Learning Objectives - Bayes' Rule

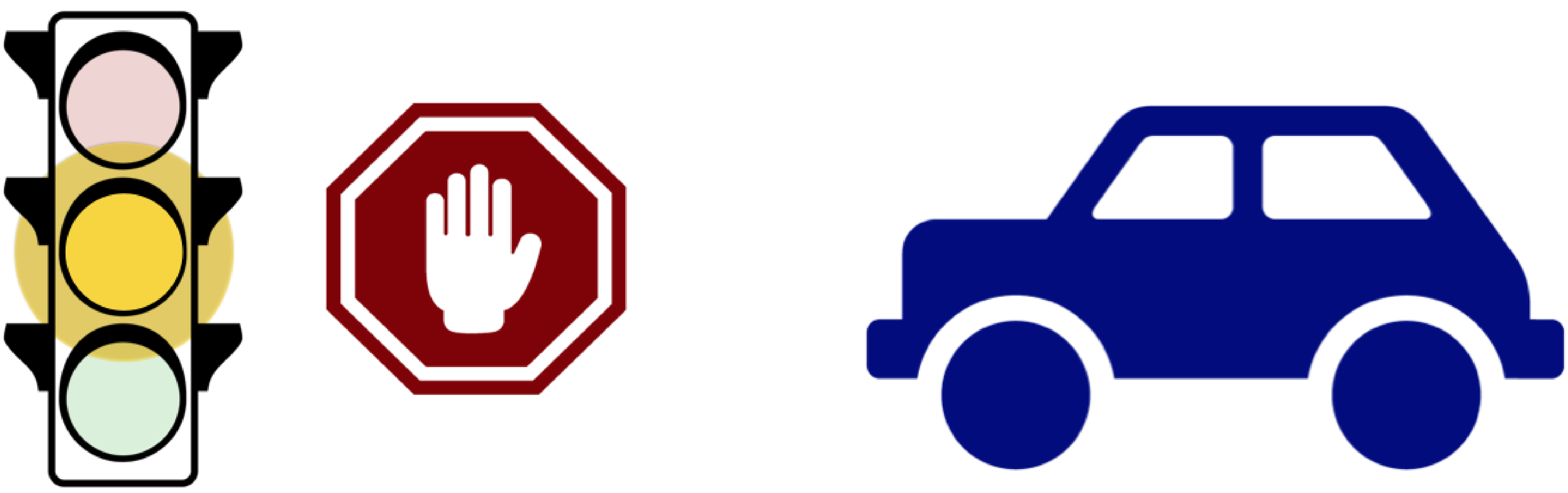
The following questions will help you review what you learned in the Bayes' Rule lesson.

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 $P(S) = 0.40$. P(~S) = 0.60
- You also know that the past probability of a traffic light being yellow (as opposed to red or green) is $P(Y) = 0.10$. P(~Y)=0.90



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*.

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

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. $P(L) = 0.2$, $P(\sim L)=0.8$
- Overall, 40% of cars on the highway are classified as going fast. $P(F) = 0.4$, $P(\sim F) = 0.6$
- Out of all the cars in the leftmost lane, 90% are going fast. $P(F|L) = 0.9$

Bayes q2

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

$$P(L|F) = \frac{P(F|L) * P(L)}{P(F)} = (0.9*0.2)/0.4 = 0.45$$

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

Prior $P(C)=0.001$ $P(\sim C)=0.99$

$P(P|C)=0.9$ $P(N|C)=0.1$

$P(P|\sim C)=0.05$ $P(N|\sim C)=0.95$

$P(C,P) = 0.1*0.9 = 0.009$

$P(\sim C,P) = 0.99 * 0.05 = 0.495$

$P(P) = 0.009 + 0.495 = 0.0585$

$P(C|P) = 0.009/0.0585 = 0.1538$