Lab 3: Vectors Part 1 (Digitizing, Attributes, and Joins)

Introduction
Vectors represent discrete geographic features using points, lines, and polygons. These might be river channels, infrastructure boundaries, or sampling locations. The exercise below focuses on creating and managing the attributes of vector datasets.

Following the 2018 floods in Ellicott City, a field assessment has documented the amount of damage to a number of buildings in the Historic District. Your goal is to identify whether this damage occurred within or outside of the FEMA designated floodplains. You will map the outlines of buildings from aerial imagery, join the damage assessments to your mapped buildings, and identify the amount of damage that occurred.

Learning Goals
By the end of this lab you will be able to:
- Build a polygon feature class and establish an attribute schema.
- Digitize vector features using snapping parameters.
- Use attribute and spatial joins to link different datasets.
- Calculate geometric properties (area) and use field calculations.
- Use Structured Query Language (SQL) to select features based on attribute criteria.

Datasets Provided

Name	Type	Description
EllicottCity_HistoricDistrict.shp	Polygon	Outline of the Ellicott City Historic District
Lab03_EllicottCity_Floodplains.shp	Polygon	FEMA 100 and 500 year floodplain maps
Lab03_EllicottCityBuildingAddresses.shp	Points	Points with addresses
Lab03_EllicottCityDamageAssessment.csv	Table	A table of flood damage at each address
Maryland Six Inch Imagery	Raster	High resolution aerial imagery (cloud-hosted)

Part A: Project Setup and Geodatabase Creation
1. Initialize Project
- Create a folder named lab03 and within it the standard subdirectories: raw, working, outputs, and docs.
- Create a new ArcGIS Pro project and map.
- Add the provided datasets Historic District polygon, Damage Assessment points, and the high-resolution Six Inch Imagery.

Part B: Digitize buildings
A field assessor has walked through central Ellicott City and noted the amount of damage at different buildings and recorded it in **Lab03_EllicottCityDamageAssessment.csv**. This CSV

has no spatial data so you cannot directly load it into GIS. It does, however, have a column for addresses. The file **Lab03_EllicottCityBuildingAddresses.shp** is a point file of addresses in Ellicott City. We want to know whether the buildings marked by these points are within the FEMA-designated floodplains, so these points aren't sufficient. We need polygons.

2. Create a shapefile to digitize the buildings

- In the Catalog pane, right click your default project geodatabase → **New** → **Feature Class**.
- Name: Structures_Digitized.
- Geometry Type: **Polygon**.
- Coordinate System: Use the same CRS as the map

3. Configure Snapping

- Turn snapping on by going to the **Edit** tab → **Snapping**.
- Open **Snapping Settings**. Ensure Vertex and Edge snapping are active.

4. Digitize Structures

- Zoom to an appropriate mapping scale (shown at the far lower left of the map window). 1:500 or 1:1000 is a good option. It's important to use a single scale when mapping or digitizing for consistency. Do not digitize at variable scales!
- Open the **Create Features** pane. Select the Structures_Digitized polygon template. If you don't see it, click the templates button to the right of the search bar.
- Digitize the footprint of 15 distinct buildings located within the EllicottCity_HistoricDistrict boundary where you have address data.
- Your features are not saved until you **Save Edits** – do this often! You can modify vectors using the Edit Vertices or Reshape tools on the Edit tab.

Part C: Table Joins

Now that you have the buildings outlines, you can join the addresses and the damage assessments.

6. Spatial Join the Addresses

- In the Geoprocessing window search for Spatial Join.
- The target features are your digitized buildings. The join features are the address points
- Spatial joins create a new output file. Name this Structures_Digitized_JoinAddresses. It can be helpful to name files like this (with the most recent geoprocessing step appended at the end) so that you can remember the file's history
- There are two types of spatial joins: One-to-one and one-to-many. Use one-to-one (if you are ever unsure about what a tool parameter does, look for the blue information marker to the left of each)
- Match option contains many options for how the join features overlap with the target features. Select which option you think is most appropriate.

7. Join the damage assessment

Now that your digitized buildings have address data, you can join the damage assessment from the damage assessment table.

- In Geoprocessing search for Join Field.
- Take a look at the table and select a field (i.e., column) that is shared by both the damage assessment and your Structures_Digitized_JoinAddresses. Note that the data in the fields needs to match exactly, so address is often not a great option. For example, if one dataset used “123 Main St.” and the other used “123 Main Street” the join would fail.
- Unlike spatial joins, attribute joins permanently fuse the data into the target feature

9. Update Symbology

Symbology describes how the quantitative data within your features is displayed on the map. The default option is for all features in a layer to look the same – you can update this so that different damage assessment levels plot as different colors.

- Click Symbology on the Feature Layer tab.
- Under Primary Symbology, select Unique Values. For the field, select Assessment.
- You can modify the colors by clicking them in the Symbol Column. For example, you might make Destroyed red, Unaffected green, etc.

Part D: Flood zone assessment

Now you have a polygon map of buildings in Ellicott City (Structures_Digitized_JoinAddresses) that contains damage assessment data. The next step is to look at which buildings are within the 100- and 500-year flood zones, and see whether those zones correlate with the observed amount of damage.

10. Determine Flood Zone Exposure

The workflow for this is up to you. You might use a Spatial Join to append the floodplain attributes to the buildings, or you can use the Select by Location tool to isolate the buildings that intersect specific flood zones.

- **Task:** Determine exactly which of your 15 digitized buildings fall within the 100-year floodplain, which fall within the 500-year floodplain, and which fall completely outside of both.

11. Calculate Building Footprint Area

To quantify the physical extent of the damage, you must calculate the geometry of the polygons you drew.

- **Task:** Open the attribute table for your buildings. Add a new field named Area_sqm (Double). Use the Calculate Geometry Attributes tool to compute the true planar area of each building in square meters.

12. Summarize the Damage

You now have the area, the damage state, and the flood zone exposure for each building. Use this data to evaluate the accuracy of the FEMA floodplains for predicting the 2018 flood damage.

- **Task:** Use the Summary Statistics tool (or manual selection and field statistics) to calculate the total square meters of buildings categorized as "Destroyed" or "Major Damage" within the 100-year floodplain.
- **Task:** Calculate the total square meters of "Destroyed" or "Major Damage" buildings located *outside* the 100-year floodplain.

13. Final Documentation

In your docs/ folder, create a plain text file named Lab03_Results.txt. Include the following:

- State the geoprocessing tool you chose to use in Step 10 (e.g., Spatial Join or Select by Location) and explain why you chose it.
- Report the total square meters of severely damaged infrastructure inside the 100-year floodplain versus outside the 100-year floodplain.
- Based on your calculated areas, state whether the FEMA 100-year floodplain accurately captured the limits of the severe destruction in your mapped area. Identify any discrepancies.