Exercise – Data Capture by Digitizing

Introduction

Recall!
***Geodata capture is the first 'step' of the GIS definition** (Burrough 1986).*
Geodata: Capture → Storing → Retrival → Transformation & Analysis → Presentation.

DIGIT-1 ➔ ➔ ➔ ➔ ➔

DIGIT-2 ➔ ➔ ➔ ➔ ➔

Data capture is the process by which [1]spatial objects are identified, [2]their absolute locations are recorded, and [3]their spatial relationship is established.

In practice, during the first phase (identification of spatial objects) you may be:

- Standing on a hill overlooking an area, recognizing the patches of forests surrounding you.
- Looking at a hand-drawn map describing the walking paths leading up to that same hill.
- Interpreting an aerial photo in a GIS software (*e.g.* ArcGIS Pro).

During the second phase (recording the spatial location of objects), geodata are generated by digitizing.
The old-school technique involved the use of a digitizing table (Fig. 1a-b).
The need of costly digitizing table equipment was greatly reduced, however, by the introduction of 'heads-up' digitizing.
Using heads-up digitizing, all digitizing is conducted within the GIS software environment directly on your PC (Fig. 1c).

Finally, during the third phase, the rules of the spatial relationship between the features (*i.e.* the topology) are set up.
Such rules establish for example whether polygon features may overlap. This moment is not covered by this exercise.

Digitizing =
Producing digital spatial data from analogue sources (or from digital sources of a different format, e.g. points, lines or polygons from a georeferenced raster image).

Fig. 1a-b) Digitizing using a digitizing table, and c) 'heads-up' digitizing of a polygon feature on a PC using a GIS software.

Objective

Aim:

In this exercise you will extend your own geodata library with georeferenced feature (vector) data. You will:

- Be introduced to the ArcGIS Pro data management environments – the Catalog pane and the Catalog view.
- Practice your skills to interpret physical objects in aerial photos and/or topographic maps.
- Learn to digitize point, line and polygon features by the 'heads-up' digitizing technique.

Exercise

Heads-up digitizing

In practice, heads-up digitizing usually calls for some measures of preparation.

i) If the working material is an analogue map, the printed map needs to be turned into digital format by scanning.

ii) The digital image is then imported to a GIS software and georectified (See preceding exercise).

Georectification =
The process by which the coordinates of an image are converted from image coordinates to real-world coordinates. Georectification typically involves rotation and scaling of pixels.

When the printed map has been transformed into a digital georectified image, the actual digitizing may commence.

Heads-up digitizing means that features are created (drawn) with the digital georectified image as a background. The digitized features (points, lines or polygons) correspond to real objects interpreted from the background image.

As a background image, you may use a nationwide orthophoto from the IGN Geodata Library.
(A Basemap is also fine, however then you ought to change the coordinate system to ETRS 1989 utm zone 32N.)
You may also consider using your georectified historical image (from the previous exercise) as a supplement.

DIGIT-3 ➔ ➔ ➔ ➔ ➔

What objects should you digitize?
Well, you are free to choose any kind of object as long as you practice to digitize each of the three feature types (*i.e.* points, lines and polygons, Fig. 2).

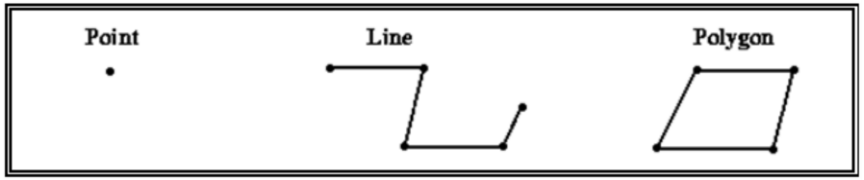


Fig. 2 The three main types of features.

Three principal feature types:

- *Point*
- *(poly-)Line*
- *Polygon*

A few examples:

- Point – metro stations, schools, churches/chapels
- Line – bicycle lanes, major/minor roads, metro lines
- Polygon – green/recreational areas, parking lots, buildings

Tip! ➔ ➔ ➔ ➔ ➔ ➔ ➔ ➔ ➔

You may also get help from the Danish webMap service at http://map.krak.dk/ to identify various objects. OpenStreetMap may also be useful (www.openstreetmap.org/). Or, Google Maps (https://www.google.com/maps)

Have a look at a contemporary orthophoto and the rectified historic aerial photo layers in ArcGIS Pro.
What kind of spatial objects are distinguishable?
You may use a topographic map (from Basemaps or Geodata Library) as support when interpretations are ambiguous.

Important!

When you are considering a type of object, think in terms of spatial questions you would like to find an answer to later.
In a subsequent exercise you will be using the geodata you have digitized here, to answer your spatial question.
For example, how many people live within a distance of 100m from a particular metro/train station?
Or, are there any schools located adjacent to/close to busy major roads?
Please contact a GIS student instructor if you are uncertain whether your spatial question is realizable.

Exercise

Feature class

Catalog pane/view – intro

Feature type
(point – line – polygon)

Catalog pane/view
– create Feature class

Advice! ➔ ➔ ➔ ➔ ➔ ➔ ➔ ➔
Avoid special characters and spaces in the name.

The icon of a point feature class

1. Start a new ArcGIS Pro project ➔ Save it in a familiar location and name it appropriately.

In ArcGIS Pro, the digitized objects of feature/vector type are often stored as a *feature class*.
It is good procedure to create an empty feature class before you start digitizing features.
Preferably, this is done using the ArcGIS Pro data management environment – the *Catalog pane/Catalog view*.

One fundamental thing to know about ArcGIS Pro is that each feature class may only contain one feature type.
Consequently, you will create three empty feature classes – one for points, one for lines, and one for polygons.

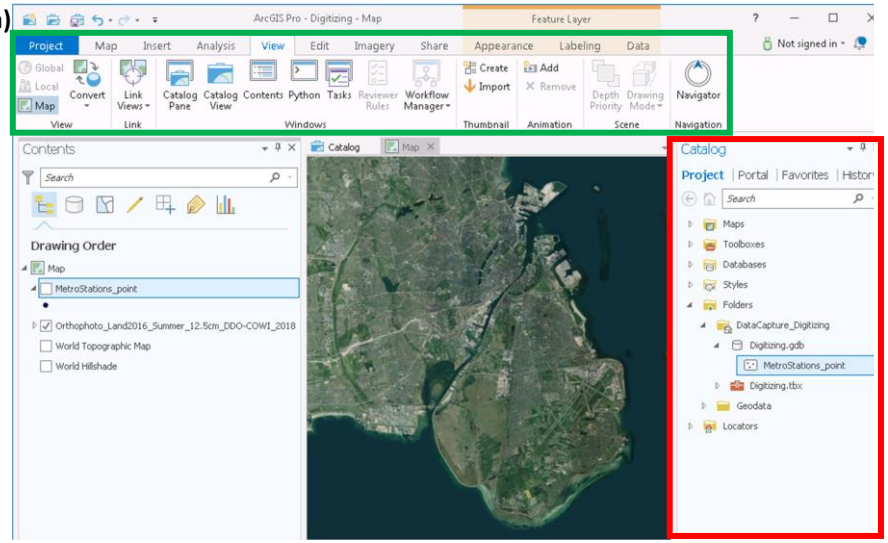
2. Create a new **point** feature class.

   a) In the Catalog pane (or the Catalog view): Right-click the project geodatabase (.gdb) ➔ New ➔ Feature Class.

   b) Follow the Create Feature Class stepwise wizard (see video).

There are two geodata management environments of ArcGIS Pro – the Catalog *pane* and the Catalog *view* (Fig. 3a-b).
They may both be opened from the View ribbon (Fig. 3a, **green** rectangle).
They do not differ much; you may do practically the same in both environments.
For example, create new and view existant folder connections, geodatabases (.gdb), feature classes and other files.

a)



b)

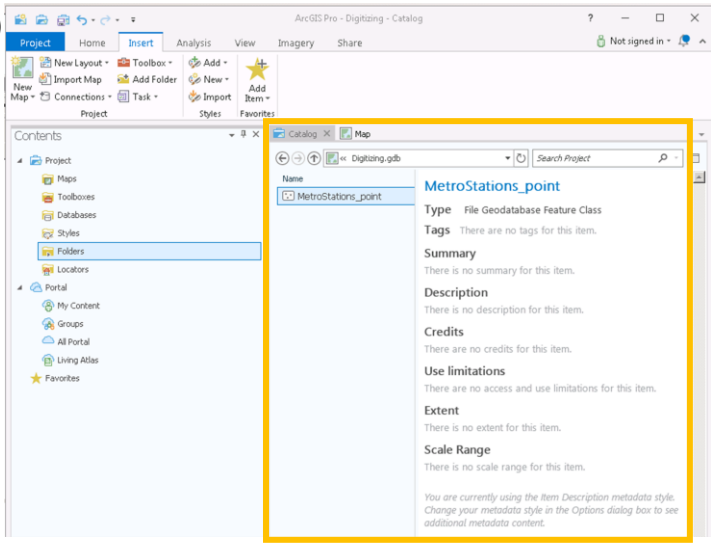


Fig. 3a) The Catalog pane (red rectangle), and the View ribbon (green rectangle). b) The Catalog view (orange rectangle).

Exercise

Geodata management

The Catalog pane/view is the place where you manage your geodata in ArcGIS Pro.
Here you may copy/move and delete existing geodata files (not just feature classes).

Here is why the Catalog pane/view is especially well-suited for copying/moving and deleting geodata files:

3. Let´s have a look at the (empty) feature class you have created.

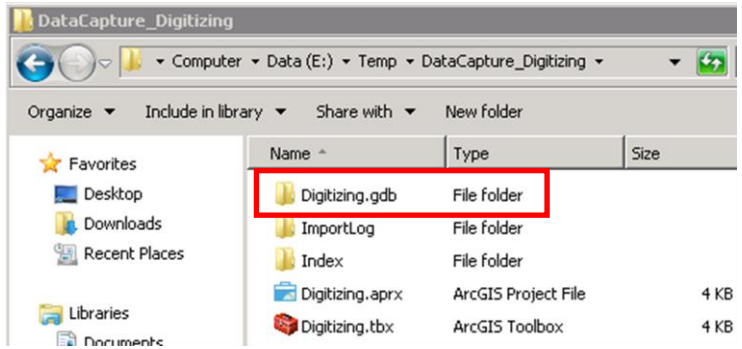
   a) In the Catalog pane (or the Catalog view), navigate to the folder where you stored the new point feature class.
   In the Catalog pane/view, you will find one single file representing the feature class (Fig. 3a-b)

Windows File Explorer
(available from the bottom panel of the screen)

   b) Now, open Windows File Explorer and navigate to the same folder.
   Notice that you may view the items of your ArcGIS Pro project, for example the project file (.aprx) and the geodatabase (.gdb) (Fig. 4a). Recall that your new point feature class is stored *inside* the geodatabase.

   c) Double-click/open the geodatabase (.gdb) in Windows File Explorer.
   There are a lot of files inside, but not anyone resembling the name of your new feature class (Fig. 4b).
   The reason is that you cannot read properly inside an ArcGIS geodatabase file using Windows File Explorer.

a)



b)

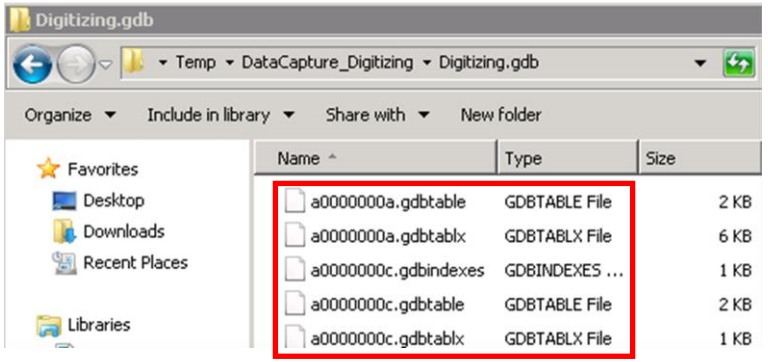


Fig. 4. In Windows Explorer: a) The geodatabase (.gdb) and a few other project items, and b) various files inside the geodatabase.

Valuable advice !!! ➔ ➔ ➔
(Do not skip.)

Catalog Pane/View vs. Windows Explorer

You are strongly recommended to use the ArcGIS Pro Catalog Pane/View to manage geodata files.

1. Sometimes geodata files are displayed the same way in both environments, for example the geodatabase file (.gdb).
Then of course, you may copy/move and delete a whole geodatabase in Windows File Explorer, although ArcGIS Pro is the preferable option.

2. Then there are occasions when you may not even read the geodata files in Windows File Explorer (*e.g.* inside a geodatabase).

3. Finally, there are the circumstances when you may read/view the geodata files in both the Catalog Pane/View and in Windows File Explorer.
The main difference, though, is that in the Catalog Pane/View the geodata is always presented as one geodata file,
whereas in Windows File Explorer the same geodata is presented as several files with varying file extensions (*e.g.* a shapefile: .shp, .dbf, .shx).
So, when moving geodata in Windows File Explorer, if you happen to overlook just one of those files (*i.e.* you fail to keep them together),
there is a serious risk the geodata will end up useless.

Exercise

Task – Digitizing points

Preparations for digitizing

Digitize point feature

It is time to start creating points to your point feature class. The points will represent some type of real-world feature. Drawing of features using the mouse and a georeferenced background map layer is called (heads-up) *digitizing*. The actual drawing activitity takes place in the Map view.

4. Insert a Map view (Insert tab ➔ New Map).

a) Select the type of Basemap you would like to use as a background image (Map ribbon ➔ Basemap).

b) Add the georectified historical aerial photo from a previous exercise.

Two things will happen automatically as you add the first map layer by yourself:

i) The Map view zooms to the full extent of the first added layer (*i.e.* central Copenhagen).

ii) The coordinate system of the Map view will change to the one of the first added layer.

Recall that the georectified image was saved in the *ETRS 1989 UTM zone 32N* projected coordinate system. Consequently, the current ArcGIS Pro project will automatically be set to this projected coordinate system.

Note! ➔ ➔ ➔ ➔ ➔ ➔
If you saved the image in another coordinate system (e.g. WGS84), you are advised to switch the Map frame to the ETRS89 UTM zone 32N.

c) Then, add one or a few alternative geodata layers to use as background for your digitizing operations.

Tip ➔ ➔ ➔ ➔ ➔ ➔
Performance is generally better using geodata from the IGN Geodata Library. The Basemaps are often much 'slower'.

The background geodata layers are preferably recent and detailed orthophotos and/or topographical maps, which you may add from the IGN Geodata Library.

d) Finally, from the project geodatabase, add the newly created empty point feature class.

5. To be able to digitize features you need to open the Edit ribbon.

Edit ribbon

a) Open the Edit ribbon and click the Create button (Fig. 5).

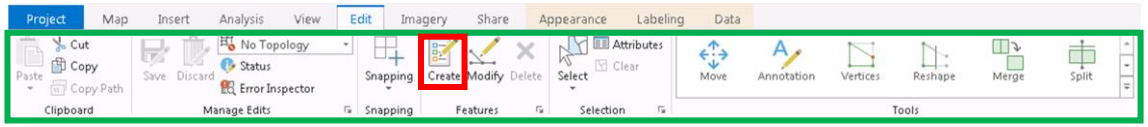


Fig. 5. The Edit ribbon (green rectangle), with the Create button (red square).

Create Features pane

b) From the Create Features pane, select the Point tool (Fig. 6).

Point tool

c) Start digitizing point features using the Point tool.

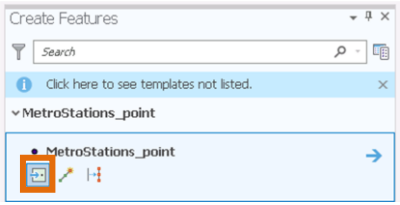


Fig. 6. The Create Features pane, with the Point tool (orange square).

Heads-up digitizing

Troubleshooting:
If you for some reason want to use any other tool in-between (*e.g.* a zoom tool) the Point tool will become deactivated. In order to re-activate a tool, you need to select it again in the Create Features pane or on the Edit ribbon.

Exercise

Tips! ➔ ➔ ➔ ➔ ➔ ➔ ➔
You may get help to find any or 'Imagery Hybrid' Basemaps. Also, the Locate tool is useful to find addresses and places.

Another tip!
Use the 'Hybrid' mode (the green rectangle in Fig. 7a) in http://map.krak.dk/ to view both the orthophoto and the names of roads and other spatial objects.

Can´t find the real-world features you are looking for?
If the background geodata layers are not helpful for locating the specific point object you are looking for (*e.g.* a metro station, a school) you may of course use any other aid for the *initial localization* of the object (Fig. 7).

a)

b)

Fig. 7a) Two spatial objects (metro stations) high-lighted in the webMap service at http://map.krak.dk/ .
b) The same two objects (light-blue dots) digitized as point features in ArcGIS Pro.

Optional tip!
Increased performance.

(Optional) Why save the project to the local hard drive (C:/ drive) temporarily?

Until now you have been advised to save your ArcGIS Pro project on your personal H/T:/ drive.
This is a good idea since the H/T drive is a network drive, and you may reach your saved data from any computer in the CGD.

However, at times there are many students in the CGD and there is heavy data traffic across the local network.
Then you may experience substantial lags, especially if you are handling large-sized data files (which geodata quite often are).

One way to improve the performance is to *temporarily* save the project and the geodata files on the C:/ drive instead.
The C:/ drive is a local storage space on the hard drive on the computer, and the data traffic will not go across the network.

IMPORTANT!
When you are finished: -Do not forget to cut-n-paste the project and the geodata files back to your personal H/T drive again!!!
Else you may risk losing the data (since the IT staff are 'cleansing' the hard drives frequently).

Exercise

Task – Digitizing points

As you may have realized, the only type of feature you may generate is points.
No matter how hard you may try to draw a line in your point shapefile you will not succeed. Why?

The answer is:
The type of feature the Point tool may generate is entirely determined by the type of target feature class.

- If the target is a *point* feature class, then the Point tool will only generate points.

- If the target is a *line* feature class, a Line tool will only generate lines and so on.

Attribute Table =
The database of a feature class, where each row corresponds to a single feature.
(In a shapefile the Attribute Table is the .dbf file.)

7. The Attribute Table helps you to get an overview of the point features digitized so far.

a) Open the Open Attribute Table (Fig. 8).
Here you will find one column/field representing the feature ID number (OBJECTID) of all the digitized points, and a column describing the type of feature (Shape).

Attribute Tables will be presented in detail in a subsequent exercise ('Geodatabases & Attribute Tables').

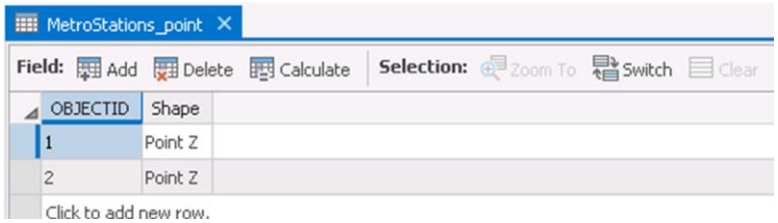


Fig. 8 The Attribute Table of the digitized feature class. The OBJECTID column/field represents the feature ID no., and the SHAPE column/field describes the feature type.

b) Check that the number of digitized features is correct.

c) Close the Attribute Table.

Notice!
The OBJECTID no starts with 1.

DIGIT-4 ➔ ➔ ➔ ➔ ➔

Edit a point

8. If you are not satisfied with the position of a digitized point, you may easily adjust its position (or just erase it).

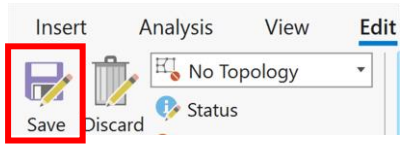
a) From the Edit ribbon, select the Move tool. 

b) Select a point by clicking on it (or by click-and-drag a rectangle around the feature).
- The selected feature is high-lighted in a yellow colour.
- The mouse pointer turns into a black arrow-cross. 

c) Use the Move tool to drag the point in any direction.

Tip!
You may select several features by holding down the SHIFT key.

9. Remember to save new edits frequently in the Edit ribbon.



10. To erase a selected feature:

a) Simply press the DELETE key on the keyboard (or right-click ➔ Delete).

b) Afterwards you may undo the action by clicking the Undo button  in the upper left corner.

If you are digitizing metro stations, you should at least complete the M1/M2-lines (22 stations altogether).

Exercise

Task – Digitizing lines

The icon of a line feature class

DIGIT-5 ➔ ➔ ➔ ➔ ➔

Digitize line feature

Node/Vertex =
The points which delimit each segment/arc of a poly-line.

Edit line feature

Network

Topology

DIGIT-6a-c ➔ ➔ ➔ ➔ ➔

Merge/Split line features

Digitizing lines is much the same technique as digitizing points.

In fact, a line is composed of a sequence of points (or nodes/vertices), connected by line segments.
And, therefore you occasionally encounter the concept of a poly-line.
A poly-line is a line (often curved) built up by shorter segments of straight lines between three or more vertices (Fig. 9).

11. Generate a new empty line feature class, much the same way as before.
    Remember to use the Feature Type: ***line***

12. Figure out what type of a line object you would like to digitize.

    a) Start digitizing a line and click wherever the line object in the orthophoto bends.

    b) Double-click to end a poly-line sequence.

    The vertical stretch of major road in figure 9 is built up by a sequence of >15 points (nodes).

13. You may edit a poly-line feature.

14. Continue digitizing at least 20-30 poly-line features, **>1 km** long, preferably some crossing the others.

In line-type of geodata you often find the vertices/nodes interconnected to each other in a complex network.
It may be a city sewage system, a railroad network, or the Amazonas river basin.
Although topology is beyond the scope of this course, we will show you how you can connect separate line stretches into a connected network.

15. Merge and Split a few of the crossing poly-lines.

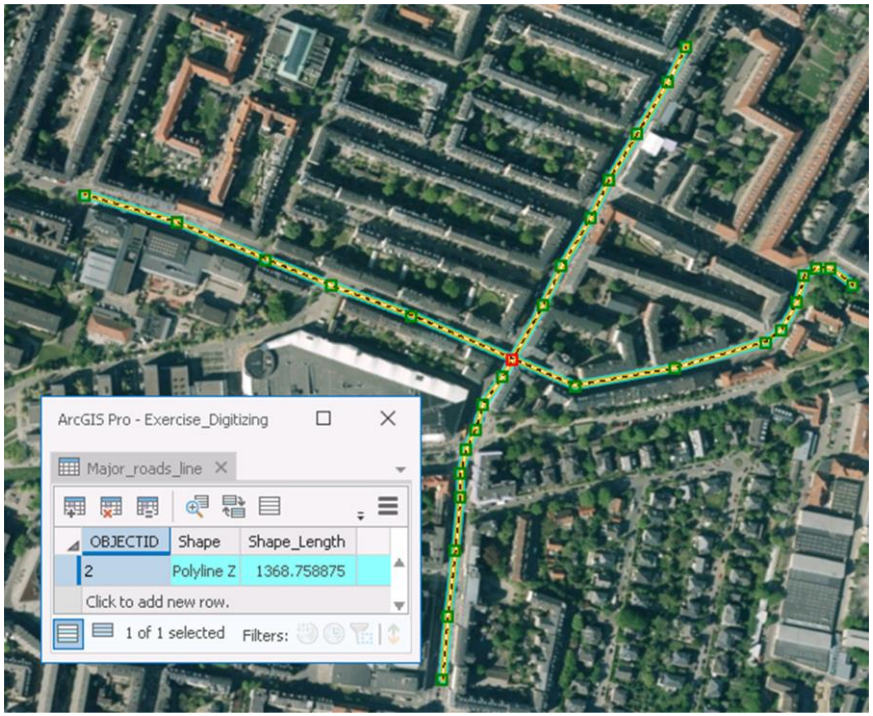


Fig. 9 Two major road features digitized as poly-line features (yellow). A poly-line is built up by a sequence of connected points (green nodes). The originally separate (two) major road poly-line features have subsequentially been merged into one feature (see Attribute Table). The former separated lines are connected at the crosspoint (red node).

(*Troubleshooting*: In the video you are introduced to Split lines 'By Value'.
In later versions of ArcGIS Pro, this function is instead presented as a new tool – the **Divide** tool.)

There are more options to edit poly-lines using the Edit ribbon. Please try out a few at your own free will.

Exercise

Task – Digitizing polygons

Digitizing polygons is very similar to digitizing poly-lines.
The difference is that you connect the start node with the end node in order to close an area bounded by line segments.

The icon of a polygon feature class

16. First, in ArcGIS Pro, generate a new empty polygon feature class, the same way as before.
    Remember to use the Feature Type: ***polygon***

Digitize polygon feature

17. Figure out what type of a polygon object you would like to digitize.

    a) Start digitizing a polygon by clicking the corners and bends of the polygon object in the image.

    b) Double-click to complete the first polygon (Fig. 10).

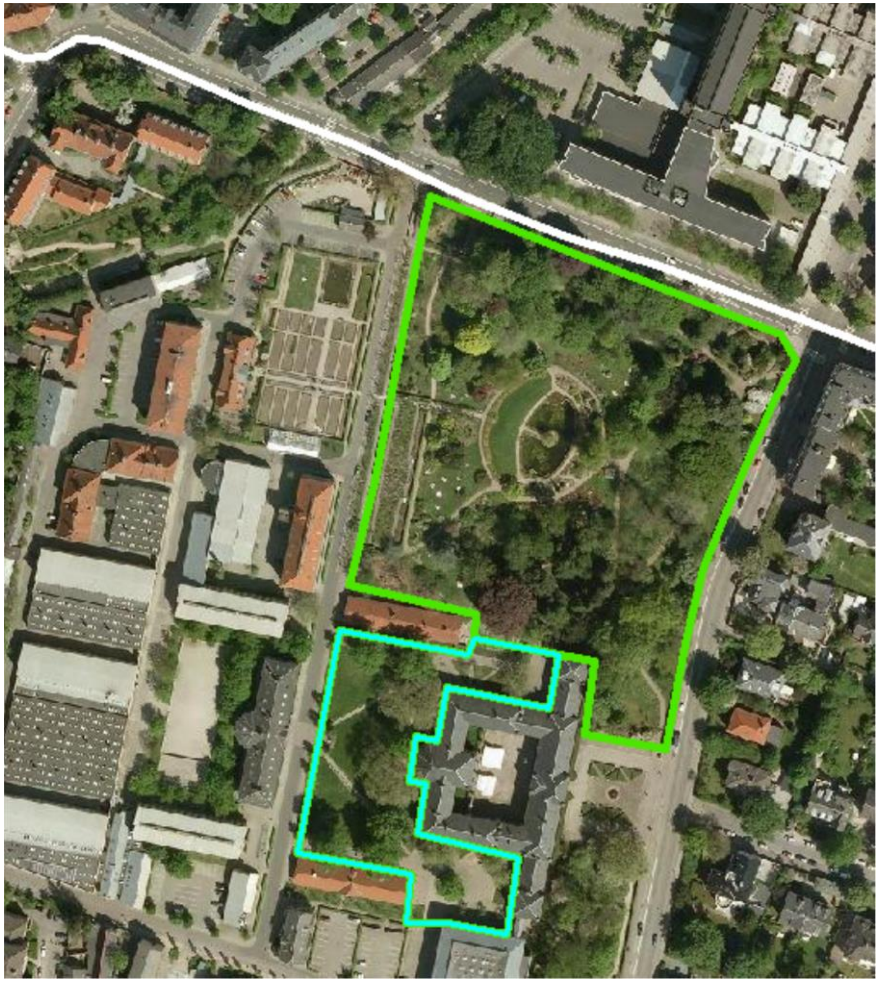


Fig. 10 Two adjoining park polygon features (outlined in green). The polygons have been made transparent.

Adjacent polygons

A recurring problem you face is when you would like to create a polygon adjacent to another polygon (Fig. 10). Probably you would like to avoid creating polygons, which are overlapping, or with narrow gaps in-between. This is particularly important with administrative areas declaring ownership, like national borders.

Gaps & Overlaps

Whether or not your polygon feature class will contain any adjoining polygons, you will now be introduced to some handy tools and functions which will help you to avoid generating gaps/overlaps and to continue digitizing an already existing feature:

i) Snapping

ii) Continue Feature

iii) Tracing

Exercise

Task – Digitizing polygons

Snapping

Snapping tool

Snapping works for all feature types (point-line-polygon)

Snapping Distance/Tolerance

Continue Feature tool (see Snapping video)

Tracing

Trace tool

Continue digitizing

Digitize 25-30 features of each type (point-line-polygon).

DIGIT-7 ➔ ➔ ➔ ➔ ➔

The first very useful function which greatly improves your accuracy when digitizing polygons is called snapping.
Snapping is a built-in 'homing-in' function that guides your pointer automatically onto the outline of a nearby feature when you are approaching it.

18. Activate or modify the snapping environment to match your own needs.

    On the Snapping toolbar are buttons representing various types of snapping (*e.g.* at a point, start or end point, vertex/node or on an edge/line, Fig. 11).
    (If you hoover the pointer above a button, the tool information will appear.)
    Some of the snapping functions may already be active at start by default.
    You may activate/deactivate snapping by clicking the Snapping tool button.

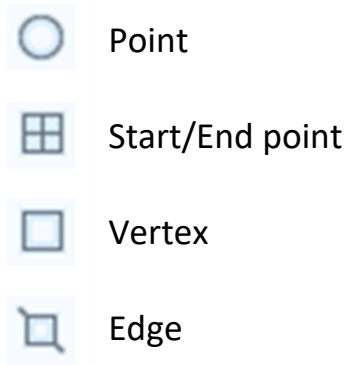


Fig. 11 The Snapping toolbar.
Snapping will occur when the mouse pointer approaches for example a edge or a vertex of a neighboring feature.

19. The Continue Feature tool lets you modify the size of an existing polygon feature.

A third very useful function, which greatly improves the accuracy when digitizing polygons is called the Trace tool.
The Trace tool makes it possible to digitize along the perimeter of another (bordering) feature (Fig. 12).
Thereby, you may avoid creating gaps and overlaps among adjacent polygon features, which should really align perfectly.

20. Try out tracing (regardless of there are any adjacent polygons).

21. Continue adding digitized points, poly-lines and polygons to your three feature classes. How many?
    There are 37 Metro stations. Perhaps, this is a good lead.
    Try to digitize at least 25-30 features of each type.

Now only one thing remains – saving your ArcGIS Pro project (and perhaps moving/copying all the project items).

22. Save your Project. Use the good practices you learnt before, to copy the Project along with all its items to a safe location on your personal H/T drive (if you initially saved it on the C drive).

Fig. 12 Digitizing using the Trace tool.
Tracing the outline of a pre-existing feature (thick green line). Here, the trace is visible as a dashed line inside the thicker green line of the pre-existing feature.

Thanks for your attention!