outcomes | At the end of the course, the student will be able to: CO 1. Illustrate the principles of multivariate data and apply dimensionality reduction techniques. CO 2. Demonstrate similarity-based learning methods and perform regression analysis. CO 3. Develop decision trees for classification and regression problems, and Bayesian models for probabilistic learning. CO 4. Implement the clustering algorithms to share computing resources. |
| | |
| | |
| | |
| | |

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum



total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are 50 Marks.

The split-up of CIE marks for record/ journal and test are in the ratio 60:40.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to 20 marks (40% of the maximum marks). The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. OR based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours



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The Correlation of Course Outcomes (CO's) and Program Outcomes (PO's)

| | | | | | | | | | | | | |
|---|-------------------------|------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|--------------|
| Subject Code: BCSL606 | | | | | | | | | | | | |
| List of Course Outcomes | Program Outcomes | | | | | | | | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 |
| CO-1 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 2 |
| CO-2 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - |
| CO-3 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - |
| CO-4 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - |
| Average | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - |

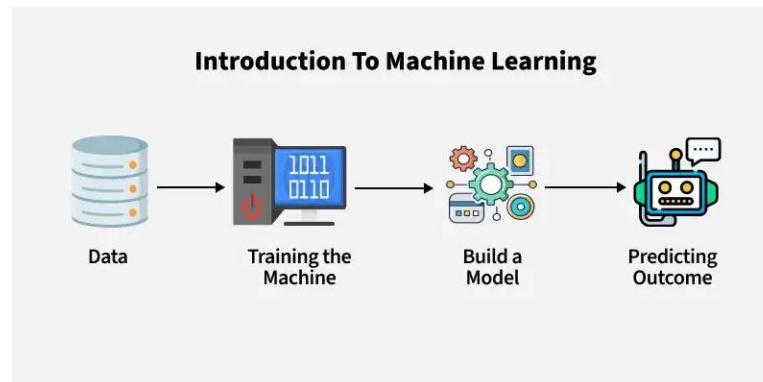
Note: 3 = Strong Contribution 2 = Average Contribution 1 = Weak Contribution 0 = No Contribution

The Correlation of Course Outcomes (CO's) and Program Specific Outcomes (PSO's)

| | | |
|---|-------------|-------------|
| Subject Code: BCSL606 | | |
| List of Course Outcomes | PSO1 | PSO2 |
| CO-1 | 2 | 2 |
| CO-2 | 2 | 2 |
| CO-3 | 2 | 2 |
| CO-4 | 2 | 2 |
| Average | 2 | 2 |

Introduction to Machine Learning

Machine learning (ML) allows computers to learn and make decisions without being explicitly programmed. It involves feeding data into algorithms to identify patterns and make predictions on new data. Machine learning is used in various applications, including image and speech recognition, natural language processing, and recommender systems.



Why do we need Machine Learning?

Machine Learning algorithm learns from data, train on patterns, and solve or predict complex problems beyond the scope of traditional programming. It drives better decision-making and tackles intricate challenges efficiently.

1. Solving Complex Business Problems

Traditional programming struggles with tasks like image recognition, natural language processing (NLP), and medical diagnosis. ML, however, thrives by learning from examples and making predictions without relying on predefined rules.

Example Applications:

- Image and speech recognition in healthcare.
- Language translation and sentiment analysis.

2. Handling Large Volumes of Data

With the internet's growth, the data generated daily is immense. ML effectively processes and analyzes this data, extracting valuable insights and enabling real-time predictions.

Use Cases:

- Fraud detection in financial transactions.
- Social media platforms like Facebook and Instagram predicting personalized feed recommendations from billions of interactions.

3. Automate Repetitive Tasks

ML automates time-intensive and repetitive tasks with precision, reducing manual effort and error-prone systems.

Examples:

- **Email Filtering:** Gmail uses ML to keep your inbox spam-free.
- **Chatbots:** ML-powered chatbots resolve common issues like order tracking and password resets.
- **Data Processing:** Automating large-scale invoice analysis for key insights.

4. Personalized User Experience

ML enhances user experience by tailoring recommendations to individual preferences. Its algorithms analyze user behavior to deliver highly relevant content.

Real-World Applications:

- **Netflix:** Suggests movies and TV shows based on viewing history.
- **E-Commerce:** Recommends products you're likely to purchase.

5. Self-Improvement in Performance

ML models evolve and improve with more data, making them smarter over time. They adapt to user behavior and refine their performance.

Examples:

- **Voice Assistants** (e.g., Siri, Alexa): Learn user preferences, improve voice recognition, and handle diverse accents.
- **Search Engines:** Refine ranking algorithms based on user interactions.
- **Self-Driving Cars:** Enhance decision-making using millions of miles of data from simulations and real-world driving.

What Makes a Machine “Learn”?

A machine “learns” by recognizing patterns and improving its performance on a task based on data, without being explicitly programmed.

The process involves:

1. **Data Input:** Machines require data (e.g., text, images, numbers) to analyze.
2. **Algorithms:** Algorithms process the data, finding patterns or relationships.
3. **Model Training:** Machines learn by adjusting their parameters based on the input data using mathematical models.
4. **Feedback Loop:** The machine compares predictions to actual outcomes and corrects errors (via optimization methods like gradient descent).

5. **Experience and Iteration:** Repeating this process with more data improves the machine's accuracy over time.
6. **Evaluation and Generalization:** The model is tested on unseen data to ensure it performs well on real-world tasks.

In essence, machines “learn” by continuously refining their understanding through data-driven iterations, much like humans learn from experience.

Importance of Data in Machine Learning

Data is the foundation of machine learning (ML). Without quality data, ML models cannot learn, perform, or make accurate predictions.

- Data provides the examples from which models learn patterns and relationships.
- High-quality and diverse data improves model accuracy and generalization.
- Data ensures models understand real-world scenarios and adapt to practical applications.
- Features derived from data are critical for training models.
- Separate datasets for validation and testing assess how well the model performs on unseen data.
- Data fuels iterative improvements in ML models through feedback loops.

Types of Machine Learning

1. Supervised learning

Supervised learning is a type of machine learning where a model is trained on labeled data—meaning each input is paired with the correct output. The model learns by comparing its predictions with the actual answers provided in the training data.

Both classification and regression problems are supervised learning problems.

Example: Consider the following data regarding patients entering a clinic. The data consists of the gender and age of the patients and each patient is labeled as “healthy” or “sick”

| Gender | Age | Label |
|--------|-----|-------|
| M | 48 | sick |
| M | 67 | sick |

| Gender | Age | Label |
|--------|-----|---------|
| F | 53 | healthy |
| M | 49 | sick |
| F | 32 | healthy |
| M | 34 | healthy |
| M | 21 | healthy |

In this example, supervised learning is to use this labeled data to train a model that can predict the label (“healthy” or “sick”) for new patients based on their gender and age. For instance, if a new patient (e.g., Male, 50 years old) visits the clinic, the model can classify whether the patient is “healthy” or “sick” based on the patterns it learned during training.

2. Unsupervised learning:

Unsupervised learning algorithms draw inferences from datasets consisting of input data without labeled responses. In unsupervised learning algorithms, classification or categorization is not included in the observations.

Example: Consider the following data regarding patients entering a clinic. The dataset includes **unlabeled data**, where only the gender and age of the patients are available, with no health status labels.

| Gender | Age |
|--------|-----|
| M | 48 |
| M | 67 |
| F | 53 |
| M | 49 |

| Gender | Age |
|--------|-----|
| F | 34 |
| M | 21 |

Here, unsupervised learning technique will be used to find patterns or groupings in the data such as clustering patients by age or gender. For example, the algorithm might group patients into clusters, such as “younger healthy patients” or “older patients,” without prior knowledge of their health status.

3. Reinforcement Learning

Reinforcement Learning (RL) trains an agent to act in an environment by maximizing rewards through trial and error. Unlike other machine learning types, RL doesn’t provide explicit instructions.

Instead, the agent learns by:

- **Exploring Actions:** Trying different actions.
- **Receiving Feedback:** Rewards for correct actions, punishments for incorrect ones.
- **Improving Performance:** Refining strategies over time.

Example: Identifying a Fruit

The system receives an input (e.g., an apple) and initially makes an incorrect prediction (“It’s a mango”). Feedback is provided to correct the error (“Wrong! It’s an apple”), and the system updates its model based on this feedback.

Over time, it learns to respond correctly (“It’s an apple”) when encountering similar inputs, improving accuracy through trial, error, and feedback.

Benefits of Machine Learning

- **Enhanced Efficiency and Automation:** ML automates repetitive tasks, freeing up human resources for more complex work. It also streamlines processes, leading to increased efficiency and productivity.
- **Data-Driven Insights:** ML can analyze vast amounts of data to identify patterns and trends that humans might miss. This allows for better decision-making based on real-world data.
- **Improved Personalization:** ML personalizes user experiences across various platforms. From recommendation systems to targeted advertising, ML tailors content and services to individual preferences.
- **Advanced Automation and Robotics:** ML empowers robots and machines to perform complex tasks with greater accuracy and adaptability. This is revolutionizing fields like manufacturing and logistics

Introduction to data Visualization

Data visualization is the graphical representation of data to help people understand the patterns, trends, and insights within the information. It involves using visual elements such as charts, graphs, and maps to convey complex data in an accessible and understandable manner. The primary goal of data visualization is to make data more interpretable, allowing users to extract meaningful information efficiently.

Key Concepts in Data Visualization:

Data Representation: Data visualization involves transforming raw data into visual forms, making it easier to grasp patterns, correlations, and outliers.

Visual Elements: Common visual elements include points, lines, bars, shapes, colors, and labels. Each element is chosen to effectively represent different types of data and relationships.

Types of Visualizations: Different types of visualizations are suitable for different types of data. Common types include:

Line Charts: Show trends and patterns over time.

Bar Charts: Compare values across categories.

Scatter Plots: Display relationships between two variables.

Pie Charts: Represent parts of a whole.

Interactivity: Interactive visualizations allow users to explore and interact with data dynamically. This can enhance the depth of understanding and enable users to focus on specific aspects.

Storytelling: Effective data visualization often tells a story. It guides viewers through a narrative, helping them uncover insights and draw conclusions.

Color and Design: Color choices and design elements play a crucial role. They should enhance understanding, avoid confusion, and highlight important information.

Data Preparation: Before creating visualizations, it's important to clean and prepare the data. This includes handling missing values, outliers, and ensuring that the data is in a suitable format for visualization.

Importance of Data Visualization:

- **Clarity and Understanding:** Visualizations simplify complex data, making it easier for both experts and non-experts to understand the information.

- **Identification of Patterns:** Visualizations reveal patterns and trends in data that may not be apparent in raw datasets.
- **Communication:** Effective visualizations facilitate communication of findings, insights, and trends to a broader audience.
- **Decision-Making:** Visualizations aid decision-making processes by providing a clear and concise representation of relevant information.
- **Exploration and Analysis:** Interactive visualizations allow users to explore data from different perspectives, enabling deeper analysis and discovery.
- **Memorability:** Well-designed visualizations are more memorable than raw data, helping people retain and recall information.

Tools for Data Visualization:

- **matplotlib:** A versatile 2D plotting library for Python.
- **seaborn:** Built on Matplotlib, Seaborn provides a high-level interface for statistical data visualization.
- **pandas:** Pandas is a powerful Python library used for data manipulation and analysis.
- **numpy:** NumPy (Numerical Python) is a powerful library for numerical computing in Python. It provides efficient handling of large arrays, matrices, and mathematical functions.
- **sklearn:** scikit-Learn (sklearn) is one of the most popular Python libraries for **machine learning**. It provides efficient tools for data preprocessing, model selection, training, and evaluation.

In summary, data visualization is a powerful tool for making data more accessible, understandable, and actionable. It plays a crucial role in the data analysis process, aiding in exploration, communication, and decision-making.

Introduction to Python

Python is a high-level, general-purpose programming language known for its readability, simplicity, and versatility. Developed by Guido van Rossum, Python has become one of the most popular programming languages worldwide. Here's a comprehensive introduction to Python:

Key Features of Python:

- **Readability:** Python emphasizes code readability and uses English-like syntax. This makes it easier for developers to write and maintain code.
- **Versatility:** Python supports multiple programming paradigms, including procedural, object-oriented, and functional programming. It can be used for a wide range of applications, from web development to scientific computing.
- **Large Standard Library:** Python comes with a vast standard library that includes modules and packages for various tasks, making it a powerful and resourceful language.
- **Interpreted and Interactive:** Python is an interpreted language, allowing for quick development and testing. It also supports an interactive mode where code can be executed line by line.
- **Dynamic Typing:** Python uses dynamic typing, meaning you don't need to declare variable types explicitly. This allows for more flexibility and faster development.
- **Community and Documentation:** Python has a large and active community, contributing to its rich ecosystem of libraries and frameworks. Additionally, Python documentation is comprehensive and user-friendly.

Basic Syntax:

Hello, World! program

```
print("Hello, World!")
```

Variables and types

```
x = 10
```

```
y = 3.14
```

```
name = "Python"
```

Lists

```
my_list = [1, 2, 3, 4, 5]
```

Conditional statements

```
if x > 5:
```

```
    print("x is greater than 5")
```

```
elif x == 5:
```

```
    print("x is equal to 5")
```

```
else:
```

```
    print("x is less than 5") #
```

Loops

```
for i in range(5):
```

```
    print(i)
```

Functions

```
def greet(name):
```

```
    print("Hello, " + name + "!") #
```

Function call

```
greet("Alice")
```

Data Structures:

- **Lists:** Ordered, mutable collections.

```
my_list = [1, 2, 3, 4, 5]
```

- **Tuples:** Ordered, immutable collections.

```
my_tuple = (1, 2, 3)
```

- **Dictionaries:** Unordered key-value pairs.

```
my_dict = { "name": "John", "age":
```

- **Sets:** Unordered, unique elements.

```
my_set = {1, 2, 3, 4, 5}
```

Machine Learning Lab (BCSL606)

1. Develop a program to create histograms for all numerical features and analyze the distribution of each feature. Generate box plots for all numerical features and identify any outliers. Use California Housing dataset.

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.datasets import fetch_california_housing

# Step 1: Load the California Housing dataset
data = fetch_california_housing(as_frame=True)
housing_df = data.frame

# Step 2: Create histograms for numerical features
numerical_features = housing_df.select_dtypes(include=[np.number]).columns

# Plot histograms
plt.figure(figsize=(15, 10))
for i, feature in enumerate(numerical_features):
    plt.subplot(3, 3, i + 1)
    sns.histplot(housing_df[feature], kde=True, bins=30, color='blue')
    plt.title(f'Distribution of {feature}')
plt.tight_layout()
plt.show()

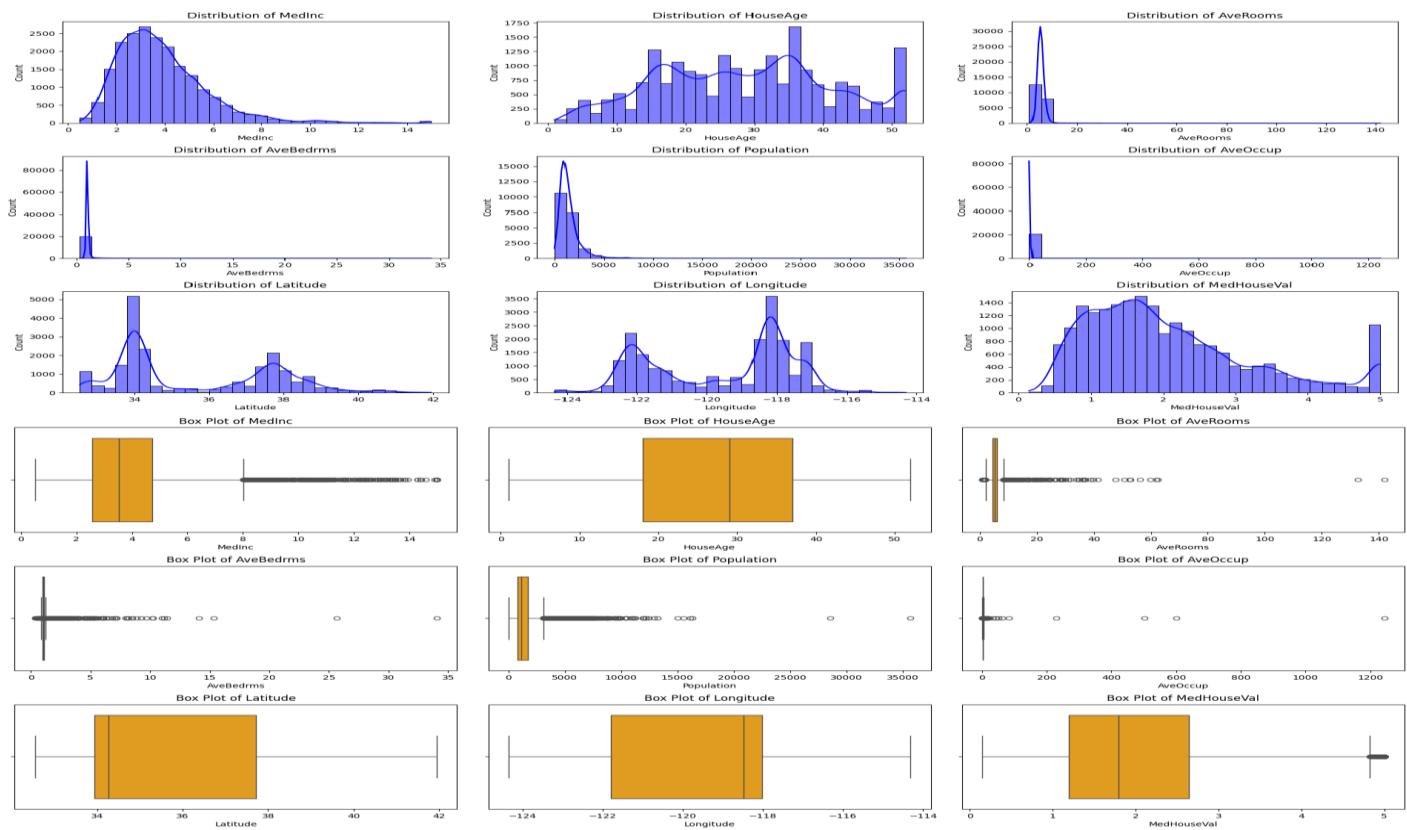
# Step 3: Generate box plots for numerical features
plt.figure(figsize=(15, 10))
for i, feature in enumerate(numerical_features):
    plt.subplot(3, 3, i + 1)
    sns.boxplot(x=housing_df[feature], color='orange')
    plt.title(f'Box Plot of {feature}')
plt.tight_layout()
plt.show()

# Step 4: Identify outliers using the IQR method
print("Outliers Detection:")
outliers_summary = {}
for feature in numerical_features:
    Q1 = housing_df[feature].quantile(0.25)
    Q3 = housing_df[feature].quantile(0.75)
    IQR = Q3 - Q1
    lower_bound = Q1 - 1.5 * IQR
    upper_bound = Q3 + 1.5 * IQR
    outliers = housing_df[(housing_df[feature] < lower_bound) |
                           (housing_df[feature] > upper_bound)]
    outliers_summary[feature] = len(outliers)
    print(f"{feature}: {len(outliers)} outliers")

# Optional: Print a summary of the dataset
print("\nDataset Summary:")
print(housing_df.describe())
```

Explanation:

This script performs exploratory data analysis (EDA) on the California Housing dataset. It first loads the dataset into a pandas DataFrame, then visualizes the distribution of numerical features using histograms and box plots. Histograms help understand how values are spread, while box plots highlight outliers. To further detect outliers, the script uses the Interquartile Range (IQR) method, identifying extreme values that may require attention. Finally, it prints a summary of the dataset, including statistical measures like mean, standard deviation, and quartiles, providing insights into the data's characteristics.

Output:

```

Outliers Detection:
MedInc: 681 outliers
HouseAge: 0 outliers
AveRooms: 511 outliers
AveBedrms: 1424 outliers
Population: 1196 outliers
AveOccup: 711 outliers
Latitude: 0 outliers
Longitude: 0 outliers
MedHouseVal: 1071 outliers

Dataset Summary:
      MedInc    HouseAge    ...    Longitude    MedHouseVal
count  20640.000000  20640.000000  ...  20640.000000  20640.000000
mean   3.870671    28.639486  ...  -119.569704    2.068558
std    1.899822    12.585558  ...     2.003532    1.153956
min    0.499900    1.000000  ...  -124.350000    0.149990
25%   2.563400    18.000000  ...  -121.800000    1.196000
50%   3.534800    29.000000  ...  -118.490000    1.797000
75%   4.743250    37.000000  ...  -118.010000    2.647250
max   15.000100    52.000000  ...  -114.310000    5.000010

```

2. Develop a program to Compute the correlation matrix to understand the relationships between pairs of features. Visualize the correlation matrix using a heatmap to know which variables have strong positive/negative correlations. Create a pair plot to visualize pairwise relationships between features. Use California Housing dataset.

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.datasets import fetch_california_housing

# Step 1: Load the California Housing Dataset
california_data = fetch_california_housing(as_frame=True)
data = california_data.frame

# Step 2: Compute the correlation matrix
correlation_matrix = data.corr()

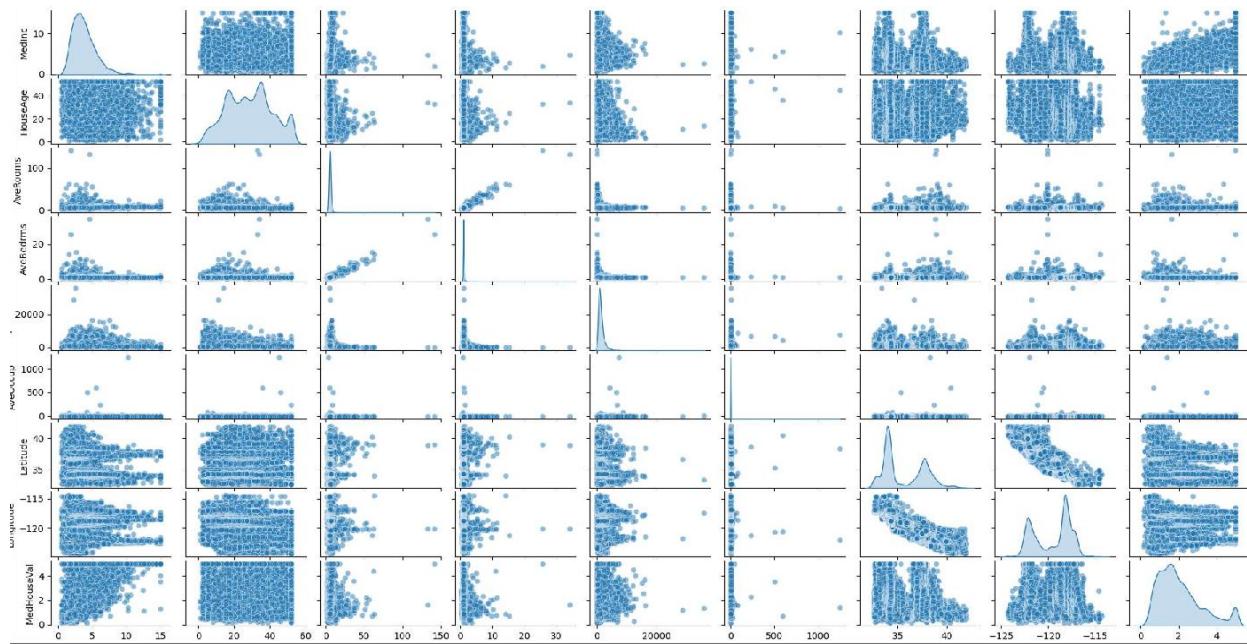
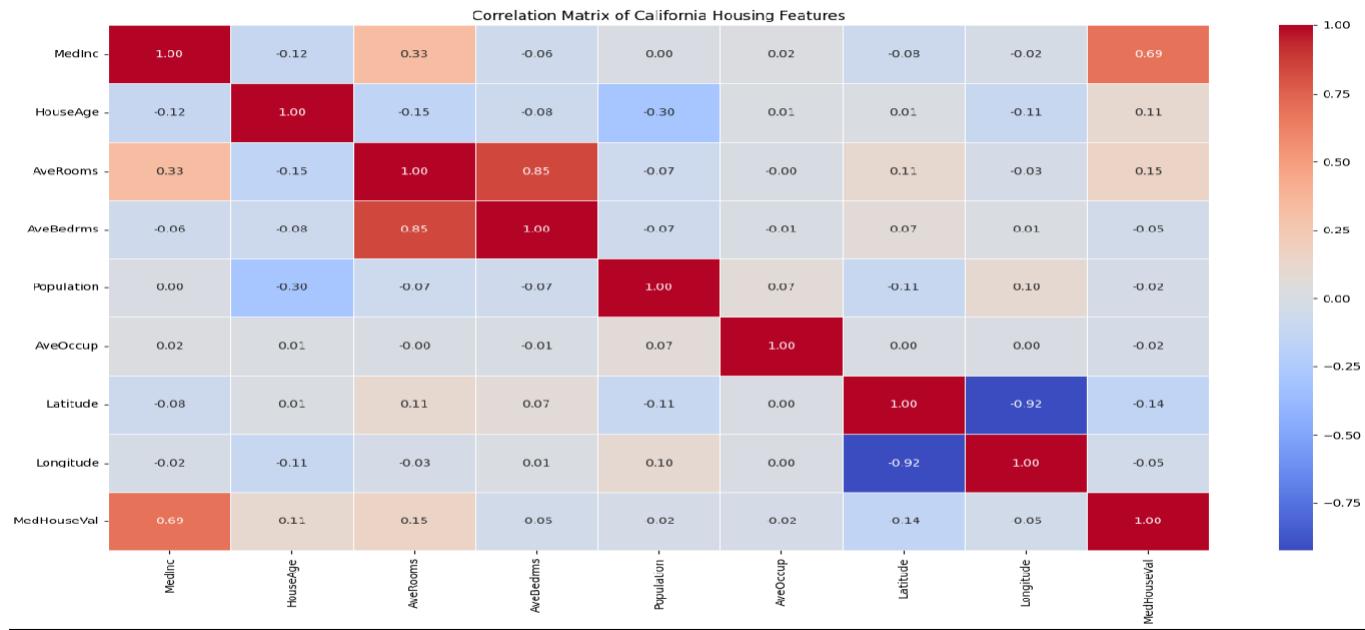
# Step 3: Visualize the correlation matrix using a heatmap
plt.figure(figsize=(10, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt='.2f',
            linewidths=0.5)
plt.title('Correlation Matrix of California Housing Features')
plt.show()

# Step 4: Create a pair plot to visualize pairwise relationships
sns.pairplot(data, diag_kind='kde', plot_kws={'alpha': 0.5})
plt.suptitle('Pair Plot of California Housing Features', y=1.02)
plt.show()
```

Explanation:

This script performs an exploratory data analysis on the California Housing dataset using Pandas, Seaborn, and Matplotlib. First, it loads the dataset, which contains various housing-related features, and converts it into a DataFrame. Then, it calculates the correlation matrix to measure relationships between numerical features. To visualize these relationships, a heatmap is created using Seaborn, displaying correlations with color gradients and numerical values for better interpretability. Additionally, a pair plot is generated to illustrate pairwise relationships between features, using scatter plots for bivariate distributions and KDE plots for univariate distributions. These visualizations help in understanding feature dependencies and potential patterns in the dataset.

Output:



3. Develop a program to implement Principal Component Analysis (PCA) for reducing the dimensionality of the Iris dataset from 4 features to 2.

```

import numpy as np
import pandas as pd
from sklearn.datasets import load_iris
from sklearn.decomposition import PCA
import matplotlib.pyplot as plt

# Load the Iris dataset
iris = load_iris()
data = iris.data
labels = iris.target
label_names = iris.target_names

# Convert to a DataFrame for better visualization
iris_df = pd.DataFrame(data, columns=iris.feature_names)

# Perform PCA to reduce dimensionality to 2
pca = PCA(n_components=2)
data_reduced = pca.fit_transform(data)

# Create a DataFrame for the reduced data
reduced_df = pd.DataFrame(data_reduced, columns=['Principal Component 1',
'Principal Component 2'])
reduced_df['Label'] = labels

# Plot the reduced data
plt.figure(figsize=(8, 6))
colors = ['r', 'g', 'b']
for i, label in enumerate(np.unique(labels)):
    plt.scatter(
        reduced_df[reduced_df['Label'] == label]['Principal Component 1'],
        reduced_df[reduced_df['Label'] == label]['Principal Component 2'],
        label=label_names[label],
        color=colors[i]
    )

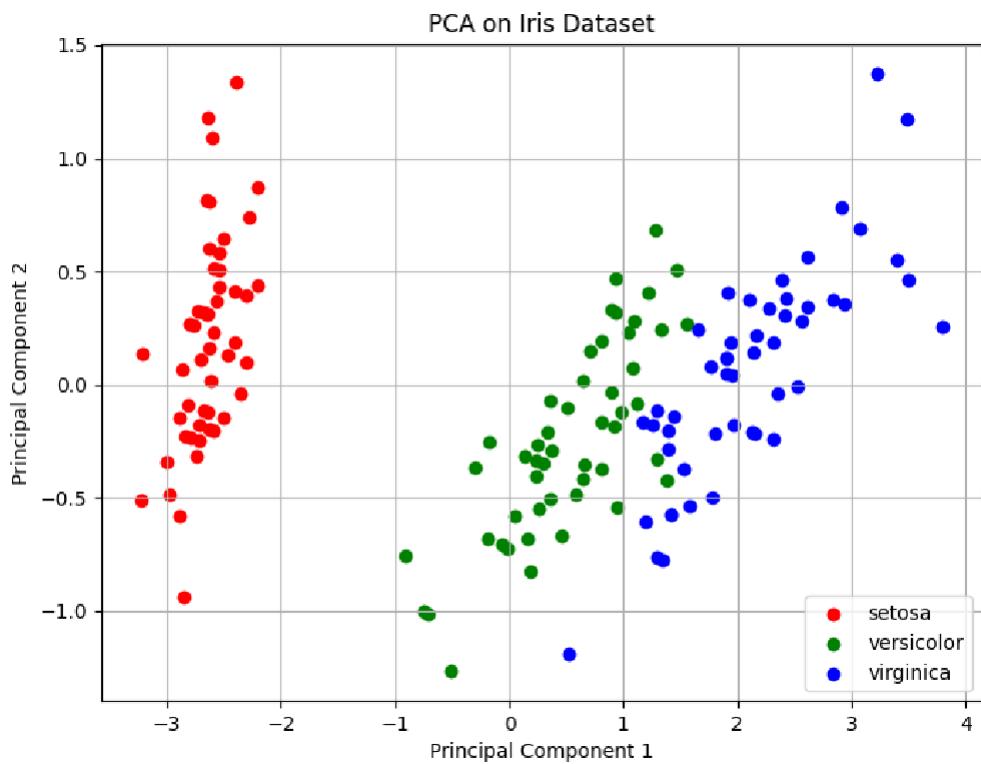
plt.title('PCA on Iris Dataset')
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.legend()
plt.grid()
plt.show()

```

Explanation:

This Python script demonstrates how to apply Principal Component Analysis (PCA) on the Iris dataset to reduce its dimensionality from four features to two, making it easier to visualize. The script first loads the Iris dataset using `sklearn.datasets.load_iris()`, extracts the feature data and labels, and converts it into a Pandas DataFrame for better readability. It then applies PCA with `n_components=2` to transform the dataset into a two-dimensional space. The transformed data is stored in another DataFrame, with the corresponding class labels. Finally, the script uses `matplotlib` to create a scatter plot, where different species of flowers are represented in distinct colors. This visualization helps in understanding how well PCA separates the three species in lower-dimensional space.

Output:



4. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Find-S algorithm to output a description of the set of all hypotheses consistent with the training examples.

```

import pandas as pd

def find_s_algorithm(file_path):
    data = pd.read_csv(file_path)

    print("Training data:")
    print(data)

    attributes = data.columns[:-1]
    class_label = data.columns[-1]

    hypothesis = ['?' for _ in attributes]

    for index, row in data.iterrows():
        if row[class_label] == 'Yes':
            for i, value in enumerate(row[attributes]):
                if hypothesis[i] == '?' or hypothesis[i] == value:
                    hypothesis[i] = value
                else:
                    hypothesis[i] = '?'

    return hypothesis

file_path = 'C:\\\\Users\\\\Admin\\\\Downloads\\\\training_data.csv'
hypothesis = find_s_algorithm(file_path)
print("\nThe final hypothesis is:", hypothesis)

```

Explanation:

The given Python script implements the Find-S algorithm using the pandas library for reading and processing a CSV dataset. The Find-S algorithm is a simple machine learning approach used to find the most specific hypothesis that fits all positive examples in a dataset. The script reads a CSV file containing training data, where the last column represents the class label (e.g., "Yes" or "No"). It initializes a hypothesis with the most general values ('?' for each attribute) and then iterates through the dataset, updating the hypothesis whenever a positive example ('Yes' in the class label) is encountered. If an attribute in a positive example matches the current hypothesis, it remains unchanged; otherwise, it is generalized to '?'. The final hypothesis is returned and printed, representing the most specific description that fits all positive examples.

Output:

| Training data: | | | | | |
|----------------|----------|-------------|----------|-------|------------|
| | Outlook | Temperature | Humidity | Windy | PlayTennis |
| 0 | Sunny | Hot | High | False | No |
| 1 | Sunny | Hot | High | True | No |
| 2 | Overcast | Hot | High | False | Yes |
| 3 | Rain | Cold | High | False | Yes |
| 4 | Rain | Cold | High | True | No |
| 5 | Overcast | Hot | High | True | Yes |
| 6 | Sunny | Hot | High | False | No |

The final hypothesis is: ['Overcast', 'Hot', 'High', '?']

5. Develop a program to implement k-Nearest Neighbour algorithm to classify the randomly generated 100 values of x in the range of $[0,1]$. Perform the following based on dataset generated.
- Label the first 50 points $\{x_1, \dots, x_{50}\}$ as follows: if $(x_i \leq 0.5)$, then $x_i \in \text{Class1}$, else $x_i \in \text{Class2}$
 - Classify the remaining points, x_{51}, \dots, x_{100} using KNN. Perform this for $k=1, 2, 3, 4, 5, 20, 30$

```

import numpy as np
import matplotlib.pyplot as plt
from collections import Counter

data = np.random.rand(100)

labels = ["Class1" if x <= 0.5 else "Class2" for x in data[:50]]

def euclidean_distance(x1, x2):
    return abs(x1 - x2)

def knn_classifier(train_data, train_labels, test_point, k):
    distances = [(euclidean_distance(test_point, train_data[i]), train_labels[i])
    for i in range(len(train_data))]

    distances.sort(key=lambda x: x[0])
    k_nearest_neighbors = distances[:k]

    k_nearest_labels = [label for _, label in k_nearest_neighbors]

    return Counter(k_nearest_labels).most_common(1)[0][0]

train_data = data[:50]
train_labels = labels

test_data = data[50:]

k_values = [1, 2, 3, 4, 5, 20, 30]

print("---- k-Nearest Neighbors Classification ---")
print("Training dataset: First 50 points labeled based on the rule (x <= 0.5 -> Class1, x > 0.5 -> Class2)")
print("Testing dataset: Remaining 50 points to be classified\n")

results = {}

for k in k_values:
    print(f"Results for k = {k}:")
    classified_labels = [knn_classifier(train_data, train_labels, test_point, k) for test_point in test_data]
    results[k] = classified_labels

    for i, label in enumerate(classified_labels, start=51):
        print(f"Point x{i} (value: {test_data[i - 51]:.4f}) is classified as {label}")
    print("\n")

```

Machine Learning Lab (BCSL606)

```
print("Classification complete.\n")

for k in k_values:
    classified_labels = results[k]
    class1_points = [test_data[i] for i in range(len(test_data)) if
classified_labels[i] == "Class1"]
    class2_points = [test_data[i] for i in range(len(test_data)) if
classified_labels[i] == "Class2"]

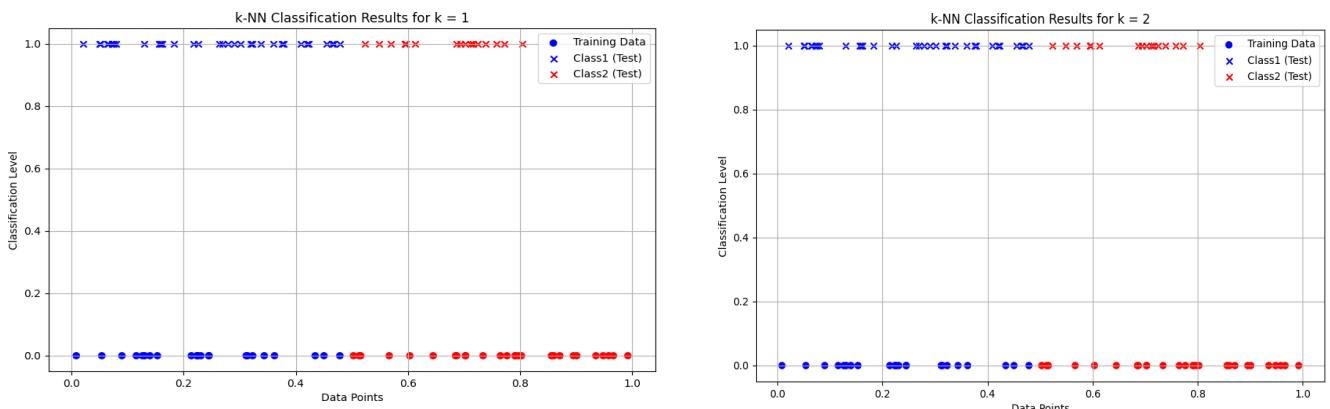
    plt.figure(figsize=(10, 6))
    plt.scatter(train_data, [0] * len(train_data), c=["blue" if label == "Class1"
else "red" for label in train_labels],
                label="Training Data", marker="o")
    plt.scatter(class1_points, [1] * len(class1_points), c="blue", label="Class1
(Test)", marker="x")
    plt.scatter(class2_points, [1] * len(class2_points), c="red", label="Class2
(Test)", marker="x")

    plt.title(f"k-NN Classification Results for k = {k}")
    plt.xlabel("Data Points")
    plt.ylabel("Classification Level")
    plt.legend()
    plt.grid(True)
    plt.show()
```

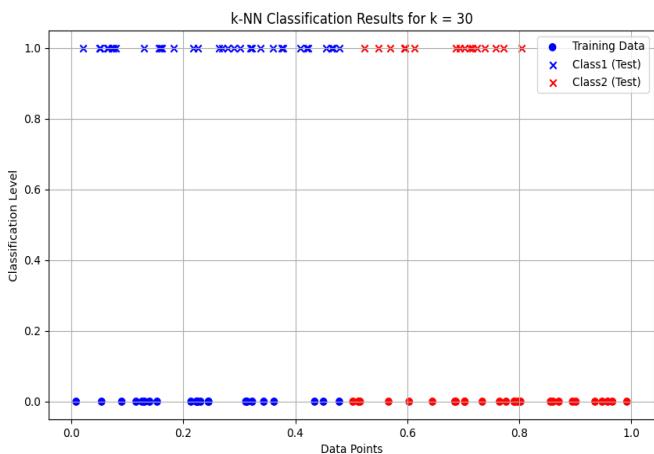
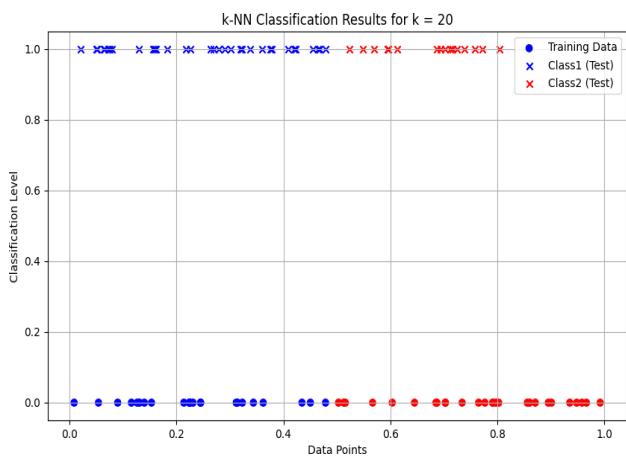
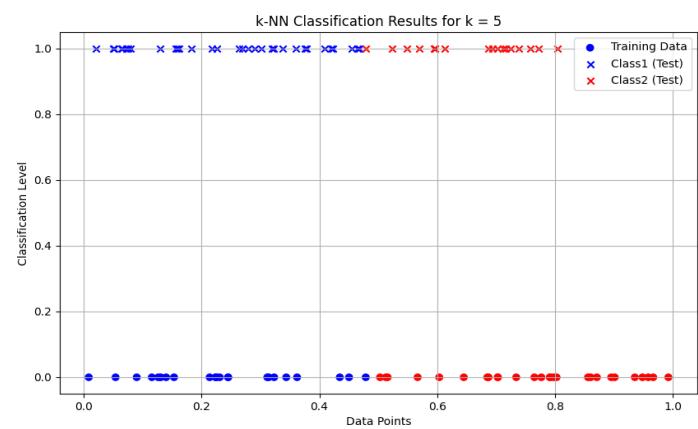
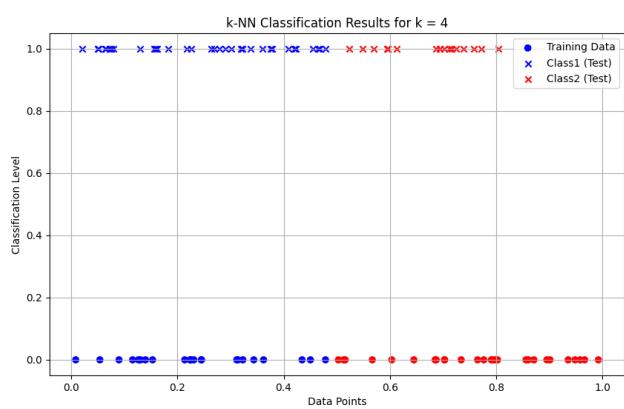
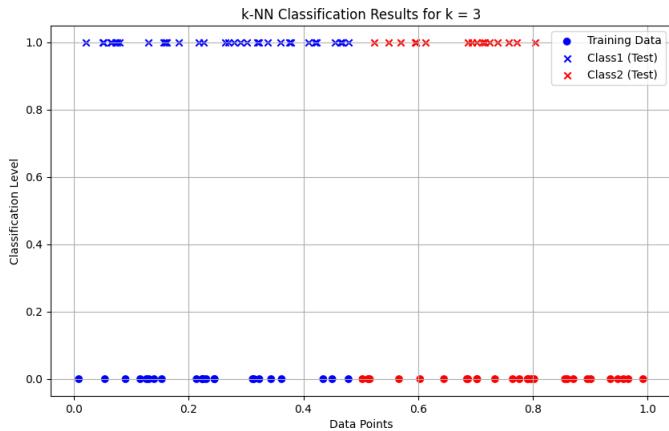
Explanation:

This Python script implements a simple k-Nearest Neighbors (k-NN) classifier using Euclidean distance for a 1D dataset generated randomly. It starts by creating 100 random values between 0 and 1, labeling the first 50 points as "Class1" if ≤ 0.5 and "Class2" otherwise. The script defines a function to calculate Euclidean distance and another to classify test points based on their nearest neighbors. It then iterates over different k-values (1, 2, 3, etc.), classifying the remaining 50 data points. The classification results are printed and visualized using Matplotlib, where training points are plotted as circles and test points as Class1 (blue crosses) or Class2 (red crosses). The visualizations help analyze how different k-values affect classification performance.

Output:



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Machine Learning Lab (BCSL606)

--- k-Nearest Neighbors Classification ---

Training dataset: First 50 points labeled based on the rule ($x \leq 0.5 \rightarrow$ Class1, $x > 0.5 \rightarrow$ Class2)

Testing dataset: Remaining 50 points to be classified

Results for $k = 1$:

Point x51 (value: 0.5702) is classified as Class2

Point x52 (value: 0.4654) is classified as Class1

Point x53 (value: 0.7016) is classified as Class2

Point x54 (value: 0.5964) is classified as Class2

Point x55 (value: 0.0643) is classified as Class1

Point x56 (value: 0.2698) is classified as Class1

Point x57 (value: 0.7124) is classified as Class2

Point x58 (value: 0.3219) is classified as Class1

Point x59 (value: 0.2637) is classified as Class2

Point x60 (value: 0.5483) is classified as Class2

Point x61 (value: 0.1561) is classified as Class1

Point x62 (value: 0.1592) is classified as Class1

Point x63 (value: 0.3752) is classified as Class1

Point x64 (value: 0.1299) is classified as Class1

Point x65 (value: 0.6934) is classified as Class2

Point x66 (value: 0.5240) is classified as Class2

Point x67 (value: 0.0203) is classified as Class1

Point x68 (value: 0.3789) is classified as Class1

Point x69 (value: 0.6866) is classified as Class2

Point x70 (value: 0.1834) is classified as Class1

Point x71 (value: 0.4197) is classified as Class1

Point x72 (value: 0.3608) is classified as Class1

Point x73 (value: 0.7579) is classified as Class2

Point x74 (value: 0.1624) is classified as Class1

Point x75 (value: 0.5943) is classified as Class2

Point x76 (value: 0.4097) is classified as Class1

Point x77 (value: 0.6124) is classified as Class2

Point x78 (value: 0.2794) is classified as Class1

Point x79 (value: 0.3193) is classified as Class1

Point x80 (value: 0.0503) is classified as Class1

Point x81 (value: 0.8038) is classified as Class2

Point x82 (value: 0.0792) is classified as Class1

Point x83 (value: 0.4230) is classified as Class1

Point x84 (value: 0.7250) is classified as Class2

Point x85 (value: 0.7162) is classified as Class2

Point x86 (value: 0.0725) is classified as Class1

Point x87 (value: 0.0752) is classified as Class1

Point x88 (value: 0.4676) is classified as Class1

Point x89 (value: 0.2256) is classified as Class1

Point x90 (value: 0.4552) is classified as Class1

Point x91 (value: 0.4787) is classified as Class1

Point x92 (value: 0.7390) is classified as Class2

Point x93 (value: 0.0649) is classified as Class1

Point x94 (value: 0.3373) is classified as Class1

Point x95 (value: 0.7719) is classified as Class2

Point x96 (value: 0.0512) is classified as Class1

Point x97 (value: 0.3012) is classified as Class1

Point x98 (value: 0.5966) is classified as Class2

Point x99 (value: 0.2897) is classified as Class1

Point x100 (value: 0.2176) is classified as Class1

Machine Learning Lab (BCSL606)

6. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points.

Select appropriate data set for your experiment and draw graphs

```
import numpy as np
import matplotlib.pyplot as plt

def gaussian_kernel(x, xi, tau):
    return np.exp(-np.sum((x - xi) ** 2) / (2 * tau ** 2))

def locally_weighted_regression(x, X, y, tau):
    m = X.shape[0]
    weights = np.array([gaussian_kernel(x, X[i], tau) for i in range(m)])
    W = np.diag(weights)
    X_transpose_W = X.T @ W
    theta = np.linalg.inv(X_transpose_W @ X) @ X_transpose_W @ y
    return x @ theta

np.random.seed(42)
X = np.linspace(0, 2 * np.pi, 100)
y = np.sin(X) + 0.1 * np.random.randn(100)
X_bias = np.c_[np.ones(X.shape), X]

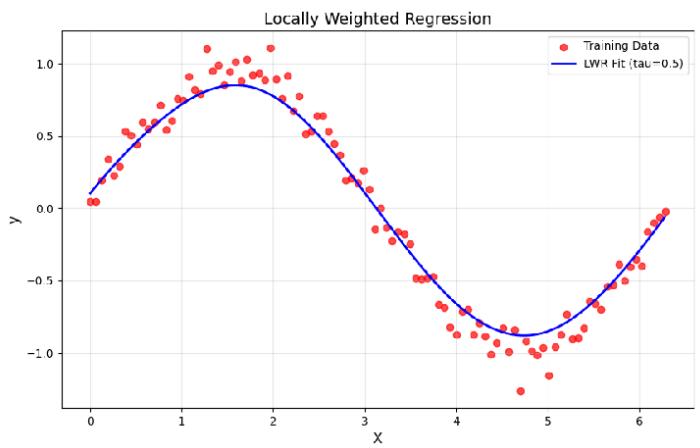
x_test = np.linspace(0, 2 * np.pi, 200)
x_test_bias = np.c_[np.ones(x_test.shape), x_test]
tau = 0.5
y_pred = np.array([locally_weighted_regression(xi, X_bias, y, tau) for xi in x_test_bias])

plt.figure(figsize=(10, 6))
plt.scatter(X, y, color='red', label='Training Data', alpha=0.7)
plt.plot(x_test, y_pred, color='blue', label=f'LWR Fit (tau={tau})', linewidth=2)
plt.xlabel('X', fontsize=12)
plt.ylabel('y', fontsize=12)
plt.title('Locally Weighted Regression', fontsize=14)
plt.legend(fontsize=10)
plt.grid(alpha=0.3)
plt.show()
```

Explanation:

This program implements **Locally Weighted Regression (LWR)** using a Gaussian kernel to assign weights to training points based on their distance from a given query point. The function `gaussian_kernel` computes the weight for each training point relative to the query point using a Gaussian function with bandwidth `tau`. The `locally_weighted_regression` function then performs weighted linear regression by computing the weighted least squares estimate for the regression coefficients. The dataset consists of noisy sine wave samples, and LWR is applied to estimate the function's trend. The predictions are visualized, showing the fitted curve along with the training data, demonstrating how LWR captures local patterns in the data.

Output:



Machine Learning Lab (BCSL606)

7. Develop a program to demonstrate the working of Linear Regression and Polynomial Regression. Use Boston Housing Dataset for Linear Regression and Auto MPG Dataset (for vehicle fuel efficiency prediction) for Polynomial Regression.

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.datasets import fetch_california_housing
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.preprocessing import PolynomialFeatures, StandardScaler
from sklearn.pipeline import make_pipeline
from sklearn.metrics import mean_squared_error, r2_score

def linear_regression_california():
    housing = fetch_california_housing(as_frame=True)
    X = housing.data[["AveRooms"]]
    y = housing.target

    X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,
random_state=42)

    model = LinearRegression()
    model.fit(X_train, y_train)

    y_pred = model.predict(X_test)

    plt.scatter(X_test, y_test, color="blue", label="Actual")
    plt.plot(X_test, y_pred, color="red", label="Predicted")
    plt.xlabel("Average number of rooms (AveRooms)")
    plt.ylabel("Median value of homes ($100,000)")
    plt.title("Linear Regression - California Housing Dataset")
    plt.legend()
    plt.show()

    print("Linear Regression - California Housing Dataset")
    print("Mean Squared Error:", mean_squared_error(y_test, y_pred))
    print("R^2 Score:", r2_score(y_test, y_pred))

def polynomial_regression_auto_mpg():
    url = "https://archive.ics.uci.edu/ml/machine-learning-databases/auto-mpg/auto-mpg.data"
    column_names = ["mpg", "cylinders", "displacement", "horsepower", "weight",
"acceleration", "model_year", "origin"]
    data = pd.read_csv(url, sep='\s+', names=column_names, na_values="?")
    data = data.dropna()

    X = data["displacement"].values.reshape(-1, 1)
    y = data["mpg"].values

    X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,
random_state=42)

    poly_model = make_pipeline(PolynomialFeatures(degree=2), StandardScaler(),
LinearRegression())
    poly_model.fit(X_train, y_train)
```

Machine Learning Lab (BCSL606)

```
y_pred = poly_model.predict(X_test)

plt.scatter(X_test, y_test, color="blue", label="Actual")
plt.scatter(X_test, y_pred, color="red", label="Predicted")
plt.xlabel("Displacement")
plt.ylabel("Miles per gallon (mpg)")
plt.title("Polynomial Regression - Auto MPG Dataset")
plt.legend()
plt.show()

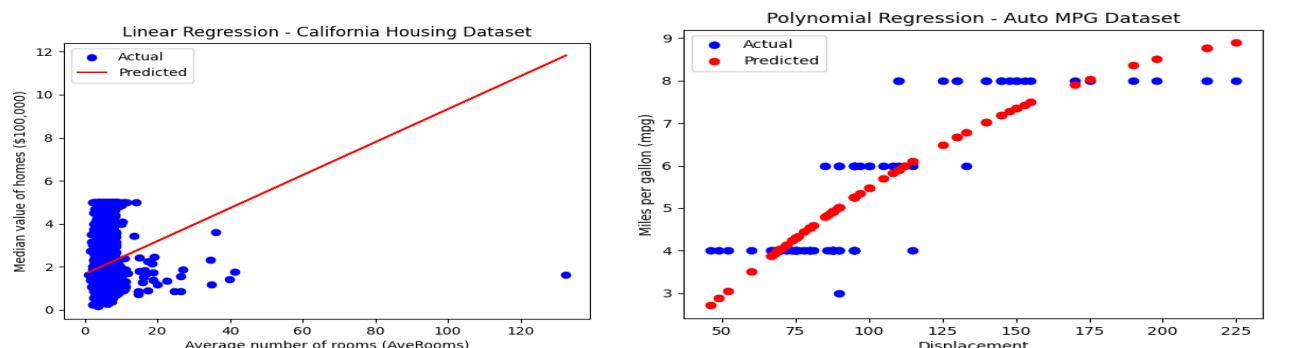
print("Polynomial Regression - Auto MPG Dataset")
print("Mean Squared Error:", mean_squared_error(y_test, y_pred))
print("R^2 Score:", r2_score(y_test, y_pred))

if __name__ == "__main__":
    print("Demonstrating Linear Regression and Polynomial Regression\n")
    linear_regression_california()
    polynomial_regression_auto_mpg()
```

Explanation:

The provided code demonstrates linear and polynomial regression using two datasets. First, it performs linear regression on the California Housing dataset, focusing on predicting the median home value based on the average number of rooms. The data is split into training and test sets, and a LinearRegression model is trained and evaluated, displaying a scatter plot comparing actual and predicted values along with the Mean Squared Error (MSE) and R² score. In the second part, polynomial regression is applied to the Auto MPG dataset, predicting fuel efficiency (mpg) based on engine displacement. A pipeline is used, consisting of polynomial feature transformation, standard scaling, and linear regression. The model's performance is visualized similarly, and metrics are printed. Both visualizations help in understanding model fit and performance.

Output:



```
Demonstrating Linear Regression and Polynomial Regression

Linear Regression - California Housing Dataset
Mean Squared Error: 1.2923314440807299
R^2 Score: 0.013795337532284901

Polynomial Regression - Auto MPG Dataset
Mean Squared Error: 0.743149055720586
R^2 Score: 0.7505650609469626
```

Machine Learning Lab (BCSL606)

8. Develop a program to demonstrate the working of the decision tree algorithm. Use Breast Cancer Data set for building the decision tree and apply this knowledge to classify a new sample.

```
import numpy as np
import matplotlib.pyplot as plt
from sklearn.datasets import load_breast_cancer
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score
from sklearn import tree

data = load_breast_cancer()
X = data.data
y = data.target

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,
random_state=42)
clf = DecisionTreeClassifier(random_state=42)
clf.fit(X_train, y_train)
y_pred = clf.predict(X_test)

accuracy = accuracy_score(y_test, y_pred)
print(f"Model Accuracy: {accuracy * 100:.2f}%")
new_sample = np.array([X_test[0]])
prediction = clf.predict(new_sample)

prediction_class = "Benign" if prediction == 1 else "Malignant"
print(f"Predicted Class for the new sample: {prediction_class}")

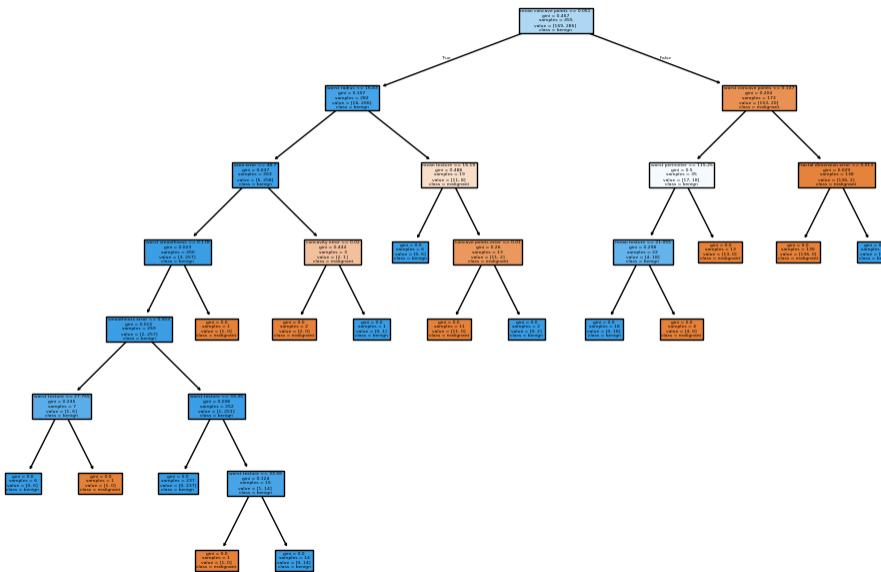
plt.figure(figsize=(12,8))
tree.plot_tree(clf, filled=True, feature_names=data.feature_names,
class_names=data.target_names)
plt.title("Decision Tree - Breast Cancer Dataset")
plt.show()
```

Explanation:

This Python script implements a Decision Tree Classifier to classify breast cancer tumors as malignant or benign using the Breast Cancer dataset from `sklearn.datasets`. It begins by importing necessary libraries, then loads the dataset and separates it into features (`X`) and target labels (`y`). The dataset is split into training (80%) and testing (20%) subsets using `train_test_split`. A `DecisionTreeClassifier` model is created and trained on the training data. After training, predictions are made on the test set, and the model's accuracy is evaluated using `accuracy_score`. The script then predicts the class of a new sample (first test sample) and prints whether it is malignant or benign. Finally, it visualizes the decision tree using `matplotlib` and `tree.plot_tree`, displaying how the classifier makes decisions based on feature splits.

Output:

Decision Tree - Breast Cancer Dataset



Machine Learning Lab (BCSL606)

9. Develop a program to implement the Naive Bayesian classifier considering Olivetti Face Data set for training. Compute the accuracy of the classifier, considering a few test data sets.

```
import numpy as np
from sklearn.datasets import fetch_olivetti_faces
from sklearn.model_selection import train_test_split, cross_val_score
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import accuracy_score, classification_report, confusion_matrix
import matplotlib.pyplot as plt

data = fetch_olivetti_faces(shuffle=True, random_state=42)
X = data.data
y = data.target

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,
random_state=42)

gnb = GaussianNB()
gnb.fit(X_train, y_train)
y_pred = gnb.predict(X_test)

accuracy = accuracy_score(y_test, y_pred)
print(f'Accuracy: {accuracy * 100:.2f}%')

print("\nClassification Report:")
print(classification_report(y_test, y_pred, zero_division=1))

print("\nConfusion Matrix:")
print(confusion_matrix(y_test, y_pred))

cross_val_accuracy = cross_val_score(gnb, X, y, cv=5, scoring='accuracy')
print(f'\nCross-validation accuracy: {cross_val_accuracy.mean() * 100:.2f}%')

fig, axes = plt.subplots(3, 5, figsize=(12, 8))
for ax, image, label, prediction in zip(axes.ravel(), X_test, y_test, y_pred):
    ax.imshow(image.reshape(64, 64), cmap=plt.cm.gray)
    ax.set_title(f"True: {label}, Pred: {prediction}")
    ax.axis('off')

plt.show()
```

Explanation:

This Python script uses machine learning to classify human face images from the Olivetti Faces dataset. It begins by importing necessary libraries like NumPy, scikit-learn, and Matplotlib. The dataset is loaded using `fetch_olivetti_faces()`, which provides grayscale 64x64 face images and corresponding labels. The data is split into training and testing sets using `train_test_split()`. A Gaussian Naïve Bayes (GNB) classifier is then trained on the training set and used to predict labels for the test set. The model's performance is evaluated using `accuracy_score`, `classification_report`, and `confusion_matrix`. Additionally, cross-validation is performed to assess generalization. Finally, a visualization is created using Matplotlib, displaying a subset of test images with their true and predicted labels.

Machine Learning Lab (BCSL606)

Output:



Accuracy: 80.83%

Classification Report:

| | precision | recall | f1-score | support |
|--|-----------|--------|----------|---------|
|--|-----------|--------|----------|---------|

| | | | | |
|----|------|------|------|---|
| 0 | 0.67 | 1.00 | 0.80 | 2 |
| 1 | 1.00 | 1.00 | 1.00 | 2 |
| 2 | 0.33 | 0.67 | 0.44 | 3 |
| 3 | 1.00 | 0.00 | 0.00 | 5 |
| 4 | 1.00 | 0.50 | 0.67 | 4 |
| 5 | 1.00 | 1.00 | 1.00 | 2 |
| 7 | 1.00 | 0.75 | 0.86 | 4 |
| 8 | 1.00 | 0.67 | 0.80 | 3 |
| 9 | 1.00 | 0.75 | 0.86 | 4 |
| 10 | 1.00 | 1.00 | 1.00 | 3 |
| 11 | 1.00 | 1.00 | 1.00 | 1 |
| 12 | 0.40 | 1.00 | 0.57 | 4 |
| 13 | 1.00 | 0.80 | 0.89 | 5 |
| 14 | 1.00 | 0.40 | 0.57 | 5 |
| 15 | 0.67 | 1.00 | 0.80 | 2 |
| 16 | 1.00 | 0.67 | 0.80 | 3 |
| 17 | 1.00 | 1.00 | 1.00 | 3 |
| 18 | 1.00 | 1.00 | 1.00 | 3 |
| 19 | 0.67 | 1.00 | 0.80 | 2 |
| 20 | 1.00 | 1.00 | 1.00 | 3 |
| 21 | 1.00 | 0.67 | 0.80 | 3 |
| 22 | 1.00 | 0.60 | 0.75 | 5 |
| 23 | 1.00 | 0.75 | 0.86 | 4 |
| 24 | 1.00 | 1.00 | 1.00 | 3 |
| 25 | 1.00 | 0.75 | 0.86 | 4 |
| 26 | 1.00 | 1.00 | 1.00 | 2 |
| 27 | 1.00 | 1.00 | 1.00 | 5 |
| 28 | 0.50 | 1.00 | 0.67 | 2 |
| 29 | 1.00 | 1.00 | 1.00 | 2 |
| 30 | 1.00 | 1.00 | 1.00 | 2 |
| 31 | 1.00 | 0.75 | 0.86 | 4 |
| 32 | 1.00 | 1.00 | 1.00 | 2 |
| 34 | 0.25 | 1.00 | 0.40 | 1 |
| 35 | 1.00 | 1.00 | 1.00 | 5 |

Machine Learning Lab (BCSL606)

| | | | | |
|--------------|------|------|------|-----|
| 36 | 1.00 | 1.00 | 1.00 | 3 |
| 37 | 1.00 | 1.00 | 1.00 | 1 |
| 38 | 1.00 | 0.75 | 0.86 | 4 |
| 39 | 0.50 | 1.00 | 0.67 | 5 |
| accuracy | | 0.81 | | 120 |
| macro avg | 0.89 | 0.85 | 0.83 | 120 |
| weighted avg | 0.91 | 0.81 | 0.81 | 120 |

Confusion Matrix:

[[2 0 0 ... 0 0 0]

[0 2 0 ... 0 0 0]

[0 0 2 ... 0 0 1]

...

[0 0 0 ... 1 0 0]

[0 0 0 ... 0 3 0]

[0 0 0 ... 0 0 5]]

Cross-validation accuracy: 87.25%

Machine Learning Lab (BCSL606)

10. Develop a program to implement k-means clustering using Wisconsin Breast Cancer data set and visualize the clustering result.

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.datasets import load_breast_cancer
from sklearn.cluster import KMeans
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA
from sklearn.metrics import confusion_matrix, classification_report

data = load_breast_cancer()
X = data.data
y = data.target

scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

kmeans = KMeans(n_clusters=2, random_state=42)
y_kmeans = kmeans.fit_predict(X_scaled)

print("Confusion Matrix:")
print(confusion_matrix(y, y_kmeans))
print("\nClassification Report:")
print(classification_report(y, y_kmeans))

pca = PCA(n_components=2)
X_pca = pca.fit_transform(X_scaled)

df = pd.DataFrame(X_pca, columns=['PC1', 'PC2'])
df['Cluster'] = y_kmeans
df['True Label'] = y

plt.figure(figsize=(8, 6))
sns.scatterplot(data=df, x='PC1', y='PC2', hue='Cluster', palette='Set1', s=100,
edgecolor='black', alpha=0.7)
plt.title('K-Means Clustering of Breast Cancer Dataset')
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.legend(title="Cluster")
plt.show()

plt.figure(figsize=(8, 6))
sns.scatterplot(data=df, x='PC1', y='PC2', hue='True Label', palette='coolwarm',
s=100, edgecolor='black', alpha=0.7)
plt.title('True Labels of Breast Cancer Dataset')
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.legend(title="True Label")
plt.show()

plt.figure(figsize=(8, 6))
sns.scatterplot(data=df, x='PC1', y='PC2', hue='Cluster', palette='Set1', s=100,
edgecolor='black', alpha=0.7)
centers = pca.transform(kmeans.cluster_centers_)
plt.scatter(centers[:, 0], centers[:, 1], s=200, c='red', marker='X',
label='Centroids')
```

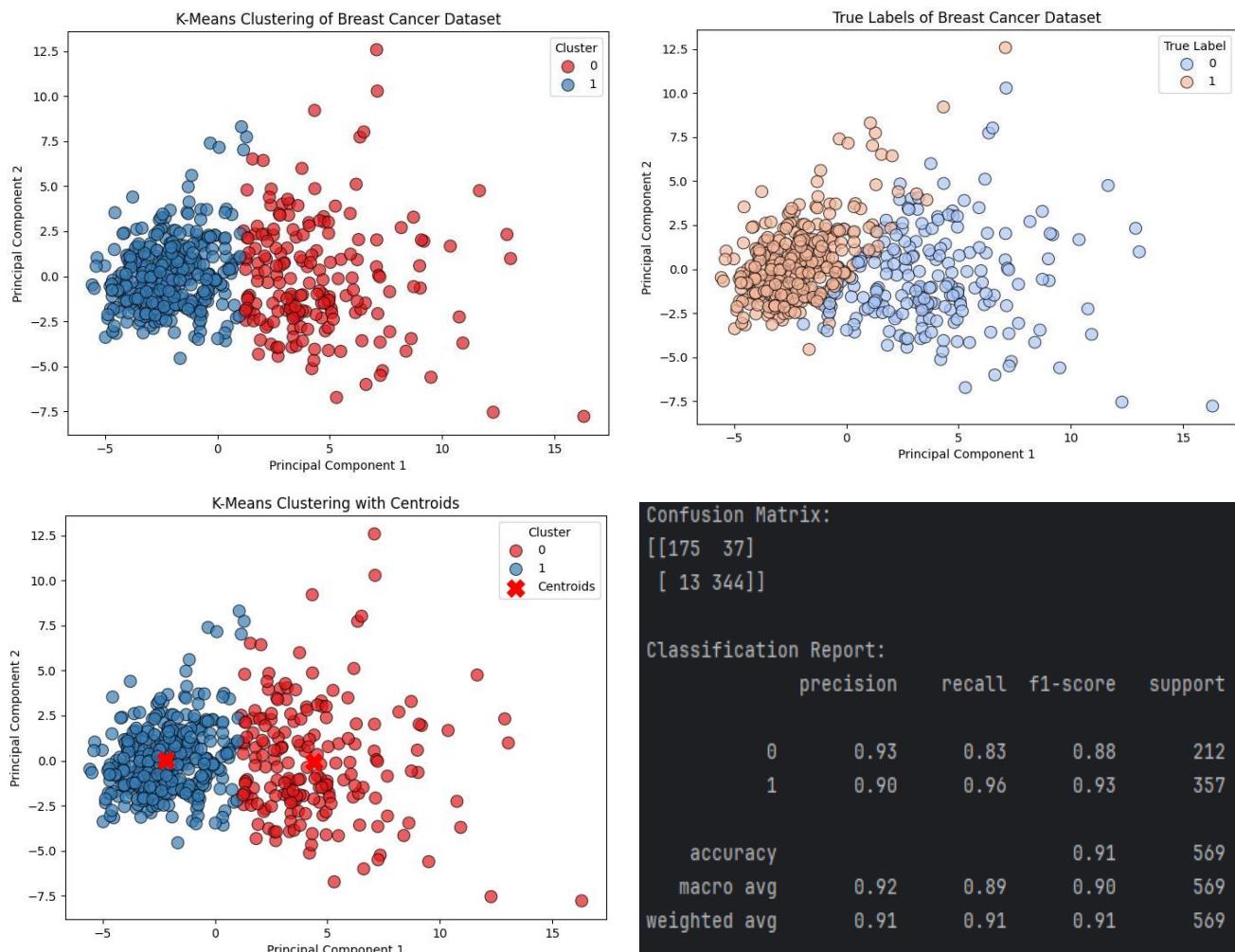
Machine Learning Lab (BCSL606)

```
plt.title('K-Means Clustering with Centroids')
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.legend(title="Cluster")
plt.show()
```

Explanation:

This code performs K-Means clustering on the Breast Cancer dataset from sklearn. It first loads the dataset and standardizes the features using StandardScaler to ensure all features have equal importance. Then, it applies K-Means clustering with two clusters, as the dataset has two target classes (malignant and benign). The clustering results are evaluated using a confusion matrix and a classification report. To visualize the data, Principal Component Analysis (PCA) is used to reduce the dimensions to two principal components, making it easier to plot. The results are displayed using scatter plots, comparing predicted clusters and true labels. Finally, the cluster centroids are plotted on the PCA-transformed data, helping to understand the separation of clusters.

Output:



Viva Questions:

1. How does machine learning differ from traditional programming?

In traditional programming, rules and logic are explicitly coded by developers. In machine learning, the system learns patterns and rules from data, allowing it to adapt to new inputs without being reprogrammed.

2. What is machine learning?

Machine learning is a subset of artificial intelligence that involves the development of algorithms and statistical models that allow computers to learn and make predictions or decisions based on data.

3. Explain the concept of "training" in machine learning?

Training in machine learning refers to the process of feeding data to a model so it can learn patterns and relationships in the data to make accurate predictions or decisions.

4. How does machine learning differ from artificial intelligence?

Machine learning is a subset of artificial intelligence. AI encompasses a broader scope, including rule-based systems, robotics, and natural language processing, while machine learning specifically focuses on learning from data.

5. What are the main types of machine learning?

Supervised Learning: Learning from labeled data.

Unsupervised Learning: Learning from unlabeled data.

Reinforcement Learning: Learning through interaction with an environment to maximize rewards.

6. Give an example of supervised learning.

Predicting house prices based on features like size, location, and number of bedrooms using historical labeled data.

7. What is the difference between supervised and unsupervised learning?

Supervised learning uses labeled data to train the model, while unsupervised learning works with unlabeled data to find hidden patterns or groupings.

8. How do you handle overfitting in a machine learning model?

Using regularization techniques.

Pruning decision trees.

Increasing training data.

Using cross-validation.

9. What are the steps involved in the machine learning process?

Problem definition.

Data collection.

Data preprocessing (cleaning, normalization).

Feature selection and engineering.

Model selection and training.

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Model evaluation.

Deployment and monitoring.

10. Why is data preprocessing important in machine learning?

Data preprocessing ensures that the data is clean, consistent, and suitable for analysis, improving the model's accuracy and performance.

11. What are some real-world applications of machine learning?

Healthcare: Disease diagnosis and drug discovery.

Finance: Fraud detection and algorithmic trading.

Retail: Recommendation systems and inventory management.

Autonomous vehicles: Object detection and navigation.

Natural language processing: Chatbots and language translation.

12. What are structured and unstructured data?

Structured Data: Organized in a fixed format, like tables (e.g., relational databases).

Unstructured Data: Lacks a predefined format (e.g., text, images, videos).

13. What is Big Data?

Big Data refers to extremely large and complex datasets that cannot be processed using traditional methods due to their volume, velocity, and variety.

14. What are the 5 V's of Big Data?

Volume: The amount of data.

Velocity: The speed at which data is generated.

Variety: Different types of data (structured, unstructured, semi-structured).

Veracity: The quality or accuracy of the data.

Value: The usefulness of the data.

15. What are the key components of a Big Data framework?

Data Sources: Origin of data (e.g., sensors, social media).

Data Storage: Systems like Hadoop HDFS, cloud storage.

Data Processing: Tools like Spark, MapReduce.

Data Analysis: Techniques like machine learning, statistical analysis.

Visualization: Presenting results through tools like Tableau or Power BI.

16. What is Hadoop, and why is it important?

Hadoop is an open-source framework for distributed storage and processing of Big Data. It allows scalability and fault tolerance.

17. What are descriptive statistics?

Descriptive statistics summarizes and organizes data to describe its main features using measures like

Machine Learning Lab (BCSL606)

mean, median, mode, and standard deviation.

18. What are the measures of central tendency?

Mean: The average value.

Median: The middle value in a sorted dataset.

Mode: The most frequently occurring value.

19. What are measures of dispersion?

Range: Difference between the highest and lowest values.

Variance: The average squared deviation from the mean.

Standard Deviation: The square root of variance.

20. What is univariate data analysis?

Univariate data analysis involves analyzing a single variable to understand its distribution, central tendency, and variability.

21. What are some common methods of univariate data visualization?

Bar Charts: For categorical data.

Histograms: For continuous data.

Box Plots: To show distribution and detect outliers.

Pie Charts: To represent proportions.

22. How do you identify outliers in univariate data?

Box Plot: Data points outside the whiskers.

Z-Score: Data points with a Z-score $> \pm 3$.

IQR Method: Values below $Q1 - 1.5 \times IQR$ or above $Q3 + 1.5 \times IQR$.

23. What is bivariate data?

Data involving two variables, often analyzed to find relationships or correlations between them.

24. What is multivariate data?

Data involving three or more variables, analyzed to study complex relationships.

25. Give an example of bivariate and multivariate data.

Bivariate: Height vs. weight of individuals.

Multivariate: Height, weight, age, and income of individuals.

26. What are common techniques in multivariate statistics?

PCA (Principal Component Analysis), Factor Analysis, MANOVA (Multivariate Analysis of Variance), and Cluster Analysis.

Machine Learning Lab (BCSL606)

27. What is feature engineering?

The process of selecting, modifying, or creating features to improve the performance of a model.

28. What is dimensionality reduction?

Reducing the number of features in a dataset while preserving as much information as possible.

29. Name common dimensionality reduction techniques.

PCA, t-SNE, LDA (Linear Discriminant Analysis), and autoencoders.

30. What is nearest-neighbor learning?

A non-parametric method where predictions are based on the closest data points in the feature space.

31. What is the K-Nearest-Neighbor algorithm?

A classification or regression algorithm that considers the 'k' closest data points to make predictions.

32. What is weighted KNN?

A variant of KNN where closer neighbors are given more weight in predictions.

33. What is a nearest centroid classifier?

A classification method where each class is represented by the mean of its data points.

34. What is Locally Weighted Regression (LWR)?

A regression method that assigns weights to data points based on their distance from the query point.

35. What is regression?

A statistical method for modeling the relationship between a dependent variable and one or more independent variables.

36. Differentiate between linear and logistic regression.

Linear regression predicts continuous values, while logistic regression predicts probabilities for classification.

37. What is multiple linear regression?

A regression model with multiple independent variables.

38. What is polynomial regression?

A regression model that fits a polynomial equation to the data.

39. What is a decision tree?

A tree-like model used for classification and regression tasks, where decisions are made at nodes based on feature values.

Machine Learning Lab (BCSL606)

40. What is decision tree induction?

The process of building a decision tree from training data.

41. What is probability-based learning?

A method of learning based on probabilistic models, such as Bayes' theorem.

42. What is Bayes' theorem?

A formula that describes the probability of an event based on prior knowledge of related events.

43. What is the Naïve Bayes algorithm?

A probabilistic classifier based on Bayes' theorem, assuming independence between features.

44. What is an artificial neuron?

A computational model inspired by biological neurons, consisting of weights, bias, and an activation function.

45. What are the types of ANNs?

Feedforward, convolutional, recurrent, and generative adversarial networks.

46. What is clustering?

An unsupervised learning method to group similar data points.

47. What is hierarchical clustering?

A method that builds a hierarchy of clusters using agglomerative or divisive approaches.

48. What is density-based clustering?

A method that groups data points based on density, such as DBSCAN.

49. What is reinforcement learning?

A learning paradigm where agents learn by interacting with an environment to maximize cumulative rewards.

50. What is a Markov Decision Process (MDP)?

A mathematical framework for modeling decision-making in reinforcement learning.

51. What is Q-Learning?

A model-free RL algorithm that learns a value function to estimate the quality of actions.

52. What is SARSA?

An on-policy RL algorithm that updates its Q-values based on the current state-action pair and the next state-action pair.