

basic probability; due next week

[version: Wednesday 14th October, 2020 18:07]

1. Say your parents paid for your Rutgers education \$100k, was their investment a good one? University education is expected to increase lifetime earnings by .5m. Yet, it is not easy to graduate from Rutgers—only 70% of students finish successfully assuming that they pass a really hard statistics class, and only 10% of students pass statistics class—you cannot continue with your studies if you don't pass statistics. [hint: of course you need to calculate expected value]

A: $.7 \times .5m \times .1$; or draw a tree: first stats: .1 and then other stuff: .7 so the probability of passing both, stats and other stuff is $.1 \times .7$, and the expected return is $.1 \times .7 \times .5m$ and see if that's bigger than investment of .1m

2. Say you take 3 classes this semester. Again, it is hard to pass statistics—only 10% of students pass. But it is easy to pass other classes, say 90% pass those—what is the probability you will continue to be a student (pass all three classes)?

A: $.1 \times .9 : .9$ was combined -probability for all other classes

3. Say you live in Delaware. The travel time is often 30 minutes from Camden to your house in Delaware (you live just across the river). But if the weather is bad, the travel time is 45 minutes, and weather is bad in New Jersey 60% of the time. One day per week, there is traffic accident, and then travel time is 2 hours. What is the expected travel time on any given day from Camden to your house in Delaware?

A: $.6 \times 45 + 1/7 \times 120 + (1 - .6 - 1/7) \times 30$; or if you assumed that we only look at business days then instead of 1/7 do 1/5

4. Say there are 7 Democrats and 3 females in this class of 10. There are no Independents (a person can be either Republican or Democrat). 2 females are Democrat. Put counts in a table, and calculate the probability that a male is a Republican.

	F	M	T
D	2	5	7
R	1	2	3
T	3	7	10

based on the table: $P(R|male) = 2/7$

or using formula $P(R|male) = \frac{P(R \cap male)}{P(male)} = \frac{2/10}{7/10} = 2/10 \times 10/7 = 2/7$

OR to calculate R and male:

Note that the table is alike to an early example where we had 2 coin flips, and we counted outcomes, eg probability of 2 heads in 2 flips was 1/4 because there was just one such combined outcome of 1st and 2nd flip out of four possible such combined outcomes. Likewise here, we look at the table and we see that only 2 out of 10 are like that.

based on the table: $P(R \cap male) = 2/10$

or using formula:

can't just do $7/10 \times 3/10$ —they're not independent—we got a male (7/10) and now getting Republican who is a male so not out of everyone (3/10), but out of males: (2/7); it's like with a tree—we got first to males and now getting to Republicans out of those males, not out of everyone; mathematically:

given that: $P(R|male) = \frac{P(R \cap male)}{P(male)}$:

$P(R \cap male) = P(R|male) \times P(male) = 2/7 \times 7/10 = 14/70 = 2/10$

or could do it the other way, starting with probability of a Republican: $3/10 \times 2/3 = 2/10$

If events were independent, we would just multiply probabilities. If they are not independent or we are unsure—use this formula.

More elaboration: <http://davidmlane.com/hyperstat/A127969.html>

<http://davidmlane.com/hyperstat/A129515.html>

<https://www.mathsisfun.com/data/probability-events-independent.html>

<https://www.mathsisfun.com/data/probability-events-conditional.html>

5. Imagine you've landed your dream job as governor of the great state of NJ! As recent history indicates, it is important to plan for disasters! Say that there is a probability of .001 that severe storm like Sandy will hit the state in any given year. Sandy costed \$65 billion. But there is much higher probability that there will be damage due to more moderate weather. Say, on average, every month there is \$100,000 in damage due to weather in the state. What, (and by how much) is more costly to the taxpayer: typical weather damage or severe weather damage?

Is $.001 * 65,000,000,000 > 100,000 * 12$

6. Say that probability that a male commits a crime during the five years of his adolescence (13-18 yo) is .01. The corresponding probability for a female is only .005. Probability increases sharply, ve-fold, for both genders if a person's father was jailed during person's childhood. In which group there is more likely to happen a crime? That is, rank order the three groups in terms of probability that someone from the group commits a crime.

Group A: 100 adolescent males (no criminal history in family)

$100 * .01$

Group B: 200 adolescent females (no criminal history in family)

$200 * .005$

Group C: 50 adolescent females, whose father was jailed during their childhood

$50 * .005 * 5$

general directions (always the same):

- ps is due in Sakai's dropbox
- keep it short; max: 5 single spaced pages; typically way less, say 1 or 2
- if you are stuck, email listserv early! also can email listserv if you want some feedback and make sure you are on the right track, etc
- show your work, a "naked" number won't do! unless indicated otherwise, always do calculations by hand
- likewise, numbers should be interpreted—we are not only interested in calculating values of interest, but we are interested in their meaning! whenever you calculate your final quantity if interest, interpret it!
- if your handwriting is bad, please type
- i may want to discuss your assignment in class, which should be beneficial to you and give you more feedback; if however, you'd like to keep it private, let me know!
- ideally you want to use this class to write a research part of your capstone
- think if you can engage civically—see section 'civic engagement component' in syllabus