Selected Formulas

CHAPTER 2

Relative Frequency = (frequency)/n

$$\bar{x} = \frac{\Sigma x}{n}$$

$$s^2 = \frac{\Sigma(x - \bar{x})^2}{n - 1} = \frac{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}{n - 1}$$

$$s = \sqrt{s^2}$$

$$z = \frac{x - \mu}{\sigma} = \frac{x - \bar{x}}{s}$$

Chebyshev = At least $\left(1 - \frac{1}{k^2}\right)100\%$

IQR = $Q_U - Q_L$

CHAPTER 3

$P(A^c) = 1 - P(A)$

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$
$\quad = P(A) + P(B)$ if A and B mutually exclusive

$P(A \cap B) = P(A|B) \cdot P(B) = P(B|A) \cdot P(A)$
$\quad = P(A) \cdot P(B)$ if A and B independent

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

$$\binom{N}{n} = \frac{N!}{n!(N - n)!}$$

Bayes's: $P(S_i|A) =$

$$\frac{P(S_i)P(A|S_i)}{P(S_1)P(A|S_1) + P(S_2)P(A|S_2) + \cdots + P(S_k)P(A|S_k)}$$

CHAPTER 6

CI for μ: $\bar{x} \pm (z_{\alpha/2})\sigma/\sqrt{n}$ (large n)
$\quad \bar{x} \pm (t_{\alpha/2})s/\sqrt{n}$ (small n, σ unknown)

CI for p: $\hat{p} \pm z_{\alpha/2}\sqrt{\frac{\hat{p}\hat{q}}{n}}$

Estimating μ: $n = (z_{\alpha/2})^2(\sigma^2)/(\mathrm{SE})^2$

Estimating p: $n = (z_{\alpha/2})^2(pq)/(\mathrm{SE})^2$

Cl for σ^2: $= \frac{(n - 1)s^2}{\chi^2_{\alpha/2}} < \sigma^2 < \frac{(n - 1)s^2}{\chi^2_{1-\alpha/2}}$

CHAPTER 4

Key Formulas

Random Variable	Prob. Dist'n	Mean	Variance
General Discrete:	Table, formula, or graph for $p(x)$	$\sum_{\text{all } x} x \cdot p(x)$	$\sum_{\text{all } x} (x - \mu)^2 \cdot p(x)$
Binomial:	$p(x) = \binom{n}{x} p^x q^{n-x}$ $x = 0, 1, 2, \ldots, n$	np	npq
Poisson:	$p(x) = \frac{\lambda^x e^{-\lambda}}{x!}$ $x = 0, 1, 2, \ldots$	λ	λ
Uniform:	$f(x) = 1/(d - c)$ $(c \leq x \leq d)$	$(c + d)/2$	$(d - c)^2/12$
Normal:	$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-1/2[(x-\mu)/\sigma]^2}$	μ	σ^2
Standard Normal:	$f(z) = \frac{1}{\sqrt{2\pi}} e^{-1/2(z)^2}$ $z = (x - \mu)/\sigma$	$\mu = 0$	$\sigma^2 = 1$

CHAPTER 5

Sample Mean (large n):	Approx. normal,	$\mu_{\bar{x}} = \mu$	$\sigma^2_{\bar{x}} = \sigma^2/n$

CHAPTER 7

Test for μ: $z = \dfrac{\bar{x} - \mu}{\sigma/\sqrt{n}}$ (large n)

$t = \dfrac{\bar{x} - \mu}{s/\sqrt{n}}$ (small n, σ unknown)

Test for p: $z = \dfrac{\hat{p} - p_0}{\sqrt{p_0 q_0/n}}$

Test for σ^2: $\chi^2 = (n - 1)s^2/(\sigma_0)^2$

CHAPTER 8

CI for $\mu_1 - \mu_2$:

$$\left.(\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}\right\}\text{(large } n_1 \text{ and } n_2\text{)}$$

Test for $\mu_1 - \mu_2$:

$$\left.z = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}}}\right\}\text{(large } n_1 \text{ and } n_2\text{)}$$

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

CI for $\mu_1 - \mu_2$:

$$\left.(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2}\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}\right\}\text{(small } n_1 \text{ and/or } n_2\text{)}$$

Test for $\mu_1 - \mu_2$:

$$\left.t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{s_p^2\left(\dfrac{1}{n_1} + \dfrac{1}{n_2}\right)}}\right\}\text{(small } n_1 \text{ and/or } n_2\text{)}$$

CI for μ_d: $\bar{x}_d \pm t_{\alpha/2}\dfrac{s_d}{\sqrt{n}}$

Test for μ_d: $t = \dfrac{\bar{x}_d - \mu_d}{s_d/\sqrt{n}}$

CI for $p_1 - p_2$: $(\hat{p}_1 - \hat{p}_2) \pm z_{\alpha/2}\sqrt{\dfrac{\hat{p}_1\hat{q}_1}{n_1} + \dfrac{\hat{p}_2\hat{q}_2}{n_2}}$

Test for $p_1 - p_2$: $z = \dfrac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{\hat{p}\hat{q}\left(\dfrac{1}{n_1} + \dfrac{1}{n_2}\right)}}$

$$\hat{p} = \frac{x_1 + x_2}{n_1 + n_2}$$

Test for (σ_1^2/σ_2^2): $F = (s_1^2/s_2^2)$

Estimating $\mu_1 - \mu_2$: $n_1 = n_2 = (z_{\alpha/2})^2(\sigma_1^2 + \sigma_2^2)/(\text{ME})^2$

Estimating $p_1 - p_2$: $n_1 = n_2 = (z_{\alpha/2})^2(p_1q_1 + p_2q_2)/(\text{ME})^2$

CHAPTER 9

ANOVA Test for completely randomized design:
$F = \text{MST}/\text{MSE}$

ANOVA Test for randomized block design:
$F = \text{MST}/\text{MSE}$

ANOVA Test for factorial design interaction:
$F = \text{MS}(\text{A} \times \text{B})/\text{MSE}$

Pairwise comparisons: $c = k(k - 1)/2$

CHAPTER 10

Multinomial test: $\chi^2 = \sum \dfrac{(n_i - E_i)^2}{E_i}$

$E_i = n(p_{i0})$

Contingency table test: $\chi^2 = \sum \dfrac{(n_{ij} - E_{ij})^2}{E_{ij}}$

$$E_{ij} = \frac{R_i C_j}{n}$$

CHAPTER 11

$$\text{SS}_{xx} = \Sigma(x - \bar{x})^2 = \Sigma x^2 - \frac{(\Sigma x)^2}{n}$$

$$\text{SS}_{yy} = \Sigma(y - \bar{y})^2 = \Sigma y^2 - \frac{(\Sigma y)^2}{n}$$

$$\text{SS}_{xy} = \Sigma(x - \bar{x})(y - \bar{y}) = \Sigma xy - \frac{(\Sigma x)(\Sigma y)}{n}$$

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x$$

$$\hat{\beta}_1 = \frac{SS_{xy}}{SS_{xx}}$$

$$\hat{\beta}_1 = \bar{y} - \hat{\beta}_1\bar{x}$$

$$r = \frac{\text{SS}_{xy}}{\sqrt{\text{SS}_{xx}}\sqrt{\text{SS}_{yy}}}$$

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CHAPTER 11 (cont'd)

$s^2 = \dfrac{\text{SSE}}{\text{n} - 2}$

$s = \sqrt{s^2}$

$r^2 = \dfrac{\text{SS}_{yy} - \text{SSE}}{\text{SS}_{yy}}$

CI for β_1: $\hat{\beta}_1 \pm (t_{\alpha/2})s/\sqrt{\text{SS}_{xx}}$

Test for β_1: $t = \dfrac{\hat{\beta}_1 - 0}{s/\sqrt{\text{SS}_{xx}}}$

CI for $E(y)$ when $x = x_p$: $\hat{y} \pm t_{\alpha/2} s \sqrt{\dfrac{1}{n} + \dfrac{(x_{\text{p}} - \bar{x})^2}{\text{SS}_{xx}}}$

CI for y when $x = x_p$: $\hat{y} \pm t_{\alpha/2} s \sqrt{1 + \dfrac{1}{n} + \dfrac{(x_{\text{p}} - \bar{x})^2}{\text{SS}_{xx}}}$

CHAPTER 12

First-Order Model (QN x's):
$E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k$

Interaction Model (QN x's):
$E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_1 x_2$

Quadratic Model (QN x):
$E(y) = \beta_0 + \beta_1 x + \beta_2 x^2$

Complete 2nd-Order Model (QN x's):
$E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_1 x_2 + \beta_4 x_1^2 + \beta_5 x_2^2$

Dummy Variable Model (QL x):
$E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2$
where $x_1 = \{1 \text{ if A}, 0 \text{ if not}\}$, $x_2 = \{1 \text{ if B}, 0 \text{ if not}\}$

$\text{MSE} = s^2 = \dfrac{\text{SSE}}{n - (k + 1)}$

$R^2 = \dfrac{\text{SS}_{yy} - \text{SSE}}{\text{SS}_{yy}}$

$R_{\text{a}}^2 = 1 - \left[\dfrac{(n - 1)}{n - (k + 1)}\right](1 - R^2)$

Test for overall model: $F = \dfrac{\text{MS(Model)}}{\text{MSE}}$

Test for individual β: $t = \dfrac{\hat{\beta}_i - 0}{s_{\hat{\beta}_i}}$

CI for β_i: $\hat{\beta}_i \pm (t_{\alpha/2}) s_{\hat{\beta}_i}$

Nested model F test: $F = \dfrac{(\text{SSE}_{\text{R}} - \text{SSE}_{\text{C}})/\#\ \beta\text{'s tested}}{\text{MSE}_{\text{C}}}$

CHAPTER 13

Key Formulas

Control Chart	Centerline	Control Limits	A–B Boundary	B–C Boundary
$\bar{x}$-chart	$\bar{\bar{x}} = \dfrac{\sum_{i=1}^{k} \bar{x}_i}{k}$	$\bar{\bar{x}} \pm A_2\bar{R}$ or $\bar{\bar{x}} \pm 2\dfrac{(\bar{R}/d_2)}{\sqrt{n}}$	$\bar{\bar{x}} \pm \dfrac{2}{3}(A_2\bar{R})$ or $\bar{\bar{x}} \pm 2\dfrac{(\bar{R}/d_2)}{\sqrt{n}}$	$\bar{\bar{x}} \pm \dfrac{1}{3}(A_2\bar{R})$
R-chart	$\bar{R} = \dfrac{\sum_{i=1}^{k} R_i}{k}$	$(\bar{R}D_3, \bar{R}D_4)$	$\bar{R} \pm 2d_3\left(\dfrac{\bar{R}}{d_2}\right)$	$\bar{R} \pm d_3\left(\dfrac{\bar{R}}{d_2}\right)$
p-chart	$\bar{p} = \dfrac{\text{Total number defectives}}{\text{Total number units sampled}}$	$\bar{p} \pm 3\sqrt{\dfrac{\bar{p}(1 - \bar{p})}{n}}$	$\bar{p} \pm 2\sqrt{\dfrac{\bar{p}(1 - \bar{p})}{n}}$	$\bar{p} \pm \sqrt{\dfrac{\bar{p}(1 - \bar{p})}{n}}$

Capability index: $C_p = (\text{USL} - \text{LSL})/6\sigma$