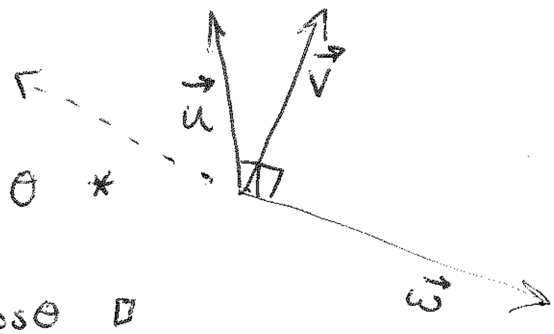
$\tilde{}$

$\vec{u} \times \vec{v} = \vec{\omega}$



$\|\vec{\omega}\| = \|\vec{u}\| \, \|\vec{v}\| \sin\theta$ *

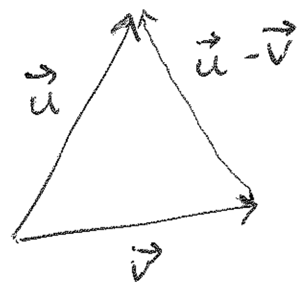
$\vec{u} \cdot \vec{v} = \|\vec{u}\| \, \|\vec{v}\| \cos\theta$ □

⊙

$(\vec{v} \cdot \vec{u})^2 + \|\vec{u} \times \vec{v}\|^2 = \|\vec{u}\|^2 \|\vec{v}\|^2$ ← easy to verify

□ + ⊙ $\Rightarrow$ *

□ = law of cosines



$u \cdot v = v \cdot u$

$(au) \cdot v = a(u \cdot v)$

$(u \cdot v) + (u \cdot w) = u \cdot (v + w)$

$\vec{u} \cdot \vec{u} = \|\vec{u}\|^2$

$u \times v = - v \times u$

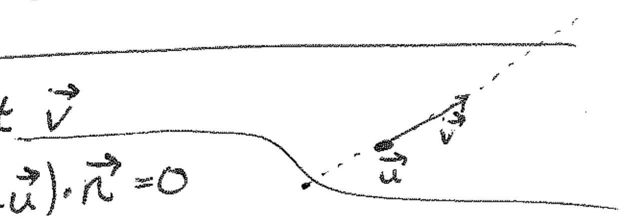
$(au) \times v = a(u \times v)$

$(u \times v) + (u \times w) = u \times (v + w)$

$\vec{u} \times \vec{u} = \vec{0}$

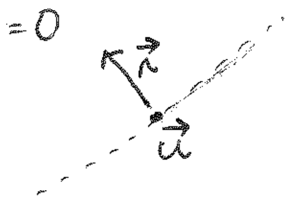
<u>lines</u>

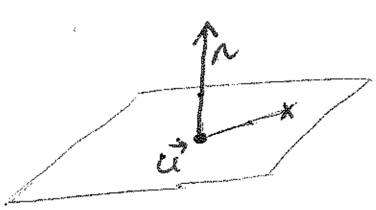
parametric: $f(t) = \vec{u} + t\,\vec{v}$



(2D) implicit: $g(\vec{x}) = (\vec{x} - \vec{u}) \cdot \vec{n} = 0$

(3D) implicit: $g(\vec{x}) = (\vec{x} - \vec{u}) \cdot \vec{n} = 0$





Matrix

$$M = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix}$$

$\underline{3 \times 3}$

m rows
n columns

$m \times n$ matrix

$$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \pm \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} = \begin{pmatrix} a_{11} \pm b_{11} & a_{12} \pm b_{12} \\ a_{21} \pm b_{21} & a_{22} \pm b_{22} \end{pmatrix}$$

$$c \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} = \begin{pmatrix} c\, a_{11} & c\, a_{12} \\ c\, a_{21} & c\, a_{22} \end{pmatrix}$$

transpose: $$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}^T = \begin{pmatrix} a_{11} & a_{21} \\ a_{12} & a_{22} \end{pmatrix} \qquad a_{ij} \longleftrightarrow a_{ji}$$

$$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} u_1 \\ u_2 \end{pmatrix} = \begin{pmatrix} a_{11} u_1 + a_{12} u_2 \\ a_{21} u_1 + a_{22} u_2 \end{pmatrix} = \begin{pmatrix} w_1 \\ w_2 \end{pmatrix}$$

$$w_i = \sum_j a_{ij} u_j$$

$$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} = \begin{pmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{pmatrix}$$

$$\boxed{c_{ij} = \sum_k a_{ik} b_{kj}}$$

$$A(Bv) = Cv = (AB)v$$

$$AB = C$$