Probability Final Exam Cheat Sheet

Gamma function

$\Gamma(z) = \int_0^\infty t^{z-1} e^{-t} dt$; for $\mathcal{R}(z) > 0$
$\Gamma(z+1) = z\Gamma(z)$; $\Gamma(n+1) = n!$ for $n \in \mathbb{N}$

Gamma distribution

$f_Y(y) = \frac{\beta^\alpha}{\Gamma(\alpha)} y^{\alpha-1} e^{-\beta y}$; $y, \alpha, \beta > 0$
$E[Y] = \alpha/\beta$; $Var(Y) = \alpha/\beta^2$
$\text{MGF}(t) = \left(1 - \frac{t}{\beta}\right)^{-\alpha}$ for $t < \beta$

Beta distribution

$f_Y(y) = \frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)} y^{\alpha-1}(1-y)^{\beta-1}$; $\alpha, \beta > 0$, $y \in [0,1]$
$E[Y] = \frac{\alpha}{\alpha+\beta}$; $Var(Y) = \frac{\alpha\beta}{(\alpha+\beta)^2(\alpha+\beta+1)}$

Multivariate Normal distribution

$f_Y(y) = \frac{\det(A)^{1/2} e^{-\frac{1}{2} b^T A b}}{(2\pi)^{d/2}} \exp\{-\frac{1}{2}(y^T A y) + b^T y\}$
$E[Y] = A^{-1}b$; $\text{MGF}(t) = \exp\{\mu t + \sigma^2 t^2/2\}$
$Y_1 | Y_2 = y_2 \sim N(\mu_1 + \Sigma_{12}\Sigma_{22}^{-1}(y_2 - \mu_2); \Sigma_{11} - \Sigma_{12}\Sigma_{22}^{-1}\Sigma_{21})$

Hypergeometric distribution

$f_Y(y) = \frac{\binom{K}{y}\binom{N-K}{n-y}}{\binom{N}{n}}$
$E[Y] = n\frac{K}{N}$; $Var(Y) = n\frac{N-K}{N}\frac{K}{N}\frac{N-n}{N-1}$

Negative Binomial distribution

$f_Y(y) = \binom{k+r-1}{k}(1-p)^k p^r$
$E[Y] = \frac{r(1-p)}{p}$; $Var(Y) = \frac{r(1-p)}{p^2}$

Series

$\sum_{n=0}^\infty x^n/n! = e^x$; $\lim_{n\to\infty}\left(1 + \frac{x}{n}\right)^n = e^x$
$\sum_{i=0}^n r^i = \frac{1-r^{n+1}}{1-r}$ for $|r| < 1$

Log base change

$\log_a(x) = \frac{\log_b(x)}{\log_b(x)}$

Trigonometric summations

$\sin(x \pm y) = \sin(x)\cos(y) \pm \sin(y)\cos(x)$
$\cos(x \pm y) = \cos(x)\cos(y) \mp \sin(x)\sin(y)$
$z^2 = x^2 + y^2 - 2xy\cos(\text{angle}(x,y))$

Derivatives

$\frac{d}{dx}\sin(x) = \cos(x)$; $\frac{d}{dx}\cos(x) = -\sin(x)$
$\frac{d}{dx}\arcsin(x) = \frac{1}{\sqrt{1-x^2}}$; $\frac{d}{dx}\arccos(x) = -\frac{1}{\sqrt{1-x^2}}$
$\frac{d}{dx}\tan(x) = \frac{1}{\cos^2(x)}$; $\frac{d}{dx}\arctan(x) = \frac{1}{1+x^2}$

Integrals

$\int x^k dx = \frac{x^{k+1}}{k+1} + C$ $k \neq 1$; $\int \frac{1}{x} dx = \log(|x|) + C$
$\int \tan(x) dx = \log(\frac{1}{\cos(x)}) + C$
$\int \frac{1}{a^2+x^2} dx = \frac{1}{a}\arctan(\frac{x}{a}) + C$
$\int \frac{1}{\sqrt{a^2+x^2}} dx = \arcsin(\frac{x}{a}) + C$

Another topic

Some stuff