EES 315: In-Class Exercise # 10

Date: 23 / 9 / 2020	
Name	ID (last 3 digits)

Instructions

1. Work alone or in a group of no more than three students. For group work, **the group cannot be the same as any of your former groups in this class.**
2. **[ENRE] Explanation is not required for this exercise.**
3. Only one submission is needed for each group.
4. You have two choices for submission:
   (a) Online submission via Google Classroom
   - PDF only.
   - Only for those who can directly work on the posted files using devices with pen input.
   - Paper size should be the same as the posted file.
   - No scanned work, photos, or screen capture.
   - Your file name should start with the 10-digit student ID of one member. (You may add the IDs of other members, exercise #, or other information as well.)

   (b) Hardcopy submission
5. **Do not panic.**

1. Consider a medical diagnostic test for detecting an illness (L). Suppose the probability that the test correctly identifies someone with the illness as positive (+) is 0.9, and the probability that the test correctly identifies someone without the illness as negative (-) is 0.8. The probability of finding the illness in the general population is 0.1.

(a) Find $P(-|L)$, the conditional probability that a randomly-chosen person tests negative given that the person does have the illness.

We are given three pieces of information: $P(L) = 0.1$, $P(+|L) = 0.9$, $P(-|L^c) = 0.8$.

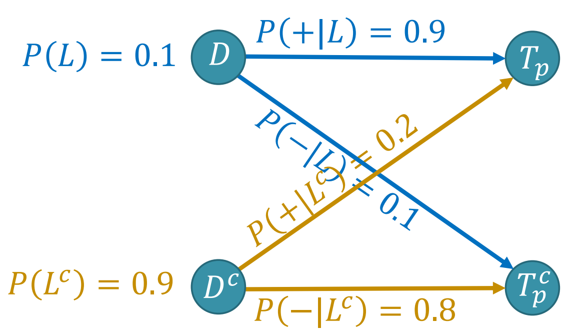
Recall that $P(A^c|B) = 1 - P(A|B)$.

Therefore, $P(-|L) = 1 - P(+|L) = 1 - 0.9 = 0.1$.

(b) A random person takes this test.
What is the probability that this person tests positive?

$P(+|L^c) = 1 - P(-|L^c) = 1 - 0.8 = 0.2$
$P(L^c) = 1 - 0.1 = 0.9$

We can also get this expression directly from the total probability theorem.



$$
\begin{aligned}
P(+) &= P(+\cap L) + P(+\cap L^c) \\
&= P(+|L)P(L) + P(+|L^c)P(L^c) \\
&= 0.9 \times 0.1 + 0.2 \times 0.9 \\
&= 0.27
\end{aligned}
$$

(c) A random person takes this test, and the test result is positive.
What is the probability that this person has the illness?

$$P(L|+) = \frac{P(L\cap +)}{P(+)} = \frac{P(+|L)P(L)}{P(+)} = \frac{0.9 \times 0.1}{0.27} = \frac{1}{3} \approx 0.33.$$

We can also get this expression directly by "Form 1" of the Bayes' theorem