

Représentations par frontières (BRepr): réalisations

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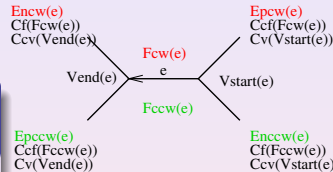
Plan

- 1 BRepr : structure topologique
- 2 Structures "arête-ailée"
- 3 Structure "Quad-edge"
- 4 Structure "demi-arête" de M.Mantyla
- 5 CGAL : Structure "demi-arête" de L.Kettner

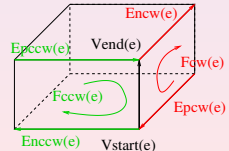
Éléments de base et relations de voisinage

Orientations : Cw ("clockwise") et Ccw ("counterclockwise")

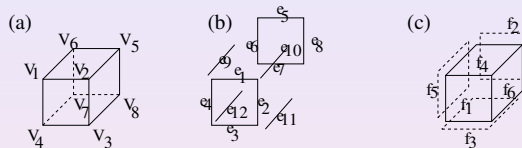
- Arête-Sommet **Vstart(e)** et **Vend(e)**
- Arête-Arête : (préc.) **Ccf(Fcw(e))**, **Ccf(Fccw(e))** et (suiv.) **Cf(Fcw(e))** et **Cf(Fccw(e))**
- Arête-Face : **Fcw(e)** et **Fccw(e)**



Edge Wings

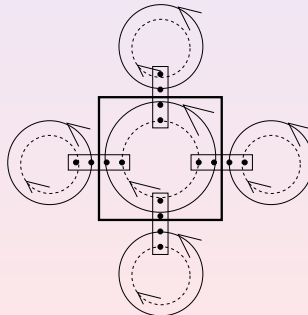


Arête-ailée ("Winged Edge Face")



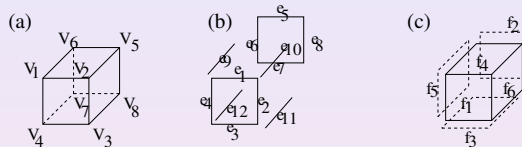
Winged Edge Face

Arête ailée basée
face



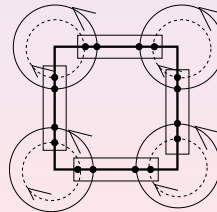
"Winged-Edge-Face"

Arête-ailée ("Winged Edge Vertex")



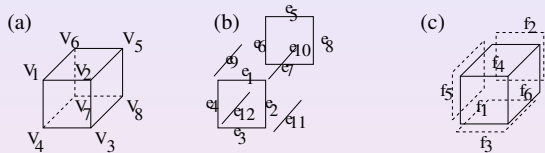
Winged Edge Vertex

Arête ailée basée
 sommet



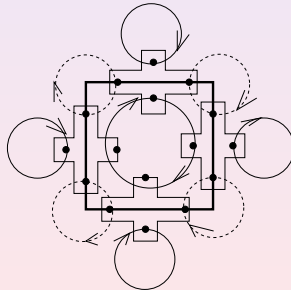
"Winged-Edge-Vertex"

Arête-ailée ("Quad Edge")



Quad Edge

Dualité de la
 representation des
 relations
 Sommet-Face

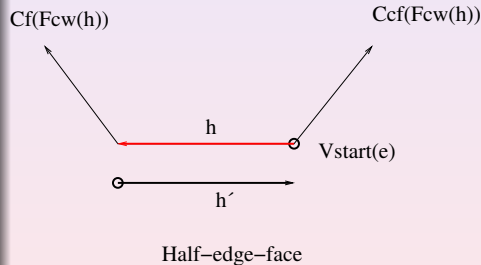


"Quad-Edge"

Demi-arête \leftrightarrow Arête-ailée "Half Edge" \leftrightarrow "Winged Edge"

Half Edge (HE)

- Début : $\text{half-edge}(\text{Vstart}(h))$
- Demi-arête correspondante : $\text{half-edge}(h)$
- Face : $\text{half-edge}(\text{Fcw}(h))$
- Demi-arête préc. : $\text{half-edge}(\text{Ccf}(\text{Fcw}(h)))$
- Demi-arête suiv. : $\text{half-edge}(\text{Cf}(\text{Fcw}(h)))$



Half Edge [M.Mantyla, 1988]

M.Mantyla

"Solid Modeling", CompSciPress,
1988

BRepr, HalfEdge

```
typedef float vector[3];  
typedef short Id;  
typedef struct Solid *Solid;  
typedef struct Face *Face;  
typedef struct Loop *Loop;  
typedef struct HalfEdge *HalfEdge;  
typedef struct Edge *Edge;  
typedef struct Vertex *Vertex;  
typedef union Nodes *Node;
```

Half Edge [M.Mantyla, 1988]

Arête

```
struct Edge
{
    HalfEdge eHe1 ;
    HalfEdge eHe2 ;
    Edge nextE ;
    Edge prevE ;
};
```

Brin d'arête

```
struct HalfEdge
{
    Edge HeEdge ;
    Vertex HeVertex ;
    Loop HeLoop ;
    HalfEdge nextHe ;
    HalfEdge prevHe ;
};
```

Sommet

```
struct Vertex
{
    Id vNumber ;
    HalfEdge vHalfEdge ;
    vector vCoordinates ;
    Vertex nextV ;
    Vertex prevV ;
};
```

CGAL HalfedgeDS

L. Kettner

"Using generic programming for designing a data structure for polyhedral surfaces, 1999

- Computational Geometry Algorithms Library
CGAL, <http://www.cs.uu.nl/CGAL>
- <http://doc.cgal.org/latest/HalfedgeDS/>
- <http://doc.cgal.org/latest/Polyhedron/>

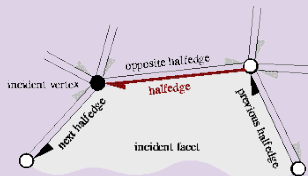
CGAL HalfedgeDS

Hiérarchie des niveaux de la création et la manipulation du BRepr

- 1 Vertex, Halfedge et Facet : composantes
- 2 Halfedge_data_structure : gestion du stockage des composantes
- 3 Polyhedron : interface pour la construction et la manipulation des BReprs valides.

CGAL HalfedgeDS

[Kettner99], Fig 7



| Vertex |
|----------------------------|
| Halfedge_handle halfedge() |
| Point& point() |

| Halfedge |
|----------------------------|
| Halfedge_handle opposite() |
| Halfedge_handle next() |
| Halfedge_handle prev() |
| Vertex_handle vertex() |
| Facet_handle facet() |

| Facet |
|----------------------------|
| Halfedge_handle halfedge() |
| Normal& normal() |
| Plane& plane() |

Construction incrémentale d'un polyèdre : 1/2

```
template <class HDS>
class Build_triangle : public CGAL::Modifier_base<HDS> {
public:
    Build_triangle() {}
    void operator()( HDS& hds) {
        // Postcondition: hds is a valid polyhedral surface.
        CGAL::Polyhedron_incremental_builder_3<HDS> B( hds, true);
        B.begin_surface(-3, 1, 6);
        typedef typename HDS::Vertex    Vertex;
        typedef typename Vertex::Point  Point;
        B.add_vertex( Point( 0, 0, 0));
        B.add_vertex( Point( 1, 0, 0));
        B.add_vertex( Point( 0, 1, 0));
    }
};
```

Construction incrémentale d'un polyèdre : 2/2

```
B.begin_facet();  
    B.add_vertex_to_facet( 0);  
    B.add_vertex_to_facet( 1);  
    B.add_vertex_to_facet( 2);  
    B.end_facet();  
    B.end_surface();  
};
```

BRepr : structure topologique
Structures "arête-aîlée" : WEF et WEV
Structure "Quad-edge"
Structure "demi-arête" de M. Mantyla
CGAL : Structure "demi-arête" de L.Kettner

Pour approfondir

L. Kettner

"Designing a Data Structure for Polyhedral Surfaces"