Homework 2

Name: _____ Lecture: _____

1. Suppose that you are a contestant on a game show, and you are given the choice of three doors. Behind one door is a brand new car, behind the other two doors are goats. The car and goats are randomly placed behind the doors. You choose door #1. The host, who knows what is behind each door, opens door #3 to reveal a goat. Should you switch your choice to door #2? Explain your answer using probability.

2. Suppose that you are a contestant on a game show, and you are given the choice of n doors. Behind one door is a brand new car, behind the other $n-1$ doors are goats. The car and goats are randomly placed behind the doors. You choose door #1. The host, who knows what is behind each door, opens door #n to reveal a goat. Should you switch your choice to door #2? Explain your answer using probability.

3. Suppose that you are a contestant on a game show, and you are given the choice of n doors. Behind one door is a brand new car, behind the other $n-1$ doors are goats. The car and goats are randomly placed behind the doors. You choose door #1. The host, who knows what is behind each door, opens door #2 to reveal a goat. Should you switch your choice to door #3? Explain your answer using probability.

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2) A woman has n keys, 2 keys work.

a) P("she opens the door on her k^{th} trial")

$P(\text{"1st try"}) = \frac{2}{n}$

$P(\text{"second try"}) =$ chance of not 1 $\cdot$ chance of 2nd

$= \frac{n-2}{n} \cdot \frac{1}{n-1} = \frac{1}{n}$

$P(\text{"third try"}) = \underset{\text{fail 1st}}{\frac{n-1}{n}} \times \underset{\text{fail 2nd}}{\frac{n-2}{n-1}} \times \underset{\text{hits 3rd time}}{\frac{1}{n-2}} = \frac{1}{n}$

$P(\text{"open door on } k^{th} \text{ try"}) = \boxed{\frac{1}{n}}$

b) P("no right keys in k tries")

P("no right keys in k trials") = the wrong key has been chosen k times.

Since she is replacing the keys, the chance the door doesn't open with randomized key $= \frac{n-1}{n}$ for every $(k-1)$.

$\underset{\text{door closed}}{\frac{n-1}{n}} \times \underset{\text{door closed}}{\frac{n-1}{n}} \times \dots \times \underset{\text{door closed } (k-1)^{th} \text{ trial}}{\frac{n-1}{n}} \times \underset{k^{th} \text{ trial}}{\frac{n-1}{n}} = \left(\frac{n-1}{n}\right)^k$

$\left(\frac{n-1}{n}\right)^k = \left(1 - \frac{1}{n}\right)^k$

$P(\text{"no key w/ replacement in } k \text{ tries"}) = \left(1 - \frac{1}{n}\right)^k$

When $n = 9$, the probability the door opens is:

$\left(\frac{n-1}{n}\right)^k \times \left(\frac{n-1}{n}\right)^k, \dots, \left(\frac{1}{n}\right)^k = \left(1 - \frac{1}{n}\right)^k \left(\frac{1}{n}\right)$

number of tries. $k-1$ fails and 1 hit.

She has 9 keys, 2 of which open the door.

The chance the first pick opens the door is $\left(\frac{2}{9}\right) = 22\frac{2}{9}\%$

Chance second pick after discarding the last one $= \left(\frac{7}{8}\right)\left(\frac{2}{8}\right) = 19.\overline{4}\%$

Chance third pick after having $= \left(\frac{7}{8}\right)\left(\frac{6}{7}\right)\left(\frac{2}{7}\right) = 16.\overline{6}\%$

Chance 4th pick opens the door $= \left(\frac{7}{8}\right)\left(\frac{6}{7}\right)\left(\frac{5}{6}\right)\left(\frac{2}{5}\right) = 12.8\%$

Chance 5th pick opens the door $= \left(\frac{7}{8}\right)\left(\frac{6}{7}\right)\left(\frac{5}{6}\right)\left(\frac{4}{5}\right)\left(\frac{2}{4}\right) = \frac{5}{12} = 11.\overline{1}\%$ $= 85\%$ total

Chance 6th pick opens the door $= \left(\frac{7}{8}\right)\left(\frac{6}{7}\right)\left(\frac{5}{6}\right)\left(\frac{4}{5}\right)\left(\frac{3}{4}\right)\left(\frac{2}{3}\right) = 8.\overline{3}\%$

Total chance after 6 picks $= 97.6\%$

When $n = 9$ & not discarding keys, 10 tries later we can be 90% sure the door is open.

When $n = 9$ & not discarding keys, the number of tries to open the door $= 1 - P(\text{"she does doesn't open"})$

$P(\text{door opens on } k^{th} \text{ try}) = 1 - P(\text{door is still closed after } k \text{ keys have been drawn})$

$\left(1 - \frac{2}{9}\right)^k$ gives the probability the door remains closed

$1 - \left(1 - \frac{2}{9}\right)^k = .9$

$\left(1 - \frac{2}{9}\right)^k = .1$

$\log_{\left(\frac{7}{9}\right)}\left(\frac{1}{10}\right) = k$

$k = \frac{\ln(.1)}{\ln(7/9)}$ $k = 9.16$ On the 10th draw, shall have at least a 90% chance of opening the door.

3) A man has 5 coins 2 are HH, 1 is TT, 2 are HT

$P(\text{double H}) = \left(\frac{2}{5}\right)$

$P(\text{double T}) = \left(\frac{1}{5}\right)$

$P(\text{fair}) = \left(\frac{2}{5}\right)$

a) eyes close, find P("horseside is H") $= \frac{6}{10 \text{ options } (5