COMP 472: Artificial Intelligence

Classification Metrics

Solutions

1 Question

(a) Assume that you have the following datasets:

training set:

	a1	**a2**	**a3**	**Expected Output**
Data1	1.0	1.0	1.0	cat
Data2	1.5	1.0	2.0	dog
Data3	3.0	1.0	4.0	elephant
Data4	5.0	1.0	7.0	cat
Data5	3.5	1.0	5.0	elephant
Data6	4.5	1.0	5.0	cat
Data7	3.5	1.0	4.5	cat

validation set:

	a1	**a2**	**a3**	**Expected Output**
Data1	1.0	1.0	1.0	cat
Data2	1.5	1.0	2.0	dog
Data3	3.0	1.0	4.0	elephant
Data4	5.0	1.0	7.0	cat
Data5	3.5	1.0	5.0	elephant
Data6	4.5	1.0	5.0	cat
Data7	3.5	1.0	4.5	cat

test set:

	a1	**a2**	**a3**	**Expected Output**
Data1	1.0	1.0	1.0	cat
Data2	1.5	1.0	2.0	dog
Data3	3.0	1.0	4.0	elephant
Data4	5.0	1.0	7.0	cat
Data5	3.5	1.0	5.0	elephant
Data6	4.5	1.0	5.0	cat
Data7	3.5	1.0	4.5	cat

and you have built 2 models that give you the following outputs with the above data sets:

with the training set:

	model 1	**model 2**
Data1	cat	cat
Data2	dog	dog
Data3	dog	elephant
Data4	dog	cat
Data5	elephant	cat
Data6	dog	cat
Data7	cat	cat

with the validation set:

	model 1	**model 2**
Data1	dog	cat
Data2	dog	cat
Data3	dog	elephant
Data4	cat	cat
Data5	elephant	cat
Data6	dog	cat
Data7	cat	cat

with the test set:

	model 1	**model 2**
Data1	dog	cat
Data2	dog	cat
Data3	elephant	cat
Data4	dog	cat
Data5	dog	elephant
Data6	cat	cat
Data7	cat	cat

(a) What is the classification accuracy of model 1? What is the classification accuracy of model 2?

Solution

The classification accuracy is equal to the percentage of instances of the test set that the model correctly classifies. Let's calculate the accuracy for model 1 and model 2.
model 1:

$$Accuracy = \frac{4}{7} \times 100 = 57\%$$

model 2:

$$Accuracy = \frac{5}{7} \times 100 = 71\%$$

(b) Show the Confusion Matrix of both models with the test set.

Solution

Confusion matrix for model 1:

	Expected		
	Dog	**Cat**	**Elephant**
Predicted Dog	1	2	1
Predicted Cat	0	2	0
Predicted Elephant	0	0	1

Confusion matrix for model 2:

	Expected		
	Dog	**Cat**	**Elephant**
Predicted Dog	0	0	0
Predicted Cat	1	4	1
Predicted Elephant	0	0	1

(c) Calculate the Precision, Recall, and F1-measure of both models.

Solution

Let's evaluate **Model 1**:
True positive: diagonal position, which is equal to 1.
False positive: sum of row (without main diagonal), which is 3.
False negative: sum of column (without main diagonal), which is 0.
Precision of class Dog:

$$\frac{TP}{TP+FP} = \frac{1}{4} = 0.25$$

Recall of class Dog:

$$\frac{TP}{TP+FN} = \frac{1}{1} = 1$$

F1-measure of class Dog:

$$\frac{2 \times Precision \times Recall}{Precision + Recall} = \frac{2 \times 0.25 \times 1}{0.25 + 1} = 0.4$$

Using the same principle, we can compute P, R and F1 for the classes Cat and Elephant:

	Precision	**Recall**	**F1-measure**
Class Dog	0.25	1	0.4
Class Cat	1	0.5	0.66
Class Elephant	1	0.5	0.66

For **Model 2** we have:
Precision of class Cat:

$$\frac{TP}{TP+FP} = \frac{4}{6} = 0.67$$

Recall of class Cat:

$$\frac{TP}{TP+FN} = \frac{4}{4} = 1$$

F1-measure of class Cat:

$$\frac{2 \times Precision \times Recall}{Precision + Recall} = \frac{0.67 \times 2}{1.67} = 0.80$$

	Precision	**Recall**	**F1-measure**
Class Dog	0	0	0
Class Cat	0.67	1	0.8
Class Elephant	1	0.5	0.67