

Learning Objectives - Bayes' Rule

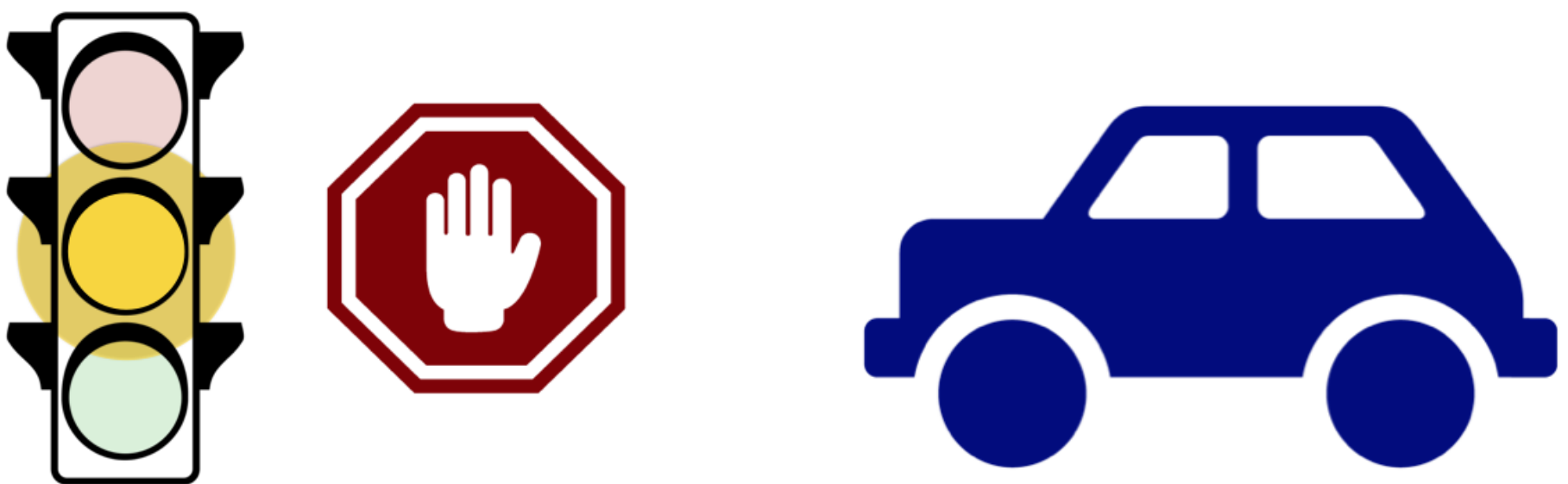
The following questions will help you review what you learned in the Bayes' Rule lesson.

Prior knowledge

For questions 1-3, assume you already have the following knowledge:

You're interested in finding out the probability of a car stopping if it sees a *yellow* traffic light.

- Past data tells you that the probability of a car stopping at a traffic light intersection is $P(S) = 0.40$.
 - You also know that the past probability of a traffic light being yellow (as opposed to red or green) is $P(Y) = 0.10$.
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Car stopping at a yellow light

Traffic Light q1

When a car is stopped at an intersection, data shows that 12% of the time the light is yellow. So if we know a car is stopped, there's a 12% chance the light is yellow. This is called a *conditional probability*.

$$P(Y|S)$$

Given $P(S)$ and $P(Y)$ above, how would you represent this conditional probability in notation?

☐ $P(S|Y) = 0.12$

☐ $P(S) = 0.12$

☒ $P(Y|S) = 0.12$

☐ $P(Y,S) = 0.12$

Traffic Light q2

Using what you know from question 1, answer the following: if the traffic light is yellow, what is the chance that the car will stop?

☐ 0.04

☐ 0.33

☐ 0.40

☒ 0.48

☐ 0.50

☐ 0.52

$$P(S|Y) = \frac{P(S \cap Y)}{P(Y)}$$

$P(Y|S) \cdot P(S)$

Traffic Light q3

Knowing that a car stopping at an intersection and the presence of a yellow traffic light are related events, what are $P(S)$ and $P(Y)$ known as?

☐ Posterior probabilities

☐ Past probabilities

☒ Prior probabilities

☐ Total probabilities

Questions 4 and 5 are different scenarios.

Prior knowledge for question 4:

On a four-lane highway, cars are either going fast or not fast. Faster cars should go in the leftmost lanes.

- At any given time, 20% of cars are in the left-most lane.
- Overall, 40% of cars on the highway are classified as going fast.
- Out of all the cars in the leftmost lane, 90% are going fast.

$$\begin{aligned} P(L) &= 0.2 \rightarrow P(\neg L) = 0.8 \\ P(F) &= 0.4 \rightarrow P(\neg F) = 0.6 \\ P(F|L) &= 0.9 \rightarrow P(\neg F|L) = 0.1 \end{aligned}$$

Bayes q2

$$P(L|F) = ?$$

Given the above information, if a car is going fast, what is the probability that it will be in the leftmost lane?

☐ 0.125

☐ 0.25

☒ 0.45

☐ 0.55

Bayes' rule is not only used to incorporate sensor data into an estimate; it's also often used to incorporate test data into a medical diagnosis.

Prior knowledge for question 5:

- 1% of all people have cancer.
- 90% of people who have cancer test positive when given a cancer-detecting blood test, meaning the test detects cancer 90% of the time.
- 5% of people will have false positives, meaning that 5% of the time, this test will produce a positive result when people do not have cancer.

Bayes q3

Given the above data, what is the probability that a person has cancer if they have a positive cancer-test result? (Note: answers are rounded to the nearest 4th decimal place).

☐ 0.1125

☒ 0.1538

☐ 0.2687

☐ 0.8924

$$P(C|P) = ?$$

