Jan 25 (Scotland)

UNBC

Generalisation

"the reduction of detail or simplification of reality"

Lawren Harris

"Nothing is less real than realism. Details are confusing. It is only by selection, by elimination, by emphasis that we get at the real meaning of things".

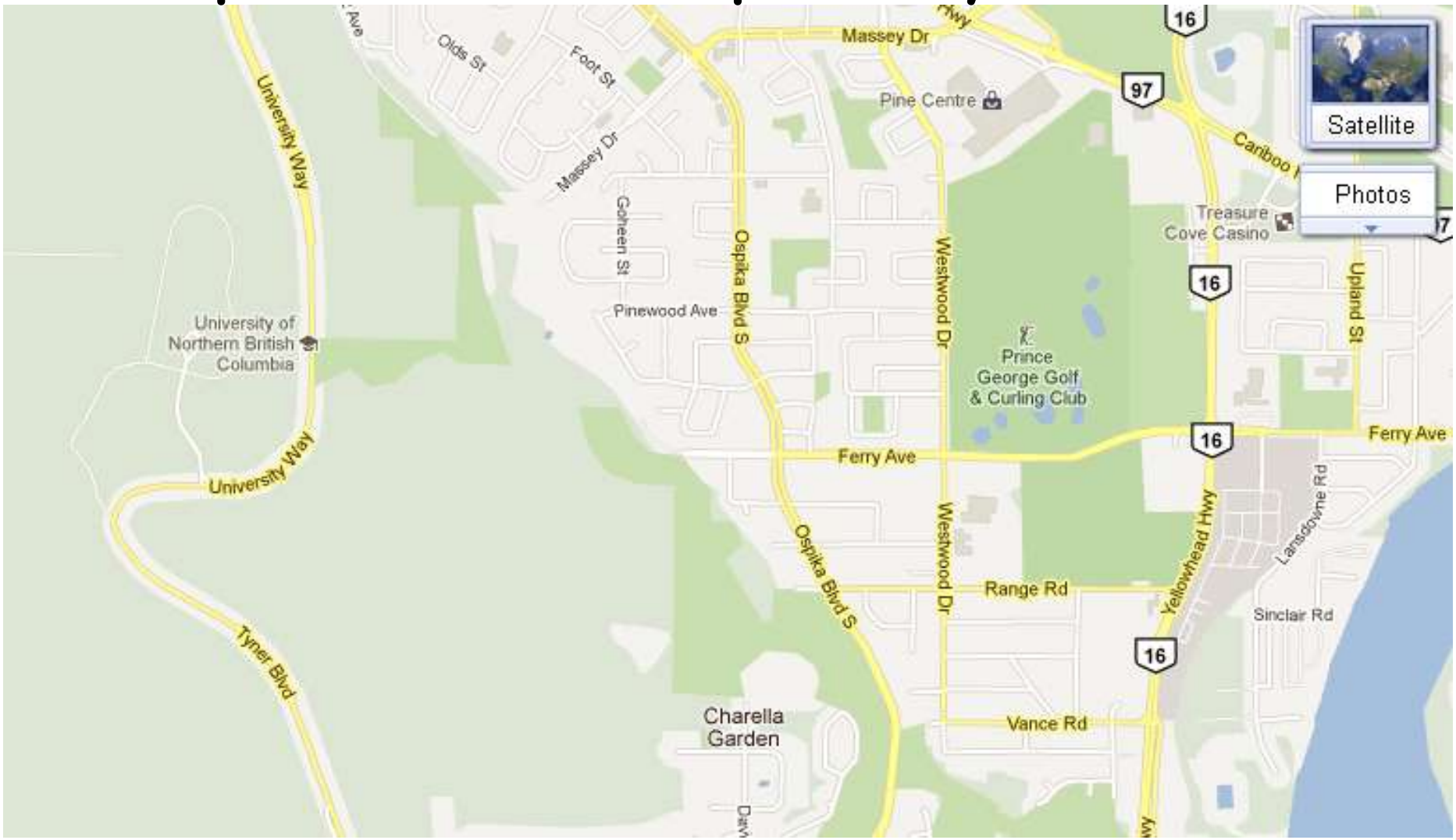
Georgia O'Keefe (1922)

Lake George, Georgia O'Keefe

Generalisation

Watercolor map of Greater Vancouver rendered by Stamen Designs using OpenStreetMap data.
https://stamen.com/

"A map is a scaled, 2-D, generalized representation of a planetary surface"

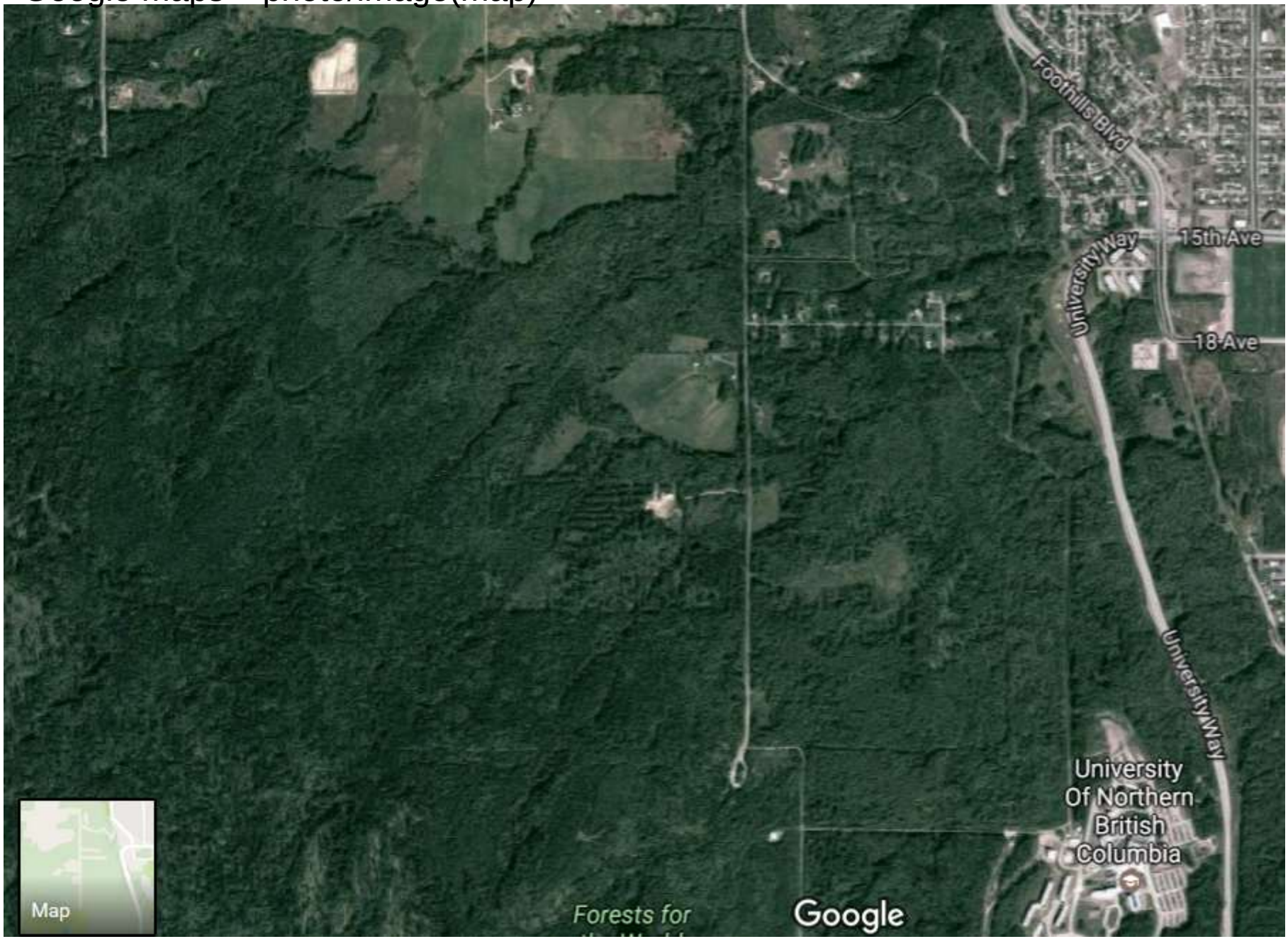


http://maps.google.ca

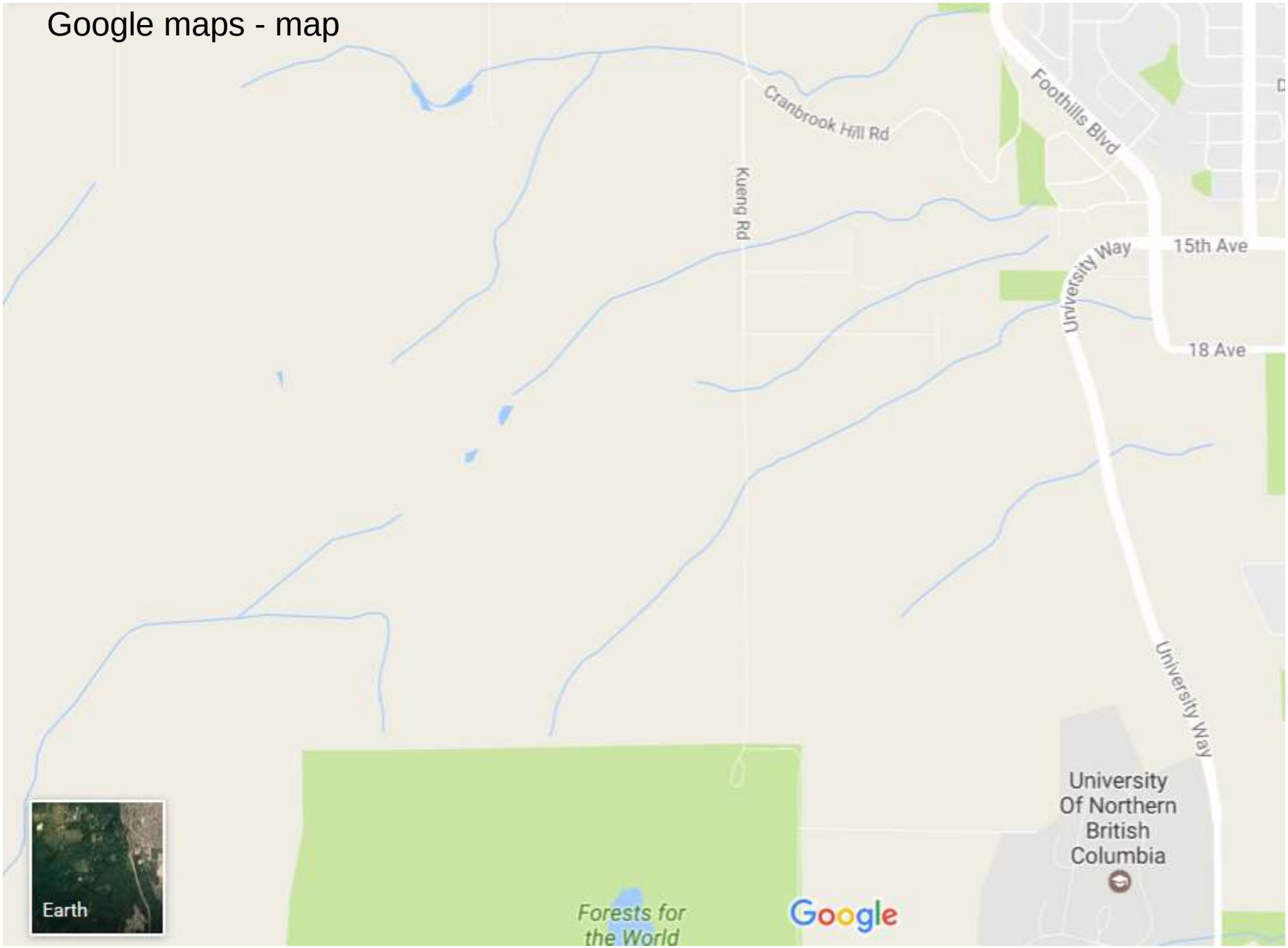
Answer to the question: Isn’t it all mapped ?

- **No, not for all Canada**
- **Range of scales (details)**
- **Range of types and designs**

Google maps – photo/image(map)

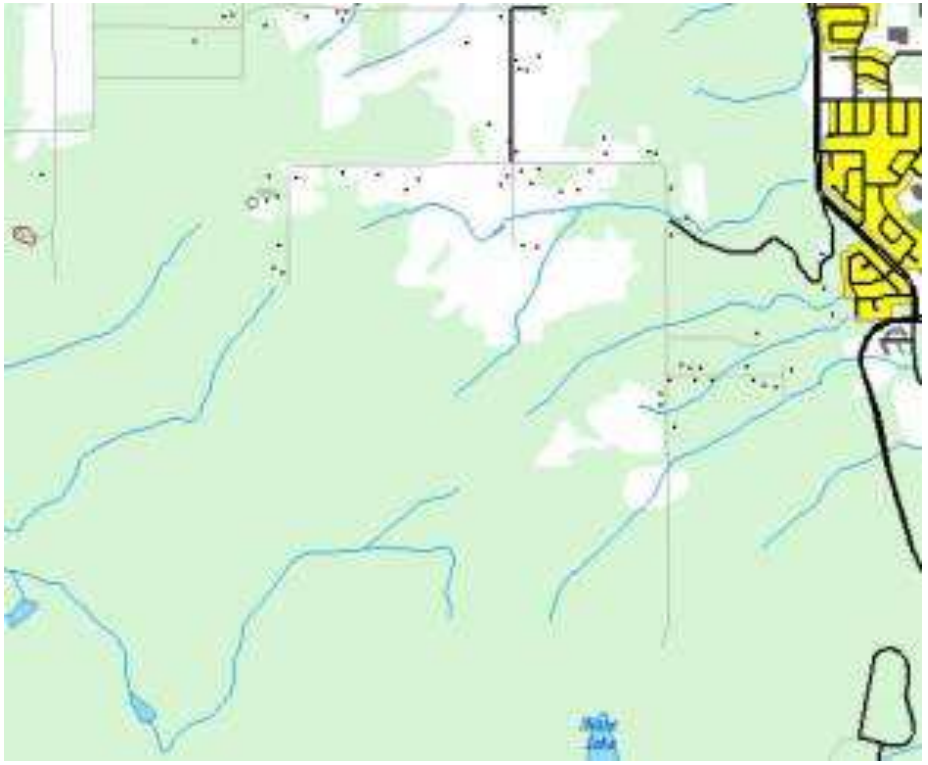


Google maps - map



Photos are not generalized: they need interpretation to be readable by users.

Air photo interpreted (= generalised) -> map



The process of **generalization** consists of these three steps:

1. simplification -> **2. selection** -> **3. classification** (4. -> symbolisation)

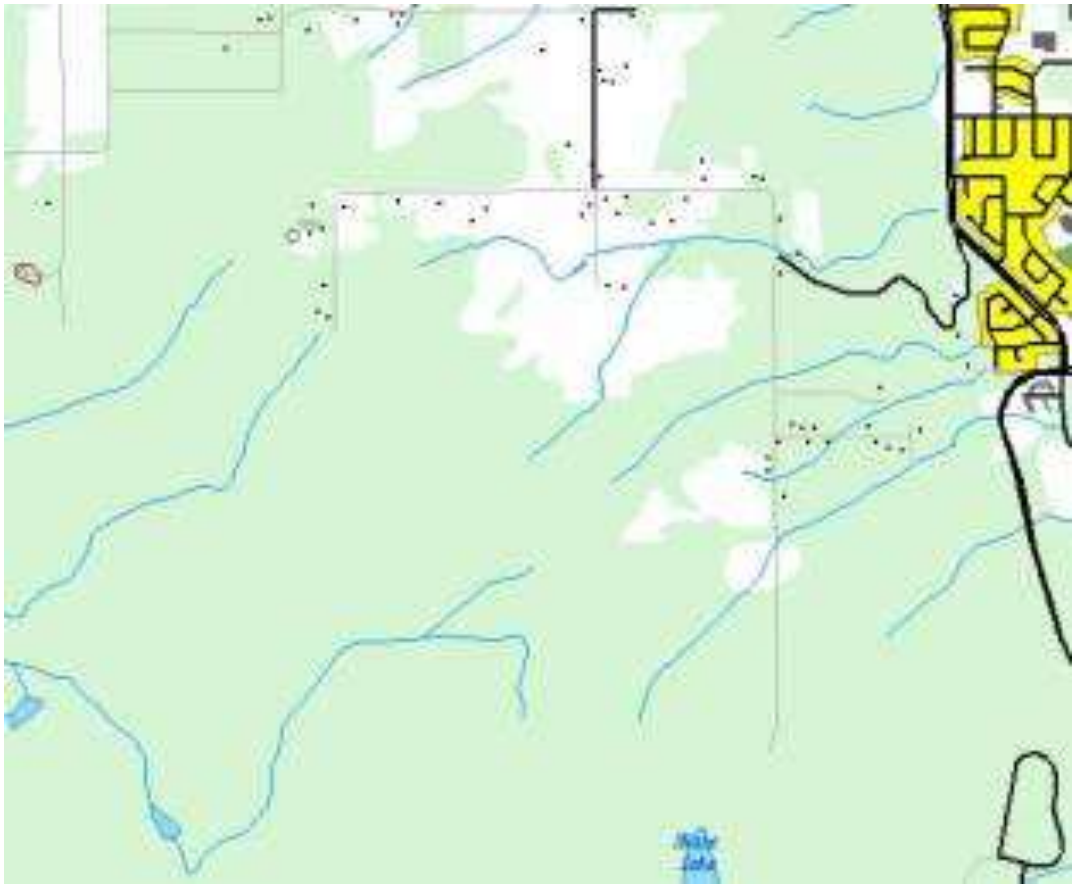
1. Simplification

All features have three dimensions: length, width and height,

They lose the third dimension as maps and displays are usually flat.

Simplification determines the most important characteristics (dimensions)

- 3D Volumes (reality)
- 2D Areas / polygons
- 1D Lines / arcs
- 0D Points



As SCALE decreases, generalisation increases

Simplification: features lose dimensionality

This is called **collapsing**

Examples :

areas -> lines: e.g. rivers

areas -> points: e.g. cities

lines -> points: ? (few examples)

2. Selection

- The map /data can NOT retain all features/details

- Which element types depend on the map **purpose**

  e.g. topographic map, parks map, city map

- How many elements depends mostly on map **scale**

  e.g. more details on 1:50,000 than 1:250,000

<u>Selection</u> can be subdivided into:

a. Aggregation (merging of several elements, most common with **areas**)

b. Elimination (removal of certain elements: **points, lines and areas**)

c. Smoothing (removal of details in shape or outline: **lines and areas**)

d. Collapsing: losing dimensions e.g. areas -> points; areas -> lines

Example: Vienna

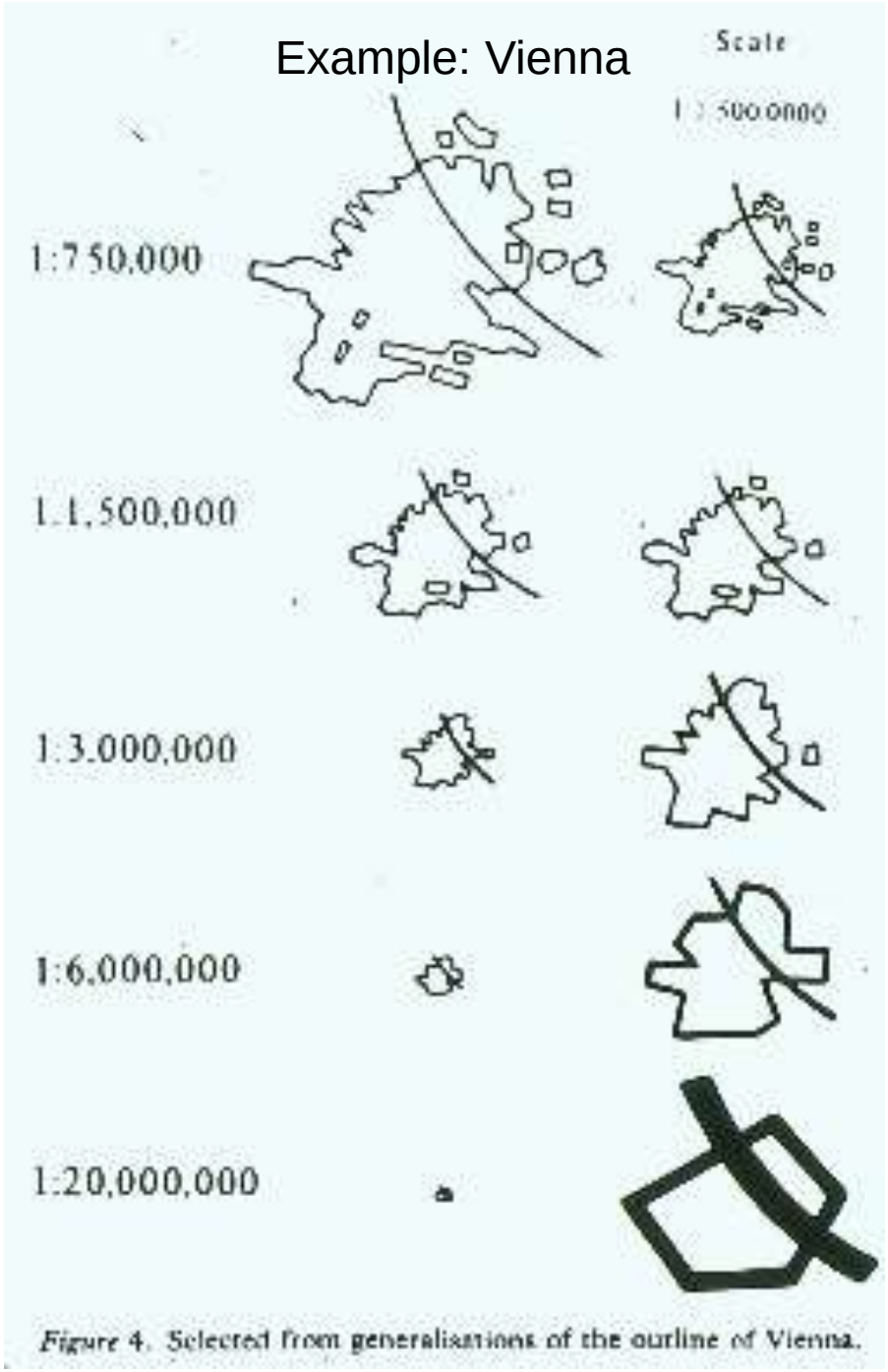
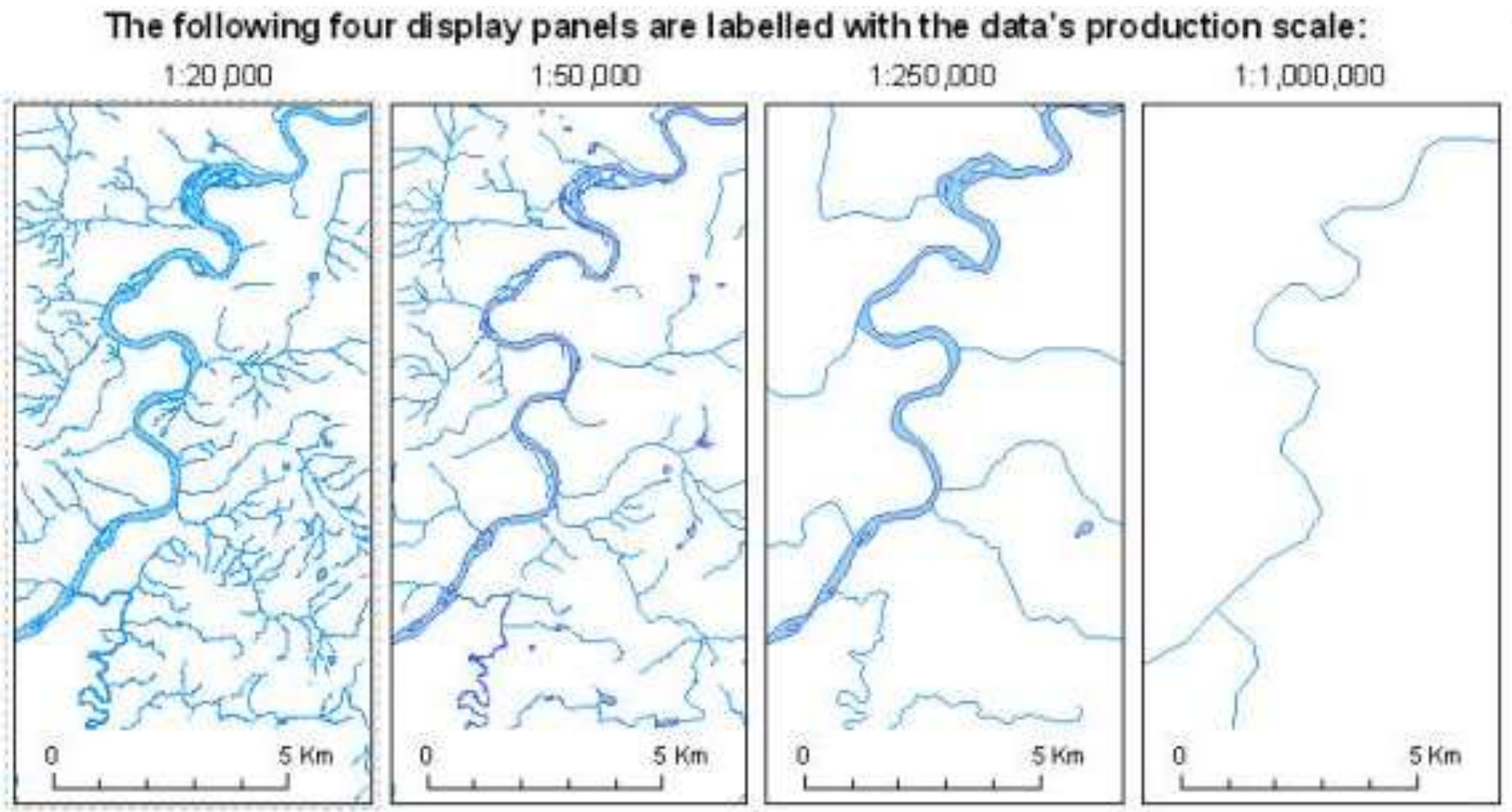


Figure 4. Selected from generalizations of the outline of Vienna.

Selection example: (elimination, smoothing) plus collapsing



http://resources.esri.com/help/9.3/arcgisengine/java/gp_toolref/data_management_toolbox/an_overview_of_the_generalization_toolset.htm

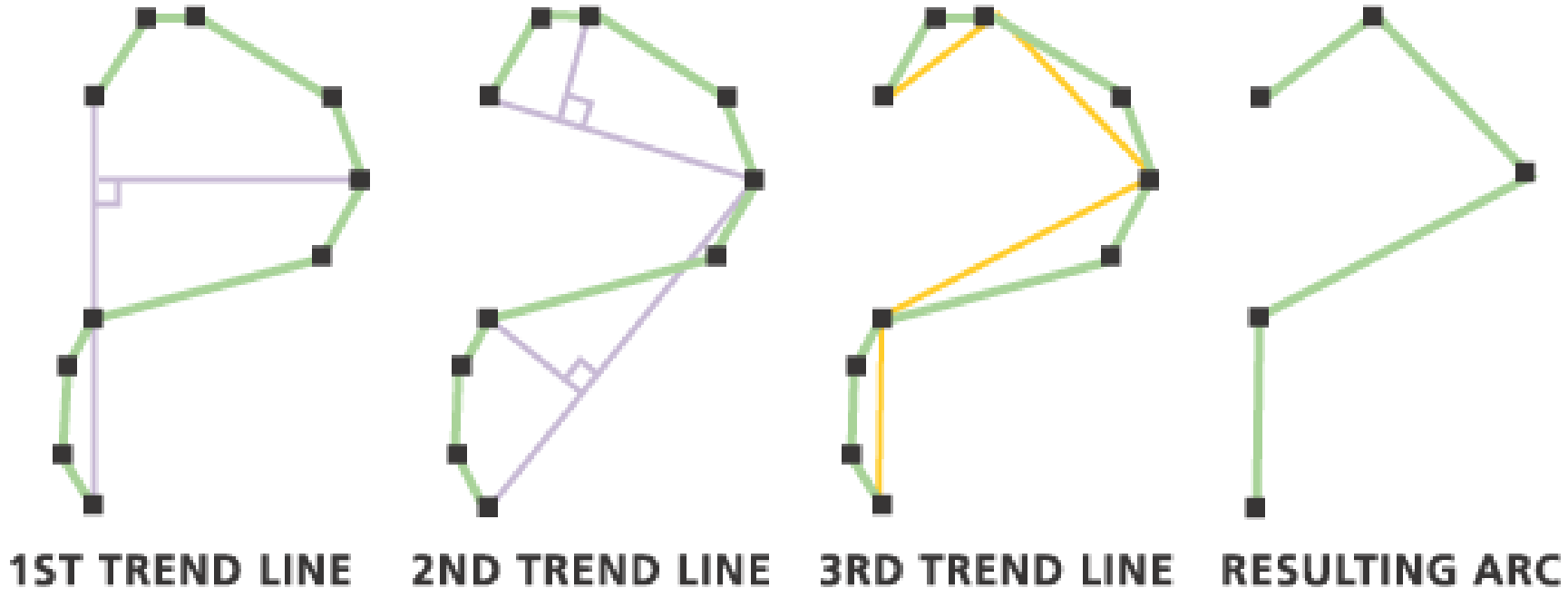
ArcGIS generalization tools – 'GIS analysis'

Aggregate Points	Creates polygon features around clusters of proximate point features.
Aggregate Polygons	Combines polygons within a specified distance of each other into new polygons.
Collapse Dual Lines To Centerline	Derives centerlines from dual-line (or double-line) features, such as road casings, based on specified width tolerances.
Collapse Road Detail	Collapses small, open configurations of road segments that interrupt the general trend of a road network, such as traffic circles, for example, and replaces them with a simplified depiction.
Delineate Built-Up Areas	Creates polygons to represent built-up areas by delineating densely clustered arrangements of buildings on small-scale maps.
Create Cartographic Partitions	Creates a mesh of polygon features that cover the input feature class where each polygon encloses no more than a specified number of input features, determined by the density and distribution of the input features.
Merge Divided Roads	Generates single-line road features in place of matched pairs of divided road lanes.
Simplify Building	Simplifies the boundary or footprint of building polygons while maintaining their essential shape and size.
Simplify Line	Simplifies lines by removing extraneous bends while preserving essential shape.
Simplify Polygon	Simplifies polygons by removing extraneous bends while preserving essential shape.
Smooth Line	Smooths sharp angles in lines to improve aesthetic or cartographic quality.
Smooth Polygon	Smooths sharp angles in polygon outlines to improve aesthetic or cartographic quality.
Thin Road Network	Generates a simplified road network that retains connectivity and general character for display at a smaller scale.

http://resources.arcgis.com/en/help/main/10.1/index.html#//00700000002r000000

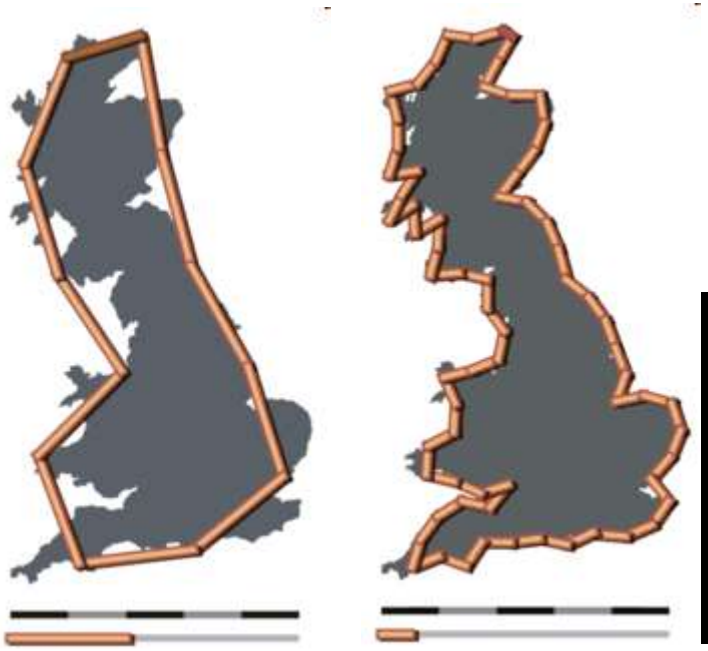
Early computer cartography … pioneered by Canadians
ArcMap ‘Simplify Line’ – based on Douglas-Peucker algorithm

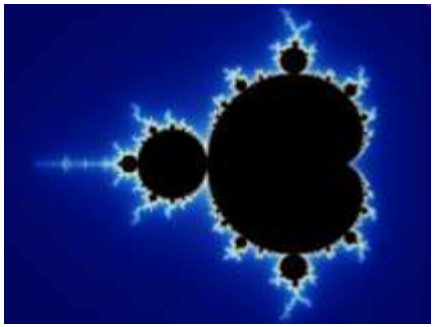
Douglas and Peucker (Poiker), 1973 U.Ottawa / SFU
.. Picks the ‘significant points’ in a line



Benoit Mandelbrot: "How Long Is the Coast of Britain? "

'Fractals' *Statistical Self-Similarity and Fractional Dimension (1967)*





Unit = 200 km, length = **2400 km**

Unit = 50 km, length = **3400 km**

CIA:	12,429 km	(1:100,000)
Ordnance Survey:	17,820 km	(1:50,000)

Infinite? ->

Try this on google maps when you zoom

Length of Coastline by Country

Canada – we're #1 (at any scale)

Length = 202,080 km or 265,523 km or …..

3. Classification (by attributes)

We can't keep all features unique – e.g. every road or building might have special characteristics, but they have to be grouped.

(in one of 3 ways)

Nominal: by 'name type' - categorical

Ordinal: in sequence (hierarchy) - ranked

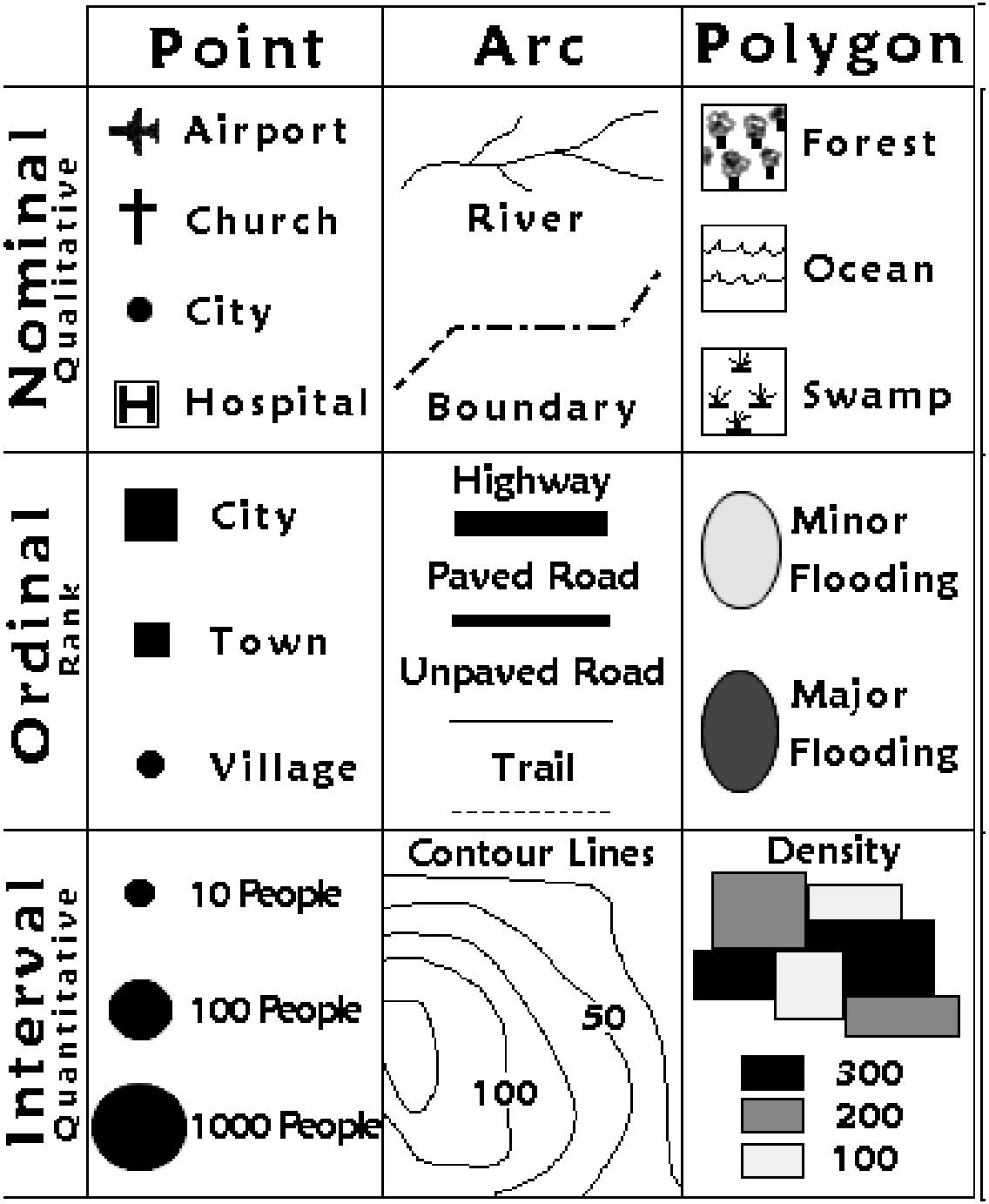
Interval: numerical (by size) - quantitative

Classification

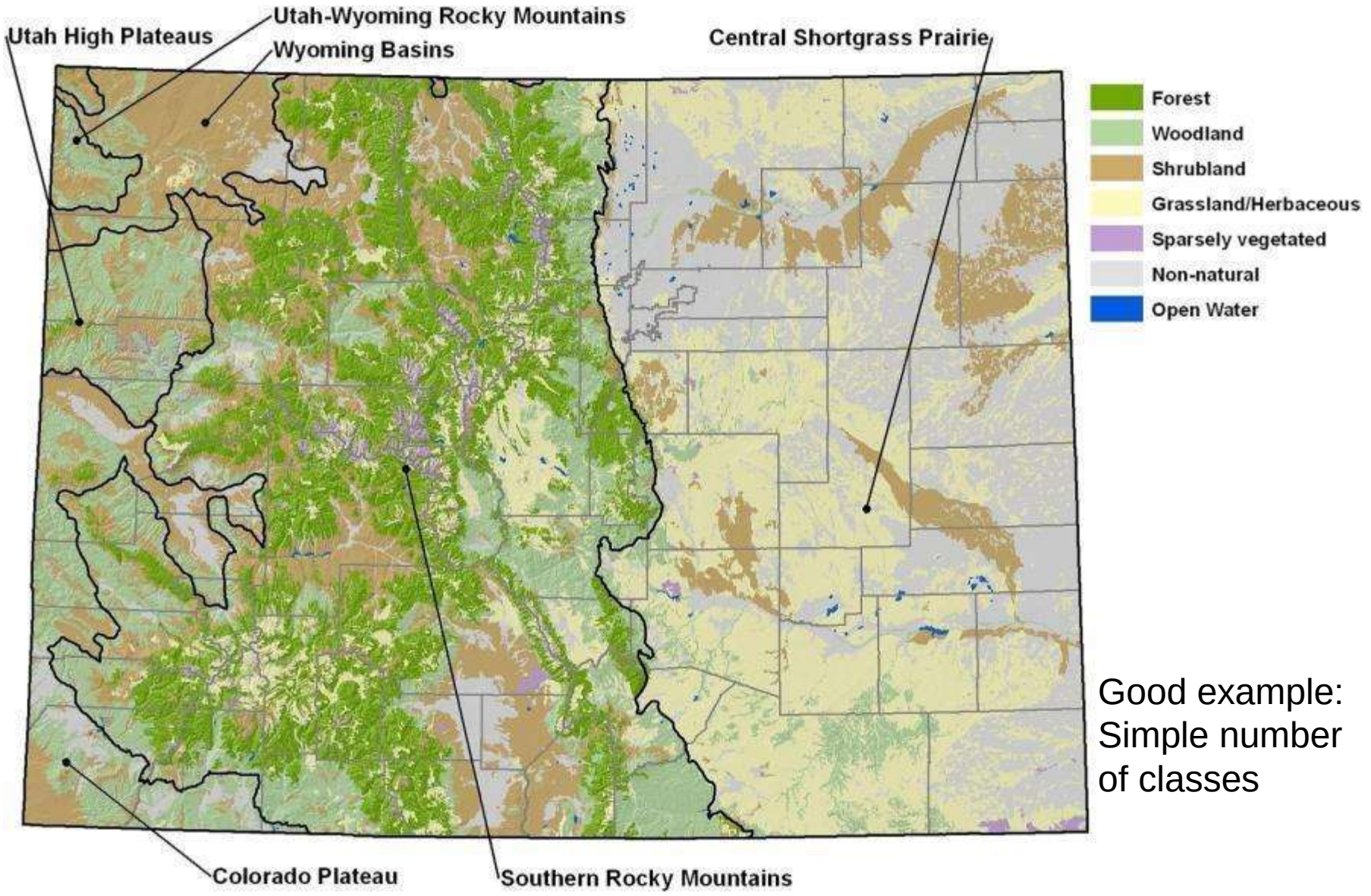
generalisation into groups

Note:

with classification, we are generalising feature attributes, while simplification and selection were more often applied to spatial elements

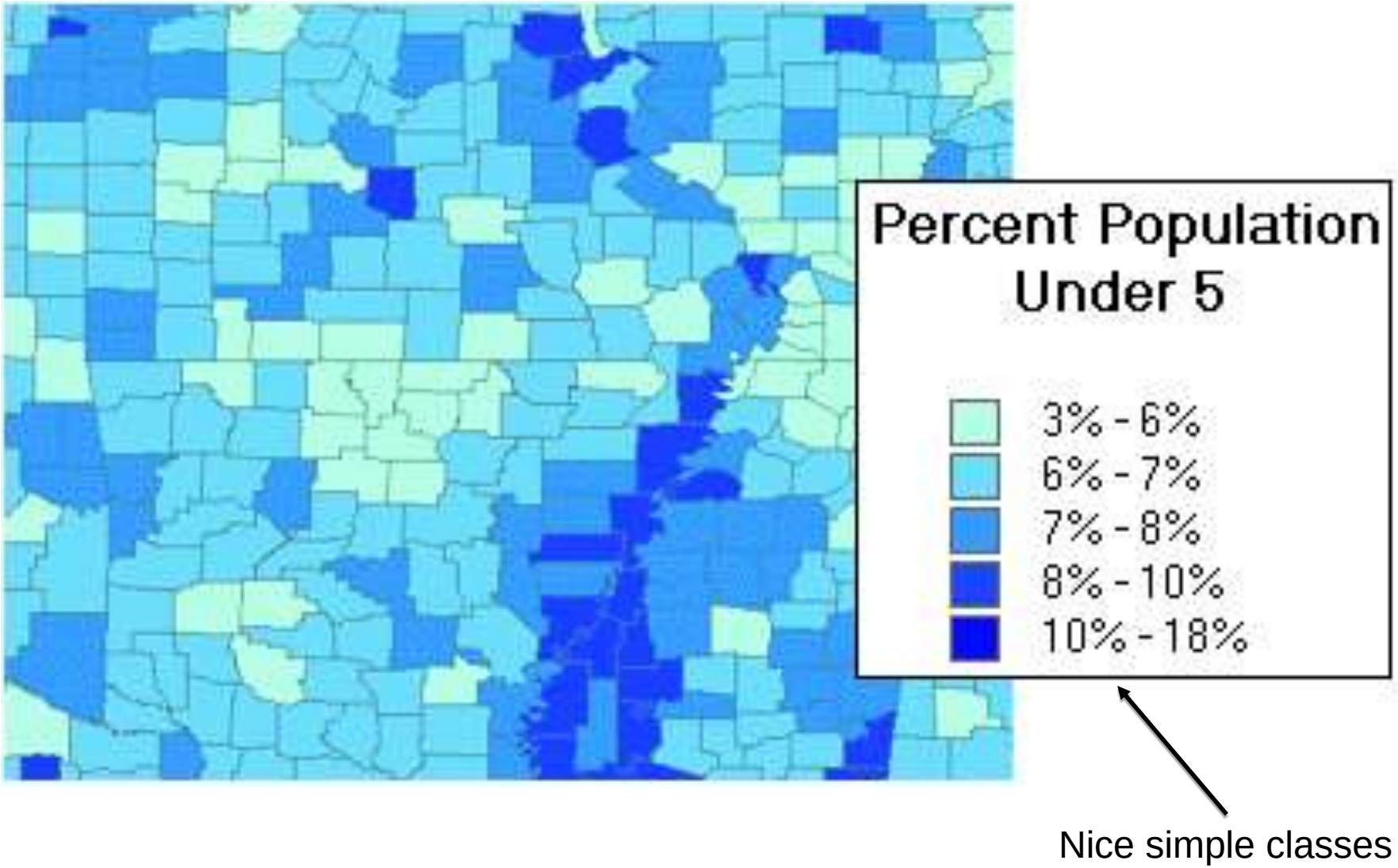


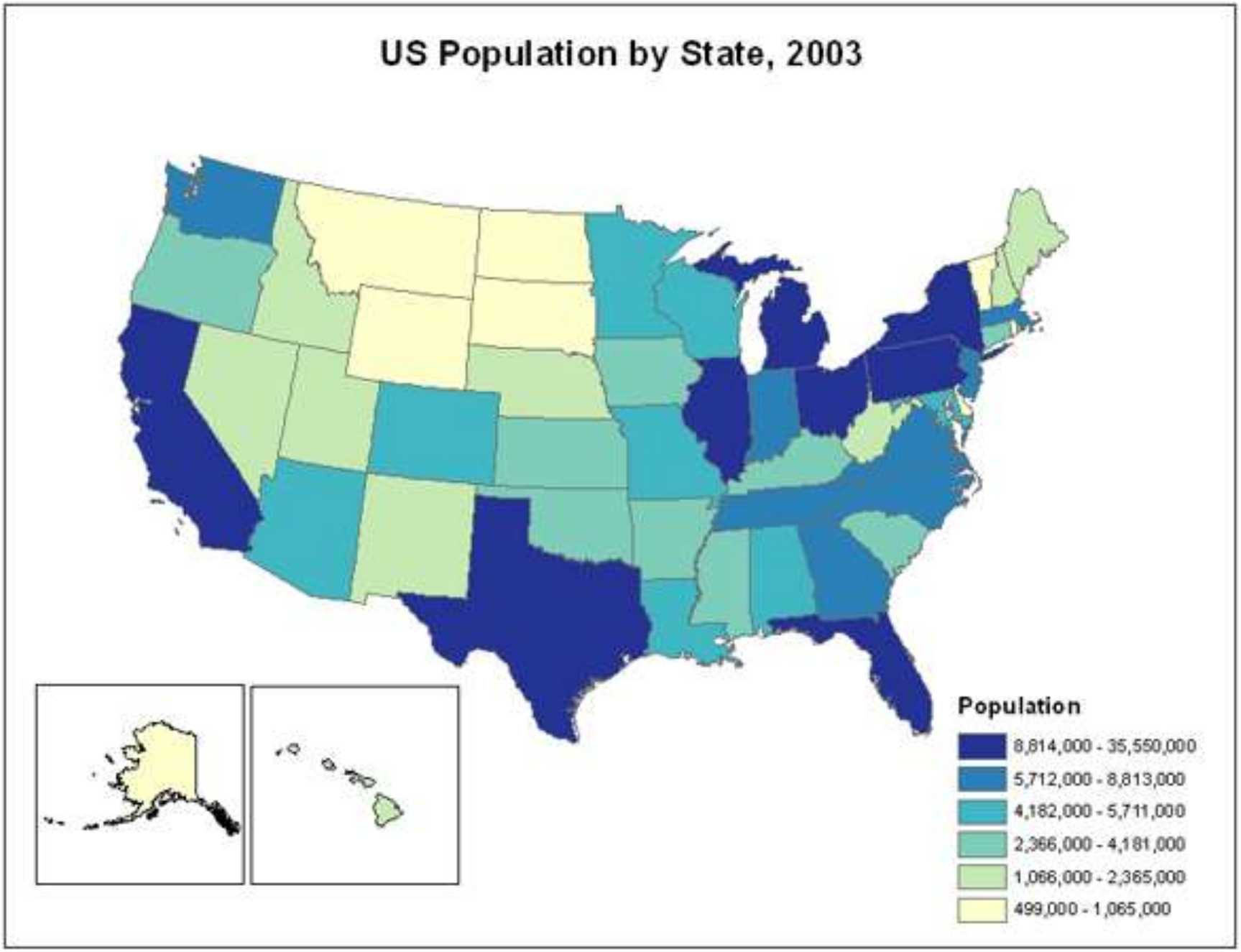
Examples: Categorical (nominal) classes



Good example: Simple number of classes

Quantitative (interval) classes





Yikes!

These classes need more simplification

Scale and Resolution

As scale decreases, spatial and attribute details decrease

There is a practical level of detail associated with any scale

One could identify a visual 'minimal resolvable unit' (MRU) of ~ 0.5 mm.

This translates for common display scales in metres:

1:20,000	10m
1:50,000	25
1:250,000	125
1:1,000,000	500

This is also synonymous with **resolution** or **precision**

This is fixed with printed maps, variable with digital display

Digital data scales for mapping

Digital data correspond directly to their analogue maps, and data are available at these common scales:

Global:	1:1,000,000	largest scale for whole world ?
Federal:	1:250,000	largest scale for all Canada before 2012
Federal:	1: 50,000	largest scale for all Canada (since 2012)
Provincial:	1: 20,000	largest scale for all BC (+ some provinces)
Municipal:	1: 1,000 to 5,000	scale for most cities / municipalities

These above are most often the data layers we see on map viewers e.g. :

New Zealand: http://www.topomap.co.nz/

Norway: http://www.norgeskart.no

Canada: http://atlas.gc.ca/toporama/en/index.html

Summary of scale and generalization

Scale is the prime control on generalization

Data captured at one scale are <u>not</u> transferable to all scales:

- **data from a larger scale are too detailed for smaller scales,**
- **data from a small scale are too generalised for larger scales.**

Too much detail

Other Controls on Generalization (apart from scale)

Map / output purpose: how much detail, and what types of features

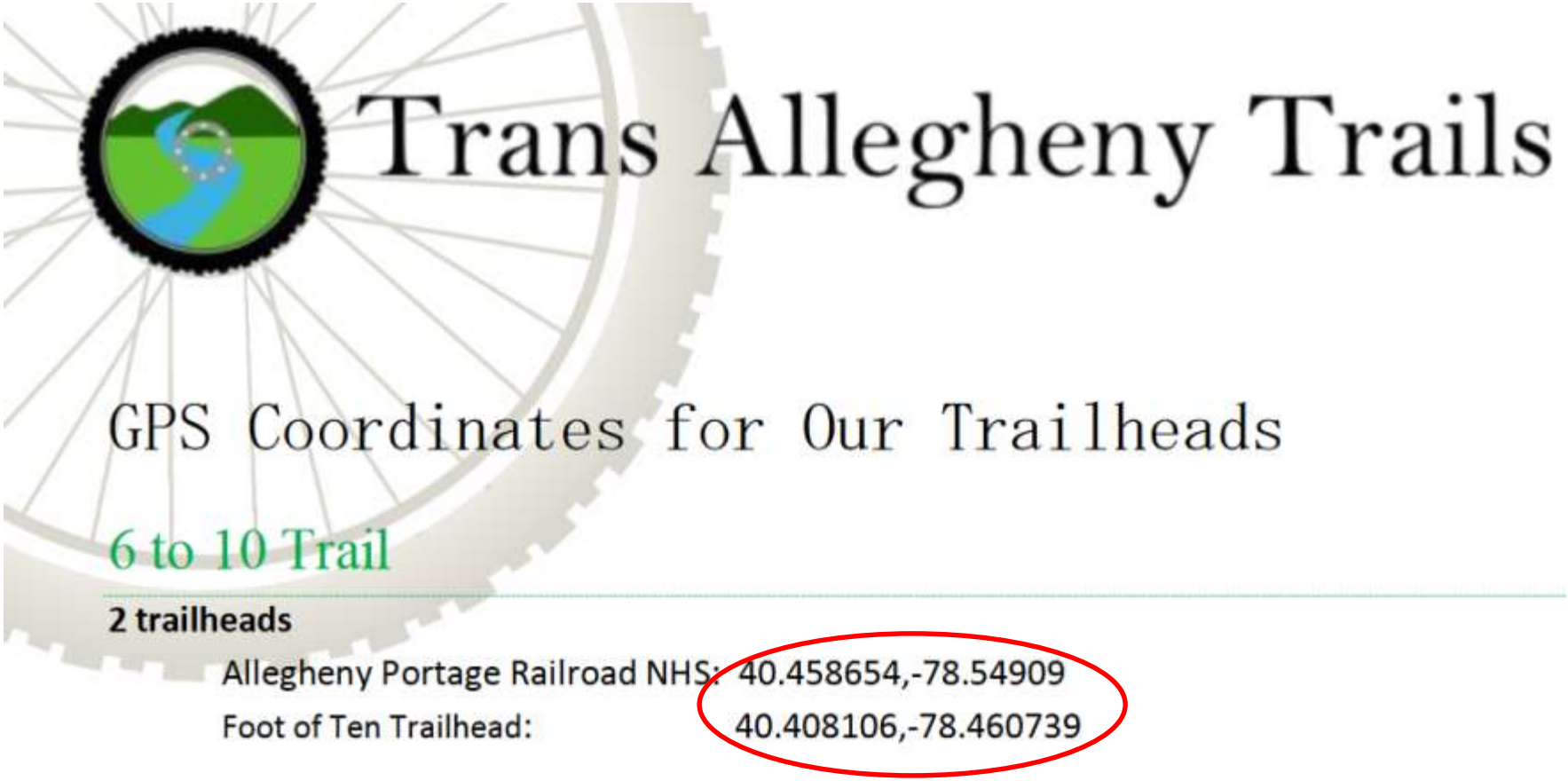
Graphic production limits: how much detail can the display convey

Data quality: survey methods may limit the details possible

Perceptual limits: the human eye / brain likes <= 7 classes

http://en.wikipedia.org/wiki/The_Magical_Number_Seven,_Plus_or_Minus_Two

Spatial generalization and precision: GPS and GIS



6 decimal places

1° =111km; .1 = 11km, .01 = 1km .001 = 100m,
.0001 = 10m, .00001 =1m, .000001=10cm

Don't just repeat decimal places from GPS / GIS software !

Trailhead

Johnston Canyon Resort, 17.5 km (11 mi) northwest along the Bow Valley Parkway from the Trans-Canada Hwy.

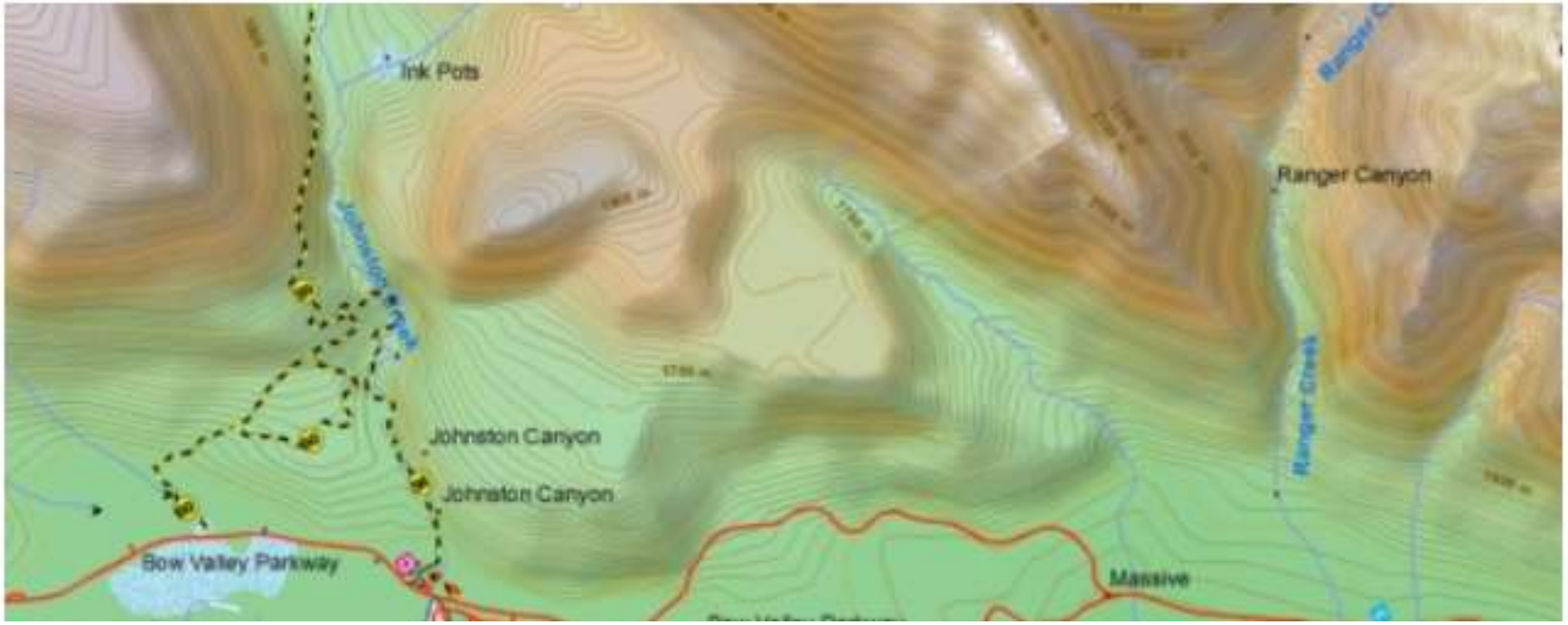
GPS Coordinates

Latitude: 51.245423072416 23

Longitude: -115.83992958068848

14 decimal places !
-too precise; NOT accurate
-not enough **generalization**
Last digit = millionths of a mm

Detailed Map



Extra: Reporting coordinates

Latitude / longitude:

Lat first, Long second – except for GIS software !

Alphabetical and which ‘came first’ (in time)

- See Google maps, Earth, PGmap, BC iMap (Lat/long)

Use N,S,E,W … (+) - are for computers, not humans

UTM:

Always Eastings then Northings (alphabetical)

Interesting for antipodeans: Northings are from the South Pole, with a ‘S’ label

e.g. Equator = 10,000,000 (S)

Summary review questions

- Why is generalisation necessary ?
- How is it related to map scale ?
- What happens to points, lines, areas as scale decreases ?
- What are aggregation, elimination, smoothing, collapsing ?
- What are the three types of data classification ?