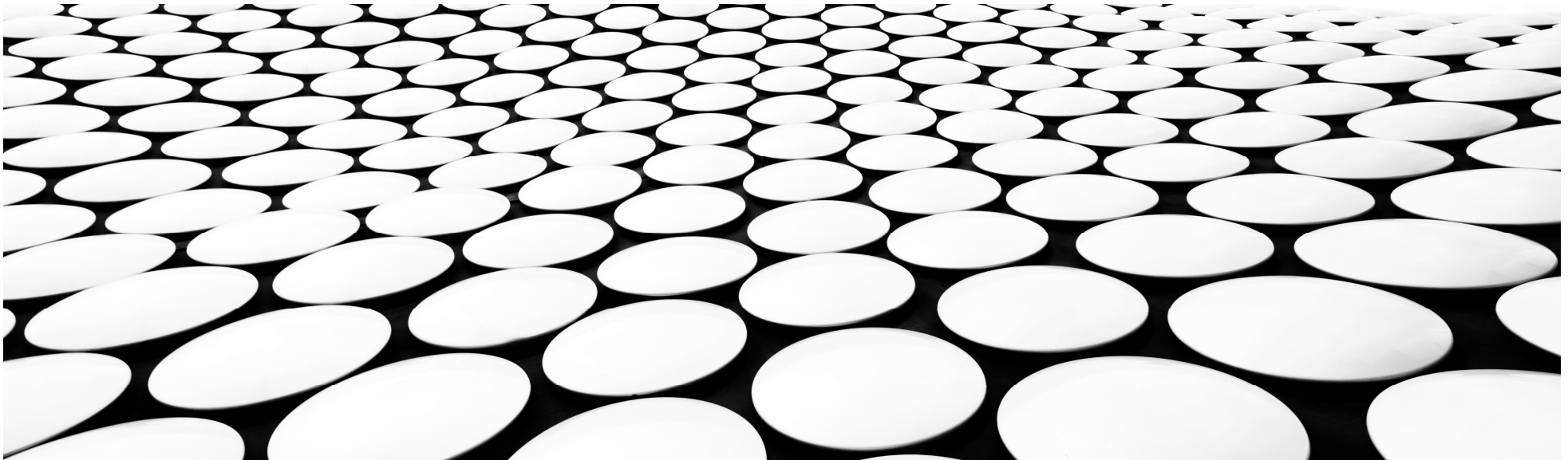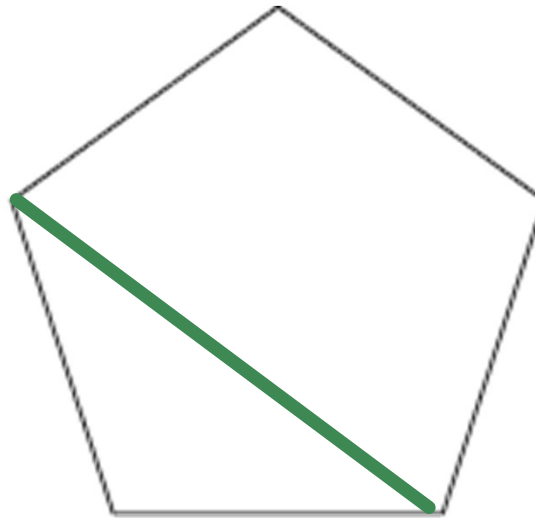# CONVEX HULL ALGORITHM

KYLE KOLODZIEJ

OVERVIEW OF PRESENTATION

1. *Convex Polygon*
2. Convex Hull
3. Jarvis' March/Gift Wrapping
4. Graham's Scan
5. Jarvis' March vs. Graham's Scan
6. Real-World Application

CONVEX POLYGON

- Simple polygon (not self-intersecting)

- Interior angles are all less than or equal to 180 degrees

- Line segments from two vertices stay in its boundaries

convex polygon   *concave polygon*

OVERVIEW OF PRESENTATION

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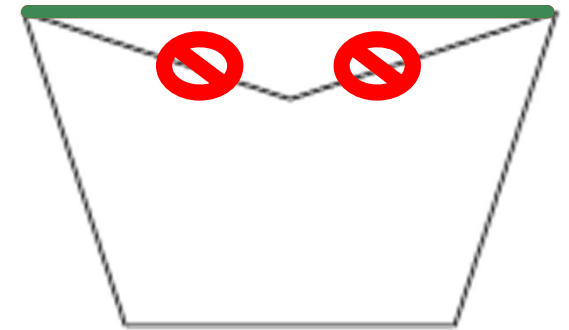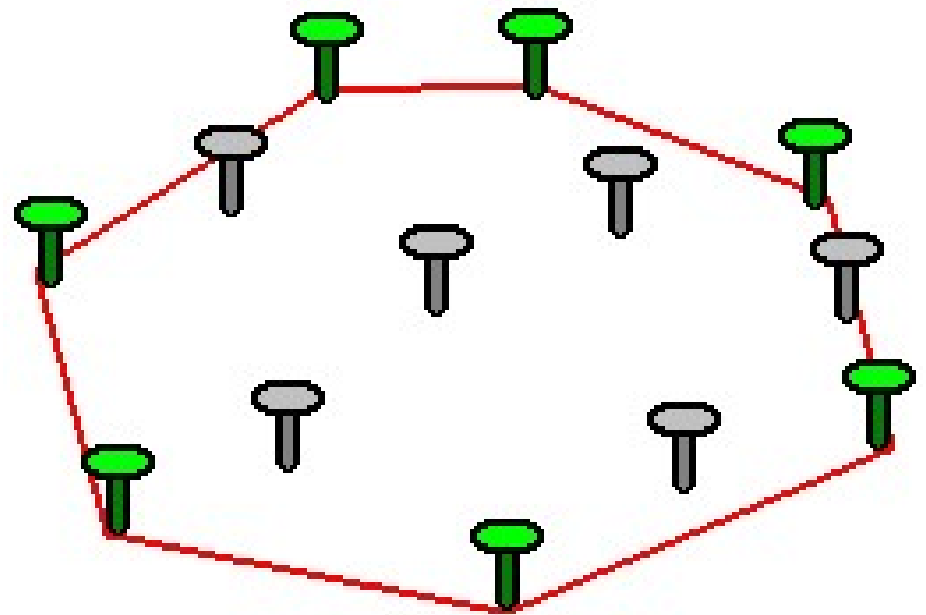6. Real-World Application

WHAT IS A CONVEX HULL

- Given a set P of n points in d-dimensional space, it finds the smallest convex polygon containing all the points of set P

- Rubber band and nail example

- Equivalents

  - Smallest convex set containing all points

  - Smallest convex polygon containing all points

CONVEX HULL ALGORITHMS

- Jarvis' March a.k.a. Gift Wrapping

- Graham's Scan

- Quickhull

- Divide and Conquer

- Monotone Chain a.k.a. Andrew's Algorithm

- Chan's Algorithm

- https://github.com/kkolodziej39/Convex Hull

The execution of jarvis's March

OVERVIEW OF PRESENTATION

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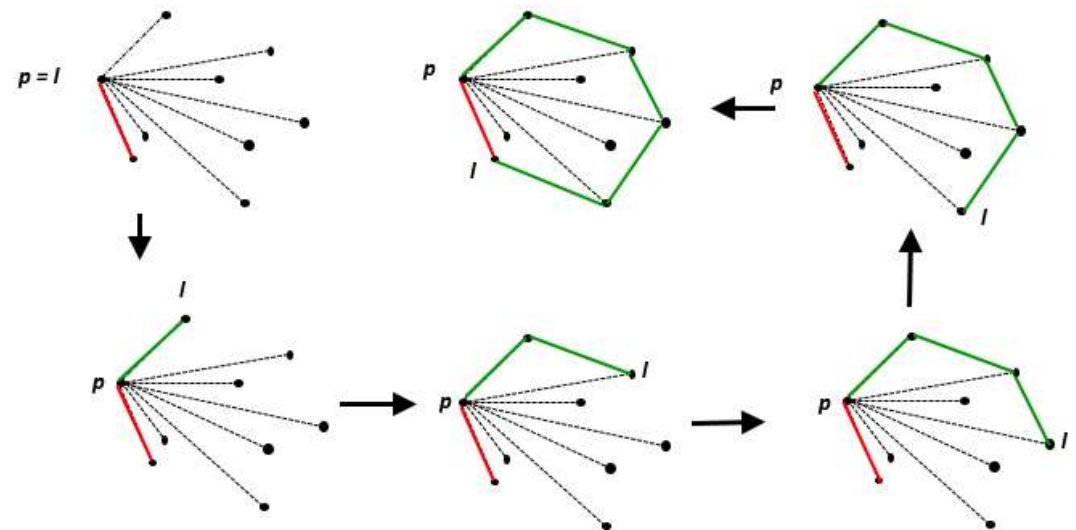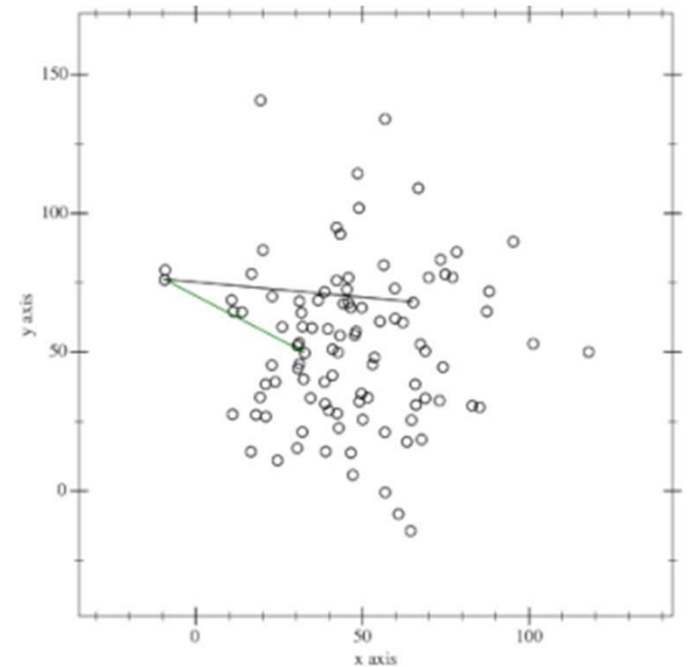5. Jarvis' March vs. Graham's Scan
6. Real-World Application

JARVIS' MARCH (GIFT WRAPPING)

- Start with an extreme point that will be in the convex hull

- Using this as a point of reference, add the point that is leftmost (most counterclockwise)

- Repeat until at initial point

- Time complexity of O(nh)

  - N = Number of input points

  - H = Number of hull points
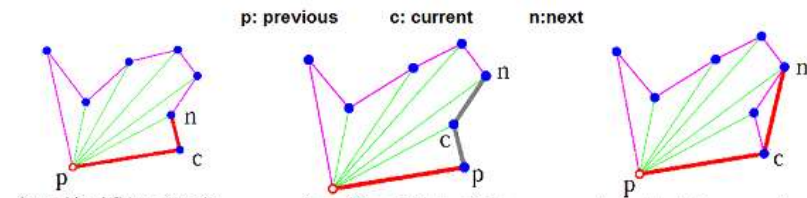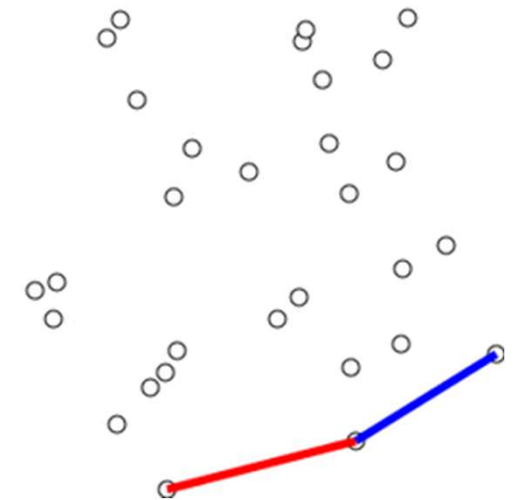
- Worst case of O(n^2)

  - All points are hull points

OVERVIEW OF PRESENTATION

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GRAHAM'S SCAN

- Start with point known to be on the convex hull

- Sort the rest in angular order around this point

- Add to the hull if previous, current, and next point form a counterclockwise orientation

- Delete chain of vertices from the hull if previous, current, and next point do not form counterclockwise orientation

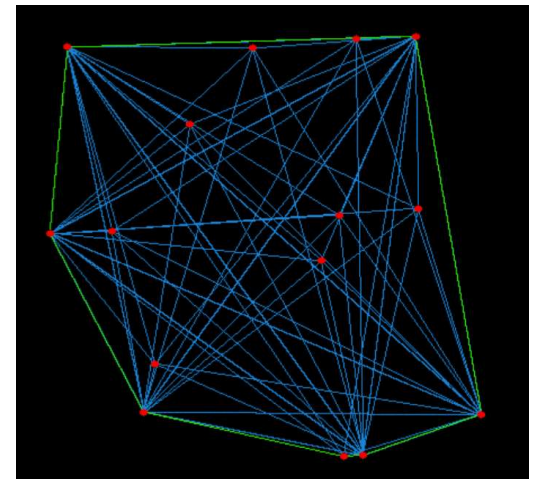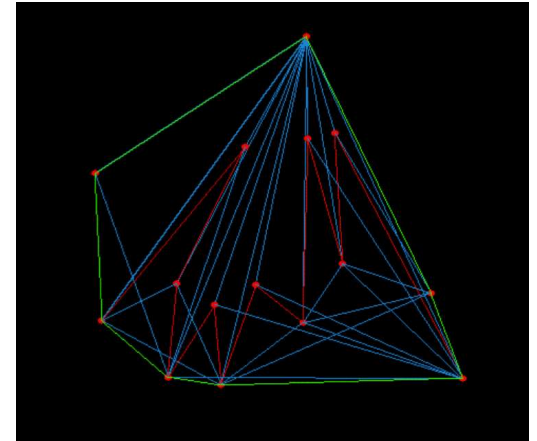- Time complexity of O(n lg n)

    - N = Number of input points

p: previous   c: current   n:next

OVERVIEW OF PRESENTATION

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JARVIS' MARCH VS. GRAHAM'S SCAN
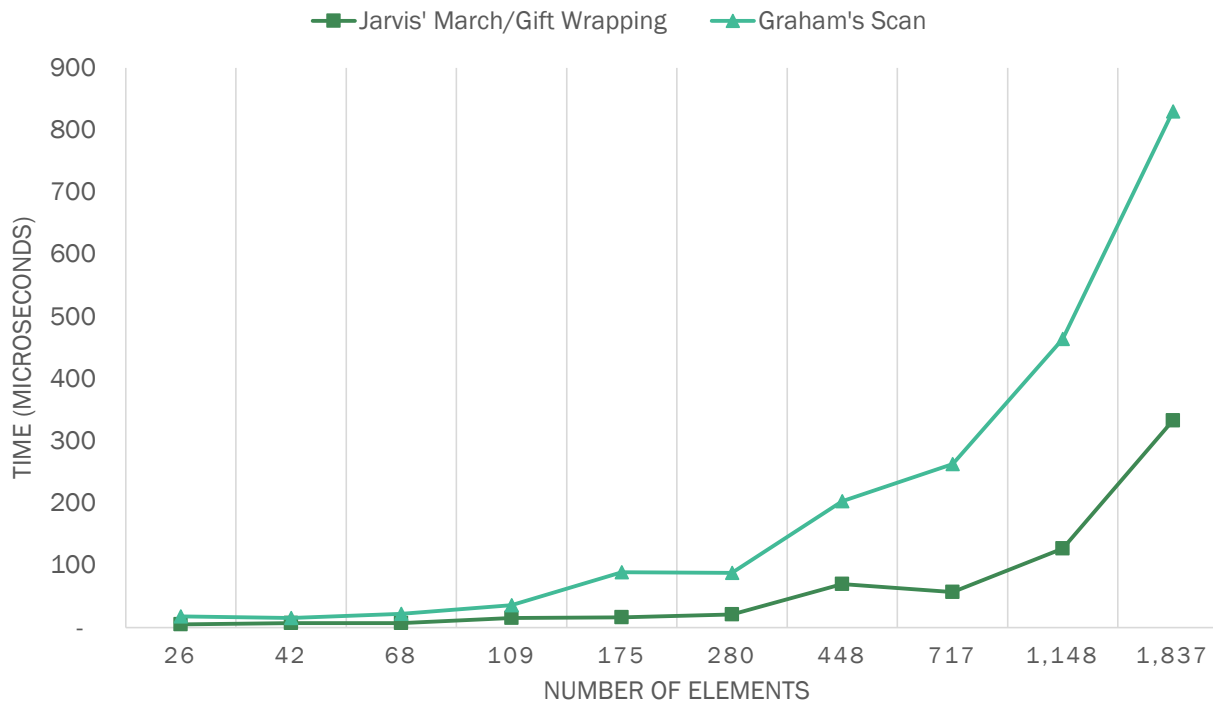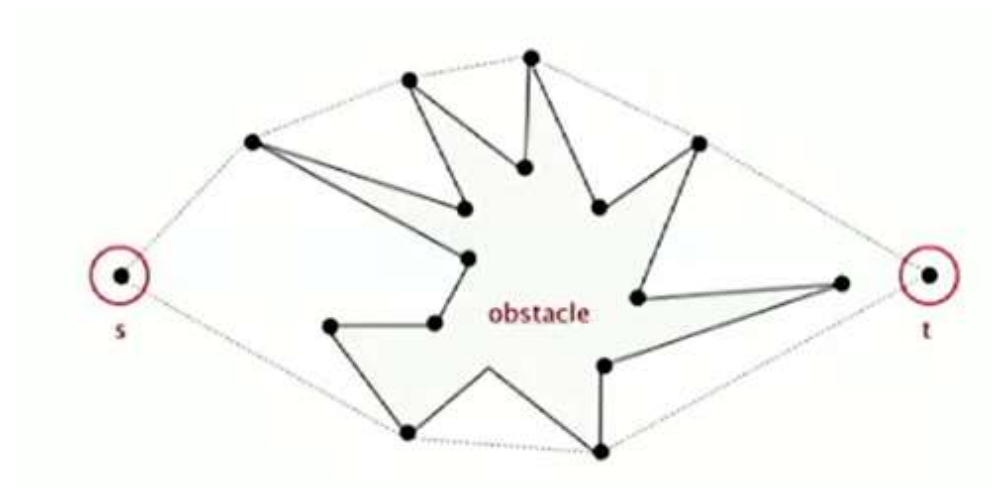

NUMBER OF ELEMENTS VS TIME OF EACH IMPLEMENTATION

OVERVIEW OF PRESENTATION

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6. *Real-World Application*

REAL-WORLD APPLICATION

- Geometry

- Collision detection and path planning

- Shape analysis/detection

- Nuclear leak evacuation

- Tracking diseases

- Cooking

  - http://veronising.blogspot.com/2008/04/cooking
    -for-nerds-ingredient-polyhedron.html

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- https://youtu.be/VP9ylElm1yY