STAT 5700 formulas

Chapter 2

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

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

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

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

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

$\binom{n}{r} = {}_n C_r = \frac{_nP_r}{r!} = \frac{n!}{(n-r)!r!}$

$\binom{n}{n_1 \quad n_2 \quad \cdots \quad n_k} = \frac{n!}{n_1!n_2!\cdots n_k!}$

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

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

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

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

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

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

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

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

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

$E(X|Y) = \int xf(x|y)dx$

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

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

$V(\sum_{i=1}^n a_i X_i) = \sum_{i=1}^n a_i^2 V(X_i) + 2(a_i)(a_j) \sum \sum_{i<j} Cov(X_i, X_j)$

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	$p(1-p)^{y-1}$	$\dfrac{1}{p}$	$\dfrac{1-p}{p^2}$
Hypergeometric	$\dfrac{\binom{r}{y}\binom{N-r}{n-y}}{\binom{N}{n}}$	$\dfrac{nr}{N}$	$n\left(\dfrac{r}{N}\right)\left(\dfrac{N-r}{N}\right)\left(\dfrac{N-n}{N-1}\right)$
Poisson	$\dfrac{\lambda^y e^{-\lambda}}{y!}$	λ	λ
Negative Binomial	$\binom{y-1}{r-1}p^r(1-p)^{y-r}$	$\dfrac{r}{p}$	$\dfrac{r(1-p)}{p^2}$

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

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