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Exercise

Bayes' theorem

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1 Making predictions from the observed data is the foundations of a classification process. Bayes' theorem takes the form

$$p(D|T) = \frac{p(D)p(T|D)}{p(T)}$$

which allows us to compute the probability of event D after observing event T. Let's consider an illustrative example where D is the presence of a disease and T is a positive test result.

a) What is $p(D)$?

b) What is $p(T|D)$?

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c) Express $p(D)$ from the entries in the confusion matrix.

d) Express $p(T|D)$ from the entries in the confusion matrix.

e) What would you call $p(T|D)$ in the context of the confusion matrix?

f) Recall the definition of the Specificity. How can you express the Specificity in Bayes' theorem? Hint: Evaluate $p(T)$ by expressing it as the probability of all the ways of observing a positive test.

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2 Transfer your calculations from assignment 1 to Python code.

a) Write a function that takes $p(D), p(T|D)$, and the Specificity as input arguments and that returns $p(D|T)$.

b) Now assume that $p(T|D)$ and the Specificity are given for a disease test, e.g., 95% and 99%, respectively. Draw a graph showing $p(D|T)$ as a function of $p(D)$.

c) Discuss the results.

d) You want to use this test to screen a population for a rare disease. Is this test appropriate?