QSCI 381: Equation Reference Sheet

Tsering Sherpa

2025

Table 1: Probability Rules Summary

Rule	**Expression / Condition**
Addition Rule	$P(A \cup B) = P(A) + P(B) - P(A \cap B)$
Mutually Exclusive Addition	If A and B are mutually exclusive: $P(A \cup B) = P(A) + P(B)$
Multiplication Rule	$P(A \cap B) = P(A) \cdot P(B\|A) = P(B) \cdot P(A\|B)$
Independence Rule	If $P(A \cap B) = P(A) \cdot P(B)$, then A and B are independent
Independent Events	$P(A\|B) = P(A)$ or $P(B\|A) = P(B)$
Complement Rule	$P(A^c) = 1 - P(A)$
Mutually Exclusive Definition	$P(A \cap B) = 0$
Law of Total Probability	$P(B) = P(A) \cdot P(B\|A) + P(A^c) \cdot P(B\|A^c)$
Bayes' Theorem	$P(A\|B) = \frac{P(A) \cdot P(B\|A)}{P(A) \cdot P(B\|A) + P(A^c) \cdot P(B\|A^c)}$

Table 2: Counting Formulas and Factorials

Concept	**Expression / Definition**
Permutations	${}_nP_k = \frac{n!}{(n-k)!}$
Combinations	${}_nC_k = \binom{n}{k} = \frac{n!}{k!(n-k)!}$
Factorial Values	$0! = 1$ (by definition), $1! = 1$, $2! = 2 \cdot 1 = 2$
Factorial Definition	$n! = n \cdot (n-1) \cdot (n-2) \cdots 3 \cdot 2 \cdot 1$

Table 3: Summary of Means and Proportions

Concept	**Formula**
Proportion	$p = \frac{x}{n}$
Sample Mean	$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$
Weighted Mean	$\bar{x} = \frac{\sum x_i w_i}{\sum w_i}$
Frequency Mean	$\bar{x} = \frac{\sum x_i f_i}{\sum f_i}$
Expected Value (Discrete)	$\mu = \sum_{i=1}^{n} x_i P(x_i)$

Table 4: Summary of Variance and Spread

Concept	**Formula**
Deviation	$D(x_i) = x_i - \mu$
Sum of Squared Deviations	$SS = \sum_{i=1}^{n}(x_i - \mu)^2$
Population Variance	$\sigma^2 = \frac{\sum_{i=1}^{N}(x_i-\mu)^2}{N}$
Sample Variance	$s^2 = \frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n-1}$
Variance (Discrete Distribution)	$\sigma^2 = \sum_{i=1}^{n}(x_i - \mu)^2 P(x_i)$
Population Std. Deviation	$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(x_i-\mu)^2}{N}}$
Sample Std. Deviation	$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n-1}}$
Coefficient of Variation	$CV = 100 \cdot \left(\frac{s}{\bar{x}}\right)$

Table 5: Statistical Theorems and Inequalities

Rule / Theorem	**Expression**
Sturges' Rule (Num. Classes)	$k = 1 + \log_2(n)$
Sturges' Class Width	Class Width $= \frac{x_{\max} - x_{\min}}{1+1.44 \cdot \log_{10}(n)}$
Chebyshev's Theorem	$P(\lvert X - \mu \rvert \geq k\sigma) \leq \frac{1}{k^2}$
z-score	$z = \frac{x-\mu}{\sigma}$

Table 6: Summary of Common Distributions

Distribution	**Mean**	**Variance**	**PDF**	**CDF**
Discrete (generic)	$\sum x_i P(x_i)$	$\sum (x_i - \mu)^2 P(x_i)$	–	–
Binomial	np	$np(1-p)$	$\binom{n}{x} p^x (1-p)^{n-x}$	$P(X \leq x) = \sum_{k=0}^{x} \binom{n}{k} p^k (1-p)^{n-k}$
Geometric	$\frac{1}{p}$	$\frac{1-p}{p^2}$	$(1-p)^{x-1} p$	$P(X \leq x) = 1 - (1-p)^x$
Poisson	λ	λ	$\frac{\lambda^x e^{-\lambda}}{x!}$	$P(X \leq x) = \sum_{k=0}^{x} \frac{\lambda^k e^{-\lambda}}{k!}$
Normal	μ	σ^2	$\frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$	$P(X \leq x) = \Phi\left(\frac{x-\mu}{\sigma}\right)$
Sampling Distribution of $\bar{x}$	μ	$\frac{\sigma^2}{n}$	–	–