

Tables of Conditional Probability

Example 2: Suppose jurors make the right decisions about guilt and innocence 95% of the time and that 80% of all defendants are truly guilty:

	Acquitted	Convicted	Totals
Innocent			
Guilty			
Totals			100

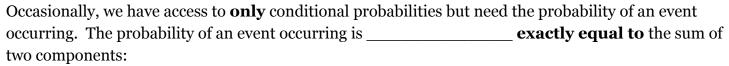
- a) What's the probability that a person is convicted given that they are innocent?
- **b)** What's the probability that a person is innocent, given that they are convicted?

Example 3: For years ELISA was the most widely used test for screening donated blood for AIDS. If a blood sample has the AIDS virus, then there is a 99% probability that ELISA will correctly give a positive result. If the blood sample does **not** have the AIDS virus then there is still a 6% probability that ELISA will incorrectly give a positive result. About 1% of the blood samples ELISA tests are truly contaminated.

	Result of Test		
	Positive	Negative	Totals
Blood has AIDS virus			
Blood does NOT have AIDS virus			
Totals			10,000

- a) What's the probability someone tested positive given that the person has the AIDS virus?
- **b)** What's the probability someone has the AIDS virus given the person tested positive?

Decomposition into Conditional Probability



 $\lceil 1 \rceil$:

[2]:

Mathematically, we express this as the following:

Bayes Rule

Sometimes, we have the exact opposite conditional data that we need. Bayes Rule provides a way to find a conditional probability:

$$P(h \mid D) = P(D \mid h) \times \frac{P(h)}{P(D)}$$

In English, Bayes Rule tells us we can compute the probability of a hypothesis (**h**) given some data (**D**) given three individual probabilities:

- 1. The independent probability of the hypothesis being true, P(h),
- 2. The independent probability of the data being true, P(D), and
- 3. The conditional probability that the data is true given the hypothesis, P(D | h)

Example 3, using Bayes Rule:

If a blood sample has the AIDS virus, then there is a 99% probability that ELISA will correctly give a positive result. If the blood sample does not have the AIDS virus then there is still a 6% probability that ELISA will incorrectly give a positive result. About 1% of the blood samples ELISA tests are truly contaminated.

Conditionals in Python

Up until today, we have discovered two different control flow techniques in Python:

Control Flow	Python Syntax	Description
	for i in range(n):	Repeats indented code n times.
	<pre>def myFunctionName(params): </pre>	Runs indented code when function is called elsewhere in program.

With conditional probability, we need to have a **mechanism to run code conditionally**. In Python, we can do this with an **if-statement**:

```
1 if red == 2:
print("The red die rolled a 2.")
```

Four key ideas:

- 1. [Identical to Pandas]:
- 2. [Control Flow]:
- 3. [Syntax]:
- 4. [Conditional]:

If statements can have an _____ statement for code for cases when the statement is false:

```
if red == 2:
print("The red die rolled a 2.")
else:
 print("The red die did NOT roll a 2.")
```

Example 4: Write a simulation for the ELISA problem.

If a blood sample has the AIDS virus, then there is a 99% probability that ELISA will correctly give a positive result. If the blood sample does not have the AIDS virus then there is still a 6% probability that ELISA will incorrectly give a positive result. About 1% of the blood samples ELISA tests are truly contaminated.

Practice Problems:

Practice #1: The following question combines all of the probability rules that we've learned. Suppose you randomly draw from these students.

	Left-Handed	Ambidextrous	Right-Handed	Totals
Male	30	20	266	316
Female	60	27	560	647
Totals	90	47	826	963

- a) What is the chance of getting a female?
- **b)** What is the chance of getting someone who is left-handed?
- c) What is the chance you'll get a female if you draw only from the left-handers?
- **d)** What is the chance you'll get a left-hander if you draw only from the females?
- e) Draw 3 students without replacement. What is the chance that all 3 students are left-handed?
- **f)** Draw 3 students *without* replacement. What's the chance that *not all* 3 students are left-handed?
- **g)** Draw 3 students *with* replacement. What is the chance that *at least one* student is right-handed?

Practice #2: What is the probability of getting at least one 5 on six rolls of a die?

Practice #3: What is the probability of rolling a die 3 times and *not* getting all "2"s?

Data Science DISCOVERY - Things To Be Doing:

- 1. HW 5 is up on PrairieLearn and due Sunday at 11:59pm; HW6 out this weekend
- 2. lab birthday due Monday, Oct. 14
- 3. Open Office Hours: Every M/W/R/F from 4:00pm 6:30pm in 23 Illini Hall
 - Professor office hours Wednesdays, 8:30am-10am in 2215 Siebel Center
- 4. Extra Credit +1 Notebook every lecture: out after lecture, due 11:30am before next lecture