# CENG 570

Computational Geometry

Tolga Can

Spring 2017-2018

# Course website

- http://www.ceng.metu.edu.tr/~tcan/ceng570_s1718/overview.shtml
- ODTU-Class for announcements, homework submissions, grades.

# Geometric preliminaries

- Scalars, vectors, vector operations, dot product, cross product
- Points in 2D, 3D space
- Distances: Euclidean, Manhattan distance
- Lines, line segments
- Planes, normal, plane equations, half spaces
- Parametric line equations
- Polygons: simple, convex/concave polygons, convex test
- Circles: circle center from 3 points
- Intersection tests, inclusion tests

# Convex hulls

- Chapter 1 from the textbook

# Additional slides

- By Prof Andy Mirzaian from Department of EECS York University, Canada.
  - COSC 6114 Computational Geometry Course
  - http://www.cse.yorku.ca/~andy/courses/6114/index.html

# Landscape of Computational Geometry

## Applications:
- Graphics
- Robotics
- Vision
- GIS
- CAD
- VLSI
- Pattern Recognition
- Optimization
- Transportation
- Statistics
- . . .

## Algorithmic Tools:
- general
- incremental
- divide-&-conquer
- space sweep
- topological sweep
- prune and search
- random sampling
- locus approach
- multidimensional search
- dynamization
- . . .

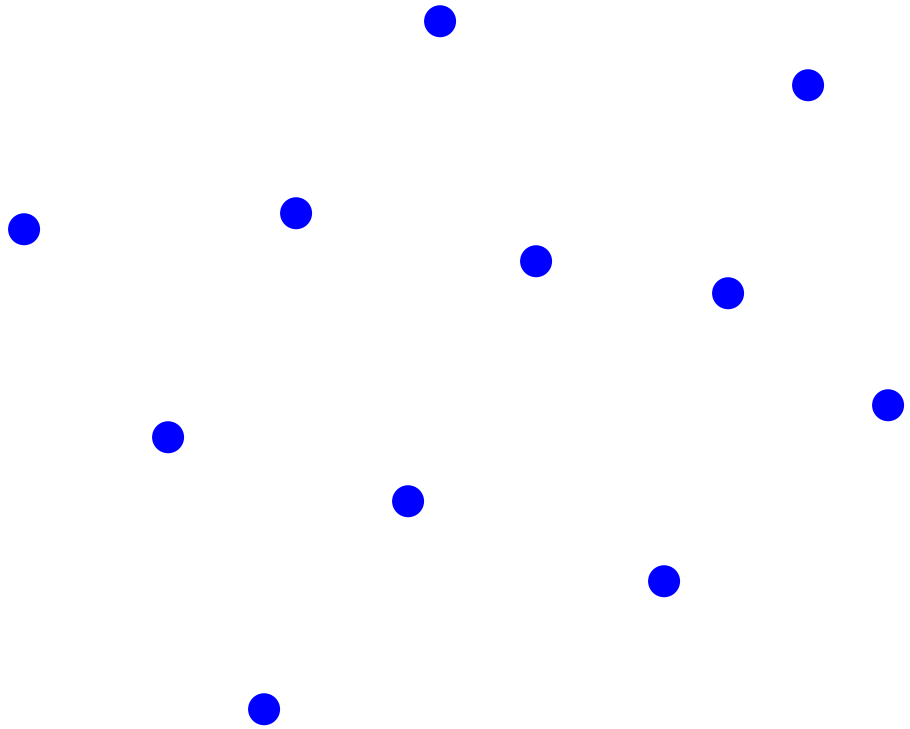
## Data Structures:
- general
- interval trees
- range trees
- segment trees
- priority search trees
- K-d trees
- fractional cascading
- persistent D.S.
- . . .

## Analysis Tools:
- general
- amortization
- Davenport-Schinzel
- . . .

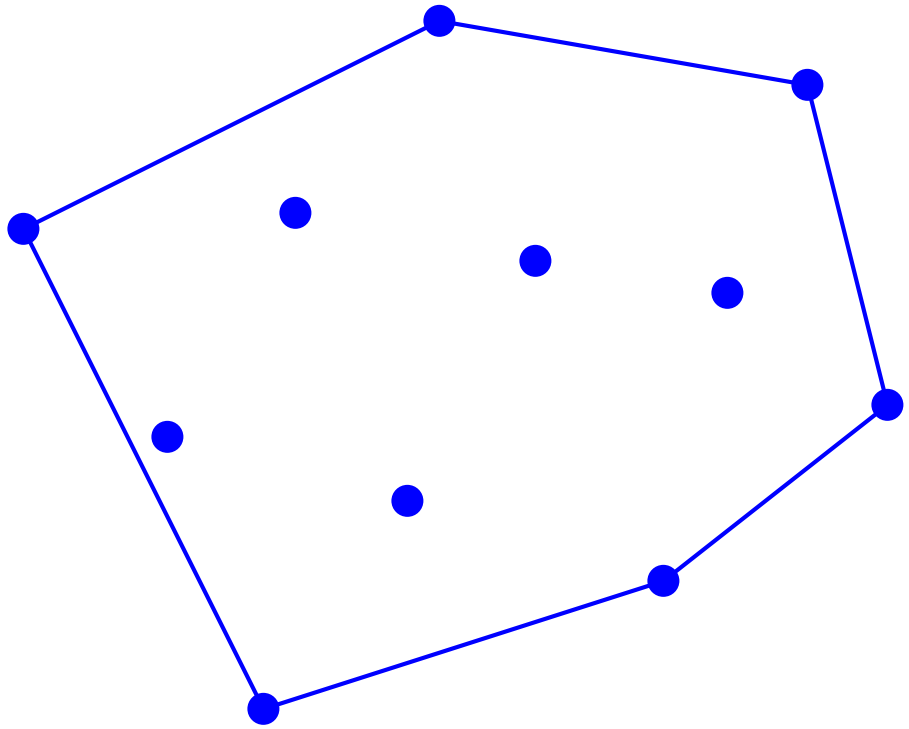
## Geometric Tools:
- Convex Hull
- Space subdivision
- Arrangements
- Voronoi / Delaunay Diagram
- Triangulations
- Geometric Transforms
- Duality
- . . .

## Implementation Issues:
- Degeneracy (symbolic perturbation)
- Robustness (inexact arithmetic)
- . . .

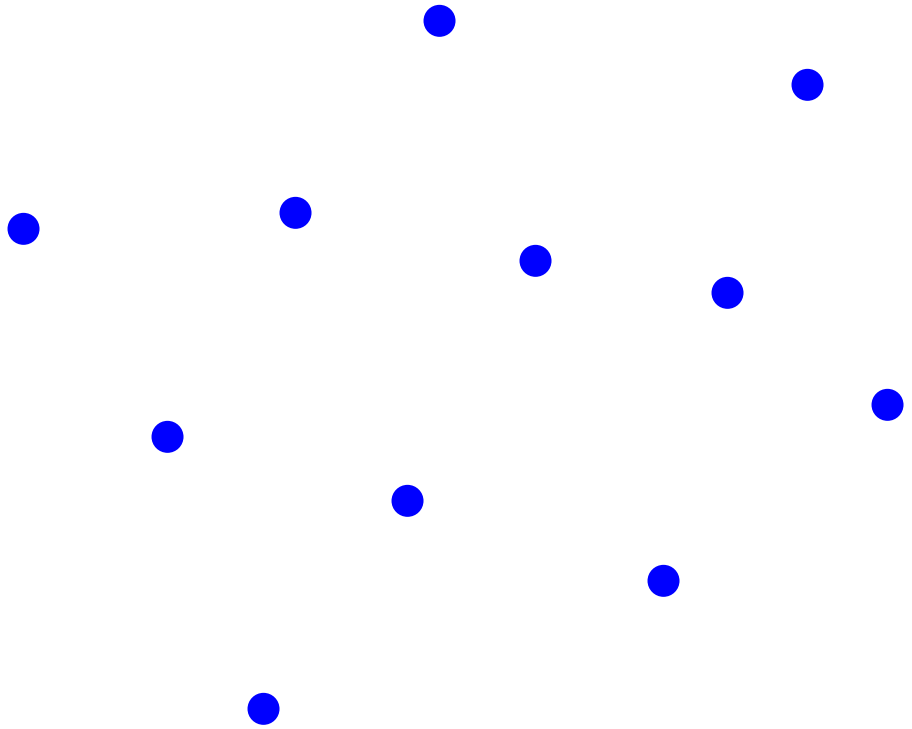
# Example 1:  Convex Hull



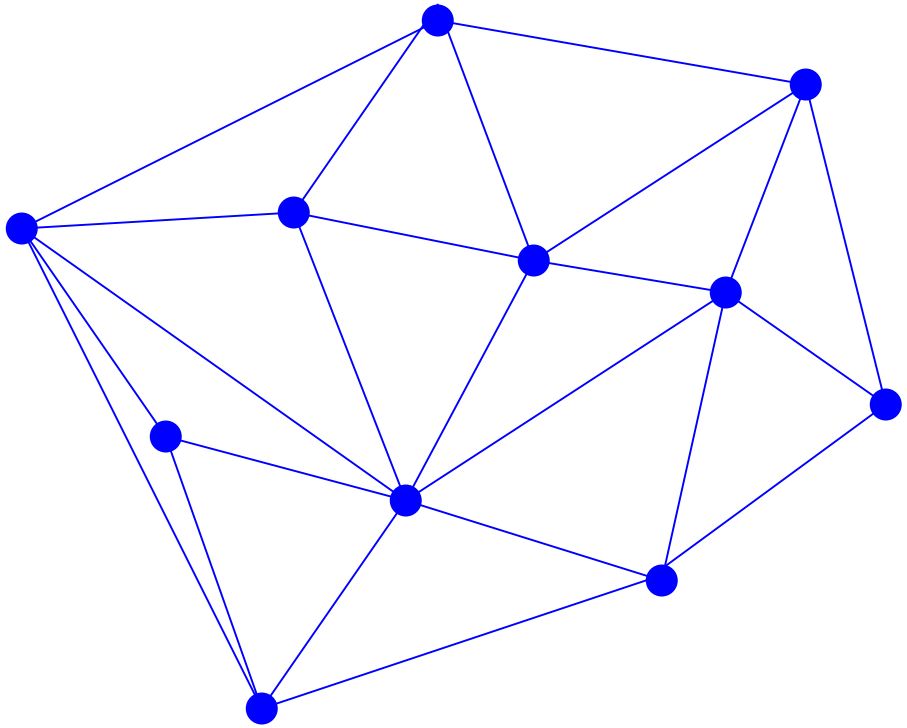
# Example 1: Convex Hull



# Example 2:  Point set triangulation



# Example 2: Point set triangulation

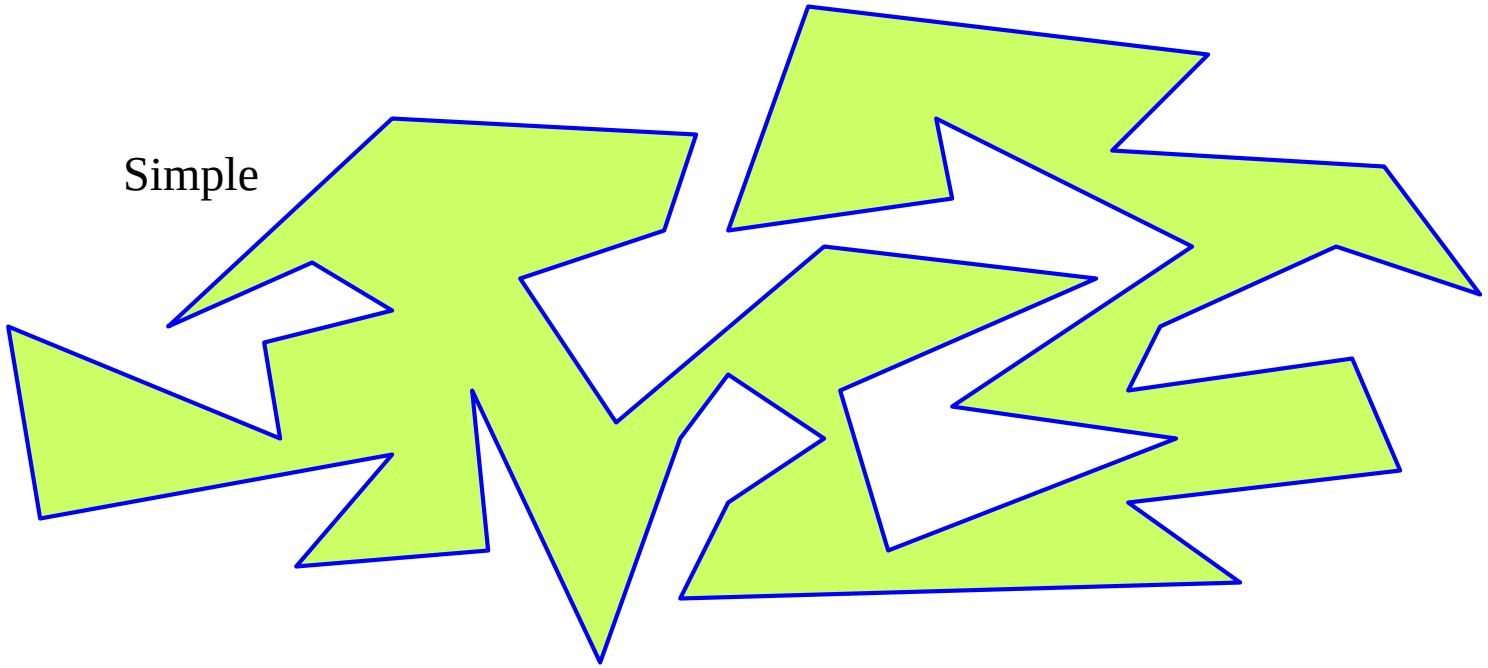


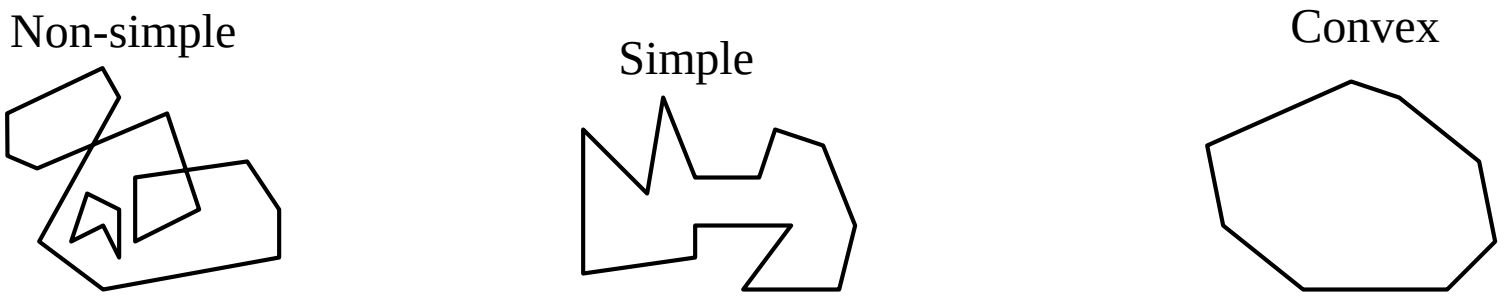
# Example 3: Simple Polygon

**Polygon:** A closed curve in the plane consisting of finitely many straight segments.

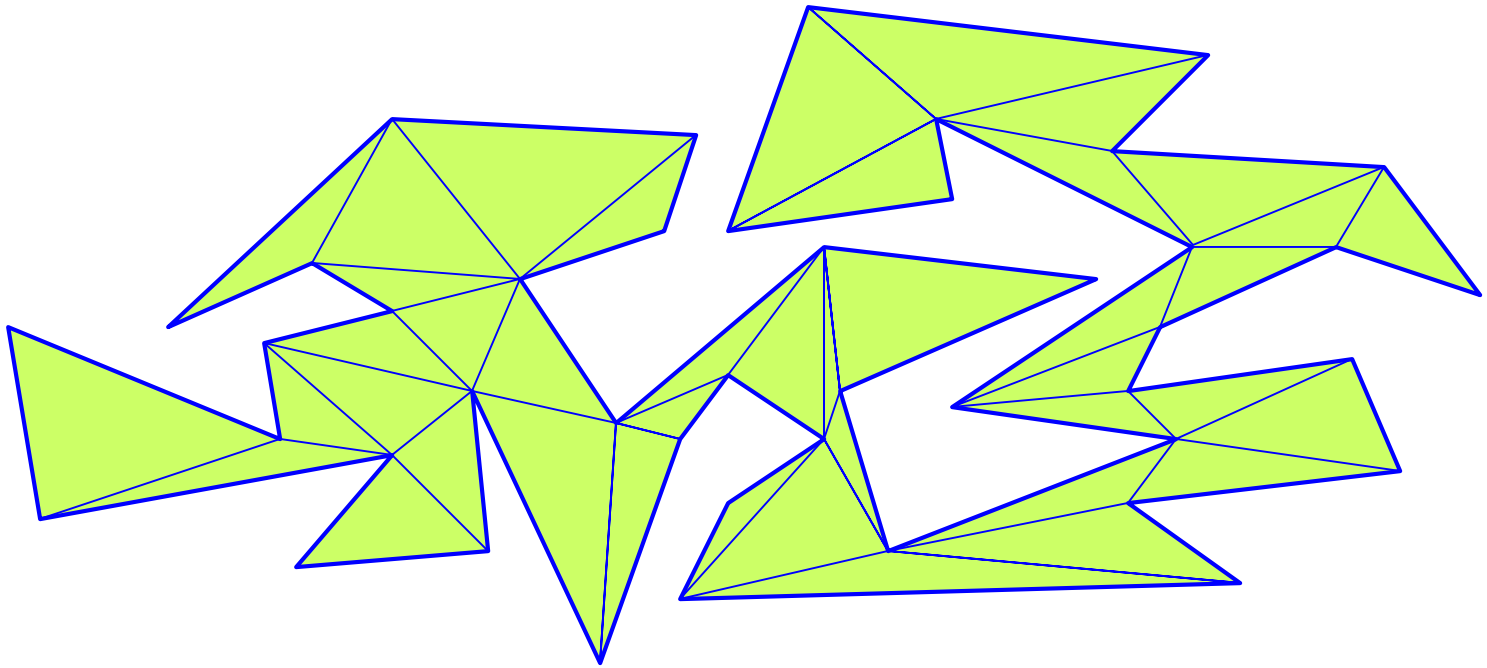
**Simple Polygon:** A connected non-self-crossing polygon.

**Convex Polygon:** A simple polygon with no interior angle exceeding 180°.

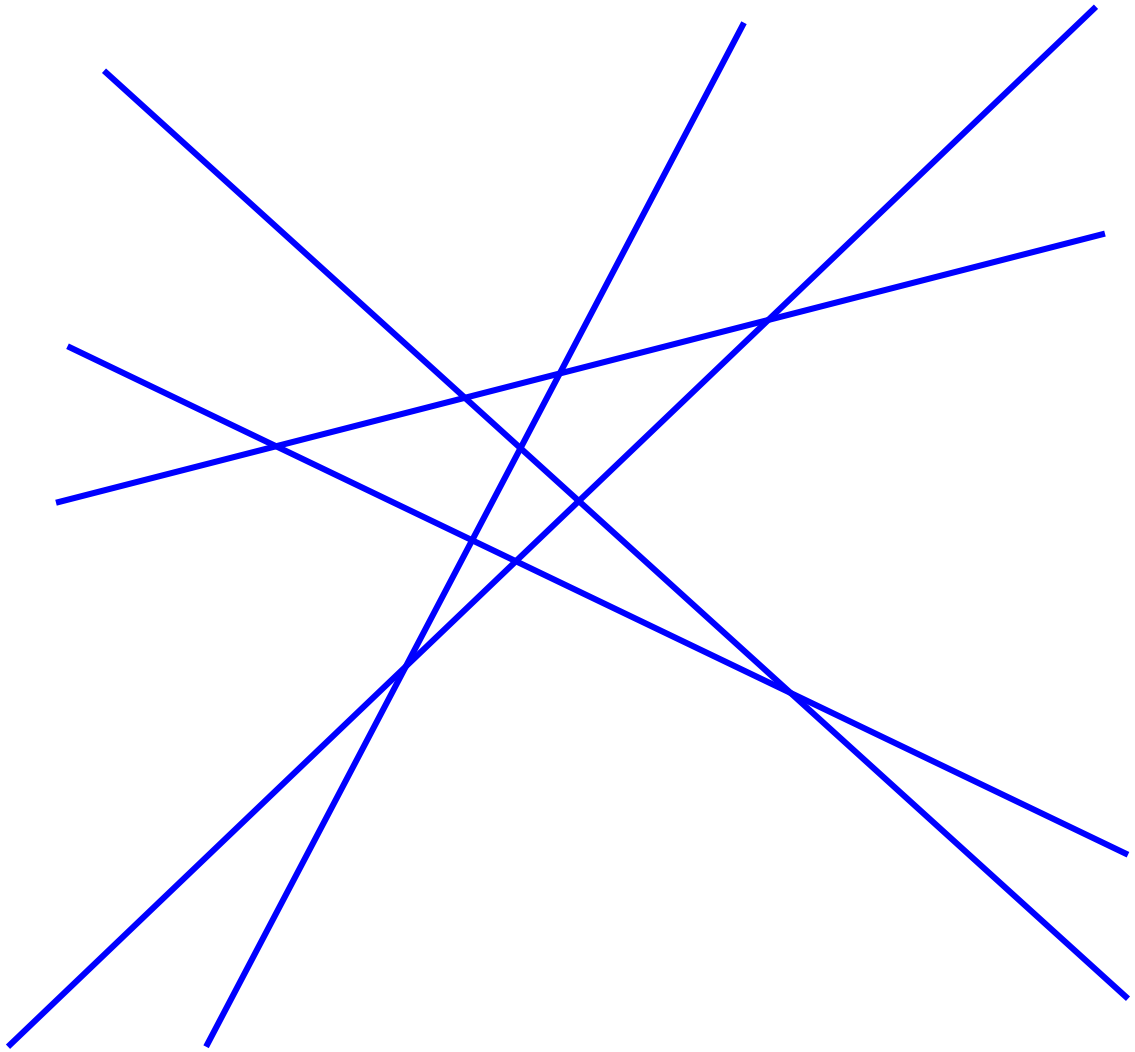


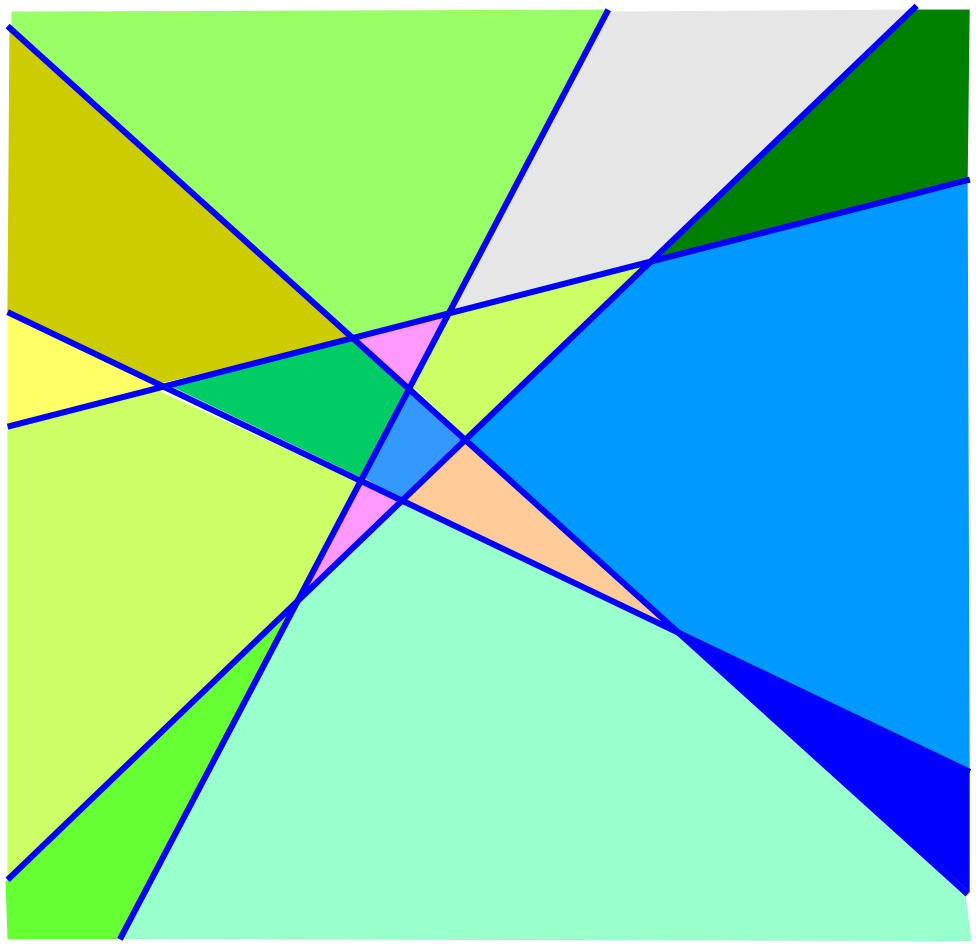
# Example 3: Simple Polygon Triangulation



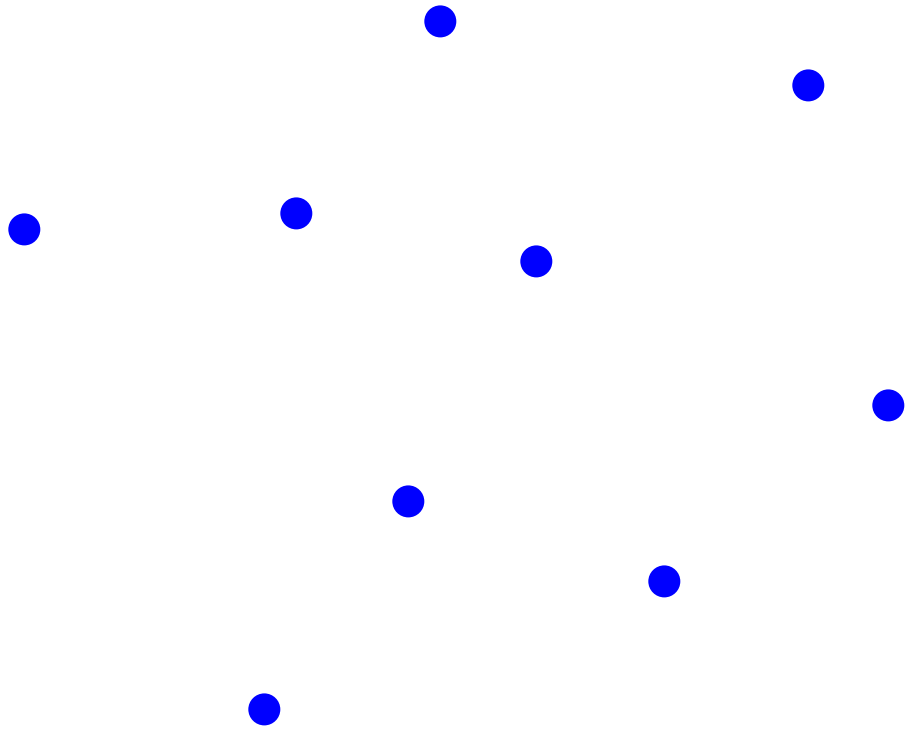
# Example 4: Planar Line Arrangement



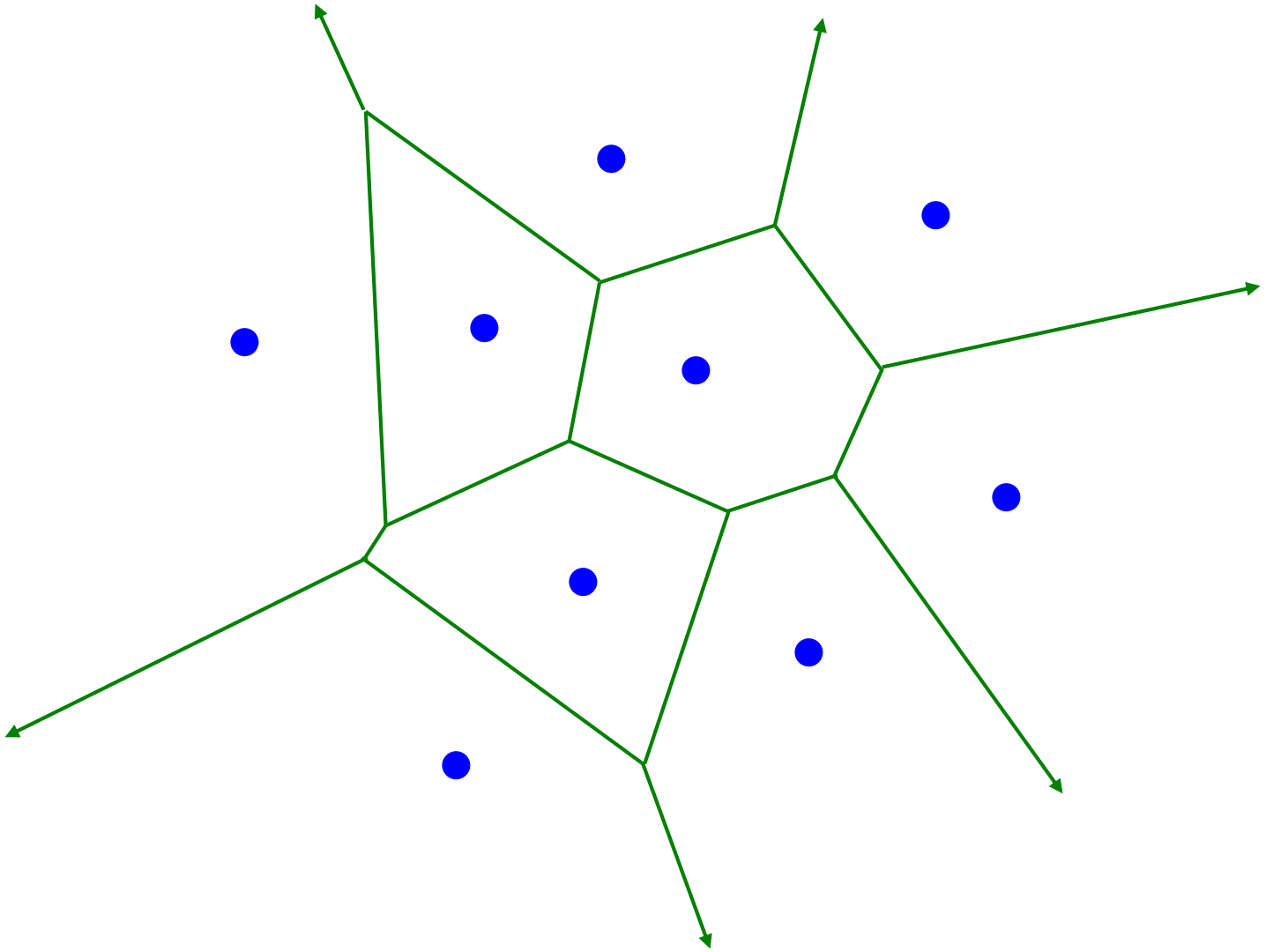
# Example 4: Planar Line Arrangement



# Example 5: Voronoi Diagram & Delaunay Triangulation

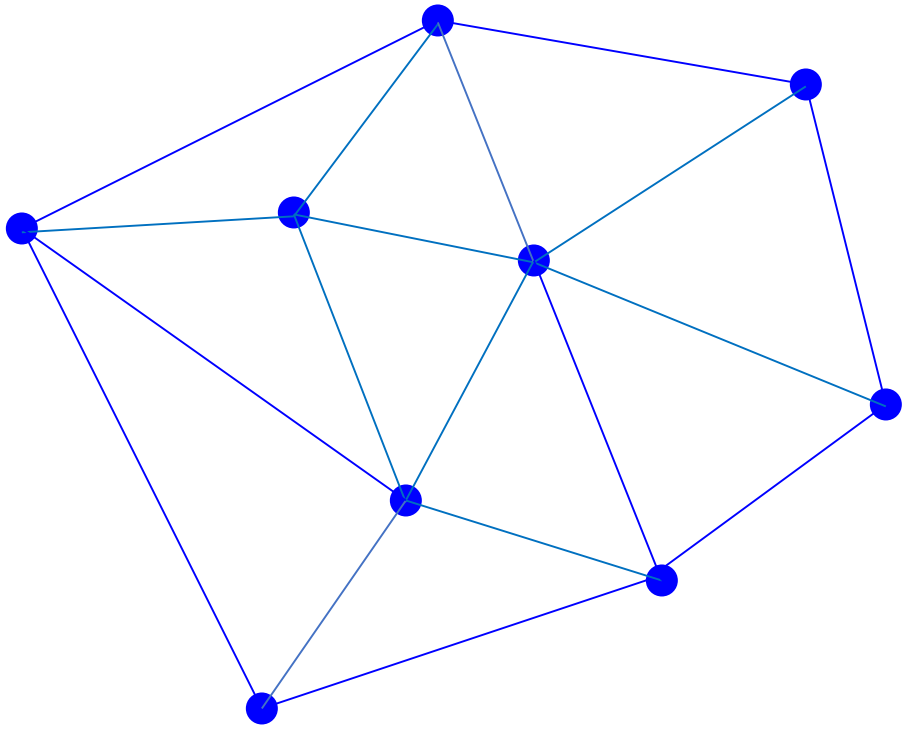


# Example 5: Voronoi Diagram & Delaunay Triangulation



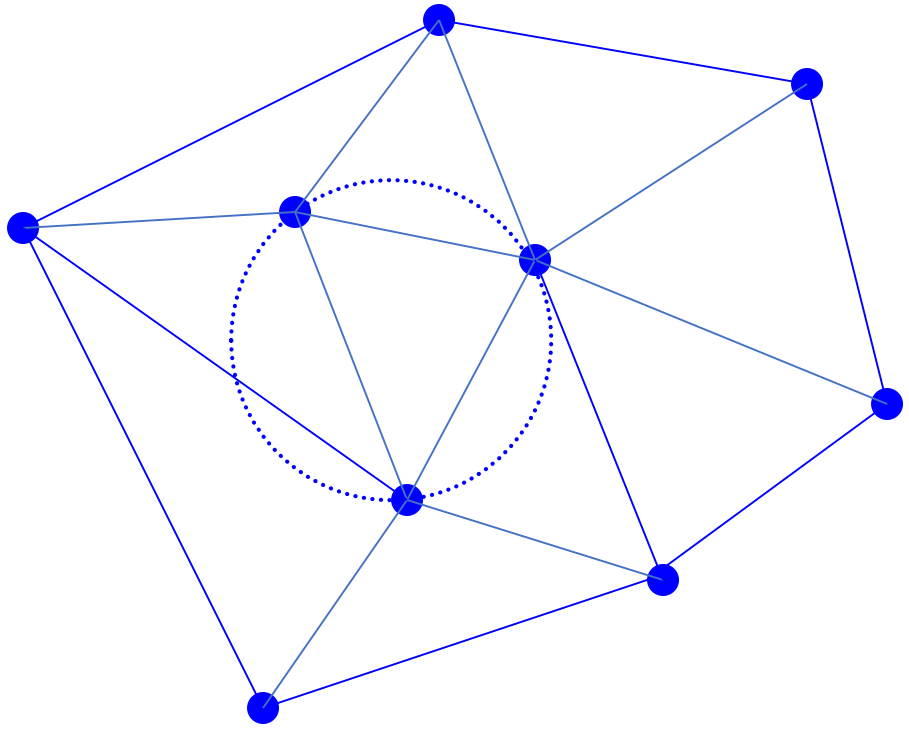
Nearest site proximity partitioning of the plane

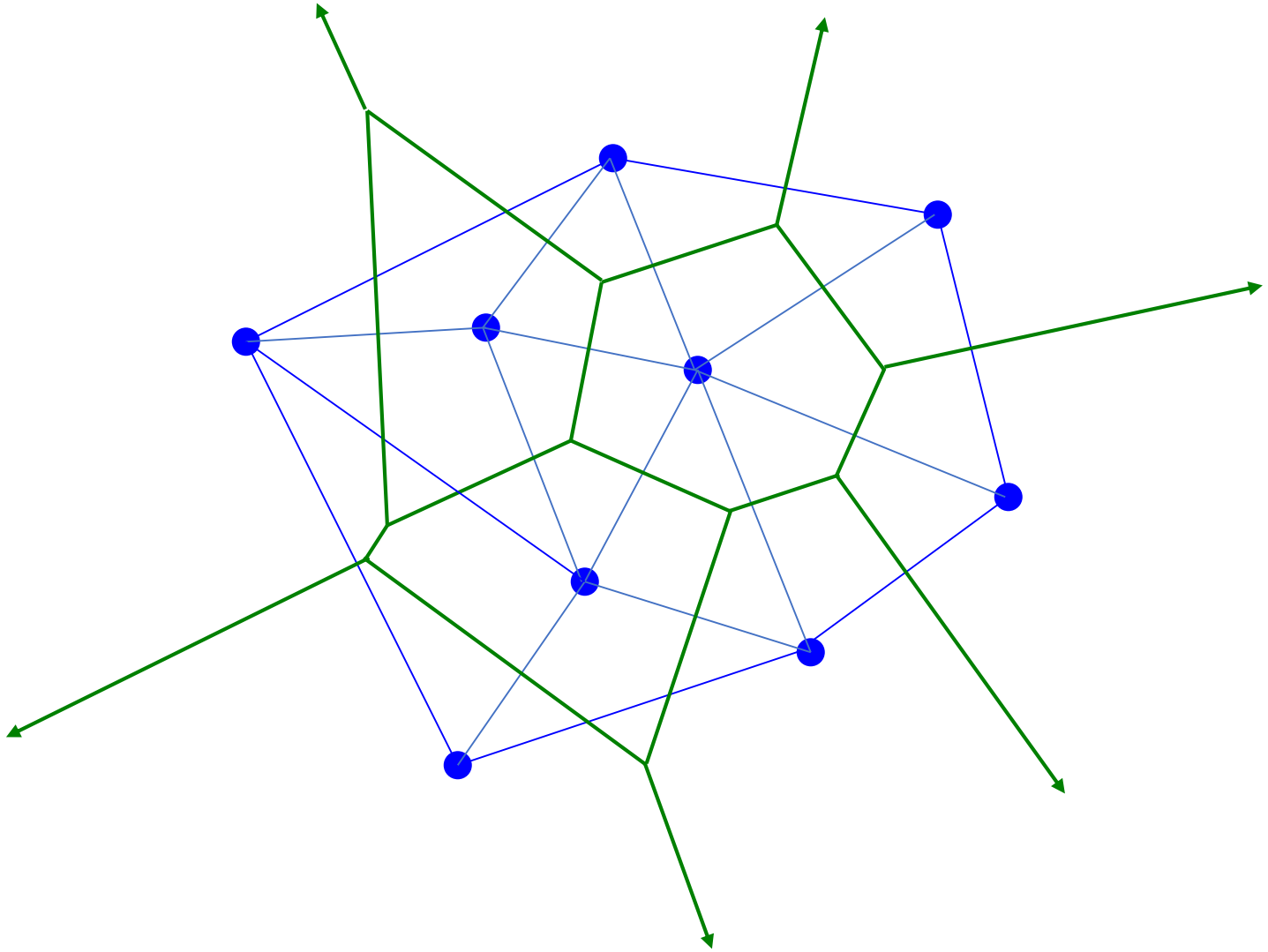
# Example 5: Voronoi Diagram & Delaunay Triangulation



Delaunay Triangulation = Dual of the Voronoi Diagram.

# Example 5: Voronoi Diagram & Delaunay Triangulation



Delaunay triangles have the “empty circle” property.

# Example 5: Voronoi Diagram & Delaunay Triangulation