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# 2.8 Probability & Probability Distributions

## Basics of probability

Probability measures the likelihood of events and takes values between 0 and 1. The sum of the probabilities of all mutually exclusive outcomes equals 1. Events are independent if the occurrence of one does not affect the other.

## Discrete distributions

* **Binomial distribution** – Models the number of successes in n independent Bernoulli trials with success probability p. The mean is np and the variance is np(1-p)【685817958353626†L362-L423】.
* **Poisson distribution** – Models the number of events occurring in a fixed interval when events occur independently at a constant rate lambda. The mean and variance are both lambda【685817958353626†L362-L423】.

## Continuous distributions

* **Normal distribution** – A symmetric, bell‑shaped distribution characterised by mean mu and standard deviation sigma. Approximately 68 %, 95 % and 99.7 % of values lie within 1, 2 and 3 standard deviations of the mean, respectively【685817958353626†L362-L423】.

## Central Limit Theorem connection

The CLT implies that sums or averages of independent random variables tend toward a normal distribution as sample size increases【685817958353626†L448-L460】.

## Example

* **Binomial** – The number of defective items in a batch of 20 if each item has a 5 % chance of being defective follows a binomial distribution.
* **Poisson** – The number of customers arriving at a service desk per hour when the average arrival rate is 10 per hour follows a Poisson distribution.
* **Normal** – Adult human heights are approximately normally distributed with a certain mean and standard deviation.

## Summary

Probability distributions describe how probabilities are distributed over possible values of a random variable. Understanding common distributions (binomial, Poisson, normal) is essential for modelling uncertainty in real‑world contexts【685817958353626†L362-L423】【685817958353626†L448-L460】.

## Reflection questions

1. What conditions make the binomial distribution appropriate?
2. Why is the normal distribution ubiquitous in statistics?
3. Describe a situation modelled by the Poisson distribution.

## References