Lecture 6:

Developing Applications with ArcGIS

Dr. Bo Wu

lsbowu@polyu.edu.hk

Department of Land Surveying & Geo-Informatics
The Hong Kong Polytechnic University

1. Learning outcomes
2. GIS Applications with ArcGIS
3. ArcGIS Customization
4. ArcObjects and MapObjects
5. Developing GIS Applications with ArcObjects/MapObjects
6. Developing Web-GIS Applications with ArcIMS

By the end of this lecture you should be able to:
- Know the basic functions that ArcGIS can offer for a GIS project
- Perform customization exercises in ArcGIS
- Know what are ArcObjects and MapObjects, and how can they be used for developments
- Know what is ArcIMS and how can it be used for web-GIS development

Desktop GIS Applications
- ArcReader, ArcView, ArcEditor, ArcInfo
- ArcGIS Desktop: ArcMap, ArcCatalog, ArcScene, ArcToolbox, ArcGlobe

GIS Applications with ArcGIS
- Desktop GIS Applications
  - ArcGIS Desktop is the primary platform for GIS professionals to compile, use, and manage geographic information
- Web Mapping Applications
  - Bring multiple services together to create compelling Web mapping applications.
- Mobile GIS Applications
  - Mobile GIS extends the reach of ArcGIS to a broad range of mobile devices including Tablet PCs, in-vehicle mounted systems, Windows Smartphones, and Apple iOS devices

Ready to use Web Apps
- ArcGIS.com Viewer
- ArcGIS Explorer Online

Configurable Applications
- ArcGIS Viewer for Flex
- ArcGIS Mapping for SharePoint
Mobile GIS Applications
- ArcGIS Mobile
- ArcGIS for iOS
- ArcGIS for Windows Phone
- ArcPad

ArcGIS Customization
- Customize ArcGIS Desktop interface without programming
- Customize and enhance ArcGIS Desktop using ArcObjects and VBA
- Incorporate ArcObjects to non-GIS applications using external development environment (VB, VC++, C#, ...). The applications still need an ArcGIS license to run.

ArcGIS Customization without Programming
- In ArcMap
  - Map documents (.mxd files)
  - Normal (default) template (Normal.mxt)
  - C:\Documents and Settings\<your username>Application Data\ESRI\ArcMap\Templates\Base template (template other than the default)
- In ArcCatalog
  - Normal (default) template (Normal.gxt)

Save the Customization
- In ArcMap
  - Map documents (.mxd files)
  - Normal (default) template (Normal.mxt)
  - C:\Documents and Settings\<your username>Application Data\ESRI\ArcMap\Templates\Base template (template other than the default)
- In ArcCatalog
  - Normal (default) template (Normal.gxt)

Fundamentals for Programming
- Object Oriented Programming
- Objects:
  - Properties
  - Methods
  - Events

Example I: making a button to change the application caption
Example II: making a tool to display (Lat, Long) on status bar

Example III: making a button to turn all layers off

What is ArcObjects?

- ArcObjects is a collection of software components (objects) with GIS functionality and programmable interfaces.
- ArcGIS Desktop is built on ArcObjects.
- ArcObjects software components expose the full range of functionality of ArcGIS to software developers.
Dim pMxDoc As IMxDocument
Set pMxDoc = ThisDocument
Dim pMap As IMap
Set pMap = pMxDoc.FocusMap
Dim Player As ILayer
Set pLayer = pMap.Layer(0)

**Visual Basic for Applications (VBA)**
- A simplified version of Microsoft Visual Basic (VB)
- An object-oriented programming language
- Included in ArcGIS Desktop (ArcMap, ArcCatalog)
- Designed to be embedded within application

**Other Methods (VB, VC++, C#, …)**

**MapObjects**
- What is MapObjects?
  - MapObjects is an ActiveX control (OCX) with nearly 50 programmable ActiveX automation objects that can be plugged in to many standard Windows development such as Visual Basic, Visual Basic for Applications (VBA), Visual C++, Visual Studio.NET (VB.NET and C#), Delphi, Borland C++ Builder, Visual FoxPro, and PowerBuilder.
- Why MapObjects?
  - GIS is a small portion of a large application system
  - Handy functions in other Windows software
  - Simple mapping or query applications

**ArcObject vs MapObject**
- MapObjects is deployable without any other installation, but ArcObjects requires a full ArcGIS Desktop installation.
- MapObjects is much simpler than ArcObjects, in terms of object number and complexity.
- ArcObjects can do much more fancy rendering and display than MapObjects. Yet MapObjects has samples to create your own renderers, but it is not that simple.
- ArcObjects implements a lot of Interfaces in COM. Programming ArcObjects must deal with these interfaces and to ensure you got the right one.

**What You Can Do with MapObjects?**
- Draw and Display
  - Display a map with multiple map layers.
  - Render features with thematic methods.
  - Label features with text from field values.
  - Draw images from aerial photography or satellite imagery.
  - Pan and zoom throughout a map.
  - Draw graphics and descriptive text.
  - Dynamically display real-time or time-series data.
- Create new shape files
- Query and analysis
  - Select features according to graphics.
  - Select features with an SQL expression.
  - Calculate basic statistics on selected features.
  - Query and update attribute data associated with selected features.
  - Use an address and find a location on a map.
  - Project your data into different coordinate systems.

**Data Formats Supported by MapObjects**
- Standard GIS formats—ArcInfo coverages, ESRI shapefiles, and ESRI GRID
- CAD formats (DGN, DXF, and DWG)
- Access to external databases through ActiveX Data Objects (ADO), Data Access Objects (DAO), and Open Database Connectivity (ODBC)
- Image catalogs, plus a variety of image formats such as GeoTIFF, TIFF, JPEG, GIF, ERDAS Imagine, and MrSID
- ESRI's ArcView StreetMap for geocoding
- ESRI's ArcSDE (ESRI's Spatial Database Engine) databases
- Common military formats such as Vector Product Format (VPF) and ASRP/USRP
Objects in MapObjects

- Data Access Objects:
  - Access geographic data from database
- Map Display Objects:
  - Display data on 2D map
- Geometric Objects:
  - Create and manipulate points, lines, polygons …
- Utility Objects:
  - Manipulate text strings
- Projection Objects:
  - Map projection
- Address Matching Objects:
  - Geocoding/address matching

Access MapObjects in Visual Basic

An example: adding and displaying a map

MapObjects Developing with VB

An example: Add a shapefile

An example: Add an image and a grid
Determine the legend's active layer

If mapDisp.Layers.Count > 0 And legMapDisp.getActiveLayer > -1 Then
  Set g_ActiveLayer = mapDisp.Layers(legMapDisp.getActiveLayer)
Else
  Set g_ActiveLayer = Nothing
End If

If g_ActiveLayer Is Nothing Then
  MsgBox "No active layers.", vbCritical
  Exit Sub
End If

mapDisp.Extent = g_ActiveLayer.Extent

mapDisp.Extent = mapDisp.FullExtent

MapObjects Developing with VB

Zoom to full extent
mapDisp.Extent = mapDisp.FullExtent

Zoom to active layer extent

MapObjects Developing with VB

Draw text, point, line, rectangle, polygon, and circle

An Example Developed with MapObjects

ESRI GISMO - Data Portal for the City of Corvallis

Map
Analyze
Check
View
Print


ArcIMS

What is ArcIMS?
- ArcIMS is a solution for delivering dynamic maps and GIS data and services via the Web. It provides a highly scalable framework for GIS Web publishing

With ArcIMS, you can
- Deliver dynamic maps and data via the Web
- Share data with others to accomplish tasks

Other Web GIS Software
- Autodesk MapGuide
- MapInfo MapX
- Intergraph GeoMedia WebMap
- GeoServer or MapServer (Free)

ArcIMS Architecture

Accessing, viewing, and analyzing geographic data.

Handling requests and administering the ArcIMS site.

Accessing to components in the business logic tier for authoring maps, administering ArcIMS services and Spatial Servers, and designing Web sites.
A Web server handles requests from a client using HTTP. It forwards a request to the appropriate application and sends a response back to the requesting client.

A JavaVM provides the application programming interface (API) for running these applications. A servlet engine is an extension to the JavaVM and provides support for servlets through a servlet API. The servlet engine plugs into a web server and provides the link between the JavaVM and the Web server.

Components of ArcIMS

- A Web server handles requests from a client using HTTP. It forwards a request to the appropriate application and sends a response back to the requesting client.
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How Does a Web Server Connect to ArcIMS Application Server?

- ArcIMS Connectors generate ArcXML before sending requests to the ArcIMS Application Server.
- ArcXML is an implementation of XML. It provides the structure for map configuration files, metadata configuration files, requests, responses, and administration.

ArcIMS Spatial Server

- Maps are generated on the server and sent to clients as JPEG, PNG, or GIF images.
- Vector features from shapefiles and ArcSDE data sets are streamed in a compressed format to a Java Applet in the client Web browser or to other ESRI products. It allows for many functional capabilities on the client.

ArcIMS Services

- Image Services
  - An Image Service uses the Image Server.
  - When a request is received, a map is generated by the Spatial Server and sent to the client as an image.
  - A new map image is generated each time a client requests new information.
  - Image Services have internal access to the Query, Geocode, and Extract Servers depending on what functionality is required to process the request.
- Feature Services
  - A Feature Service uses the Feature Server.
  - Rather than a map being rendered on the server, data is bundled and streamed to the requesting client.
  - Since more of the processing is done in the client, requests are sent to an ArcIMS Spatial Server only when additional data is needed.
  - Feature Services have internal access to the Geocode and Extract Servers for handling geocode and extract requests, respectively.
Designing Web Pages

The output from Designer is a group of HTML files and JavaScript files.

ArcIMS Viewers

ArcIMS comes with two Java Viewers: Java Custom and Java Standard.
- Java Viewers supports Image, ArcMap Image, and Feature Services. Multiple services can be combined with local data and viewed in the same Java Viewer.
- The Java Custom Viewer uses JavaScript and can be customized using Viewer Object Model API. It is only supported on Internet Explorer.
- The Java Standard Viewer does not use JavaScript and can not be customized. It is supported on Netscape and Internet Explorer.
- The Java Viewers use a Java 2 Applet for displaying the information and processing requests. They require two downloads: Java plug-in and the needed ArcIMS Viewer components.

HTML Viewer

- HTML Viewer is written using HTML, DHTML, and JavaScript.
- Only one Image Service (or ArcMap Image Service) can be displayed at a time.
- All requests are generated using JavaScript, and all responses are parsed using JavaScript.
- The client browser must be Internet Explorer or Netscape.

Example HTML Viewer

Java Viewers

Example Java Custom Viewer

Customizing ArcIMS HTML Viewer

- ArcIMS Designer creates output files, including HTML and JavaScript files (.js), that form the foundation of the HTML Viewer. HTML files are used to generate Web page content, and the JavaScript functions allow for user interaction with the map.
- You may want to customize HTML Viewer in the following ways:
  - Changing the frame layout
  - Modifying the toolbar
  - Adding functionality
  - Changing the graphic look
  - Inserting your own company logo

ArcIMS HTML Viewer Frames
Changing Frame Layout

```html
// Change the title
// var theTitle = "ArcIMS Viewer";
// var theTitle = "Local Maps";
```

Changing the logo and background on the topFrame

```html
// Initial map extent
var startLeft = -45.005;
var startRight = 100.005;
var startTop = 100.005;
var startBottom = -40.005;

// Maximum map extent
var limitLeft = -1214.892;
var limitRight = 707.508;
var limitTop = 1244.3436;
var limitBottom = -678.0564;
```

Modifying the toolbar

```html
var usePan=true;
var usePanNorth=true;
var usePanWest=true;
var usePanEast=true;
var usePanSouth=true;
var useZoomIn=true;
var useZoomOut=true;
var useFullExtent=true;
var useZoomActive=true;
var useZoomLast=true;
var useIdentify=true;
var useMeasure=true;
var useSetUnits=true;
var useSelect=false;
var useQuery=false;
var useFind=false;
var useGeoNetwork=false;
var useBuffer=false;
var useStoredQuery=false;
var useClearSelect=true;
var usePrint=true;
```

Working with ArcIMSparam.js includes, but is not limited to, variables for:
- Changing services and map extents
- Setting the initial display of the legend
- Defining North arrows and copyright text on an acetate layer
- Defining fields for attribute display
- Changing tools and the toolbar

```html
// North Arrow
var drawNorthArrow = true;
var NorthArrowType = "4";
var NorthArrowSize = "15";
var NorthArrowCoords = "20 35";
var NorthArrowAngle = "0";

// Scale Bar
var drawScaleBar = true;
var MapUnits=DEGREES,FEET,METERS
// can MapUnits be changed by user?
var setMapUnits=false;
ScaleBarUnits=KILOMETERS,METERS,MILES,FEET
var ScaleBarBackgroundColor = "false";
var ScaleBarBarColor = "0,0,0";
var ScaleBarFontColor = "0,0,0";
var ScaleBarBarWidth = "128,128,128";
var ScaleBarForeColor = "rii=rii=rii=rii=",rii=rii=rii=rii=";
var ScaleBarStyle = "Regular";
var ScaleBarBarRound = "1";
var ScaleBarFontSize = "5";
var ScaleBarBarPrecision = 2;
var numDecimals = ScaleBarBarPrecision;
```

An Example
Further readings

- ArcGIS Applications. (http://resources.arcgis.com/content/arcgisserver/9.3/server-applications)
- ArcGIS Web Apps (http://resources.arcgis.com/content/web/web-apps)

Summarization of the main ideas presented in this lecture:

Questions?