Principles of Generalization

Introduction

- The **International Cartographic Association** defines **Cartographic Generalization** as "the selection and simplified representation of detail appropriate to the scale and/or the purpose of a map" (ICA 1967).
- More generally, the objective of generalization is to supply information on a content and detail level corresponding to the necessary information for correct geographical reasoning. Generalization inputs are :
  - The needs
  - The geographical data: density, distribution, size, diversity etc.
  - The readability rules
  - The means: time, money, technique etc.

Generalization from large into small scale

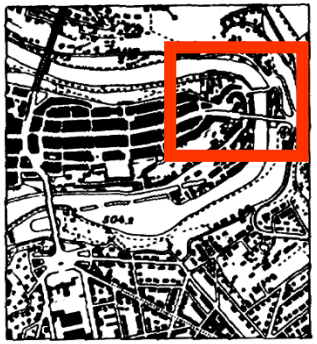
Increase of area

Decrease of detail

Scale 1:10,000

1 cm = 100 meters

Scale 1:25,000



1 cm = 250 meters

Scale 1:50,000

1 cm = 500 meters

Scale 1:100,000

1 cm = 1 kilometer

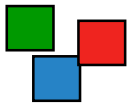
Scale 1:200,000

1 cm = 2 kilometer

Scale 1:500,000

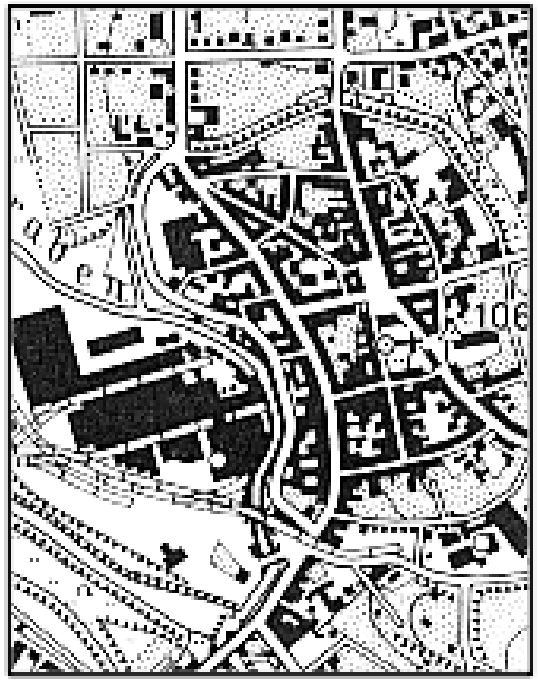
1 cm = 5 kilometer

Absolute minimum dimensions of graphic elements (point,line,area)

	0.05 mm	Black line
	0.08-0.1 mm	Colored line
	0.15 mm	Line separation
	0.25 mm	Separation of colored lines
	0.15 mm	Diameter of circle
	0.3 x0.3 mm	Square
	0.2 mm	Area separation
	4.0 mm^2	Dimensions for colored areas

Scale reduction without generalisation

1:25,000 map



1:25,000 map

reduced to 50%

without generalization

1:25,000 map

reduced to 25%

without generalization

Why is Generalization necessary?

- When geographic data are gathered at a scale that is larger than the scale at which they are presented, it is necessary to reduce the complexity of the data to make the resulting map more aesthetically pleasing(Increased density of the map contents due to scale reduction).
- Generalization ensures that geographic data are presented at a scale appropriate to the purpose of the map and the application requirements of the user.
- Features become too small to be seen clearly, or to be represented at true size (to scale) on a monitor or on paper.

What is generalization?

- The process of reducing the amount of detail in a map (or database) in a meaningful way
- Generalization related to:
  - the map purpose
  - scale
  - output

Generalization activities are scale related

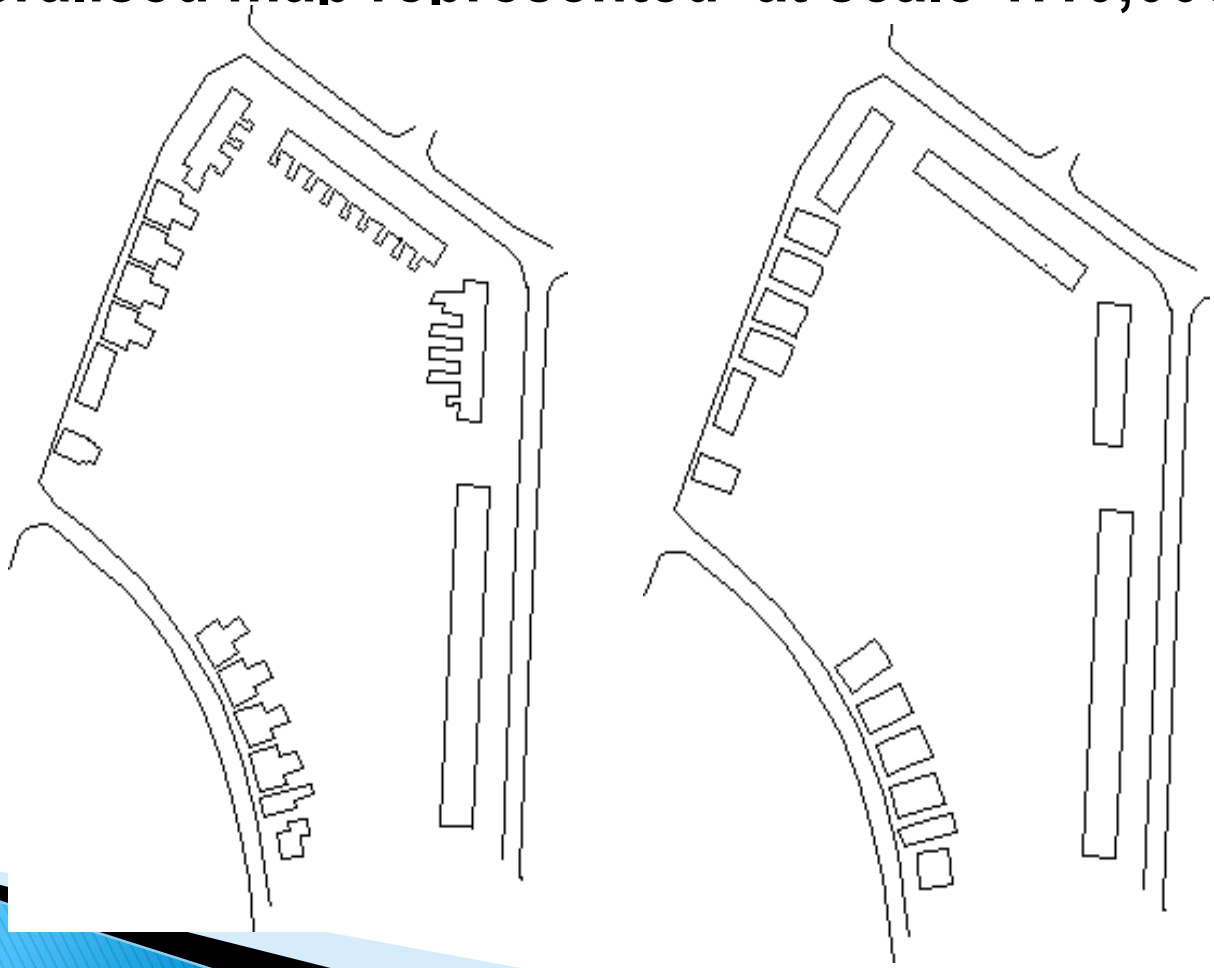
- On large scale maps the real world can be represented with large detail. Such maps require only little Generalization: some simplification, some enlargement or some displacement of features.
- However, the smaller the scale of the map, the less detail can be represented, the more important Generalization becomes.

Generalizing activities are scale related

- Where does Generalization really begin?
- Scales ≥ 1:5,000: the planimetric accuracy of the original survey data are fairly well maintained.
- Scales 1:10,000 – 1:25,000: some roads and other features (e.g. railways) are no longer true to scale. Some simplification, enlargement or displacement of features.
- Scales 1:25,000 – 1:50,000: roads and buildings are no longer true to scale (roads are represented by lines). Buildings are often simplified and displaced. In densely built-up areas buildings are already omitted or combined.

Generalization (example)

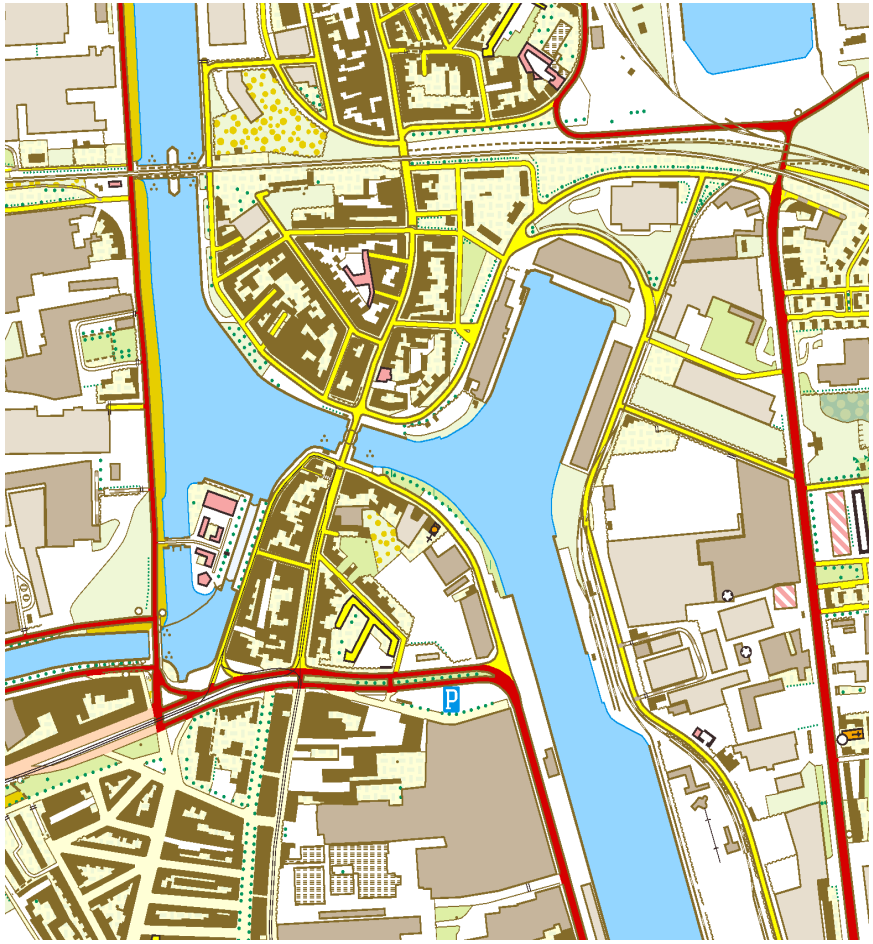
- **Generalised map represented at scale 1:10,000**



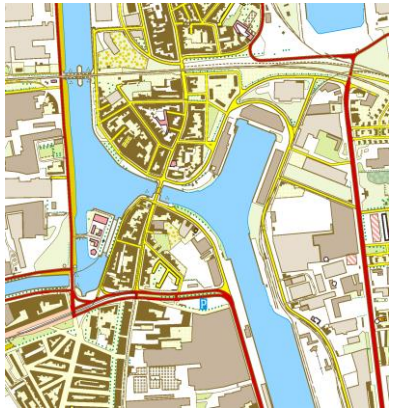
Generalizing activities are scale related

- Scales ≤ 1:50.000:
  - Selection, reclassification and resymbolization;
  - Strong simplification and displacements;
  - Buildings no longer true to scale or not shown as individual buildings;
  - Merging of area features.

Generalization (example)

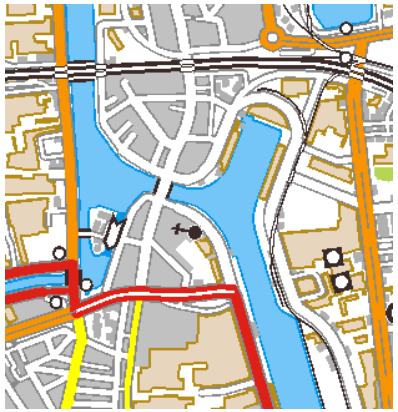


Topographic Map1:10 000



Result after a

scale reduction



Topographic Map

1:50 000

after Generalization

Sequential processing for model Generalization

- Selection: Extraction of purpose and scale adapted objects or group of objects based on database attributes.
- Reclassification: Reclassify objects into another category to enable aggregation with objects having the same class.
- Collapsing: Collapses a polygon either to a line or to a point
- Aggregation: Combines an objects with other objects of the same or a similar class to a new object.
- Typification: Transformation of an initial set of objects into a subset, while maintaining and preserving the characteristics of distribution and pattern of the original data set.
- Deletion: removes an object from the data set
- Simplification: reduces the granularity of an outline of an object

Generalization Procedures

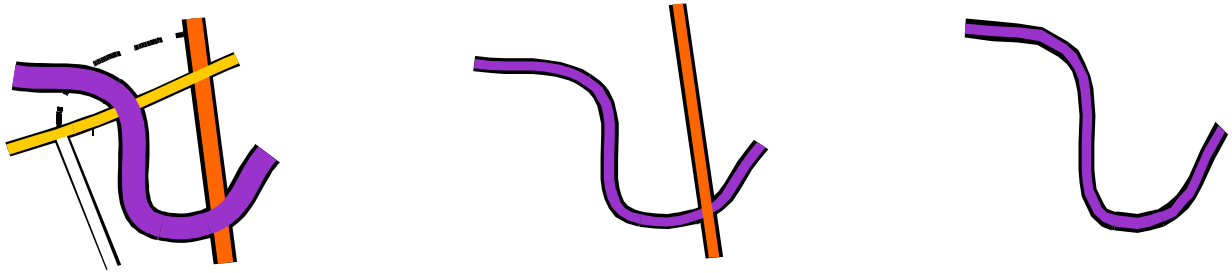
- Selection
- Simplification
- Combination (Aggregation)
- Smoothing
- Enhancement (Exaggeration)
- Displacement

Selection

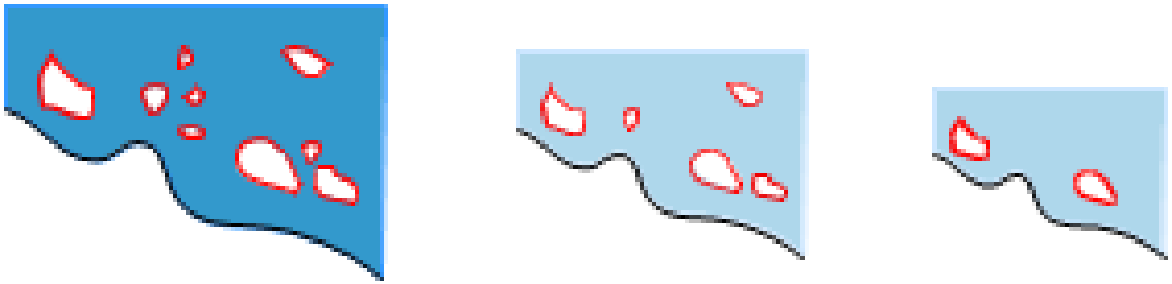
- Map generalization is designed to reduce the complexities of the real world by strategically reducing ancillary and unnecessary details. One way that geospatial data can be reduced is through the selection process.
- The cartographer can select and retain certain elements that he/she deems the most necessary or appropriate.
- In this method, the most important elements stand out while lesser elements are left out entirely.

Selection

- Selection (omission) of categories



Exp1

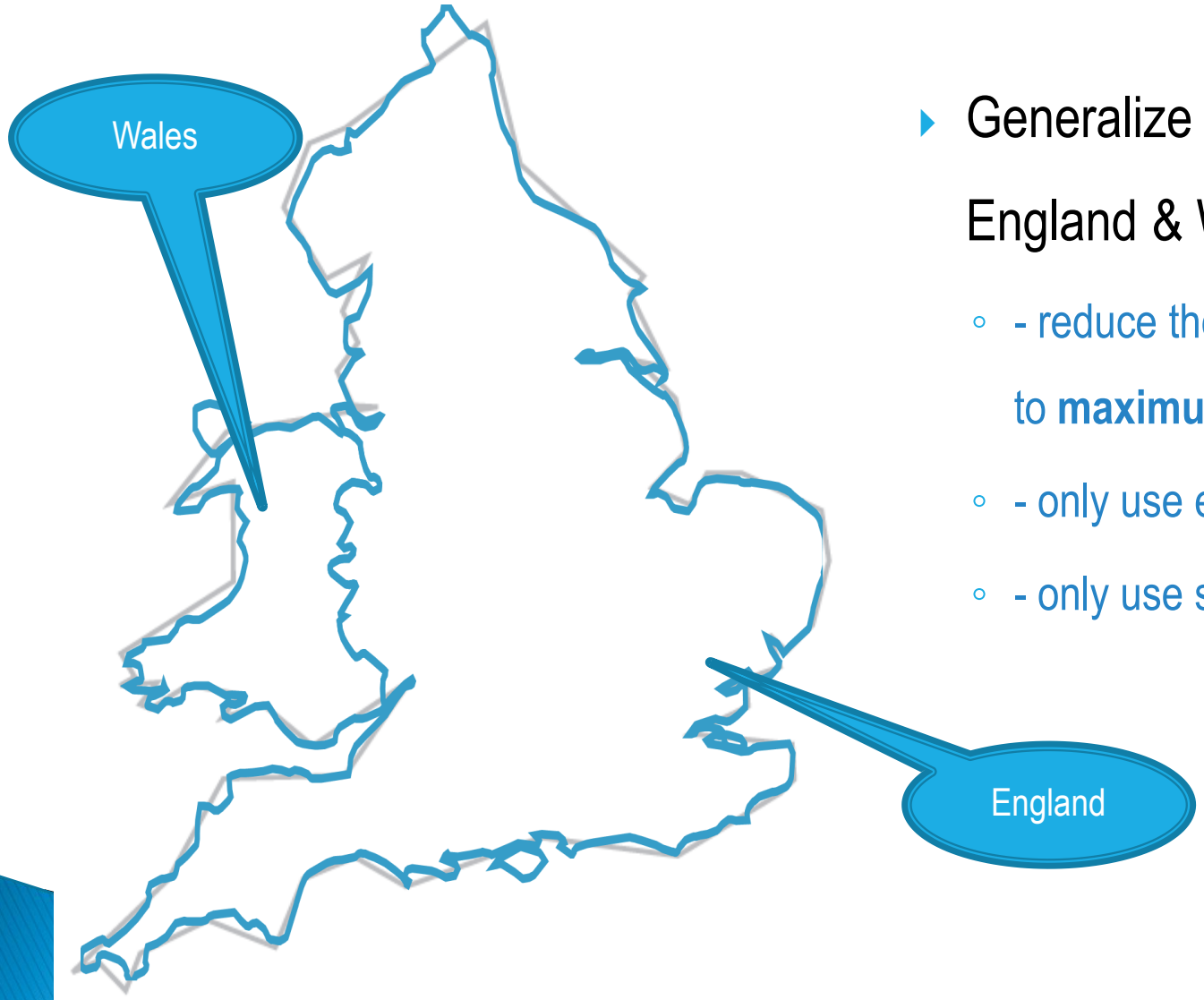


Exp2

Simplification

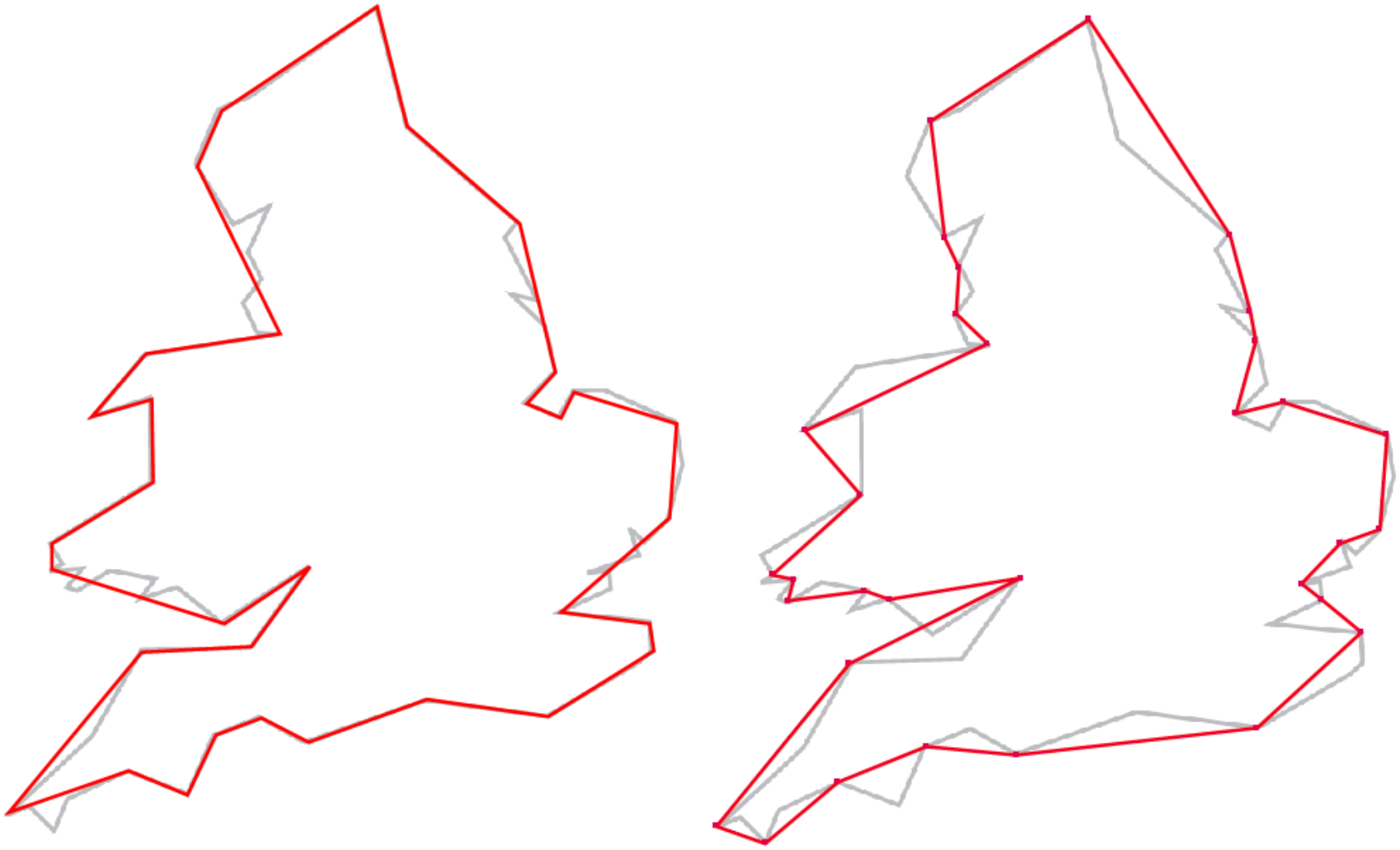
- Generalization is not a process that only removes and selects data, but also a process that simplifies it as well.
- Simplification is a technique where shapes of retained features are altered to enhance visibility and reduce complexity.
- Smaller scale maps have more simplified features than larger scale maps because they simply exhibit more area.

Line simplification exercise



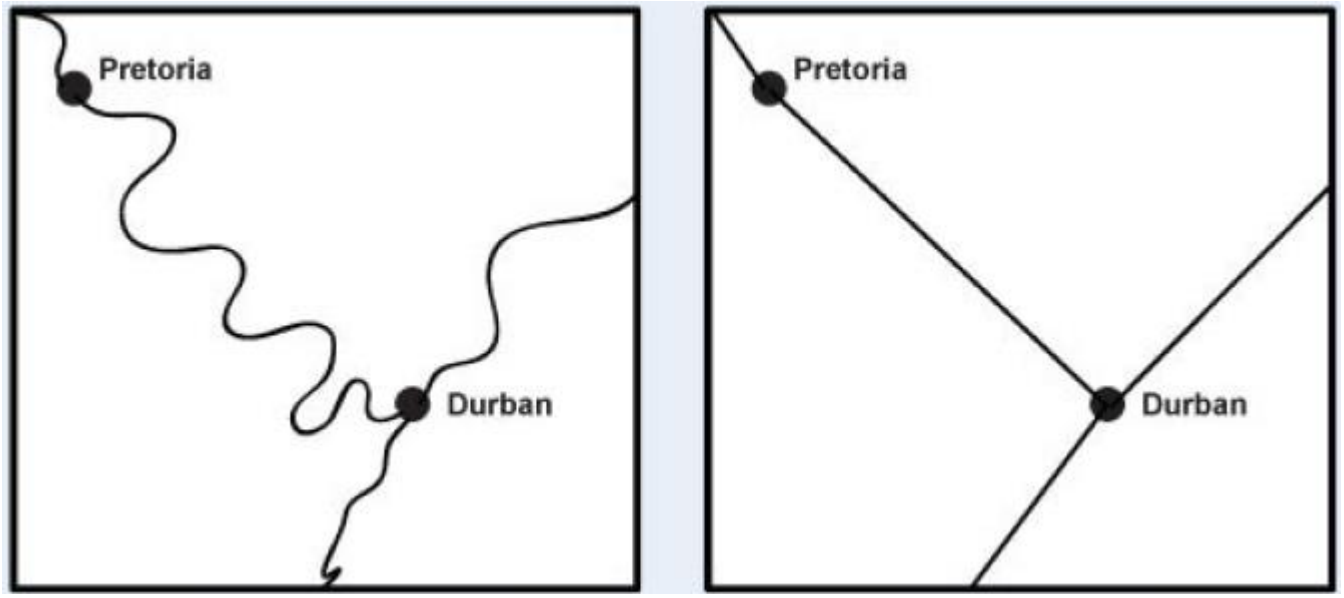
- Generalize this map of the England & Wales
  - - reduce the existing 66 points to **maximum 33**
  - - only use existing points
  - - only use straight lines

Line simplification exercise



Simplification and Map Purpose

- On the following example the road between the towns is straightened because the purpose of the map is simply to show connectivity between towns, and not to depict the road's precise location features.



Less simplified

More simplified

Combination (Aggregation)

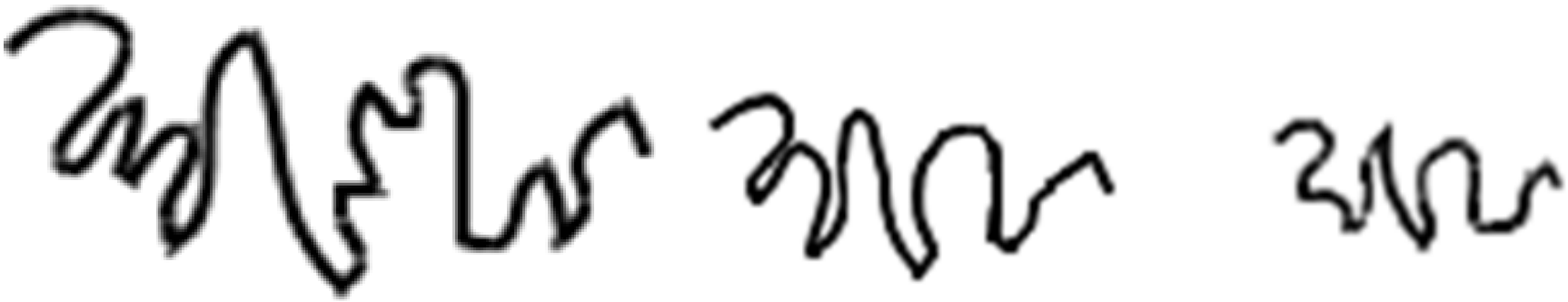
- Combines an objects with other objects of the same or a similar class to a new object.
- The map reader has to remember that because of scale limitations combined elements are not concise depictions of natural or manmade features.

Combination Example

Smoothing

- Smoothing is also a process that the map maker can employ to reduce the angularity of line work.
- Smoothing is yet another way of simplifying the map features, but involves several other characteristics of generalization that lead into feature displacement and locational shifting.
- The purpose of smoothing is to exhibit line work in a much less complicated and a less visually jarring way.

Enhancement



Enhancement (Exaggeration)

- Enhancement is also a method that can be employed by the cartographer to illuminate specific elements that aid in map reading.
- As many of the aforementioned generalizing methods focus on the reduction and omission of detail, the enhancement method concentrates on the addition of detail.
- Enhancement can be used to show the true character of the feature being represented and is often used by the cartographer to highlight specific details about his or her specific knowledge, that would otherwise be left out.

Displacement

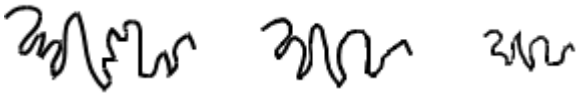
- Displacement can be employed when 2 objects are so close to each other that they would overlap at smaller scales.
- Another common case is when a road and a railroad run parallel to each other.

Examples

Graphic generalization activities:

Selection (omission)

Merging (combination or aggregation)



Simplification

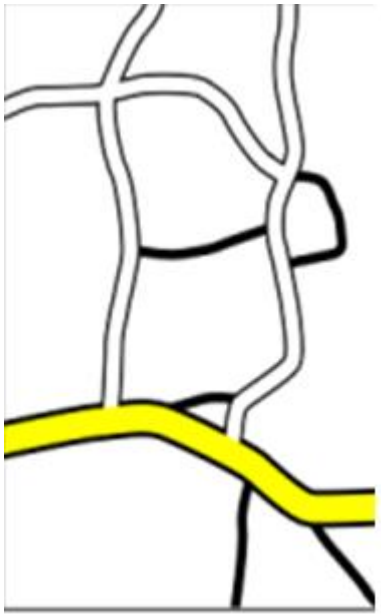
Enlargement (exaggeration)

Displacement

Question 1

- The Following pictures show
  1. The source map
  2. The generalized map (on the scale of the source map
  3. The generalized map on the final scale
- Which basic rules are applied?

a) Simplification b) Selection c) Displacement d)Exaggeration



1 2 3

Question 2

- The Following pictures show
  1. The source map
  2. The generalized map (on the scale of the source map
  3. The generalized map on the final scale
- Which basic rules are applied?

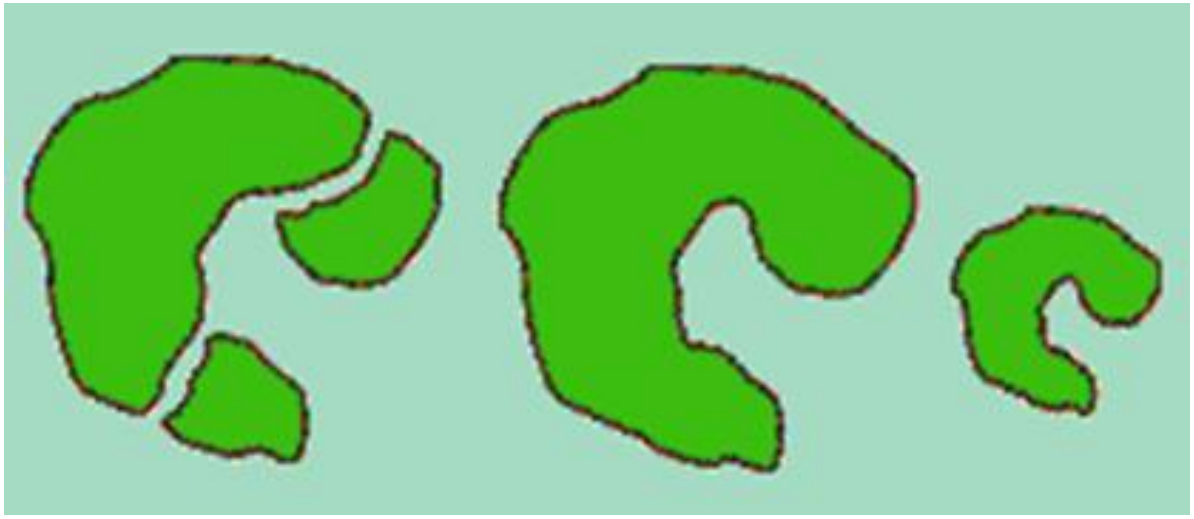
a) Aggregation b) Selection c) Simplification d)Exaggeration

1 2 3

Question 3

- The Following pictures show
  1. The source map
  2. The generalized map (on the scale of the source map
  3. The generalized map on the final scale
- Which basic rules are applied?

a) Aggregation b) Selection c) Simplification d)Exaggeration



1 2 3

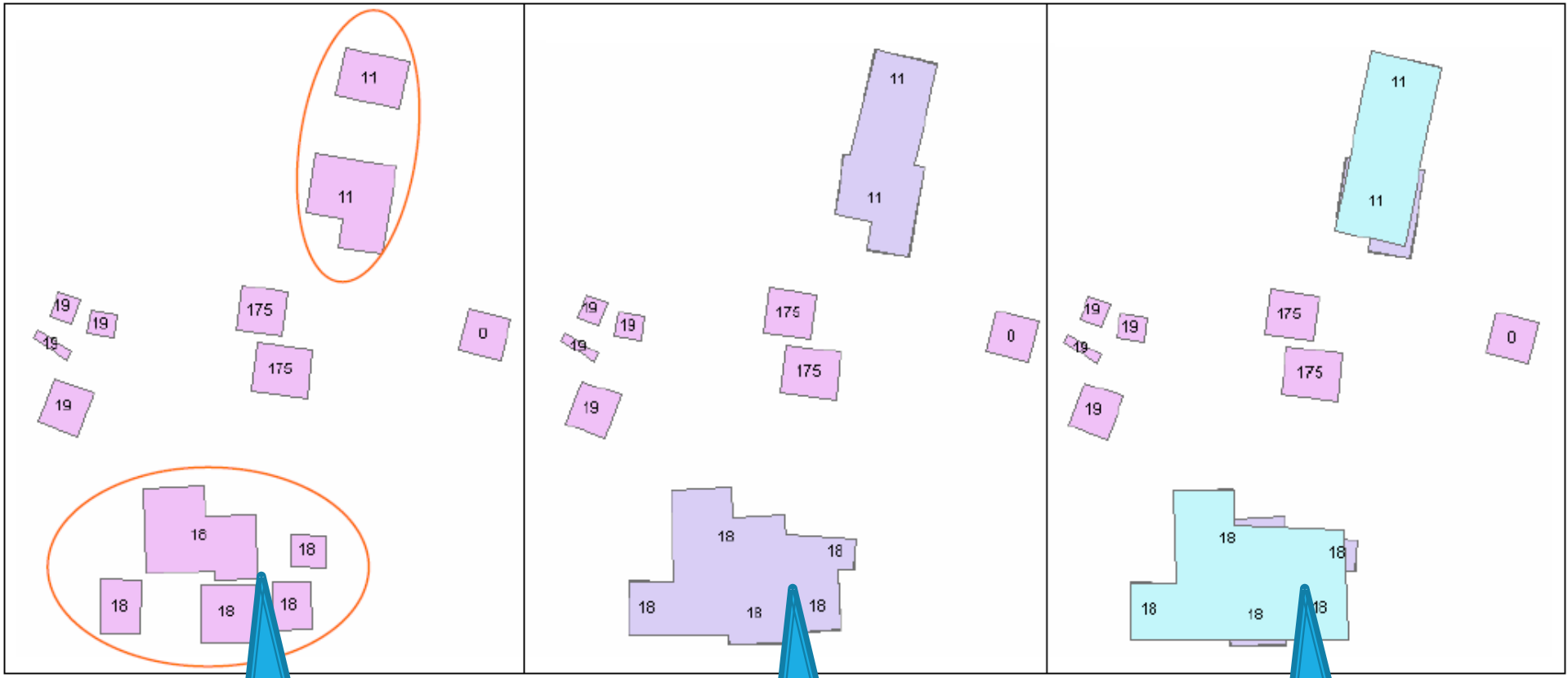
Question 4

- The Following pictures show
  1. The source map
  2. The generalized map (on the scale of the source map
  3. The generalized map on the final scale
- Which basic rules are applied?

a) Aggregation b) Selection c) Simplification d)Exaggeration

1 2 3

Example of building aggregation

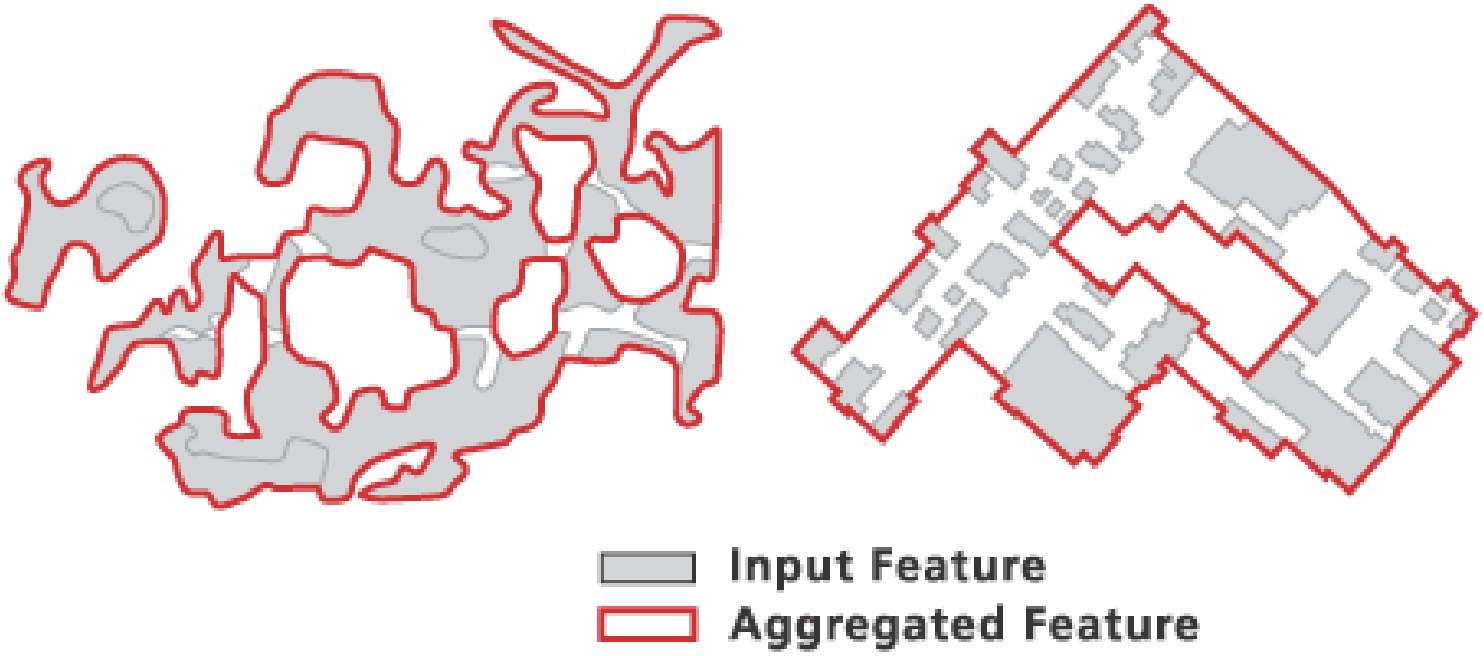


Selection (building no 18)

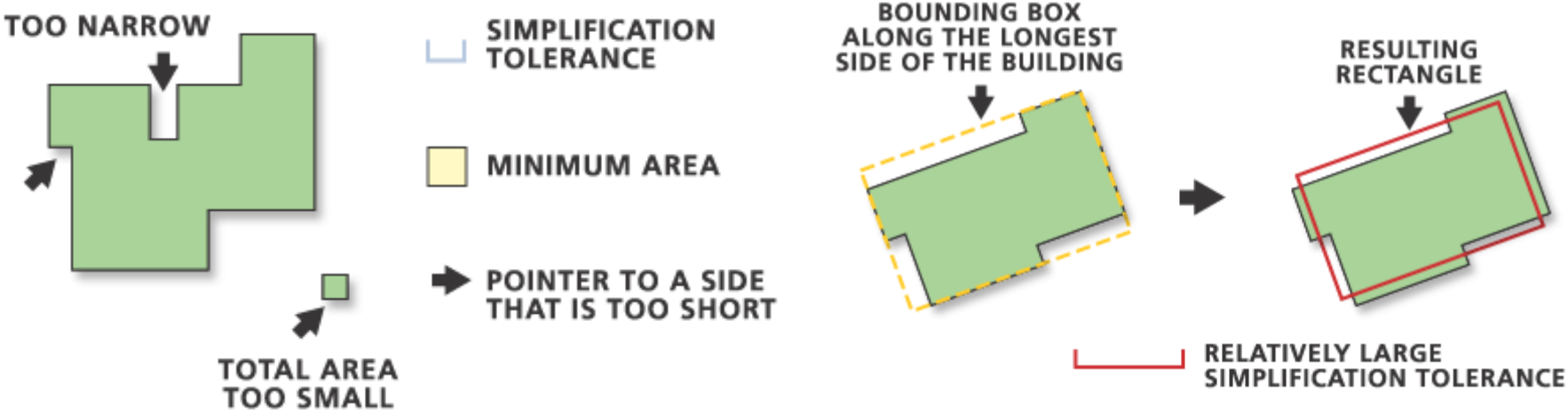
aggregation

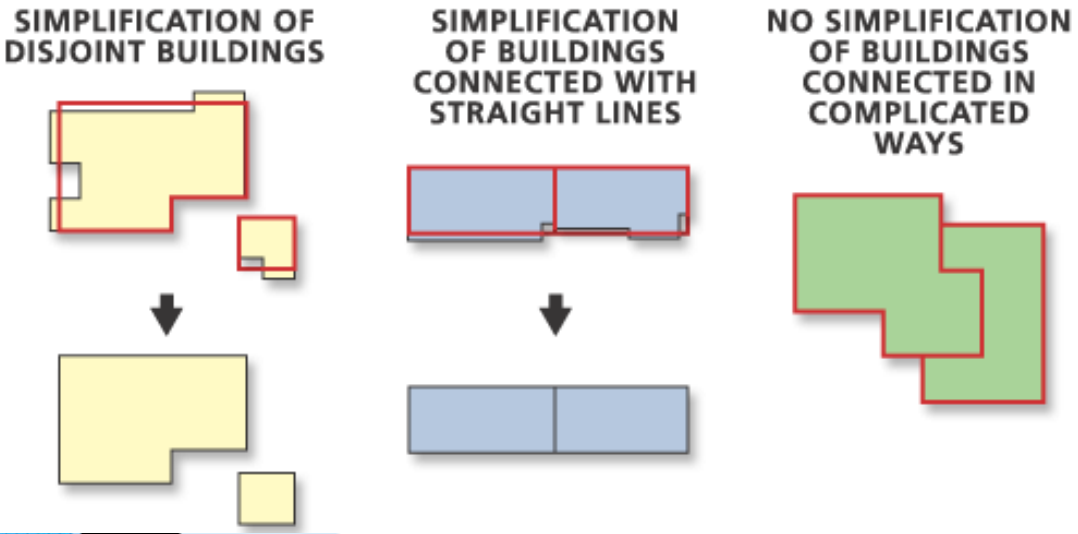
Simplification

Aggregate polygons

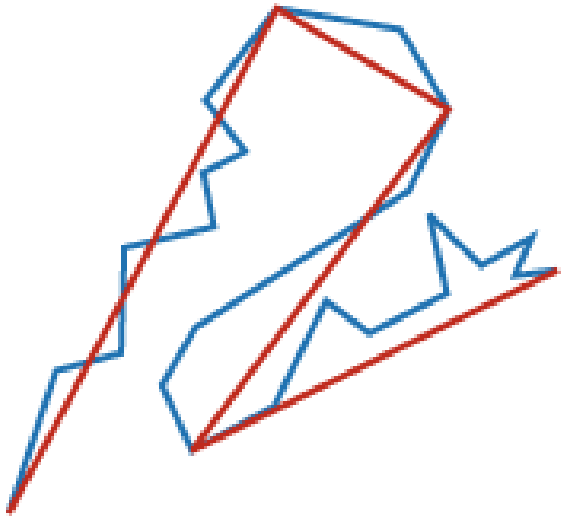


Simplify buildings

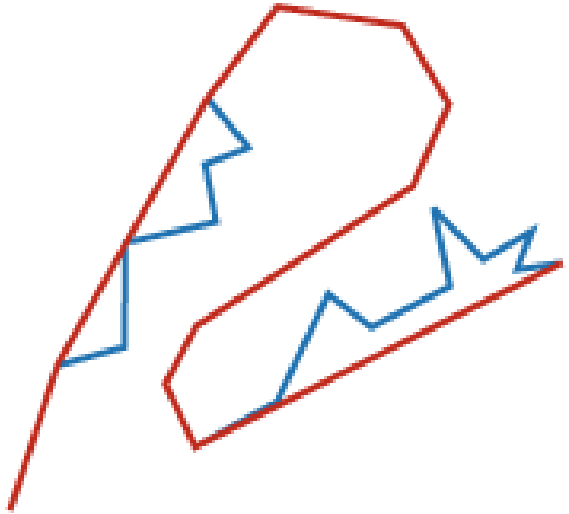




Simplify lines



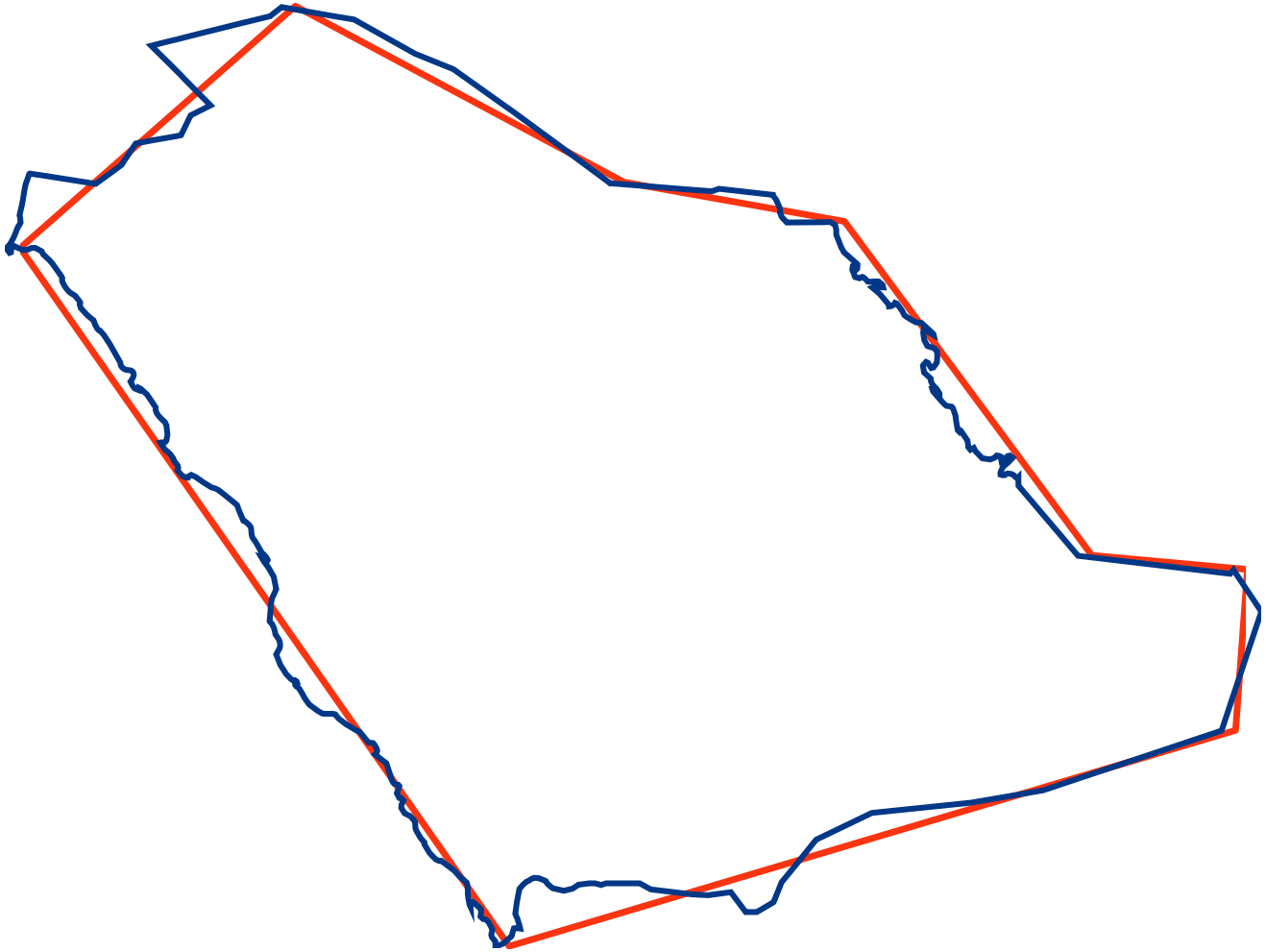
POINT REMOVE



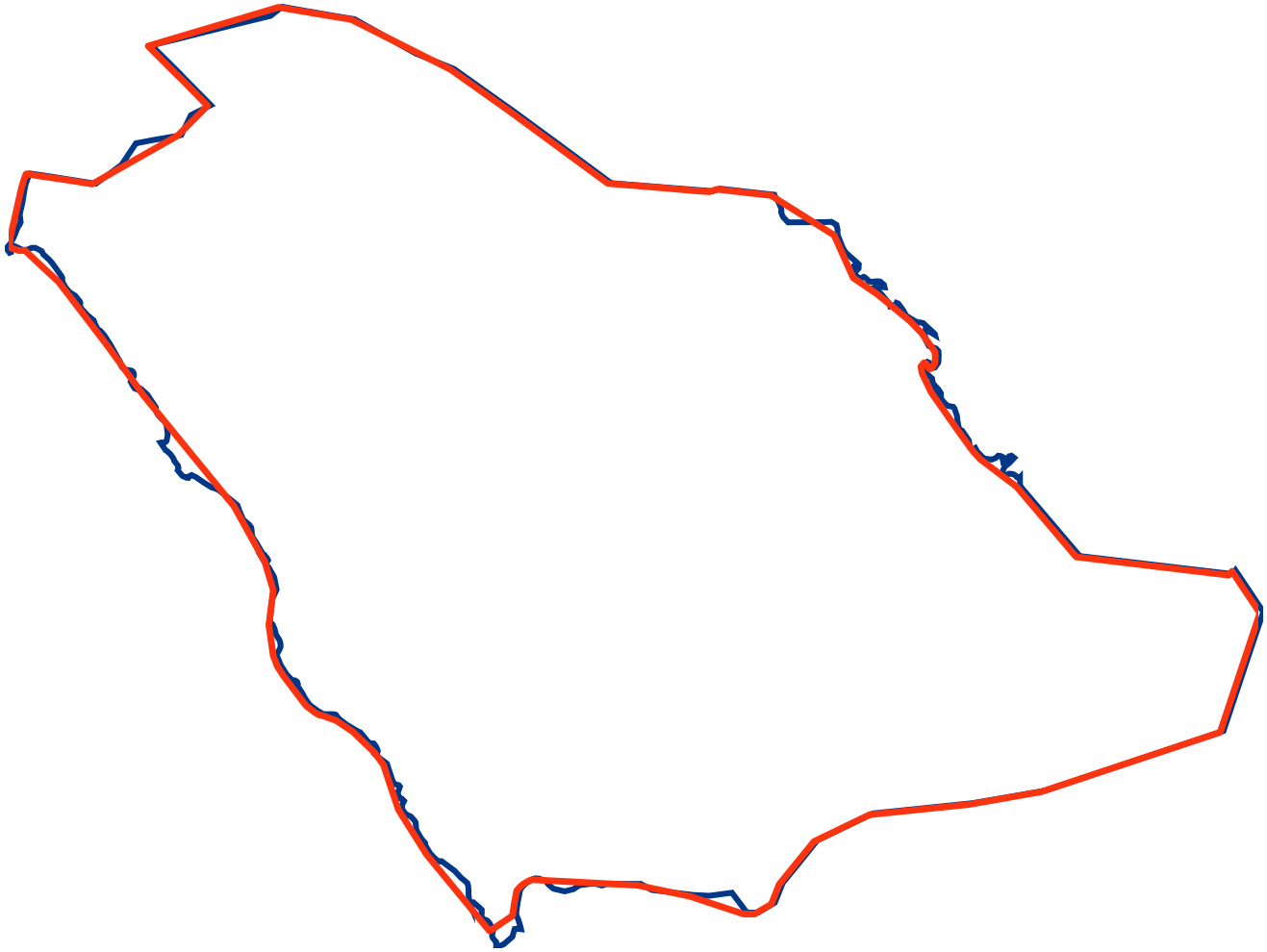
BEND SIMPLIFY

ORIGINAL
SIMPLIFIED

POINT_REMOVE



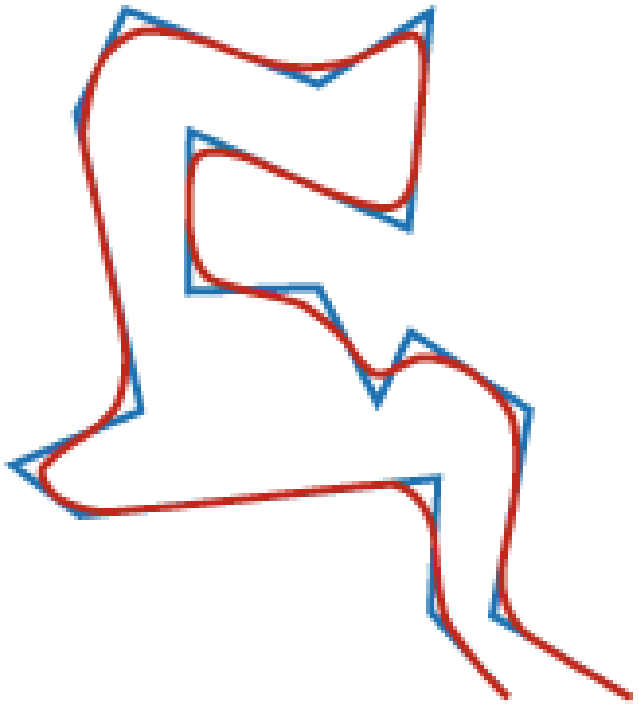
BEND_SIMPLIFY



Simplify lines

- POINT REMOVE : Keeps the so-called critical points that depict the essential shape of a polygon and removes all other points.
- BEND SIMPLIFY : Keeps the main shape of a polygon and removes extraneous bends in the boundary.

Smooth lines



PAEK

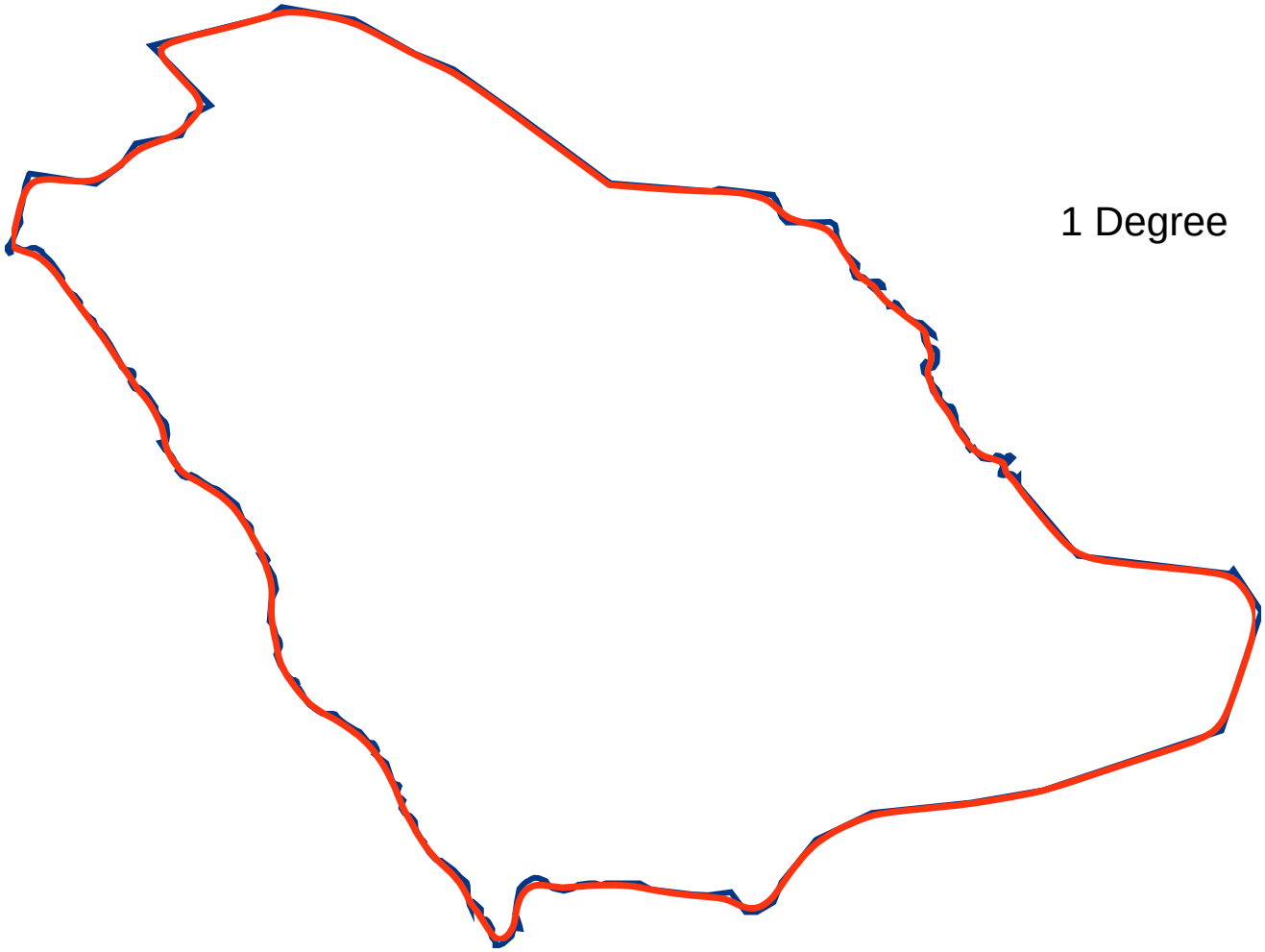
Bezier Interpolation

ORIGINAL
SMOOTHED

Smooth lines

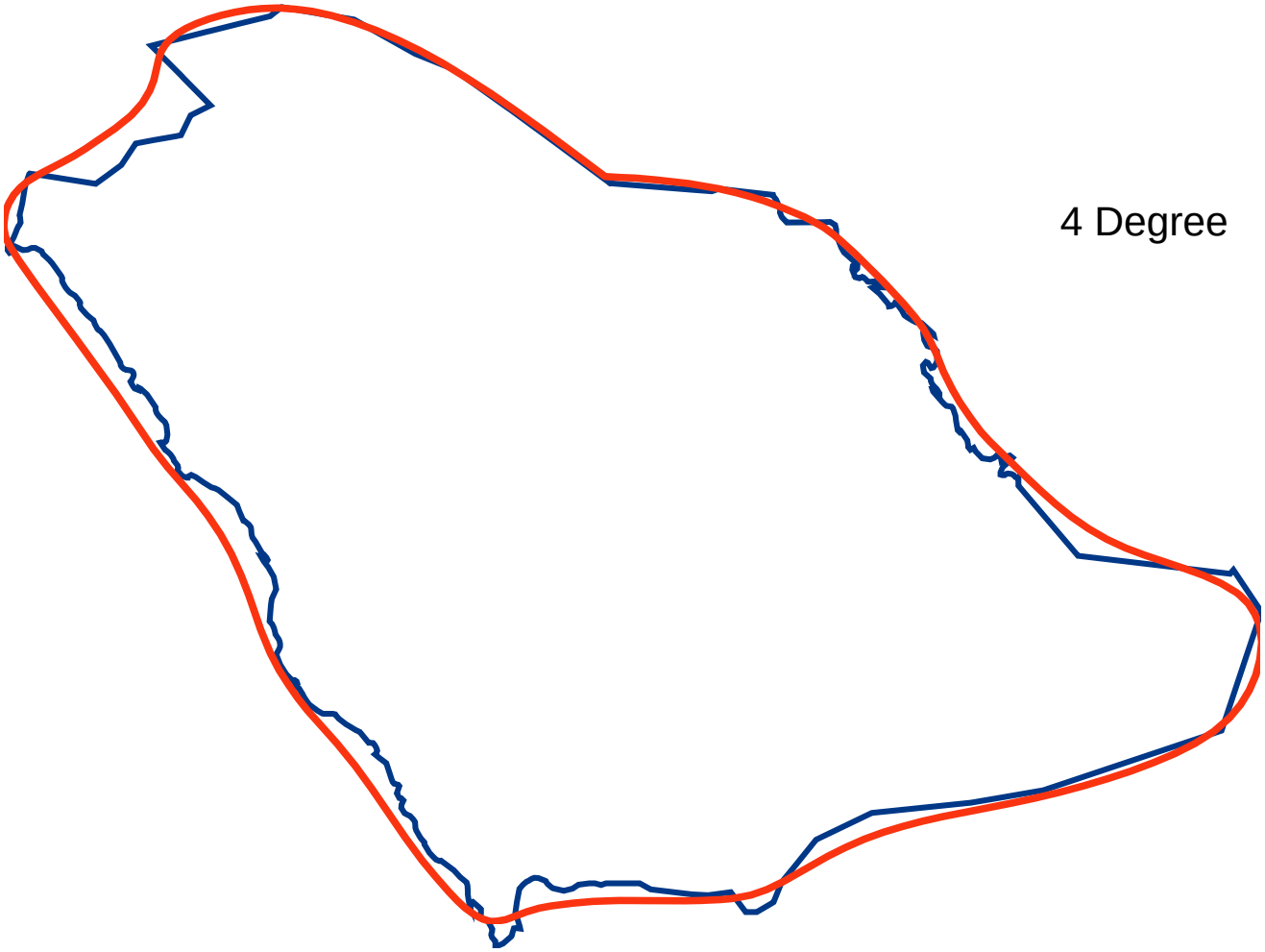
- PAEK : Acronym for Polynomial Approximation with Exponential Kernel. It calculates a smoothed line that will not pass through the input line vertices. This is the default.
- BEZIER_INTERPOLATION: Fits Bezier curves between vertices. The resulting line passes through the vertices of the input line. This algorithm does not require a tolerance. Bezier curves will be approximated in shapefile output.

PAEK



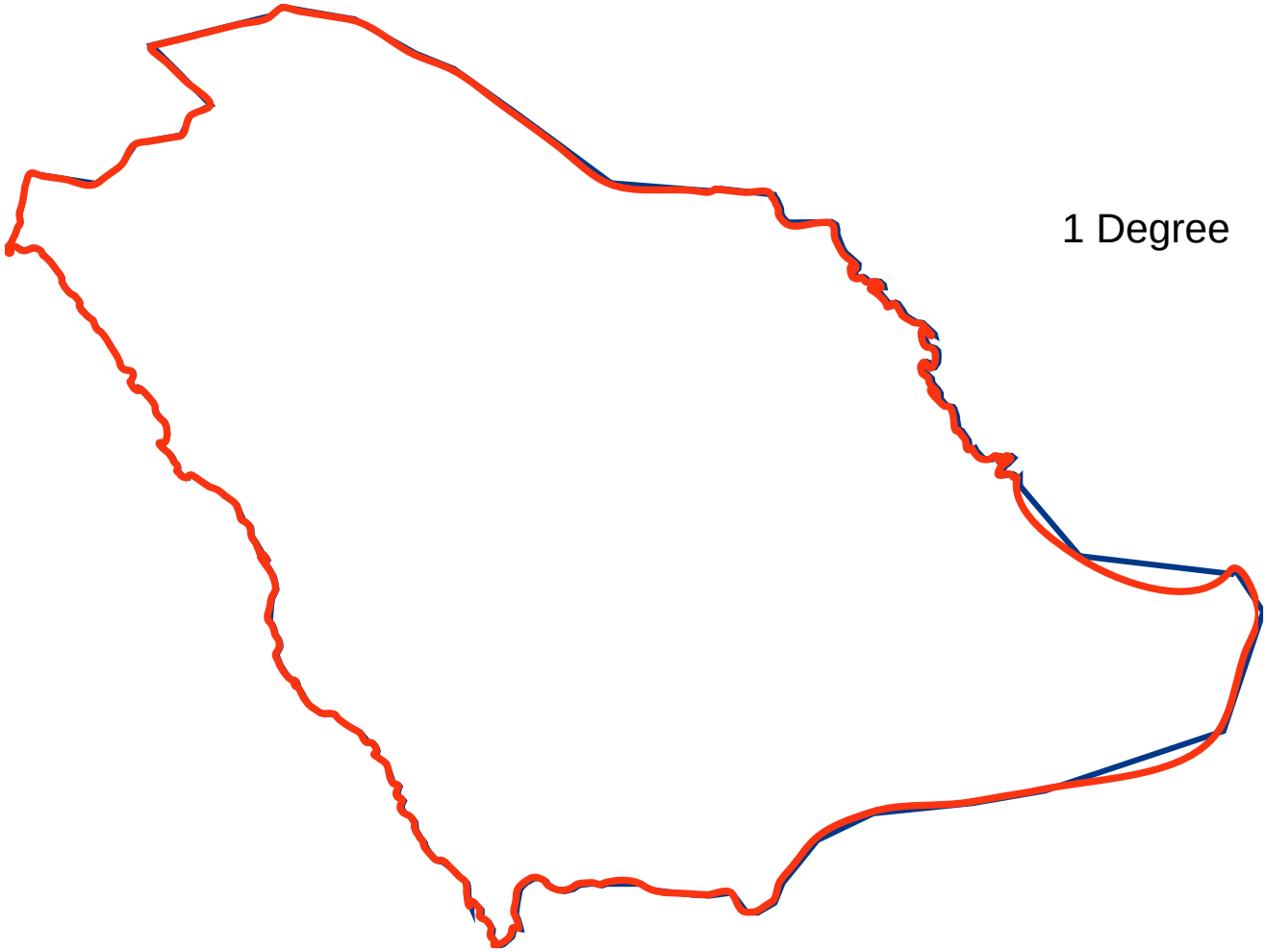
1 Degree

PAEK



4 Degree

BEZIER_INTERPOLATION



1 Degree