1 Prerequisites and notational differences

1.1 Prerequisites

- Vectors in 2 and 3 dimensions. Positive normal and line through P and Q in $\mathbb{R}^2$. Dot (scalar) products. Norm of a vector. Cross product and plane through P, Q, R in $\mathbb{R}^3$. 2×2 determinants. Gauss-Jordan elimination.

Outline syllabus (subject to change)

- 2×2 and 3×3 determinants. Cramer's Rule and the Adjoint form of inverse.
- Determinants in n dimensions. (For exam purposes, $n \leq 4$.) Evaluating by cofactor expansion along some row or column. Evaluating through upper triangular form. Cramer's rule and the adjoint formula for an inverse. $\det(AB) = (\det A)(\det B)$, $\det(A^T) = \det A$.
- Linear dependence and independence.
- Linear maps: Projection, reflection, rotation in $\mathbb{R}^3$.
- Coordinate systems, change of basis formula. Orthogonal matrices and orthonormal bases.
- Matrices of linear maps in 'old' and 'new' coordinate systems.
- Least squared error estimates for linear and quadratic functions in $\mathbb{R}^2$.
- Eigenvalues and eigenvectors, calculation and basis of eigenvectors in $\mathbb{R}^2$. Calculating e^A. Solving differential equations $dX/dt = AX$, with initial conditions $X = X_0$ at $t = 0$.
- Probability. Official tables of formulae. Sample spaces and distributions. Addition principle. Uniform distribution: a fair coin, a fair die, two fair dice.
- Random variables. Binomial distribution. Mean and variance of a distribution. Sample average, variance, standard distribution.
- Continuous distributions: uniform, normal, student's t-distribution, chi-squared (omitted).
- The Central Limit Theorem. Normal approximation to the Binomial Distribution.
- Conditional probability and Bayes Theorem. Inverting conditional probabilities.
- Confidence intervals for mean of a normal distribution, estmated from sample average, (a) assuming its variance σ^2 is known, and (b) using the sample variance S^2 as an estimate for σ^2. Confidence intervals for σ and σ^2 using S^2.
- Hypothesis testing and Paul the Octopus.

1.2 Notation

- Number systems $\mathbb{N}$ (the 'natural numbers,' including zero), $\mathbb{R}$ (real number system), $\mathbb{C}$ (complex numbers).

  Also $\mathbb{Q}$ are the rational numbers and $\mathbb{Z}$ the integers (whole numbers, positive, negative, or zero).

- I prefer to use capital letters for points, $\vec{AB}$ for the displacement vector from A to B, and $\vec{V}$ for a general vector (has magnitude and direction).

  Given points P and Q, the scalar (dot) product is $\vec{OP} \cdot \vec{OQ}$. Or, if they are presented as column vectors, $P^T Q$.

  $\vec{OP} \cdot (\vec{OQ} \times \vec{OR})$ is the triple product.