



Calculating probabilities

Assuming equally likely outcomes, the probability of an event is:

$$P(\text{event}) = \frac{\text{number of outcomes in event}}{\text{total number of outcomes}}$$

Remember: The probability of each outcome is between 0 and 1, and the sum of all probabilities is 1.

Probability rules

Rule	Formula
Complement (NOT A)	$P(A') = 1 - P(A)$
Addition (OR)	$P(A \cup B) = P(A) + P(B) - P(A \cap B)$
Mutually exclusive events	$P(A \cap B) = 0$, so $P(A \cup B) = P(A) + P(B)$
Conditional probability	$P(A B) = \frac{P(A \cap B)}{P(B)}$
Multiplication rule	$P(A \cap B) = P(A B) \cdot P(B)$
Independent events	$P(A B) = P(A)$ and $P(A \cap B) = P(A) \cdot P(B)$

Mutually exclusive: Events that cannot both occur at the same time.

- Being a teenager and being over 30 — mutually exclusive
- Being married and being over 30 — NOT mutually exclusive

Example: Two-way table (counts)

	Plant A	Plant B	Total
Defective	20	30	50
Nondefective	180	70	250
Total	200	100	300

a) $P(\text{defective}) = \frac{50}{300} = 0.17$
b) $P(\text{Plant B}) = \frac{100}{300} = 0.33$
c) $P(\text{defective and Plant B}) = \frac{30}{300} = 0.10$

Example: Two-way table (probabilities)

	Male	Female
Colourblind	0.04	0.002
Not colourblind	0.47	0.488

a) $P(\text{colourblind male}) = 0.04$ (directly from table)

b) $P(\text{not colourblind female}) = 0.488$ (directly from table)

c) $P(\text{male}) = 0.04 + 0.47 = 0.51$ (add the column)

d) $P(\text{colourblind}) = 0.04 + 0.002 = 0.042$ (add the row)

e) $P(\text{male or colourblind}) = P(\text{male}) + P(\text{colourblind}) - P(\text{male and colourblind})$

$$= 0.51 + 0.042 - 0.04 = 0.512$$

f) $P(\text{colourblind} \mid \text{male}) = \frac{P(\text{colourblind and male})}{P(\text{male})} = \frac{0.04}{0.51} \approx 0.078$

g) Are “male” and “colourblind” independent?

If independent, then $P(\text{colourblind and male}) = P(\text{colourblind}) \cdot P(\text{male})$.

Check: $P(\text{colourblind}) \cdot P(\text{male}) = (0.042)(0.51) = 0.021$

But $P(\text{colourblind and male}) = 0.04 \neq 0.021$. **Not equal, so the events are dependent.**