Binomial Distribution — Formulas & Cheat Sheet

statisticsfundamentals.com/tables/binomial-distribution-table/

What Is the Binomial Distribution?

The **binomial distribution** is a discrete probability distribution that models the number of successes in *n* independent Bernoulli trials, each with a fixed probability of success *p*. It is written **X ~ B(n, p)**.

The 4 Conditions — FINS

	Fixed	A fixed number of trials n (e.g., 10 coin flips)
I	**Independent**	Each trial is independent — one result does not affect another
	Two outcomes	Each trial has exactly two outcomes: Success or Failure
S	**Same p**	The probability of success p is constant across every trial

Core Formulas

Formula	Expression	Notes
Probability P(X = k)	`C(n,k) x p^k x (1-p)^(n-k)`	C(n,k) = n! / [k!(n-k)!]
Cumulative P(X <= k)	`Sum of P(X=i) for i=0..k`	Use complement for P(X>=k)
Complement P(X >= k)	`1 - P(X <= k-1)`	Fastest for "at least" problems
Mean mu	`n x p`	Expected number of successes
Variance sigma^2	`n x p x (1-p) = npq`	q = 1 - p
Std Deviation sigma	`sqrt(n x p x (1-p))`	Typical spread around mean
Binomial Coefficient	`C(n,k) = n! / [k! x (n-k)!]`	"n choose k" — ways to pick k from n

How to Read the Binomial Distribution Table — 5 Steps

Step	Action	Detail
	Identify n	Find the section/block of the table for your number of trials n.
2	**Find p column**	Locate the column header matching your probability of success p.
	Locate k row	Move down to the row for k — your desired number of successes.
4	**Read the cell**	The value at the intersection is P(X = k) — your exact probability.
	Cumulative/Complement	For P(X <= k): sum rows 0 to k. For P(X >= k): use 1 - P(X <= k-1).

Worked Examples

Example	Parameters	Find	Answer

Fair coin — 8 flips
P(exactly 3 heads)
	`n=8, k=3, p=0.50`	P(X=3)	`C(8,3) x 0.5^3 x 0.5^5`
			`= 56 x 0.125 x 0.03125`
			`= 0.2188`

Basketball — 60% free throws
6 shots, P(fewer than 4)
	`n=6, p=0.60`
	`"< 4" means k<=3`
		P(X<=3)	`P(0)+P(1)+P(2)+P(3)`
			`= 0.0041+0.0369`
			`+0.1382+0.2765`
			`= 0.4557`

Quality control — 15% defect rate
10 items, P(at least 2 defective)
	`n=10, p=0.15`
	`">=2" means complement`
		P(X>=2)
		= 1-P(X<=1)
			`P(X<=1) = P(0)+P(1)`
			`= 0.1969+0.3474 = 0.5443`
			`P(X>=2) = 1-0.5443`
			`= 0.4557`

Quick-Reference Values (p = 0.50)

n	k	p	P(X=k)	P(X<=k)	Mean mu	Variance s2
5	2	0.50	0.3125	0.5000	2.50	1.2500
5	3	0.50	0.3125	0.8125	2.50	1.2500
8	4	0.50	0.2734	0.6367	4.00	2.0000
10	3	0.30	0.2668	0.6496	3.00	2.1000
10	5	0.50	0.2461	0.6230	5.00	2.5000
10	7	0.70	0.2668	0.6172	7.00	2.1000
15	5	0.25	0.1651	0.8516	3.75	2.8125
15	8	0.50	0.1964	0.6964	7.50	3.7500
20	10	0.50	0.1762	0.5881	10.00	5.0000
20	6	0.40	0.1244	0.2500	8.00	4.8000

TI-84 Calculator Reference

Function	Syntax	Returns	Example
`binompdf`	`binompdf(n, p, k)`	P(X = k) — exact probability	`binompdf(10, 0.5, 3) = 0.1172`
`binomcdf`	`binomcdf(n, p, k)`	P(X <= k) — cumulative probability	`binomcdf(10, 0.5, 3) = 0.1719`

Normal Approximation (Large n)

When **n is large** and tables don't cover it, approximate with a Normal distribution if both **np** ≥ **5** and **n(1–p)** ≥ **5**. Then X ≈ N(np, np(1–p)). Apply continuity correction: P(X = k) ≈ P(k–0.5 < Z < k+0.5).

Source: NIST/SEMATECH e-Handbook of Statistical Methods §1.3.6.6.18 · DeGroot & Schervish, Probability and Statistics, 4th ed., Ch. 5 · Harvard Statistics 110 (stat110.net)

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