Symbols

Symbol	Meaning		Symbol	Meaning
X, x	RV, its value		$\bar{X}$	Sample mean
μ, σ^2, σ	Mean, variance, SD		$E[X]$	Expectation
z_α, $t_{n-1,\alpha}$	Critical values		α	Tail area (1–CL)

Theory

Concept	Summary
Random Variable	Discrete (countable) or continuous (infinitely many) outcomes
PMF/PDF	$p(x) = P(X = x)$ or $f(x)$ s.t. $\int f(x)\,dx = 1$
Expected Value	$E[X] = \sum x\,p(x)$ or $\int x f(x)\,dx$
Variance	$Var(X) = E[(X-\mu)^2]$
CLT	$\bar{X} \sim N(\mu, \sigma^2/n)$ for large n (≥ 30)
CI Concept	Range where parameter likely lies; wider = more confident

Distributions

Dist.	When / Use	Parameters	$E[X]$	$Var(X)$	Formula
Bernoulli	1 trial, success/fail	p	p	$p(1-p)$	$P(X=1) = p$
Binomial	n indep. Bernoulli	n, p	np	$np(1-p)$	$\binom{n}{x} p^x (1-p)^{n-x}$
Poisson	# of rare events	λ	λ	λ	$\frac{e^{-\lambda}\lambda^x}{x!}$
Normal	Continuous, bell curve	μ, σ^2	μ	σ^2	$\frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/(2\sigma^2)}$

Core Formulas (Grouped)

Category	Formula	Notes
Binomial PMF	$P(X=x) = \binom{n}{x} p^x (1-p)^{n-x}$	discrete, 0–n
Binomial Coeff.	$\binom{n}{k} = \frac{n!}{k!(n-k)!}$	# of combinations

Category	Formula	Notes
Poisson PMF	$P(X = x) = e^{-\lambda}\lambda^x/x!$	mean=var=λ
Z-Score	$Z = \frac{X-\mu}{\sigma}$	standardize any normal
SE (Mean)	$\frac{\sigma}{\sqrt{n}}$	sample mean variability
SE (Proportion)	$\sqrt{\frac{p(1-p)}{n}}$	use $\hat{p}$ if unknown
Normal Approx. to Binomial	$Z = \frac{x+0.5-np}{\sqrt{np(1-p)}}$	CC +0.5
CLT Dist.	$\bar{X} \sim N(\mu, \sigma^2/n)$	for means
CI (Z-known)	$\bar{X} \pm z_{\alpha/2}\frac{\sigma}{\sqrt{n}}$	two-sided
CI (T-unknown)	$\bar{X} \pm t_{n-1,\alpha/2}\frac{s}{\sqrt{n}}$	small n
One-Sided CI	$\bar{X} + z_{\alpha}\frac{\sigma}{\sqrt{n}}$	flip for lower
Sample Size	$n \geq (\frac{z_{\alpha/2}\sigma}{k})^2$	margin k
Prop. CI	$\hat{p} \pm z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$	large n

Quick Reference Table

CL $(1-\alpha)$	$z_{\alpha/2}$	**Coverage**	**Comment**
90%	1.645	0.90	narrowest
95%	1.96	0.95	standard
99%	2.576	0.99	widest

Quick Notes

- **CI Interpretation:** 95% → in long run, 95% of such CIs contain true mean.
- **Increasing CL** ⇒ larger $z_{\alpha/2}$ ⇒ wider CI.
- **Poisson ≈ Binomial:** when $n > 20$, $p < 0.05$.
- **Sketch shapes:** Binomial (bumps), Poisson (right-skew→normal), Normal (bell).
- **Check assumptions:** independence, fixed n, constant p, proper model.