14. Provide an example of an object from your discipline and suggest the kinds of properties and methods that the object can have.
15. What is an interface?
16. Table 3.1 shows "must not overlap" as a topology rule for polygon features. Provide an example from your discipline that can benefit from enforcement of this topology rule.
17. "Must not intersect" is a topology rule for line features. Provide an example from your discipline that can benefit from enforcement of this topology rule.
18. The text covers several advantages of adopting the geodatabase. Can you think of an example in which you would prefer the geodatabase to the coverage for a GIS project?
19. Compare Figure 3.19 with Figure 3.21, and explain the difference between the geodatabase and the coverage in handling the route data structure.
20. How can you tell regions from polygons in a polygon coverage?
21. Draw a small TIN to illustrate that it is a composite of simple features.

APPLICATIONS: VECTOR DATA MODEL

This applications section consists of six tasks. In Task 1, you will convert a coverage into a shapefile and examine the data structure of the coverage and the shapefile. In Task 2, you will work with the basic elements of the file geodatabase. Task 3 shows how you can update the area and perimeter values of a polygon shapefile by converting it to a personal geodatabase feature class. In Task 4, you will view routes in the form of polylines with *m* values. In Task 5, you will view regions and route subclasses that reside in a hydrography coverage. Task 6 lets you view a TIN in ArcCatalog and ArcMap.

Task 1: Examine the Data File Structure of Coverage and Shapefile

What you need: *land*, a coverage.

In Task 1, you will view data layers (feature classes) associated with a coverage in ArcCatalog and examine its data structure using Windows Explorer. Then, you will convert the coverage into a shapefile and examine the shapefile's data structure.

1. Start ArcCatalog, and access the Chapter 3 database. Click the plus sign to expand the coverage *land* in the Catalog tree. The coverage contains four feature classes: *arc, label, polygon,* and *tic*. On the Preview tab, you can preview each feature class by first highlighting it in the Catalog tree. *arc* shows lines (arcs); *label*, the label points, one for each polygon; *polygon*, polygons; and *tic*, the tics or control points in *land*. Notice that the symbols for the four feature classes correspond to the feature type.
2. Right-click *land* in the Catalog tree and select Properties. The Coverage Properties dialog has four tabs: General, Projection, Tics and Extent, and Tolerances. The General tab shows the presence of topology for the polygon feature class. The Projection tab shows an unknown coordinate system. The Tics and Extent tab shows the tics and area extent of the coverage, and the Tolerances tab shows various tolerance values for editing and building topology.
3. Right-click *polygon* and select Properties. The Coverage Feature Class Properties dialog has the General, Items, and Relationships tabs. The General tab shows 76 polygons. The Items tab describes the items or attributes in the attribute table, and the Relationships tab shows none.
4. Data files associated with *land* reside in two folders in the Chapter 3 database: land and INFO. You can use the Windows Explorer to

view these files. The land folder contains arc data files (.adf). Some of these graphic files are recognizable by name, such as arc.adf for the arc-coordinate list and pal.adf for the polygon/arc list. The INFO folder, which is shared by other coverages in the same workspace, contains attribute data files such as arc0000.dat, arc0000.nit, and so on. All files in both folders are binary files and cannot be read.

5. This step converts *land* to a polygon shapefile. Click the Show/Hide ArcToolbox Window button to open the ArcToolbox window. There are at least two options for the conversion. First, you can use the Feature Class to Shapefile (multiple) tool in the Conversion Tools/To Shapefile toolset. The tool converts a coverage's feature classes to shapefiles. Second, you can use the Export function in a data set's context menu. Here you will use the second option. Right-click *land_polygon* (the *polygon* feature class of *land*), point to Export, and select To Shapefile (single). In the next dialog, select the Chapter 3 database for the output location, and enter *land_polygon* for the output feature class name. Click OK. This conversion operation creates *land_polygon.shp* and adds the shapefile to the Catalog tree.
6. Right-click *land_polygon.shp* in the Catalog tree and select Properties. The Shapefile Properties dialog has the General, XY Coordinate System, Fields, and Indexes tabs. The XY Coordinate System tab shows an unknown coordinate system. The Fields tab describes the fields or attributes in the shapefile. The Indexes tab shows that the shapefile has a spatial index, which can increase the speed of drawing and data query.
7. The *land_polygon* shapefile is associated with a number of data files. You can use Windows Explorer to view these files in the Chapter 3 database. Among these files, *land_polygon.shp* is the shape (geometry) file, *land_polygon.dbf* is an attribute data file in dBASE format, and *land_polygon.shx* is the spatial index file.

Q1. Describe in your own words the difference between a coverage and a shapefile in terms of data structure.

Q2. The coverage data format uses a split system to store geometries and attributes. Use *land* as an example and name the two systems.

Task 2: Create File Geodatabase, Feature Dataset, and Feature Class

What you need: *elevzone.shp* and *stream.shp*, two shapefiles that have the same coordinate system and extent.

In Task 2, you will first create a file geodatabase and a feature dataset. You will then import the shapefiles into the feature dataset as feature classes and examine their data file structure. The name of a feature class in a geodatabase must be unique. In other words, you cannot use the same name for both a standalone feature class and a feature class in a feature dataset.

1. Make sure that ArcCatalog is connected to the Chapter 3 database. This step creates a file geodatabase. Right-click the Chapter 3 database in the Catalog tree, point to New, and select File Geodatabase. Rename the new file geodatabase *Task2.gdb*.
2. Next, create a new feature dataset. Right-click *Task2.gdb*, point to New, and select Feature Dataset. In the next dialog, enter *Area_1* for the name (connect Area and 1 with an underscore; no space is allowed). Click Next. In the next dialog, select in sequence Projected Coordinate Systems, UTM, NAD 1927, and NAD 1927 UTM Zone 11N and click Next. Choose None in the next dialog and click Next. Accept the defaults on the tolerances and click Finish.
3. *Area_1* should now appear in *Task2.gdb*. Right-click *Area_1*, point to Import, and

select Feature Class (multiple). Use the browse button or the drag-and-drop method to select *elevzone.shp* and *stream.shp* for the input features. Make sure that the output geodatabase points to *Area_1*. Click OK to run the import operation.

4. Right-click *Task2.gdb* in the Catalog tree and select Properties. The Database Properties dialog has the General and Domains tabs. A domain is a validation rule that can be used to establish valid values or a valid range of values for an attribute to minimize data entry errors.
5. Right-click *elevzone* and select Properties. The Feature Class Properties dialog has 10 tabs. Although some of these tabs such as Fields, Indexes, and XY Coordinate System are similar to those of a shapefile, others such as Subtypes, Domain, Representations, and Relationships are unique to a geodatabase feature class. These unique properties expand the functionalities of a geodatabase feature class.
6. You can use Windows Explorer to find *Task2.gdb* in the Chapter 3 database. Because it is a file geodatabase, *Task2.gdb* has many small-sized files.

Task 3: Convert a Shapefile to a Personal Geodatabase Feature Class

What you need: *landsoil.shp*, a polygon shapefile that does not have the correct area and perimeter values.

When shapefiles are used as inputs in an overlay operation, ArcGIS Desktop does not automatically update the area and perimeter values of the output shapefile. *landsoil.shp* represents such an output shapefile. In this task, you will update the area and perimeter values of *landsoil.shp* by converting it into a feature class in a personal geodatabase.

1. Click *landsoil.shp* in the Catalog tree. On the Preview tab, change the preview type to Table. The table shows two sets of area and perimeter values. Moreover, each field contains duplicate values. Obviously, *landsoil.shp* does not have the updated area and perimeter values.
2. Right-click the Chapter 3 database in the Catalog tree, point to New, and select Personal Geodatabase. Rename the new personal geodatabase *Task3.mdb*. Right-click *Task3.mdb*, point to Import, and select Feature Class (single). In the next dialog, select *landsoil.shp* for the input features. Make sure that *Task3.mdb* is the output location. Enter *landsoil* for the output feature class name. Click OK to create *landsoil* as a standalone feature class in *Task3.mdb*.

Q3. Besides shapefiles (feature classes), what other types of data can be imported to a geodatabase?

3. Now, preview the table of *landsoil* in *Task3.mdb*. On the far right of the table, the fields Shape_Length and Shape_Area show the correct perimeter and area values, respectively.

Task 4: Examine Polylines with Measures

What you need: *decrease24k.shp*, a shapefile showing Washington state highways.

decrease24k.shp is a shapefile downloaded from the Washington State Department of Transportation (WDOT) website. The shapefile contains polylines with measure (*m*) values. In other words, the shapefile contains highway routes. Originally in geographic coordinates, *decrease24k.shp* has been projected onto the Washington State Plane, South Zone, NAD83, and Units feet for Task 4.

1. Launch ArcMap. Rename the data frame Task 4, and add *decrease24k.shp* to Task 4. Open the attribute table *decrease24k*. The Shape field in the table suggests that *decrease24k* is a polyline shapefile with measures. The SR field stores the state route identifiers. Close the table.
2. This step is to add the Identify Route Locations tool. The tool does not appear on any toolbar by default. You need to add it. Select Customize from the Tools menu. On

the Commands tab, select the category Linear Referencing. The Commands frame shows five commands. Drag and drop the Identify Route Locations command to a toolbar in ArcMap. Close the Customize dialog.

3. Use the Select Features tool to select a highway from *decrease24k.shp*. Click the Identify Route Locations tool, and then click a point along the selected highway. This opens the Identify Route Location Results dialog and shows the measure value of the point you clicked as well as the minimum measure, maximum measure, and other information.

Q4. Can you tell the direction in which the route mileage is accumulated?

Task 5: View Regions and Routes

What you need: *nhd*, a hydrography data set for the 8-digit watershed (18070105) in Los Angeles, California.

nhd is a coverage with built-in regions and route subclasses. Task 5 lets you view these composite features as well as the simple features of arcs and polygons in the coverage.

1. Expand *nhd* in the Catalog tree. The *nhd* coverage contains 11 layers: *arc, label, node, polygon, region.lm, region.rch, region.wb, route.drain, route.lm, route.rch,* and *tic*. A *region* layer represents a regions subclass, and a *route* layer a route subclass.
2. Launch ArcMap, if necessary. Insert a data frame, rename it nhd1, and add *polygon, region.lm, region.rch*, and *region.wb* to nhd1. The *polygon* layer consists of all polygons on which the three regions subclasses are built. Right-click *nhd region.lm*, and select Open Attribute Table. The field FTYPE shows that *nhd region.lm* consists of inundation areas.

Q5. Regions from different regions subclasses may overlap. Do you see any overlaps among the three subclasses of the *nhd* coverage?

3. Insert a new data frame and rename it nhd2. Add *arc, route.drain, route.lm*, and *route.rch* to nhd2. The *arc* layer consists of all arcs on which the three route subclasses are built. Right-click *nhd route.rch*, and select Open Attribute Table. Each record in the table represents a reach, a segment of surface water that has a unique identifier.

Q6. Different route subclasses can be built on the arcs. Do you see any arcs used by different subclasses of the *nhd* coverage?

4. Each layer in *nhd* can be exported to a shapefile or a geodatabase feature class. For example, you can right-click *nhd route.rch*, point to Data, and select Export Data. The Export Data dialog lets you save the data set as either a shapefile or a geodatabase feature class.

Task 6: View TIN

What you need: *emidatin*, a TIN prepared from a digital elevation model.

1. Click *emidatin* in the Catalog tree. The Contents tab shows that *emidatin* is a TIN.
2. Insert a new data frame in ArcMap. Rename the data frame Task 6, and add *emidatin* to Task 6. Right-click *emidatin*, and select Properties. On the Source tab, the Data Source frame shows the number of nodes and triangles as well as the *Z* (elevation) range.

Q7. How many triangles does *emidatin* have?

3. On the Symbology tab, uncheck Elevation and click the Add button in the Show frame. In the next dialog, highlight Edges with the same symbol, click Add, and then click Dismiss. Click OK to dismiss the Layer Properties. The ArcMap window now shows the triangles (faces) that make up *emidatin*. You can follow the same procedure to view nodes that make up *emidatin*.

Challenge Task

NHD_Geo_July3 is a geodatabase downloaded from the National Hydrography Dataset program **(http://nhd.usgs.gov/data.html)**.

Q1. Name the feature datasets included in the geodatabase.

Q2. Name the feature classes contained in each of the feature datasets.

Q3. *NHD_Geo_July3* contains the same types of hydrologic data as *nhd* in Task 5. *NHD_Geo_July3* is based on the geodatabase, whereas *nhd* is based on the coverage. Compare the two data sets and describe in your own words the difference between them.

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