# Assignment 8

*FOML (IT-582)*

Dhirubhai Ambani University

## Part I — Soft-Margin Role (Linear Kernel)

Dataset : IRIS

1. **Train Linear SVM:** Train a Support Vector Machine using a `Linear Kernel` with multiple values of the regularization parameter $C$.

   $$C \in \{0.01, 0.1, 1, 10, 100\}$$

   Use the `SVC(kernel='linear')` implementation from `scikit-learn`.

2. **Plot Decision Boundary:** For each value of $C$, plot the corresponding decision boundary along with the data points. Observe how the margin changes with varying $C$.

3. **Report and Analysis:**

   - Training accuracy for each $C$ value.
   - Validation accuracy for each $C$ value.
   - Number of support vectors used by the model.
   - Observe the following:
     - Margin width variation as $C$ increases.
     - Number of misclassifications and how they change with $C$.

## Part II — Kernel SVM (Nonlinear Data using Toy Synthetic Datasets)

- **Datasets Used:**
  - `make_moons`: Nonlinear, two-class dataset.
  - `make_circles`: Nonlinear, concentric circles dataset.
  - Add Gaussian noise to both datasets to make them more realistic.

1. **Train SVMs with Different Kernels:**

- **Linear Kernel:** `kernel='linear'`
- **Polynomial Kernel:** `kernel='poly'`, with polynomial degrees $d = 2, 3$ (tuned)
- **RBF Kernel:** `kernel='rbf'`, with parameter $\gamma$ tuned

2. **Report and Analysis:**
   - Record the following metrics for each combination of kernel :
     - Training accuracy
     - Validation accuracy
     - Number of support vectors
   - **Observations:**
     - Examine the number of misclassifications and their dependence on kernel .
     - Compare how linear and nonlinear kernels handle complex decision boundaries in noisy data.