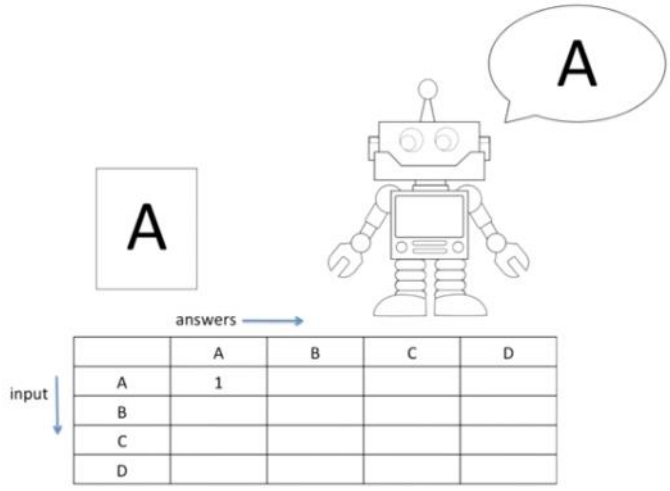
confusion matrix(배포용)

2019년 1월 23일 수요일 오후 2:13

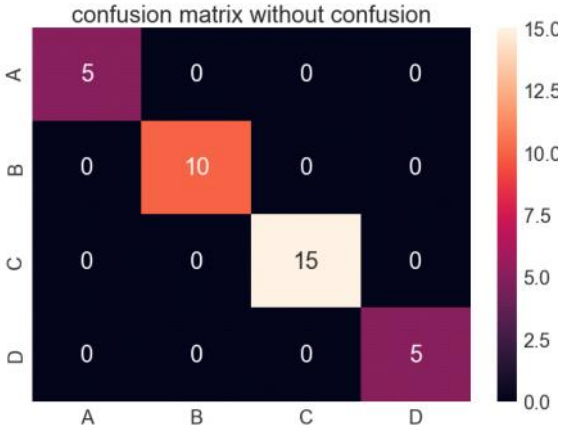


	A	B	C	D
A	1	0	0	0
B	0	1	0	1
C	0	0	1	0
D	0	0	0	2

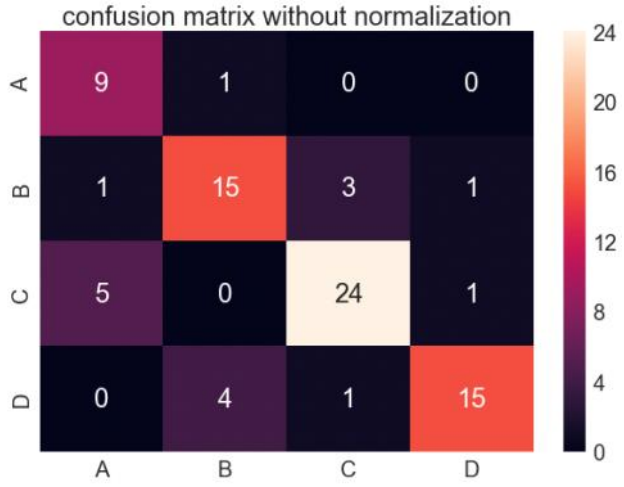
Performance measures

- **Accuracy**
- **Precision**
- **Recall**
- **F1 score**

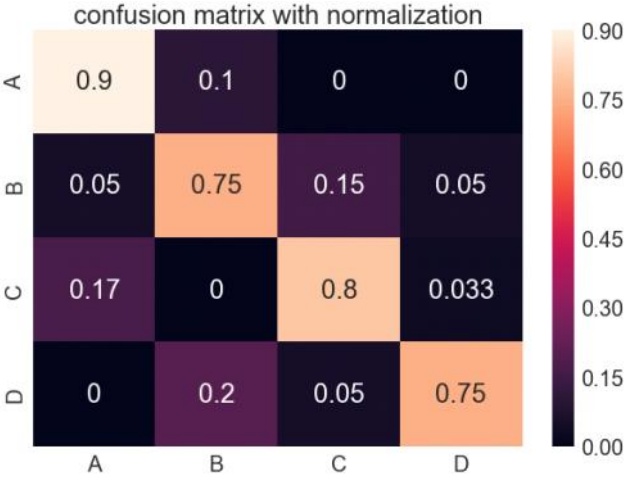
1. Basic Confusion Matrix



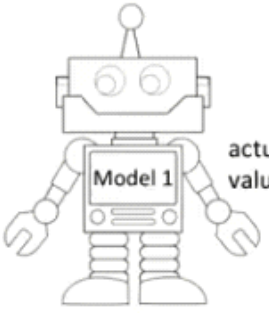
2. Confusion Matrix with confusion



3. Confusion Matrix with normalization



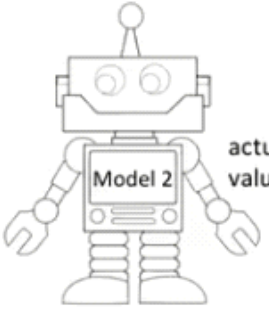
Which model performs better?



actual values

predictions →

	A	B	C	D
A	10	0	0	0
B	0	5	3	2
C	0	1	8	1
D	0	1	0	9



actual values

predictions →

	A	B	C	D
A	8	2	0	0
B	1	7	0	2
C	0	0	9	1
D	2	3	0	5

Performance measures

- TP (true positive)
- TN (true negative)
- FP (false positive)
- FN (false negative)

predictions →

actual values ↓

	A	B	C	D
A	9	1	0	0
B	1	15	3	1
C	5	0	24	1
D	0	4	1	15

True Positive

predictions (output) →

actual class (input) ↓

	A	B	C	D
A	**9**	1	0	0
B	1	**15**	3	1
C	5	0	**24**	1
D	0	4	1	**15**

correctly identified prediction for each class

True Negative for A

predictions (output) →

actual class (input) ↓

	A	B	C	D
A	9	1	0	0
B	1	15	3	1
C	5	0	24	1
D	0	4	1	15

correctly rejected prediction for certain class (A)

True Negative for D

predictions (output) →

actual class (input) ↓

	A	B	C	D
A	9	1	0	0
B	1	15	3	1
C	5	0	24	1
D	0	4	1	15

correctly rejected prediction for certain class (D)

False Positive for A

predictions (output) →

actual class (input) ↓

	A	B	C	D
A	9	1	0	0
B	1	15	3	1
C	5	0	24	1
D	0	4	1	15

incorrectly identified predictions for certain class (A)

False Positive for B

predictions (output) →

actual class (input) ↓

	A	B	C	D
A	9	1	0	0
B	1	15	3	1
C	5	0	24	1
D	0	4	1	15

incorrectly identified predictions for certain class (B)

False Negative for A

predictions (output) →

actual class (input) ↓

	A	B	C	D
A	9	1	0	0
B	1	15	3	1
C	5	0	24	1
D	0	4	1	15

incorrectly rejected for certain class (A)

Accuracy

- Accuracy is calculated as the total number of correct predictions divided by the total number of dataset

Accuracy

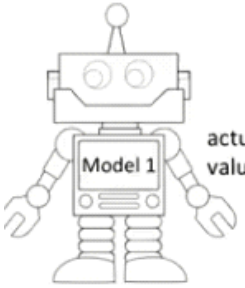
predictions (output) →

actual class (input) ↓

	A	B	C	D
A	9	1	0	0
B	1	15	3	1
C	5	0	24	1
D	0	4	1	15

correctly identified prediction for each class
9 + 15 + 24 + 15

Accuracy Comparison

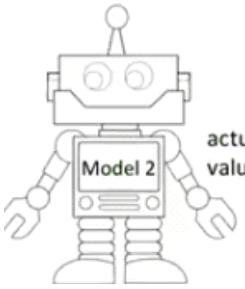


predictions →

actual values ↓

	A	B	C	D
A	10	0	0	0
B	0	5	3	2
C	0	1	8	1
D	0	1	0	9

(10 + 5 + 8 + 9) / 40 = **0.8**



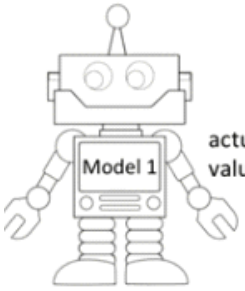
predictions →

actual values ↓

	A	B	C	D
A	8	2	0	0
B	1	7	0	2
C	0	0	9	1
D	2	3	0	5

(8 + 7 + 9 + 5) / 40 = **0.725**

Accuracy on imbalanced data misleads performance

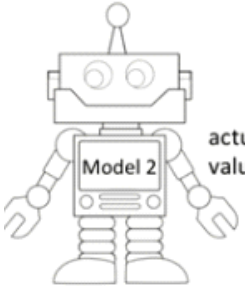


predictions →

actual values ↓

	A	B	C	D
A	100	80	10	10
B	0	9	0	1
C	0	1	8	1
D	0	1	0	9

(100 + 9 + 8 + 9) / 230 = **0.547**



predictions →

actual values ↓

	A	B	C	D
A	198	2	0	0
B	7	1	0	2
C	0	8	1	1
D	2	3	4	1

(198 + 1 + 1 + 1) / 230 = **0.87**

F1 score is good metric when data is imbalanced

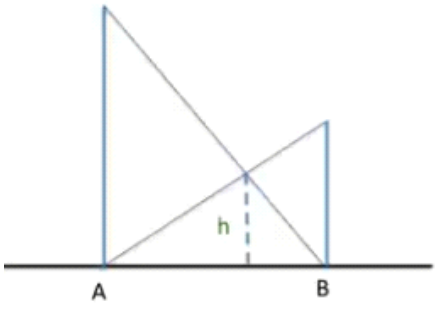
Given a class, will the classifier detect it ? (recall)

	A	B	C	D
A	100	80	10	10
B	0	9	0	1
C	0	1	8	1
D	0	1	0	9

Given a class prediction from the classifier,
how likely is it to be correct? (precision)

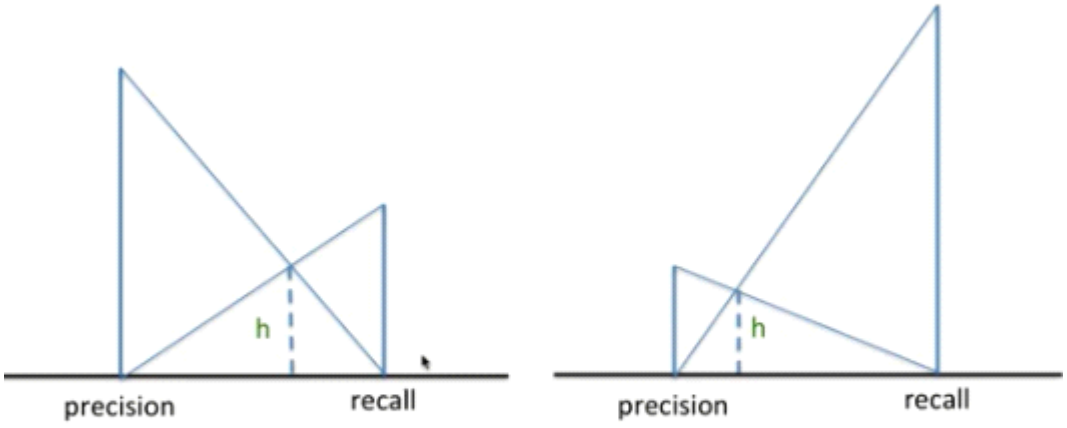
F1 Score is harmonic mean of recall and precision

Harmonic Mean



h is half the harmonic mean

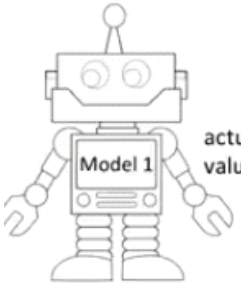
Harmonic Mean punishes extreme value more



h is half the harmonic mean

$$\text{F1 Score} = 2 \times \frac{\text{Precision X Recall}}{\text{Precision + Recall}}$$

Precision of Model 1 (macro average)



actual values

predictions →

	A	B	C	D
A	100	80	10	10
B	0	9	0	1
C	0	1	8	1
D	0	1	0	9
	TP: 100 FP: 0	TP: 9 FP: 82	TP: 8 FP: 10	TP: 9 FP: 12

Precision = TP / (TP + FP) P(A) = 1 P(B) = 9/91 P(C) = 8/18 P(D) = 9/21

average precision = P(A) + P(B) + P(C) + P(D) / 4 = 0.492

the number of classes

Recall of Model 1 (macro average)

predictions →

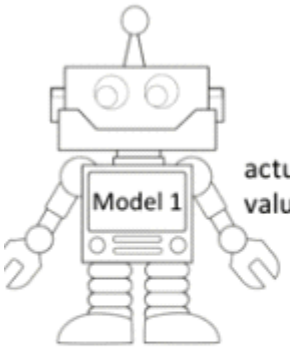
	A	B	C	D	
A	100	80	10	10	TP: 100, FN: 100 R(A) = 100 / 200
B	0	9	0	1	TP: 9, FN: 1 R(B) = 9/10
C	0	1	8	1	TP: 8, FN: 2 R(C) = 8/10
D	0	1	0	9	TP: 9, FN: 1 R(D) = 9/10

Recall = TP / (TP + FN)

average recall = R(A) + R(B) + R(C) + R(D) / 4 = 0.775

the number of classes

F1 Score of Model 1



predictions →

actual values ↓

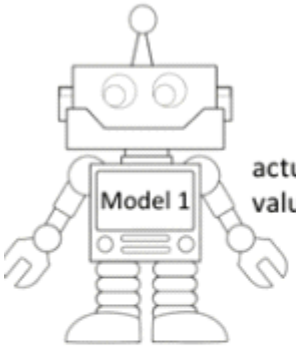
	A	B	C	D
A	100	80	10	10
B	0	9	0	1
C	0	1	8	1
D	0	1	0	9

$$\text{F1 Score} = 2 \text{ X } \frac{\text{Precision X Recall}}{\text{Precision + Recall}}$$

$$2 \text{ X } \frac{0.492 \text{ X } 0.775}{0.492 + 0.775}$$

0.601

F1 Score on imbalanced data

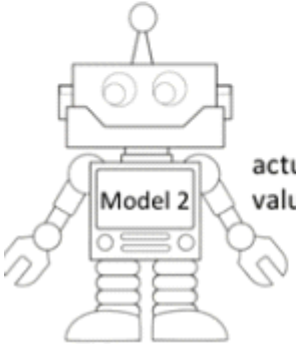


predictions →

actual values ↓

	A	B	C	D
A	100	80	10	10
B	0	9	0	1
C	0	1	8	1
D	0	1	0	9

F1 Score = **0.601** accuracy = 0.547



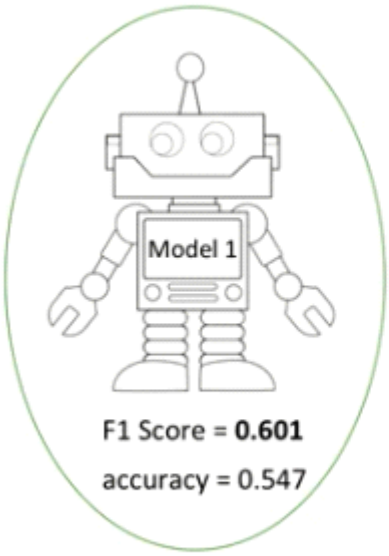
predictions →

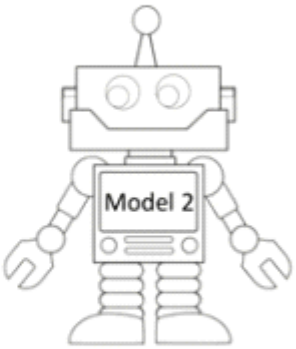
actual values ↓

	A	B	C	D
A	198	2	0	0
B	7	1	0	2
C	0	8	1	1
D	2	3	4	1

F1 Score = **0.342** accuracy = 0.87

F1 Score on imbalanced data





Model 1 predicts well on multiple class classification on imbalanced given data, and F1 score is the metric to quantify its performance.