Distribution Formulas

📘 1. Binomial Distribution

- **Use:** Number of successes in n independent Bernoulli trials

$$P(X = k) = \binom{n}{k} p^k (1-p)^{n-k}$$

Where:

- n: number of trials
- k: number of successes
- p: probability of success
- X: binomial random variable

📕 2. Poisson Distribution

- **Use:** Counts of events in fixed intervals (time/space)

$$P(X = k) = \frac{\lambda^k e^{-\lambda}}{k!}$$

Where:

- λ: average rate (mean number of events)
- k: observed number of events

📗 3. Normal (Gaussian) Distribution

- **Use:** Continuous variable with symmetric bell-shaped distribution

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Where:

- μ: mean
- σ: standard deviation
- $f(x)$: probability density function

📕 4. t-Distribution

- **Use:** When estimating population mean with small sample size

$$f(t) = \frac{\Gamma\left(\frac{\nu+1}{2}\right)}{\sqrt{\nu\pi}\,\Gamma\left(\frac{\nu}{2}\right)} \left(1 + \frac{t^2}{\nu}\right)^{-\frac{\nu+1}{2}}$$

Where:

- ν: degrees of freedom
- Γ: gamma function

📒 5. Chi-Square Distribution

- **Use:** Sum of squares of k independent standard normal variables

$$f(x) = \frac{1}{2^{k/2}\Gamma(k/2)} x^{(k/2-1)} e^{-x/2}$$

Where:

- k: degrees of freedom

📘 6. Exponential Distribution

- **Use:** Time until first event in a Poisson process

$$f(x) = \lambda e^{-\lambda x}, \quad x \geq 0$$

Where:

- λ: rate parameter (mean = $1/\lambda$)

📓 7. Gamma Distribution

- **Use:** Waiting time until kth event in Poisson process

$$f(x) = \frac{\lambda^k x^{k-1} e^{-\lambda x}}{\Gamma(k)}, \quad x \geq 0$$

Where:

- k: shape parameter
- λ: rate parameter

📕 8. Weibull Distribution

- **Use:** Reliability and survival analysis

$$f(x) = \frac{k}{\lambda}\left(\frac{x}{\lambda}\right)^{k-1} e^{-(x/\lambda)^k}, \quad x \geq 0$$

Where:

- k: shape parameter
- λ: scale parameter