Comprehension Check: Conditional Probabilities Part 1

Q1

1/1 point (graded)

In a previous module, we covered Bayes' theorem and the Bayesian paradigm. Conditional probabilities are a fundamental part of this previous covered rule.

$$P(A|B) = P(B|A)\frac{P(A)}{P(B)}$$

We first review a simple example to go over conditional probabilities.

Assume a patient comes into the doctor's office to test whether they have a particular disease.

- The test is positive 85% of the time when tested on a patient with the disease (high sensitivity): $P(\text{test}+|\text{disease}) = 0.85$
- The test is negative 90% of the time when tested on a healthy patient (high specificity): $P(\text{test}-|\text{heathy}) = 0.90$
- The disease is prevalent in about 2% of the community: $P(\text{disease}) = 0.02$

Using Bayes' theorem, calculate the probability that you have the disease if the test is positive.

0.1478261 ✔ **Answer:** 0.1478261

0.1478261

Explanation

$$P(\text{disease}|\text{test}+) = P(\text{test}+|\text{disease}) \times \frac{P(\text{disease})}{P(\text{test}+)} = \frac{P(\text{test}+|\text{disease})\,P(\text{disease})}{P(\text{test}+|\text{disease})\,P(\text{disease}) + P(\text{test}+|\text{healthy})\,P(\text{healthy})]} = \frac{0.85 \times 0.02}{0.85 \times 0.02 + 0.1 \times 0.9}$$

Submit You have used 1 of 2 attempts

Answers are displayed within the problem

The following 4 questions (Q2-Q5) all relate to implementing this calculation using R.

We have a hypothetical population of 1 million individuals with the following conditional probabilities as described below:

- The test is positive 85% of the time when tested on a patient with the disease (high sensitivity): $P(\text{test}+|\text{disease}) = 0.85$
- The test is negative 90% of the time when tested on a healthy patient (high specificity): $P(\text{test}-|\text{heathy}) = 0.90$
- The disease is prevalent in about 2% of the community: $P(\text{disease}) = 0.02$

Here is some sample code to get you started:

```
set.seed(1)
disease <- sample(c(0,1), size=1e6, replace=TRUE, prob=c(0.98,0.02))
test <- rep(NA, 1e6)
test[disease==0] <- sample(c(0,1), size=sum(disease==0), replace=TRUE, prob=c(0.90,0.10))
test[disease==1] <- sample(c(0,1), size=sum(disease==1), replace=TRUE, prob=c(0.15, 0.85))
```

Q2

1/1 point (graded)

What is the probability that a test is positive?

0.114509 ✔ **Answer:** 0.114509

0.114509

Explanation
The probability of a positive test can be calculated using `mean(test)`.

Submit You have used 1 of 5 attempts

Answers are displayed within the problem

Q3

1/1 point (graded)
What is the probability that an individual has the disease if the test is negative?

0.003461356 ✔ **Answer:** 0.003461356

0.003461356

Explanation
The probability of having the disease given a negative test can be calculated using `mean(disease[test==0])`.

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Answers are displayed within the problem

Q4

1/1 point (graded)
What is the probability that you have the disease if the test is positive?
Remember: calculate the conditional probability the disease is positive assuming a positive test.

0.1471762 ✔ **Answer:** 0.1471762

0.1471762

Explanation
The probability of having the disease given a positive test can be calculated using `mean(disease[test==1]==1)`.

Submit You have used 1 of 5 attempts

Answers are displayed within the problem

Q5

1/1 point (graded)
If the test is positive, what is the relative risk of having the disease?
First calculate the probability of having the disease given a positive test, then normalize it against the disease prevalence.

7.389106 ✔ **Answer:** 7.389106

7.389106

Explanation
The relative risk can be calculated using `mean(disease[test==1]==1)/mean(disease==1)`.

Submit You have used 1 of 5 attempts

Answers are displayed within the problem