**Contingency Table & Performance Evaluation**

Table shows the (actual) class label alongside the (predicted) response values of five classifiers A-E.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Instance | **(actual) class label** | Classifier A | Classifier B | Classifier C | Classifier D | Classifier E |
| 1 | **P** | P | P | P | P | P |
| 2 | **P** | P | P | P | P | N |
| 3 | **N** | P | P | P | N | P |
| 4 | **N** | P | P | N | N | N |
| 5 | **P** | P | P | N | N | P |
| 6 | **P** | P | N | P | P | N |
| 7 | **N** | P | N | P | P | P |
| 8 | **N** | P | N | P | N | N |
| 9 | **P** | P | N | N | N | P |
| 10 | **P** | P | N | N | N | N |
| 11 | **N** | N | P | P | P | P |
| 12 | **N** | N | P | P | P | N |
| 13 | **P** | N | P | P | N | P |
| 14 | **P** | N | P | N | N | N |
| 15 | **N** | N | P | N | N | P |
| 16 | **N** | N | N | P | P | N |
| 17 | **P** | N | N | P | P | P |
| 18 | **P** | N | N | P | N | N |
| 19 | **N** | N | N | N | N | P |
| 20 | **N** | N | N | N | N | N |

**(Q1)** Fill in the blanks with TP, FP, FN, TN, and the corresponding frequency value for each category. Also, write down the row sum or column sum in the last column and the last row, respectively.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Actual class (known) | |  |
|  |  | P | N |  |
| Classifier A  (returned) | P | TP = 0.3 | FP = 0.2 | 0.5 |
| N | FN = 0.2 | TN = 0.3 | 0.5 |
|  |  | 0.5 | 0.5 | 1 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Actual class (known) | |  |
|  |  | P | N |  |
| Classifier B  (returned) | P | .25 | .25 | .5 |
| N | .25 | .25 | .5 |
|  |  | .5 | .5 | 1 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Actual class (known) | |  |
|  |  | P | N |  |
| Classifier C  (returned) | N | .3 | .3 | .6 |
| P | .2 | .2 | .4 |
|  |  | .5 | .5 | 1 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Classifier D | |  |
|  |  | P | N |  |
| Actual class (known) | P | .2 | .2 | .4 |
| N | .3 | .3 | .6 |
|  |  | .5 | .5 | 1 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Classifier E | |  |
|  |  | P | N |  |
| Actual class  (known) | N | .25 | .25 | .5 |
| P | .25 | .25 | .5 |
|  |  | .5 | .5 | 1 |

Table shows the (known) class label, where ‘1’ and ‘0’ stands for ‘P’ and ‘N’, respectively. Based upon the (predicted) probability values (with Classifiers F) given in the third column, answer the questions below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Instance | **(Known) class label** | (Returned)  probability | ≥0 | ≥0.1 | ≥0.2 | ≥0.3 | ≥0.4 | ≥0.5 | ≥0.6 | ≥0.7 | ≥0.8 | ≥0.9 | ≥1.0 |
| 1 | **1** | 0.99 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 2 | **1** | 0.88 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| 3 | **0** | 0.77 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 4 | **0** | 0.44 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | **1** | 0.66 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 6 | **1** | 0.55 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 7 | **0** | 0.58 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 8 | **0** | 0.11 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | **1** | 0.44 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | **1** | 0.79 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 11 | **0** | 0.33 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | **0** | 0.22 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | **1** | 0.75 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 14 | **1** | 0.65 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 15 | **0** | 0.51 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 16 | **0** | 0.15 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | **1** | 0.63 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 18 | **1** | 0.36 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | **0** | 0.18 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | **0** | 0.42 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| TP | | | 10 | 10 | 10 | 10 | 9 | 8 | 7 | 4 | 2 | 1 | 0 |
| FP | | | 10 | 10 | 7 | 6 | 5 | 3 | 1 | 1 | 0 | 0 | 0 |
| FN | | | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 6 | 8 | 9 | 10 |
| TN | | | 0 | 0 | 3 | 4 | 5 | 7 | 9 | 9 | 10 | 10 | 10 |
| accuracy | | | .5 | .5 | .65 | .7 | .7 | .75 | .8 | .65 | .6 | .55 | .5 |
| precision | | | .5 | .5 | .588235 | .625000 | .642857 | .727273 | .875 | .8 | 1 | 1 | Nan |
| recall | | | 1 | 1 | 1 | 1 | .9 | .8 | .7 | .4 | .2 | .1 | 0 |
| F1-score | | | .666667 | .666667 | .740741 | .769231 | .75 | .761905 | .777778 | .5333333 | .333333 | .181818 | NaN |
| TPR | | | 1 | 1 | 1 | 1 | .9 | .8 | .7 | .4 | .2 | .1 | 0 |
| FPR | | | 1 | 1 | .7 | .6 | .5 | .3 | .1 | .1 | 0 | 0 | 0 |

**(Q2)** Referring to the Classification Metrices at the scikit-learn resource (below), write a Python code that computes TP, FP, FN, TN, accuracy, precision, recall, F1-score, TPR, and FPR for each threshold t.

**Code in actual\_vs\_predicted.ipynb**

Reference for Classification Metrices:

<https://scikit-learn.org/stable/modules/classes.html#classification-metrics>

**(Q3)** Also, based upon the TPR and FPR values (obtained above), write a Python code that generates both ROC (Receiver Operating Characteristic) curve and computes AUC (Area Under Curve) value for Classifier F.

**Code in actual\_vs\_predicted.ipynb**