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Exercise: The expected value rule with conditioning

(5/6 points)

For each of the formulas below, state whether it is true or false.

1) $\mathbf{E}[g(X,Y) \mid Y=2] = \sum_x g(x,y) p_{X,Y}(x,y)$

False ✔ **Answer:** False

2) $\mathbf{E}[g(X,Y) \mid Y=2] = \sum_x g(x,y) p_{X,Y}(x,2)$

False ✔ **Answer:** False

3) $\mathbf{E}[g(X,Y) \mid Y=2] = \sum_x g(x,2) p_{X,Y}(x,2)$

False ✔ **Answer:** False

4) $\mathbf{E}[g(X,Y) \mid Y=2] = \sum_x g(x,2) p_{X|Y}(x \mid 2)$

True ✔ **Answer:** True

5) $\mathbf{E}[g(X,Y) \mid Y=2] = \sum_x g(x,2) \dfrac{p_{X,Y}(x,2)}{p_Y(2)}$

True ✔ **Answer:** True

6) $\mathbf{E}[g(X,Y) \mid Y=2] = \sum_x \sum_y g(x,y) p_{X,Y|Y}(x,y \mid 2)$

False ✖ **Answer:** True

Answer:
1-3) There is no reason for any of the first three formulas to be true.

4) True. This is just the usual expected value rule, in a model in which the event $\{Y=2\}$ is known to have occurred. Given the information that $Y=2$, the function $g(x,y)$ is replaced by $g(x,2)$, and we are dealing with a function $g(x,2)$ of a single variable x. We apply the expected value rule for a function of a single variable, but since we are within a conditional model, we need to use the conditional PMF of X.

5) True. This is the same as the fourth statement, except that we have substituted in the definition of $p_{X|Y}(x \mid 2)$.

6) True. This is just the expected value rule for a function of two variables, applied within a conditional universe where the event $\{Y = 2\}$ is known to have occurred.

Notice that $p_{X,Y|Y}(x, y \mid 2)$ will be zero for any $y \neq 2$. And for $y = 2$,

$$p_{X,Y|Y}(x, 2 \mid 2) = \mathbf{P}(X = x, Y = 2 \mid Y = 2) = \mathbf{P}(X = x \mid Y = 2) = p_{X|Y}(x \mid 2$$

so that the sixth formula agrees with the fourth one.

You have used 1 of 1 submissions

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