Vectors
matrices
derivatives
integrals

Vector
- multidimensional numbers
- direction + length

$(x, y) + (a, b) =$

$(x+a, y+b)$

$(3, 1, 3.75, 12, -2, 0)$ +

element-wise

$$\begin{bmatrix} 3 \\ 1 \\ 3.75 \\ 12 \\ -2 \\ 0 \end{bmatrix}$$

x
y
z
w
r
g
b
s
t
.
.
.

$\begin{bmatrix} 3 & 1 & 3.75 & 12 & -2 & 0 \end{bmatrix}$

Scalar = number

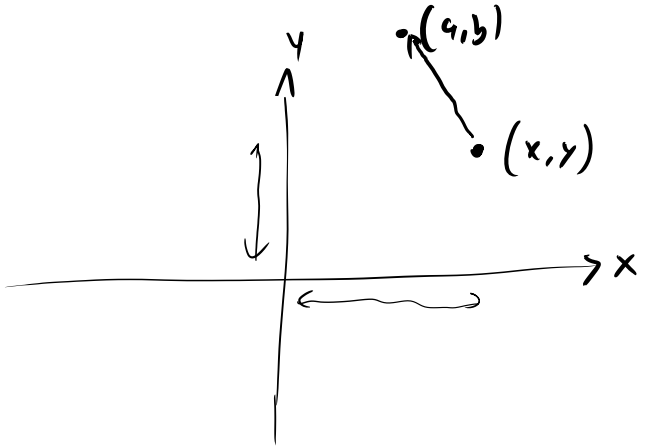
$(x, y, z) * s =$

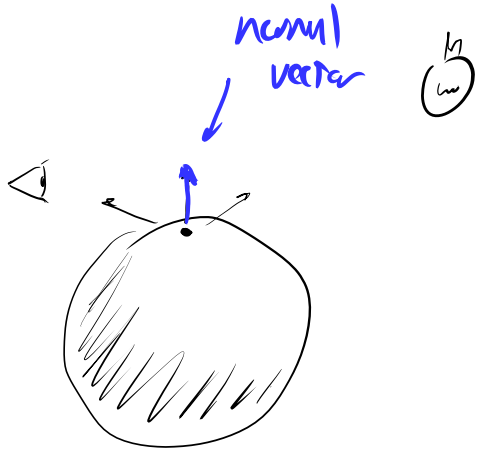
$(x \cdot s, y \cdot s, z \cdot s)$

Vector

- convenient math
- points
- separations $P_2 - P_1$
- directions

vector





length of vector $(3,4)$

2 (or dimension)

5 $\sqrt{3^2 + 4^2}$

ell-2 norm

L_2

$\| (3,4) \|_2 = 5$

$(3, 4, 5, 6, 0, -2)$

$\sqrt{3^2 + 4^2 + 5^2 + 6^2 + 0^2 + (-2)^2}$

Normalize

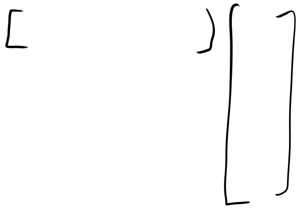
$\frac{\vec{d}_{\text{direction}}}{\|\vec{d}\|}$

$d * \frac{1}{\|d\|}$

Unit vector

Normal ≙ perpendicular to a surface

$\vec{x}$ $\vec{x}$ $\times$ x



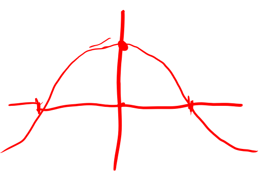
Trig

$$\|\vec{x}\| = \sqrt{\vec{x} \cdot \vec{x}}$$

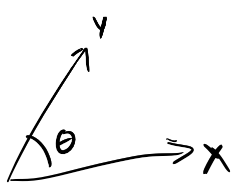
dot (inner)

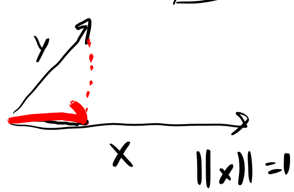
$$(x, y, z, w) \cdot (a, b, c, d) =$$

$$x \cdot a + y \cdot b + z \cdot c + w \cdot d$$



$$\vec{x} \cdot \vec{y} = \|\vec{x}\| \cdot \|\vec{y}\| \cdot \cos(\theta)$$





$$(\vec{x} \cdot \vec{y})\,\vec{x} =$$ projection of y onto x (assum x is unit vector)

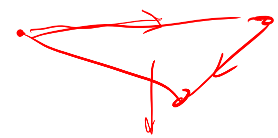
cross

3D only (2D fake verson)

$$(x, y, z) \times (a, b, c) =$$

$$(yb - cz, \; za - cx, \; xb - ay)$$

$\vec{a} \times \vec{b}$ perp to both $\vec{a}$ & $\vec{b}$



$$\|\vec{x} \times \vec{y}\| = \|\vec{x}\| \cdot \|\vec{y}\| \cdot \sin(\theta)$$

Matrix

$$\begin{bmatrix} x+4y+2z \\ -y+3z \\ y \end{bmatrix} = \begin{bmatrix} 1 & 4 & 2 \\ 0 & -1 & 3 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

identity matrix

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 21 & 38 & 45 \\ 17 & 19 & 21 \\ 4 & 5 & 6 \end{bmatrix} = \begin{bmatrix} 1 & 4 & 2 \\ 0 & -1 & 3 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

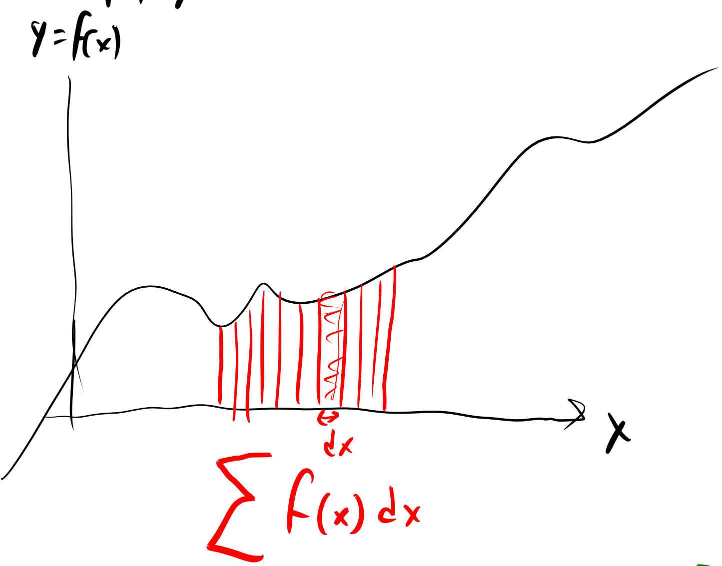
1. linear system of eq

$$A\vec{x} = \vec{b}$$

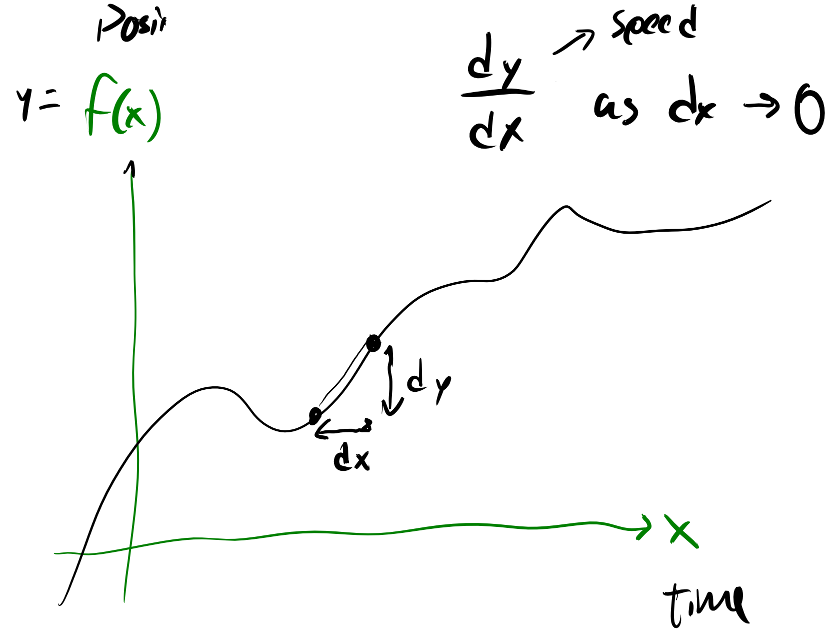
2. SVD rotate scale rotate

$$A = \begin{bmatrix} & & \end{bmatrix} \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix} \begin{bmatrix} & & \end{bmatrix}$$

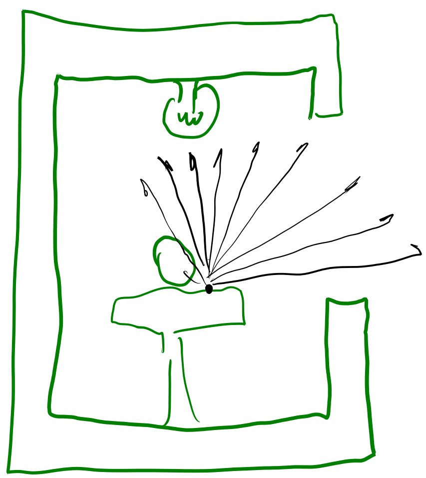
integral
integral

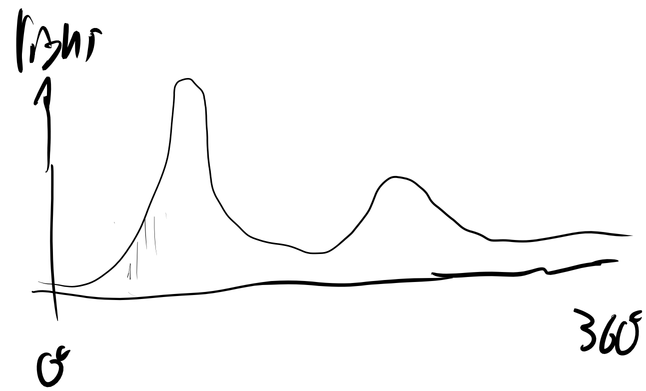


derivative
differentiation



limit





$$\iint \text{Func}(\theta,\phi)\, d\theta,\phi$$

$$\sum \iiint F(x,y,z)\, dx\, dy\, dz$$

$$P(t) = \int_{t=0}^{t} \text{motion}\ dt$$

$$\iint \text{accel}\ dt\,dt$$