Chapter 2

- Permutation (no replacement) $_nP_r = \frac{n!}{(n-r)!}$
- Combination (w/ replacement) $_nC_r = \frac{_nP_r}{r!}$
- $P(A|B) = (P(A) \cap P(B))/P(B)$ If independant then $P(A|B) = P(A)$

If disjoint, $P(A)+P(B) \leq 1$. | If independant means multiply $P(A \cap B) = P(A)P(B)$

$\bar{A} = 1 - P(A)$ | $P(A) \cup P(B) = P(A) + P(B) - P(A \cap B)$

Chapter 3

$E(x) = \sum x\, P(x=x)$ $V(x) = E(x-E(x))^2 = E(x^2) - E(x)^2$ std. dev $= \sigma = \sqrt{V(x)}$

Chebysheff $P(|x-\mu| \geq k\sigma) \leq 1/k^2$

Bernoulli $(0,1)$ - $p(x) = p^x(1-p)^{1-x}$ $E(x) = p$ $V(x) = p(1-p)$

Binomial (k success N tries) - $\binom{n}{k} p^k (1-p)^{n-k}$ $E(x) = np$ $V(x) = np(1-p)$

Geometric (1^{st} success) - $P(x=n) = p(1-p)^{n-1}$ $E(x) = 1/p$ $V(x) = (1-p)/p^2$

Geometric (n^{th} try) - $P(x>n) = (1-p)^n$ $E(x) = 1/p$ $V(x) = (1-p)/p^2$

Negative Binomial (k^{th} success N tries) $= \binom{n-1}{k-1} p^k (1-p)^{n-k}$ $E(x) = k/p$ $V(x) = \frac{k(1-p)}{p^2}$

Poisson (λ = rate) = How many if known avg $= (\lambda^k/(k!))e^{-\lambda}$ $E(x) = \lambda$ $V(x) = \lambda$

Hyper Geometric (without replacement) $\left(\binom{k}{x}\binom{N-k}{n-x}\right)/\binom{N}{n}$ $E(x) = n\left(\frac{k}{N}\right)$

$V(x) = n\left(\frac{k}{N}\right)\left(1-\frac{k}{N}\right)\left(\frac{N-n}{N-1}\right)$ N = total choices to start; n = total trials; k = total choice of x

Chapter 4. P.d.f. $\int_{-\infty}^{\infty} c f(x)dx = 1$ $P(a \leq x \leq b) = \int_a^b f(x)dx$ $F(x) = \int f(x)dx$

Continuous Random Variable $F(b) = \int_{-\infty}^{b} f(x)dx$ $E(x) = \int x f(x)dx$ $E(g(x)) = \int g(x)f(x)dx$

$V(x) = E(x^2) - E(x)^2 = \int x^2 f(x) - \left(\int x f(x)\right)^2$

Uniform Distribution $f(x) = \begin{cases} \frac{1}{b-a} & , a \leq x \leq b \\ 0 & , \text{elsewhere} \end{cases}$ $E(x) = \frac{a+b}{2}$ $V(x) = \frac{(b-a)^2}{12}$

$P(x=x) = F(x) = \frac{x-a}{b-a}$ or $\frac{b-x}{b-a}$

Exponential Distribution (memoryless) $f(x) = \begin{cases} \frac{1}{\theta} e^{\frac{-x}{\theta}} & , x \geq 0 \\ 0 & , \text{elsewhere} \end{cases}$

$E(x) = \theta$ $V(x) = \theta^2$

$P(x>a) = e^{\frac{-a}{\theta}}$ $P(x \leq a) = 1 - e^{\frac{-a}{\theta}}$

Gamma Integral $\int_0^\infty x^{\alpha-1} e^{\frac{-x}{\beta}} = \Gamma(\alpha)\beta^\alpha$, $\beta = \theta$, $\Gamma(\alpha+1) = \alpha\Gamma(\alpha) = \Gamma(n+1) = n!$

ex) $g(x) = x^3$; $\int x^3 f(x)dx$ where $f(x) = \frac{1}{\theta}e^{\frac{-x}{\theta}}$; $= \frac{1}{\theta}\int x^3 e^{\frac{-x}{\theta}}$; $\alpha - 1 = 3$; $\alpha = 4$

Normal Distribution $f(x) = \frac{1}{\sqrt{2\pi}\,\sigma} e^{\frac{-(x-\mu)^2}{2\sigma^2}}$; $Z = \frac{X-\mu}{\sigma}$; $x = \mu + \sigma z$

$E(x) = \mu$; $V(x) = \sigma^2$

Chapter 5 Joint Marginal - Marginal - $p(x,y) = P(X=x, Y=y)$

$p(x) = \sum_y p(x,y)$ and $p(y) = \sum_x p(x,y)$

Joint Probability Dens. $P(a_1 \leq x \leq a_2, b_1 \leq y \leq b_2) = \int_{b_1}^{b_2}\int_{a_1}^{a_2} f(x,y)dxdy$

Covariance $(x,y) = E(xy) - E(x)E(y)$

Conditional P.d.f. $f(x|y) = \frac{f(x,y)}{f_y(y)}$

Independance (multiply) $f(x,y) = f_x(x) f_y(y)$