An introduction to ArcGIS

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ArcGIS overview
The ArcGIS system

- ArcGIS is an integrated family of GIS software products for building a complete GIS.

- ArcGIS provides a scalable framework for implementing GIS for a single user or many users on desktops, in servers over the Web and in the field.
The ArcGIS system

ArcView, ArcEditor and ArcInfo

ArcIMS, ArcGIS Server and ArcGIS Image Server

Embeddable software components for developers to extend GIS desktops, build custom GIS applications, add custom GIS services and Web applications and create mobile solutions

ArcPad and ArcGIS Mobile for field computing

ArcObjects

Desktop GIS

Server GIS

Developer GIS

Mobile GIS

XML, SOAP, ArcXML, Geodatabase XML, OGC WMS, WFS...

Many Files

Multiple DBMSs

Web Services

Application Bridges (SAP, SAS, ERP, Permitting, ...)

Data

Common Software Components

the four frameworks of GIS applications in ArcGIS
The ArcGIS system

A scalar and modular system

- ArcReader: visualisation
- ArcView: visualisation, analysis, basic editing
- ArcEditor: advanced editing
- **ArcInfo: complete tool**
- Extensions: advanced analysis
- ArcSDE: DB services
- ArcIMS: internet services
- ArcPAD: sw for PDAs
Available tools (ArcGIS 10)

• ArcMap ⇒ display, editing and analysis of maps

• ArcCatalog ⇒ tool used to access and manage data and metadata (embedded in ArcMap or available as a separate module)
ESRI data format

coverage

- standard arc/info format
  data are distributed in the directories of the single coverages and in the common directory INFO
  ⇒ single coverages can’t be used alone
  ⇒ copy/paste/delete operations must be executed via ArcCatalog

- arc/info PC format
  each coverage contains all the data inside its own directory
  ⇒ single directories can be used alone
ESRI data format

**shape file**

This format stores in a single data set non-topological geometry and attributes of a spatial entity (point, line or surface).

<table>
<thead>
<tr>
<th>.dbf</th>
<th>.prj</th>
<th>.shp</th>
<th>.xml</th>
</tr>
</thead>
<tbody>
<tr>
<td>attributes</td>
<td>projection</td>
<td>geometry</td>
<td>metadata</td>
</tr>
</tbody>
</table>

- .dbf
- .prj
- .shp
- .xml
- .ain, .aih
- .shx, .sbn, .sbx
- .ain, .aih
- .shx, .sbn, .sbx
ESRI data format

shape file

Mandatory files
* .shp — shape format; the feature geometry itself
* .shx — shape index format; a positional index of the feature geometry to allow seeking forwards and backwards quickly
* .dbf — attribute format; columnar attributes for each shape, in dBase III format.

Optional files
* .prj — projection format; the coordinate system and projection information, a plain text file describing the projection using well-known text format
* .sbn & .sbx — a spatial index of the features
* .fbn & .fbx — a spatial index of the features for shapefiles that are read-only
* .ain & .aih — an attribute index of the active fields in a table or a theme's attribute table
* .ixs — a geocoding index for read-write shapefiles
* .mxs — a geocoding index for read-write shapefiles (ODB format)
* .atx — an attribute index for the .dbf file in the form of shapefile.columnname.atx (ArcGIS 8 and later)
* .shp.xml — metadata in XML format
ESRI data format

**geodatabase**

Data model introduced with ArcGIS 8
- object-oriented data model
  - standard GIS object
  - complex objects, direct modeling of reality
- XML-based data exchange

Two different implementations:
1. Personal Geodatabase
2. Enterprise Geodatabase
ESRI data format

The ESRI raster format has a structure on the file system that is similar to the standard arc/info format used for the coverages:

- an info directory for common data
- each directory contains data for a single raster map

⇒ copy/paste/delete operations must be executed via ArcCatalog
An introduction to ArcMap
Layers

Geographic information is partitioned in layers, that can be managed distinctly and have different sources:

- coverage
- shape file
- geodatabase
- GRID
- images
- CAD
- ...

ESRI formats
- vector
- raster
- other formats
ArcMap interface

GUI (Graphic User Interface)

cartographic view

ArcCatalog

ArcToolbox

Table of Contents: complete list of layers
There can be multiple frames and for each of them it is possible to define different properties (geographic region, reference system,...)

There can be one or more layers inside each frame
Add a layer

geodatabase

shape files

DWG

coverage

coverage

raster files

network access
Layer properties

right-click on the layer name
Layer properties: symbols

changing graphical properties

list of predefined symbols

color & width
Layer properties: symbols
changing graphical properties

resulting style
characteristics of the composing element
composed style (overlap of multiple lines)
Layer properties: symbols

The graphical customization can be applied also to area elements...

list of predefined symbols
Layer properties: symbols

...and point elements.

list of predefined symbols
Layer properties: symbols

Display the layer according to the attribute values

Available discrimination criteria
Layer properties: symbols

Example: different symbols for different values

- Data field
- Predefined color scheme
- Buttons used to manage the list of symbols
Layer properties: symbols

Legend elements

double click to modify symbols
double click to insert/modify labels
to modify the hierarchy of elements
Layer properties: symbols

Example: different symbols for different ranges of values

- **Data field**
- **Number of classes**
- **Predefined color scheme**
Layer properties: symbols

Example
Layout view

Display a print preview of the project
Layout view: customization

Insert a title

Map of Como

Format:
- font
- dimension
- ...
Layout view: customization

In a similar way it is possible to add and customize:

- a legend
- a north arrow
- a scale bar
- text and other graphical elements
Layout view: customization
Layout view: customization

To modify objects in the layout view:

- click on the object to select it (move, copy, paste, stretch,...)
- double click on the object to modify its properties
Saving a project means saving:

- the list of used layers
- their visualization options (colors, labels, etc)
- the print layout

*mxd* format: it is required to have at least the ArcView license in order to open it.
**Saving a project**

The *mxd* file contains only references to maps, it does not enclose cartographic contents in itself.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>absolute path:</td>
<td></td>
</tr>
<tr>
<td>c:\temp\carte\prova.shp</td>
<td>the map position does not depend on the position of the project file</td>
</tr>
<tr>
<td>relative path:</td>
<td></td>
</tr>
<tr>
<td>.\carte\prova.shp</td>
<td>the map position is defined in function of the position of the project file</td>
</tr>
</tbody>
</table>

It is possible to choose between two kinds of reference, in function of the intended use of the project - es:

- **absolute path:**
  - c:\temp\progetto.mxd
  - c:\temp\carte\prova.shp

- **relative path:**
  - .\carte\prova.shp
Saving a project

To define the reference type:

absolute path is set by default; put the check to choose the relative path
Exporting a project

It’s possible to export a project as an image or as a pdf document.

Different options will be available in function of the chosen format.
An introduction to ArcCatalog
ArcCatalog

ArcCatalog is a tool to access and manage data and metadata:
• content visualization
• operations on cartographic files (copy, cut, paste, rename)
• metadata creation and updating
• search functions
• format conversion tools
• reference system setting and transformation
The ArcCatalog interface

GUI (Graphic User Interface)
catalog view
catalog tree
Content visualization

cartographic content displayed by ArcCatalog

actual content of the directory
Content visualization

- **GIS Servers**: management of the connection to ArcGIS Server and ArcIMS Server to access data distributed via internet
Content visualization

- **Database Connection**: management of the connection to spatial databases
Content visualization

• geographic data view
Content visualization

• geographic data view

navigation (zoom in, zoom out, pan, zoom extent)
Content visualization

- geographic data view
Content visualization

• attribute table view
Reference systems

ArcCatalog makes available tools to manage the reference system associated to maps:

• associate a reference system to a map
• convert a map from a reference system to another one
Reference systems

associate a reference system: vector maps

display the properties window in ArcCatalog, then insert the reference system in the given field
Reference systems

associate a reference system: raster maps

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>GRID</td>
</tr>
<tr>
<td>Source Type</td>
<td>continuous</td>
</tr>
<tr>
<td>Pixel Type</td>
<td>unsigned integer</td>
</tr>
<tr>
<td>Pixel Depth</td>
<td>8 bit</td>
</tr>
<tr>
<td>NoData Value</td>
<td>0</td>
</tr>
<tr>
<td>Colormap</td>
<td>absent</td>
</tr>
<tr>
<td>Pyramids</td>
<td>absent</td>
</tr>
<tr>
<td>Compression</td>
<td>RLE</td>
</tr>
<tr>
<td>Extent</td>
<td>956098,9</td>
</tr>
<tr>
<td>Left</td>
<td>641387,5</td>
</tr>
<tr>
<td>Right</td>
<td>659662,5</td>
</tr>
<tr>
<td>Bottom</td>
<td>936223,9</td>
</tr>
<tr>
<td>Spatial Reference</td>
<td>Roma_1940_Gauss_Boaga_Ovest</td>
</tr>
<tr>
<td>Linear Unit</td>
<td>Meter (1,000000)</td>
</tr>
<tr>
<td>Angular Unit</td>
<td>Degree (0,017459292519943299)</td>
</tr>
<tr>
<td>False_Easting</td>
<td>1500000</td>
</tr>
<tr>
<td>False_Northing</td>
<td>0</td>
</tr>
<tr>
<td>Central Meridian</td>
<td>0</td>
</tr>
</tbody>
</table>

[Image of Raster Dataset Properties window]
Most geoprocessing tasks are accessed through ArcToolbox:
• format conversion
• data management and interoperability
• analysis tools
• editing tools
• statistical tools
ArcToolbox

ArcToolbox is embedded both in ArcMap and ArcCatalog:
ArcGIS help system

standard Windows help interface: hierarchical contents with sub-topics
An introduction to interpolation methods

Geostatistics, as mentioned in the introductory topic What is geostatistics?, is a collection of methods that allow you to estimate values for locations where no samples have been taken and also to assess the uncertainty of these estimates. These functions are critical in many decision-making processes, as it is impossible in practice to take samples at every location in an area of interest.

It is important to remember, however, that these methods are a means that allows you to construct models of reality (that is, of the phenomenon you are interested in). It is up to you, the practitioner, to build models that suit your specific needs and provide the information necessary to make informed and defensible decisions. A big part of building a good model is your understanding of the phenomenon, how the sample data was obtained and what it represents, and what you expect the model to provide. General steps in the process of building a model are described in The geostatistical workflow.

Many interpolation methods exist. Some are quite flexible and can accommodate different aspects of the sample data. Others are more restrictive and require that the data meet specific conditions. Kriging methods, for example, are quite flexible, but within the kriging family there are varying degrees of conditions that must be met for the output to be valid. Geostatistical Analyst offers the following interpolation methods:

- Global polynomial
- Local polynomial
- Inverse distance weighted
- Radial basis functions
- Diffusion kernel
- Kernel smoothing
- Ordinary kriging
- Simple kriging
- Universal kriging
- Indicator kriging