Aprendizagem 2023
Homework II – Group 28

Gonçalo Bárias (ist1103124) & Raquel Braunschweig (ist1102624)

Part I: Pen and Paper

Consider the following dataset:

D	y_1	y_2	y_3	y_4	y_5	y_6
$\mathbf{x}_1$	0.24	0.36	1	1	0	A
$\mathbf{x}_2$	0.16	0.48	1	0	1	A
$\mathbf{x}_3$	0.32	0.72	0	1	2	A
$\mathbf{x}_4$	0.54	0.11	0	0	1	B
$\mathbf{x}_5$	0.66	0.39	0	0	0	B
$\mathbf{x}_6$	0.76	0.28	1	0	2	B
$\mathbf{x}_7$	0.41	0.53	0	1	1	B
$\mathbf{x}_8$	0.38	0.52	0	1	0	A
$\mathbf{x}_9$	0.42	0.59	0	1	1	B

1. **Consider x_1 - x_7 to be training observations, x_8 - x_9 to be testing observations, y_1 - y_5 to be input variables and y_6 to be the target variable.**
   ***Hint*: you can use `scipy.stats.multivariate_normal` for multivariate distribution calculus**

   (a) **Learn a Bayesian classifier assuming: i) $\{y_1, y_2\}$, $\{y_3, y_4\}$ and $\{y_5\}$ sets of independent variables (e.g., $y_1 \perp\!\!\!\perp y_3$ yet $y_1 \perp\!\!\!\perp y_2$), and ii) $y_1 \times y_2 \in \mathbb{R}^2$ is normally distributed. Show all parameters (distributions and priors for subsequent testing).**

   Blah

   (b) **Under a MAP assumption, classify each testing observation showing all your calculus.**

   Blah

   (c) **Consider that the default decision threshold of $\theta = 0.5$ can be adjusted according to**

$$f(\mathbf{x}|\theta) = \begin{cases} A, & P(A|\mathbf{x}) > \theta \\ B, & \text{otherwise} \end{cases}$$

   Under a maximum likelihood assumption, what thresholds optimize testing accuracy?

   Blah

2. **Let y_1 be the target numeric variable, y_2 - y_6 be the input variables where y_2 is binarized under an equal-width (equal-range) discretization. For the evaluation of regressors, consider a 3-fold cross-validation over the full dataset (x_1 - x_9) without shuffling the observations.**

   (a) **Identify the observations and features per data fold after the binarization procedure.**

   Blah

(b) **Consider a distance-weighted kNN with k = 3, Hamming distance (d), and 1 / d weighting. Compute the MAE of this kNN regressor for the 1^{st} iteration of the cross-validation (i.e. train observations have the lower indices).**

Blah

Part II: Programming and critical analysis

Considering the `column_diagnosis.arff` dataset available at the course webpage's homework tab. Using `sklearn`, apply a 10-fold stratified cross-validation with shuffling (`random_state=0`) for the assessment of predictive models along this section.

1. **Compare the performance of kNN with k = 5 and naïve Bayes with Gaussian assumption (consider all remaining parameters for each classifier as `sklearn`'s default):**

   (a) **Plot two boxplots with the fold accuracies for each classifier.**

   Blah

   (b) **Using `scipy`, test the hypothesis "kNN is statistically superior to naïve Bayes regarding accuracy", asserting whether is true.**

   Blah

2. **Consider two kNN predictors with k = 1 and k = 5 (uniform weights, Euclidean distance, all remaining parameters as default). Plot the differences between the two cumulative confusion matrices of the predictors. Comment.**

   Blah

3. **Considering the unique properties of `column_diagnosis`, identify three possible difficulties of naïve Bayes when learning from the given dataset.**

   Blah