Triangulations in CGAL

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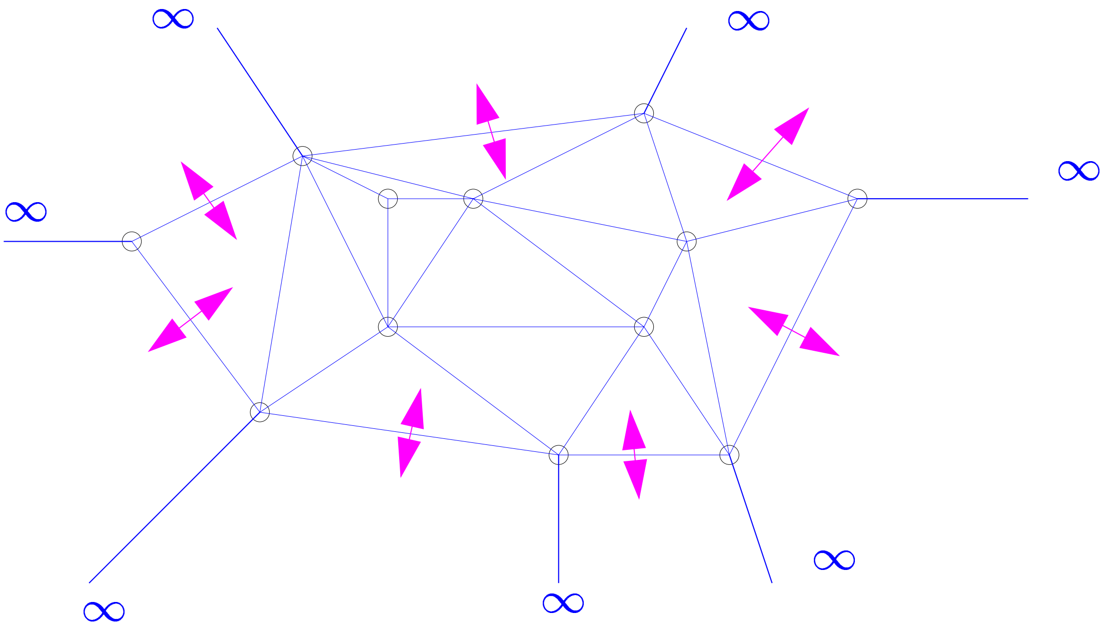
Computational Geometry Algorithms Library

Developed by a consortium of eight sites

Triangulation

S set of points in $\mathbb{R}^2$ or $\mathbb{R}^3$

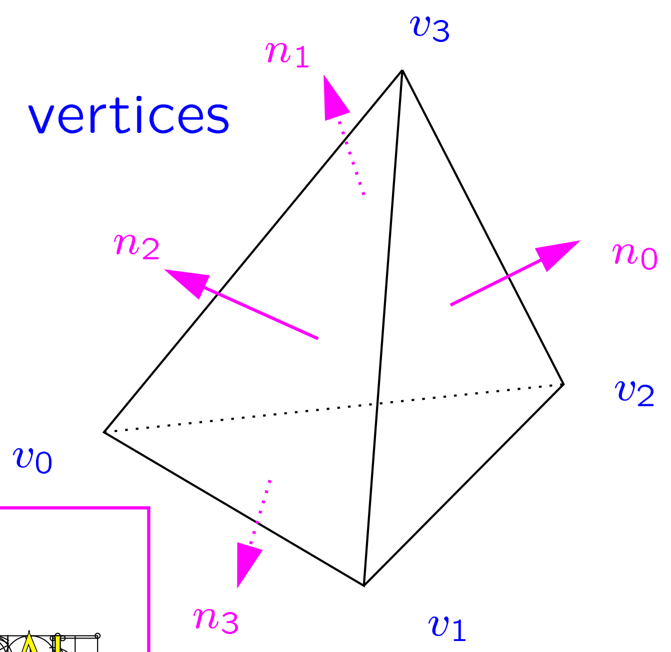
Partition of the whole space



Representation

Based on cells and vertices

Adjacency
Incidence



Storage

2D	DCEL	CGAL
	$27n - 52$	$13n - 4$
3D	3-map	CGAL
	$61t + n$	$8t + n$

Design Overview

Three layers [Kettner]

Triangulation

Geometry

location

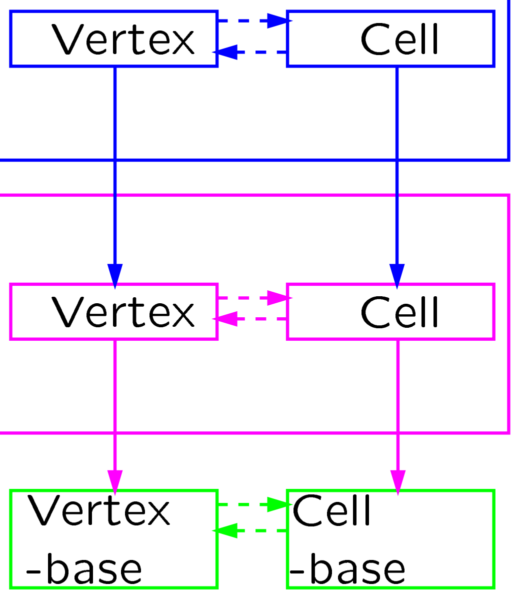
Data Structure

Combinatorics

insertion

Geometric information

Additional information



$d = 2, 3$

`CGAL::Triangulation_d< TDS, Traits >`

TDS = Triangulation data structure

Traits = Geometric traits class

CGAL Traits classes parameterized:

`CGAL::Triangulation_..._traits_d< R >`

objects, predicates of the CGAL kernel

`R` representation class:

- Cartesian or homogeneous coordinates
- Number type

C++
GMP
LEDA

CGAL
Filtered interval [Pion]
Fixed precision [Devillers]

other

Geometric degeneracies

collinear / coplanar points

cocircular / cospherical points

...

Combinatorial degeneracies

all points collinear in 2D or 3D

all points coplanar in 3D

Flexibility

`CGAL::Triangulation_d< TDS, Traits >`

`Traits` : Geometric definitions

- Objects :

  points, segments,
  triangles, tetrahedra
  ...

- Predicates :

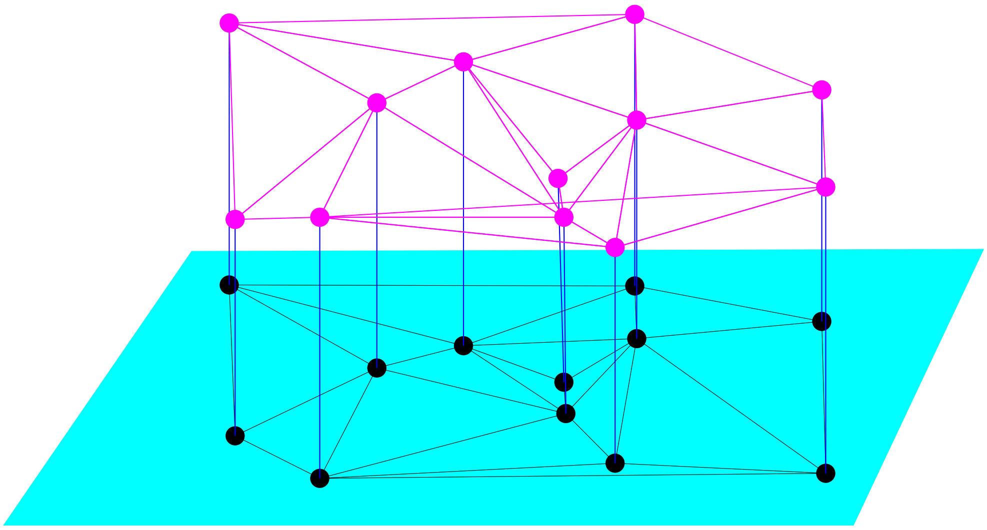
  orientation
  in_circle, in_sphere
  ...

Terrain in 3D

Data = 3D points (2D points + z)

Goal = 2D Delaunay triangulation

of the projected points



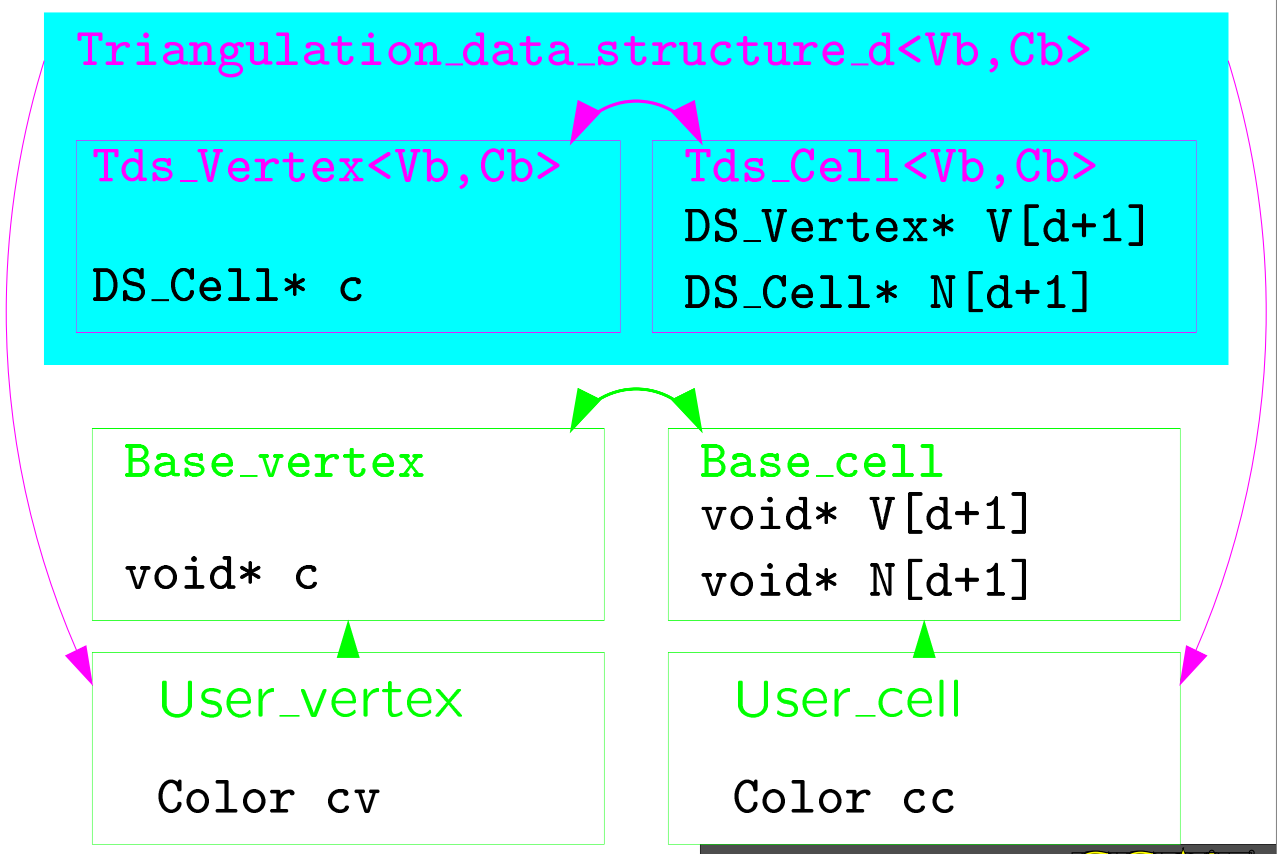
`CGAL::Delaunay_triangulation_2<TDS,Traits>`

Change the Traits Class

CODE

Flexibility

Colored cells



CODE

Algorithms

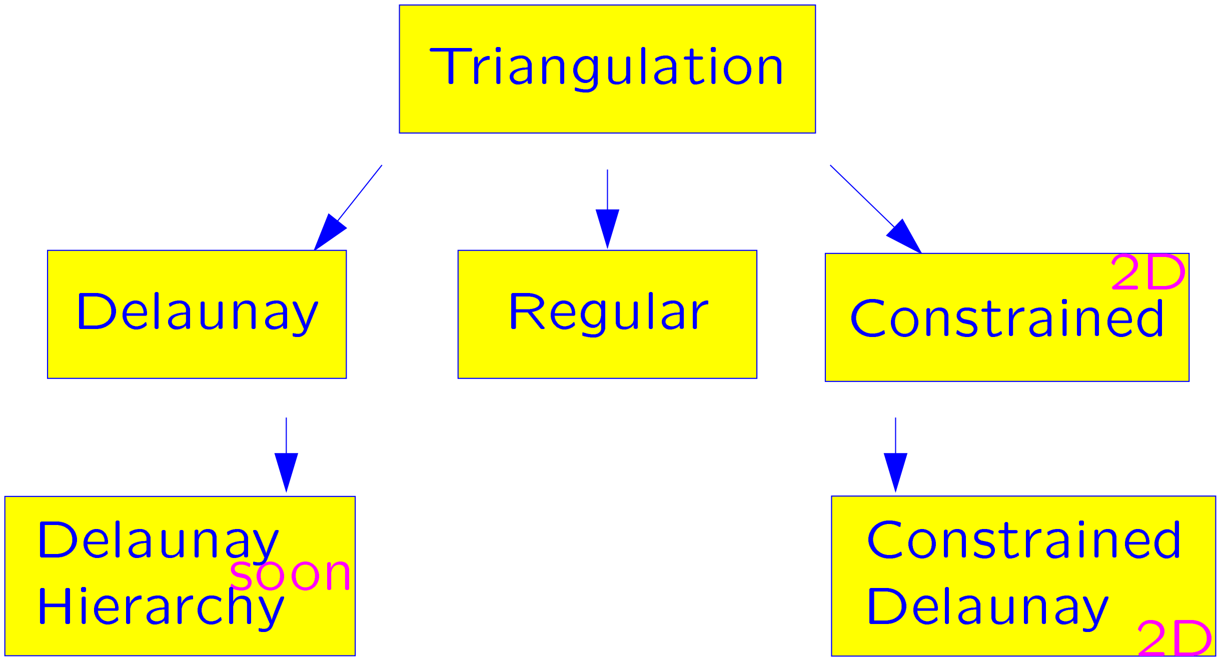
Point location
Insertion
Removal
    in 2D
    (coming) in 3D-Delaunay triangulation

Checking

Iterators, circulators

Flips
. . .

Hierarchy of Triangulations



Benchmarks

CGAL 24-bits integers

Delaunay 2D incremental		100,000 square	143,231 terrain	100,000 parabola
walk	CGAL	29	46	191
	Gem IV	30	*loop*	*loop*
	Devillers	9.5	18	95
jump & walk	CGAL	5.4	9.0	15
	Shewchuk	6.7	11.3	18
	Devillers	2.8	4.8	4.9
Delaunay hierarchy	CGAL	3.6	5.6	18
	Devillers	1.7	2.6	2.1

Benchmarks

Delaunay 3D incremental		100,000 cube	145,300 object	5,000 moment
walk	CGAL Devillers	50 17	71 24	136 18
jump & walk	CGAL Devillers	31 11.2	51 17	131 17
non-incremental				
d & c	qhull	27	55	*loop*

Triangulations in CGAL

Demo

Viewer and demo written by

François Rebufat

Conclusion

Flexibility
Ease of use
Robustness

Performance

Still under development

new functionalities
improvements
...

Use it

Send feedback

Submit Extension Packages

http://www.cgal.org