Exercise #4 Bayes Box
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In this exercise you are going to build a simple Bayes box to figure out the posterior probabilities for a simple experiment involving black balls and white balls to illustrate how adding information to a situation can change probabilities. This helps illustrate one of the main principles of Bayesian statistics.

Imagine that your friend has a bowl and it is filled with black marbles and white marbles. She then takes out three marbles and puts them in a velvet bag. You do not know what the color of any marble is that she put in the bag.

Follow the following steps to fill out the Bayes box.

1. In the hypotheses column list out all of the possible combinations for marble colors that might be in the bag.

Hypotheses	Prior Prob	Likelihood	h	Posterior Prob
black,white,black				
white,black,white				
Black,black,black				
white,white,white				
Total				

2. What is the prior probability of each hypothesis being true given you know nothing about what the actual number of white balls and black balls that are in the velvet bag? Put this in the Prior Probaility column. Be sure to copy the information from step 1 above into this table as well.

Hypotheses	Prior Prob	Likelihood	h	Posterior Prob
black,white,black	3/8			
white,black,white	3/8			
Black,black,black	1/8			
white,white,white	1/8			
Total	1.0			

why would the prior probs be different from each other? As in the example and lecture you start with

3. Now imagine that you get to pull out one marble from the bag and when you do you notice the color of the marble is white. Now you have some additional information that may help you make a better estimate about the probability that each hypothesis is true. Put the likelihood of each hypothesis given what you have just observed into the likelihood columns. Be sure to copy all of the information present from the table in step 2 above.

Hypotheses	Prior Prob	Likelihood	h	Posterior Prob
black,white,black	3/8	1.0		
white,black,white	3/8	1.0		
Black,black,black	1/8	0		
white,white,white	1/8	1.0		
Total	1.0			

4. Calculate the h or unnormalized posterior probabilities for each hypothesis and put your results in the h column. Be sure to copy all of the information from the table in step 3 above.

Hypotheses	Prior Prob	Likelihood	h	Posterior Prob
black,white,black	3/8	1.0	3/8*1=.375	
white,black,white	3/8	1.0	3/8*1=.375	
Black,black,black	1/8	0	1/8*0=0	
white,white,white	1/8	1.0	1/8*1=.125	
Total	1.0		0.875	

5. Normalize the posterior probabilities for each hypothesis and put the results in the Posterior Probability column. Be sure to copy all of the information from the table in step 4 above.

Hypotheses	Prior Prob	Likelihood	h	Posterior Prob
black,white,black	3/8	1.0	3/8*1=3/8	(3/8) / (7/8) = (24/56)
white,black,white	3/8	1.0	3/8*1=3/8	(3/8) / (7/8) = (24/56)
Black,black,black	1/8	0	1/8*0=0	0 / (7/8) = 0
white,white,white	1/8	1.0	1/8*1=1/8	(1/8) / (7/8) =(8/56)
Total	1.0		7/8	(24/56)+ (24/56)+ (8/56)=(56/56)=1

6. Answer the following questions

a. Compare the prior probabilities with the posterior probabilities – what happened to all of them?
   Pulling 1 white marble eliminated the hypothesis of pulling all 3 black marbles, thus elevating the probability of the other 3 hypothesis. correct +4
b. What is the most possible event according to the posterior probabilities column?
   With a 24/56 probability pulling 1 black and 2 white marbles or 2 blacks and 1 white marble.