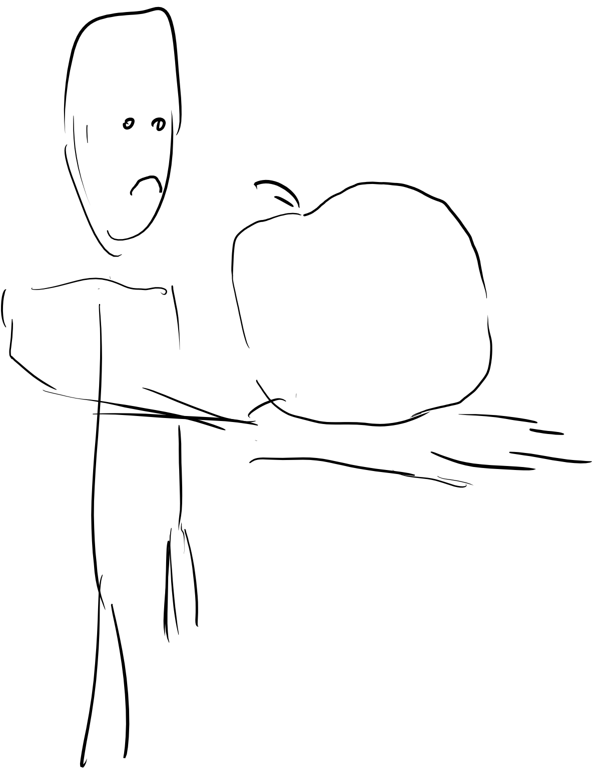


α opacity

50% 25% - $\frac{1}{4}$

100% 50% - $\frac{3}{8}$

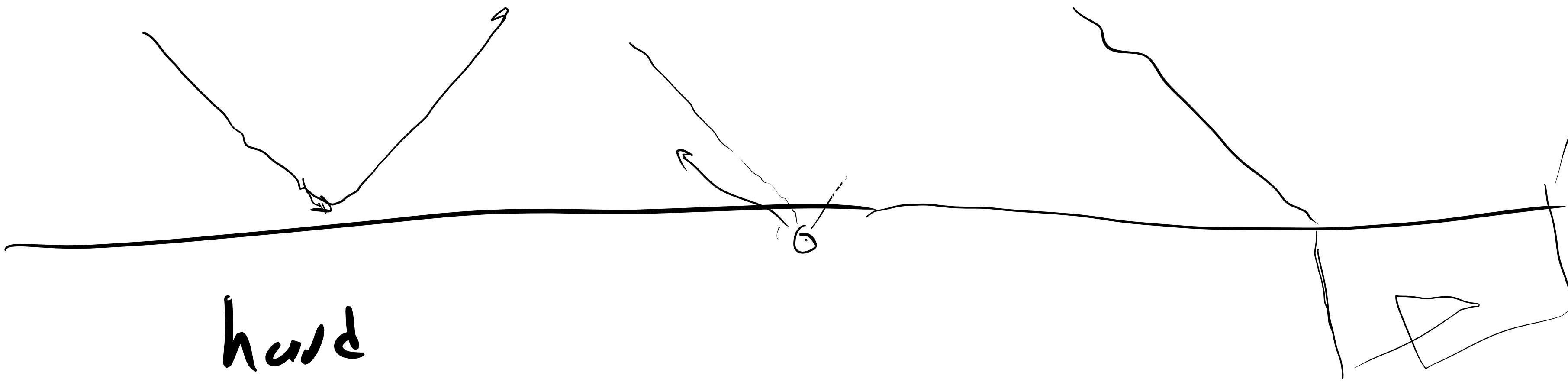
- $\frac{5}{8}$ = 62.5%

$$\underline{(.5)(.25) + 1(.5)(.75)}$$

$$.625$$

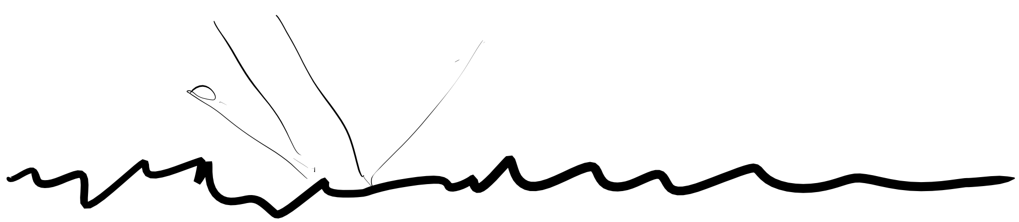
$\frac{3}{8}$

Glare



hard

smooth



Vector – list of numbers

$\vec{x} = (1, 3, 0, -2.1)$
$\vec{y} = (3, 3, 1, 1)$

$\vec{x} + \vec{y} = (4, 6, 1, -1.1)$

$\vec{x} - \vec{y} = (-2, 0, -1, -3.1)$

$2\vec{x} = (2, 6, 0, -4.2)$

$\vec{x} \cdot \vec{y} = 3 + 9 + 0 + -2.1 = 9.9$

length — dimension : # of values

length — magnitude : $\sqrt{\vec{x} \cdot \vec{x}}$ = $\|\vec{x}\|$

$\vec{x} = (x_1, x_2, x_3)$

Orthogonal (perpendicular) $x \cdot y = 0$

dot inner

3D: $\vec{x} \times \vec{y} = (x_2 y_3 - x_3 y_2, x_3 y_1 - x_1 y_3, x_1 y_2 - x_2 y_1)$

cross product

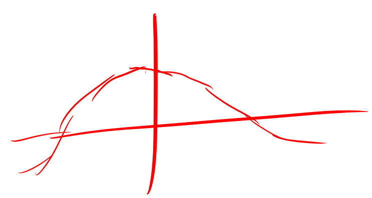
$(x \times y) \cdot x = 0$

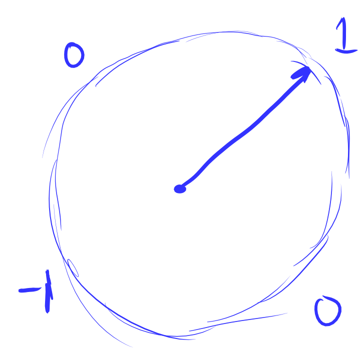
$(x \times y) \cdot y = 0$

2D: $(x_1, x_2) \cdot (-x_2, x_1) = 0$

$\vec{x} \times \vec{y} = x_1 y_2 - x_2 y_1$

$x \cdot y = \|x\| \, \|y\| \cos(\theta)$



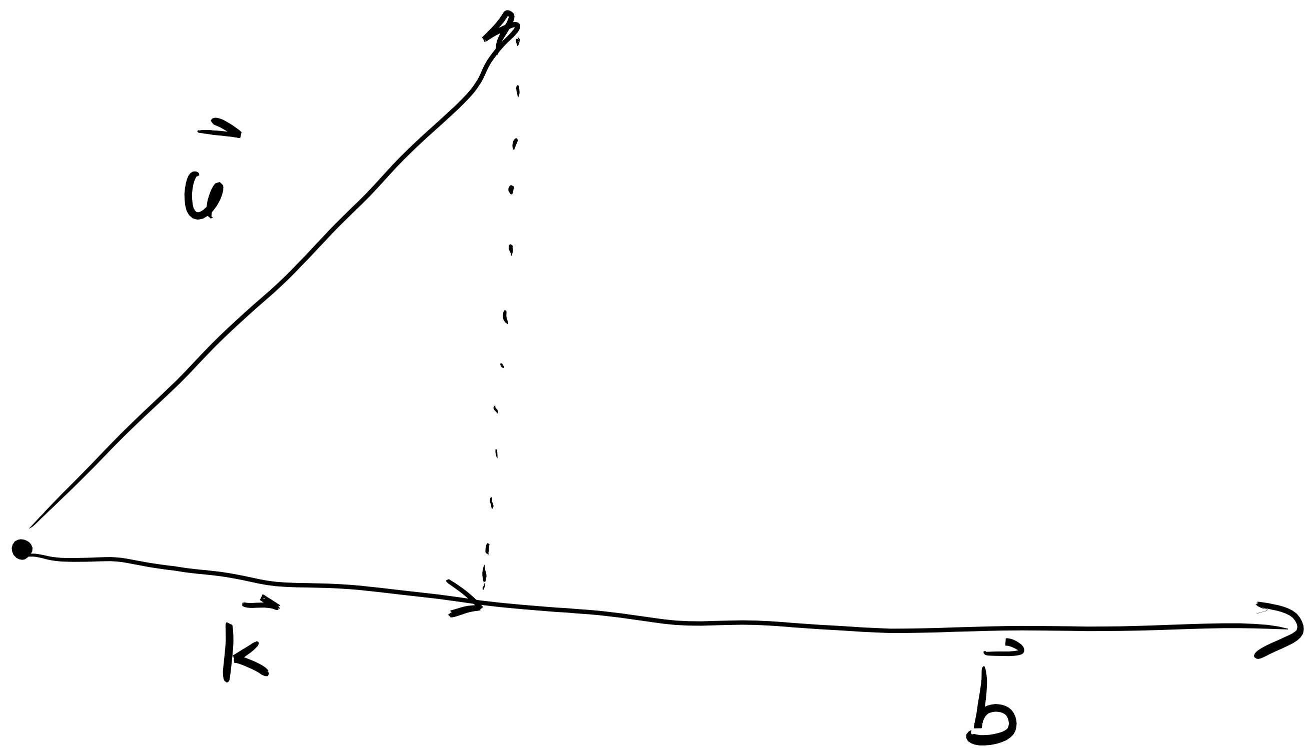


$\|x \times y\| = \|x\| \, \|y\| \sin(\theta)$

Normalize $\vec{x}$ by $\frac{\vec{x}}{\|\vec{x}\|}$

$\|\vec{x}\| = 1$, unit vector

normal vector perpendicular to surface



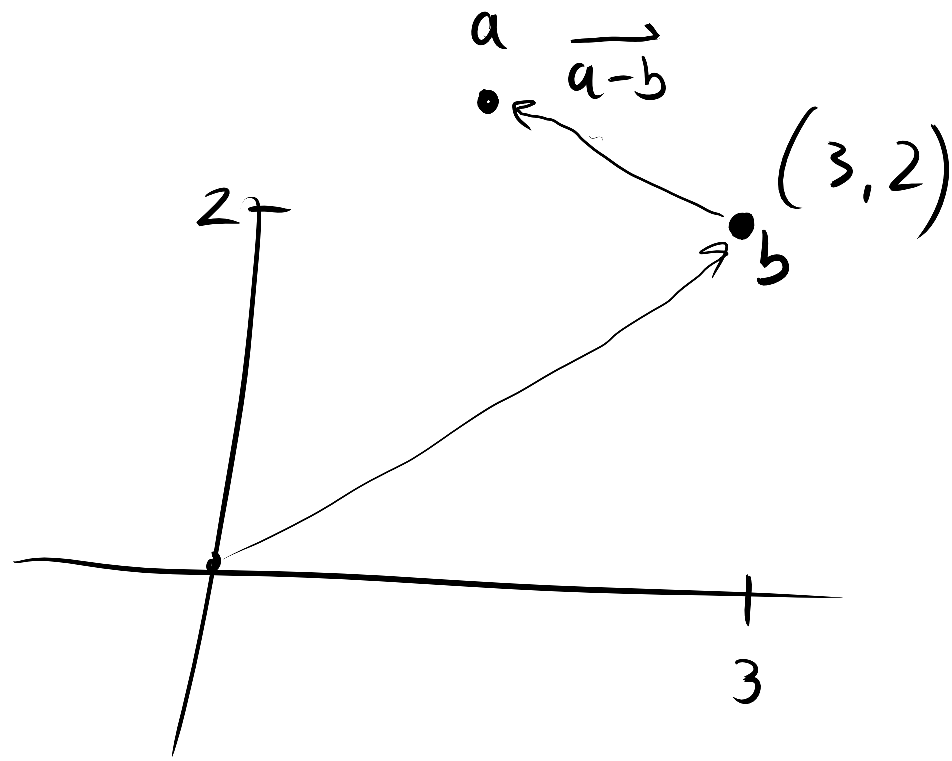
$$\vec{k} = (\vec{a}\cdot\vec{b})\,\vec{b} \quad \text{if} \quad \|\vec{b}\| = 1$$

Vector – main list of #s

↳ point

offset

homogenous



Matrix grid of numbers

$A\vec{x}$

$\vec{x}^T A$

$$\begin{bmatrix} 3 & 1 & 2 \\ 0 & -4 & 0 \\ 3 & 0 & 1 \end{bmatrix}^T = \begin{bmatrix} 3 & 0 & 3 \\ 1 & -4 & 0 \\ 2 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} a \cdot d & a \cdot e & \\ b \cdot d & & \\ & & \end{bmatrix} = \begin{bmatrix} \text{---}\; a \;\text{---} \\ \text{---}\; b \;\text{---} \\ \text{---}\; c \;\text{---} \end{bmatrix} \begin{bmatrix} | & | & | \\ d & e & f \\ | & | & | \end{bmatrix}$$

Singular Value Decompostion

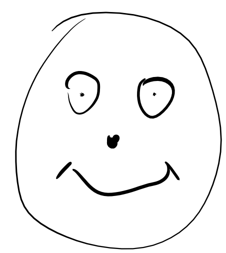
$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} & & \\ & M_{3\times 3} & \\ & & \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

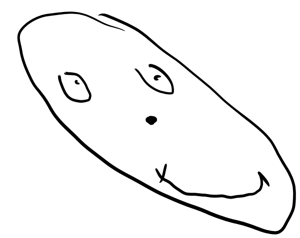
$$U \cdot U^T = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

orthogonal diagonal orthogonal

$$A = USV$$

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





$$3x - 2y + z = 0$$
$$x + 3z = -2$$
$$y = 1$$

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

$$A^{-1}A = AA^{-1} = I$$

$$\vec{x} = A^{-1}\vec{b}$$

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

Calculus

$x(t)$ = position

$\ddot{x}(t)$ = velocity

$\ddot{x}(t)$ = acceleration

derivative

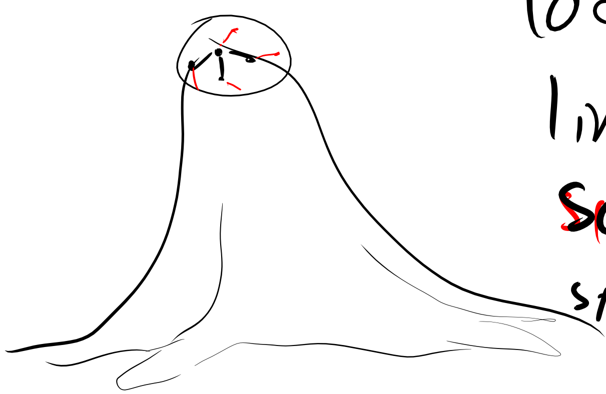
$f(x)$

$$\frac{df}{dx} = \frac{\delta f}{\delta x} = f' = \dot{f} = f_x = \text{rate of change}$$

Integral = area undr curve

Diff EQ

$$\ddot{x}(t) = f(x(t))$$



localize

linearize at t

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

step time

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

sparse

symmetric

positive-definite

conjugate gradient