Exercise: The multiplication rule

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2/4 points (graded)

Are the following statements true or false? (Assume that all conditioning events have positive probability.)

1. $\mathbf{P}(A \cap B \cap C^c) = \mathbf{P}(A \cap B)\,\mathbf{P}(C^c \mid A \cap B)$

True ✔ Answer: True

2. $\mathbf{P}(A \cap B \cap C^c) = \mathbf{P}(A)\,\mathbf{P}(C^c \mid A)\,\mathbf{P}(B \mid A \cap C^c)$

True ✔ Answer: True

3. $\mathbf{P}(A \cap B \cap C^c) = \mathbf{P}(A)\,\mathbf{P}(C^c \cap A \mid A)\,\mathbf{P}(B \mid A \cap C^c)$

False ✖ Answer: True

4. $\mathbf{P}(A \cap B \mid C) = \mathbf{P}(A \mid C)\,\mathbf{P}(B \mid A \cap C)$

False ✖ Answer: True

Answer:

1. True. This is the usual multipication rule applied to the two events $A \cap B$ and C^c.

2. True. This is the usual multiplication rule.

3. True. This is because

$$\mathbf{P}(C^c \cap A \mid A) = \frac{\mathbf{P}(C^c \cap A \cap A)}{\mathbf{P}(A)} = \frac{\mathbf{P}(C^c \cap A)}{\mathbf{P}(A)} = \mathbf{P}(C^c \mid A).$$

So, this statement is equivalent to the one in part 2.

4. True. This is the usual multiplication rule $\mathbf{P}(A \cap B) = \mathbf{P}(A)\mathbf{P}(B \mid A)$, applied to a model/universe in which event C is known to have occurred.

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