Assignment1: Probability

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Exercise 1.3 (Basic Probability)

Which of the following equalities are always true?

1. $P(b) = P(a, b) + P(\neg a, b)$

   Always true. It's the sum rule(i.e. marginalization): a and $\neg a$ all events for the A variable.

2. $P(a) = P(a|b) + P(a|\neg b)$

   Never true. $P(a) = P(a|b) \cdot P(b) + P(a|\neg b) \cdot P(\neg b)$.
   Let's say that $A = a$ - first ball is red and $B = b$ - second ball is blue, where $A, B \in \{a, b\}$.
   Given equation above we can conclude that $P(A = a) = 1$, which is wrong.

3. $P(a, b) = P(a) \cdot P(b)$

   Not always true. Correct if A and B are independent.

4. $P(a, b|c) \cdot P(c) = P(c, a|b) \cdot P(b)$

   Always true. From both sides of the equation are $P(a, b, c)$.

5. $P(a \vee b) = P(a) + P(b)$

   Not always true. Correct if A and B are disjoint.

6. $P(a, \neg b) = (1 - P(b|a)) \cdot P(a)$

   Always true. Product rule, where $P(\neg b|a) = 1 - P(b|a)$