Explosive Hazard Detection Scoring: *Hand-held* & *Vehicular* Systems

2017 09 26

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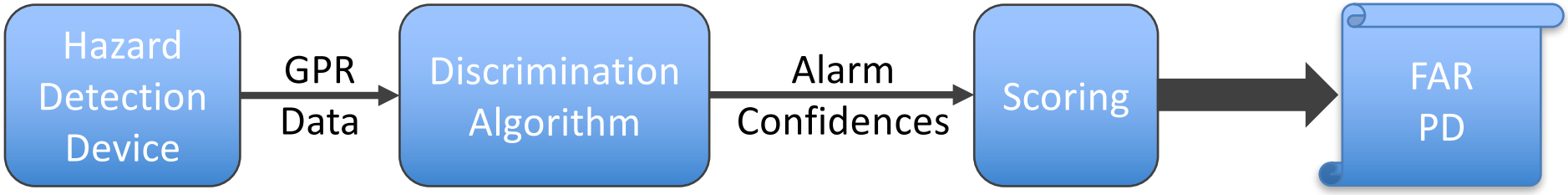
Process


Hazard Detection Device
GPR Data
Discrimination Algorithm
Alarm Confidences
Scoring
FAR PD

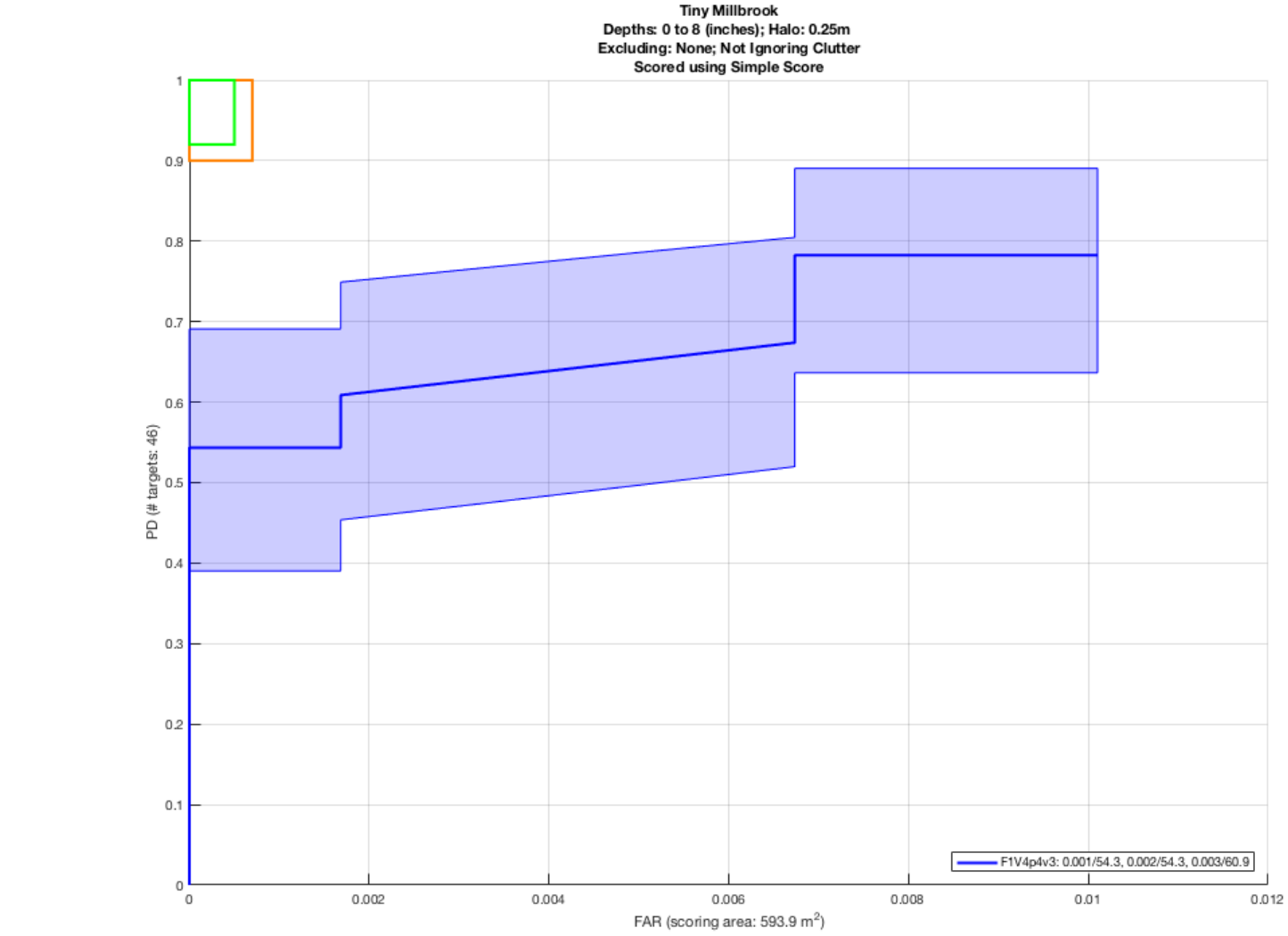
Scoring

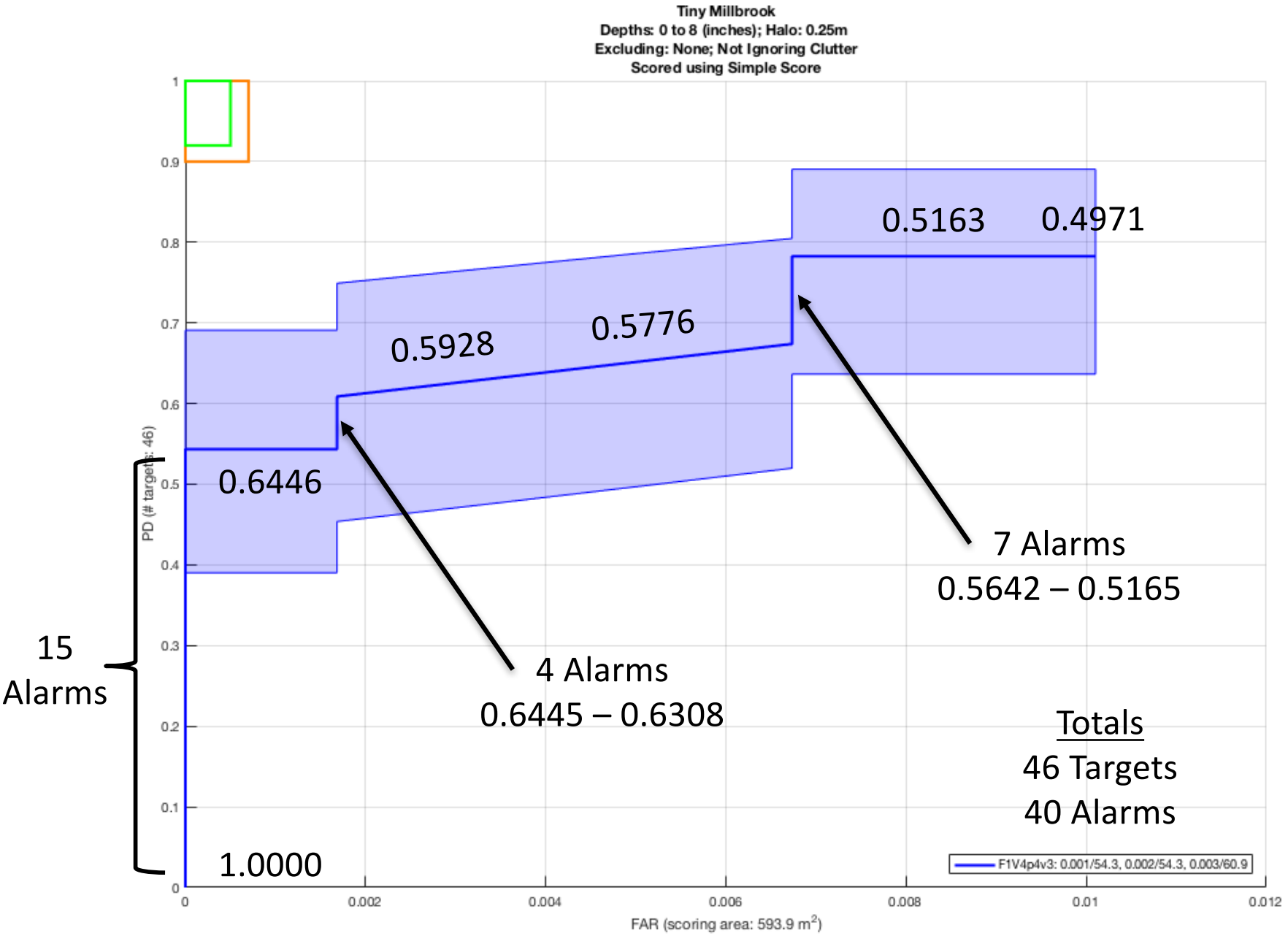
Algorithms examine data responses sampled by collection devices to classify alarmed locations as *hits* or *false* alarms.

Scoring uses the classification *confidence* an algorithm assigns to an alarm and the *location* of the alarm to evaluate performance.

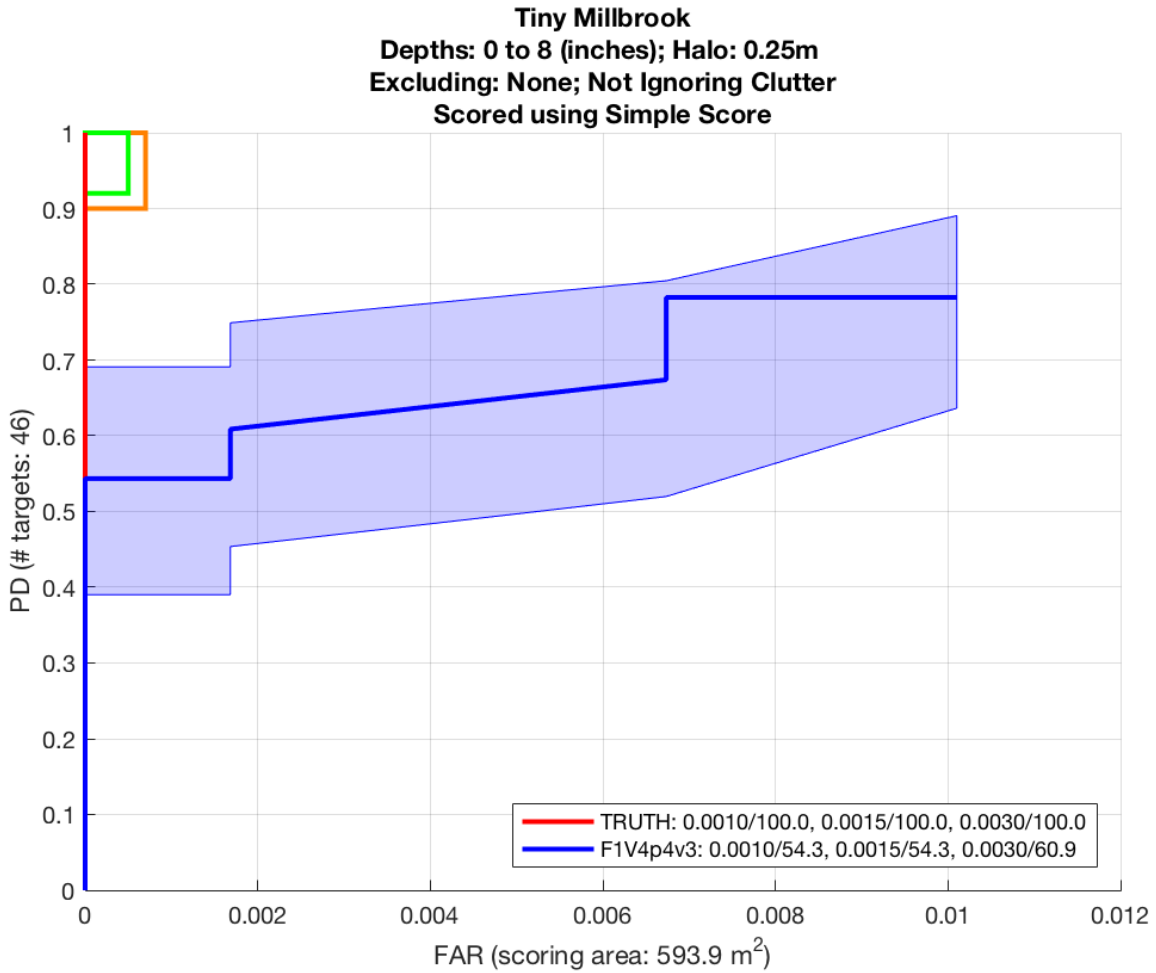
When the confidence is above a *threshold* at a desired *false alarm* rate, the *probability of detection* is assessed.

Receiver Operating Characteristic (ROC) Curve



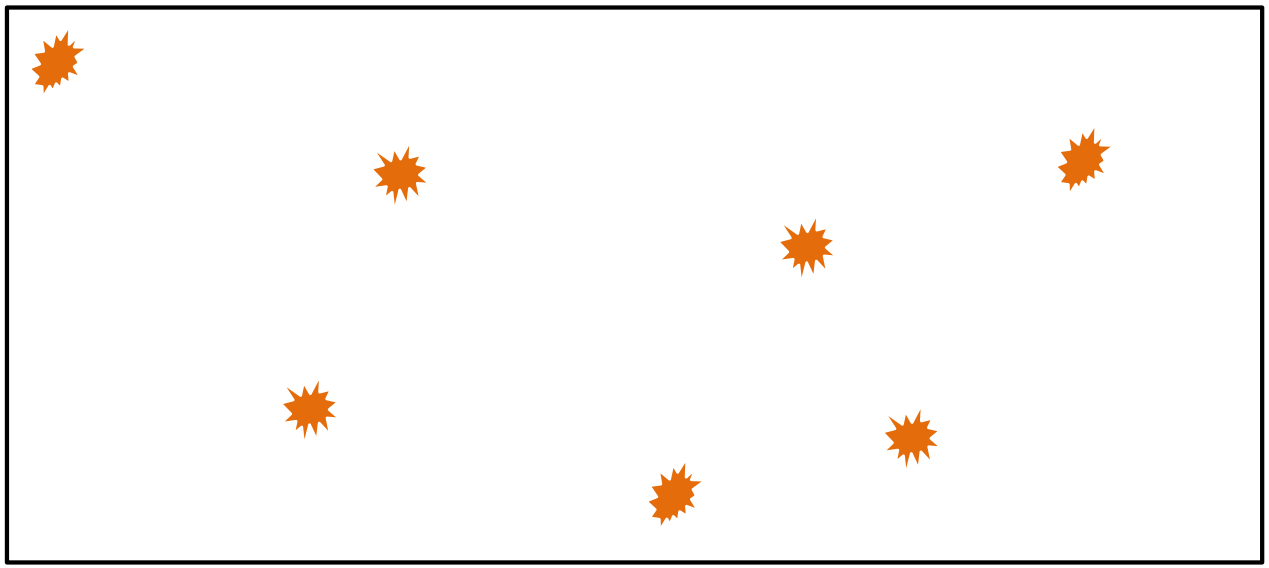

Tiny Millbrook
Depths: 0 to 8 (inches); Halo: 0.25m
Excluding: None; Not Ignoring Clutter
Scored using Simple Score
PD (# targets: 46)
FAR (scoring area: 593.9 m²)
0.5163
0.4971
0.5928
0.5776
0.6446
7 Alarms
0.5642 – 0.5165
15
Alarms
4 Alarms
0.6445 – 0.6308
Totals
46 Targets
40 Alarms
1.0000
F1V4p4v3: 0.001/54.3, 0.002/54.3, 0.003/60.9
Show Missed in Datatip

Receiver Operating Characteristic (ROC) Curve



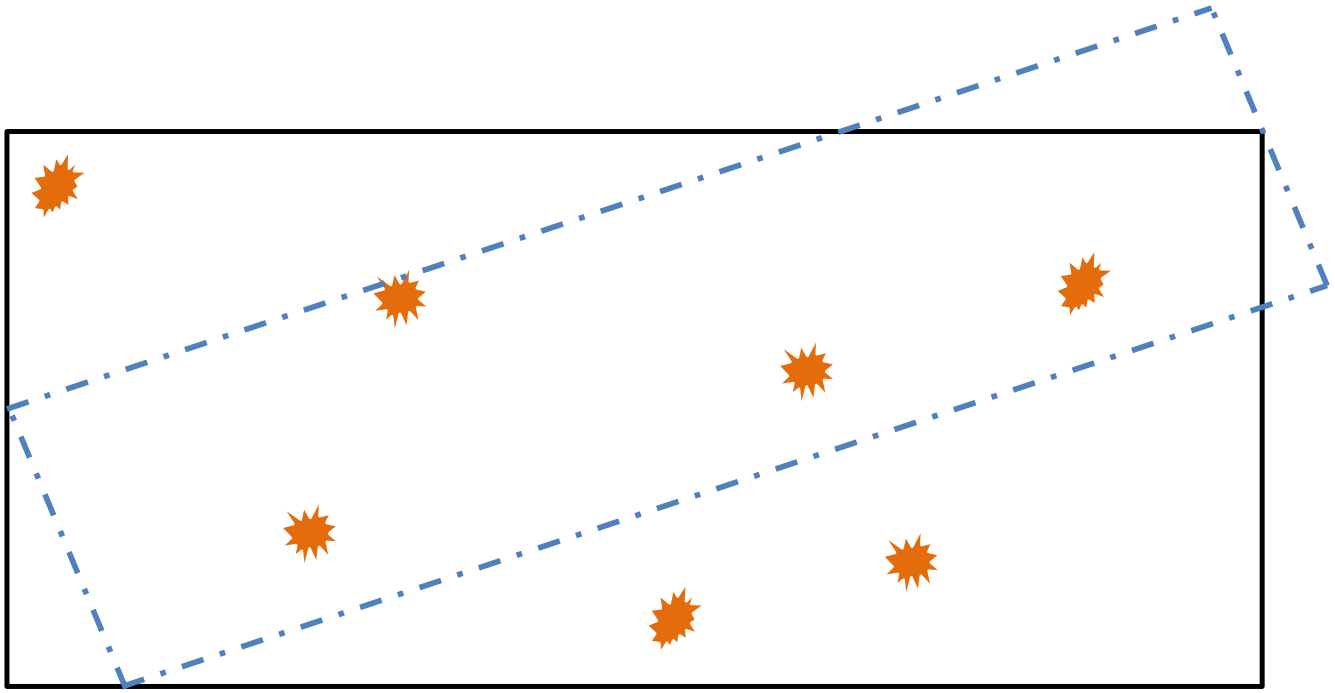
Truth Lane

Coordinates of truth lane and emplaced objects



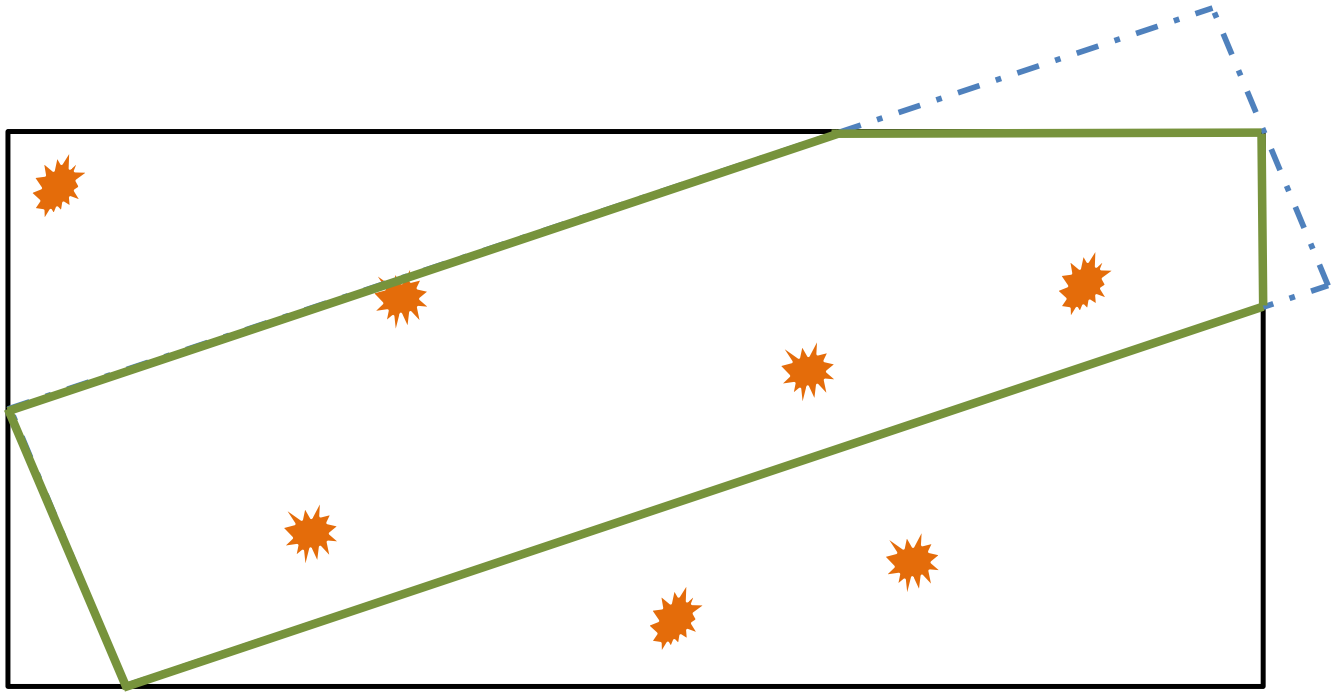
Scoring Area

Intersection between a swept path and truth lane



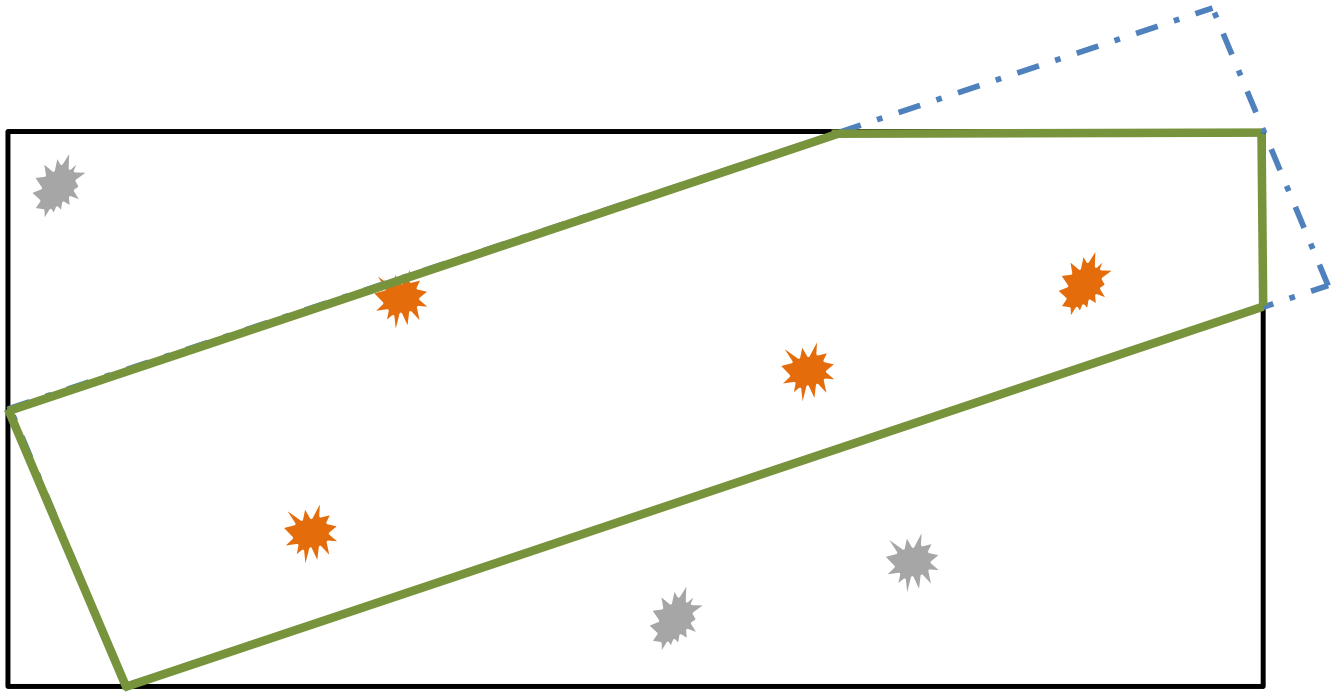
Scoring Region

Intersection between a swept path and truth lane



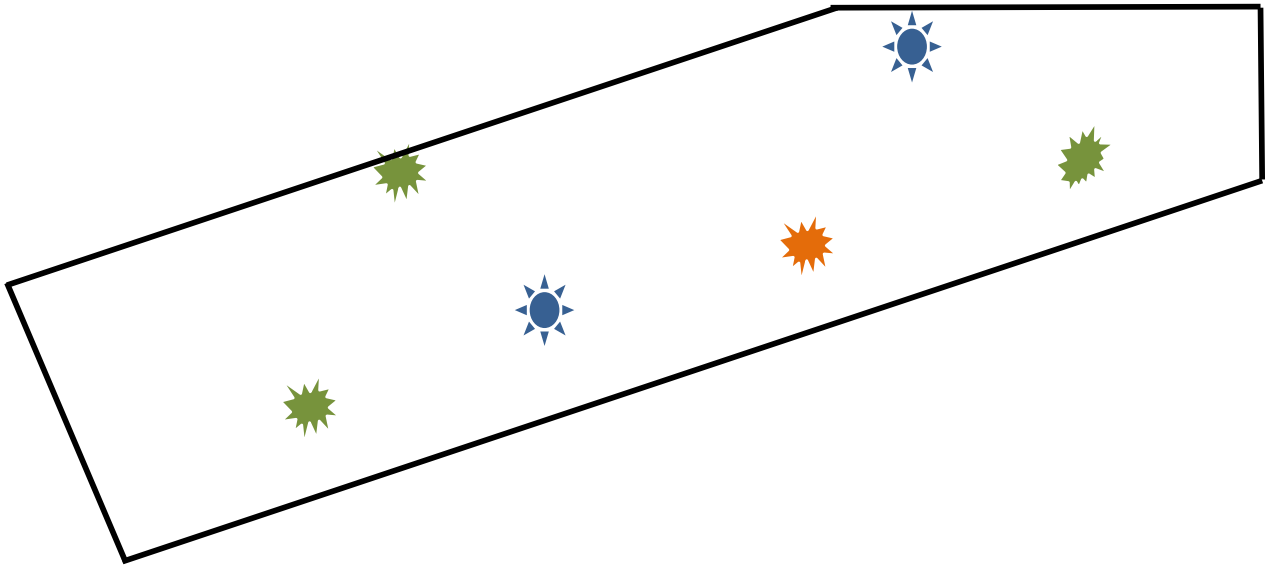
Scoring Region

Encountered and un-encountered objects



Scoring Region

false alarms, hits, and missed targets



Husky Mounted Detection System

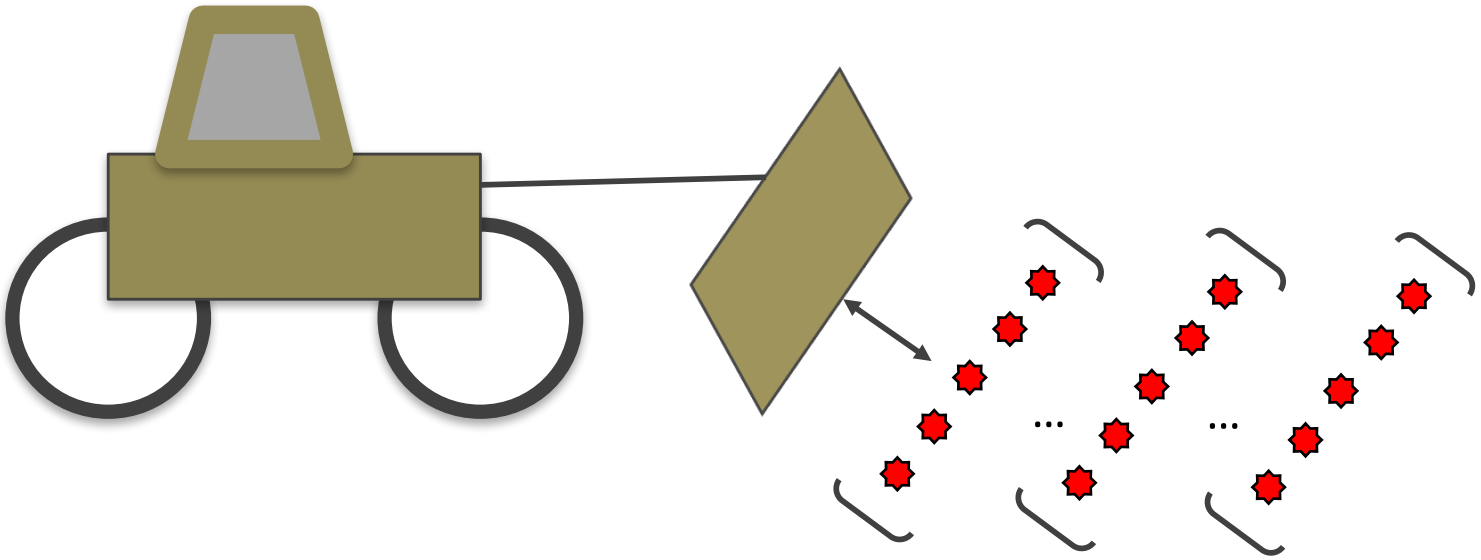
NO!

Yes!

Vehicular Data

〔 〕 Lane Boundaries

Sampled Data



Vehicular Data

Initial Polygon

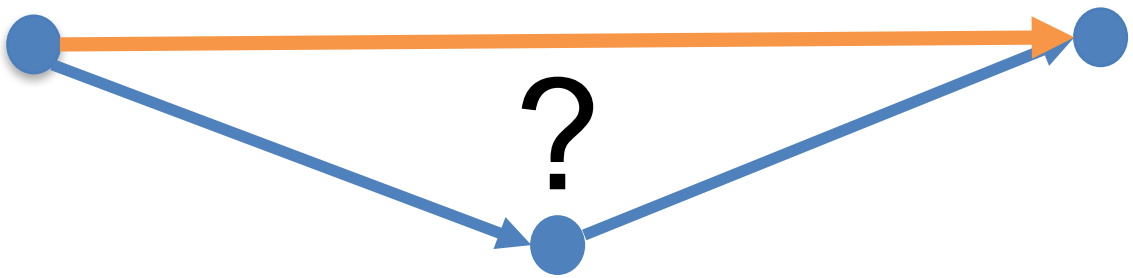
- Left and right lane boundaries

Point reduction

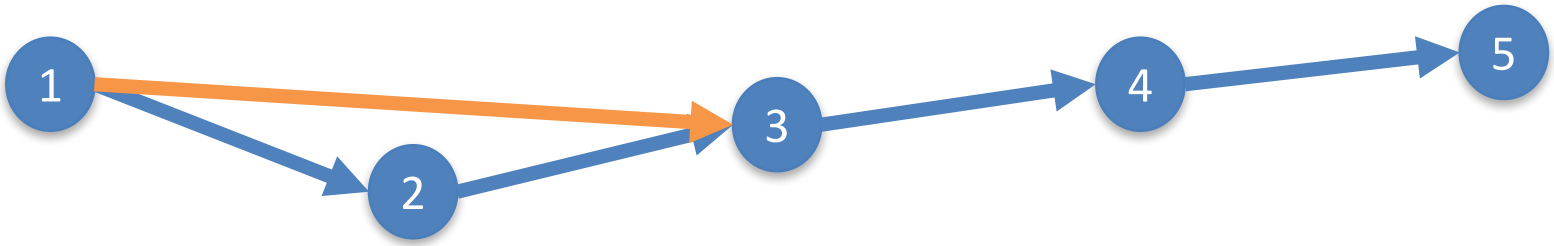
- Polygon decimation
- Alpha shape

Polygon Decimation

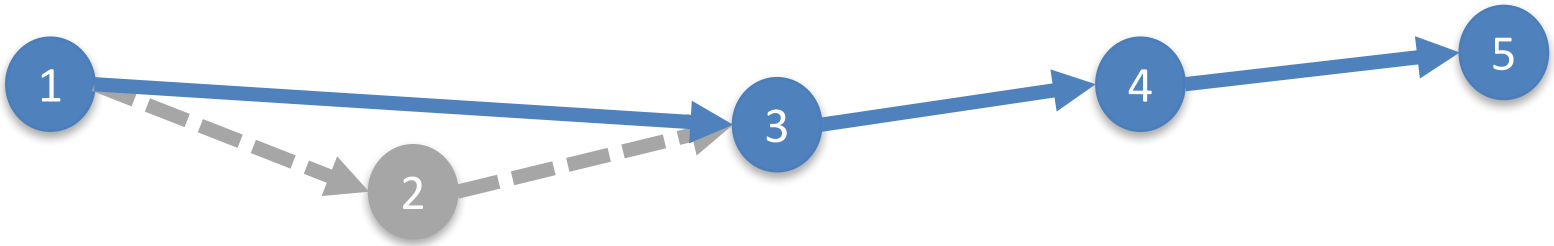
Approximate the same polygon by removing intermediate points, when change in area is below a defined threshold.



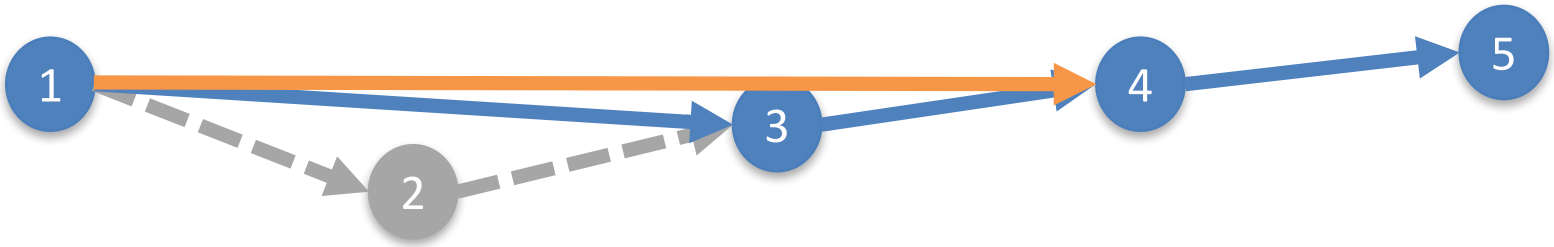
Polygon Decimation



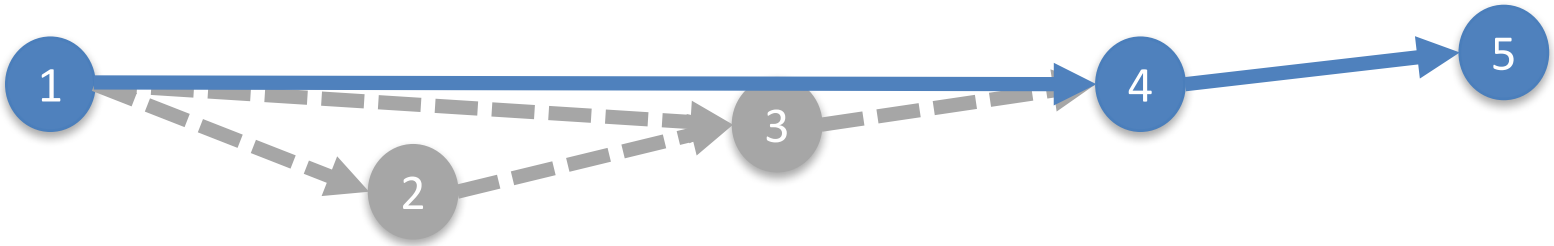
Polygon Decimation



Polygon Decimation

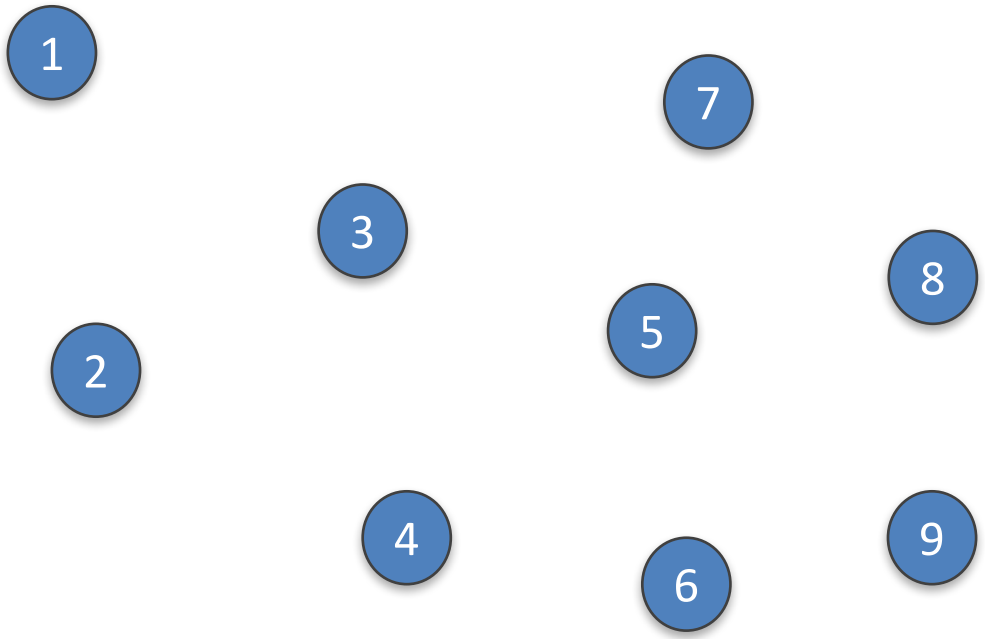


Polygon Decimation



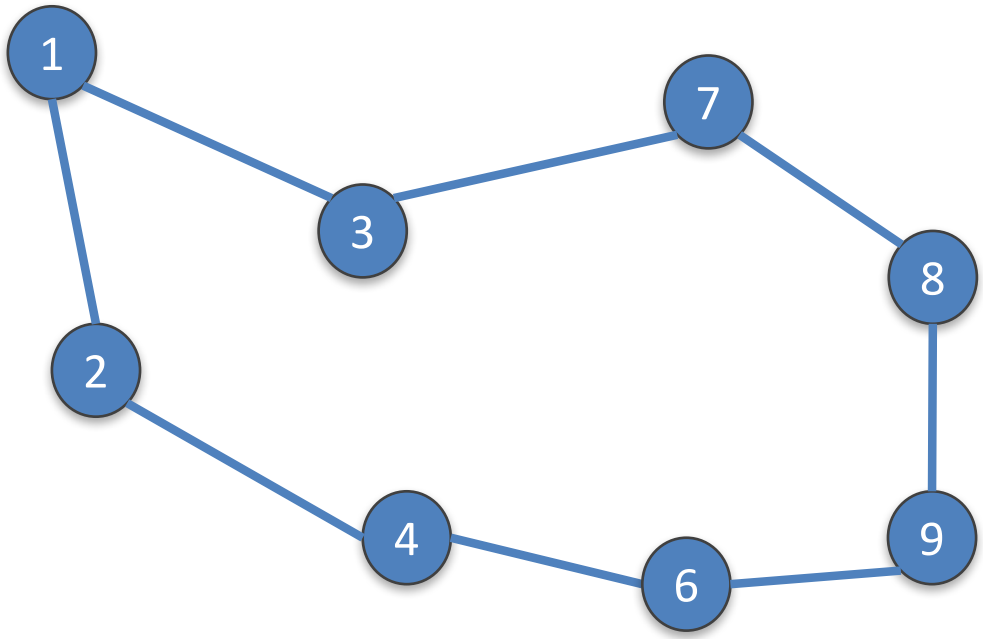
Alpha Shape

Fits a polygon around a set of points



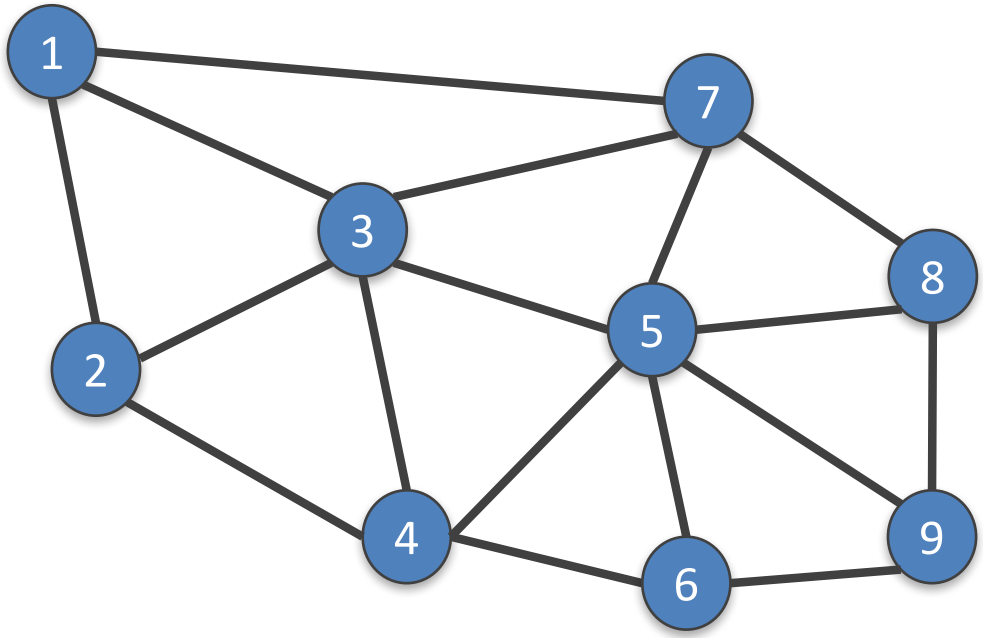
Alpha Shape

Desired polygon



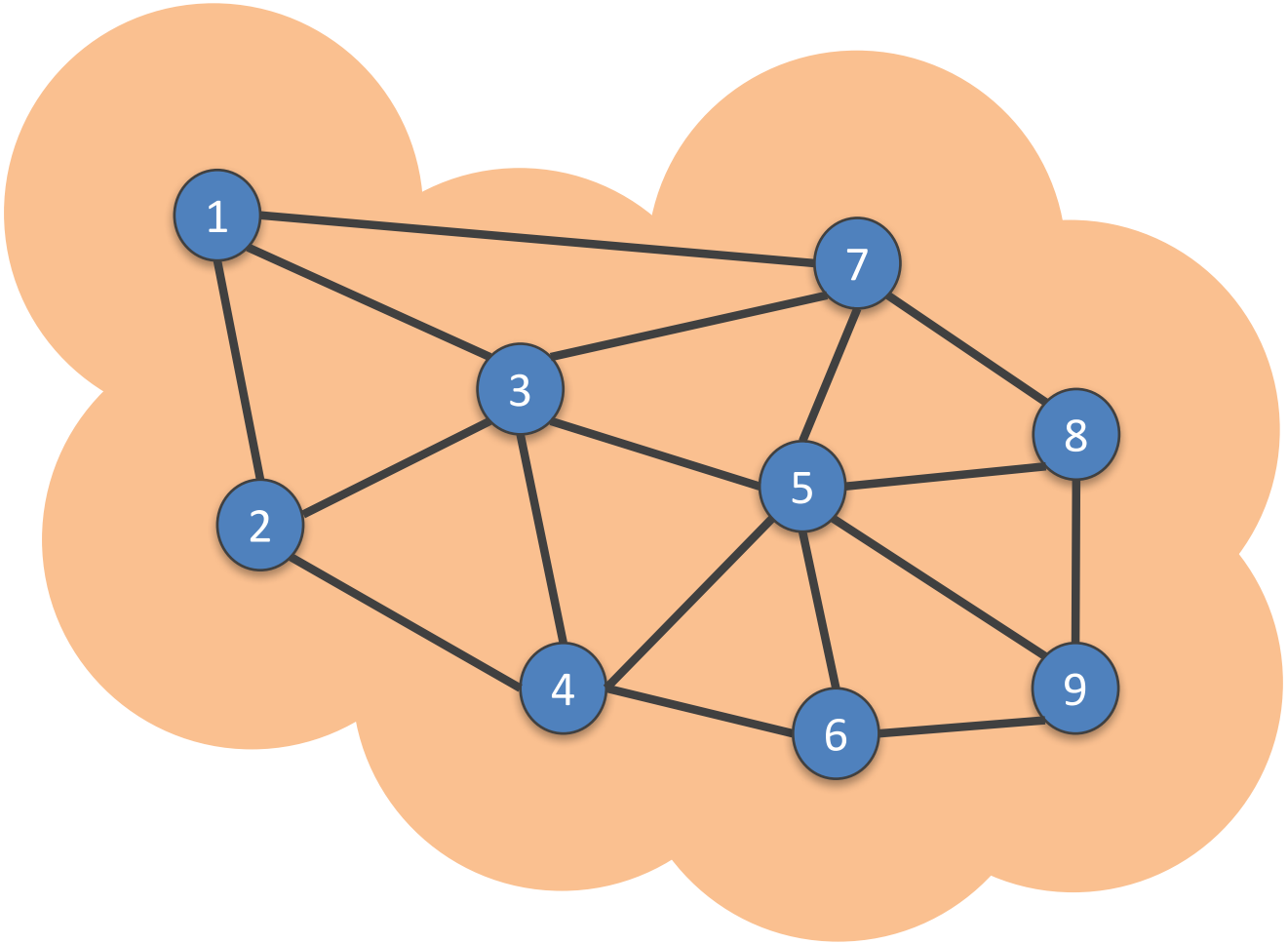
Alpha Shape

Delauney Triangulation



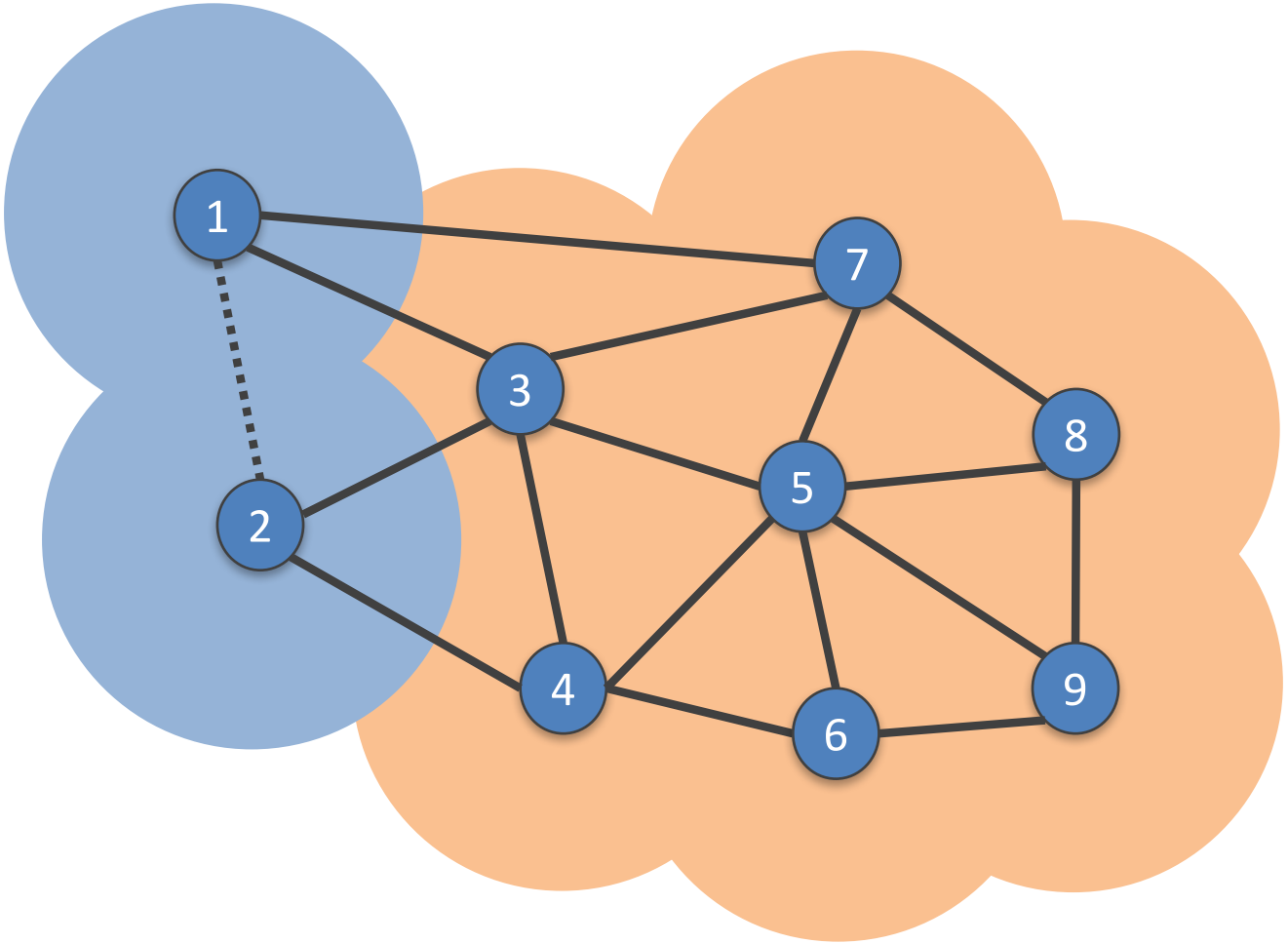
Alpha Shape

Set disk with radius alpha around each point



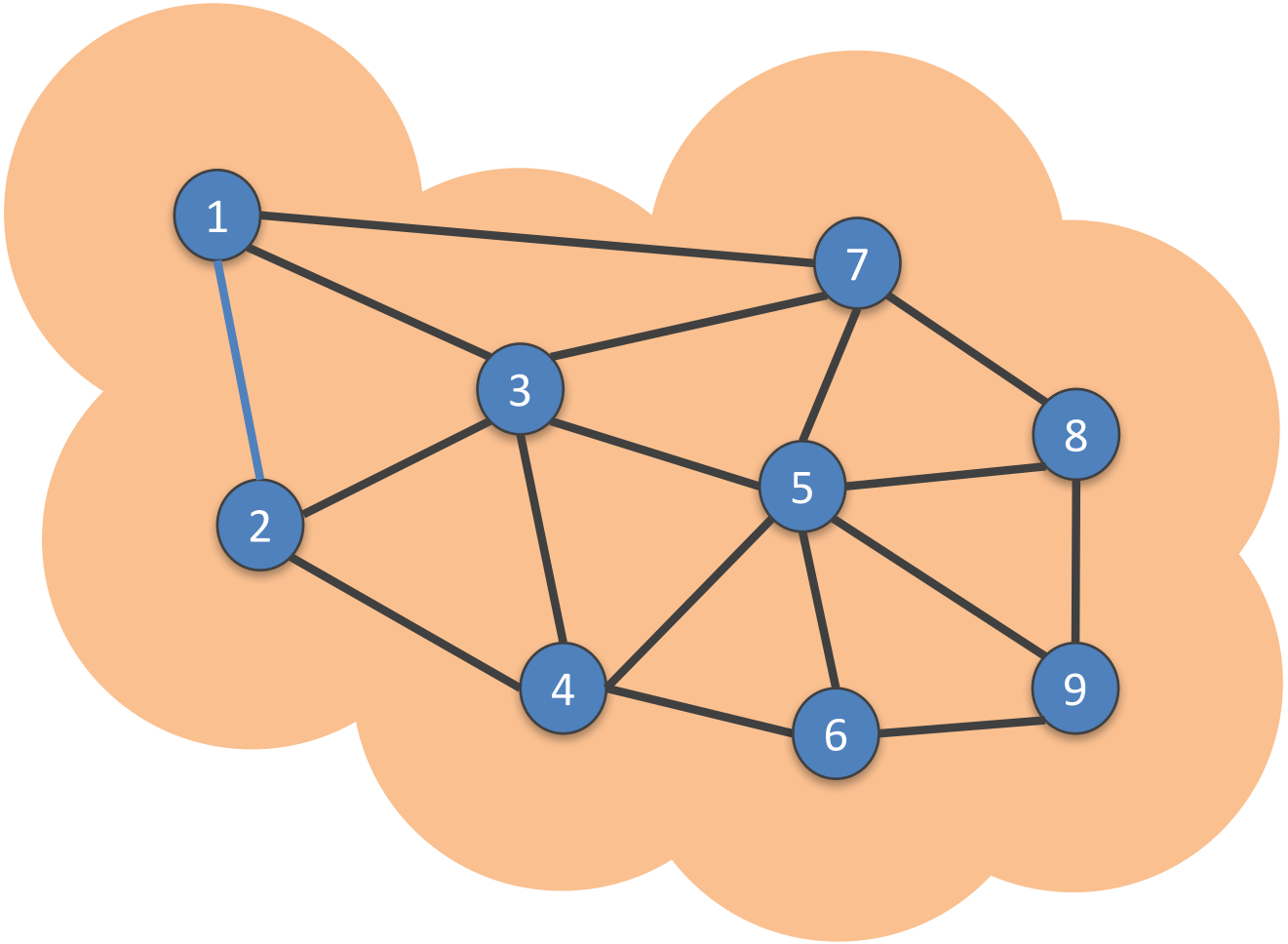
Alpha Shape

Check for disk intersection

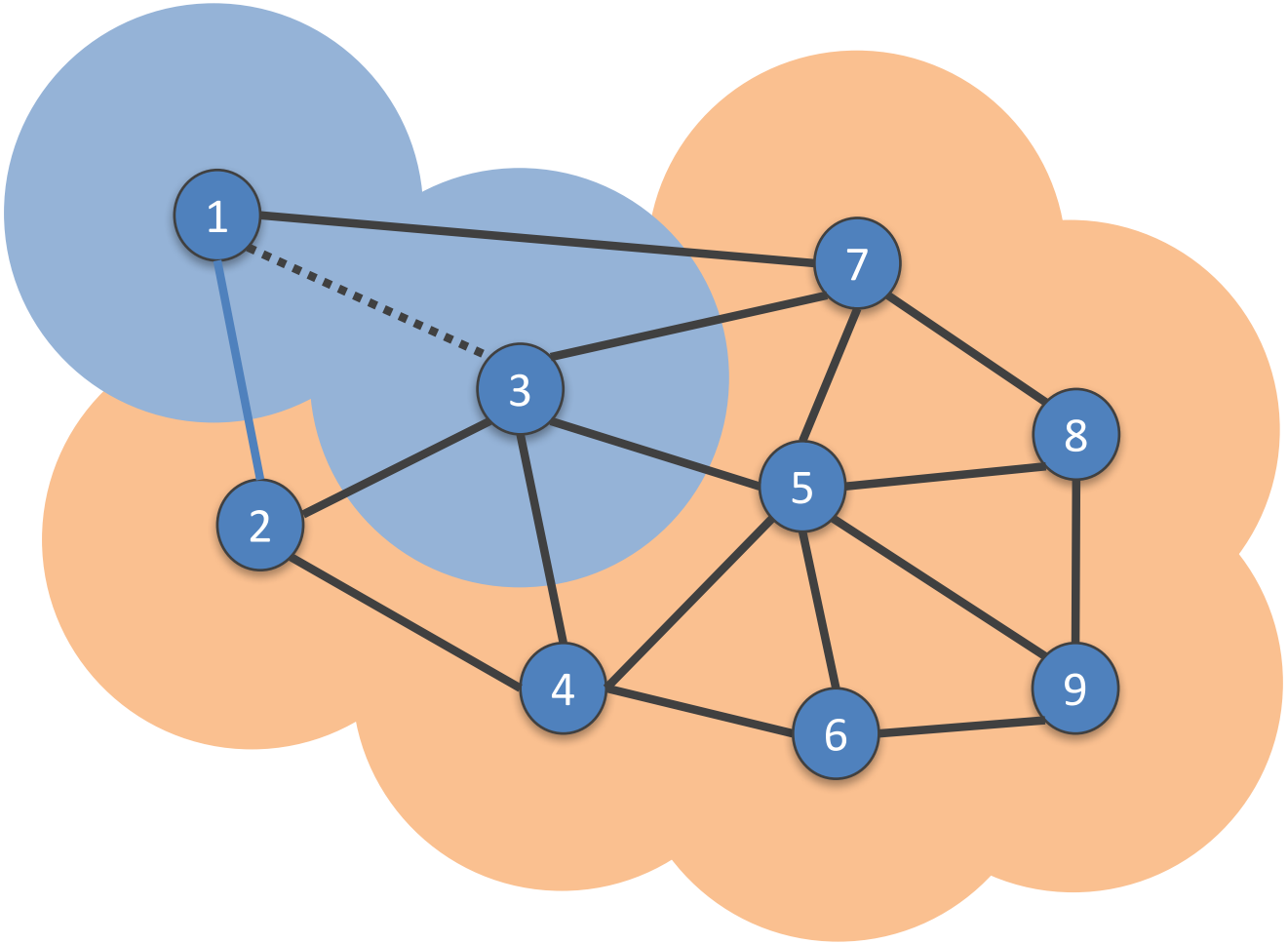


Alpha Shape

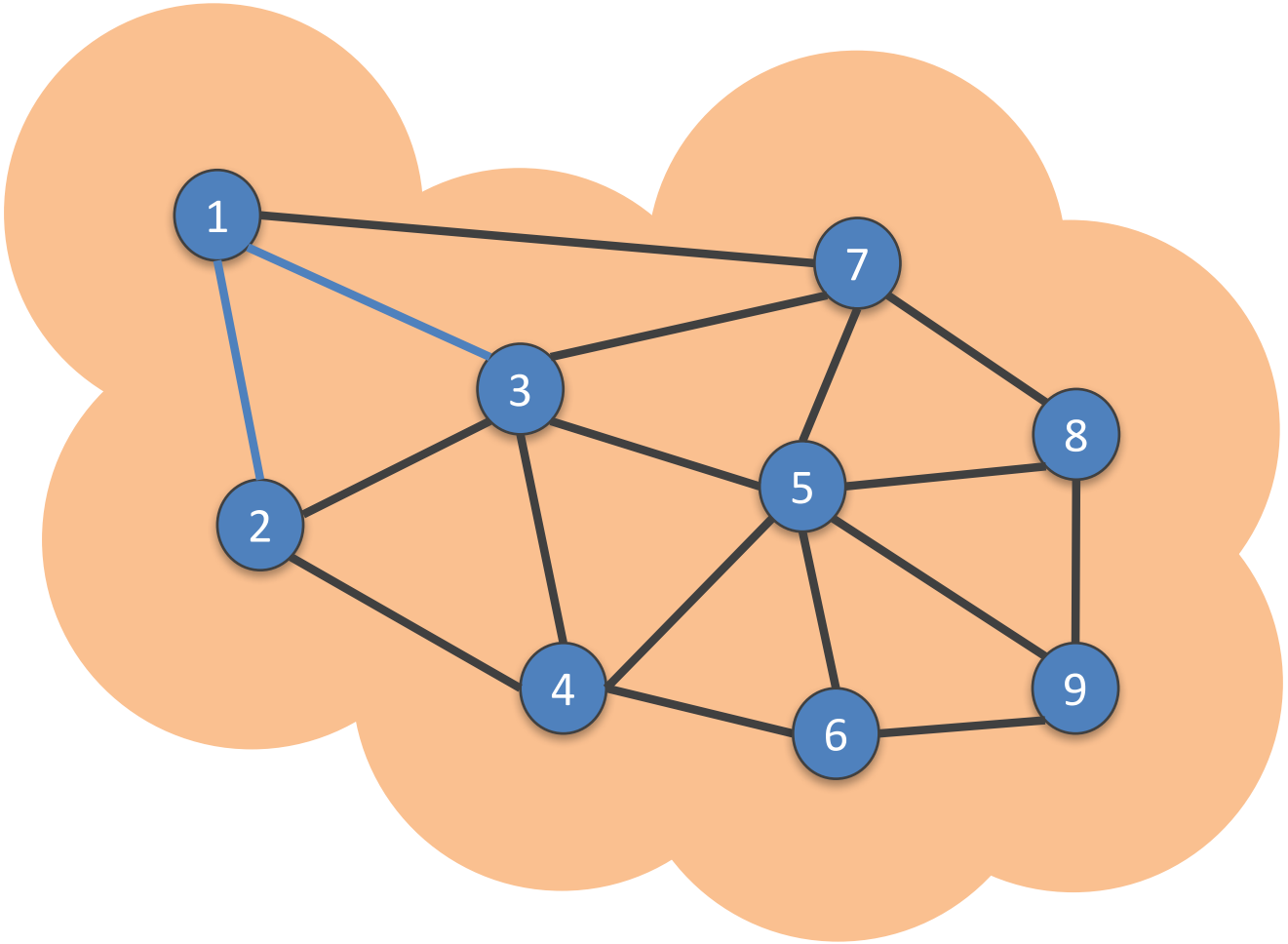
Keep intersected line segment



Alpha Shape

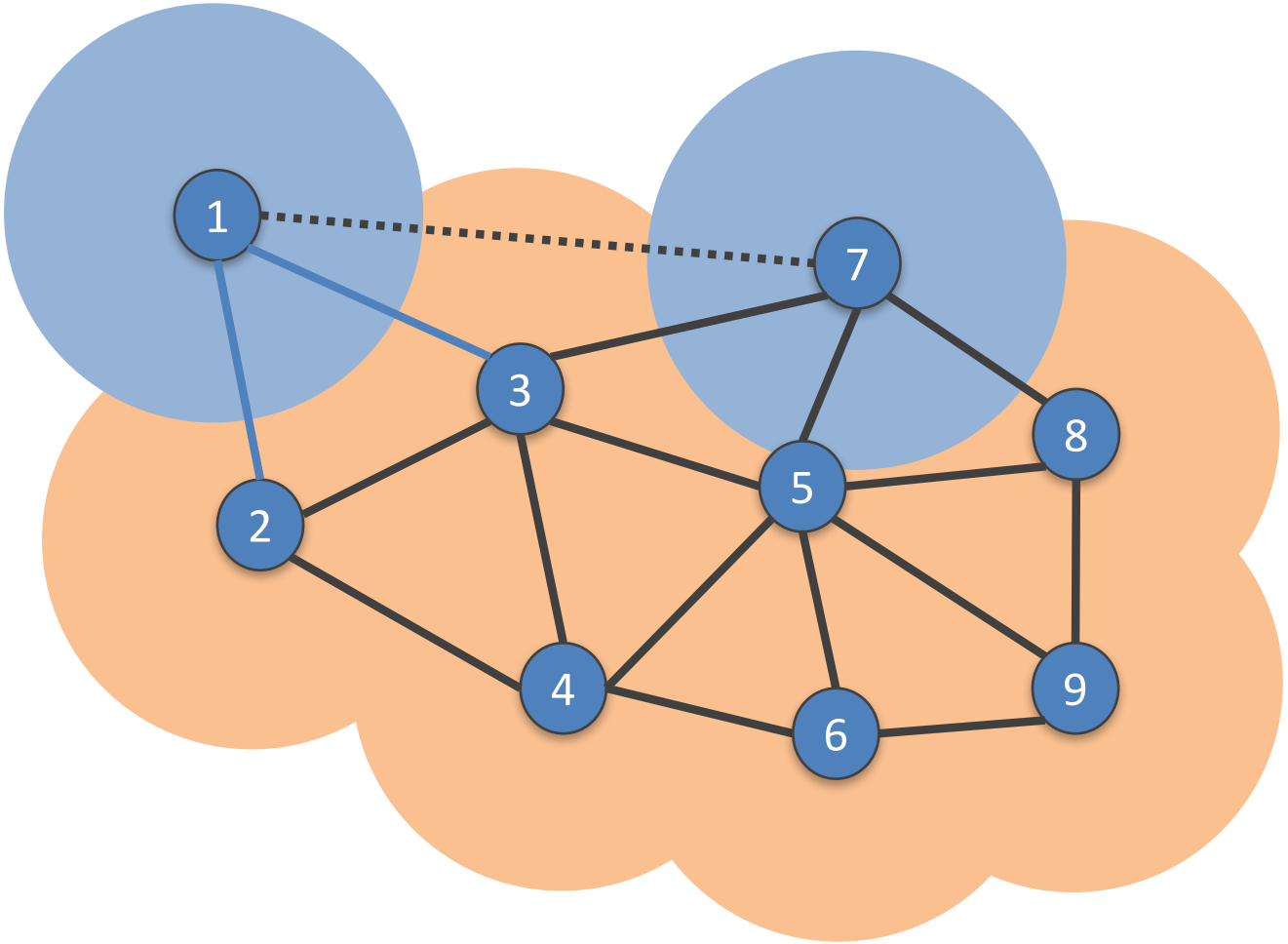


Alpha Shape



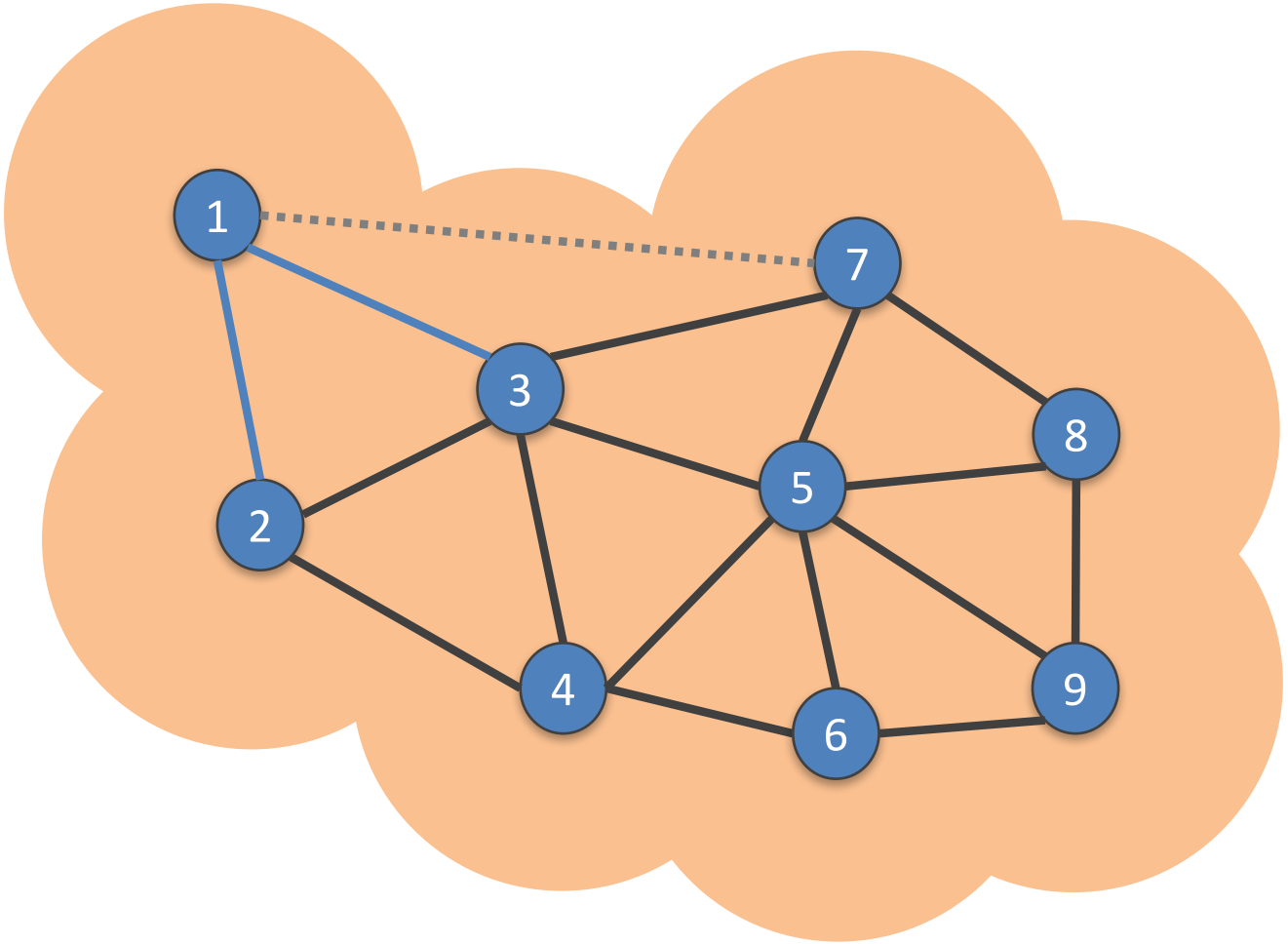
Alpha Shape

No intersection



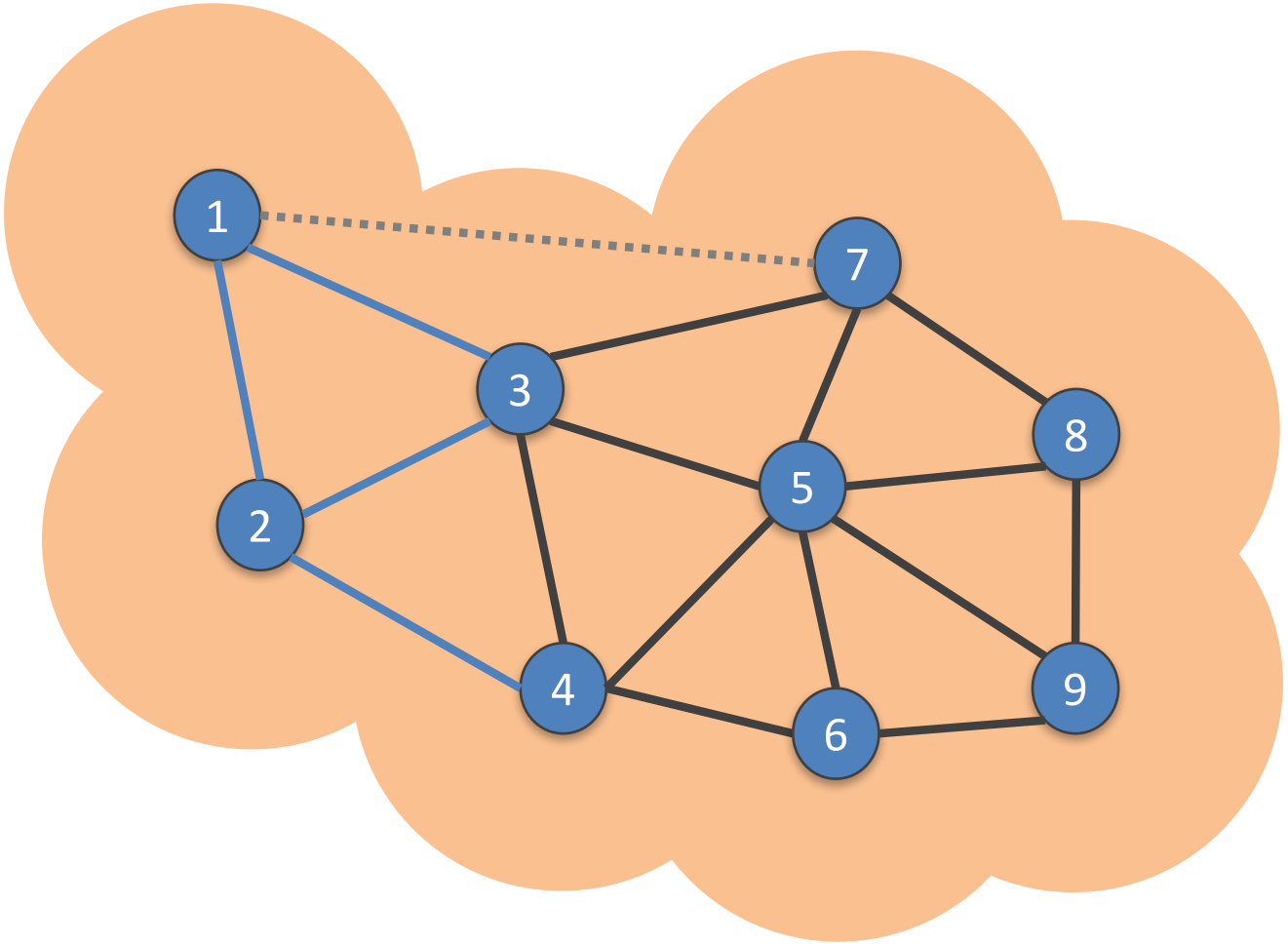
Alpha Shape

Discard non-intersected segment



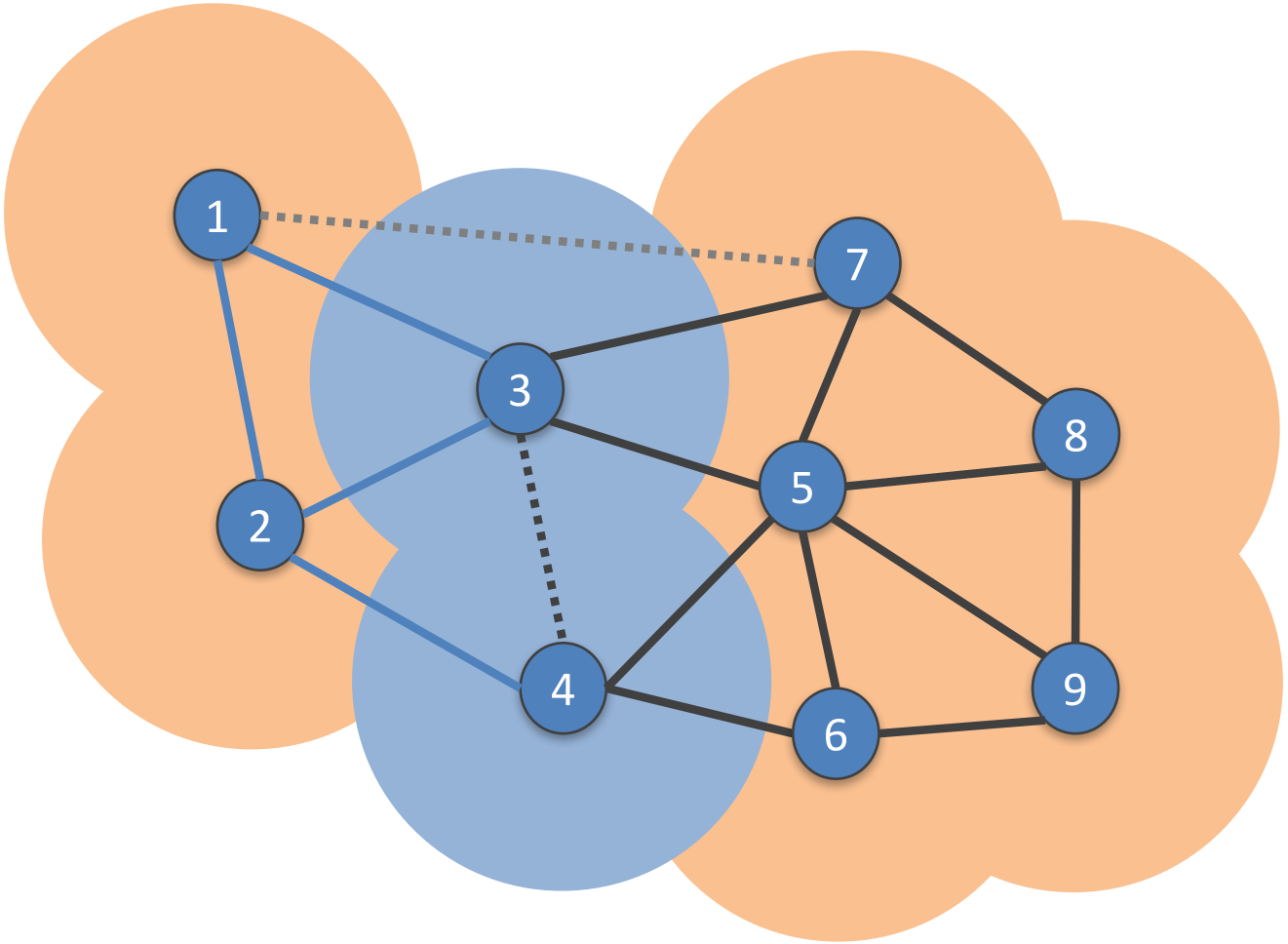
Alpha Shape

Skip ahead to Point #3 linked to Point #4



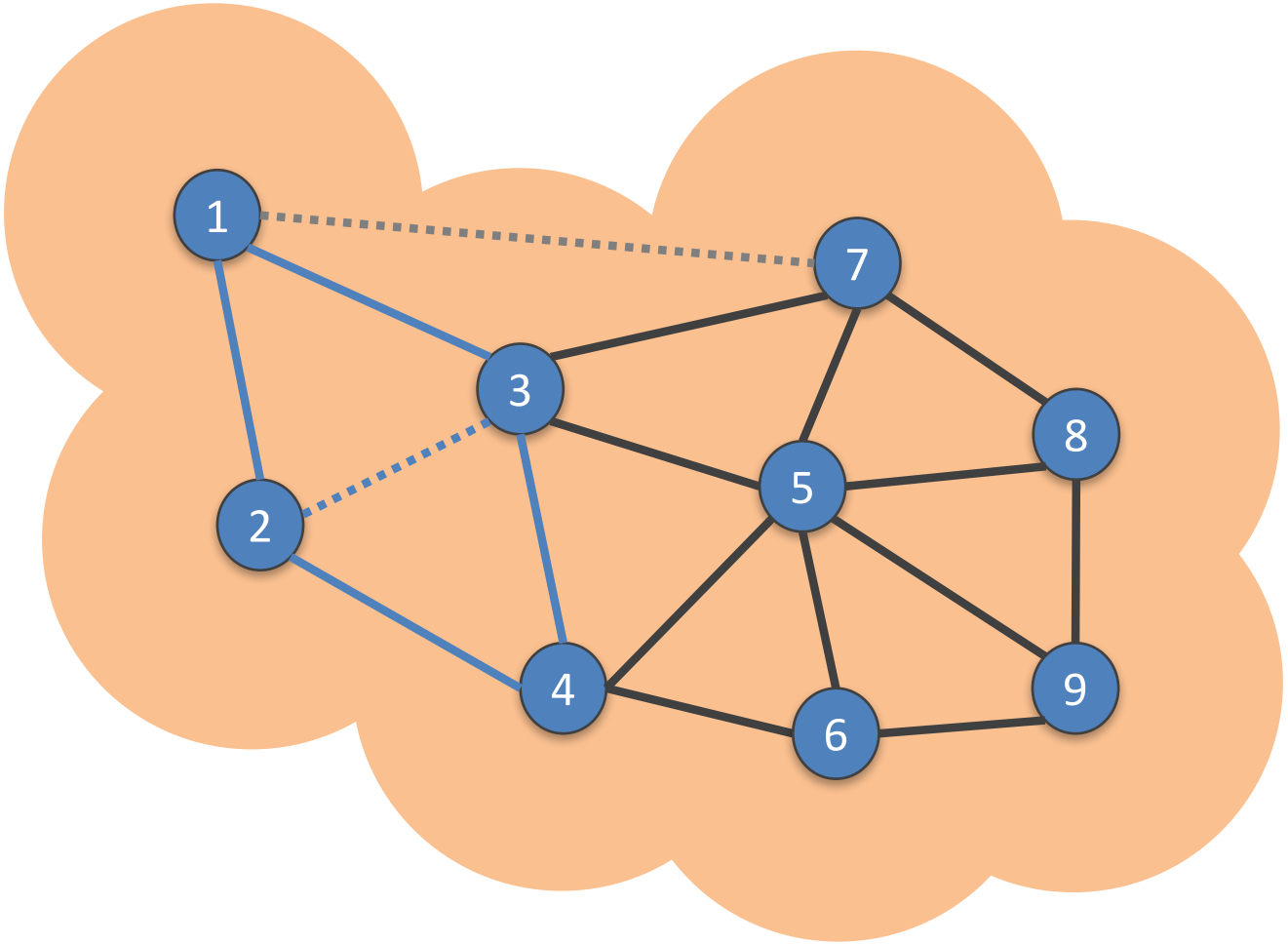
Alpha Shape

Keeping this line segment ...



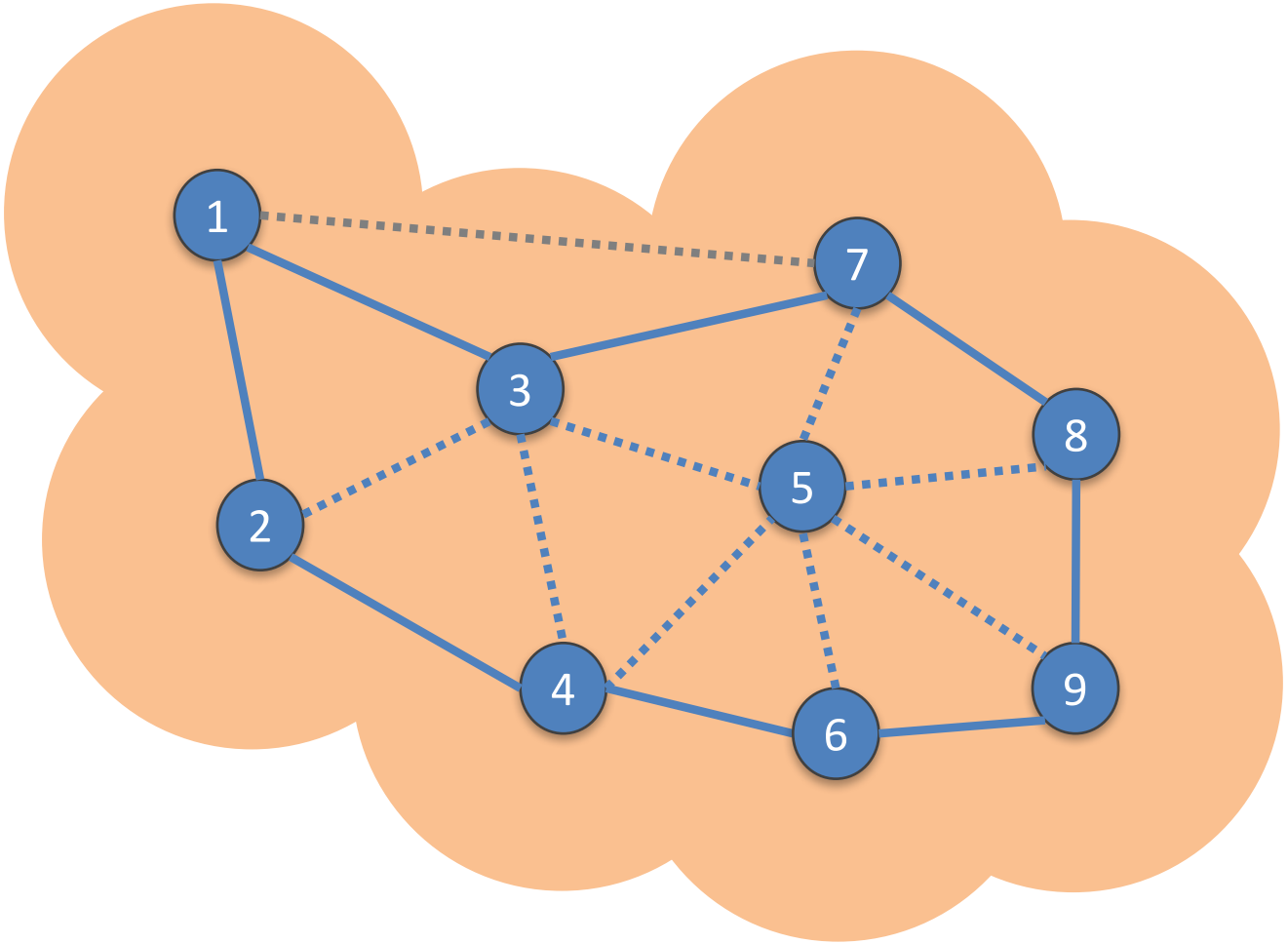
Alpha Shape

… creates an internal link to discard



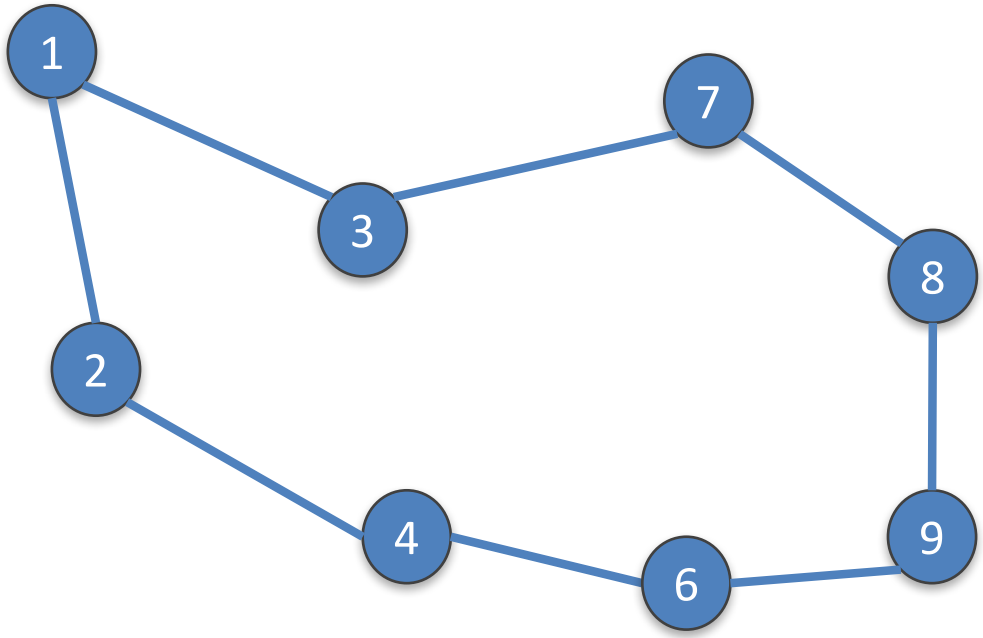
Alpha Shape

All external and internal links

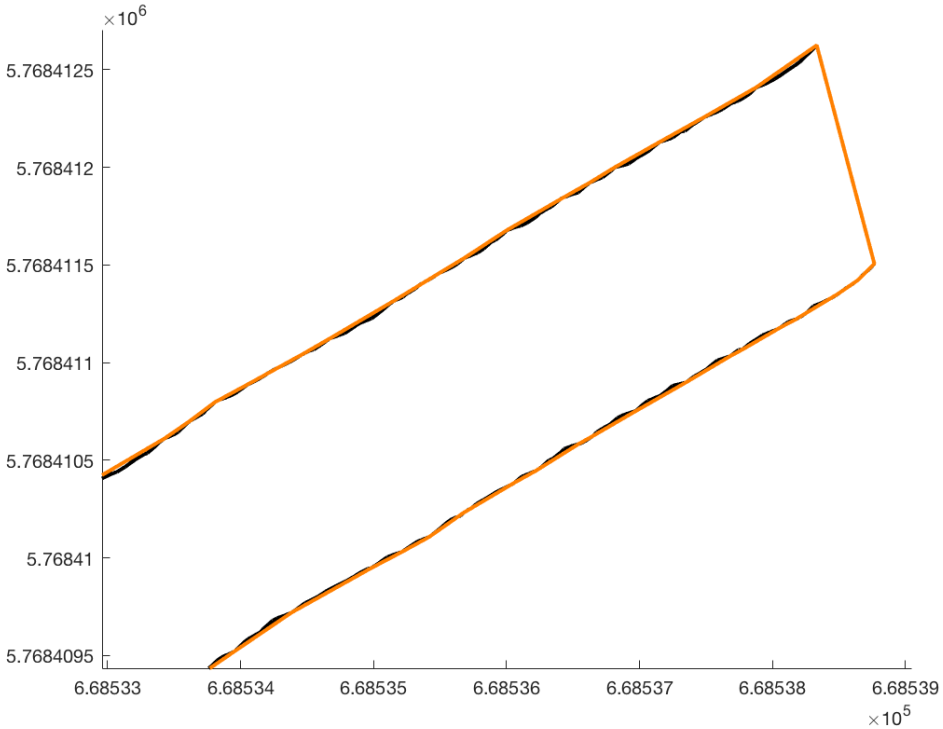


Alpha Shape

Polygon Result

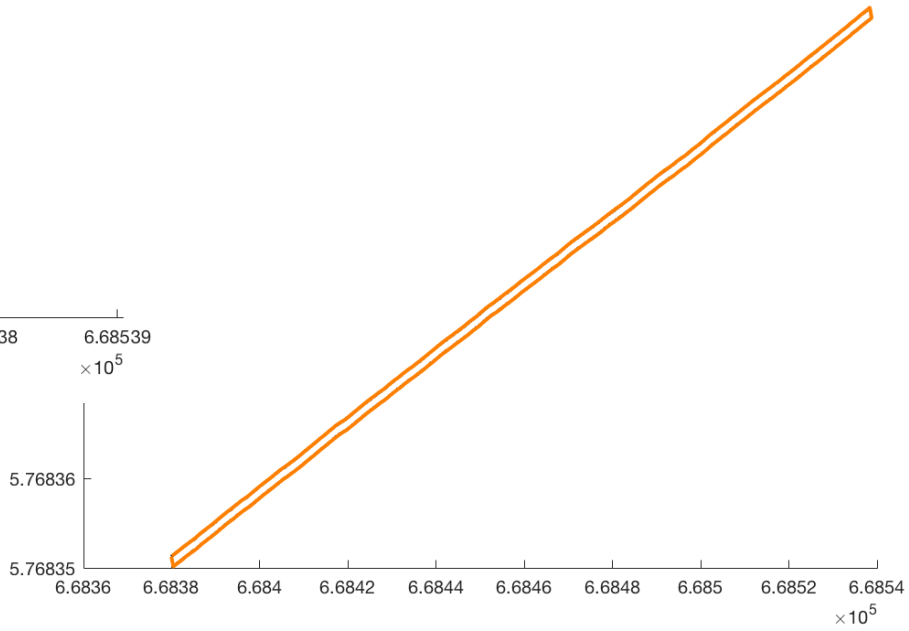


Vehicular Example



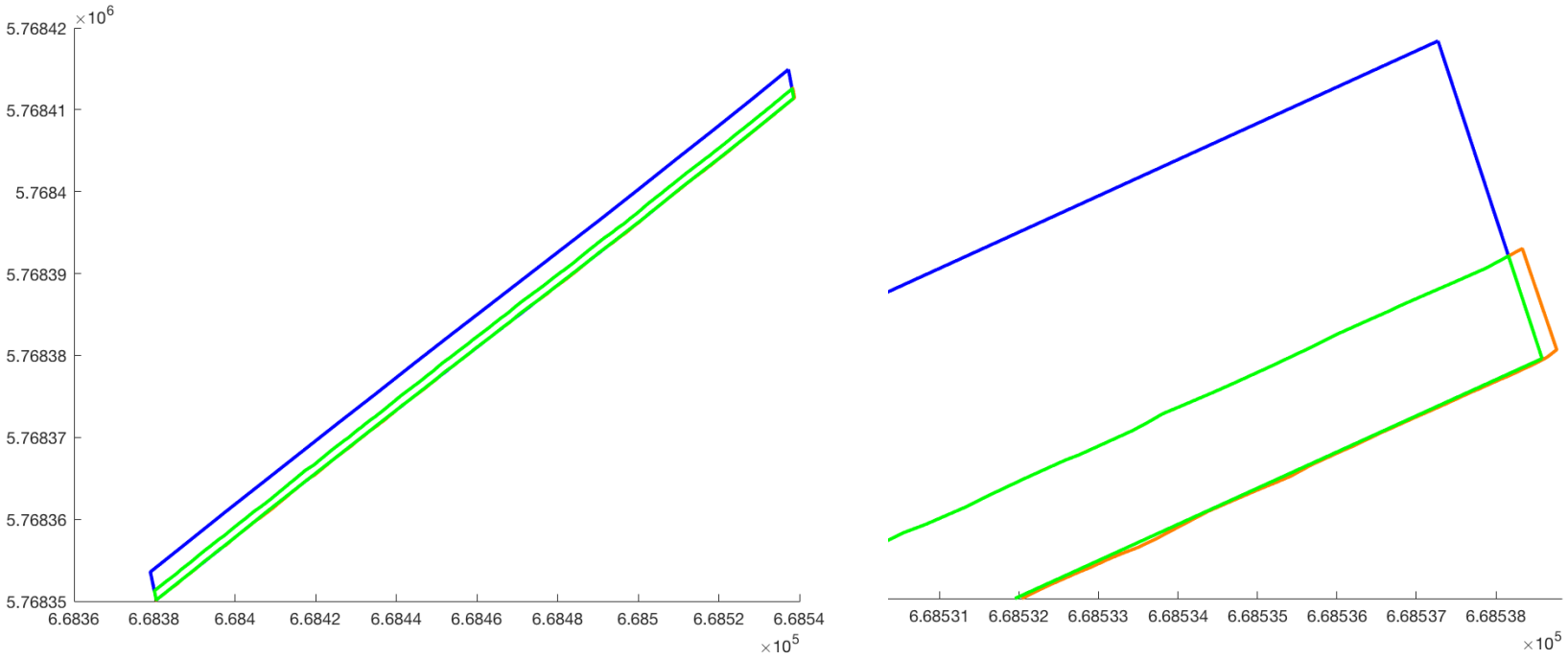
Alpha Shape

Swept Lane



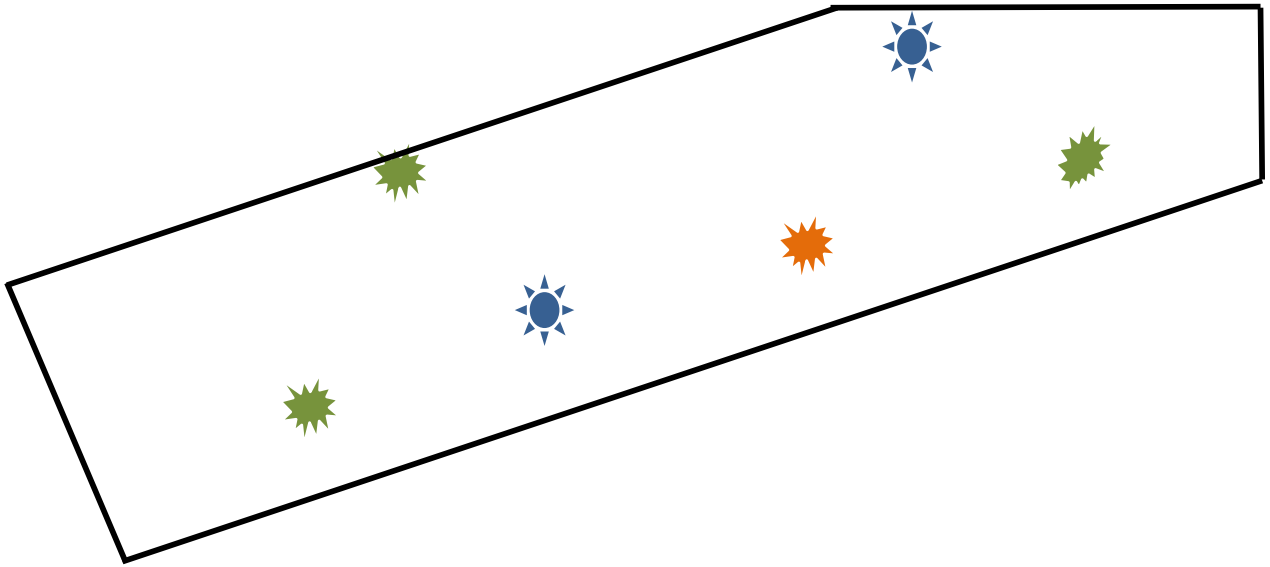
Vehicular Example

Alpha / Intersected / Truth Lanes



Scoring Region

false alarms, hits, and missed targets



Point Reduction Statistics

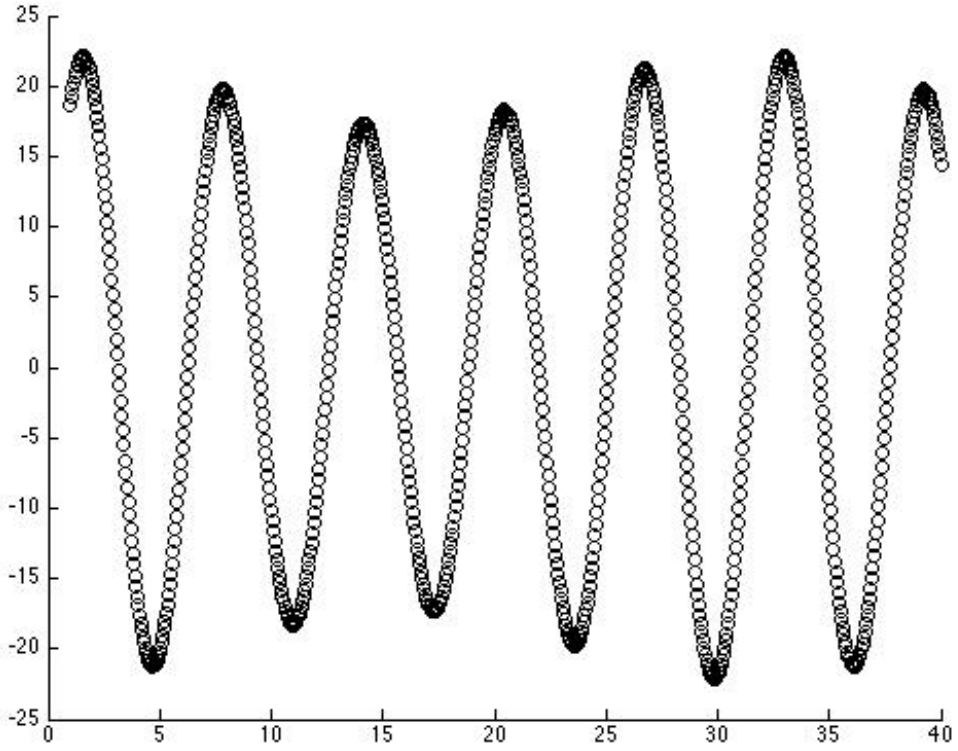
Lane	Data Points	Area m^2
Original	6,727	203.83
Decimated	1,880	203.83
Alpha Shape	919	206.28

86.34% Point Reduction

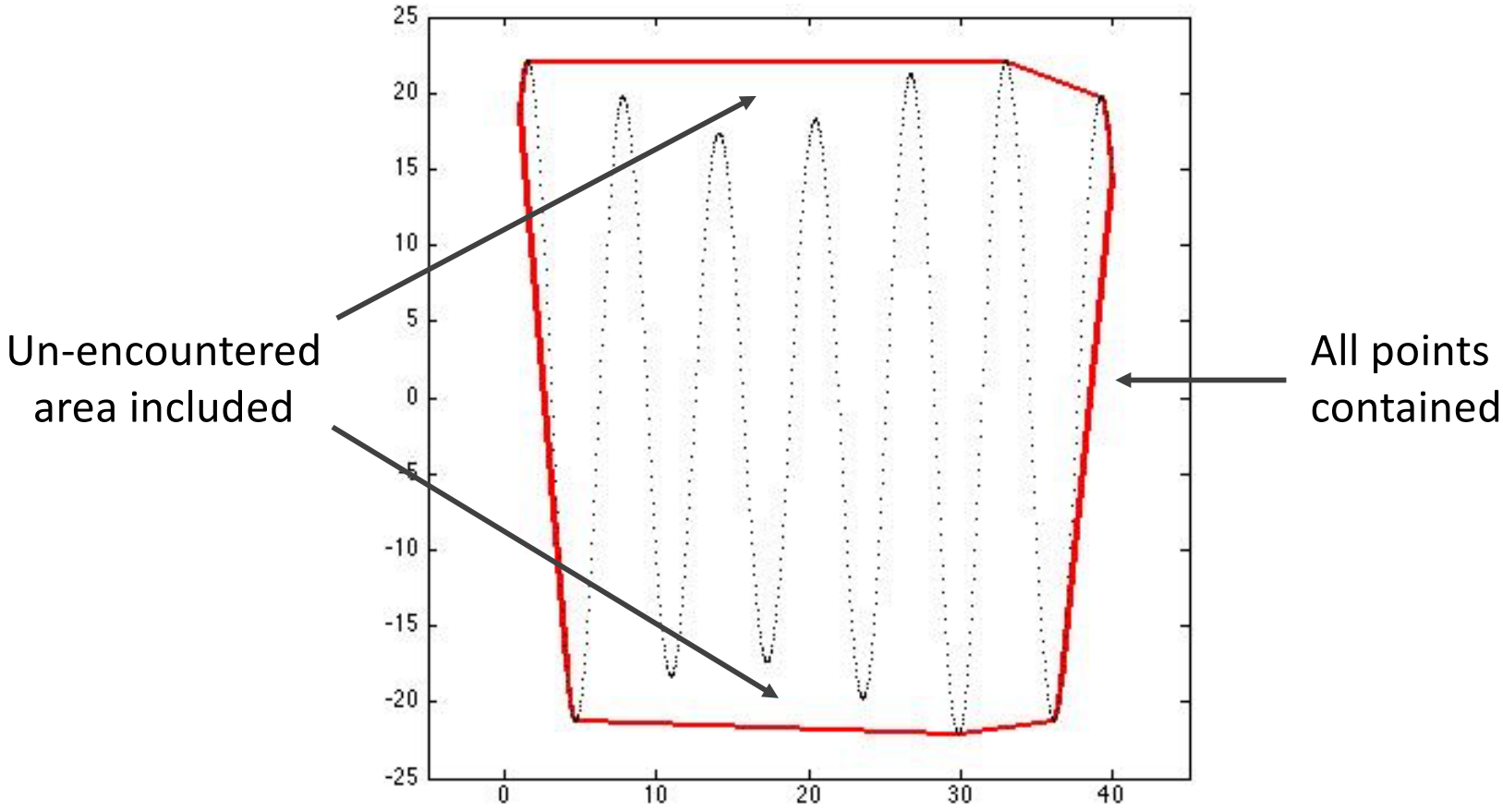
101.2% Same Area

Yes!

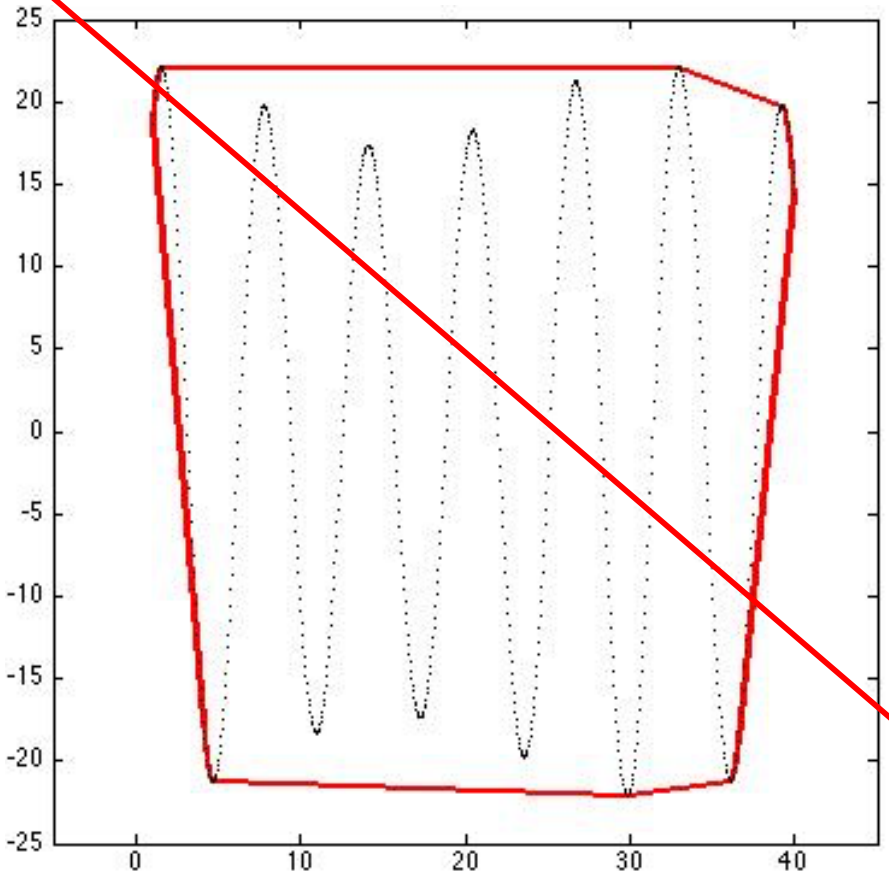
Hand-held Data



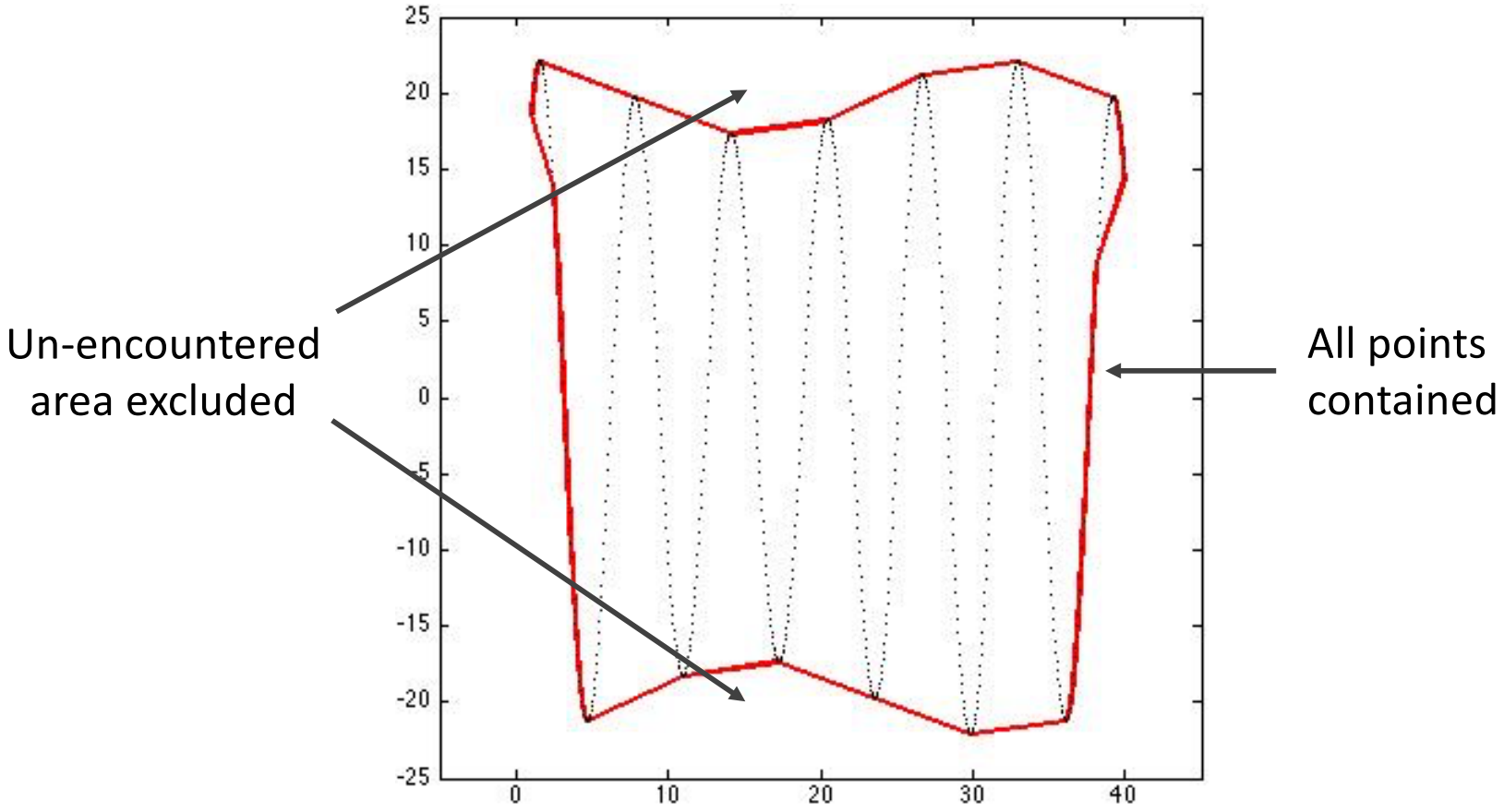
Forming a Polygon: Convex Hull



Forming a Polygon: Convex Hull

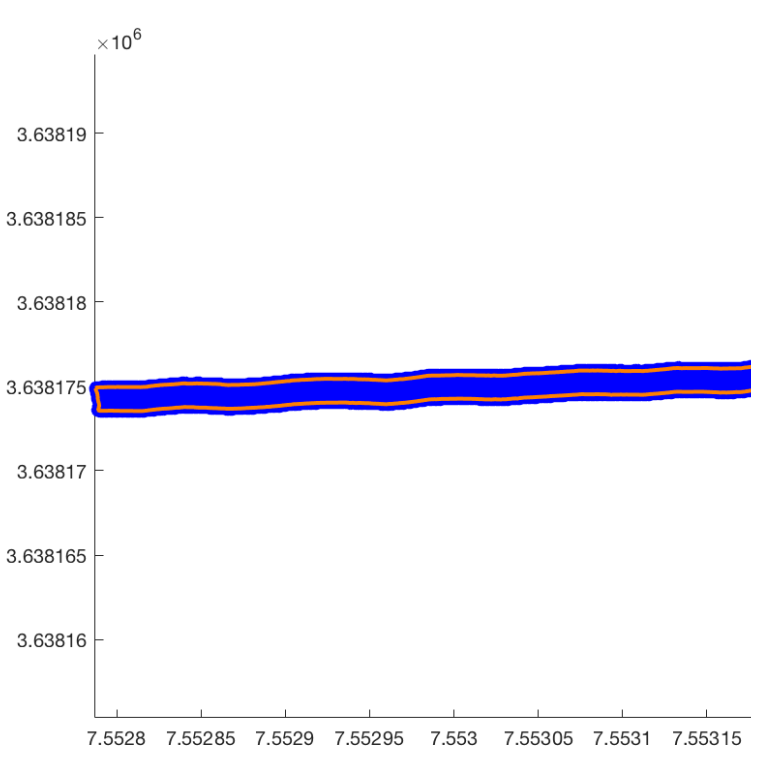


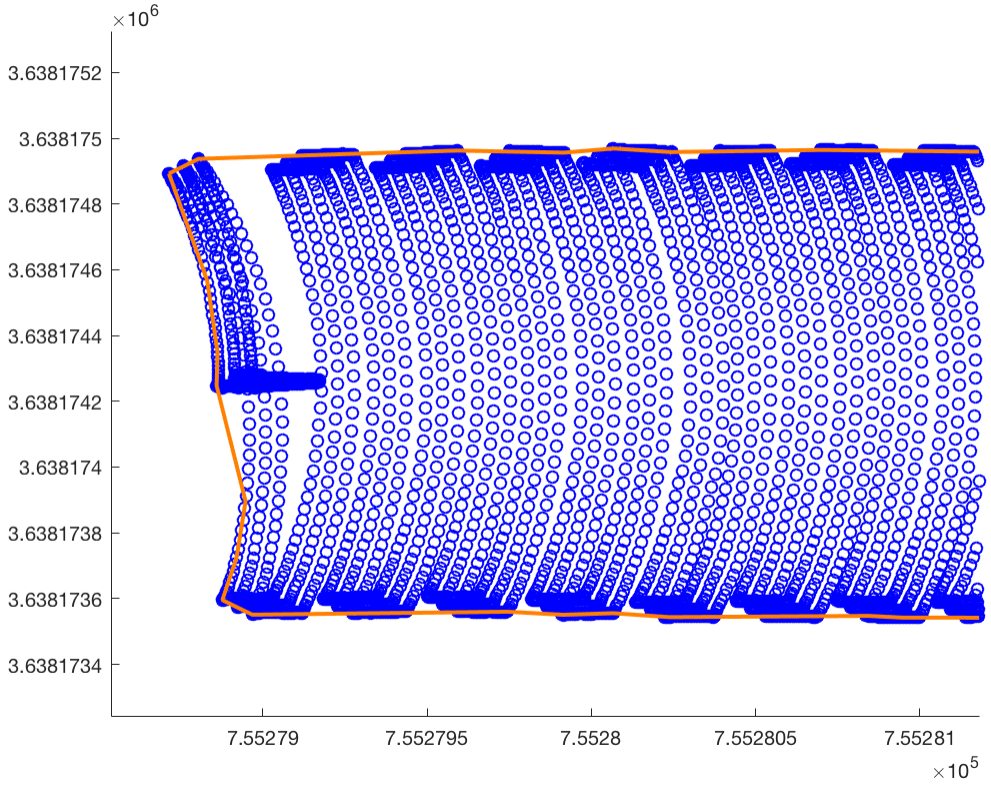
Forming a Polygon: Alpha Shape



Hand-held Example

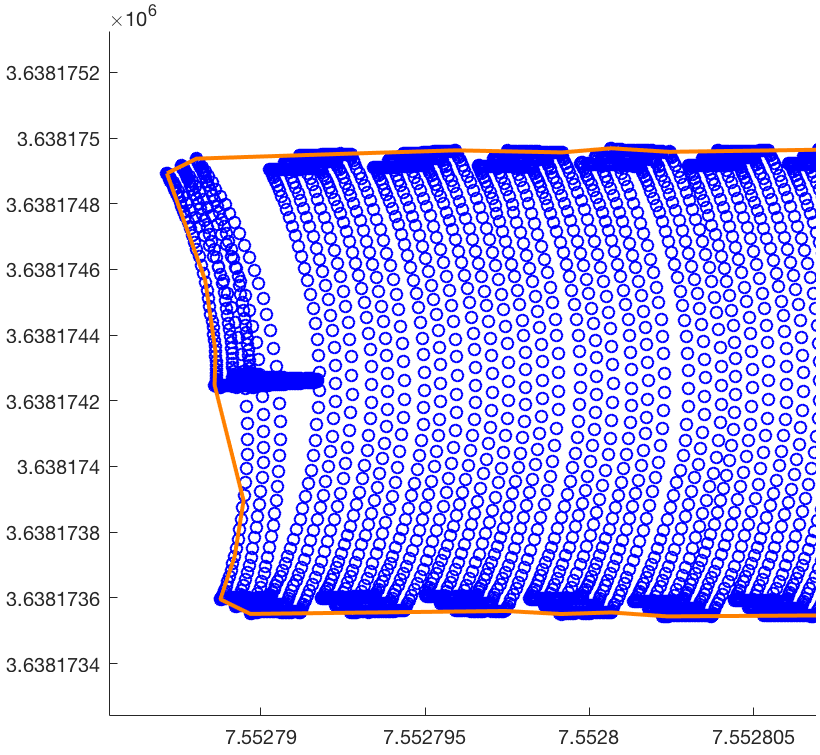
Alpha Shape / Swept Points

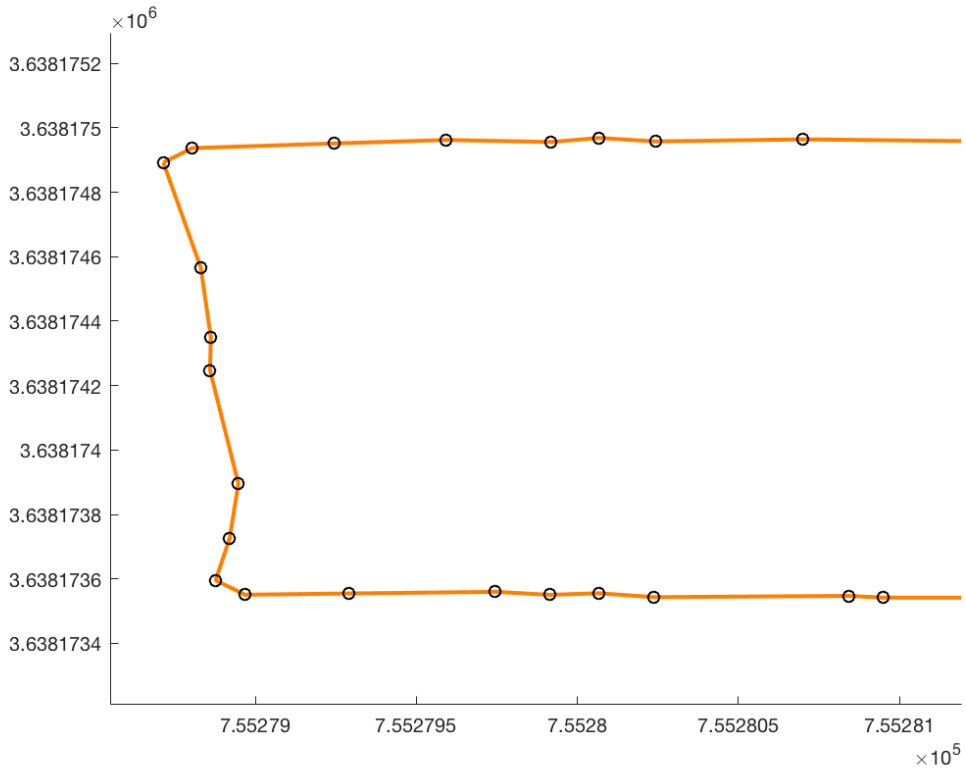




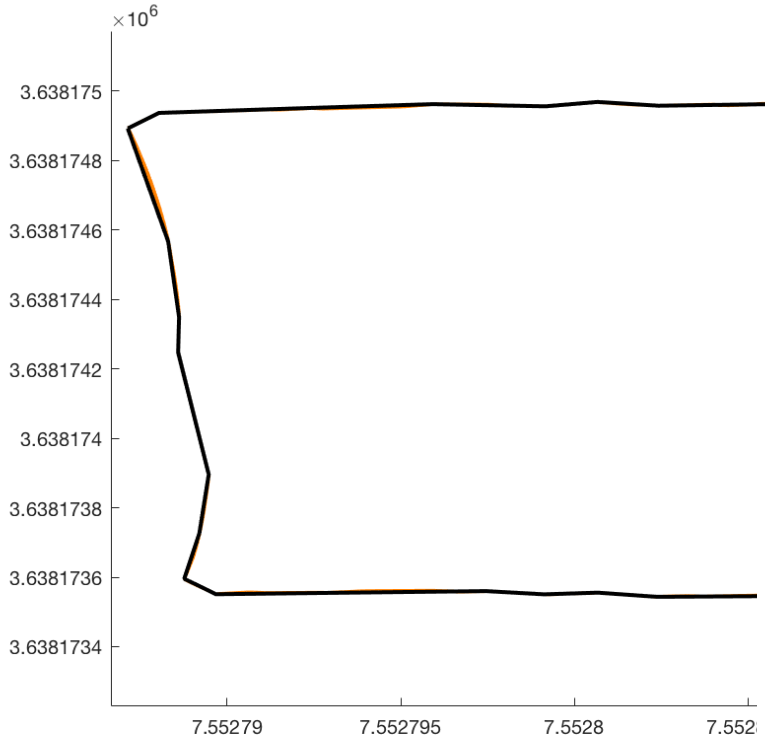
Hand-held Example

Alpha Shape / Swept Points



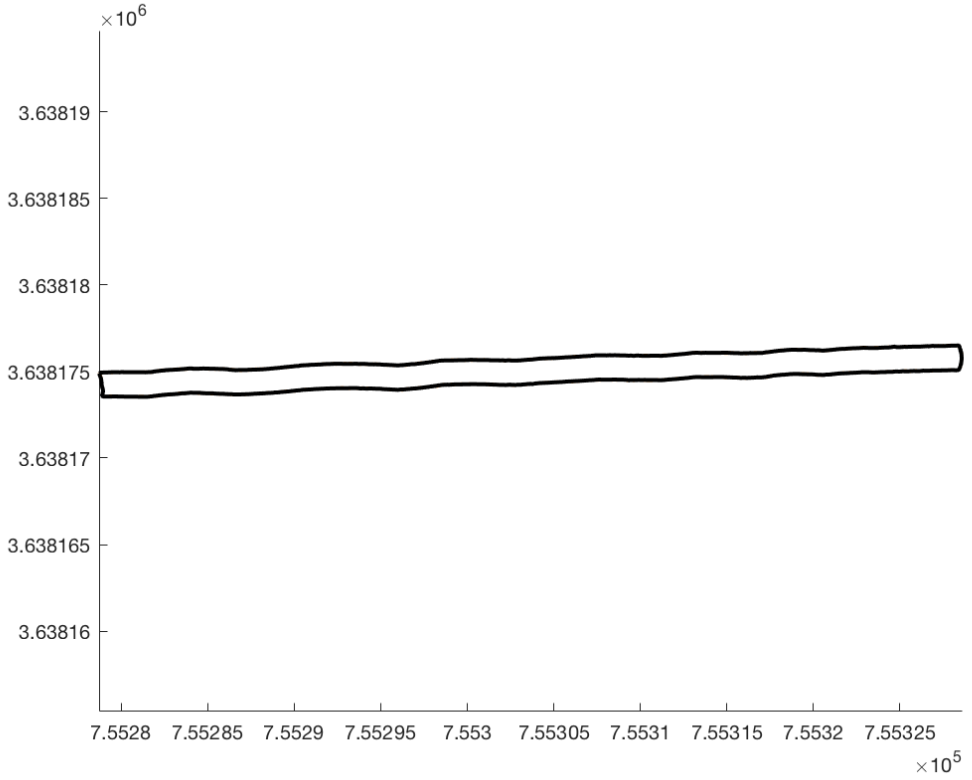


Hand-held Example



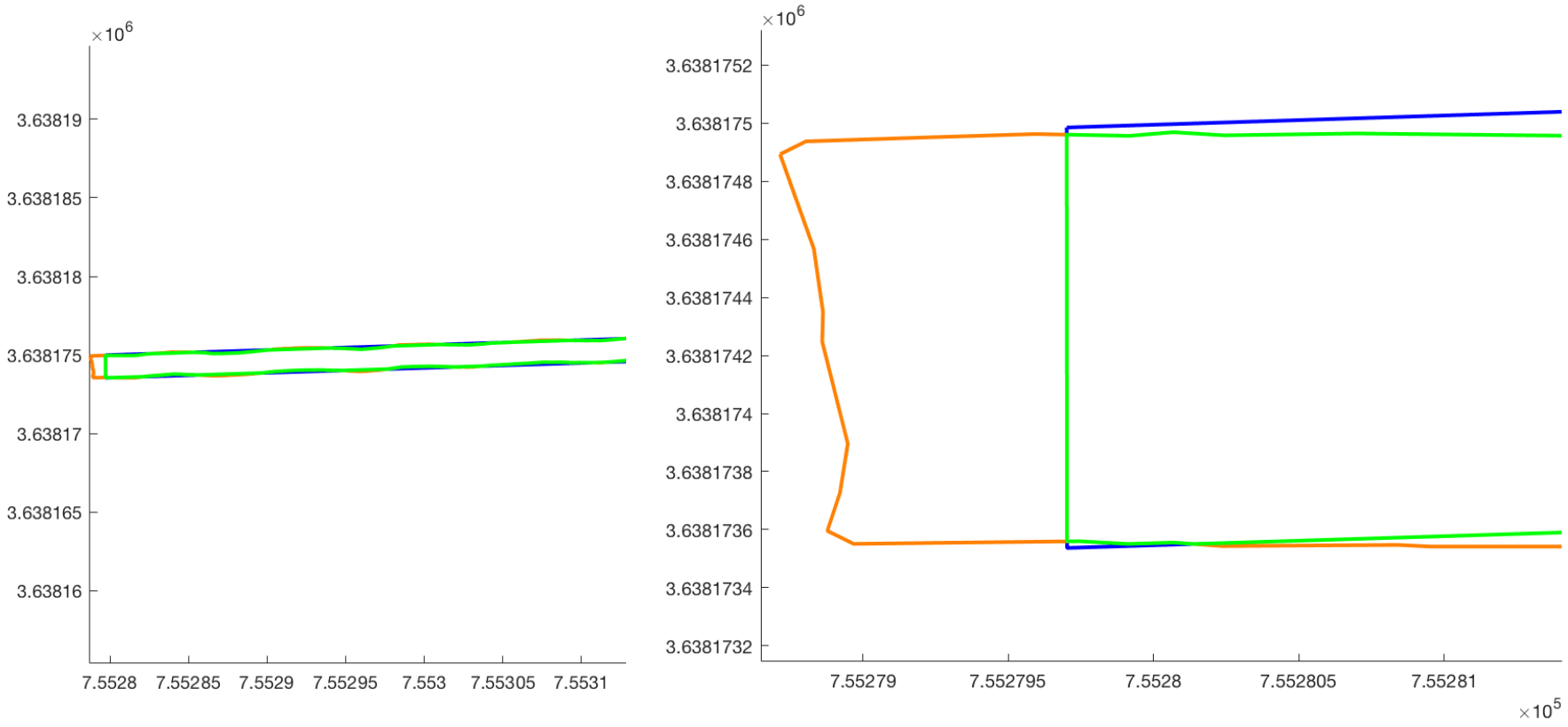
Alpha Shape
(Swept Lane)

Decimated Polygon



Hand-held Example

Alpha / Intersected / Truth Lanes



Point Reduction Statistics

Lane	Data Points	Area m^2
Original	565,854	N/A
Alpha Shape	4,507	70.6
Decimated	377	70.5

93.34% Point Reduction

99.99% Same Area