| SCHOOL OF COMPUTER SCIENCE AND ARTIFICIAL INTELLIGENCE | | DEPARTMENT OF COMPUTER SCIENCE ENGINEERING | |
|---|---|---|---|
| **Program Name:** B. Tech | | **Assignment Type:** Lab | **Academic Year:** 2025-26 |
| **Course Coordinator Name** | | Dr.Vairachilai Shenbagavel | |
| **Instructor(s) Name** | | Srinivas Komakula | |
| **Course Code** | 23CA201SE402 | **Course Title** | Explainable AI (P) |
| **Year/Sem** | III/V | **Regulation** | R24 |
| **Date and Day of Assignment** | 28-07-2025 | **Time(s)** | 09:00AM -05:00PM |
| **Duration** | 2 Hours | **Applicable to Batches** | **23CSBTB36** |
| **Assignment Number:** 01 | | | |

| Q. No. | Question | Expected Time to complete |
|---|---|---|
| 1 | Smart Gym – Fitness App | |

**Context:**

Smart Gym uses daily push notifications to increase user workout sessions.

| Push Notifications Sent (x) | Workout Sessions (y) |
|---|---|
| 1 | 25 |
| 2 | 35 |
| 3 | 42 |
| 1 | 28 |
| 2 | 38 |

**Objective:**

Analyze the effect of push notifications on daily workout sessions for Smart Gym by performing Linear Regression and interpreting SHAP values.

Requirements:

1. **Perform Linear Regression Analysis**
   - Use the given dataset where:
     - **Independent Variable (x):** Push Notifications Sent
     - **Dependent Variable (y):** Workout Sessions
2. **Calculate the Baseline Value**
   - Compute the **mean of all workout sessions (y values)**.
3. **Calculate SHAP Values**
   - For each record, calculate the difference between the **predicted value** and the **baseline**.
   - This difference is the **SHAP value**, attributed to the number of push notifications sent.
4. **Compute Final Prediction**
   - Use the **linear regression model** to calculate predicted workout sessions for each x value.
   - Confirm that:
     Final Prediction=Baseline+SHAP Value\text{Final Prediction} = \text{Baseline} + \ text{SHAP Value}Final Prediction=Baseline+SHAP Value
5. **Interpret the Results**
   - Explain how the number of push notifications influenced each predicted workout count.
   - Compare the predicted value to the actual value for each row.
   - Identify **underproduction** or **overproduction**, and provide reasoning.

**Deliverables:**

A notebook or document containing:

- Linear regression implementation with coefficients
- Baseline (mean of y)
- Table of SHAP values and predictions
- Explanation of how each input influenced the prediction
- Comparison of predicted vs actual values, with over/under prediction notes
- Summary analysis covering:
  - Accuracy of the model
  - Trend analysis
  - SHAP interpretation insights

| Q. No. | Question | Expected Time to complete |
|---|---|---|
| 2 | FitFuel – Brand Awareness Campaign using Multiple Linear Regression and SHAP Analysis | |

**Objective:**

Analyze how gym collaborations and influencer posts contribute to the brand awareness score using Multiple Linear Regression and explain the model outputs using SHAP value interpretation.

**Given Dataset:**

| Gym Collabs ($x_1$) | Influencer Posts ($x_2$) | Awareness Score ($y$) |
|---|---|---|
| 2 | 5 | 70 |
| 1 | 3 | 55 |
| 3 | 4 | 80 |
| 0 | 2 | 40 |
| 2 | 1 | 50 |

**Tasks:**

1. **Perform Multiple Linear Regression Analysis**
   - Use Gym Collaborations and Influencer Posts as independent variables
   - Use Awareness Score as the dependent variable
2. **Calculate the Baseline Value**
   - Compute the mean of all awareness scores
3. **Calculate SHAP Values**
   - Calculate SHAP Value
   - Distribute SHAP contributions between Gym Collabs and Influencer Posts based on model coefficients
4. **Compute Final Prediction for Each Record**
   - Use the regression equation
   - Verify: Prediction = Baseline + SHAP (Gym Collabs) + SHAP (Influencer Posts)
5. **Interpret the Results**
   - For each data point, describe how gym collaborations and influencer posts contributed to the predicted awareness score
   - Compare prediction to actual score
   - Note whether the model overpredicted or underpredicted and provide reasoning

| | | |
|---|---|---|
| **Q. No.** | **Question** | **Expected Time to complete** |
| 3 | **Regression with Diabetes Dataset** | |

**Objective:**

Understand how patient features influence disease progression using Multiple Linear Regression and

SHAP value analysis.

Tasks

*1. Perform Multiple Linear Regression Analysis*

- Use all available features from the Diabetes dataset as independent variables.
- Fit a Multiple Linear Regression model to predict disease progression.

*2. Calculate the Baseline Value*

- Compute the **mean** of the target variable (disease progression scores) from the training data.
- This will serve as the **baseline prediction**.

*3. Calculate SHAP Values*

- Apply SHAP to compute **feature contributions** to each prediction.
- Use model coefficients to proportionally attribute the difference from the baseline to each feature.

*4. Compute Final Prediction for Each Record*

- For every test record, verify that:

**Prediction = Baseline + SHAP(Feature$_1$) + SHAP(Feature$_2$) + ... + SHAP(Feature$_n$)**

*5. Interpret the Results*

- For each patient record:
  - Explain how each feature contributed to the predicted disease progression.
  - Compare the **predicted value** vs the **actual observed value**.
  - Comment on whether the model **overpredicted or underpredicted** and **why**, based on SHAP values.

| Q. No. | Question | Expected Time to complete |
|---|---|---|
| 4 | **Regression with Student Performance Dataset** | |

**Objective:**

Investigate how student background and behavior influence final exam scores using Multiple Linear Regression and SHAP value analysis.

**Tasks**

*1. Perform Multiple Linear Regression Analysis*

- Use all relevant student attributes (e.g., study time, parental education, absences, etc.) as independent variables.
- Fit a regression model to predict the **final exam score**.

*2. Calculate the Baseline Value*

- Compute the **mean of the final exam scores** from the training set.
- This serves as the **baseline prediction** (expected value).

*3. Calculate SHAP Values*

- Use SHAP to compute the contribution of each student attribute to the final exam score prediction.
- Distribute the prediction deviation from the baseline among the features.

*4. Compute Final Prediction for Each Record*

- For each student record, confirm:

**Predicted Score = Baseline + SHAP(Feature$_1$) + SHAP(Feature$_2$) + ... + SHAP(Feature$_n$)**

*5. Interpret the Results*

- For every prediction:
  - Explain how different features (e.g., study time, failures, health) impacted the exam score.
  - Compare predicted score to actual score.
  - Comment on overprediction or underprediction and possible reasons behind it.