

# Joint, marginal, conditional probabilities

- Joint:  $P(x, y)$  where  $P(\cdot) \in \mathbb{R}^{|X| \times |Y|}$
- Marginal:  $P(x) = \sum_y P(x = x, y = y)$
- Conditional:  $P(y | x) = \frac{P(y = y, x = x)}{P(x = x)}$

# Product rule, independence, conditional independence

- Product rule: 
$$P(x^{(1)}, \dots, x^{(n)}) = P(x^{(1)}) \prod_{i=2}^n P(x^{(i)} \mid x^{(1)}, \dots, x^{(i-1)})$$
- Independence condition: 
$$P(x, y) = P(x)P(y)$$
- Conditional independence condition: 
$$P(x, y \mid z) = P(x \mid z) P(y \mid z)$$