What's New in the JTS Topology Suite

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What is JTS?

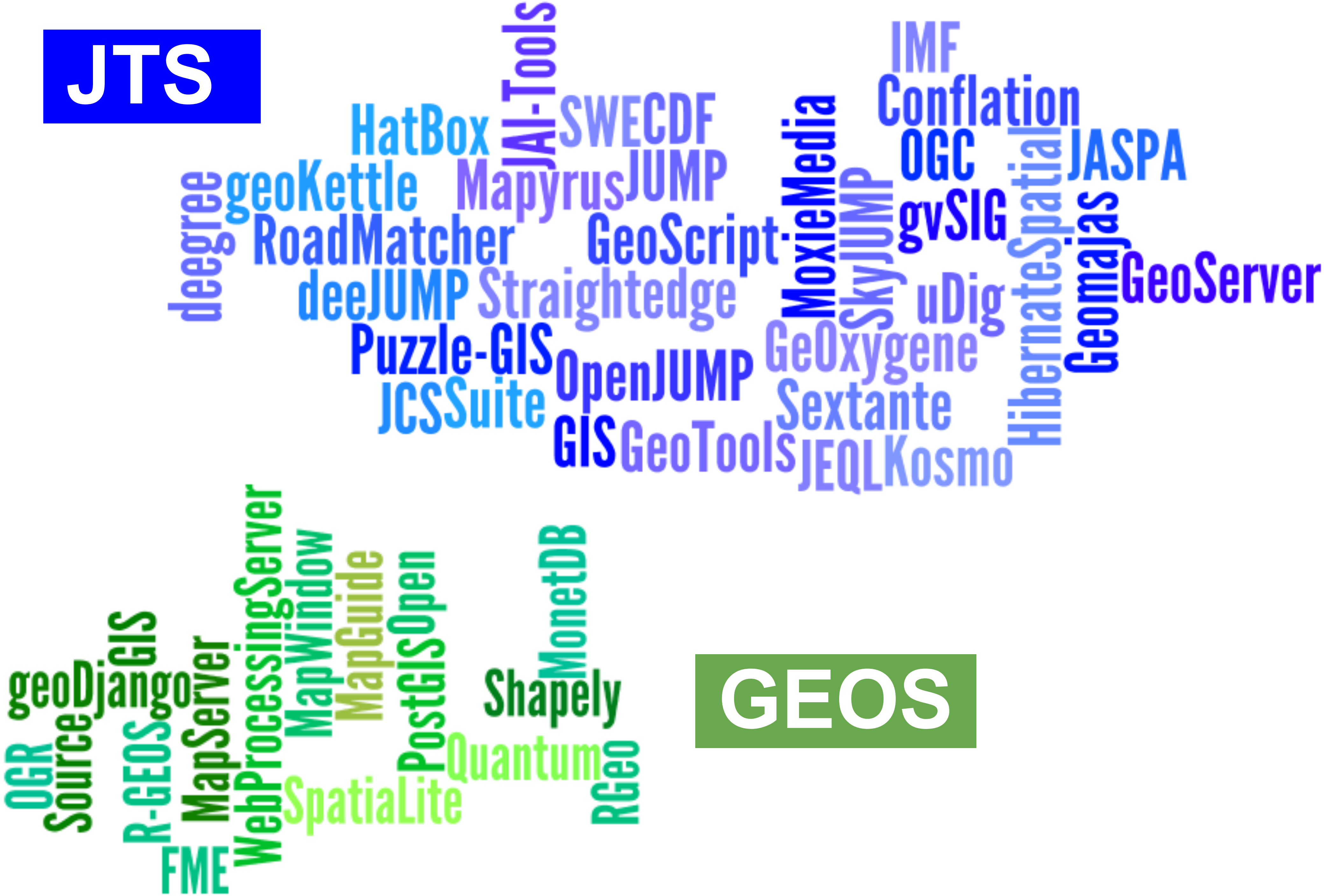
- API for representing and processing **2D linear vector Geometry**
- Implemented in Java; licensed under LGPL
- Provides the full OGC **Simple Features for SQL** geometry specification:
    - Points, Linestring, Polygons, collections
    - **Metrics:** Length, Area, Distance
    - **Predicates:** intersects, contains, etc.; relate for DE-9IM
    - **Overlay:** intersection, union, difference, symDifference
    - **Algorithms:** Convex Hull, Buffer
- Other features:
    - Validation, Polygonization, Simplification, Linear Referencing, etc.

Project History

- **Version 1.0** - May 2001

  ...
- **Version 1.9** - January 2008
- **Version 1.10** - December 2008
- **Version 1.11** - March 2010
- **Version 1.12** - June 2011
- **Version 1.13** - *Coming Soon!*

Where is it used ? (1)



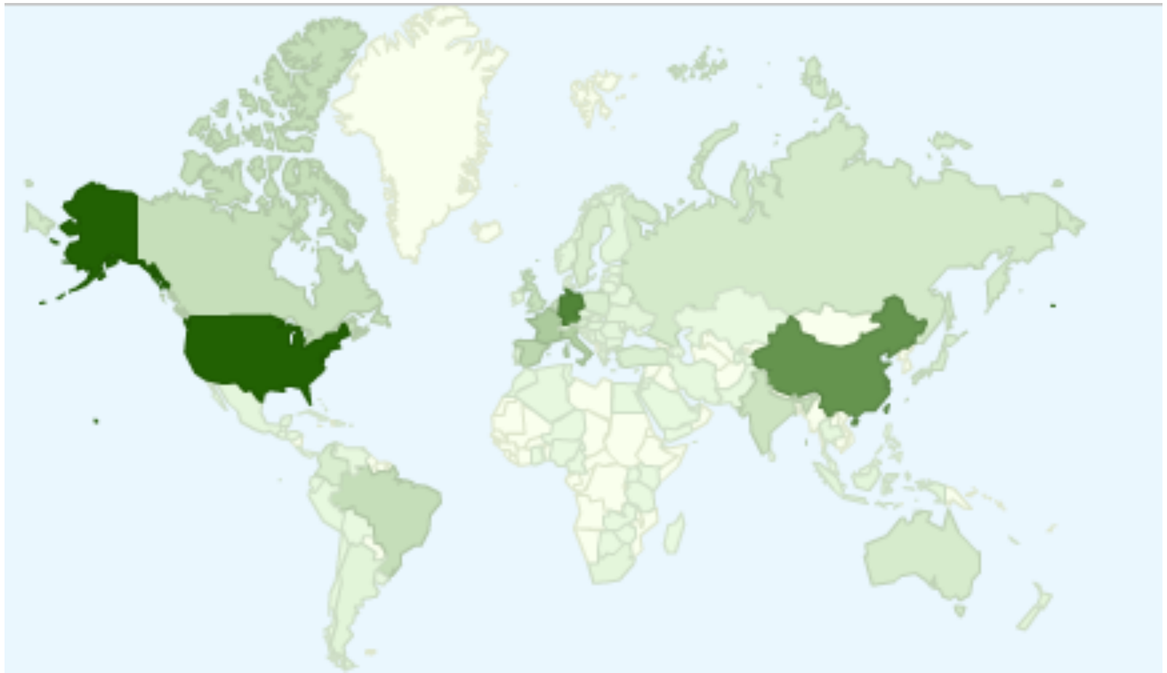
JTS

IMF Conflation OGC JASPA HatBox JAI-Tools SWECDF deegree geoKettle Mapyrus JUMP MoxieMedia SkyJUMP gvSIG HibernateSpatial Geomajas GeoServer RoadMatcher GeoScript deeJUMP Straightedge uDig Puzzle-GIS OpenJUMP GeOxygene JCSSuite Sextante GIS GeoTools JEQL Kosmo

GEOS

OGR Source geoDjango GIS R-GEOS MapServer FME WebProcessingServer MapWindow MapGuide PostGISOpen SpatiaLite Quantum MonetDB Shapely RGeo

Where is it used ? *(2)*

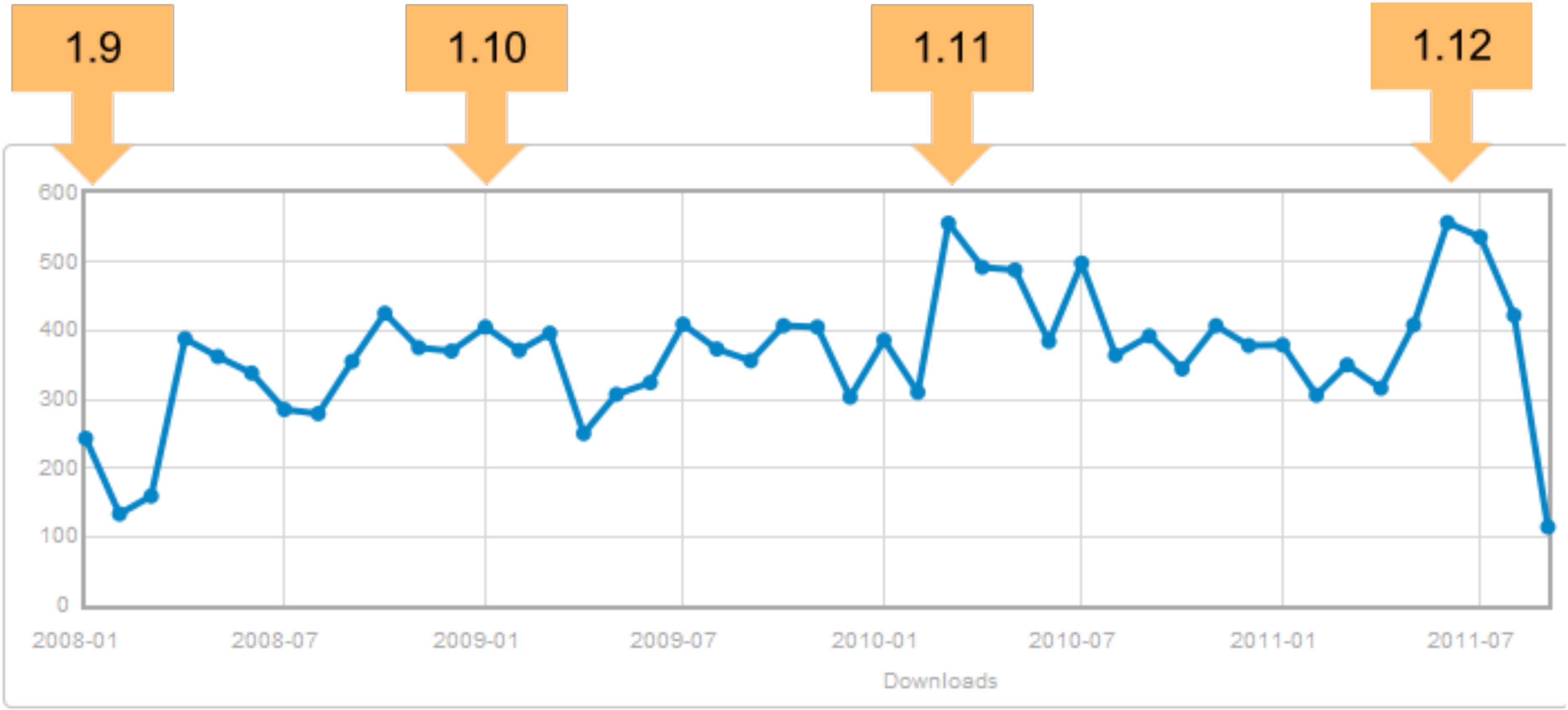


Downloads [Jan. 1, 2008 - Sept. 8 2011]

1. United States -- 1,384
2. Germany -- 1,051
3. China -- 915
4. France -- 424
5. Italy -- 375

Project Statistics

Total downloads [Jan 2008 - Sept 2011] : **16,405**



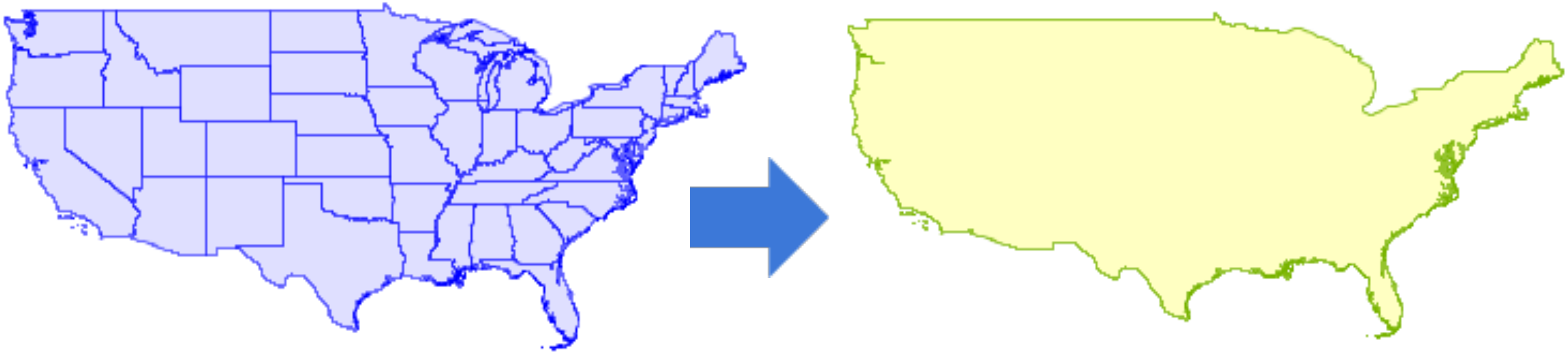
JTS in other languages

- **Ports**
  - ***GEOS*** ---> C++
  - ***Net Topology Suite*** ---> C#
  - ***JSTS*** ---> JavaScript
- **Bindings *(on JVM)***
  - Groovy, Scala, Jython, JRuby, Clojure, etc
- **Bindings *(to GEOS)***
  - Shapely (Python)
  - RGeo (Ruby)
  - R-GEOS (R)

What's New in **JTS**

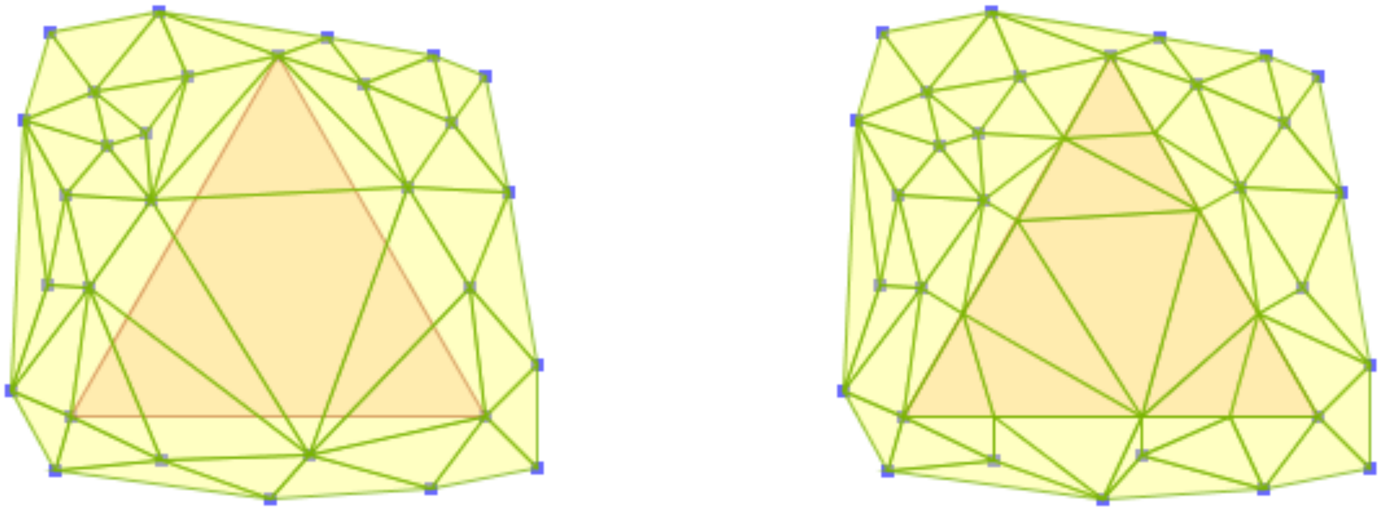
Unary Union

- Geometry.union()
  - High-performance union of geometry collections
  - Uses spatial index to optimize union
  - In most situations much more efficient than iterating Geometry.union(Geometry)
  - handles heterogeneous GeometryCollections



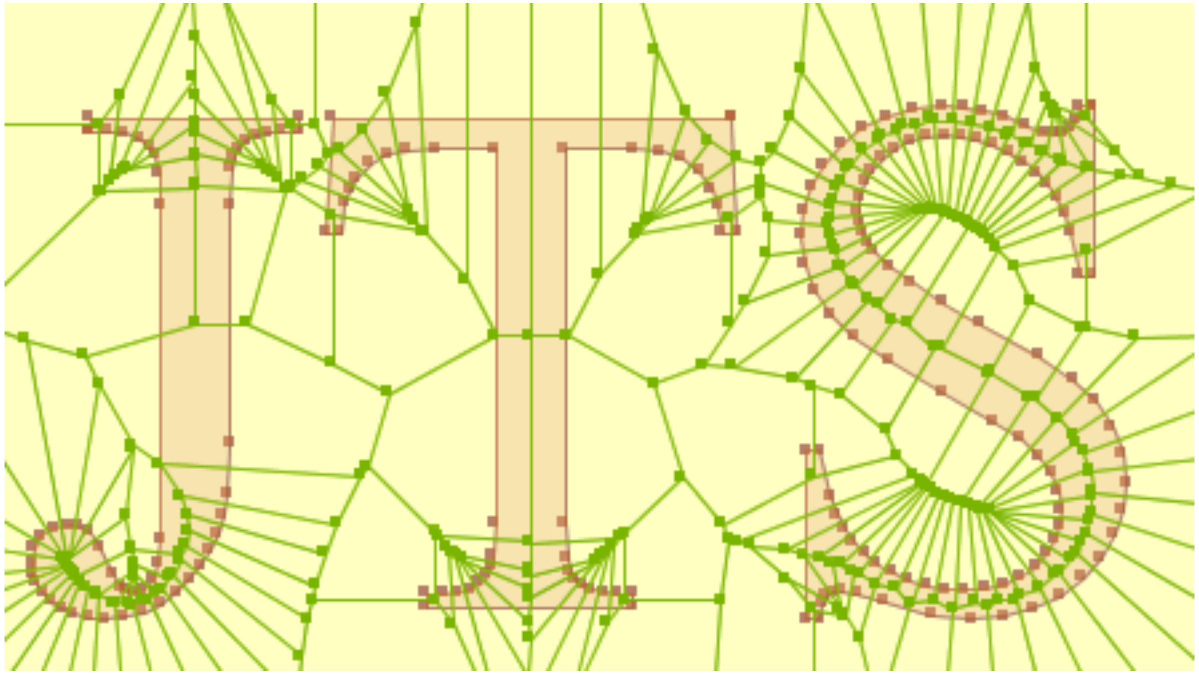
Delaunay Triangulation

- DelaunayTriangulationBuilder
  - Optimal triangulation of point sets
  - Efficient, robust algorithm
  - Uses QuadEdge data structure
- ConformingDelaunayTriangulationBuilder
  - Delaunay triangulation with linear constraints
  - approximates constraints by adding vertices along segments



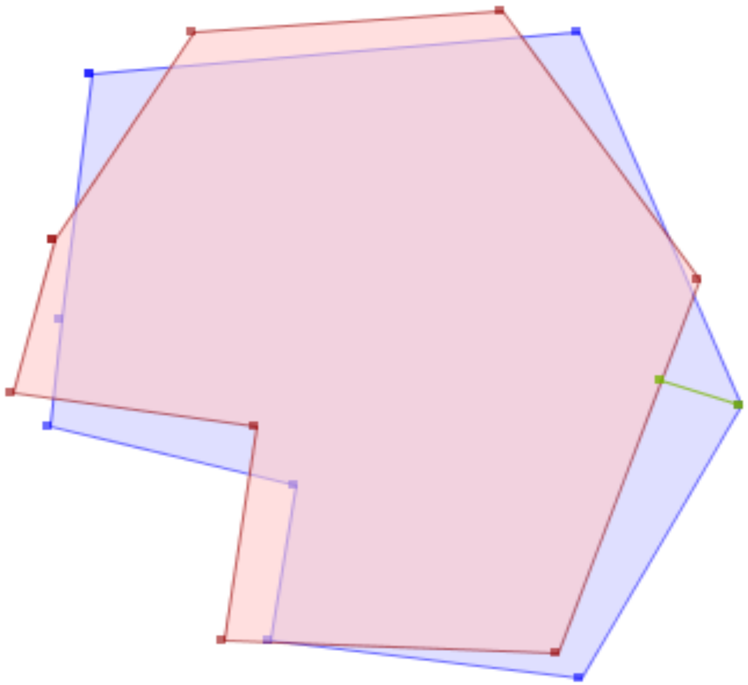
Voronoi Diagram

- Dual of **Delaunay Triangulation**
- Voronoi & Delaunay scale to millions of points



Hausdorff Distance

- DiscreteHausdorffDistance **distance metric**
  - "How far apart are two geometries"
  - useful for QA, geometry matching (conflation)
  - true Hausdorff distance is difficult/slow to compute, so uses faster discrete version

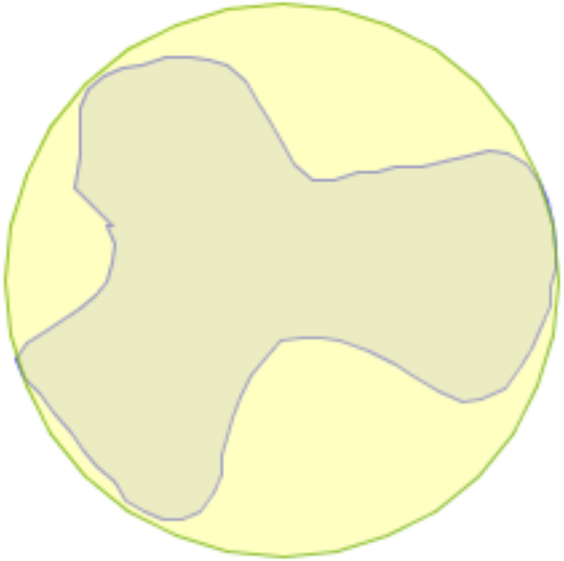


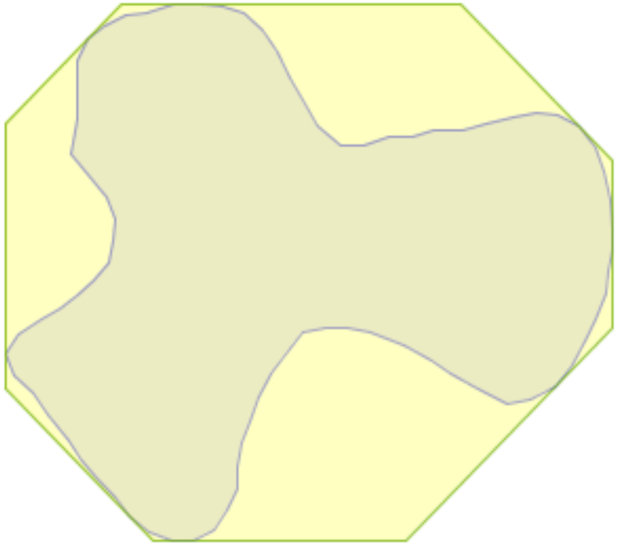
Euclidean distance = 0

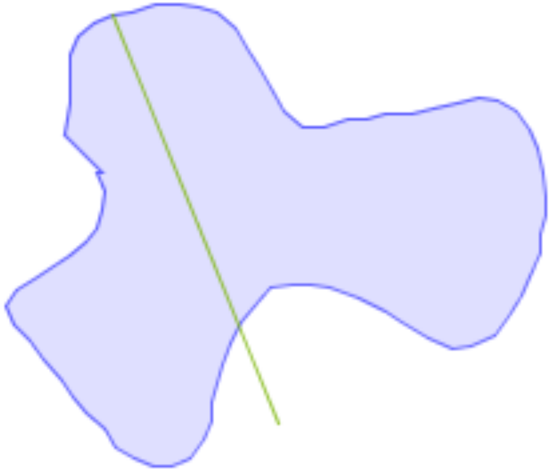
Hausdorff distance = 18.23

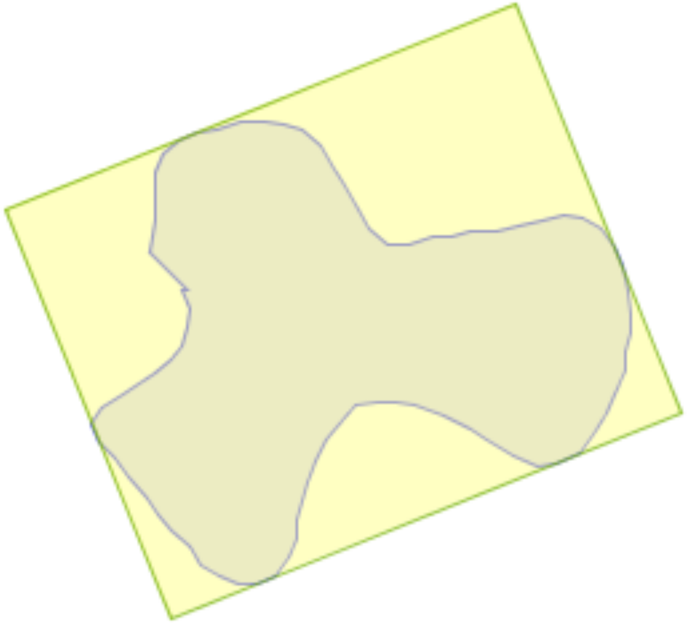
Bounding Containers

- MinimumBoundingCircle
- OctagonalEnvelope
- MinimumDiameter
  - *also* **Minimum Rectangle**



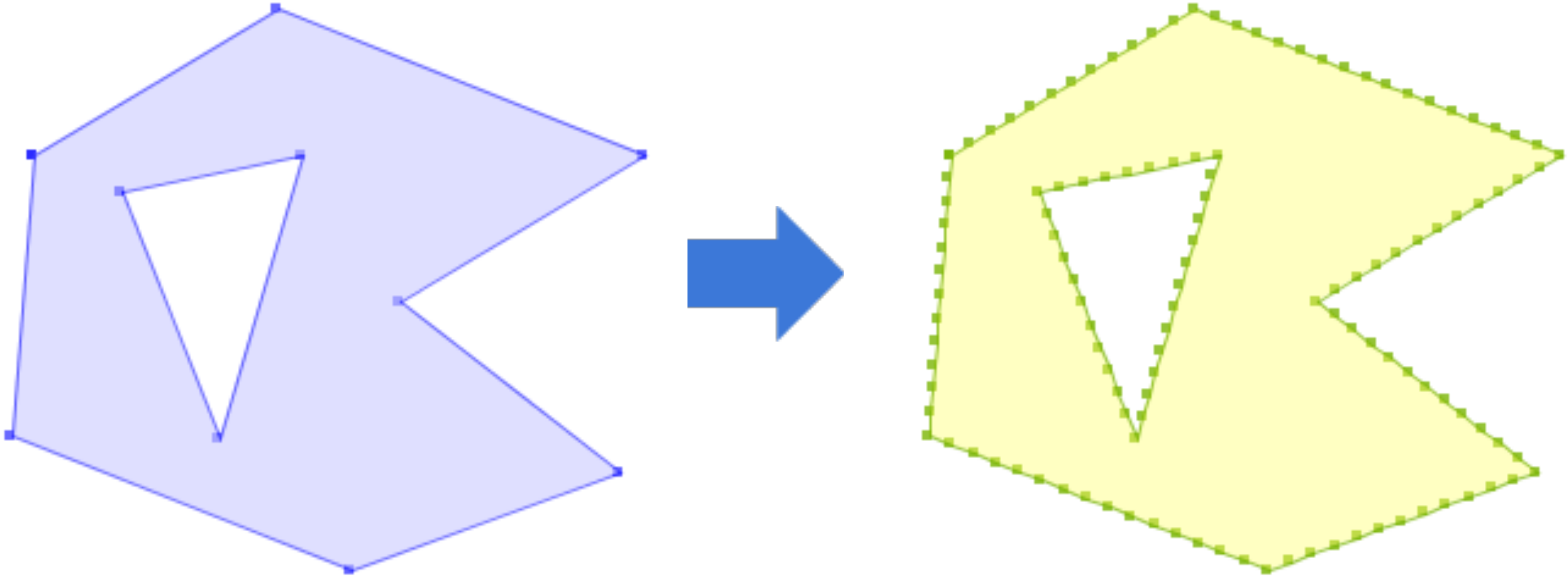






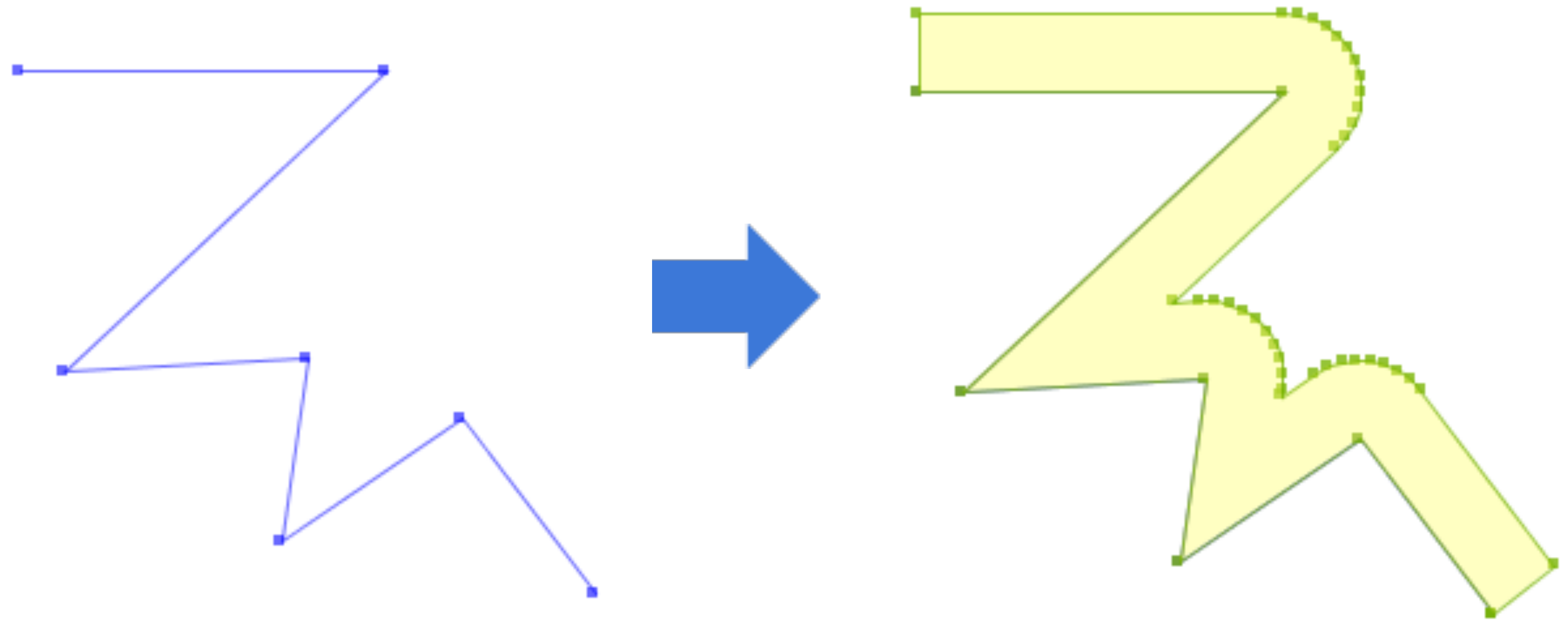
Densification

- Densifier
  - ○ specify maximum length of segments
  - ○ ensures result has valid topology



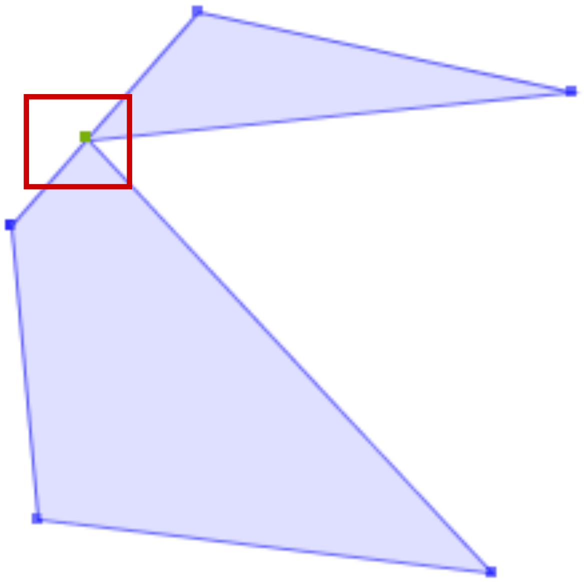
Single-Sided Buffers

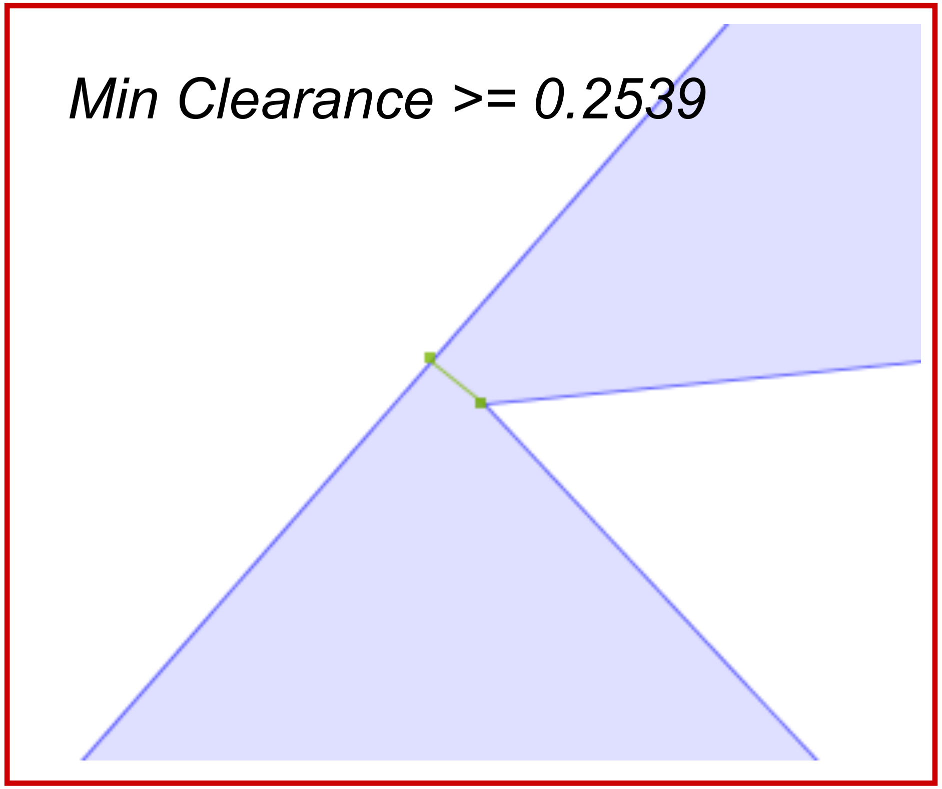
- Invoke by BufferParameters.setSingleSided()
    - Sign of distance determines side
- *Some warnings apply!*



Minimum Clearance

- Determines if Precision Reduction might product invalid result
- Uses STRtree Nearest Neighbour for efficient computation



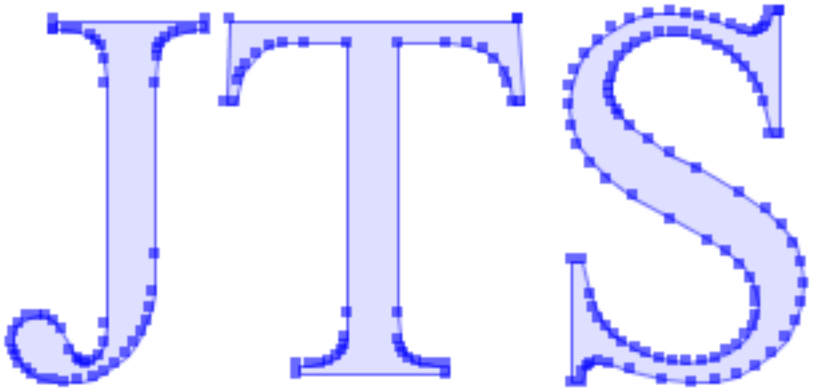


Nearest Neighbour

- **Nearest Neighbour**
  - between an object and a set
  - within a set
  - between two sets
- **implemented via** STRtree **index**
  - efficient search
  - user-definable distance metric
- **Uses**
  - MinimumClearance
  - Fast distance calculation

Java2D utilities

- ShapeReader
  - converts java.awt.Shape to Geometry
- ShapeWriter
  - converts Geometry to java.awt.Shape
  - provides PointTransformation to map coordinates
  - supports **decimation** for faster rendering
- FontGlyphReader
  - converts Font text to a Polygon geometry



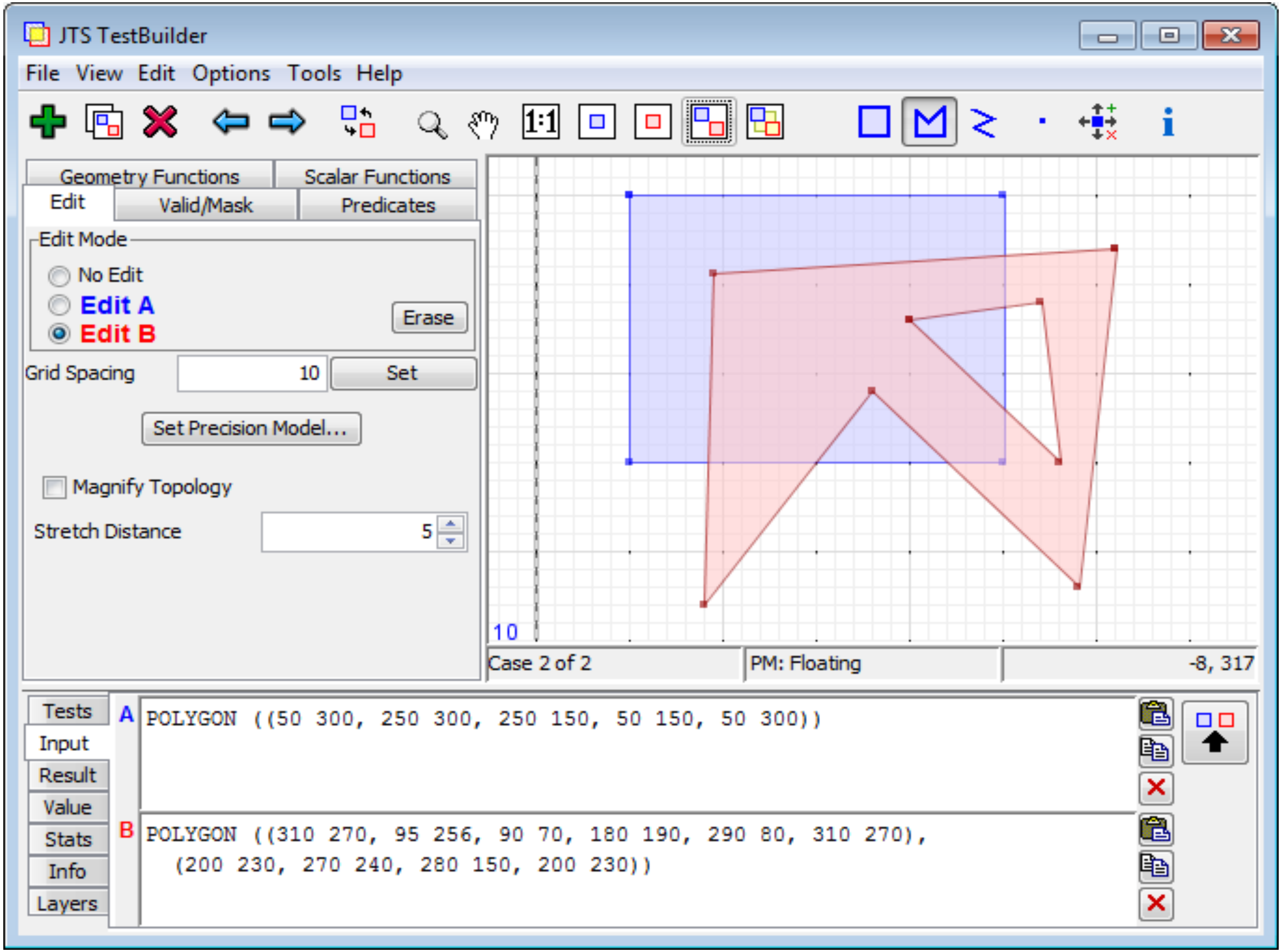
Mathematics utilities

- Vector2D
  - vector structure & operations

- DD - DoubleDouble
  - higher-precision floating-point arithmetic
  - 106 bits of precision
  - provides robust computation of:
    - **inCircle** test for Delaunay triangulation
    - triangle **area** & **orientation**

```
public static DD triAreaDDFast(
   Coordinate a, Coordinate b, Coordinate c) {
  DD t1 = DD.valueOf(b.x).selfSubtract(a.x)
       .selfMultiply(DD.valueOf(c.y).selfSubtract(a.y));
  DD t2 = DD.valueOf(b.y).selfSubtract(a.y)
       .selfMultiply(DD.valueOf(c.x).selfSubtract(a.x));
  return t1.selfSubtract(t2);
}
```

What's New in **TestBuilder**



Edit Mode
○ No Edit
○ Edit A
● Edit B

Grid Spacing 10

□ Magnify Topology

Stretch Distance 5

Case 2 of 2 | PM: Floating | -8, 317

A
```
POLYGON ((50 300, 250 300, 250 150, 50 150, 50 300))
```

B
```
POLYGON ((310 270, 95 256, 90 70, 180 190, 290 80, 310 270),
  (200 230, 270 240, 280 150, 200 230))
```

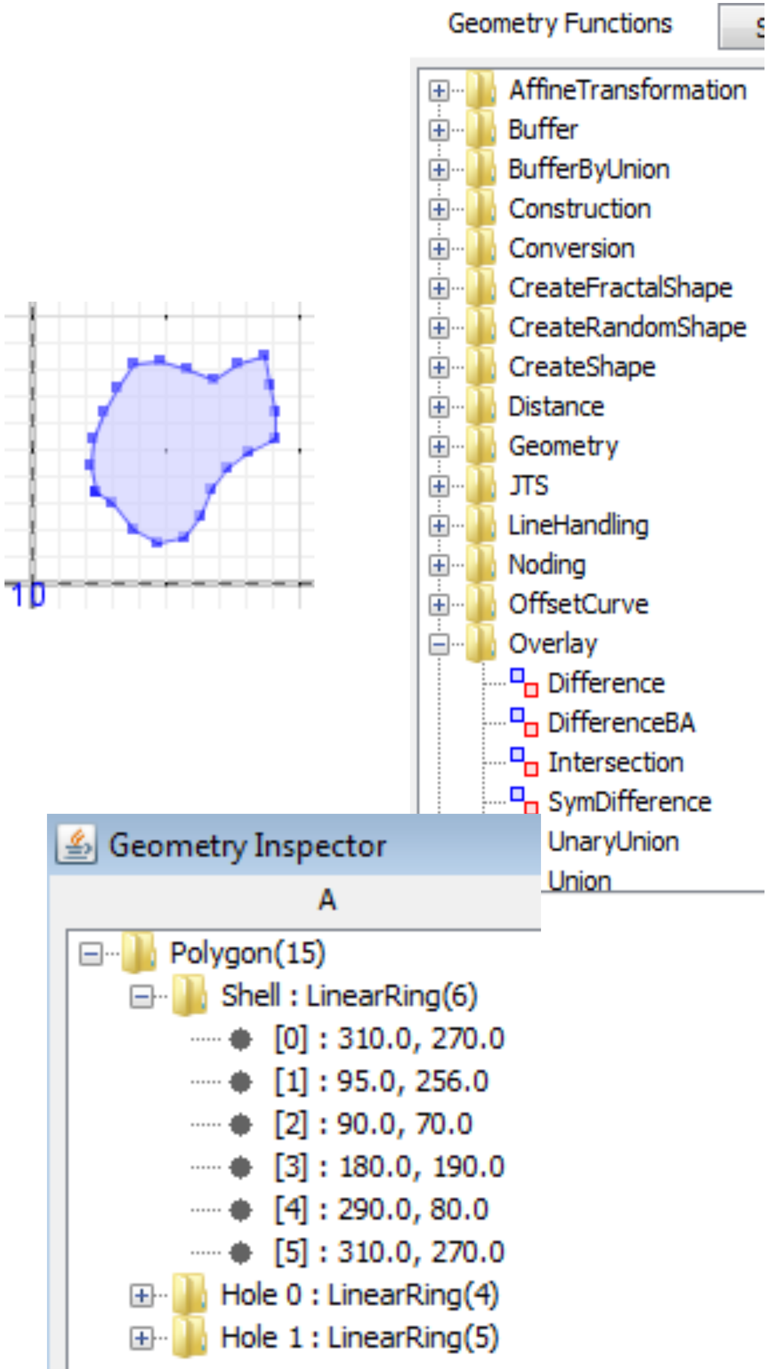
What's New in **TestBuilder**

- **User-Defined Functions**
  - ○ via Java public static methods
- **Many new functions**

- **Dynamic digitizing grid**
- **Stream digitizing**

- **Drag-and-drop data load**
  - ○ WKT, XML tests, Shapefile
- **Threading**
  - ○ Function execution
  - ○ Rendering
- **Display function run time**

- **Geometry Inspector**



Geometry Functions

- AffineTransformation
- Buffer
- BufferByUnion
- Construction
- Conversion
- CreateFractalShape
- CreateRandomShape
- CreateShape
- Distance
- Geometry
- JTS
- LineHandling
- Noding
- OffsetCurve
- Overlay
  - Difference
  - DifferenceBA
  - Intersection
  - SymDifference
  - UnaryUnion
  - Union

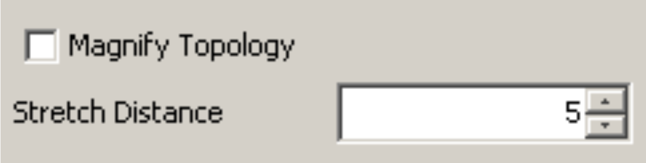
Geometry Inspector

A

- Polygon(15)
  - Shell : LinearRing(6)
    - [0] : 310.0, 270.0
    - [1] : 95.0, 256.0
    - [2] : 90.0, 70.0
    - [3] : 180.0, 190.0
    - [4] : 290.0, 80.0
    - [5] : 310.0, 270.0
  - Hole 0 : LinearRing(4)
  - Hole 1 : LinearRing(5)

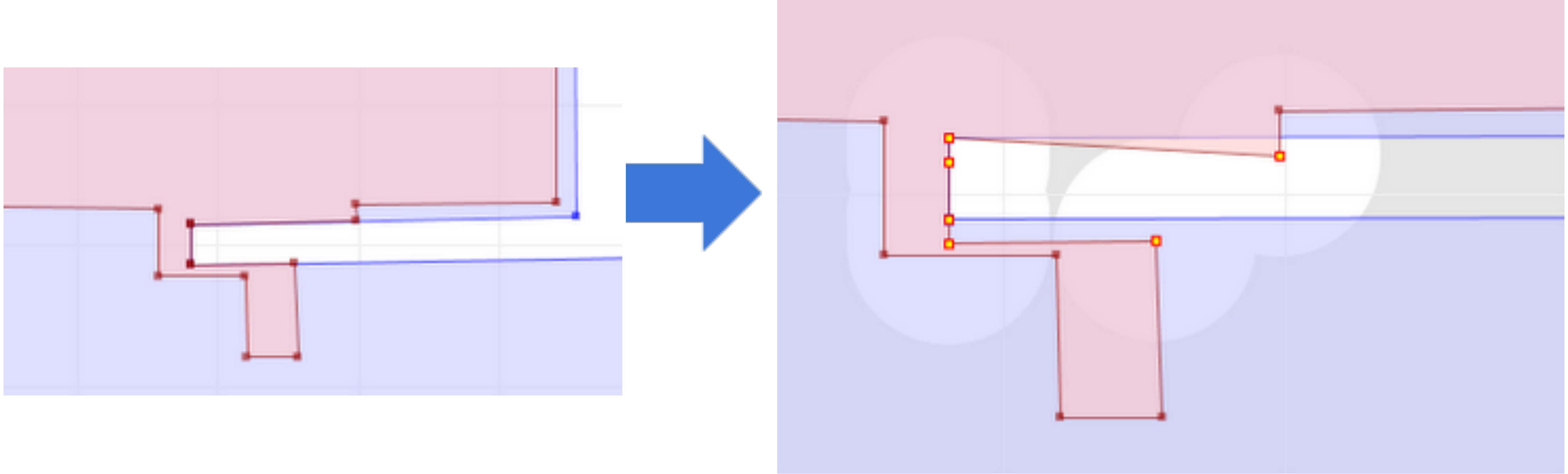
What's New in the **TestBuilder**

- **Magnify Topology**
  - Visualize very small geometry & topology discrepancies



□ Magnify Topology

Stretch Distance 5



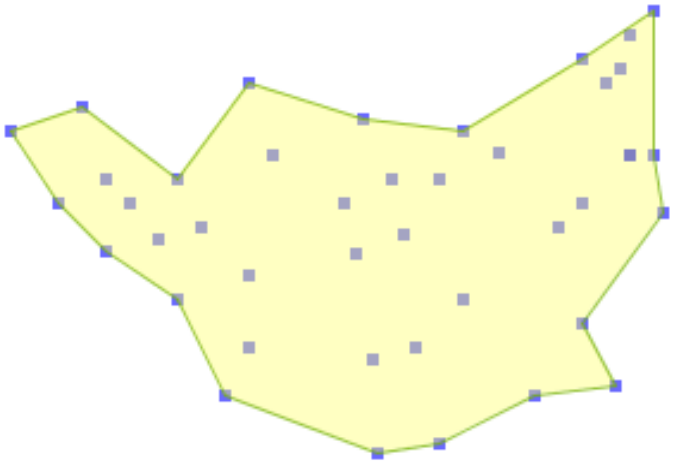
What's New in the **TestRunner**

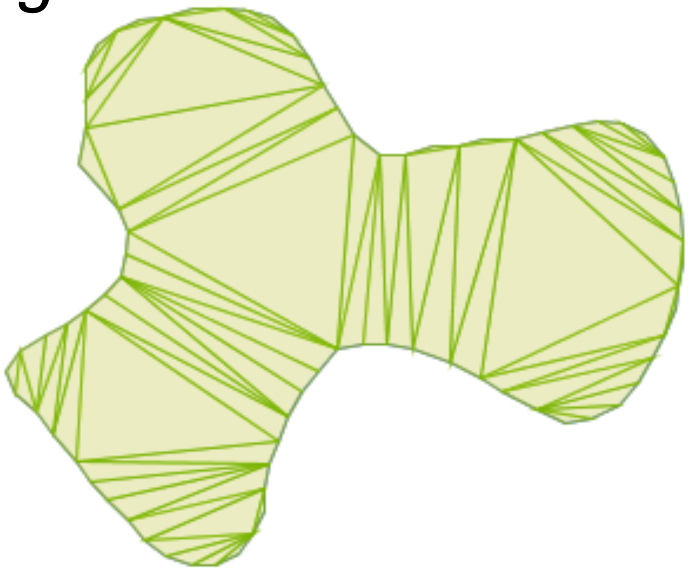
- **Custom operations**
  - Implement as Java code, configure in test file or cmd line
  - Uses:
    - Experiment with different algorithms
    - Re-use test corpus with different operations
    - Compare JTS results with external code
- **Custom Result Matching strategies**
  - use for operations which produce approximate results
  - e.g. buffer()
- **Ability to run single Test Case out of a set**

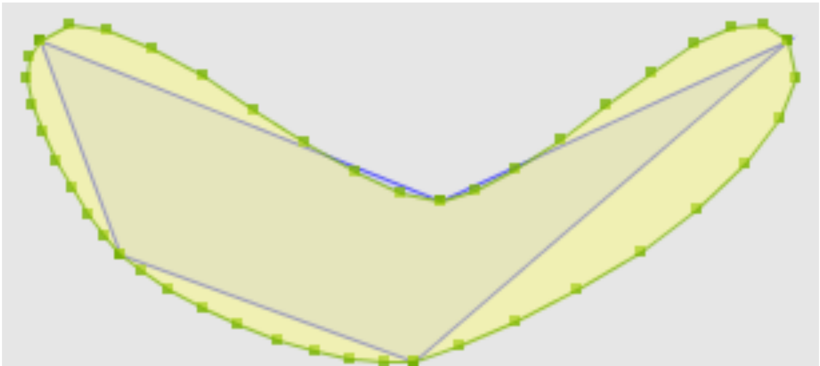
In the Lab

- **Performance improvements**
    - **Buffer** (again!)
    - Fast **Distance** computation

- **New algorithms:**
    - **Concave Hull**
    - **Point Clustering (***e.g. K-means)*
    - **Polygon triangulation** (*Ear Clipping with Delaunay improvement*)
    - **Orthogonalization**
    - **Bezier Smoothing**







Future Plans

- **Computation in Geodetic coordinate systems**
  - Area, Distance first
  - Other operations ...somehow
- **Support measures on coordinates**
- **Improve performance, robustness**
  - Constant quest...
- **Split packaging into Core and Algorithms**
- **Refactor Geometry classes to use interfaces**
  - allows alternate geometry representations
  - => *JTS 2.0*

Distribution & Support

- **JTS available from SourceForge**

http://sourceforge.net/projects/jts-topo-suite/

- **Mailing List**

https://lists.sourceforge.net/lists/listinfo/jts-topo-suite-user

- **Other JTS resources**
  - Javadoc
  - References
  - FAQ
  - more to come...

`http://tsusiatsoftware.net/jts/main.html`