

Part one: Theory Questions

1)

$$\text{class 1} = \begin{bmatrix} -2 & 1 \\ -5 & -4 \\ -3 & 1 \\ 0 & 3 \\ -8 & 11 \end{bmatrix} \quad \text{class 2} = \begin{bmatrix} -2 & 5 \\ 1 & 0 \\ 5 & -1 \\ -1 & -3 \\ 6 & 1 \end{bmatrix}$$

a)

Feature 1

$$p_{-2} = 1, p_{-5} = 1, p_{-3} = 1, p_0 = 1, p_{-8} = 1$$

$$n_{-2} = 1, n_{-5} = 1, n_{-3} = 1, n_0 = 1, n_{-8} = 1$$

$$\mathbb{E}(H(1)) = \left(\frac{2}{10}\right) * \left(-\frac{1}{2} * \log_2\left(\frac{1}{2}\right) - \frac{1}{2} \log_2\left(\frac{1}{2}\right)\right) = 0.2$$

Only -2 considered since rest evaluate to 0.

$$IG(1) = \left(-\frac{5}{10} * \log_2\left(\frac{5}{10}\right) - \frac{5}{10} \log_2\left(\frac{5}{10}\right)\right) - 0.2 = 0.8$$

Feature 2

$$p_1 = 2, p_{-4} = 1, p_3 = 1, p_{11} = 1$$

$$n_5 = 1, n_0 = 1, n_{-1} = 1, n_{-3} = 1, n_1 = 1$$

$$\mathbb{E}(H(2)) = \left(\frac{3}{10}\right) * \left(-\frac{2}{3} * \log_2\left(\frac{2}{3}\right) - \frac{1}{3} \log_2\left(\frac{1}{3}\right)\right) = 0.2755$$

Only 1 considered since rest evaluate to 0.

$$IG(2) = \left(-\frac{5}{10} * \log_2\left(\frac{5}{10}\right) - \frac{5}{10} \log_2\left(\frac{5}{10}\right)\right) - 0.2755 = 0.7245$$

b) Based on the results in part a, since Feature 1 has a higher information gain, Feature 1 is more discriminating.

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Part two: Dimensionality Reduction via PCA

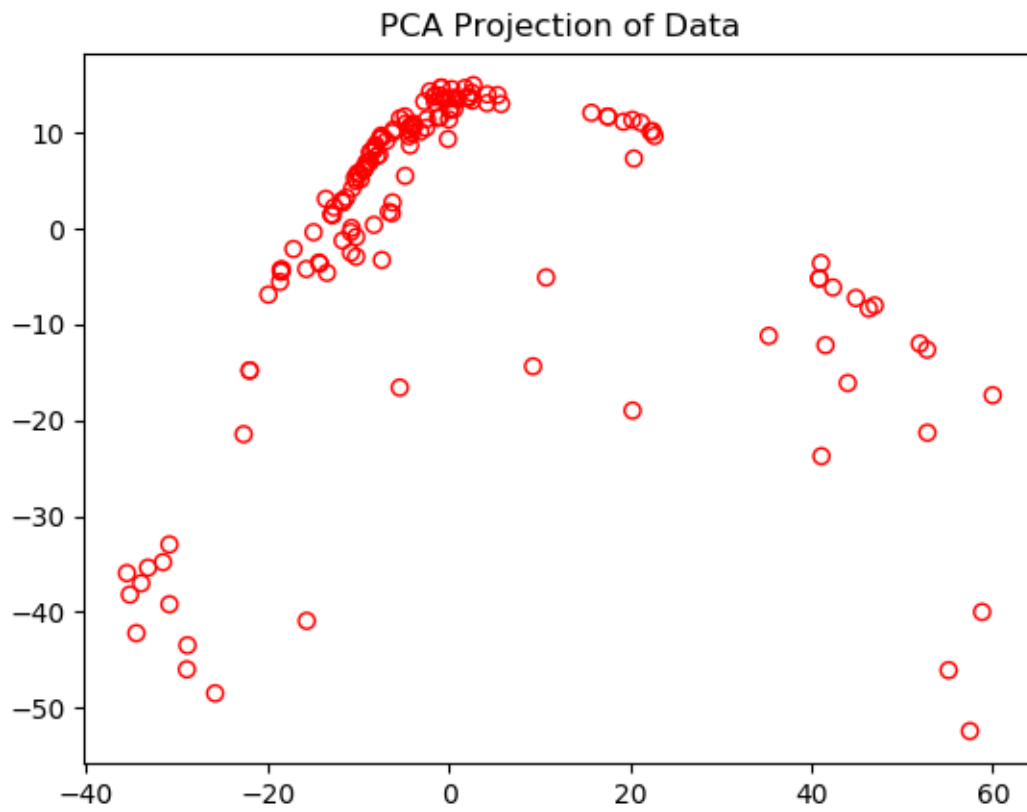


Fig 1: PCA projection of data

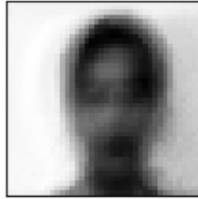
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Part three: Eigenfaces

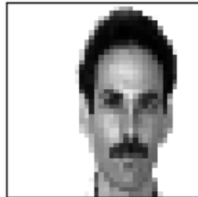
1) Primary Principle Component



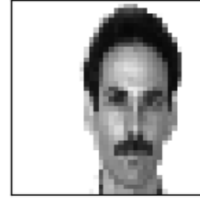
3) Single PC Reconstruction



5) Reconstruction using all eigenvectors



2) Original Image



4) K (=49) PC Reconstruction

