ENGR 421: HW0 Report

- **Data Generation:**

  The 3 sets of data were generated with 3 gaussian distribution function, using the built-in function in the numpy library: `np.random.multivaraite_normal(mean, cov, size)`

  Where the mean, cov and size are the parameters provided in the HW0 question.

- **Parameters Estimation:**

  The parameters $\hat{\mu}_1$, $\hat{\mu}_2$, $\hat{\mu}_3$, $\hat{\Sigma}_1$, $\hat{\Sigma}_2$, $\hat{\Sigma}_3$, **$\hat{P}(y = 1)$, $\hat{P}(y = 2)$, $\hat{P}(y = 3)$** were estimated using the following formulas:

$$\hat{\mu} = \frac{\sum_{i=1}^{N}[1(y_c = c)x_i]}{N_c}$$

$$\hat{\Sigma} = \frac{\sum_{i=1}^{N}[1(\mathrm{y_i} = c)(x_i - \hat{\mu}_c)(x_i - \hat{\mu}_c)^T]}{\mathrm{N_c}}$$

$$\hat{\mathrm{P}}(\mathrm{y} = \mathrm{c}) = \frac{\sum_{i=1}^{N} 1(\mathrm{y_i} = \mathrm{c})}{N}$$

- **Data Points Estimation:**

  For the data estimation a score function $\boldsymbol{g_c(x)}$ was calculated for each data class. i.e. for c = 1, c = 2 and c = 3. Then all the data points are predicted with the score functions: each data point is tested with the three score functions and if the score was maximum when tested with $\boldsymbol{g_1(x)}$ the point is classified as from class 1 and so on.

$$g_c(x) = x^T W_c x + w_c^T x + w_{c0}$$

Where:

$$W_c = -\frac{1}{2}\hat{\Sigma}_c^{-1}$$

$$w_c = \hat{\Sigma}_c^{-1}\hat{\mu}_c$$

$$w_{c0} = -\frac{1}{2}\hat{\mu}_c^T\hat{\Sigma}_c^{-1}\hat{\mu}_c - \frac{1}{2}\log(\left|\hat{\Sigma}_c\right|) + \log(\hat{P}(y = c))$$