

Linear Algebra Cheatsheet

Eventual outline

- **Part 1: Vectors**
 - Vectors
 - Plane geometry
 - Generalizing beyond \mathbf{R}^3 : vector spaces
 - Projections
 - Gram-Schmidt
 - Applications of projections: linear regression least squares
- **Part 2: Matrices**
 - Linear transformations (as matrices)
 - Types of linear transformations (geometric perspective)
 - Matrix multiplication
 - * Maybe: application: Markov chain/linear dynamical systems
 - Matrix algebra rules (transpose, various identities, etc.)
 - Special matrices (symmetric, orthogonal, etc.)
- **Part 3: Linear systems**
 - Matrix inverses
 - Systems of equations as matrices
 - LU and QR decompositions
- **Part 4: Further matrix algebra (or name this eigenvalues)**
 - Eigenvalues and eigenvectors
 - Spectral theorem (diagonalization) and definiteness of symmetric matrices
 - Singular value decomposition
 - The Hessian and the second derivative test
- **Part 5: Matrix calculus and optimization**
 - Aside: Lagrange multipliers (constrained optimization)
 - Calculus with vectors and matrices
 - * Gradient, Jacobian, Hessian, chain rule
 - Basics of convex functions and optimization
 - Momentum

- Extra:
 - * [Gauss-Newton method](#)
 - * CS 205L stuff

I. Vectors

Definition 0.1 (\mathbf{R}^2 , \mathbf{R}^3 , \mathbb{R}^n). The set \mathbf{R}^2 is the set of all ordered pairs of real numbers ($\mathbf{R}^2 = \{(x, y) : x, y \in \mathbf{R}\}$). The set itself should be thought of as a plane (i.e. the xy-cartesian plot). The set \mathbf{R}^3 is the set of all ordered triples of real numbers ($\mathbf{R}^3 = \{(x, y, z) : x, y, z \in \mathbf{R}\}$). The set itself should be thought of as ordinary space. This generalizes to higher dimensions (\mathbf{R}^n).