

STAT 5700 formulas

Chapter 2

$$(A \cup B)' = A' \cap B'$$

$$(A \cap B)' = A' \cup B'$$

$$P(A) = 1 - P(A')$$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$${n \choose r} P_r = \frac{n!}{(n-r)!}$$

$${n \choose n_1 \ n_2 \ \dots \ n_k} = \frac{n!}{n_1! n_2! \dots n_k!}$$

$$P(B|A) = \frac{P(A \cap B)}{P(A)}$$

$$P(B'|A) = 1 - P(B|A)$$

$$\text{Bayes Rule: } P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

Definition	Discrete	Continuous
$\mu = E(Y)$	$\sum_{y \in S} yp(y)$	$\int_S y f(y) dy$
$\sigma^2 = V(Y) = E[(Y - \mu)^2]$	$\sum_{y \in S} (y - \mu)^2 p(y)$	$\int_S (y - \mu)^2 f(y) dy$
k^{th} moment = $E(Y^k)$	$\sum_{y \in S} y^k p(y)$	$\int_S y^k f(y) dy$
$m(t) = E(e^{tY})$	$\sum_{y \in S} e^{ty} p(y)$	$\int_S e^{ty} f(y) dy$
$E(g(Y))$	$\sum_{y \in S} g(y) p(y)$	$\int_S g(y) f(y) dy$

$$f_X(x) = \int_y f(x, y) dy$$

$$f_Y(y) = \int_x f(x, y) dx$$

$$p_X(x) = \sum_y p(x, y)$$

$$p_Y(y) = \sum_x p(x, y)$$

$$f(x|y) = \frac{f(x,y)}{f_Y(y)}$$

$$\sigma_{XY} = Cov(X, Y) = E((X - \mu_X)(Y - \mu_Y))$$

$$\rho_{XY} = Corr(X, Y) = \frac{Cov(X, Y)}{\sigma_X \sigma_Y}$$

Distribution	Probability Function	Mean	Variance
Bernoulli	$p^y(1-p)^{1-y}$	p	$p(1-p)$
Binomial	$\binom{n}{y} p^y (1-p)^{n-y}$	np	$np(1-p)$
Geometric	$p(1-p)^{y-1}$	$\frac{1}{p}$	$\frac{1-p}{p^2}$
Hypergeometric	$\frac{\binom{r}{y} \binom{N-r}{n-y}}{\binom{N}{n}}$	$\frac{nr}{N}$	$n \left(\frac{r}{N}\right) \left(\frac{N-r}{N}\right) \left(\frac{N-n}{N-1}\right)$
Poisson	$\frac{\lambda^y e^{-\lambda}}{y!}$	λ	λ
Negative Binomial	$\binom{y-1}{r-1} p^r (1-p)^{y-r}$	$\frac{r}{p}$	$\frac{r(1-p)}{p^2}$

Distribution	Probability Density Function (pdf)	Mean	Variance
Uniform	$\frac{1}{\theta_2 - \theta_1}, \quad \theta_1 \leq y \leq \theta_2$	$\frac{\theta_1 + \theta_2}{2}$	$\frac{(\theta_2 - \theta_1)^2}{12}$
Normal	$\frac{1}{\sigma\sqrt{2\pi}} e^{-(y-\mu)^2/(2\sigma^2)}$	μ	σ^2
Exponential	$\frac{1}{\beta} e^{-y/\beta}, \quad y \geq 0$	β	β^2
Gamma	$\frac{1}{\beta^\alpha \Gamma(\alpha)} y^{\alpha-1} e^{-y/\beta}, \quad y \geq 0$	$\alpha\beta$	$\alpha\beta^2$
Chi-square	$\frac{1}{2^{\nu/2} \Gamma(\nu/2)} y^{\nu/2-1} e^{-y/2}, \quad y \geq 0$	ν	2ν
Beta	$\frac{\Gamma(\alpha + \beta)}{\Gamma(\alpha)\Gamma(\beta)} y^{\alpha-1} (1-y)^{\beta-1}, \quad 0 \leq y \leq 1$	$\frac{\alpha}{\alpha + \beta}$	$\frac{\alpha\beta}{(\alpha + \beta)^2(\alpha + \beta + 1)}$

Geometric series: $\sum_{n=0}^{\infty} ar^n = \frac{a}{1-r}$

For geometric random variable, $P(Y > k) = (1 - p)^k$

Maclaurin series expansion: $e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!}$

Binomial expansion: $(a + b)^n = \sum_{y=0}^n \binom{n}{y} a^y b^{n-y}$