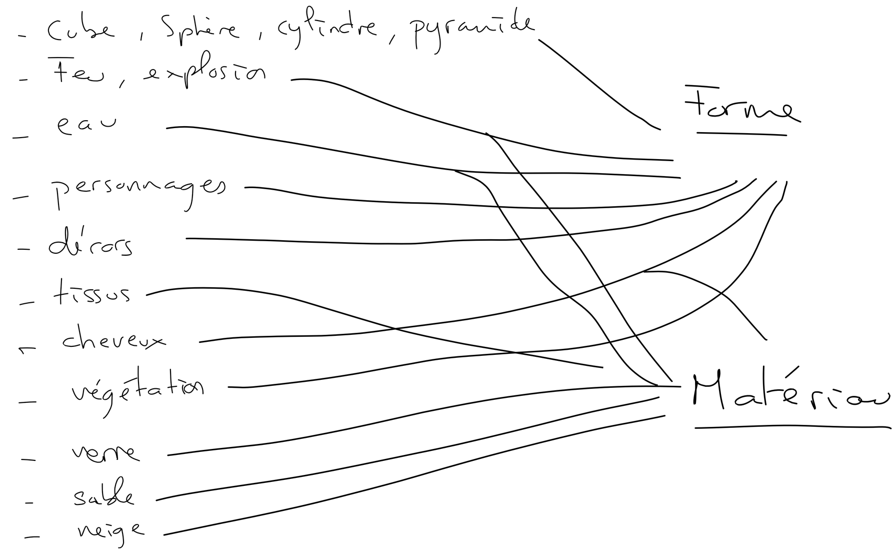
Objets 3D



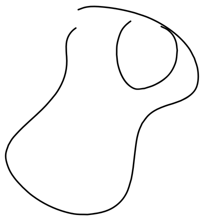
- Cube, Sphère, cylindre, pyramide
- Feu, explosion
- eau
- personnages
- décors
- tissus
- cheveux
- végétation
- verre
- sable
- neige

Forme

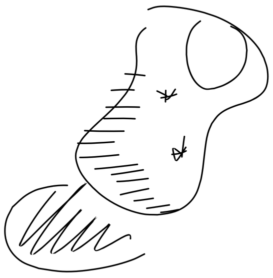
Matériau

Affichage

① Forme



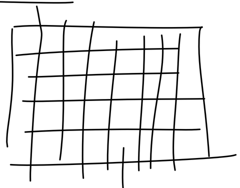
② Matériau



Images 2D

① Matricielles
Raster

→ pixels

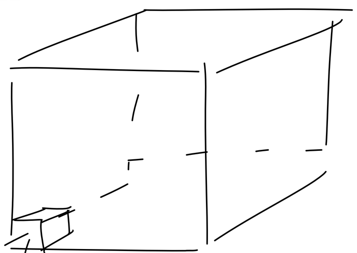


↳ Couleur
↳ RGB

② Vectorielles

→ Primitives
- * courbes
- * cercles
- * rectangles
- * texte

* Voxels



↳ Voxel
  ↳ binaire
  ↳ densité
  ↳ couleur

- - - -

* Surfaces Implicites

↳ équation

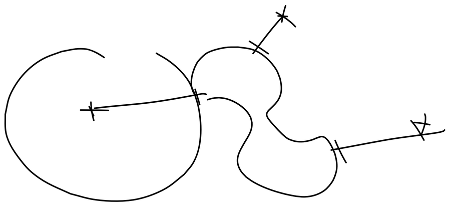
Sphère , $\{(x,y,z) \text{ tq } (x-o_x)^2+(y-o_y)^2+(z-o_z)^2 = r^2\}$

↳ centre (o_x, o_y, o_z) , rayon r^2

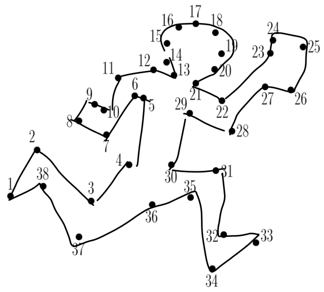
↳ Isosurface

$$f(x,y,z) = v$$

↳ fonction distance



* Maillages


1
2
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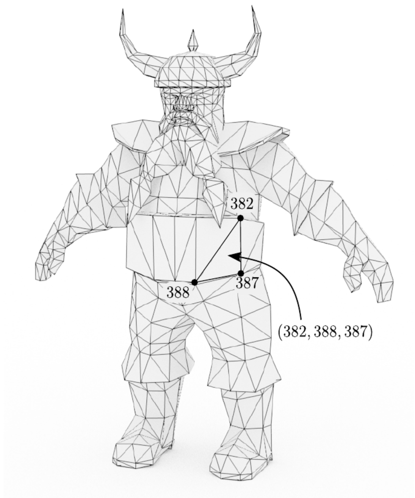
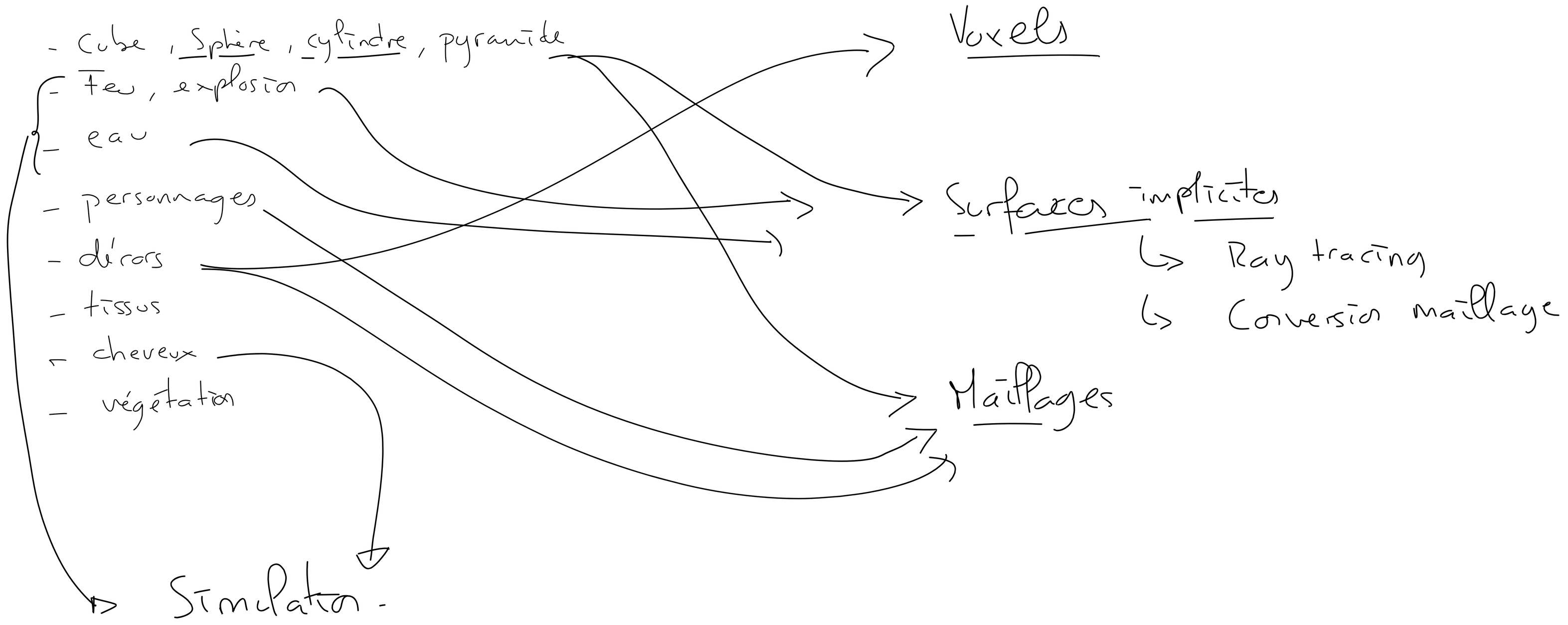
37
38


382
388
387
(382, 388, 387)

Sommets |x y z | x y z | - - -

Triangles |s0 s1 s2 | s0 s1 s2 | - - -



- Cube , Sphère , cylindre , pyramide
- Feu , explosion
- eau
- personnages
- décors
- tissus
- cheveux
- végétation

Voxels

Surfaces implicites

↳ Ray tracing

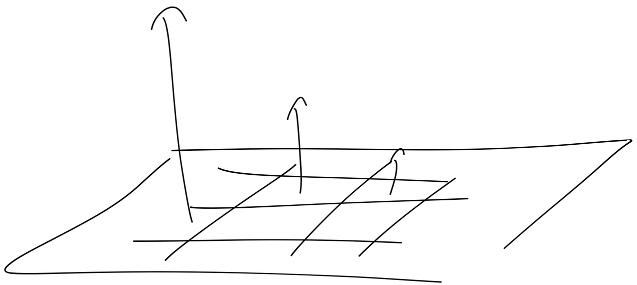
↳ Conversion maillage

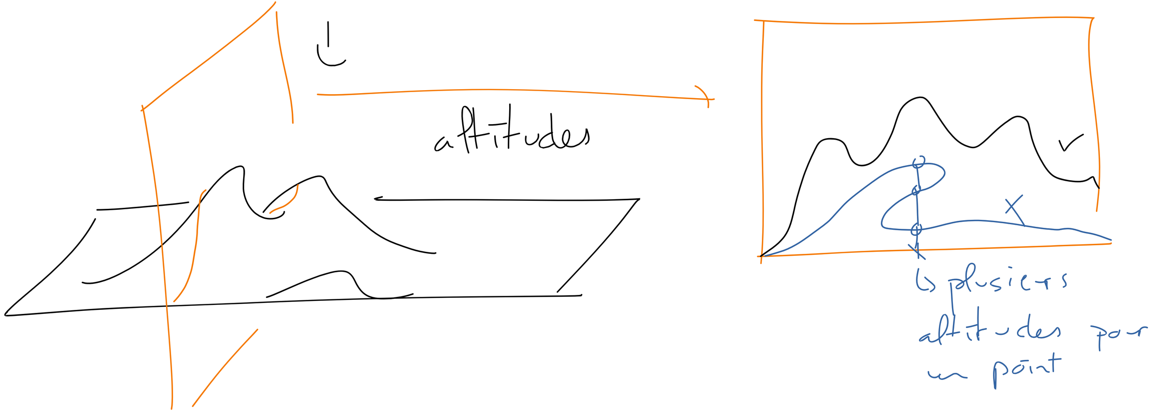
Maillages

Simulation .

↳ Navier stokes

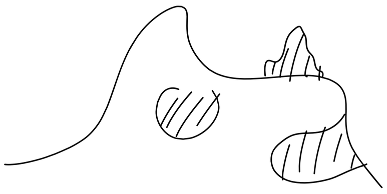
Terrain




altitudes
v
x
↳ plusieurs altitudes pour un point

Avec des Voxels

édition simplifiée



Quelle que soit la représentation

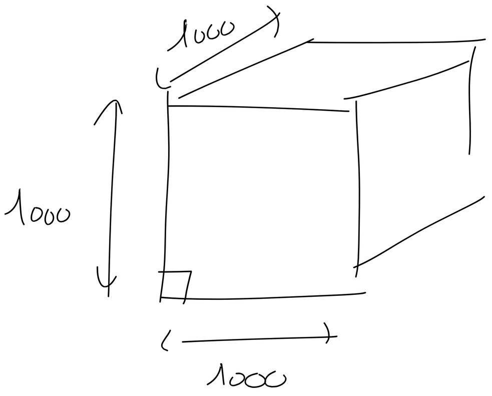
↳ afficher ⇒ image, pixels

⇓ carte graphique → triangles

↳ stocker

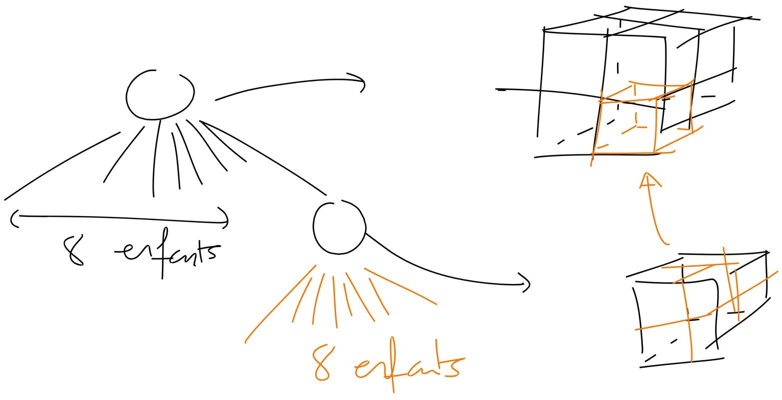
Voxels → résultat médical IRM

- stocker

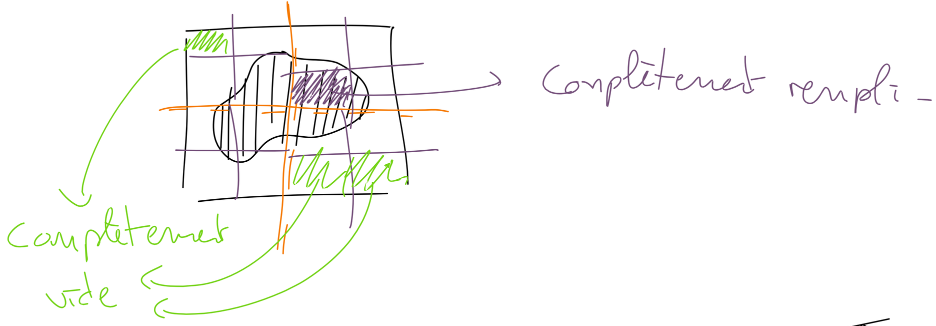

1000
1000
1000

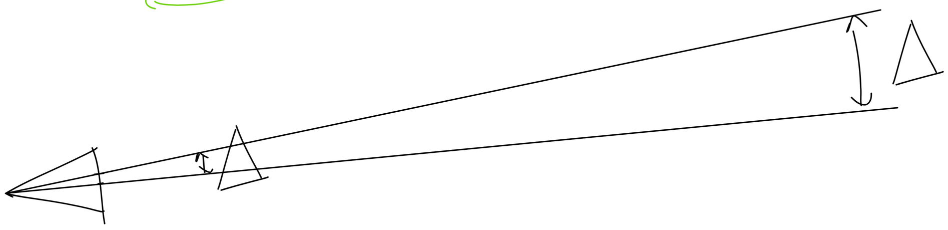
→ 1×10^9 voxels

↳ Arbres octree


8 enfants
8 enfants

en 2D quadtree


Complètement rempli -
Complètement vide



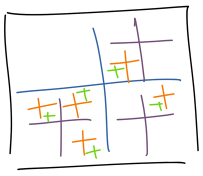
Affichage

↳ LOD level of details

→ charger l'octree partiellement

↳ taille de cube en fonction du nombre de pixels qu'ils occupent

2) Mipmaps

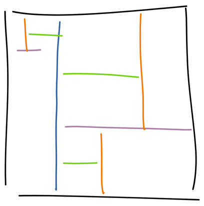


Quadtree / Octree

→ régulière (4 ou 8)

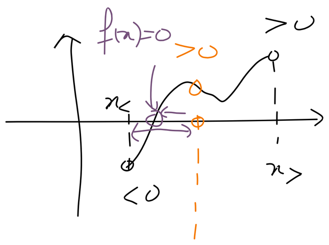
→ milieu

Kd-tree



Surfaces Implicites

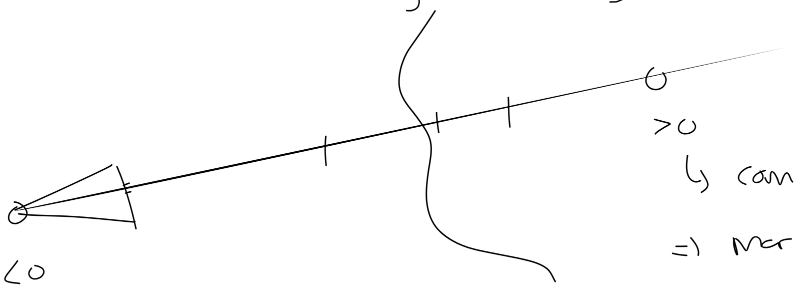
équation → localiser l'isosurface (obtenir un point dessus)



fonction continue
1 point < 0
1 point > 0
} 1 point = 0

$$f\left(\frac{x_< + x_>}{2}\right) > 0 \; ? \;\Rightarrow\; x_> \leftarrow \frac{x_< + x_>}{2}$$

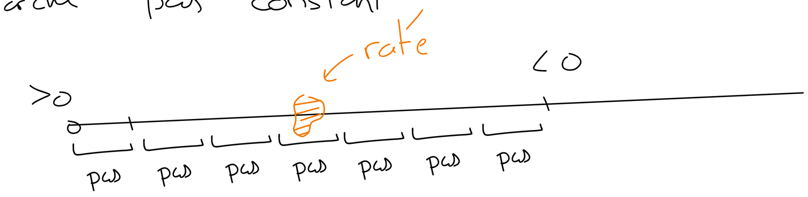
Dichotomie → Ray marching



↳ comment le trouver

⇒ marche

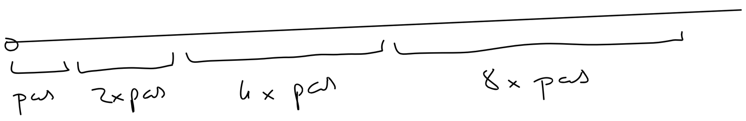
- marche pas constant


raté
>0
<0
pas
pas
pas
pas
pas
pas
pas

→ quand s'arrêter

→ taille du pas → taille objets détectés

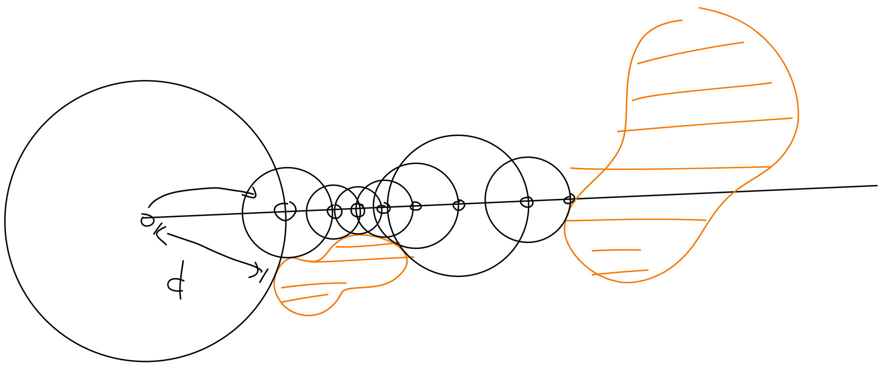
- marche à pas exponetiel


pas
2×pas
4×pas
8×pas

Fonction distance

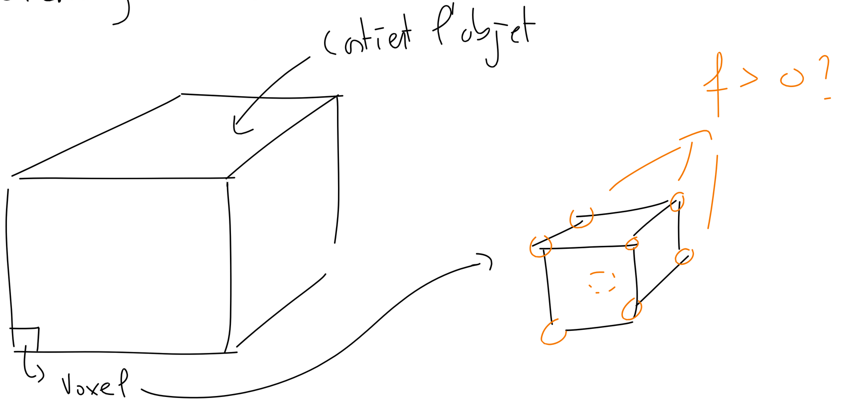
→ ou plus petit que distance

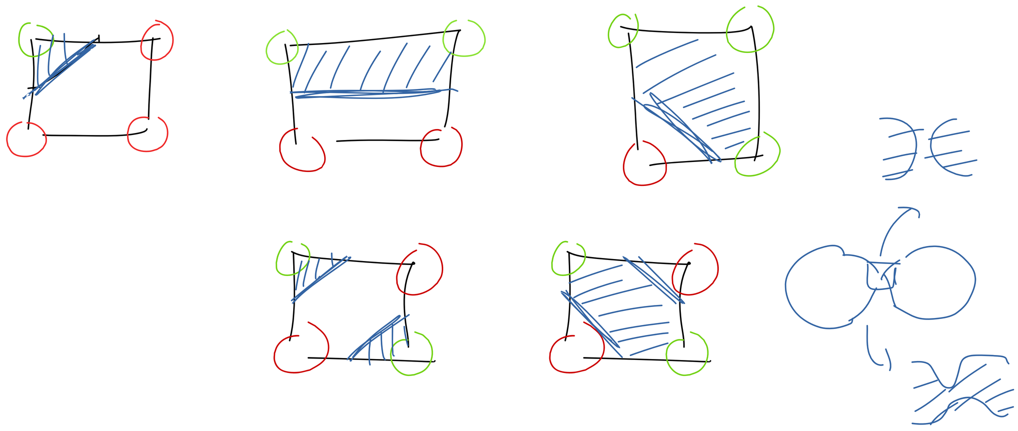
en tout point p, distance(p, objet)

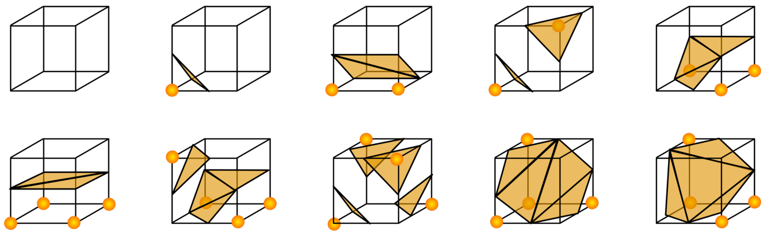


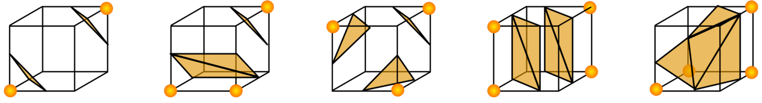
Conversion vers maillage

↳ Marching cubes

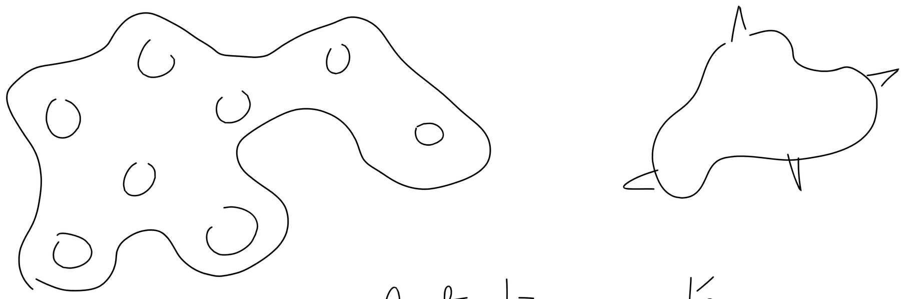

contient l'objet
f > 0 ?
Voxel







(Wikipedia)



Application santé

↳ surface moléculaire.

Maillages

Index

↳ sommets |x y z|x y z| - - - - - -

↳ triangles |s0 s1 s2| s0 s1 s2| - - - - - -

↳ gl_draw_indices

Duplication sommets

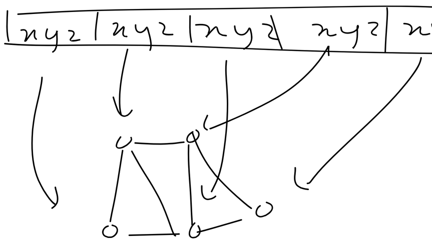
↳ sommets |x y z|x y z|x y z| | | | - - -

triangle

↳ gl_draw_arrays

↳ strips

|xyz|xyz|xyz| xyz| xyz



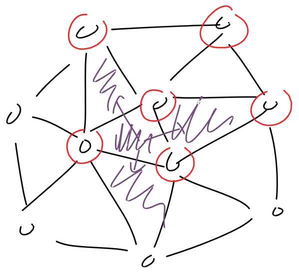
Orienté rendu GPU

Parcourir un maillage

↳ sommet → sommets voisins

↳ triangle → sommets

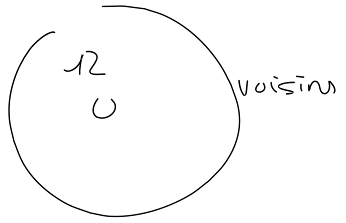
→ triangles voisins.



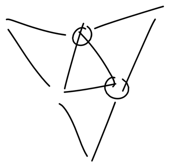
Problème

↳ Parcourir linéairement les triangles, y chercher des indices de sommets

↳ Θ(nb triangles)



```
[] voisins
pour chaque triangle
    si 12 dans les sommets
        ajouter les autres aux voisins
```

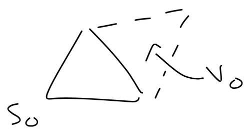


```
[] voisins
pour chaque triangle
    si deux sommets en commun
        ajouter le triangle aux voisins.
```

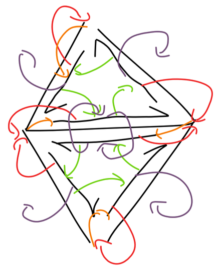
① stocker les triangles voisins

voisins | v_0 v_1 v_2 |

↳ triangle opposé à s_0



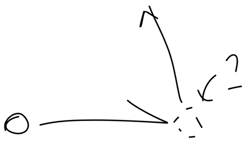
② Demi-arête



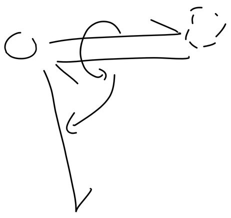
Demi arête
- ↳ sommet de départ 🟥
- ↳ demi arête suivante 🟩
- ↳ demi arêt opposée 🟪

Sommets
- ↳ coordonnées
- ↳ une demi arête sortante 🟧

Triangle
- ↳ une demi arête



suivante → source



(1) sommet au bout demi arête

(2) arête = (arête → opposée) → suivante

:

Outils de base de géométrie

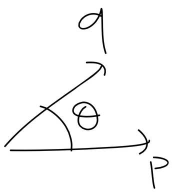
Produit scalaire

- $\begin{pmatrix}p_x\\p_y\\p_z\end{pmatrix} \cdot \begin{pmatrix}q_x\\q_y\\q_z\end{pmatrix} = p_x q_x + p_y q_y + p_z q_z$

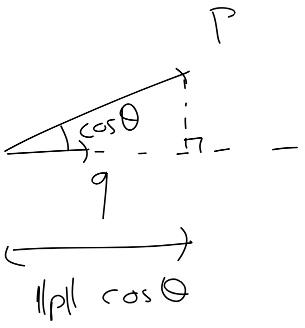
- nul ⇒ perpendiculaire

- projection

$$(p \cdot q) = \|p\| \times \|q\| \times \cos\theta$$



q est normalisé $(\|q\| = 1)$

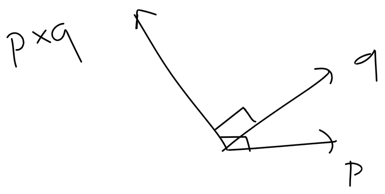

p
cosθ
q
‖p‖ cos θ

Produit vectoriel

- $\begin{pmatrix}p_x\\p_y\\p_z\end{pmatrix} \times \begin{pmatrix}q_x\\q_y\\q_z\end{pmatrix} = \begin{pmatrix}p_y q_z - q_y p_z\\p_z q_x - q_z p_x\\p_x q_y - q_x p_y\end{pmatrix}$

$$\begin{array}{ccc} p_x & \wedge & q_x \\ p_y & & q_y \end{array}$$

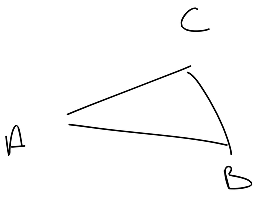
- produit des vecteurs orthogonaux



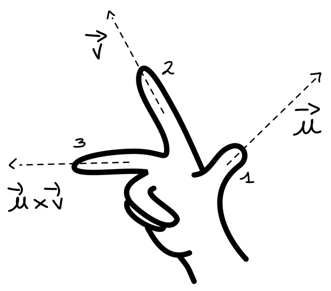
$p \times q \perp p$

et $p \times q \perp q$

si p et q sont colinéaires $p \times q = 0$



→ normale $(B-A) \times (C-A)$


$\vec{v}$
2
$\vec{u}$
3
1
$\vec{u} \times \vec{v}$

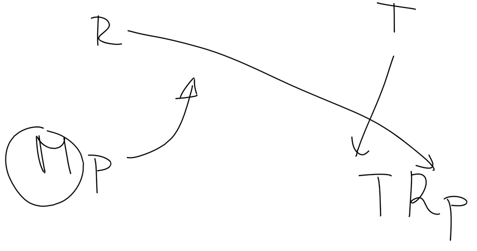
Homogènes

$$\begin{pmatrix}x\\y\\z\\w\end{pmatrix} \sim \begin{pmatrix}x/w\\y/w\\z/w\\1\end{pmatrix}$$

$$\begin{pmatrix}x\\y\\z\\1\end{pmatrix}$$

$$\begin{pmatrix}1&0&0&t_x\\0&1&0&t_y\\0&0&1&t_z\\0&0&0&1\end{pmatrix}\begin{pmatrix}x+t_x\\y+t_y\\z+t_z\\1\end{pmatrix} \rightarrow \text{translation}$$

Composition

Rotation puis Translation