

The product rule:

$$\begin{aligned}P(A = true \wedge B = true) &= P(A = true|B = true)P(B = true) \\P(A = true \wedge B = false) &= P(A = true|B = false)P(B = false) \\P(A = false \wedge B = true) &= P(A = false|B = true)P(B = true) \\P(A = false \wedge B = false) &= P(A = false|B = false)P(B = false)\end{aligned}$$

The product rule in our shorthand notation:

$$\begin{aligned}P(A \wedge B) &= P(A|B)P(B) \\P(A \wedge \neg B) &= P(A|\neg B)P(\neg B) \\P(\neg A \wedge B) &= P(\neg A|B)P(B) \\P(\neg A \wedge \neg B) &= P(\neg A|\neg B)P(\neg B)\end{aligned}$$

The product rule using the comma notation:

$$P(A, B) = P(A|B)P(B)$$

When in doubt, always explicitly write out each random variable and the value it takes.