Computational statistics and data analysis

Exercises

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Summary of Lecture 1

- Theory of sets
- Probability: Kolmogorov axioms
  1. $P(\Omega) = 1$
  2. $P(A) \geq 0, \quad \forall A \subset \Omega$
  3. $P(A \cup B) = P(A) + P(B), \quad \forall A \cap B = \{\}$
- Conditional probability for dependent random experiments, Bayes law

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

- Random variable X and its quantification: expectation value, variance, covariance, correlation coefficient

$$E(X) = \Sigma_i x_i P(X = x_i)$$
$$Var(X) = E([X - E(X)]^2)$$
$$Cov(X, Y) = E([X - E(X)][Y - E(Y)])$$
$$\rho_{XY} = \frac{Cov(X, Y)}{Var(X)Var(Y)}$$

- Cauchy-Schwarz inequality

$$|E(XY)|^2 \leq E(|X|^2)E(|Y|^2)$$

- Chebyshev inequality

$$P\left(|X - E(X)| \geq \epsilon\right) \leq \frac{Var(X)}{\epsilon^2} \quad \text{for all} \quad \epsilon > 0$$

- Law of large numbers

$$P\left(\left|\frac{X_1 + \cdots + X_n}{n} - E(X_1)\right| \geq \epsilon\right) \leq \frac{M}{n\epsilon^2}$$