Quiz 3

STAT 109: Introductory Biostatistics

Quiz 3

Quiz 3 Practice Problems

These are practice problems covering:

- **Lectures 3–4:** sample spaces, outcomes, events, and probability calculations when the outcomes are equally likely
- **Lecture 5:** addition rule
- **Lab 2 (R code by hand):** types, vectors, matrices, bracketing, `length()`, `dim()`, and basic `for` loops + simulation structure

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Instructions

- Work **without notes** first; then check your answers. I'll post my solutions to Lab 2 after the due date.
- For **R questions**, write **valid R code** exactly as you would type it (by hand).
- The in-class quiz in lab on Thursday will be created from these practice problems.

Part A: Vocabulary and notation (Lecture 3)

A1. Identify terms for a trial

Consider the trial of rolling a single six-sided die one time.

1. Write the sample space S.
2. Give one outcome.
3. Define an event A and list the outcomes in A.

A2. Set language in words

Suppose a trial has sample space S and two events A and B.

1. In words, what does "A and B" mean?
2. In words, what does "A or B" mean?
3. In words, what does "not A" mean?

A3. Translate probability notation to English

Write a one-sentence interpretation for each:

1. $P(A) = 0.7$
2. $P(A \text{ and } B) = 0.2$
3. $P(\text{not } A) = 0.1$

Part B: Equally likely outcomes and careful counting (Lectures 3–4)

B1. Equally likely outcomes rule

State the **probability rule** for an event A if the outcomes in S are equally likely:

$$P(A) = \quad ?$$

Be sure to define what $|A|$ and $|S|$ mean in words.

B2. A probability rule

State the **condition** that must be true for the probability rule $P(A) = |A|/|S|$ to be valid.

B3. Two coin tosses

Suppose a fair coin is tossed **two times**.

1. List the sample space S so that all outcomes are equally likely.
2. Let A be the event "at least one tail." List the outcomes in A.
3. Compute $P(A)$.

B4. Two dice (sum equals 11)

Suppose a fair die is rolled **twice**.

1. How many outcomes are in the **sample space** S written so that all outcomes are equally likely?
2. List the outcomes from S in the event $C =$ "the sum is 11."
3. Compute $P(C)$.

B5. Random babies (Lecture 4)

Three babies are randomly returned to three mothers (assume all pairings are equally likely).

1. How many outcomes are in the sample space?
2. Let A be the event "all 3 mothers get the correct baby." Compute $P(A)$.
3. Let B be the event "none of the mothers get the correct baby." Compute $P(B)$

Part C: Addition rule and special cases (Lecture 5)

C1. State the addition rule

State the **Addition Rule** for any two events A and B.

C2. Backpacks and hats

A class has 65 students:

- 40 have backpacks
- 10 have hats
- 5 have **both** a backpack and a hat

Let A be the event a randomly selected student "has a backpack" and B be "has a hat."

1. Compute $P(A)$ and $P(B)$.
2. Compute $P(A \text{ and } B)$.
3. Use the addition rule to compute $P(A \text{ or } B)$.

C3. Complement rule (Special Case of Addition Rule)

If $P(\text{rains at least once in July}) = 0.91$, compute:

$$P(\text{no rain in July})$$

C4. Non-overlapping events (special case)

Suppose A and B are **non-overlapping** (mutually exclusive) events.

1. What does "non-overlapping" mean in words?
2. What does it imply about $P(A \text{ and } B)$?
3. Write the simplified formula for $P(A \text{ or } B)$ in this case.

Part D: R code by hand (Lab 2)

D1. Types and `class()`

Write R code that:

1. creates `x_num` as the numeric value of 0,
2. creates `x_int` as an integer (use the `L`),
3. prints the class of each.

D2. Vectors, length, and scalar operations

Write R code that:

1. creates a numeric vector `v` that contains the values 2, 4, 6, 8 and 10.
2. prints the length of `v`
3. creates a new vector called `v_plus_one` that is `v` with `1` added to each of it's values.

D3. Bracketing practice (vectors)

Using `v <- c(2, 4, 6, 8, 10)`, write R code for each:

1. the 3rd element
2. the 2nd through 4th elements
3. everything except the 3rd element
4. all elements greater than 5

D4. Matrices and `dim()`

Write R code that:

1. creates a 2x3 matrix `m` filled by column using `1:6`,
2. prints the dimensions of `m`
3. extracts the value of m in the second row and first column
4. extracts the first row
5. extracts the second column

D5. A simple `for` loop with pre-allocation

Write R code that uses a `for` loop to fill a vector named `squares` with the squares of 1 through 5:

Expected result for `squares`

```
[1]  1  4  9 16 25
```

D6. Simulation structure (for loop + `mean()`)

Write R code to estimate the probability that a fair die roll is even using simulation:

- simulate `n <- 10000` die rolls using `sample(1:6, size = n, replace = TRUE)`
- compute the estimated probability with `mean(...)`

Your code should create objects named `n`, `rolls`, and `p_even`.