# GST 103: Data Acquisition & Management Lab Series

# Lab 4: Vector Data Structure

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**Organization:** Del Mar College
Author: Richard Smith



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## Introduction

This lab is part of a series of lab exercises designed through a grant initiative by the National Information, Security & Geospatial Technologies Consortium (NISGTC), funded by the United States Department of Labor in partnership with the Department of Education under the Trade Adjustment Assistance Community College and Career Training Grant Program (TAACCCT).

A topology organizes the spatial relationships between features in a set of feature classes. Using a topology we can make sure that the data is logically sound, such as checking for overlapping properties or other inconsistencies.

Your instructor may require that you provide screen captures and/or exported files Please check with your instructor for the requirements specific to your class.

This lab includes the following tasks:

1. Using a Shapefile Topology
2. Creating a Geodatabase Topology and Validating the Data
3. Editing and Cleaning the Topology

## Objective: Topology and Topological relationships

In this lab, we will be looking at the spatial relationship between points, lines, and polygons. We will be building a topology and repairing the existing topology to ensure the connectivity of the roads.

## Lab Settings

### Required Virtual Machines and Applications

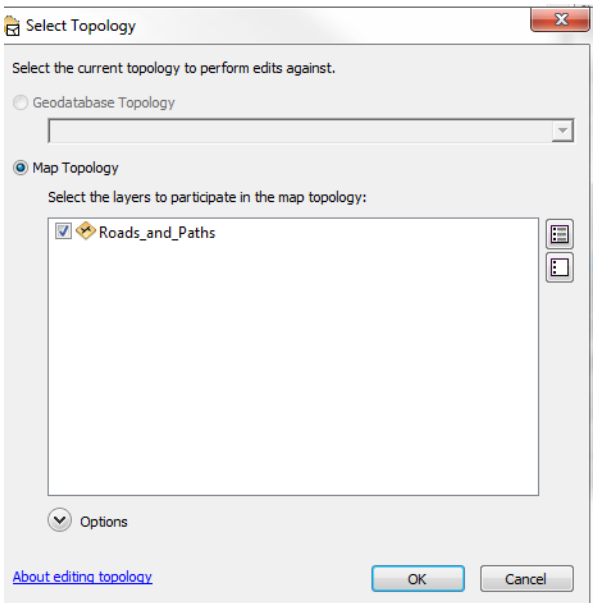
| | |
|---|---|
| Windows Machine User Account | Train |
| Windows Machine User Password | Train1ng$ |

# 1 Using a Shapefile Topology

A topology organizes the spatial relationships between features in a set of feature classes. You can simultaneously edit shared edges and nodes with the Topology Edit tool to correct common errors in line datasets, such as dangles, overshoots and undershoots.

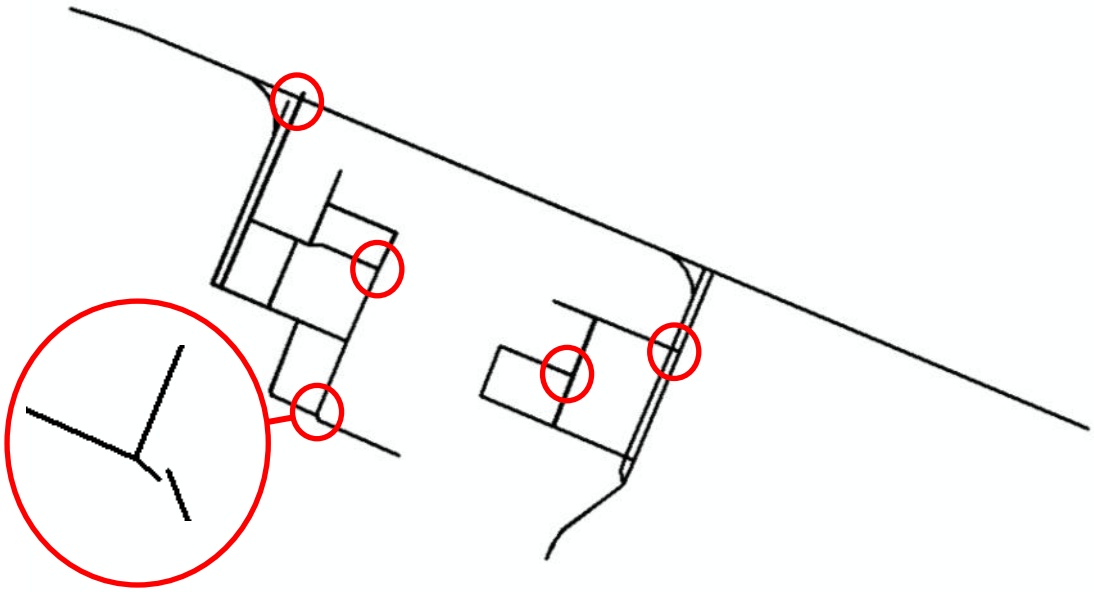
1. Log into the computer, using the information provided in the Lab Settings section.
2. Click **Start->all Programs->ArcGIS->ArcCatalog 10.1** this will open ArcCatalog.
3. Connect to your *D:\GST 103\Lab 4* folder.
4. Open **ArcMap** to a blank map.
5. Add the ***Roads_and_paths*** shapefile to the map window from the *Lab 4*folder.
6. Enable the **Editor** toolbar. Click on the **Editor** Dropdown and click **Start Editing**. In order to edit the topology we will need to be in edit mode, which will allow us to make changes to a feature's characteristics. Enable the Topology toolbar (shown below) by clicking **Customize->Toolbars->Topology**. This toolbar allows us to edit the topology of both the shapefile and the geodatabase (once it is created).

7. Before we can edit a topology, one must be selected. Click the **Select Topology**  button and the Select Topology window will appear. Select **Map Topology** and make sure there is a checkmark in the ***Roads_and_Paths*** layer checkbox. Click **OK.** You are now editing the topology of that shapefile.

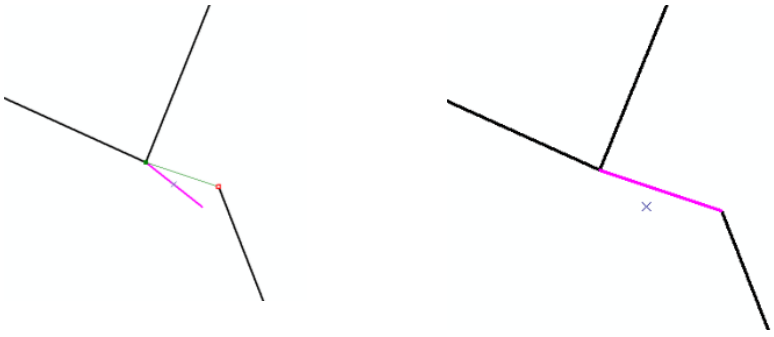


8. Next, we click on the **Topology Edit** button  and the cursor will change. With the Topology Edit cursor, we can select the topology vertices and edit them how we please.
9. We will fix the dangles, overshoots, and undershoots. These are common errors in line datasets. Enable your **Snapping** toolbar to make the process easier.
10. Look at the Roads_and_Paths dataset. There are several errors, such as lines that are not connecting, lines that have overshot the connection, and lines that did not make the connection. The errors in this dataset are highlighted with red circles in the diagram below. You may need to zoom into the areas to see some of the errors.



11. Looking at the "missed connection" error above (highlighted in the large circle), we can see that the line sections were not joined. You will be instructed on how to fix this error and then correcting the rest will follow a similar process.
12. While in Topology Edit mode, double-click on the line segment to select (the line shown in pink below). We will grab the vertex (indicated by a red square) and move the vertex to the join the end of the line it missed. If the Snapping function is turned on, the line will jump to the connection. Once you are done, **press F2** (Function Key 2) to end your sketch and the drawing will change.



13. Correct the rest of the errors, save your edits, stop editing and close ArcMap.

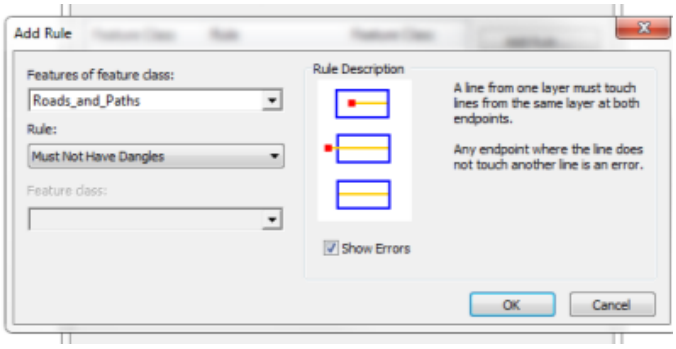
## 2 Creating a Geodatabase Topology and Validating the Data

In this task, we will create a database topology using data that has been erroneously captured. We will fix it using topological rules and validation to validate and clean the errors from the data, keeping the spatial relationships intact.

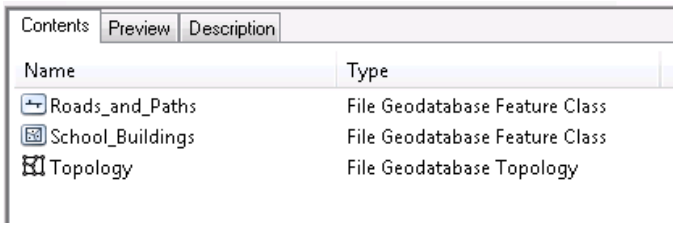
1. Open **ArcCatalog**.
2. Navigate to the geodatabase called ***Topology***. In this database, there is a feature class and a raster satellite image of the area we are working with. To create a topology, the data must be in a feature dataset as there may be various other items in a database, to which the topology does not apply. Locating the items we want in a feature dataset will allow us to store the items we want in the topology.
3. To start building the topology, right-click on the feature dataset named ***TopologyData*** and go to **New->Topology**. The Create Topology wizard will appear. The first screen just explains what a topology is and how it works**.** Click **Next**.
4. In the next screen, we will name the topology. Name it, `Topology` or accept the default. Be sure not to include any spaces. The cluster tolerance is the distance at which items are perceived as the same object. Leave the cluster tolerance as default and click **Next**.
5. The datasets that will participate in the topology are the ***Roads_and_Paths*** and the ***School_Buildings*** feature classes. Put a check mark in the box next to those feature classes or click **Select All**. Click **Next**.
6. Now, we have to set a rank on our feature classes. This is an important ranking as it determines the objects movement when the data is validated. If we have a high rank such as 1, the features are likely to move only very small distances. These figures are determined by the accuracy of the initial data. Since our data has been digitized from a satellite image, we will rank both the feature classes at 3 because they have the same source and same initial feature accuracy. Click **Next**.

7. We need to add the topology rules. These are the rules that will ensure your data has logical consistency and is error free after validation. Before we add any rules, let's take a look at what rules are available for use. Click on **Help->ArcGIS Desktop Help** and search for ***Geodatabase Topology Rules***. Browse through the rules listed for polygons, lines, and points. These are the rules you would choose from when creating a topology. When you are done, close **ArcGIS Help**. . Next, we will add a rule by clicking **Add Rule**. Select ***Roads_and_Paths*** in the **Features of feature class** dropdown, and then as the **Rule**, select **Must Not Have Dangles** (see screenshot below). Click **OK** and the rule is added.




9. Now, create a rule with the ***School_Buildings*** feature class, where the buildings **Must Not Overlap**. Click **Next** and view the **Summary**. We have 2 rules. One rule deals with the lines and one rule deals with the polygons.
10. Click **Next** and **Finish**. When asked to validate the topology. Click **Yes**. The **Topology** layer will appear in your TopologyData dataset.



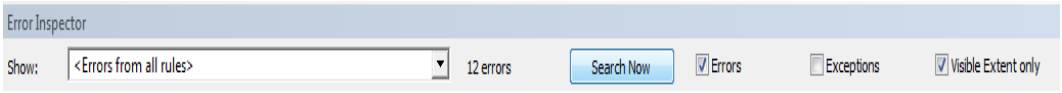

11. We have created a topology, as seen in the database (see the screenshot above). This can be used to clean the data. We will look at cleaning the data in the next task. **Close ArcCatalog**.

## 3 Editing and Cleaning the Topology

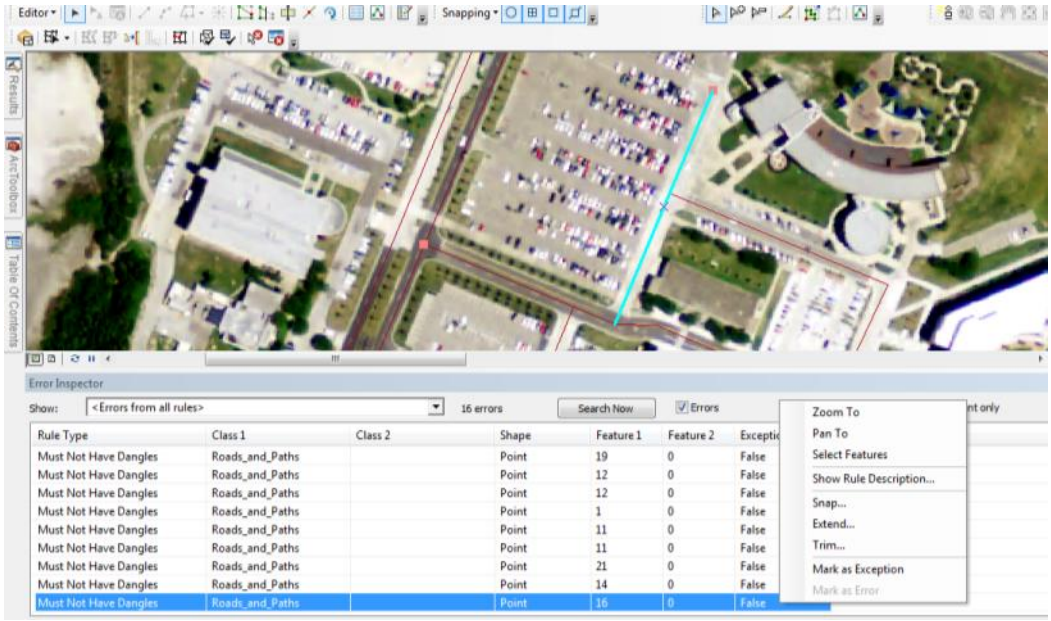
In this task, we will fix the topological errors that have been identified. It is possible to edit the topology at a later stage; all that is required is for us to revalidate the topology.

1. Open **ArcMap** to a blank map.
2. Navigate to the **Topology** database and in the ***TopologyData*** feature dataset Add ***Topology*** to ArcMap. It will ask if you want to add the feature classes that participate in the topology. Click **Yes.** Add the ***Campus*** satellite image to the map display as well.
3. Make sure the Topology and Editor toolbars are enabled. Enter an edit session by clicking the dropdown on the Editor toolbar and selecting **Start Editing**. There are more options to edit the database topology then there are to edit the map topology. Notice the icons on the toolbar are no longer grayed out as they were in the previous task.

4. In order to see all the errors, click on the **Error Inspector**  button. This will allow us to see all the errors on the topology. When we click the Error Inspector button, a window like the one in the screenshot below will pop up. From this window, we have options we can choose from when looking at specific errors. The drop down box allows us to look at errors pertaining to the rules that were made. The check boxes allow us to search for errors, exceptions, and whether or not to search within the visible extent. This is handy if we only want to look at the dangles.

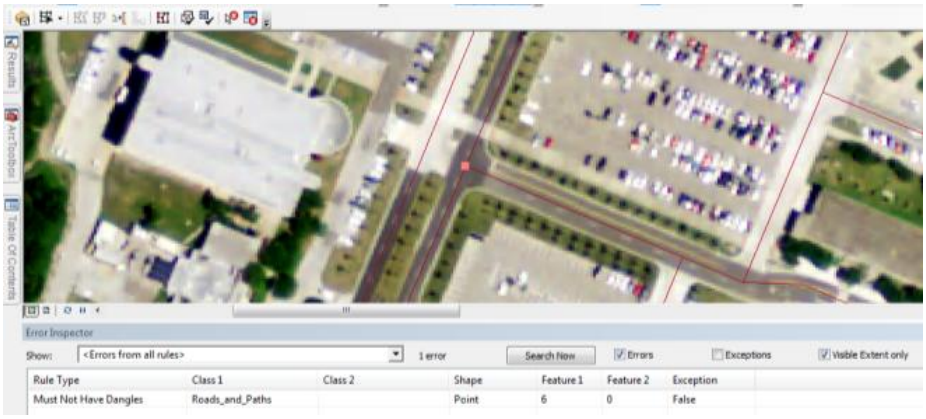


5. We will be looking at ***all*** the topological errors so ensure that **<errors from all rules>** is selected. We need to set some exceptions in terms of the dangles. In some cases, some road "ends" might be erroneously considered a dangle. So, using the satellite image, we will mark the roads that are currently identified as dangles and set them as exceptions to the rule. To do this, click on each road or path listed in the Error Inspector and it will be highlighted in the display. Determine if it fits the exception qualifier. If it qualifies, right-click on the listed road and click **Mark as Exception**.

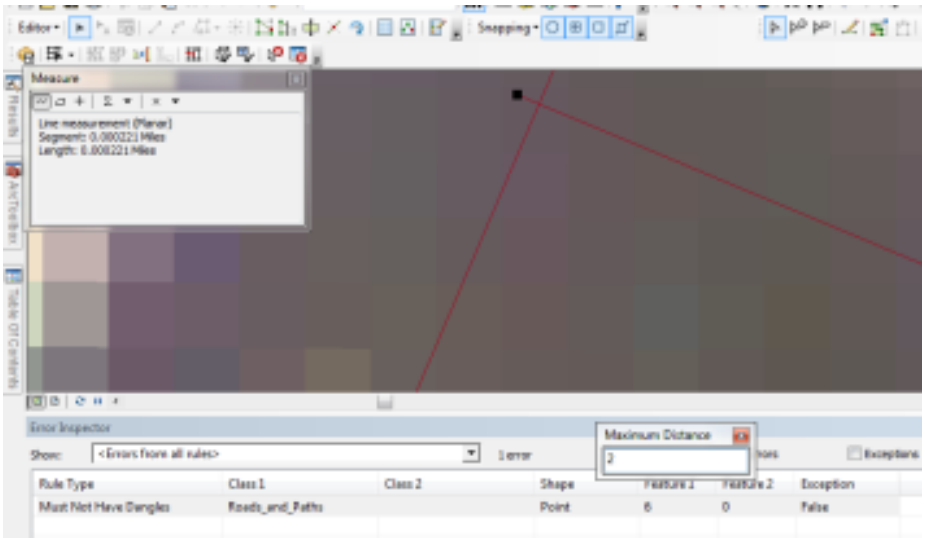



Using the Error Inspector, we can also fix overshoot and undershoot errors. If we have an overshoot we can trim the line, if we have an undershoot, we can extend the line. If we have items that do not snap to the line, we can snap the objects to the lines. When we select an error in the table, the error will change color from pink to black. We can then **Zoom To** the error by right-clicking on our selection, make a decision on what action to take and then implement the fix by right-clicking on the selection and clicking on the appropriate option.

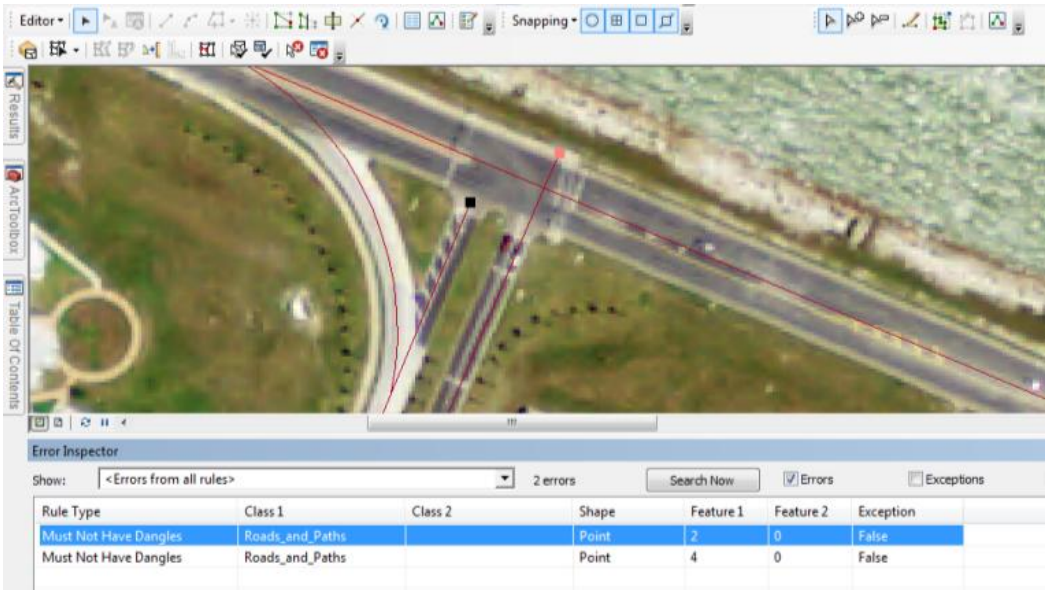
6. As an example, let's look at an overshoot. Zoom into the error displayed in the screenshot below. To fix this error, we need to trim the line that is overshooting the intersecting line. The trim will cut the line to the nearest point of intersection.




7. Right-click on the error in the Error Inspector table and click **Trim**. It will ask for a distance, enter 2 in the textbox. Press **Enter** and the line will snap to the intersection.

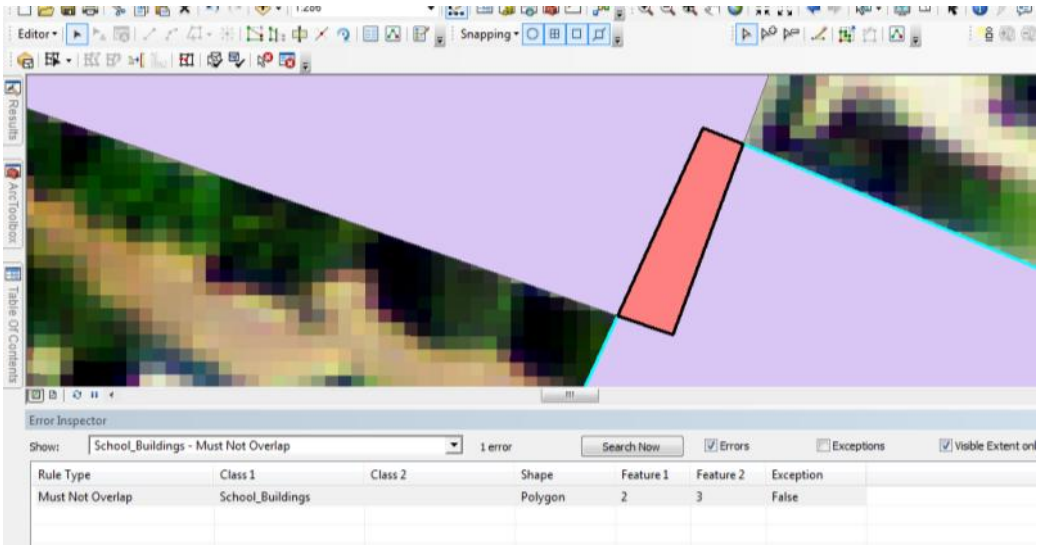


8. Next, we will look at an undershoot. This is where the line does not extend to the line of intersection because it is too short. Correcting this error follows the same workflow as an overshoot. Look at the error at the first entrance to the campus from the left of the image below.




9. We will need to extend the line. Right click on the row and click **Extend**. This will extend the line to the nearest point of intersection. However, this distance will be large. For the maximum distance enter **50** and press **Enter**. The error disappears. You have fixed the error.

10. Next we will look at the building errors. Some careless digitizing has led to two buildings overlapping. We can merge the feature, subtract from the feature, or mark it as an exception. In this example, we will be subtracting from the feature. This will delete the overlap. Go to the **Show** dropdown in the Error Inspector and select ***School_Buildings***-**Must Not Overlap** and **Search Now**. Right-click on the error and zoom to it.




11. To fix the error, right-click and select Subtract. There will now be a gap. You have corrected another error.
12. Correct the rest of the errors in the topology.

## Conclusion

In this lab, we have learned about topologies and what they mean for our data. It pays to have and uphold a high quality dataset. Datasets are only as good as the data from which they were captured, and quite often we need to implement constraints to ensure that there is logical consistency in the dataset.

## Discussion Questions

1. Should a topology be managed periodically or as datasets are added to a database?

2. Explain the use of topology in industry.

3. How would a topology be useful for property data?