L27: Monday, April 3.

Housekeeping: ✓ Grade reports post-Exam 2?

- Week 7 $\left\{\begin{array}{l}\text{summary}\\ \text{discussion post}\end{array}\right.$ due 11:59 p.m. on Canvas

- written HW due Weds. in class

- essay draft for book project due April 19 on Canvas (& Apr. 21 in class)

Last time: Finished Chap. 3 (probability)

Today: Start Ch. 4 (Random variables)

New Chapter – new working groups.

A <u>random variable</u> describes the outcomes of a statistical experiment IN WORDS.

The <u>value</u> of a random variable can change on each repetition of an experiment.

e.g.:
- A student takes a 10-question, true/false quiz;
  - the <u>r.v.</u> is the student's score
  - if s/he didn't study, the <u>value</u> of the r.v. might be lower; if student did study, the value might be higher — but the r.v. <u>itself</u> remains the same.
  - looking ahead... if we call the r.v. as X, we might be interested in $P(X > 70\%)$ — i.e., $\underbrace{\text{the probability that}}_{P(}$ $\underbrace{\text{the value of}}_{X}$ $\underbrace{\text{the random variable}}_{X}$ $\underbrace{\text{exceeds 70\%}}_{> 70\%}$. $\underbrace{}_{)}$

Other examples of random variables:

- The number of users on a particular mobile network at 5:07 p.m. on a weekday
- The combined weight of all cars/trucks/pedestrians/birds (?) on a bridge
- Others?

Random variables can be

- DISCRETE — taking on only certain values

  e.g., # of users on mobile network

- CONTINUOUS — taking on any value in an unbroken spectrum

  e.g., weight of cars on bridge

For now, we'll focus on discrete random variables.

Convention: r.v.'s are usually denoted by capital letters, e.g., X = score on last week's exam.

The values of r.v.'s are usually denoted by lowercase letters, e.g.,
" X can take values in the range $0\% \le x \le 100\%$ ".

Example Let $X :=$ the # of heads you get when tossing 3 fair coins.

Then $x = 0, 1, 2$, or 3. (X is in words, and x is in numbers.)

Q: Is X (in this example) a discrete r.v.?

– YES: can take only the values $x = 0, 1, 2$, or 3.

We are typically interested in the probability that a r.v. takes on a certain value.

For discrete random variables, can create a table showing the probabilities that a r.v. ~~can~~ takes on the values in its range.

Example: Tossing 3 fair coins.

x	$P(X=x)$
0	1/8
1	3/8
2	3/8
3	1/8

PROBABILITY DISTRIBUTION FUNCTION or P.D. TABLE

Sample space for experiment of tossing 3 fair coins: {HHH, HHT, HTH, THH, TTT, TTH, THT, HTT}

L27, ct'd.

Properties of a PDF (or PDT):

1. Each of the probabilities needs t/b btwn. 0 and 1.

2. The probabilities should <u>sum to 1</u>.

Checking our 3-flips-of-a-coin table:

1. Yes - all values btwn. 0 & 1

2. Sum: $\frac{1}{8} + \frac{3}{8} + \frac{3}{8} + \frac{1}{8} = \frac{1+3+3+1}{8}$

$= \frac{8}{8} = 1$ ✓.

Ex. 4.1, p.241 (o.s.)

X = # of times per week tht. a newborn baby wakes up the mother after midnight

~~$x \in \{0,1,2,3,4,5\}$~~ / $x = 0, 1, 2, 3, 4,$ or 5

x	$P(X=x)$
0	2/50
1	11/50
2	23/50
3	9/50
4	4/50
5	1/50

To check that this table shows a real / possible-in-real-life PDF,

① For each x, $0 \le P(X=x) \le 1$ ✓

② $P(X=0)+P(X=1)+\cdots+P(X=5) \overset{?}{=} 1$

$$\frac{2}{50}+\frac{11}{50}+\frac{23}{50}+\frac{9}{50}+\frac{4}{50}+\frac{1}{50} =$$

25 + 15 + 10 = 50

$$= \frac{2+11+23+9+4+1}{50} = \frac{50}{50} = 1. \checkmark$$

Try It 4.1 p. 241

For a random sample of 50 patients, the # of times they ring the nurse during his 12-hour shift is recorded. None rang more than 5 times:

x	$P(X=x)$
0	4/50
1	8/50
2	16/50
3	14/50
4	6/50
5	2/50

Ex. 4.2 Nancy has classes 3 days/wk. She attends class on all 3 days 80% of the time, ~~one~~ two days 15% of the time, one day 4% of the time, and no days 1% of the time. Suppose one week is randomly selected.

(a) Let $X :=$ the number of days Nancy attends class

(b) X takes on (which / what) values? $x = 0, 1, 2, 3$

(c) ~~Sample~~ PDF of X:

x	$P(X=x)$
0	0.01
1	0.04
2	0.15
3	0.80 +
	1