Week 2
Short Answers Assignment 2

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1. In a two-class, two-action problem if the loss function is $\lambda_{11} = \lambda_{22} = 0$, $\lambda_{12} = 12$, and $\lambda_{21} = 5$, write the optimal decision rule. (Follow the convention in in the slides.) Show your work.

$R(\alpha 1/X) = 0.P(C1/X) + 12.P(C2/X)$
$= 12(1-P(C1/X))$

$R(\alpha 2/X) = 5.P(C1/X) + 0.P(C2/X)$
$= 5(P(C1/X))$

Action	C1	C2
α1: Choose C1	0	12
α2: Choose C2	5	0

The decision rule is.
Choose α1 if:

$R(\alpha 1/X) < R(\alpha 2/X)$
$12(1-P(C1/X)) < 5(P(C1/X))$
$12 - 12P < 5P$
$12 < 17P$
Result will be $P(C1/X) > 12/17$

Otherwise, we arrive at α2.

2. How does the rule change if we add the third action of reject with $\lambda_r = 1$? Show your work.

$R(\alpha 1/X) = 12\ (1 - P(C1/\ X))$
$R(\alpha 2/X) = 5\ P(C1/X)$

Choose α1 if:

$R(\alpha 1/X) < R(\alpha r/X)$
$12\ (1 - P(C1/X)) < 1$
$12 - 12\ P(C1/X) < 1$
$P(C1/X) > 11/12$

Action	C1	C2
α1: Choose C1	0	12
α2: Choose C2	5	0
αr	1	1

Choose α2 if:

$R(\alpha 2/X) < R(\alpha r/X)$
$5.P(C2/X)) < 1$
$P(C2/X) < 4/5$

Otherwise, we arrive at αr.

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3. In a two-class, two-action problem, use the decision rule for equal loss to solve for a posterior probability for each class for a new sample x = —0.1. The prior distributions are defined by point estimates with probability $P(C_1) = 0.45$ and $P(C_2) = 0.55$. The likelihoods are univariate normal: $P(x|C_1)$ having mean (μ) of 0.35 and standard deviation (σ) of 1.5; and $P(x|C_2)$ has a mean of 1.5 and standard deviation of 1. What are the posterior probabilities for the classes? Which action should be chosen, α_1 or α_2? (Hint: You can use the class Jupiter notebook to solve for the posterior probabilities for this problem, there is no need to calculate by hand.)

Posterior Probability of the classes given below:

P(C1/X) = 0.652
P(C2/X) = 1- 0.652 = 0.347

P(C1/X) > 12/17

α1 is the action needed here.

Here the risk is minimal.

4. Use the decision rule you found in problem 1 to interpret the posterior probability from problem 3. Which action should we choose, α_1 or α_2?

Posterior Probability From 3rd problem value is 0.65.
Hence, we choose α2.

5. Use the decision rule with reject you found in problem 2 to interpret the posterior probability from problem 3. Which action should we choose, α_1, α_2, or α_r?

Given, Posterior probability values.
P(C1/X) = 0.652
P(C2/X) = 0.347

Choose α1 if P(C1/X) > 11/12(0.91) (reject)
Choose α2, if P(C2 /X) < 1/5 (0.2) (reject)

αr is selected since α1 and α2 are rejected.

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6. Briefly describe a hypothetical situation where a decision rule with reject would be helpful in a real-world problem.

In criminal justice, a decision rule containing a reject option might be used during the initial investigation before legally charging a person with a crime. Law enforcement has the right to reject a charge if the evidence is weak or unclear, protecting innocent individuals from unfair punishment and legal consequences.

7. For the table below, calculate the support and confidence of the following rules (show the fractional values, do not calculate with decimals):
broccoli -> rice
rice -> broccoli
tea -> beets
beets -> tea
Customer 1:broccoli, rice, tea
Customer 2:broccoli, tea, beets
Customer 3:broccoli
Customer 4:rice, tea, beets
Customer 5:broccoli
Customer 6:broccoli, rice
Customer 7:beets, tea

	Support	**Confidence**
broccoli -> rice	2/7	2/5
rice -> broccoli	2/7	2/5
tea -> beets	3/7	3/4
beets -> tea	3/7	3/3

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8. Interpret the results of problem 7.

According to the results of Problem 7, rice and broccoli are associated with buyer purchases more strongly than tea and beets. The support values show the frequency that these relationships show up in the dataset, while the confidence values provide insights into the probability of one item being purchased when the other is purchased.