ASSIGNMENT 3 REPORT

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Under the guidance
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CLASSIFICATION USING NAVIE BAYES

Introduction :

In this homework we implemented the Naive Bayes classifier , in which we have 3 classes and total 10 features were there and features followed different probability distributions. Feature 1 and 2 followed Gaussian distribution, feature 3 and 4 followed Bernoulli distribution, feature 5 and 6 followed Laplace distribution , feature 7 and 8 followed Exponential Distribution and feature 9 and 10 followed Multinomial Distribution.

Implementation :

We initially calculated the parameters of each datapoint (x1,x2,x3,x4,x5,x6,x7,x8,x9,x10) related to their respective distribution. Then we added the log of their probability density function (pdf) and calculated their log maximum likelihood, of each class.

Thus, the class which has the maximum likelihood is assigned that particular data point. And so on we calculate the probability of each data point. We used the following probability density function given below:

Probability Density function and log likelihood estimation of different distributions used in this Classifier:

Prior Probability :

Class 0	Class 1	Class 2
0.33	0.33	0.33

1. **Gaussian Distribution :**

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}}\, e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

$f(x)$ = probability density function

σ = standard deviation

μ = mean

2. Bernoulli Distribution :

$$f(k; p) = p^{k}(1 - p)^{1-k} \text{ for k} \in \{0,1\}$$

p = probability

k = possible outcomes

$f(x)$ = probability density function

f = probability mass function

3. Laplace Distribution :

$$f(x \mid \mu,b) = \frac{1}{2b} exp(- \frac{|x-\mu|}{b})$$

μ = mean

$f(x)$ = probability density function

4. Exponential Distribution :

$$f(x; \lambda) = \begin{cases} \lambda e^{-\lambda x} & x \geq 0, \ 0 \ x < 0 \end{cases}$$

$f(x; \lambda)$= Probability density function

λ = Rate parameter

5. Multinomial Distribution:

$$f(x_1,\ldots..,x_k; p1,\ldots.. p_k) = \frac{\Gamma(\sum_i x_i + 1)}{\prod_i \Gamma(x_i + 1)} \prod_{i=1}^{k} p_i^{x_i}$$

$p1,\ldots.. p_k$ = event probabilities

f(x;λ)= Probability density function

1. **Gaussian (Features: X1, X2):**

Feature	Parameter	Class 0	Class 1	Class 2
X1	Mean(μ)	2.02	0.021	8.02
	Variance(σ^2)	9.05	25.16	35.66
X2	Mean(μ)	3.90	0.855	-0.021
	Variance(σ^2)	78.43	230.03	4.00

2. **Bernoulli (Features : X3, X4):**

Feature	Parameter	Class 0	Class 1	Class 2
X3	p	0.20	0.59	0.90
X4	p	0.10	0.80	0.19

3. **Laplace (Features : X5, X6):**

Feature	Parameter	Class 0	Class 1	Class 2
X5	μ	0.06	0.38	0.74
	b	1.98	0.99	3.00
X6	μ	0.86	0.29	0.21
	b	5.97	5.99	3.06

4. **Exponential (Features: X7,X8):**

Feature	Parameter	Class 0	Class 1	Class 2
X7	λ	1.97	2.98	8.94
X8	λ	3.93	7.98	14.68

5. Multinomial(Features :X9, X10):

Feature	Parameter	Class 0	Class 1	Class 2
X9	p0	0.202	0.097	0.205
	p1	0.203	0.198	0.299
	p2	0.204	0.404	0.103
	p3	0.196	0.158	0.341
	p4	0.193	0.141	0.050
X10	p0	0.121	0.101	0.197
	p1	0.123	0.051	0.048
	p2	0.125	0.051	0.048
	p3	0.127	0.199	0.105
	p4	0.127	0.152	0.155
	p5	0.127	0.149	0.153
	p6	0.124	0.200	0.098
	p7	0.123	0.096	0.194

Result :

Accuracy on Test Data Set: 0.9021666666666667

Training Accuracy : 0.9014666666666666

Validation Accuracy : 0.9021666666666667

Training F1 Score :

Class 0	Class 1	Class 2
0.8813118688131187	0.878725018972932	0.943606981663

Validation F1 Score :

Class 0	Class 1	Class 2
0.880856360468011	0.8781627883345189	0.946671279592744 6

Accuracy on test dataset : 0.9021666666666667

Conclusion :

We successfully implemented the Naive Bayes classifier, and got the validation accuracy of 90.216