Programming Problem 1: LIME for Classification

Use the **Diabetes dataset**.

1. Train three classification models (e.g. Logistic Regression, SVM, and MLP). (3 points)
2. Select 5 test samples and generate local explanations using **LIME**. (5 points)
3. Report the most influential features identified by LIME for each sample. (3 points)
4. Discuss whether the influential features align with the global model behavior. (5 points)
5. In LIME, the importance of perturbed samples is determined using a kernel function that assigns higher weights to points closer to the instance being explained. The kernel is defined as:

$$\pi_x(z) = \exp\left(-\frac{D(x,z)^2}{(0.75\sqrt{d})^2}\right),$$

where:

- x = instance being explained,
- z = perturbed sample,
- D(x, z) = Euclidean distance between x and z,
- d = number of features in the dataset.

Analyze how the choice of the kernel width parameter $0.75\sqrt{d}$ affects the distribution of weights. Experiment by replacing 0.75 with 0.25 and 1.0. Discuss your observations on two samples. (4 points)

Programming Problem 2: SHAP for Classification

Use the **Breast Cancer dataset** from sklearn.datasets.load_breast_cancer.

1. Train three classification models (e.g. Logistic Regression, SVM, and MLP). (3 points)
2. Use **SHAP** to explain predictions for 5 randomly chosen test samples. (5 points)
3. Plot SHAP summary and dependence plots to visualize feature importance. (5 points)

Programming Problem 3: LIME and SHAP on MNIST

Use the **MNIST dataset**.

1. Train a CNN model on MNIST. (2 points)
2. Use **LIME** to explain predictions for 5 test images. (5 points)
3. Use **SHAP (DeepExplainer or GradientExplainer)** to explain the same 5 images. (5 points)
4. Compare and discuss the differences and similarities between LIME and SHAP explanations. (5 point)

Programming Problem 4: LIME and SHAP with Pretrained Model

1. Load a pretrained **Inception V3 or ResNet50** model and classify 5 CIFAR-10 images. (5 points)
2. Generate explanations for each image using both **LIME** and **SHAP**. (5 points)
3. Critically evaluate which method provides more intuitive explanations and justify your reasoning. (5 points)