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Experiment No. 6

Title: Implementation of Prediction algorithm (Linear Regression).

Aim: To implement a simple linear regression algorithm using Python to predict output based on input data.

Introduction :

Linear Regression is a **supervised learning algorithm** used for **predictive modeling**. It models the relationship between a **dependent variable** (target) and one or more **independent variables** (features) using a **linear equation**. The equation of a simple linear regression is: `y = mx + c`
Where:

- `y` is the predicted value
- `m` is the slope (coefficient)
- `x` is the input feature
- `c` is the intercept

Scikit-learn's `LinearRegression` model simplifies the process of **training** and **predicting**.

Procedure :

1. **Import Libraries:**
    - Use `numpy`, `matplotlib.pyplot`, and `sklearn.linear_model`.
    - Import `train_test_split` from `sklearn.model_selection`.

2. **Load and Prepare Data:**
    - Create or load input (e.g., experience) and output (e.g., salary) data.
    - Format the data as arrays or DataFrames.

3. **Split the Dataset:**
    - Use `train_test_split()` to create training and testing sets.

4. **Train the Model:**
    - Create `LinearRegression()` object and use `.fit()` with training data.

5. **Predict and Evaluate:**
    - Predict using `.predict(X_test)`.
    - Evaluate using `mean_squared_error()` and `r2_score()`.

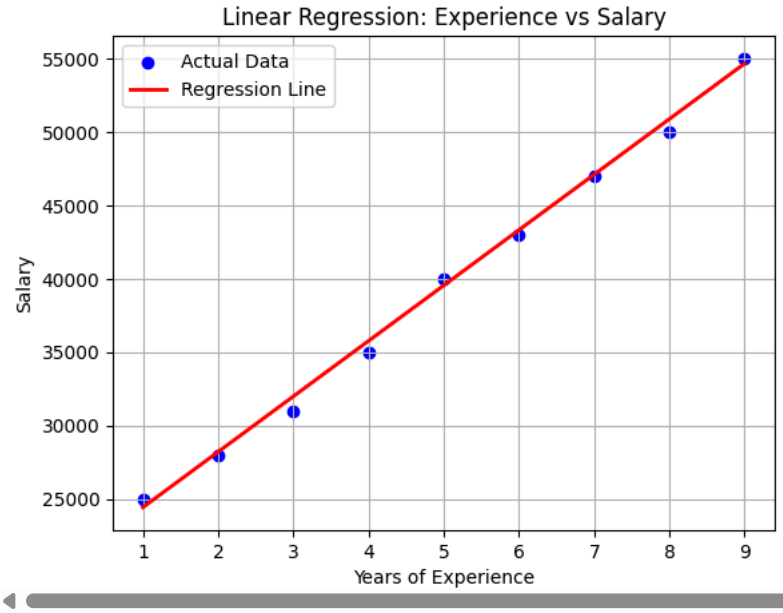
6. **Visualize Results:**
    - Plot data points and regression line using `matplotlib`.

Program Code and Output:

```
# DWM EXP6 TY9 40

# Importing necessary libraries
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score

# Sample data (Years of Experience vs Salary)
X = np.array([1, 2, 3, 4, 5, 6, 7, 8, 9]).reshape(-1, 1)  # Years of Experience
y = np.array([25000, 28000, 31000, 35000, 40000, 43000, 47000, 50000, 55000])  # Salary

# Splitting the dataset into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=0)

# Creating and training the Linear Regression model
model = LinearRegression()
model.fit(X_train, y_train)

# Predicting the values
y_pred = model.predict(X_test)

# Display the title before output
from IPython.display import display, Markdown
display(Markdown("**Implementation/Output snap shot:**"))

# Displaying the actual and predicted values
print("Actual values:", y_test)
print("Predicted values:", y_pred.astype(int))

# Evaluating the model
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)

print("Mean Squared Error (MSE):", round(mse, 2))
print("R² Score:", round(r2, 2))

# Plotting the regression line
plt.scatter(X, y, color='blue', label='Actual Data')
plt.plot(X, model.predict(X), color='red', linewidth=2, label='Regression Line')
plt.title("Linear Regression: Experience vs Salary")
plt.xlabel("Years of Experience")
plt.ylabel("Salary")
plt.legend()
plt.grid(True)
plt.show()
```

Implementation/Output snap shot:

```
Actual values: [50000 31000]
Predicted values: [50871 31984]
Mean Squared Error (MSE): 865021.75
R² Score: 0.99
```



Start coding or generate with AI.

Conclusion :

In this experiment, we successfully developed a basic Linear Regression model using Python along with the scikit-learn library. The model was trained on sample data, followed by prediction and performance evaluation using Mean Squared Error (MSE) and the R^2 Score. The graphical visualization supported the presence of a linear correlation between the input and output variables. Overall, this experiment provided valuable insights into the functioning of prediction algorithms and the techniques used to assess their accuracy and effectiveness.

Review Questions :

1. **What are the key steps involved in implementing a simple linear regression model using Python and scikit-learn?**

Ans. The following are the key steps to implement a **simple linear regression** using **Python** and **scikit-learn**:

- **Import libraries**: Required modules like `pandas`, `numpy`, `matplotlib`, `sklearn`.
- **Load/prepare dataset**: Read and preprocess the data.
- **Split the data** using `train_test_split()`: Separate into training and testing datasets.
- **Create and train the model**: Use `LinearRegression()` and `.fit()` to train.
- **Predict outcomes**: Use `.predict()` to make predictions on test data.
- **Evaluate**: Use metrics like Mean Squared Error (MSE) and R^2 Score.
- **Visualize results**: Plot regression line and residuals for better understanding.

2. **How can you evaluate the performance of a linear regression model in Python? List and explain at least two metrics.**

Ans. Two commonly used metrics to evaluate a linear regression model are:

- **Mean Squared Error (MSE)**: Measures the **average of the squares of errors** (differences between actual and predicted values). A lower MSE indicates better accuracy.
- **R^2 Score (Coefficient of Determination)**: Indicates how well the model explains the variability in the dependent variable. A value closer to **1** signifies a good model fit.

3. **What is the role of the train_test_split() function in building a linear regression model, and why is it important?**

Ans. The `train_test_split()` function is used to **divide the dataset** into training and testing sets.

- This allows the model to be **trained on one portion** of the data and **tested on another**, which helps:
    - Evaluate the model's performance on **unseen data**.
    - Prevent **overfitting**, ensuring better **generalization**.

Github Link: https://github.com/SrishtiPandey15/DWM-Batch-B-Exps