Linear Algebra cheat sheet

Vectors

dot product: $u * v = ||u|| * ||v|| * cos(\phi) = u_x v_x + u_y v_y$
cross product: $u \times v = \begin{pmatrix} u_y v_z - u_z v_y \\ u_z v_x - u_x v_z \\ u_x v_y - u_y v_x \end{pmatrix}$
enclosed angle:

$$cos\phi = \frac{u * v}{||u|| * ||v||}$$

$$||u|| * ||v|| = \sqrt{(u_x^2 + u_y^2)(v_x^2 + v_y^2)}$$

Matrices

basic operations

transpose: $[A^{\mathrm{T}}]_{ij} = [A]_{ji}$: "mirror over main diagonal"
multiply: $A_{N \times M} * B_{R \times K} = M_{N \times K}$
invert: $\begin{bmatrix} a & b \\ c & d \end{bmatrix}^{-1} = \frac{1}{\det(\mathbf{A})} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix} = \frac{1}{ad-bc} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$
norm:
condition:

determinants

$det(A \cdot B) = det(A) \cdot det(B)$
TODO: other rules

eigenvalues/vectors

definiteness

common properties

square: $N \times N$
symmetric: $A = A^T$
orthogonal: $A^T = A^{-1}$
diagonal: 0 except a_{kk}
$\Rightarrow$ Eigenvalues on main diagonale

nonsingular

A is nonsingular = invertible = regular iff:

> There is a matrix $B := A^{-1}$ such that $AB = I = BA$.
>
> $det(A) \neq 0$
>
> T$Ax = b$ has exactly one solution for each b.
>
> The columns of A are linearly independent.

$\Rightarrow det(A)^{-1} = det(A^{-1})$
$\Rightarrow (A^{-1})^{-1} = A$
$\Rightarrow (A^T)^{-1} = (A^{-1})^T$

diagonalizable

$A^{N \times N}$ can be diagonalized iff it has n linear independant eigenvectors. Then, there is an invertible T, such that:

$$D := T^{-1}AT = \begin{pmatrix} \lambda_1 & & \\ & \ddots & \\ & & \lambda_n \end{pmatrix}$$

$$A = T^{-1}DT \quad \textbf{and} \quad AT = T \begin{pmatrix} \lambda_1 & & \\ & \ddots & \\ & & \lambda_n \end{pmatrix}$$

T can be created with eigenvectors of A.

diagonally dominant matrix

$\forall i. |a_{ii}| \geq \sum_{j \neq i} |a_{ij}|$

Hermitian matrix

triangular

$\Rightarrow$ Eigenvalues on main diagonale

rank / kernel / trance