Prototype of a 3D polyedral modeler

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LASTIG
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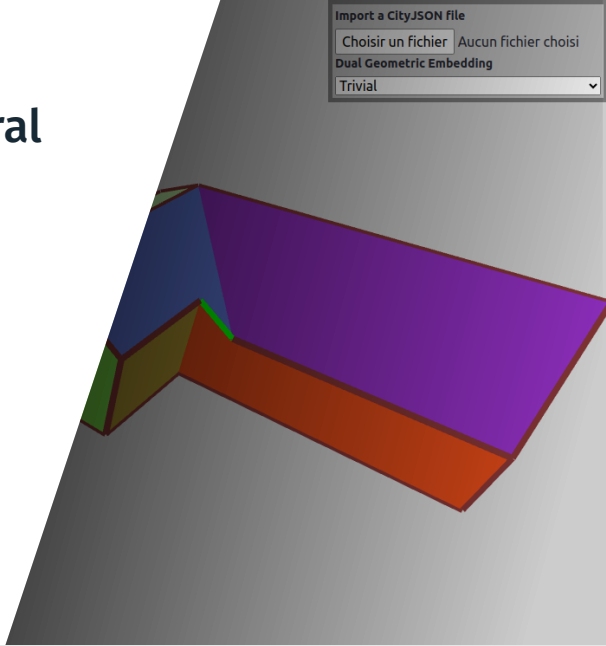
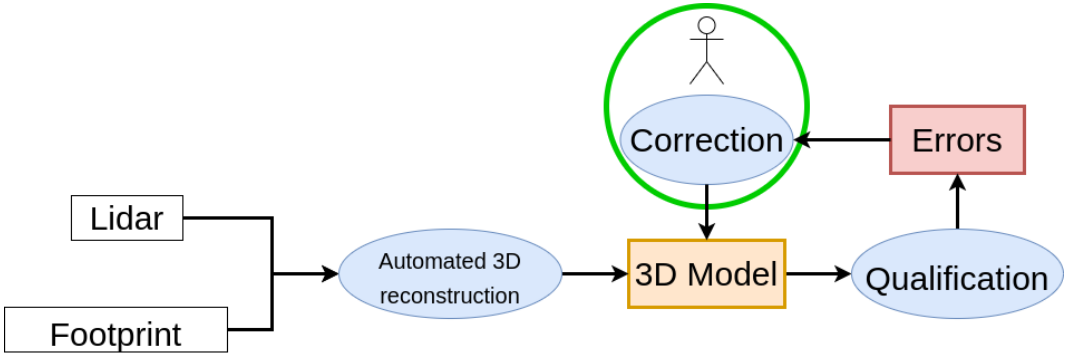
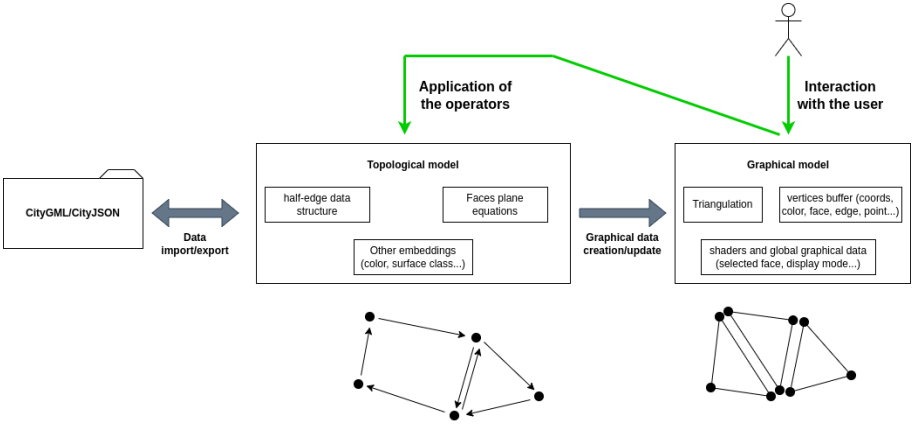


Context : Creation of a semi-automatic reconstruction pipeline



Polyedral modeler overview

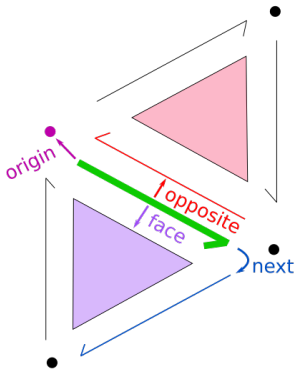


Topological data structure

Topological data stucture

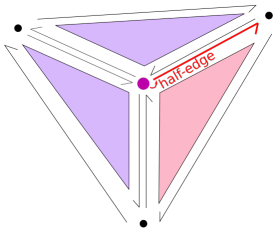
We use the **half-edge data structure**.

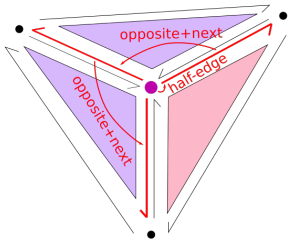
half-edge pointers	pointed data type
origin	vertex
opposite	half-edge
next	half-edge
face	face



Topological data stucture

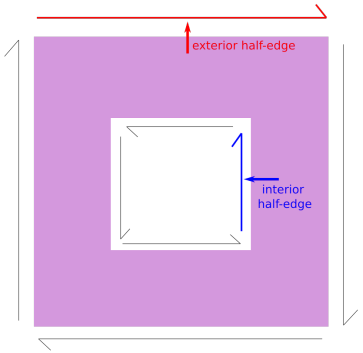
vertex pointers	pointed data type
half-edge	half-edge

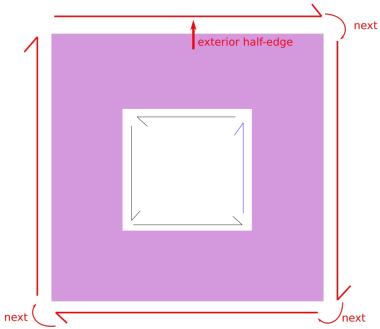




Topological data stucture

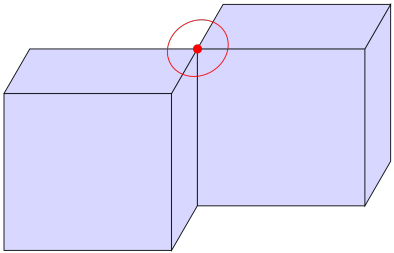
face pointers	pointed data type
Exterior half-edge	half-edge
Interior half-edges	half-edge[]



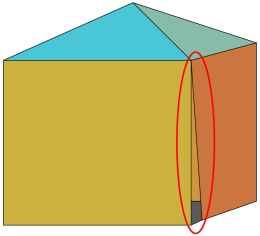


Topological validity

We want to ensure that our objects stay closed, manifold and have no borders. This means that they define one unique volume.



Not manifold : the surface defines 2 volumes

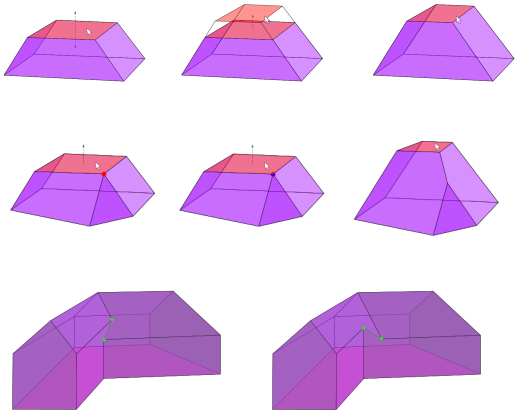


The surface has a border : it doesn't define a volume

Operators

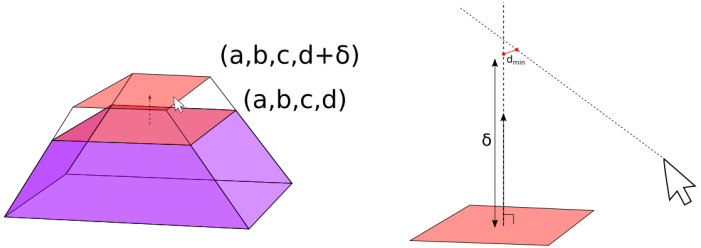
Operators

- **Face Shift**
- **Point Merge/Point Split**
- **Edge Flip**



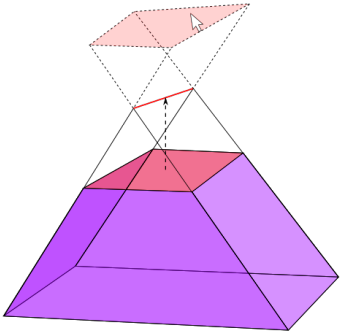
Shift operator

There is no need for topological modification ! We just modify the plane equation of the face : **translation along the normal of the face.**



Shift operator

We want to avoid faces self-intersections !



For the triangle (A, B, C), we define the orientation as follow :

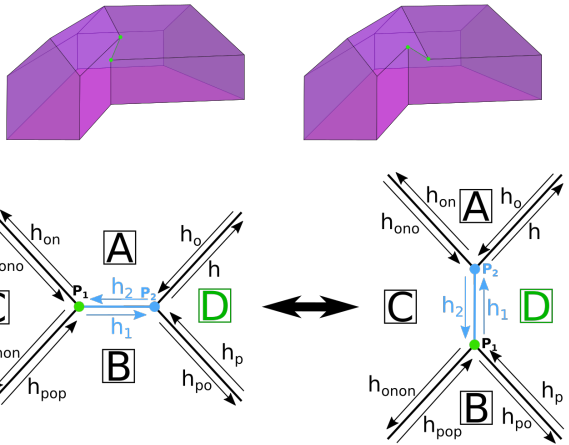
$$Ori_{ABC} = \vec{n} \cdot (\vec{AB} \wedge \vec{AC})$$

But we can also compute that value using the plan's equations of the faces :

$$Ori_{P,P_1,P_2,P_3} = \begin{vmatrix} \vec{n_P} & \frac{PP_2P_3}{1} & \frac{P_1PP_2}{1} & \frac{P_1PP_3}{1} \\ 0 & & & \end{vmatrix}$$

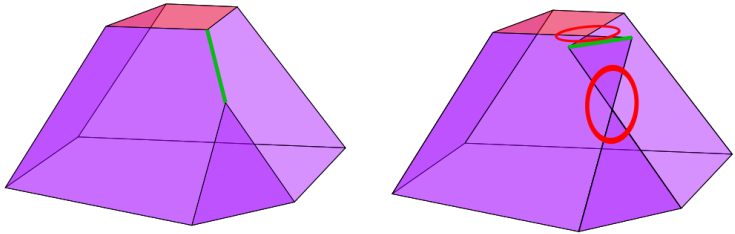
And we find that $Ori_{P,P_1,P_2,P_3} = a\delta + b$

Flip operator

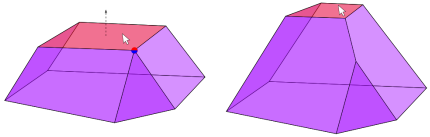


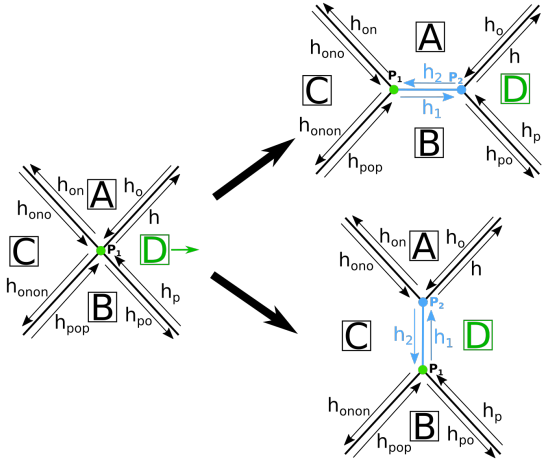
Flip operator

Example of bad flip :



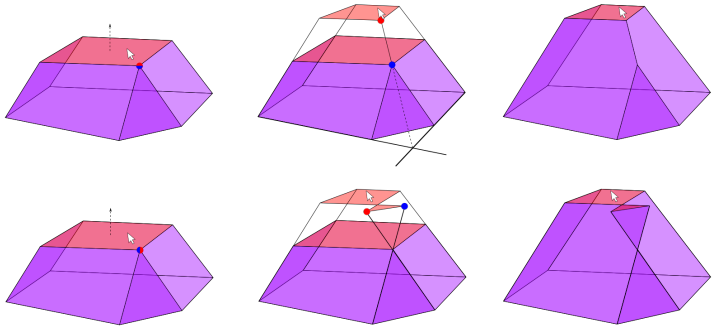
Split operator





Split operator

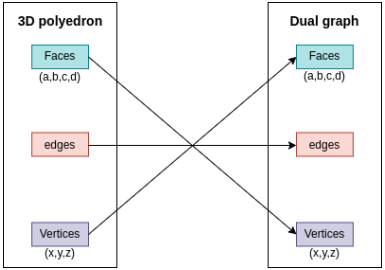
Example of bad split :

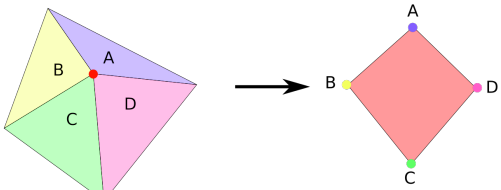


Dual structure

Dual structure

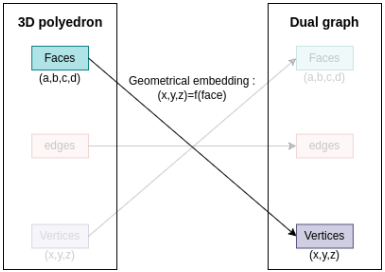
Definition of the dual structure of a geometrical form :





Dual structure

The topology is thus well defined, but the geometry is not ! We need a **geometrical embedding** for the dual structure.



Some embeddings exemples:

- $(\frac{a}{d}, \frac{b}{d}, \frac{c}{d})$
- $(a(d+1), b(d+1), c(d+1))$
- $(a\frac{d^2}{a^2+b^2+c^2}, b\frac{d^2}{a^2+b^2+c^2}, c\frac{d^2}{a^2+b^2+c^2})$
- $(x, y, z) = center(face)$

Thank you for your attention !!