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Unit 3, Lesson 2, Project 8 (Monty Hall problem)

The Monty Hall problem can be described as such:
You are on a game show and given the choice of whatever is behind three doors. Behind one door is a fantastic prize (some examples use a car, others use cash) while behind the other two doors is a dud (some examples say a goat, others say it's just empty). You pick a door. Then the host opens one of the other two doors to reveal a dud. But here's the wrinkle: the host now gives you the opportunity to switch your door. What should you do?

To apply Baye's rule we need to know the following:

1. A label for the state/situation/event we want to calculate the probability of. Call this H
   MHP: there is a car behind door 1, the door you chose
2. A label for the observations/evidence that would inform the probability, E
   MHP: Monty Hall shows you a goat
3. The probability that the state/situation/event ($P(H)$) is true (this is the prior which will be updated in light of other information)
   MHP: Each door has an equal starting probability; ($P(H) = \frac{1}{3}$)
4. The probability of the observations/evidence, E, given the claim, H, is true: $P(E|H)$
   MHP: The probability that Monty Hall shows you a goat given there is a car behind door 1; ($P(E|H) = 1$)
5. The probability of the observations/evidence (E) given the claim (H) is false: $P(E| \sim H)$
   MHP: The probability that Monty Hall shows you a goat given there is a goat behind door 1; ($P(E| \sim H) = 1$)

$$P(H|E) = \frac{P(E|H)P(H)}{P(E|H)P(H) + P(E| \sim H)P(\sim H)} \tag{1}$$

$$= \frac{1 * \frac{1}{3}}{1 * \frac{1}{3} + 1 * \frac{2}{3}} \tag{2}$$

$$= \frac{1}{3} \tag{3}$$

The probability that the car is behind door 1, given you initially guess door 1 is $\frac{1}{3}$, so the probabilty that it is behind the door that was not openned is $\frac{2}{3}$ (and thus you are better off changing your pick).

Code: `https://github.com/jordanplanders/Thinkful/blob/master/Unit%203/Monty%20Hall%20problem.ipynb`