Introduction to GIS

Lab04 Geodatabase Development and Spatial Editing

Exercise 01 – Creating a GIS Database using Geodatabase Format

> This section covers screen digitization of a geo-rectified image. Digitization is a GIS data input method that transforms data from either a raster image or a paper map into vector form. An online base map will be used to create three feature classes using the Geodatabase data format.
> To complete exercises, you need the following:
> - ArcGIS Pro 3.3.1 (Basic, Standard, or Advanced)
>
> Video Demonstration:
> https://mediaweb.ap.panopto.com/Panopto/Pages/Viewer.aspx?id=f252f83b-6fca-496b-a064-aec200236436

1. Start ArcGIS Pro and sign in if necessary. Click **Map** and create a new project **IntroToGIS_Lab04_Exercise01**.

2. In **Catalog** Pane, navigate to your working folder. Right-click the folder and select **New → File GeoDatabase**. Rename the new Geodatabase as **IntroToGIS_Lab04_Exercise01_Database.gdb**.

3. Next, we will create feature classes of various geometry types (i.e., point, polyline, and polygon). Below are instructions for creating new feature classes in ArcGIS Pro.

4. Create a road (**polyline**) feature class. Right-click the Geodatabase you created, and choose **New → Feature Class**. In the **Create Feature Class** pane on the right, enter the following information.

Page 1/6	**Name**	major_road
	Alias	Major Road
	Type	Line
Page 2/6	**New data field**	Name (use Text as the data type)
Page 3/6	**XY Coordinate system**	Select "SVY21 Singapore TM"

Note: Choose **Line** for **Feature Class Type**, and use default settings for the remaining items.

Click **Finish**. You should find a new feature class named **major_road** under the geodatabase.

5. Create a building (**polygon**) feature class. Right-click the Geodatabase you created, and choose **New → Feature Class**. In the **New Feature Class** pane on the right, enter the following information.

Page 1/6	**Name**	building
	Alias	Building
	Type	Polygon
Page 2/6	**New data field**	Name (use Text as the data type) Type (use Text as the data type)
Page 3/6	**XY Coordinate system**	Select "SVY21 Singapore TM"

Note: Choose **Polygon** for **Feature Class Type**, and use default settings for the remaining items.

Click **Finish**. You should find a new feature class named **building** under the geodatabase.

6. Create a POI (point) feature class. Right-click the Geodatabase you created, and choose **New → Feature Class**. In the **New Feature Class** pane on the right, enter the following information.

Page 1/6	**Name**	poi

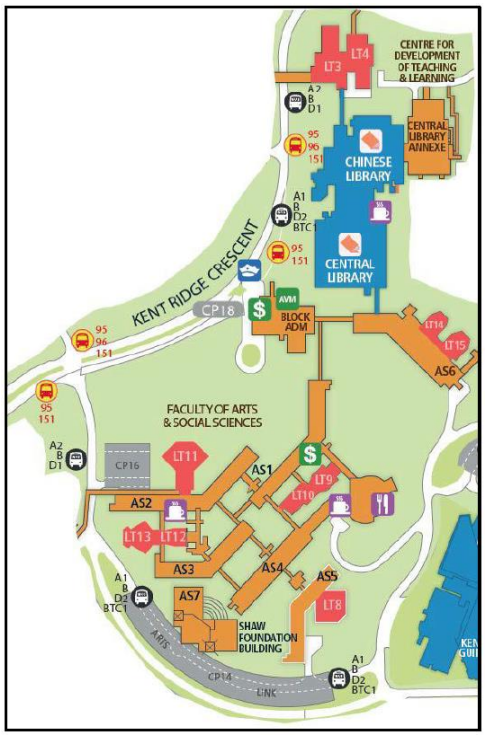
	Alias	Point of Interest
	Type	Point
Page 2/6	**New data field**	POI_Type (use Text as the data type)
Page 3/6	**XY Coordinate system**	Select "SVY21 Singapore TM"

Note: Choose **Point** for **Feature Class Type**, and use default settings for the remaining items.

Click **Finish**. You should find a new feature class named **poi** under the geodatabase.

7. The above steps allow you to create feature classes with the chosen geometry types. These feature classes are "empty" at the moment – there are no roads, buildings or POI points in these feature classes. Next, we will populate the feature classes with data by digitalizing images on screen. We will use NUS campus image to digitize major roads and buildings.

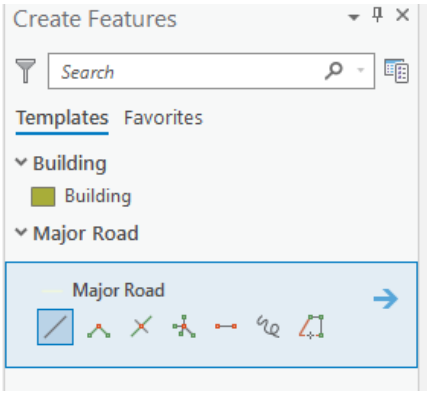
8. On the ribbon, in the **Map** tab, click **Basemap** and choose **Imagery**. Zoom in to FASS in NUS, Singapore.



9. Add the **Building** and **road** feature classes to the map (if you do not see them in the **Contents** pane on the left).

10. Click on the **Edit** tab on the ribbon, and click on **Create**. A **Create Features** panel will pop up on the right. In this panel, make sure you select "Major Road".

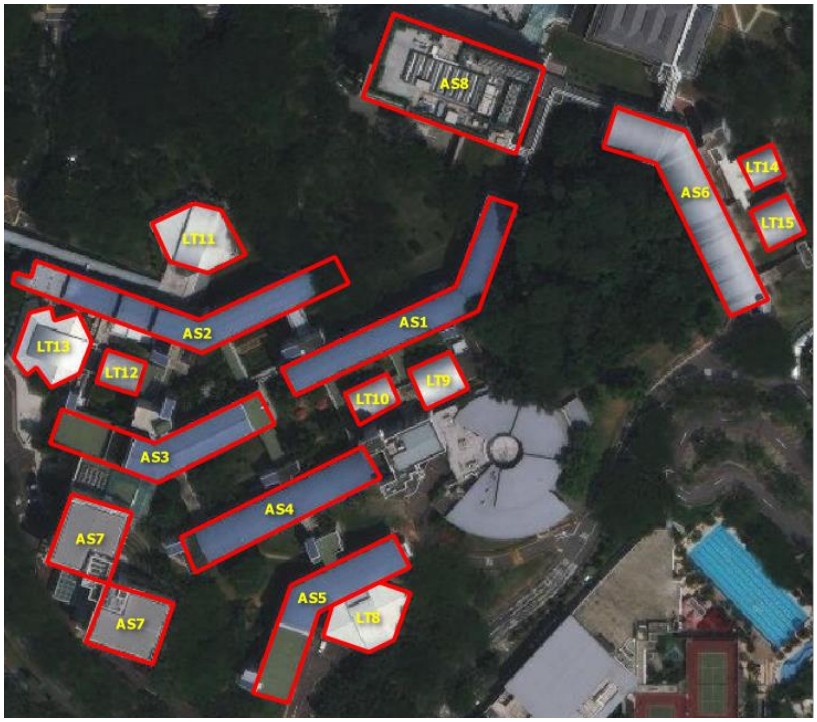
11. The cursor should change to a crosshair. Use this tool to digitize roads in NUS by following the center line of the roads. Note that you are using the point mode digitizing method – "you need to click at every turn of a line."



- If two roads connect to each other, you have to make sure that they are connected in the sense that a node should exist at the location where the two roads intersect.
- Digitize the roads on the following map. Each time you finish a line, **double-click** to confirm it and start a new line (same for the polygon below). After finishing all the lines, click **Save**

on the **Manage Edits** group under the **Edit** tab. Also, remember to save your project frequently.

12. Now you need to add the road names to the *Roads* feature class. In the **Contents** pane, right-click on *major roads*, and choose **Attribute Table**. The **Name** field is currently null. You can fill in the road names by double-clicking the box. You can refer to **Google Maps** or a pre-existing NUS campus map for this information. Make sure to click **Save** under the **Edit** tab to save your edits.
13. In the **Contents** pane, select *major roads*. On the ribbon, click the **labeling** tab, and make sure **Label** is activated. Check **Label Features In This Class** box, and select **Name** in the **Field** drop-down list. Now the road names should appear on the map (change the Text Symbol Color to yellow if you cannot see the names).
14. Next, we will proceed to digitize the buildings in FASS. Following the instructions in the above steps. Enter the name of each building (please digitize at least 5 building polygons).



15. Next, we will proceed to digitize the point facilities in FASS. Following the instructions in the above steps, digitize <u>at least 5 points</u> (e.g., ATM, canteen, coffee shops) in FASS. Enter the name of each POI in the attribute table.

    Q-1. Create and design a FASS map with roads, buildings, and POIs and export it from layout view to a Tiff file (300 dpi) with appropriate map elements. Insert the map into your Word document. (3 marks)

<u>Notes:</u>
Explore to make good use of the symbology for POIs, such that they are represented by easily recognizable symbols. *Hint:* Use Categorized Symbology (with POI_Type as the Value) and Pictographic Symbols such as for ATM and for coffee shops to distinguish the POIs.

Introduction to GIS

Lab04 Geodatabase Development and Spatial Editing

Exercise 02 – Using Geodatabase Topology to clean up data

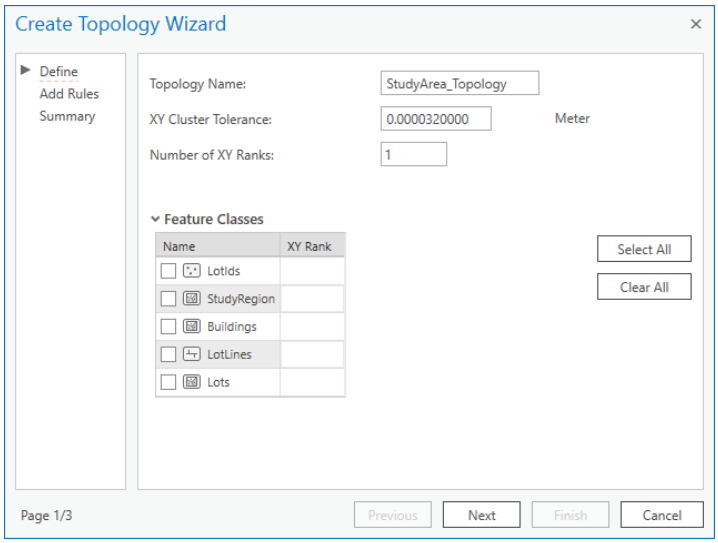
> Objectives of this exercise:
> To practice how to use **geodatabase topology** to clean your data in ArcGIS Pro
> To complete exercises, you need the following:
> - ArcGIS Pro 3.3.1 (Basic, Standard, or Advanced)
>
> The data needed for this exercise are under the folder Lab04
> Video Demonstration:
> https://mediaweb.ap.panopto.com/Panopto/Pages/Viewer.aspx?id=93791e9f-d609-40cf-b8b5-aed1008f050f

I. Creating a topology rule for a single feature class

1. Start ArcGIS Pro and sign in if necessary. Click **Map**, and create a new project. Name the project **IntroToGIS_Lab04_Exercise02**.

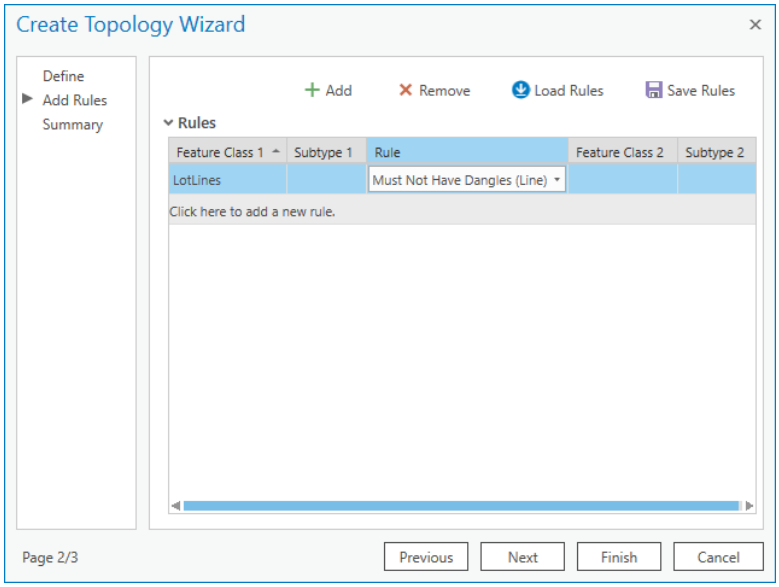
2. In the **Catalog** pane, right-click **Folders** and choose **Add Folder Connection**. Create a folder connection to the **Lab04Data** folder.

3. Expand the folder, and you will find a *StudyArea* feature dataset. Right-click on it and choose **New → Topology**. A dialog appears.

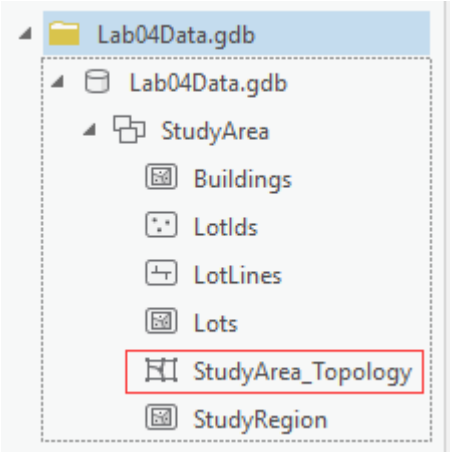


4. In the dialog box, check *Lotlines* to indicate that you want to apply the topology rule to the features in the *LotLines* feature class. Accept the default **topology name** and **cluster tolerance**. Click **Next**.

5. On the next page, click **Add** + Add, then click on the blank cell under **Feature Class 1**, and a dropdown list will appear. Choose *LotLines*. Click on the blank cell under **Rule**, and choose *Must not have Dangles (Line)*. Click **Next**. The rule is now added to the list of topology rules.



6. Accept the default **Topology Name**, **XY cluster Tolerance** and **Number of XY Ranks**. Click **Finish**. This concludes the steps of creating a topological rule in the geodatabase. Refresh the *StudyArea* feature dataset if you do not see it.

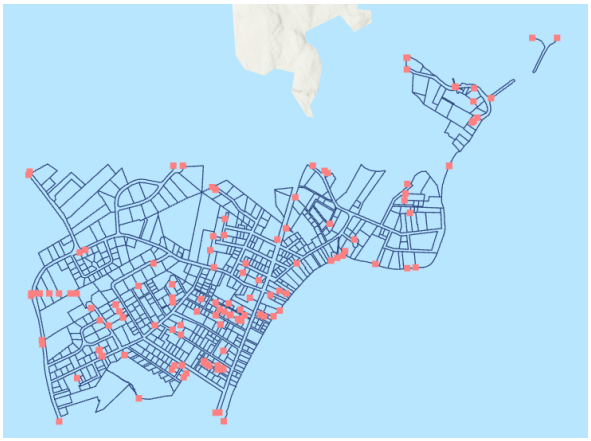


II. Finding topology errors

7. In the **Catalog** pane, drag *StudyArea_Topology* to the map area (refresh the Lab04Data.gdb database or the StudyArea feature dataset if you cannot find the *StudyArea_Topography*). It will also appear in the **Contents** Pane.

8. In the **Contents** Pane, select *LotLines*, and **Zoom to Layer**.

9. On the ribbon, under the **Edit** tab, click **Error Inspector** to open the **Error Inspector** window. Click **Validate (** Validate **)** to validate the topology. The result is shown below.



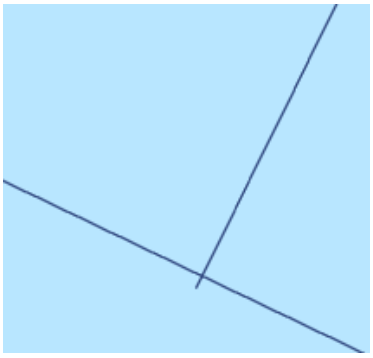
Note: By clicking **Validate**, it will only identify topological errors on layers in the current map extent. So you need to make sure that the current map extent contains all the features of the *LotLines* layer.

The topology layer shows all topology errors. The *StudyArea_Topology* has one feature class (*LotLines*) and one rule (must not have dangles), so all topology errors seen in ArcGIS Pro are related to the specific rule. The geometry for error dangles is point, located at the dangling end of a line feature. All of the red features on the map are dangles.

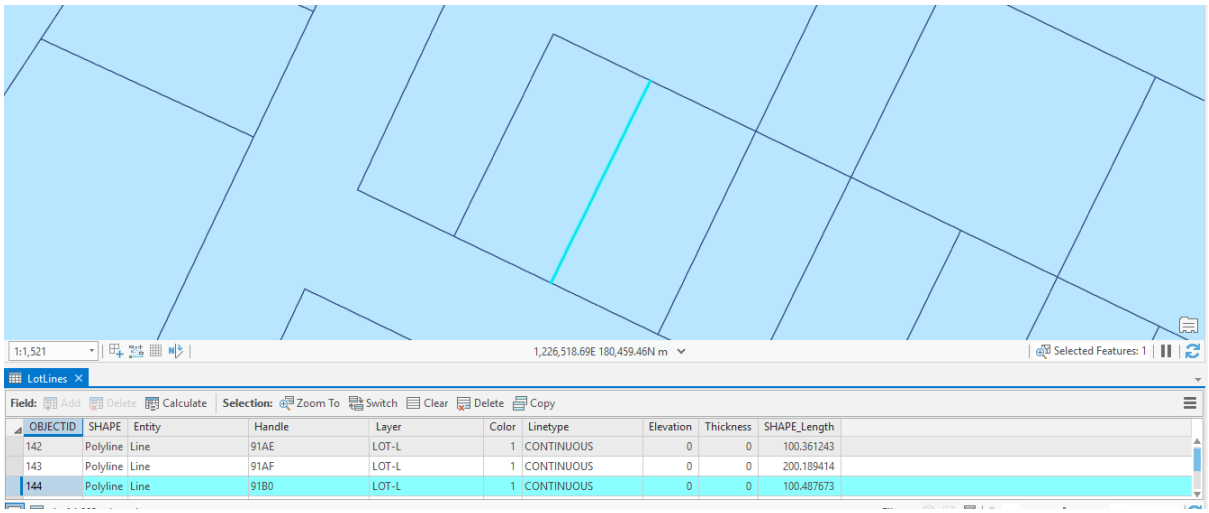
10. Click the **Modify (**  **)** button in the **Features** group under the **Edit** tab. The **Modify Features** pane appears on the right.

11. Open the **Attribute Table** of *LotLines*. Click on the record with **OBJECTID** of 144, and choose **Zoom To**. You will find an overshot error on the line. Close the **Attribute Table**.

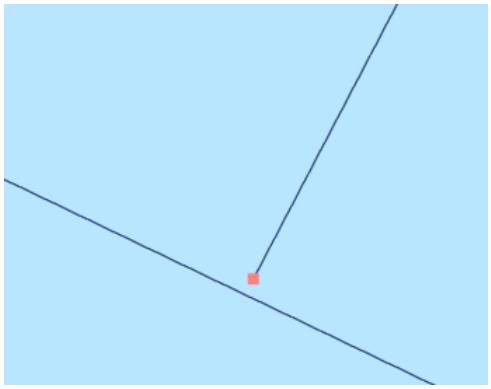
12. In the **Error Inspector window**, select the *LotLines* 144 record (note that the default filter is **Map Extent**. Therefore, make sure that *LotLines* 144 is completely shown in the map area). On the right of the **Error Inspector** window, click the **Fix** tab (enlarge/expand the Error Inspector window if you do not see the Fix tab), and choose **Trim** (enlarge/expand the Error Inspector window if you do not see the Trim tool). In the pop-up dialog box, type "**3**" **m** and press **Enter**. The dangling segment is trimmed to where the lines intersect, and the error disappears from the window. Click **Save** under the Edit tab to save edits. Also, save the project.



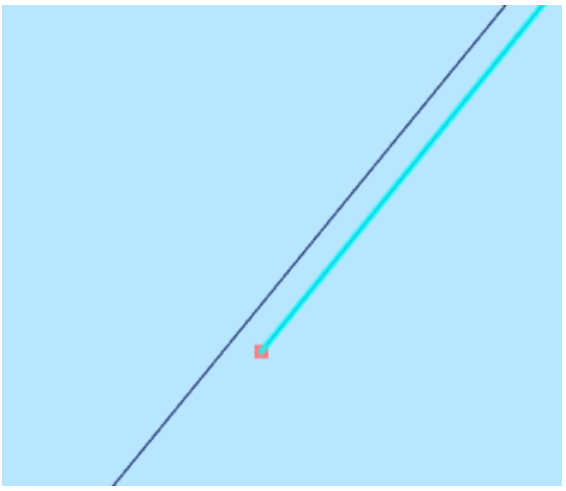
Note that the parameter of **3m** means that if the dangle is less than 3m far from the intersection, the dangling segment will be trimmed. It also means that if the distance is larger than 3m, we would not consider it as a dangle.



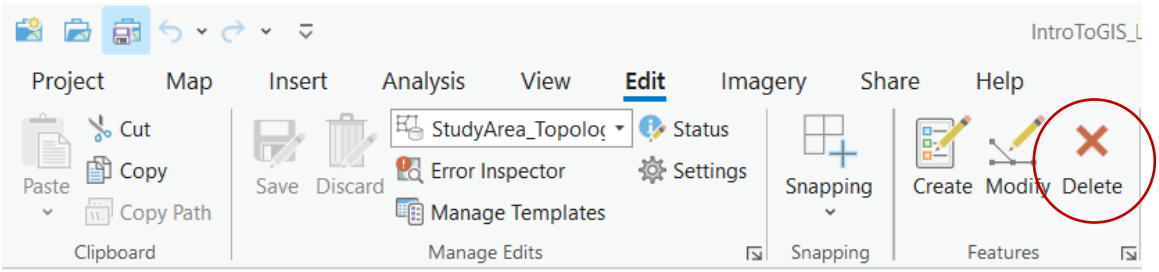
13. Apply the above method to the feature **180**. However, the feature 180 is with an error of undershoot. Therefore, we cannot use **Trim** to fix this error.



14. We will use another approach to fix this error. In the **Error Inspector window**, right-click the *LotLines* 180 record and choose **Extend**. In the pop-up **Maximum Distance** dialog box, type "3" **m** and press **Enter**. Click **Save** under the Edit tab to save edits. Also, save the project.

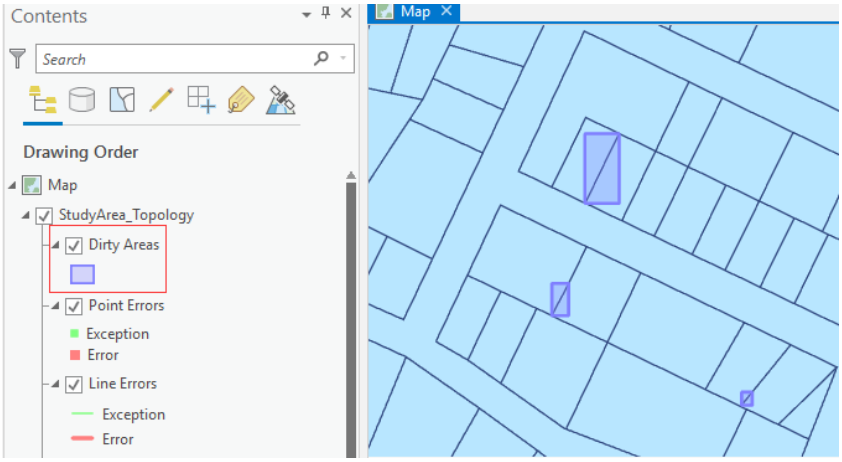


15. Select and Zoom to Feature **182**. The line feature is with the dangle flashes (see the figure on the right. Keep zooming in until you can see two parallel lines). This represents a double digitization error (the same feature being digitized twice).
16. To fix this error, we can just delete this line.
17. Select Feature 182, then click the **Delete** button under the **Edit** tab. The extra line is deleted. Click **Save** to save edits. Also, save the project.



So far you have learned how to correct three topological errors: **trim**, **extend**, and **delete**. When you perform such a task, the topology tracks where changes have been made. These places are called **dirty areas** as new errors could be potentially created by the editing work just performed. These new errors will not be discovered until the dirty area is validated again (and dirty areas will be cleared after being validated).

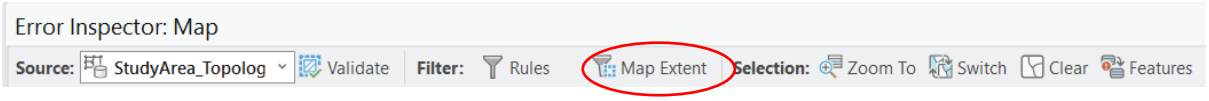
18. In order to see the dirty areas, check **Dirty Areas** in the **Contents** pane. The dirty areas are shown on the map. They cover the features that you have just edited. The use of dirty areas optimizes the validation process, as only dirty areas instead of the whole area must be checked for topology errors.



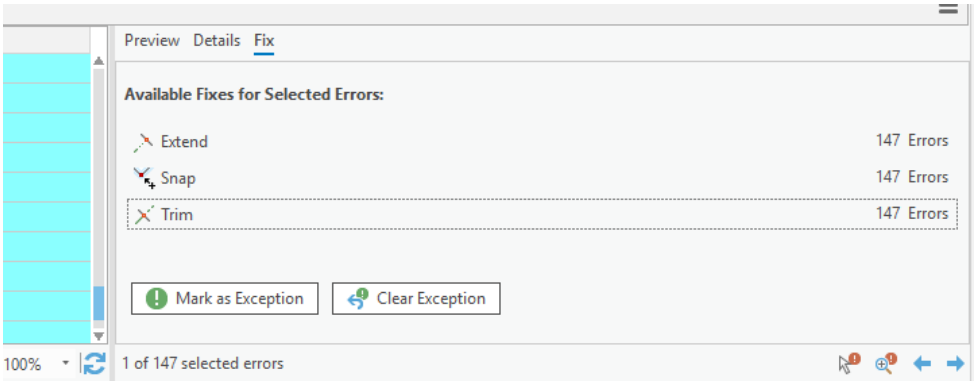
Question 2: The feature Lotlines 968 has been identified as an error according to the rule set above (Must not Have Dangles). How will you handle this error? (2 marks)

III. Fixing multiple errors at once

19. Ensure that the **Error Inspector Error window** remains open. **Deactivate** the **Map Extent** Filter so that all errors are shown in the table. Select all error records in the table by using "shift" key (or "Ctrl + A").

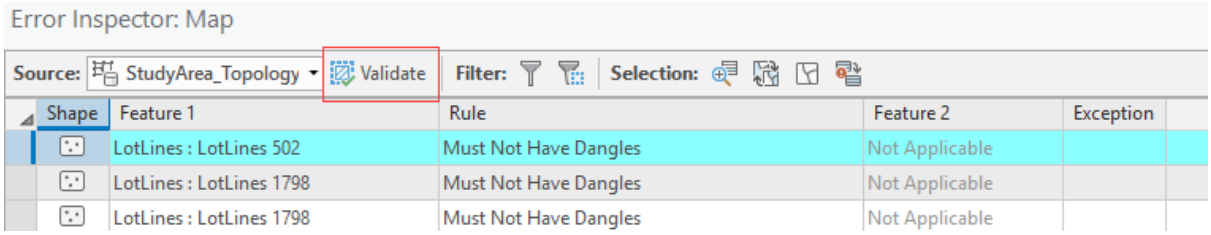


20. In the **Modify Features** pane on the right (if you do not see the pane, on the ribbon, click **Modify** under the **Edit** tab), click **Fix Error** under **Validate** group. Click the **Fix** tab in the **Error Inspector** window.



21. First, fix the undershoot errors. Click **Extend**. Set the Maximum Distance as **3 m**. Press **Enter**. The process may take a few seconds while all of the features with dangles are checked to see if there is a feature within three meters that they can be extended to. A number of dirty areas will appear on your map.

22. Repeat the above step to fix other errors (try extent, trim, and then snap, setting the maximum distance/snap tolerance as 3m, repeat the steps several times until no error can be batch fixed in the **Error Inspector Error window**, click **Validate** to see if you have amended all errors in the dataset (you will see some errors left unfixed as the batch processing cannot fix all of them).



23. Save the editing under the **Edit** tab, and save the project under the **Project** tab.

IV. Adding Feature Classes and Rules into Topology

Now you will create a new polygon feature class from the *Lotlines* feature class that you have been working on and from the *LotIds* (point) feature class that will provide the attributes of the new lot features.

24. Now you will practice adding feature classes to the topology. In the **Catalog** pane, expand the *StudyArea* feature dataset to see all feature classes and the topology file *StudyArea_Topology*. Right-click *StudyArea_Topology* and choose **Properties**. The **Topology Properties** dialog appears.

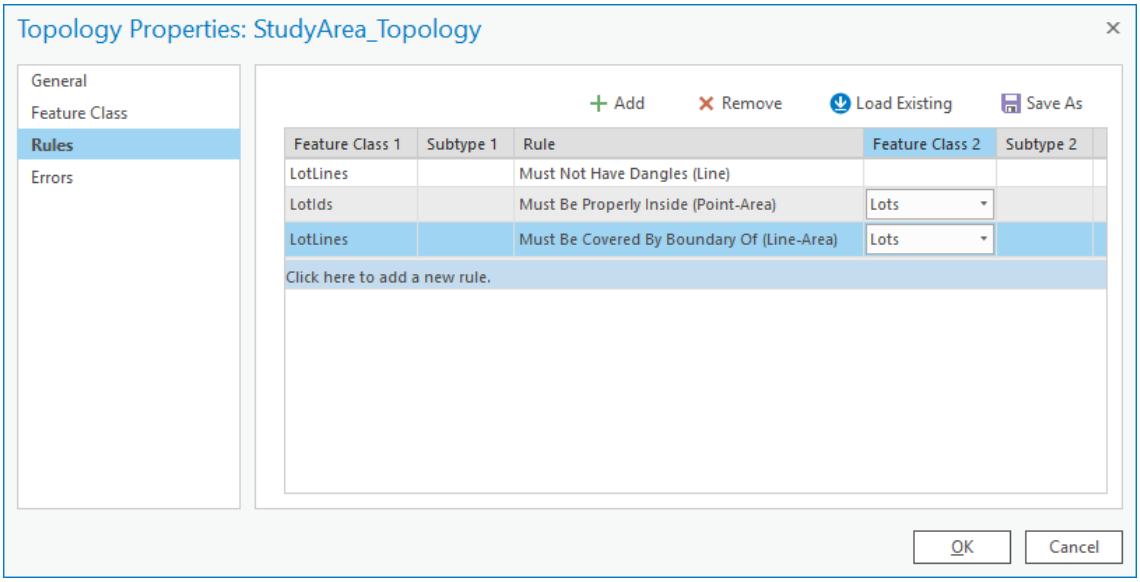
25. Click the **Feature Class** tab. Under the **Feature Classes** table, make sure *LotLines* is checked. Check both *LotIds* and *Lots*. Click **OK**.

    Just now, two feature classes have been added to the topology. They are now ready for topology rules.

26. This step involves adding topological rules that enable us to identify potential errors with the Lots feature class.

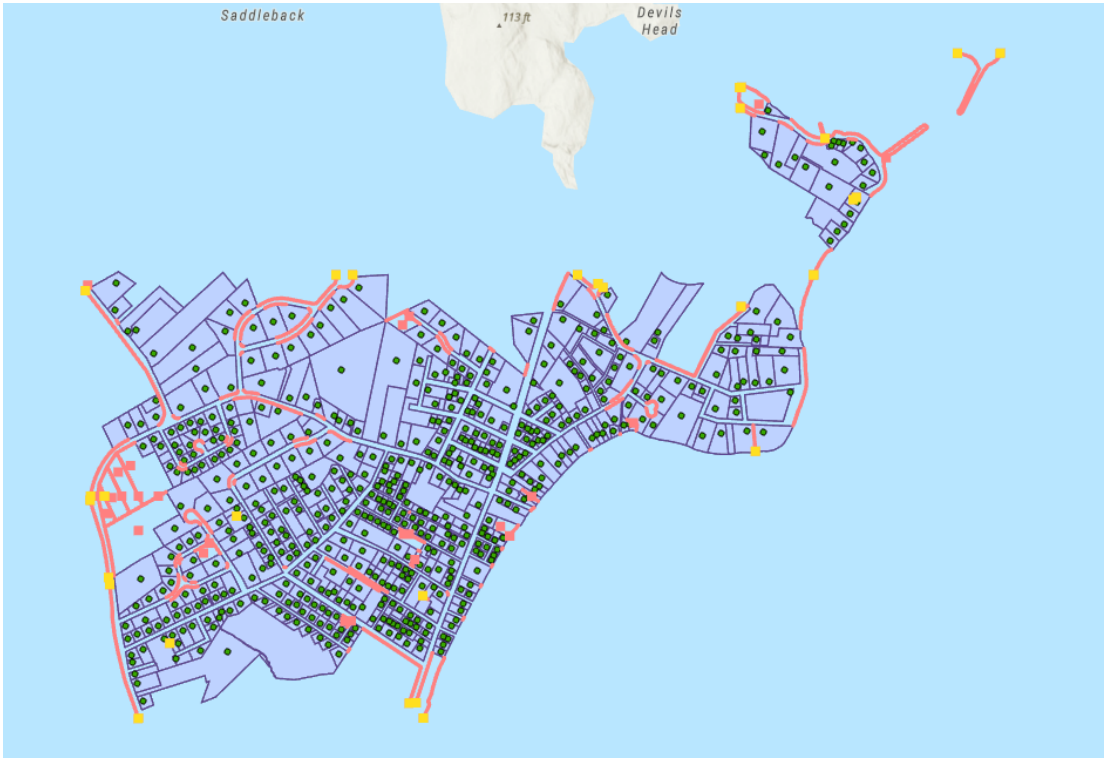
    - Right-click *StudyArea_Topology* and choose **Properties**. The **Topology Properties** dialog appears again.
    - Click the **Rules** tab, and then click "**Click here to add a new rule**". Click the blank cell under **Feature Class 1** and choose ***LotIds*** from the drop-down list. Choose ***Must Be Properly Inside (Point-Area)*** as the **Rule** and ***Lots*** as the **Feature Class 2**.
    - Click "**Click here to add a new rule**" to add one more rule. Choose ***LotLines*** as **Feature Class 1**, and choose ***Must Be Covered By Boundary Of (Line-Area)*** as the **Rule** and ***Lots*** as the **Feature Class 2**. Click **OK**.

      Two more topology rules have just been added to the topology to impose constraints on spatial relationships between feature classes.

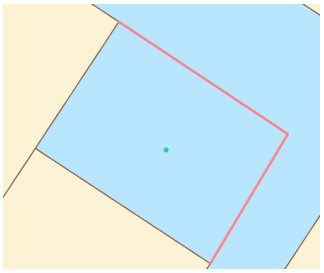


27. Now you will examine the revised topology in ArcGIS Pro and continue cleaning up your data. Drag *LotIds* and *Lots* feature classes to the **Contents** Pane.

28. Open the **Error Inspector** Window if it is not open (click **Error Inspector** under the **Edit** tab on the ribbon). Click **Validate**.



The red lines represent a new type of topology error.



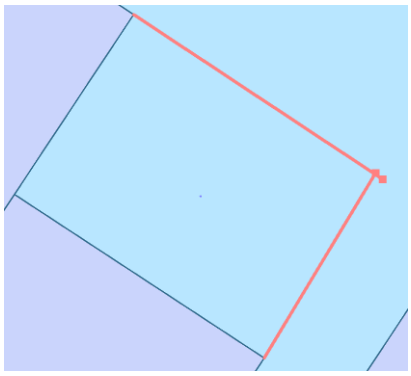
29. Open the **Attribute Table** of *LotIds*, and zoom in to *LotIds* feature with OBJECTID 1119. Close the **Attribute Table**. The two red lines beside *LotIds* 1119 (see the figure on the right) have violated the rule of "***Must Be Covered By Boundary Of***".

30. There should be two types of errors that can be found on point features. The first one is to violate the rule of "**Must Not Have**

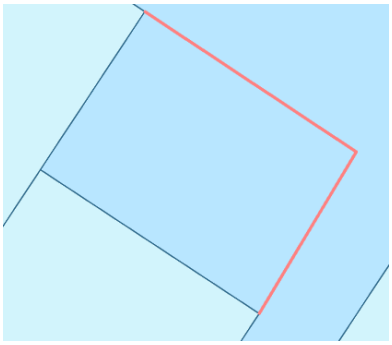
Dangles", which you are already familiar with. However, in Section **III**, this topology error is not completely amended yet. The second one is to violate the rule of "**Must Be Properly Inside**".

31. In This step, we will try to fix the **LotIds 1119** error. In the **Error Inspector** window, select the record **Lotlds 1119**. In order to quickly find this record, you can activate the **Map Extent** again. On the right, click the **Fix** tab. Click **Delete Feature** to fix the error.

32. On the ribbon, under the **Edit** tab, click the **Snapping** button to ensure "snapping" is enabled.

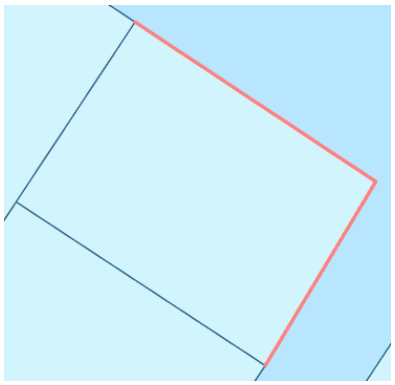


33. In this step, you will fix the error of the two red lines. That is, please solve the problem of "Must Not Have Dangles" for Lotlines 1507 and Lotlines 1514 (Hint: Try **Trim** and/or **Edit Vertices** under the **Reshape** group in the **Modify Features** pane; Click **Validate** in the **Error Inspector** Window if you do not see any change after editing). The result is shown below.

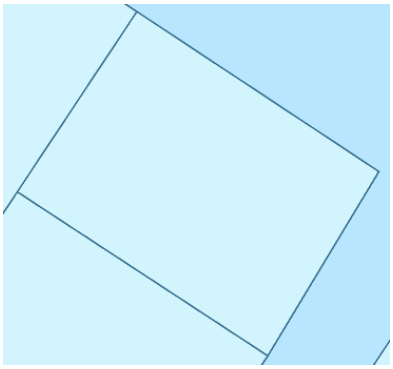


34. Now you should be able to see the new "lot", but there is no polygon for this "lot". Now the new polygon can be constructed.

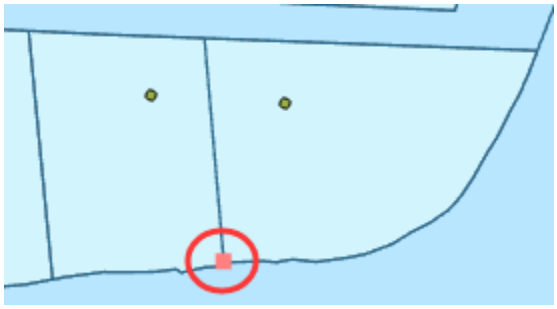
35. Click the **Construct Polygon** button under the **Construct** group in the **Modify Features** pane. Select the four lines that form the new polygon lot (you can select multiple items by pressing Shift), accept all the default values and click **Construct**. A new lot polygon feature is created.

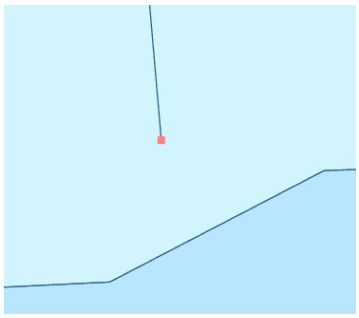


36. Click **Validate** in the **Error Inspector Window**, and you will find the two red lines disappear. Save your edits and save the project.

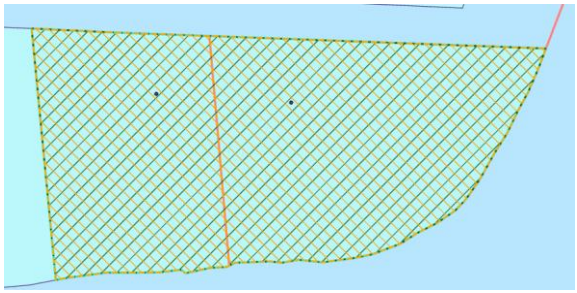


37. Now we will shift our attention to a problem caused by undershoot dangle error. Zoom to *LotLines 1842* (see figure below). The line in the middle should cut the polygon into two. However, due to the undershoot dangle error, the parking lot is only **one** polygon. We are going to use another method to fix this error.



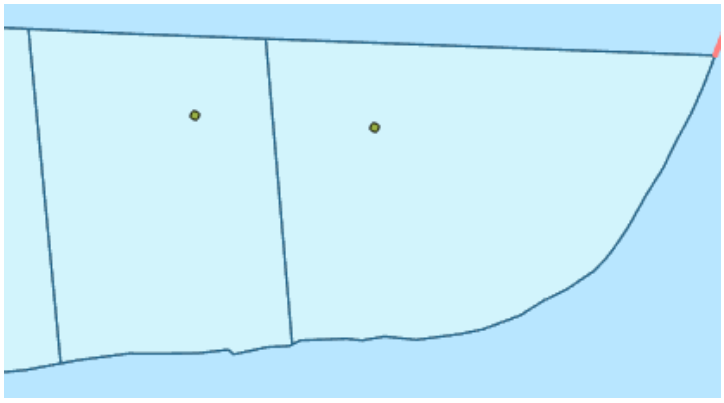


38. In the **Modify Features** pane, click **Extend or Trim** under **Reshape** group. The tool works differently from the **Extend** tool to fix the topology error. Rather than specifying a distance, you select a feature to which the tool will extend a line. Click on the error point and then click on the lot line that you want to extend to. Click **Validate** in the **Error Inspector Window**, and you will find that the dangle point disappears. **Save** the edit.



39. Although the undershot line was extended, the lot polygon is still not divided yet. Now we will split the polygon by the lot line. In the **Modify Features** pane, click **Split** under **Divide** group. Click the **By Feature** tab. Under the **Input Features** tab, select both the lot polygon and the splitting line (use shift). Place the LotLines layer at the top of the Contents pane if you do not see the line in the middle. Under **Target Features**, select only the lot polygon. Click **Split**.

40. Click on the polygons on the two sides of the splitting line to check if the polygon has been split or not.



Question 3. What are the areas of the two polygons, respectively? (2 marks)