

Exercise 4 (16 points) – individual work

- The answers can be typed or handwritten (handwriting must be clear and readable), in this exercise sheet or your own sheet (put your name & ID at the top of the sheet). All answers must be saved to only 1 PDF file.
 - Some questions also require the submission of processes/workflows (file.rmp or file.ipynb).
 - In case of re-submission (after first grading) or submission after solution is given, your points will be weighted by 0.5.
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Two classifiers are used to classify 60 customer records whether they would buy sedan, pickup, or SUV. Their confusion matrices are

Classifier 1

	Predicted Sedan	Predicted Pickup	Predicted SUV
Actual Sedan	15	4	5
Actual Pickup	4	14	2
Actual SUV	3	3	10

Classifier 2

	Predicted Sedan	Predicted Pickup	Predicted SUV
Actual Sedan	18	3	3
Actual Pickup	3	10	7
Actual SUV	6	2	8

Answer all questions except (2.7) and (3.7) in 4 decimal places.

1. (Total 2 points) Consider overall performance.

1.1 Overall accuracy of classifier 1 $= \text{sum of correct prediction} / \text{total records}$ $= (15+14+10)/60$ = 0.6500	1.2 Overall accuracy of classifier 2 $= (18+10+8)/60$ = 0.6000
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2. (Total 7 points) Consider performance of predicting class **Sedan**.

2.1 Precision of classifier 1 $= \text{TP}(\text{sedan_c1}) / \text{all pred (sedan_c1)}$ $= \text{TP} / (\text{TP+FP}) \# \text{false alarm for Sedan}$ $= 15/(15+4+3)$ = 0.6818	2.4 Precision of classifier 2 $= 18/(18+3+6)$ = 0.6666
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2.2 Recall of classifier 1 $= \text{TP}(\text{sedan_c1}) / \text{all actual (sedan_c1)}$ $= \text{TP} / (\text{TP+FN}) \# \text{missing Sedan}$ $= 15/(15+4+5)$ = 0.6250	2.5 Recall of classifier 2 $= 18/(18+3+3)$ = 0.7500
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2.3 F-measure of classifier 1 $= [2 * \text{precision}(\text{sedan_c1}) * \text{recall}(\text{sedan_c1})] / [\text{precision}(\text{sedan_c1}) + \text{recall}(\text{sedan_c1})]$ $= (2 * 0.6818 * 0.6250) / (0.6818 + 0.6250)$ $= \textbf{0.6522}$	2.6 F-measure of classifier 2 $= (2 * 0.6666 * 0.7500) / (0.6666 + 0.7500)$ $= \textbf{0.7055}$
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2.7 By considering only precision, recall, and F-measure in (2.1)-(2.6), which classifier is better at predicting Sedan?

Since we didn't specify the goal of wanting 'confident positives'(precision) or 'don't want to miss positives'(recall), we consider the F-measure as the criteria here, since it is the balance between precision and recall. Classifier 1 have higher precision, but classifier 2 have higher recall and higher F-measure/F1-score with only slightly lower precision than classifier 1. So the answer should be **classifier 2**

3. (Total 7 points) Consider performance of predicting class **Pickup**

3.1 Sensitivity of classifier 1 $= \text{TP} / (\text{TP} + \text{FN}) \text{ #same as recall}$ $= 14 / (14 + 4 + 2)$ $= \textbf{0.7000}$	3.4 Sensitivity of classifier 2 $= 10 / (10 + 3 + 7)$ $= \textbf{0.5000}$
3.2 Specificity of classifier 1 $= \text{TN} / (\text{TN} + \text{FP})$ $= 33 / (33 + 4 + 3)$ $= \textbf{0.8250}$	3.5 Specificity of classifier 2 $= 35 / (35 + 3 + 2)$ $= \textbf{0.8750}$
3.3 Youden's J index of classifier 1 $= \text{sensitivity}(\text{Pickup_c1}) + \text{specificity}(\text{Pickup_c1}) - 1$ $= 0.7 + 0.825 - 1$ $= \textbf{0.5250}$	3.6 Youden's J index of classifier 2 $= 0.5 + 0.875 - 1$ $= \textbf{0.3750}$

3.7 By considering only sensitivity, specificity, and Youden's J index in (3.1)-(3.6), which classifier is better at predicting Pickup?

Classifier 1 have higher sensitivity meaning that it can detects more actual Pickups, and Classifier 2 have higher specificity meaning that it could avoids false Pickup predictions (but only slightly better $0.875 > 0.825$). But overall, according the the Youden's J index (tells us overall trade-off between sensitivity and specificity), classifier 1 have much higher Youden's J index than classifier 2. So, we can conclude that the better classifier for predicting Pickup in this case is **classifier 1**