Random Variables

your name

2024-09-26

Math 2265 Section 3.4

- Work as a group! You will need to replace <> or "ans" in the source code or answer questions
- Update your name in L3
- Make sure your save and knit your work (to html or pdf) before submitting it to Canvas

Question 0. Who are your group members? (List their first names should be sufficient)

Answer:

1. <name_1>
2. <name_2>

Load Packages

```
## Loading required package: airports
```

```
## Loading required package: cherryblossom
```

```
## Loading required package: usdata
```

Example

Review the example and code below to answer the questions listed after the example. There is no question in the example.

Expected Value of a Discrete Random Variable

In a game of cards, you win \$1 if you draw a heart (excluding the ace of hearts), \$5 if you draw an ace (including the ace of hearts), \$10 if you draw the king of spades, and nothing for any other card you draw. Write the probability model for your winnings, and calculate your expected winning.

The table below provides the relevant information:

Event	Heart (not ace)	Ace	King of spades	All else
X (reward in \$)	1	5	10	0
$P(X)$	12/52	4/52	1/52	35/52

1. Create the variables to store the probability distribution

```
# Define the winnings for X and their respective probabilities P(X)
rewards <- c(1, 5, 10, 0)
probabilities <- c(12/52, 4/52, 1/52, 35/52)
print(rewards)
```

```
## [1]  1  5 10  0
print(probabilities)
```

```
## [1] 0.23076923 0.07692308 0.01923077 0.67307692
```

2. Use the formula for the expected value:

$$\mathbb{E}(X) = \sum_i x_i \cdot P(X = x_i)$$

```
expected_value <- sum(rewards * probabilities)
expected_value
```

```
## [1] 0.8076923
```

3. Calculate the standard deviation

Hint: First, calculate the variance using the formula:

$$\mathrm{Var}(X) = \sum_i (x_i - \mathbb{E}(X))^2 \cdot P(X = x_i)$$

Then, take the square root to find the standard deviation:

$$\sigma_X = \sqrt{\mathrm{Var}(X)}$$

```
# Calculate the variance
variance <- sum((rewards - expected_value)^2 * probabilities)

# Calculate the standard deviation
std_dev <- sqrt(variance)
std_dev
```

```
## [1] 1.850556
```

Baggage Fees Worksheet

We will work on Problem 2.38 in HW3.

2.38 Baggage fees in HW3

> An airline charges the following baggage fees: $30 for the first bag and $30 for the second. Suppose 50% of passengers have no checked luggage, 33% have only one piece of checked luggage, and 17% have two pieces. We assume a negligible portion of people check more than two bags.

Let the random variable X denote the number of pieces of checked luggage. Complete the following table of the probability distribution (we will ignore the **3+** category):

Complete the table below

Number of Luggage	0	1	2
X (Revenue in $)	0	30	60
$P(X)$	0.5	0.33	0.17

Question 1. What is the average baggage-related revenue per passenger?

Complete the code below to store your answer to the variable `expected_value`.

Hint: Use the formula for the expected value:

$$\mathbb{E}(X) = \sum_i x_i \cdot P(X = x_i)$$

```
X <- c(0, 30, 60)
prob <- c(0.5, 0.33, 0.17)
expected_value <- sum(X*prob)
expected_value
```

```
## [1] 20.1
```

Question 2. What is the standard deviation of baggage-related revenue?

Complete the code below to store your answer to the variable `expected_value`.

Hint: First, use the formula for variance, and then take the square root to get the standard deviation:

$$\mathrm{Var}(X) = \sum_i (x_i - \mathbb{E}(X))^2 \cdot P(X = x_i)$$

Then, standard deviation:

$$\sigma_X = \sqrt{\mathrm{Var}(X)}$$

```
my_variance <- sum((X - expected_value)^2 * prob)
my_std_dev <- sqrt(my_variance)
my_std_dev
```

```
## [1] 22.47198
```

Question 3. About how much revenue should the airline expect for a flight of 100 passengers?

```
total_revenue <- expected_value * 100
total_revenue
```

```
## [1] 2010
```

Question 4. Knit your code and check your outcomes.

Did it produce an outcome?

Yes/No

Question 5. Check your answer

```
if(sum((c(expected_value,my_std_dev, total_revenue) - c(20.1, 22.47198, 2010))<0.001)==3) {
  print("Your answers are correct")
} else {
  print("Check your answers")
}
```

```
## [1] "Your answers are correct"
```

Discuss your answers and help your group members before uploading your work to Canvas