

1 Homework Problem

Question 1

A banknote authentication data set includes images that were taken from 1000 genuine and 320 forged banknote-like specimens. A classification algorithm predicted that 950 out of the 1000 banknotes are authentic and 240 out of the 320 forged. Calculate the sensitivity, specificity, precision, false discovery rate and classification accuracy.

Solution: It is given that $Pos = TP + FN = 1000$, $Neg = TN + FP = 320$, $TP = 950$, $TN = 240$. Thus $FN = 50$ and $FP = 80$. Therefore

$$sensitivity = \frac{TP}{Pos} = 950/1000 = 95\%$$

$$specificity = \frac{TN}{Neg} = 240/320 = 75\%$$

$$precision = \frac{TP}{TP + FP} = 950/(950 + 80) = 92.2\%$$

$$FDR = \frac{FP}{TP + FP} = 80/(950 + 80) = 7.8\%$$

$$accuracy = \frac{TP + TN}{Pos + Neg} = (950 + 240)/(1000 + 320) = 90.2\%$$

Question 2

Calculate the root-mean squared (RMS) error of the function $f(x) = 3 * x^2 - 10$ for the following dataset, where x denotes the input variable and y the target variable. (Note: It is suggested to copy-paste the values into an Excel worksheet or Libre Office for automated calculations.)

Solution: The RMS error is 0.794 as explained in the following table.

| x | y |
|----------|----------|
| 1.2 | -5.4 |
| 5.5 | 81.3 |
| 3.4 | 25.0 |
| 0.1 | -10.2 |
| 2.9 | 14.5 |
| 3.4 | 23.9 |
| 0.1 | -10.8 |
| 1.2 | -6.3 |
| 3.9 | 34.6 |
| 1.9 | 1.4 |
| 0.2 | -9.1 |
| 1.0 | -7.5 |
| 1.4 | -4.1 |
| 5.1 | 66.5 |
| 6.1 | 102.9 |
| 1.6 | -1.1 |
| 2.7 | 12.4 |

| x | y | $f(x) = 3x^2 - 10$ | $(y - f(x))^2$ | RMS |
|-----|-------|--------------------|----------------|-------|
| 1.2 | -5.4 | -5.68 | 0.08 | 0.794 |
| 5.5 | 81.3 | 80.75 | 0.30 | |
| 3.4 | 25 | 24.68 | 0.10 | |
| 0.1 | -10.2 | -9.97 | 0.05 | |
| 2.9 | 14.5 | 15.23 | 0.53 | |
| 3.4 | 23.9 | 24.68 | 0.61 | |
| 0.1 | -10.8 | -9.97 | 0.69 | |
| 1.2 | -6.3 | -5.68 | 0.38 | |
| 3.9 | 34.6 | 35.63 | 1.06 | |
| 1.9 | 1.4 | 0.83 | 0.32 | |
| 0.2 | -9.1 | -9.88 | 0.61 | |
| 1 | -7.5 | -7.00 | 0.25 | |
| 1.4 | -4.1 | -4.12 | 0.00 | |
| 5.1 | 66.5 | 68.03 | 2.34 | |
| 6.1 | 102.9 | 101.63 | 1.61 | |
| 1.6 | -1.1 | -2.32 | 1.49 | |
| 2.7 | 12.4 | 11.87 | 0.28 | |