
Introduction to GIS

ArcGIS Desktop 10.1 Instructional Guide



RICE

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This guide was created by the staff of the GIS/Data Center at Rice University and is to be used for individual educational purposes only. The tutorial outlined in this guide requires access to particular software and datasets which are available at Fondren Library.

INSTRUCTION TEXT STYLES

Explanatory text

1. **Instruction text**

Required action

Object of the action

File name or *file name*

Name of Program or Toolbar

'Name of window or entry field'

"Text to be typed"

INTRODUCTION TO GIS

Introduction

A GIS (Geographic Information System) is a powerful tool used for computerized mapping and spatial analysis. A GIS provides functionality to capture, store, query, analyze, display, and output geographic information. This course covers ArcGIS for Desktop 10.1, the newest version of the popular GIS software produced by Esri. This course is meant to teach some fundamental ArcGIS concepts, but is not a comprehensive course in ArcGIS software or GIS in general. We hope to get you started using GIS and excited about learning more.

ArcGIS for Desktop license levels

ArcGIS for Desktop is available at three license levels: Basic, Standard, and Advanced. These license levels provide increasing levels of functionality within the software. The *Basic* level is sufficient for the majority of ArcGIS users and provides base mapping and analysis tools. The *Standard* level provides all the capabilities of the Basic license, plus multiuser editing and advanced data management capabilities. The *Advanced* license provides all the Standard capabilities plus advanced analysis, high-end cartography, and even more database management tools. Nearly all computers at Rice have an Advanced license.

ArcGIS for Desktop applications

Licensing levels aside, ArcGIS Desktop is comprised of a set of integrated applications, which are accessible from the start menu of your computer. The most commonly used applications are ArcMap and ArcCatalog. *ArcMap* is the main mapping application which allows you to create maps, query attributes, and analyze spatial relationships. *ArcCatalog* assists you in organizing spatial data and the associated metadata contained on your computer and various other locations and allows for you to search, preview, and add data into ArcMap. *ArcToolbox* is the main interface for performing operations with geospatial data in ArcGIS Desktop. Although it is not a stand-alone application and is not accessible from the start menu, it is frequently used within ArcMap and ArcCatalog. ArcToolbox contains tools for geoprocessing, data conversion, and more. The other applications in ArcGIS Desktop include *ArcGlobe* and *ArcScene*, which both allow for 3D modeling.

GIS data types

The two general categories of data that can be viewed in ArcGIS are vector and raster data. *Vector* data is a format whereby points, lines, and polygons are used to represent real features on the earth's surface, such as address locations, street centerlines, or zip code boundaries. *Raster* data represents a continuous portion of the earth's surface and is made up of a grid of pixels, called cells, as in an aerial image. Rasters are typically used to represent data relating to natural phenomena that vary continuously across the earth's surface, such as elevation, rainfall, temperature, and land cover. If both vector data and raster data are georeferenced to the same position, they can be used simultaneously in the same map view.

Another type of data frequently used in ArcGIS is *tabular* data that might come in the form of a text file, spreadsheet, or database. Though tabular data does not inherently contain a spatial component, it can be viewed, analyzed, and manipulated in ArcGIS by associating it with corresponding vector data.

Common GIS file types

The Esri *shapefile* format is an industry accepted and largely open source GIS data format developed by Esri. It is a widely adopted standard that can be used in all GIS software. A shapefile is actually comprised of three or more associated files. All associated files will have the same file name, but a variety of file extensions, such as .shp, .shx, .dbf, and oftentimes several others. It is recommended that you use ArcCatalog whenever copying, moving, or renaming a shapefile, so that the changes will automatically be applied to all files associated with that shapefile.

A geodatabase is a type of spatial database developed by Esri, designed to hold multiple datasets of different file types in a single storage container. There are three types of geodatabases: the *personal geodatabase*, which uses the Microsoft Access file format with extension .mdb; the *file geodatabase*, which is a proprietary Esri database with file extension .gdb and is the recommended file format when working with ArcGIS software; and the *SDE geodatabase*, which is meant for multiuser management and server access. Geodatabases define, manage, process and store all the types of data that can be used in ArcGIS.

ArcGIS can also make use of a wide variety of other file types, such as CAD files, image files (tiff, jpeg, jpeg2000, png), tabular files (xls, txt, csv, dbf), and many more.

Obtaining the Tutorial Data

Before beginning the tutorial, you will copy all of the required tutorial data onto your Desktop. Follow the applicable set of instructions below depending on the particular computer you are using.

Accessing tutorial data from Fondren Library using the *gistrain* profile

If you are completing this tutorial from a public computer in Fondren Library and are logged on using the *gistrain* profile, follow the instructions below:

1. On the Desktop, **double-click** the **Computer icon** → **gisdata (\\fon-gis04) (O:)** → **Short_Courses** → **Getting_Started_with_ArcGIS_Series > Introduction_to_GIS**.
2. To create a personal copy of the tutorial data, **drag** the **IntroTutorialData** folder onto the Desktop.
3. **Close all windows**.

Accessing tutorial data online using a personal computer

If you are completing this tutorial from a personal computer, you will need to download the tutorial data online by following the instructions below:

1. Using a web browser, go to the Introduction to GIS short course webpage at: <https://library.rice.edu/gis-intro>
2. At the bottom of the webpage, under the Resources section, **click** the **Introduction to GIS – Tutorial Data** link to download the tutorial data.
3. **Unzip** the **IntroTutorialData** folder.
4. **Copy** the unzipped **IntroTutorialData** folder to your Desktop or another location of your choice. Ensure that you note the file path of the location you have selected.

Any time throughout the tutorial that you see reference to the file path `C:\Users\gistrain\Desktop\IntroTutorialData`, you will need to substitute it with the file path you have just selected.

The following step-by-step instructions and screenshots are based on the Windows 7 operating system with the Windows Classic desktop theme and ArcGIS for Desktop 10.1 software with an Advanced license. If your personal system configuration varies, you may experience minor differences from the instructions and screenshots.

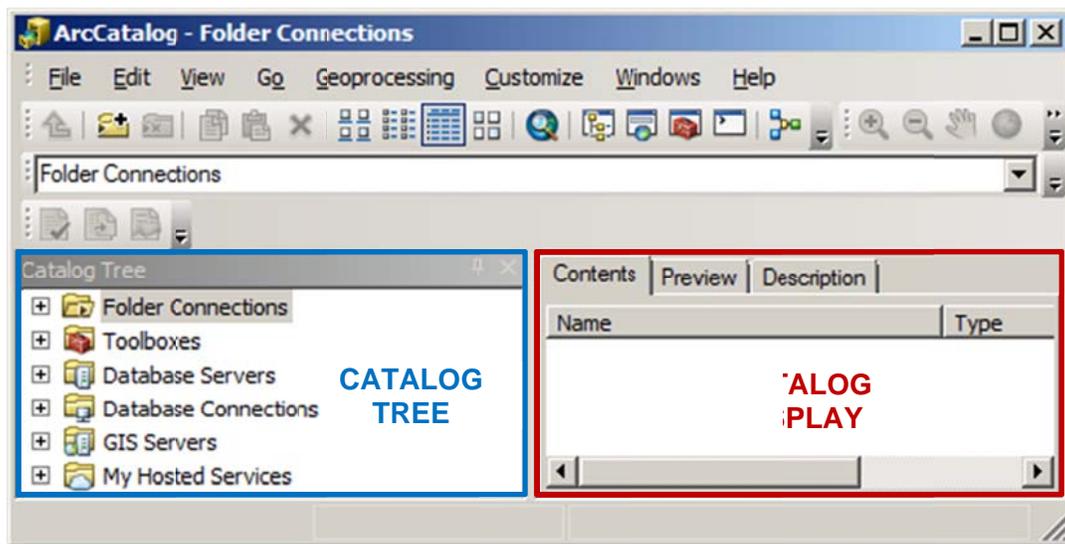
Getting Started with ArcCatalog

Opening ArcCatalog

1. On the Desktop, click the **Start** menu and select **All Programs → ArcGIS**.

From the Start menu, you can access all of the components of ArcGIS for Desktop, including ArcCatalog, ArcGlobe, ArcMap, and ArcScene.

2. To open ArcCatalog, select **ArcCatalog 10.1**.



On the left side of ArcCatalog is the Catalog Tree, which allows you to browse through your file directories, much like you would in Windows Explorer. On the right side of ArcCatalog is the Catalog Display, which allows you to view the contents of a folder, preview a file, and examine its metadata.

Connecting to a folder

Previously, you copied the required tutorial data onto the Desktop. Currently, the Desktop does not show up in the Catalog Tree, because you have not yet connected to it.

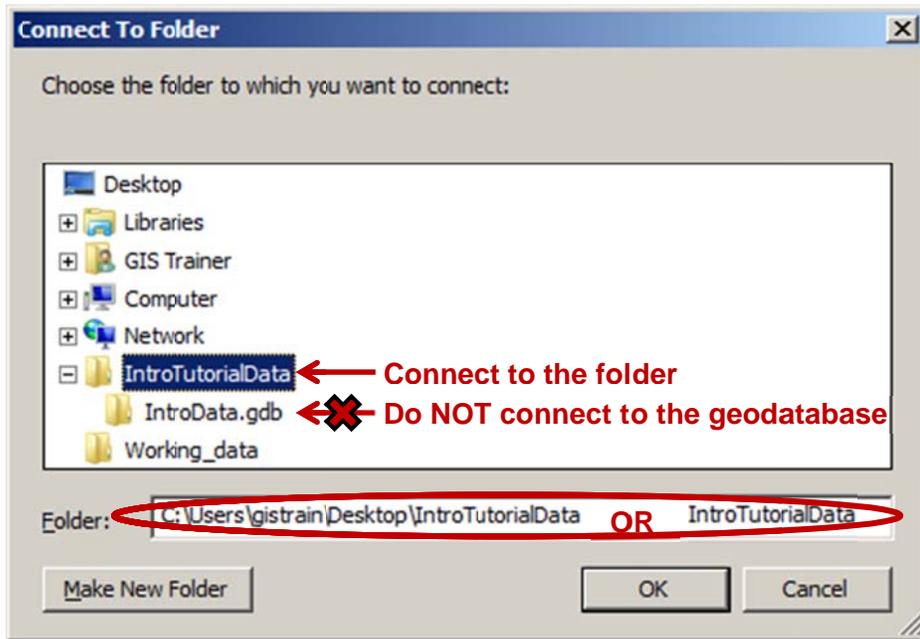
1. On the Standard toolbar, click the **Connect To Folder** button.



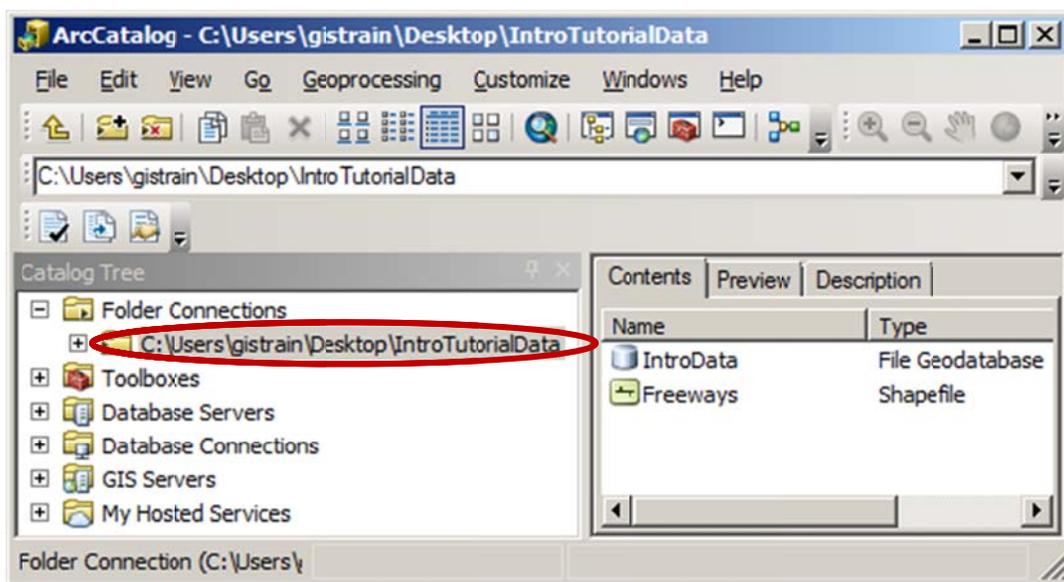
2. In the 'Connect To Folder' window, select the **IntroTutorialData** folder located on the Desktop.

Ensure that the *IntroTutorialData* folder is highlighted in blue and not the *IntroData.gdb* geodatabase that appears inside it. You will learn more about this geodatabase later, but you never want to connect directly to a geodatabase, as doing so will prevent you from being able to access any of the data contained inside of it.

3. For 'Folder:', verify that either the *IntroTutorialData* folder or the *C:\Users\gistrain\Desktop\IntroTutorialData* filepath is listed as shown below and click **OK**.



In the Catalog Tree, under Folder Connections, you should now see a file path connecting directly to your *IntroTutorialData* folder as shown below.



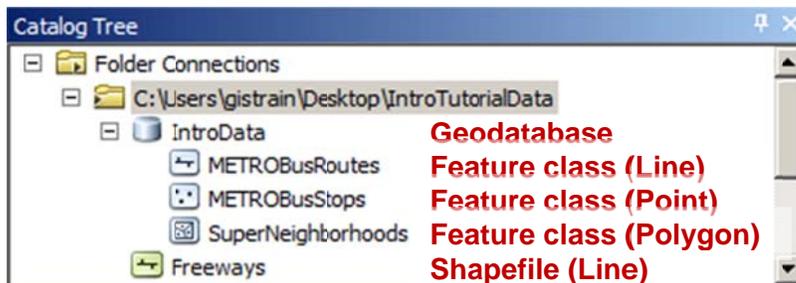
Exploring GIS file formats

1. In the Catalog Tree, click the **+** to the left of the **C:\Users\gistra\Deskto\IntroTutorialData** folder to expand its contents.

Notice that the *IntroTutorialData* folder contains one *IntroData* geodatabase and one *Freeways* shapefile.

2. In the Catalog Tree, click the **+** to the left of the **IntroData** geodatabase to expand its contents.

Notice that the *IntroData* geodatabase contains three feature classes: *METROBusRoutes*, *METROBusStops*, and *SuperNeighborhoods*. Notice also from the respective icons that these three feature classes represent three different geometries: lines, points, and polygons. Feature classes and shapefiles both contain vector data.



Though the file types are listed in the Catalog Display, the file extensions are currently hidden.

3. Click the **Customize** menu and select **ArcCatalog Options....**
4. Towards the bottom of the 'ArcCatalog Options' window, uncheck **Hide file extensions** and click **OK**.

Notice that the shapefile extension is .shp. While ArcCatalog presents a shapefile as a single file, it is actually a group of files with a common name and different extensions, as shown below in the same *IntroTutorialData* folder as viewed through Windows Explorer.

Name ^	Type	Size
IntroData.gdb	File folder	
Freeways.cpg	CPG File	1 KB
Freeways.dbf	DBF File	569 KB
Freeways.prj	PRJ File	1 KB
Freeways.sbn	SBN File	23 KB
Freeways	Adobe Illustrator Tsume File	2 KB
Freeways.shp	SHP File	369 KB
Freeways.shp	XML Document	43 KB
Freeways.shx	SHX File	18 KB

Note that the *Freeways* shapefile actually consists of 8 distinct files.

One of the primary advantages of using ArcCatalog is that it represents GIS data files by their respective layers, much as you would think of them and make use of them. If you move or rename a shapefile using ArcCatalog, it will automatically move or rename all of the associated files. If you were to move or rename a shapefile using Windows Explorer, you risk leaving a component file behind or entering a typo in one of the component file names, rendering the entire shapefile unusable. For these reasons, you should always use ArcCatalog to manage your GIS data.

Notice also that the file geodatabase extension is *.gdb*. As seen on the previous page, this geodatabase shows up as a regular file folder with a *.gdb* extension when viewed through Windows Explorer. Inside this folder are numerous files with cryptic names as shown below, which is to prevent you from altering and potentially corrupting the files outside of the ArcGIS environment.

Name ^	Type	Size
 a0000000b.gdbinde...	GDBINDEXES File	1 KB
 a0000000b.gdbtable	GDBTABLE File	3,369 KB
 a0000000b.gdbtblx	GDBTABLX File	61 KB
 a0000000b	VLC media file (.spx)	145 KB
 a0000000c.gdbindexes	GDBINDEXES File	1 KB
 a0000000c.gdbtable	GDBTABLE File	841 KB
 a0000000c.gdbtblx	GDBTABLX File	6 KB
 a0000000c	VLC media file (.spx)	5 KB

From a beginning ArcGIS user's perspective, a shapefile within a folder can be considered equivalent to a feature class within a geodatabase. The main differences are that a feature class can be considerably smaller in size than its equivalent shapefile and the manner in which the computer stores the data in a feature class is more efficient, thereby reducing the length of time required for various operations.

For these reasons, it is considered best practice to store your GIS files in a geodatabase when using ArcGIS for Desktop software. There are two types of geodatabases: a file geodatabase, which is a proprietary Esri data format with extension *.gdb*, and a personal geodatabase, which uses the Microsoft Access format *.mdb*. Microsoft Access databases are limited to a size of 2 GB and do not have all of the advanced functionality of file geodatabases. Therefore, file geodatabases are presently the recommended format for working with GIS data when using ArcGIS software.

Managing GIS Data in ArcCatalog

Creating a new file geodatabase

First you will learn how to create a new file geodatabase where you will store all of the GIS data for your project.

1. In the Catalog Tree, right-click the **C:\Users\gistrain\Desktop\IntroTutorialData** folder and select **New → File Geodatabase**.
2. When the *New File Geodatabase* appears in the Catalog Display and is highlighted in blue, type “**Houston**” to rename the geodatabase and press **Enter**.

(Due to a bug in the software, you may temporarily see two geodatabases named *Houston*, as if the preexisting *IntroData* geodatabase was also renamed *Houston*. This display error will automatically correct itself when the view is refreshed in the next steps.)

Copying feature classes between geodatabases

Now you will learn how to copy feature classes from one geodatabase to another.

1. In the Catalog Tree, expand the **C:\Users\gistrain\Desktop\IntroTutorialData** folder once again.
2. In the Catalog Tree, select the *IntroData* geodatabase.
3. In the Catalog Display, click the first **METROBusRoutes** feature class, then hold down Shift and click the last **SuperNeighborhoods** feature class to simultaneously select all three feature classes in the *IntroData* geodatabase.
4. Click and hold and drag the three selected feature classes to the *Houston* geodatabase in the Catalog Tree.
5. In the ‘Data Transfer’ window, click **OK**.
6. In the Catalog Tree, expand the *Houston* geodatabase.

You should now see three feature classes within the *Houston* geodatabase that are identical to the three feature classes in the *IntroData* geodatabase.

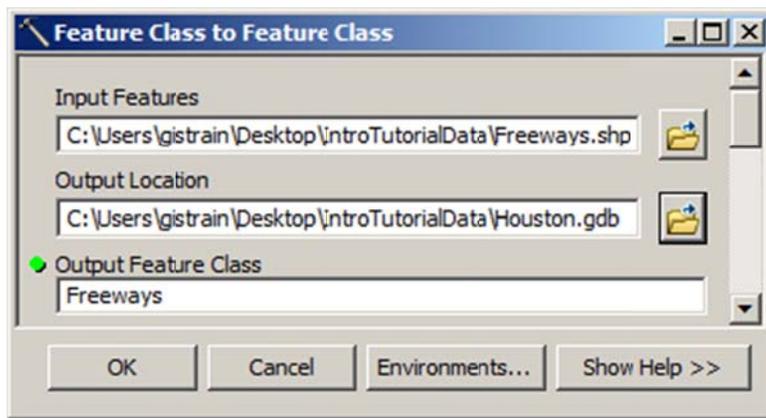
Converting shapefiles to geodatabase feature classes

Because it is still quite common to receive data or download data online in shapefile format, you will also learn how to load shapefiles into a geodatabase. Because a shapefile is a different file format than the feature classes contained within a geodatabase, they cannot simply be dragged or copied into a geodatabase, as you did with the other feature classes. Instead they must be exported to a geodatabase.

1. In the Catalog Tree, right-click the **Freeways** shapefile and select **Export → To Geodatabase (single)**....

The (single) option is for exporting a single shapefile into a geodatabase and the (multiple) option is for exporting a batch of shapefiles into a single geodatabase. Because you only have one shapefile to convert, you used the (single) option in this instance.

2. For 'Output Location', drag in the **Houston** geodatabase from the Catalog Tree.
3. For 'Output Feature Class', type "**Freeways**".
4. Ensure the 'Feature Class to Feature Class' window appears as shown below and click **OK**.



The export may take some time. When the operation has successfully completed, notice that a *Freeways* feature class now appears in your *Houston* geodatabase.

Converting geodatabase feature classes to shapefiles

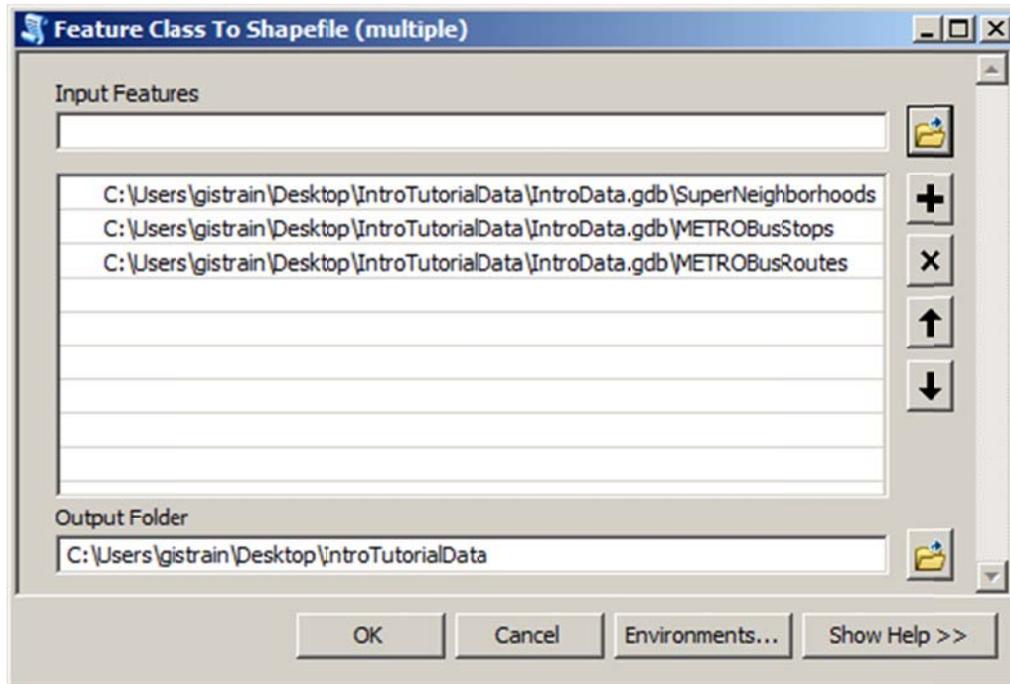
Though you have learned that it is best practice to store your files in a file geodatabase, there are times when you will need to convert your feature classes back to shapefiles. One reason is that file geodatabases are a proprietary Esri format, meaning they cannot be used with other software programs, whereas shapefiles can be used by all GIS programs. In addition, there are many online GIS programs, including Esri's ArcGIS Online, which allow you to upload your own GIS files to create web maps to share with others. These online programs frequently require you to upload GIS data in a zipped shapefile format.

You will now learn how to export feature classes to shapefiles. If you select a single feature class, you can export it to a single shapefile, but if you select a geodatabase, you can export all feature classes in the entire geodatabase to multiple shapefiles at once, which you will do now.

1. In the Catalog Tree, right-click the **IntroData** geodatabase and select **Export → To Shapefile (multiple)**....

Notice that you were not provided with the (single) export option, because multiple feature classes are contained within the geodatabase.

2. For 'Output Folder', drag in the **C:\Users\gistrain\Desktop\IntroTutorialData** folder from the Catalog Tree.
3. Ensure the 'Feature Class to Feature Class' window appears as shown below and click **OK**.



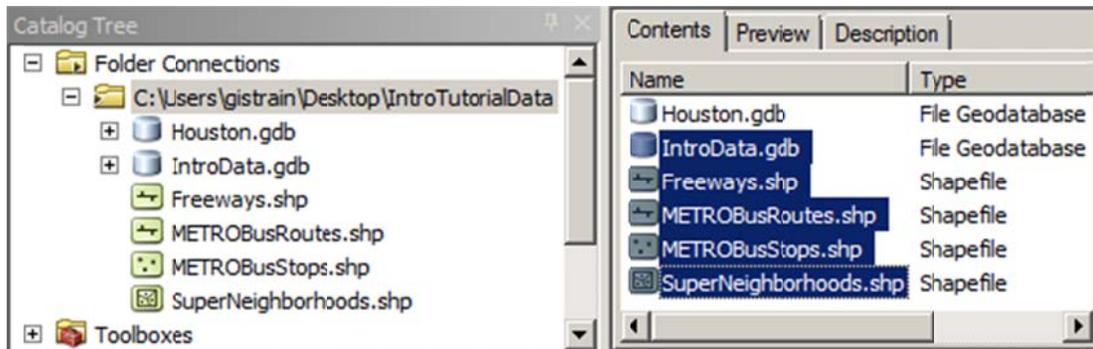
The export may take some time. When the operation has successfully completed, you would expect to see three new shapefiles in your *IntroTutorialData* folder, but folders in ArcCatalog do not always automatically refresh themselves to reflect all changes in files.

4. If necessary, in the Catalog Tree, right-click the **C:\Users\gistrain\Desktop\IntroTutorialData** folder and select **Refresh**.

Now you should see the three new shapefiles you just exported.

Since you will be using the four feature classes you newly imported into your *Houston* geodatabase for this tutorial, you will delete the *IntroData* geodatabase and the four shapefiles. Rather than deleting each file individually, you would like to shift-select all of the files to delete them simultaneously. Unfortunately, you can only shift-select in the Catalog Display, not in the Catalog Tree.

5. In the Catalog Tree, select the **C:\Users\gistrain\Desktop\IntroTutorialData** folder, if it is not already selected.
6. In the Catalog Display, click the first **IntroData** geodatabase, then hold down **Shift** and click the last **SuperNeighborhoods** shapefile to simultaneously select the geodatabase and all three shapefiles in the *IntroTutorialData* folder, as shown below.



7. Right-click the selected files and select **Delete**.
8. Click **Yes** to confirm deletion.

You should now have a single *Houston* geodatabase containing four feature classes in your *IntroTutorialData* folder.

Exploring GIS Data in ArcCatalog

Previewing GIS data features and attributes

Now that your file format and structure has been established, you are ready to explore the contents of the files themselves.

1. In the Catalog Tree, expand the **Houston** geodatabase.
2. In the Catalog Tree, select the **SuperNeighborhoods** feature class.
3. At the top of the Catalog Display, click the **Preview** tab.

This feature class contains polygons delineating the super neighborhood planning areas designated by the City of Houston. It was obtained from the *Census 2010 datasets* link on the 2011 City of Houston GIS (COHGIS) Database website at <http://gisdata.houstontx.gov/cohgis/index.html>.

At bottom of the Map Display, notice that the ‘Preview:’ drop-down menu is currently set to Geography, which allows you to preview the layer’s geometry.

4. At the bottom of the Catalog Display, use the ‘Preview:’ drop-down menu to select **Table**.
5. At the bottom of the Catalog Display, use the scroll bar to scan through **all the attribute fields** to the right.

Notice that there are many columns, or fields, containing what appears to be census data, followed by the names of the super neighborhoods along with their respective perimeter lengths and areas. These last two *Shape_Length* and *Shape_Area* fields are automatically included in the

attribute table of all feature classes by default and are automatically updated to reflect any changes in feature geometry. These two fields cannot be deleted, though they can be hidden from view, if desired.

Now you will learn more about the data you have just previewed.

6. At the top of the Catalog Display, click the **Description tab.**

You can see from the Summary that the data was taken from the 2010 PL94-171 redistricting census data. From reading the Description, you can also guess that in the field names “NH” stands for Non-Hispanic, “VAP” stands for Voting Age Population, and HU stands for Housing Units.

With this new knowledge, examine the attribute table for this layer one more time to become more familiar with the particular census variables available.

7. At the top of the Catalog Display, click the **Preview tab.**

8. At the bottom of the Catalog Display, use the ‘Preview:’ drop-down menu to select Table to reexamine the attribute fields.

Now you will explore the other feature classes.

9. In the Catalog Tree, select the **Freeways feature class.**

10. After browsing through the attribute table, use the ‘Preview:’ drop-down box to select Geography.

This feature class was originally obtained from the *COHGIS 2011 route datasets* link on the same COHGIS website listed above. It was converted to the shapefile you exported earlier for the purposes of this tutorial.

11. In the Catalog Tree, select the **METROBusRoutes feature class to preview its geometry and attributes.**

12. In the Catalog Tree, select the **METROBusStops feature class to preview its geometry and attributes.**

Both METRO feature classes were obtained from the *Metro Routes* and *Metro Bus Stops* links on the Houston-Galveston Area Council (H-GAC) GIS Data Clearinghouse website at https://www.h-gac.com/rds/gis_data/clearinghouse/default.aspx