Probability Topics

By:

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Probability Topics

Class time:

Names:

Student Learning Outcomes

- The student will use theoretical and empirical methods to estimate probabilities.
- The student will appraise the differences between the two estimates.
- The student will demonstrate an understanding of long-term relative frequencies.

Do the Experiment Count out 40 mixed-color M&Ms® which is approximately one small bag's worth. Record the number of each color in [link]. Use the information from this table to complete [link]. Next, put the M&Ms in a cup. The experiment is to pick two M&Ms, one at a time. Do **not** look at them as you pick them. The first time through, replace the first M&M before picking the second one. Record the results in the "With Replacement" column of [link]. Do this 24 times. The second time through, after picking the first M&M, do **not** replace it before picking the second one. Then, pick the second one. Record the results in the "Without Replacement" column section of [link]. After you record the pick, put **both** M&Ms back. Do this a total of 24 times, also. Use the data from [link] to calculate the empirical probability questions. Leave your answers in unreduced fractional form. Do **not** multiply out any fractions.

Population

Color	Quantity
Yellow (Y)	
Green (G)	
Blue (BL)	

Color	Quantity
Brown (*B*)	
Orange (*O*)	
Red (*R*)	

Theoretical Probabilities

	With Replacement	Without Replacement
P(2 reds)		
$P(R_1B_2$ OR $B_1R_2)$		
$P(R_1$ AND $G_2)$		
$P(G_2 \mid R_1)$		
P(no yellows)		
P(doubles)		
P(no doubles)		

Note

G_2 = green on second pick; R_1 = red on first pick; B_1 = brown on first pick; B_2 = brown on second pick; doubles = both picks are the same colour.

Empirical Results

With Replacement	Without Replacement
(__ , __) (__ , __)	(__ , __) (__ , __)
(__ , __) (__ , __)	(__ , __) (__ , __)
(__ , __) (__ , __)	(__ , __) (__ , __)
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(__ , __) (__ , __)	(__ , __) (__ , __)

With Replacement	Without Replacement
(__ , __) (__ , __)	(__ , __) (__ , __)
(__ , __) (__ , __)	(__ , __) (__ , __)
(__ , __) (__ , __)	(__ , __) (__ , __)

Empirical Probabilities

	With Replacement	Without Replacement
P(2 reds)		
$P(R_1B_2$ OR $B_1R_2)$		
$P(R_1$ AND $G_2)$		
$P(G_2\|R_1)$		
P(no yellows)		
P(doubles)		
P(no doubles)		

Discussion Questions

1. Why are the “With Replacement” and “Without Replacement” probabilities different?
2. Convert P(no yellows) to decimal format for both Theoretical “With Replacement” and for Empirical “With Replacement”. Round to four decimal places.
    1. Theoretical “With Replacement”: P(no yellows) = _____
    2. Empirical “With Replacement”: P(no yellows) = _____
    3. Are the decimal values “close”? Did you expect them to be closer together or farther apart? Why?
3. If you increased the number of times you picked two M&Ms to 240 times, why would empirical probability values change?
4. Would this change (see part 3) cause the empirical probabilities and theoretical probabilities to be closer together or farther apart? How do you know?
5. Explain the differences in what $P(G_1$ AND $R_2)$ and $P(R_1|G_2)$ represent. Hint: Think about the sample space for each probability.