GIS programming (2)

GIS 400/500

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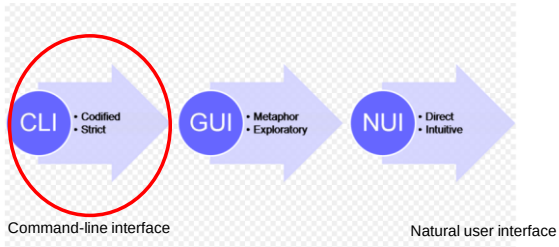
Outline

- Programming introduction
- Programming process
- ArcGIS programming

Interface change 1



Interface change 2

Interface	Analogy	Elements	Attributes
CLI	Typewriter	Prompt, Command and arguments, Result	Single task, Single user, Command oriented, Keyboard input
GUI	Papers arranged on a desk	Windows, Icons, Menus, Pointer (WIMP)	Multi-task, Single user, Task oriented, Keyboard + Mouse input
NUI	Objects	Objects, Containers, Gestures, Manipulations (OCGM)	Multi-task, Multi-user, Object oriented, Touch input

http://nui.joshland.org/2009/01/natural-user-interface-revolution.html

Programming

- Computer program
  - A sequence of instructions written to perform a specified task with a computer.
  - Programming instructions are written using a programming language
    - Examples: C/C++, Java, Fortran, Python …
- Compiler
  - Translates a computer program written in a human-readable computer language (like Java) into a form that a computer can execute (binary code).
    - Examples: C++ and .Net
    - exe files are the output of compilers.

Python

- Python was created by Guido van Rossum in Netherlands and first released in 1991
- It is an interpreted language, which means it does not need to be compiled. It makes Python easier to work with and more portable than code in compiled language.

Levels of programming language

- Professional (directly interact with hardware, very efficient, but hard to learn)
  - Assembly language (not portable)
    - `10110000 01100001` x86/IA-32 processer, loads the AL register with the data 01100001
- Mid-level (efficient, software development tools)
  - C, C++, Java (like directly write HTML code)
- Application tools
  - Visual Studio (VB.NET, C#, like using Dreamweaver)
  - Python ?
  - and VBA (like using Dreamweaver)

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Visual Basic

- The simplest programming language
- Syntax similar to English

```
If score >= 90 Then
        grade = "A"
ElseIf score >= 80 And score < 90 Then
        grade = "B"
ElseIf score >= 70 And score < 80  Then
        grade = "C"
ElseIf score >= 60 And score < 70 Then
        grade = "D"
Else
        grade="F"
End If
```

- Everyone can learn Visual Basic

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Visual Basic, VBScript and VBA

- Visual Basic is a stand-alone tool for creating separate software components, such as executable programs, COM components and ActiveX Controls, and is useful when you must build a specialized solution from scratch.
- VBA offers the same powerful tools as Visual Basic in the context of an existing application, and is the best option for customizing software that already meets most of your needs.
- VBScript is a lightweight version of the Visual Basic language, and is designed specifically for use on Web pages. While scripting can sometimes be used for simple automation, VBA is the premier technology designed specifically for application automation. Unlike VBA, VBScript does not have an **integrated development environment** (IDE).

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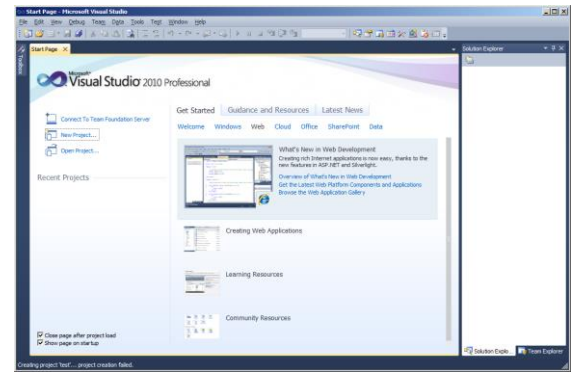
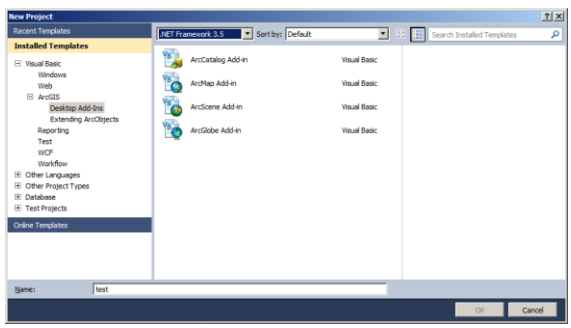
Visual Basic.NET



Visual Basic.NET



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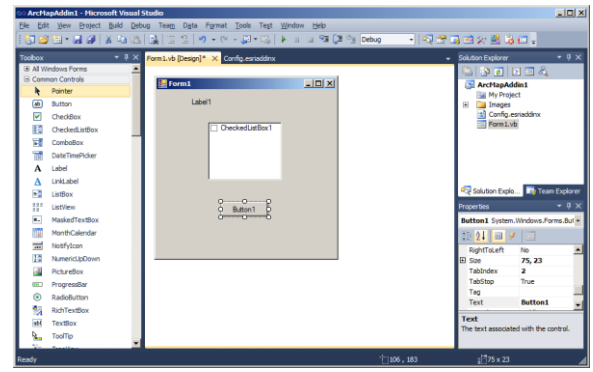
Visual Basic.NET



VBA

- Used in ArcGIS 8, 9, and 10.0
- Not available from ArcGIS10.1
- Still available in MS Office system
  - Excel 2016
  - Access 2016
  - Word 2016
  - File -- Options -- Customize Ribbon

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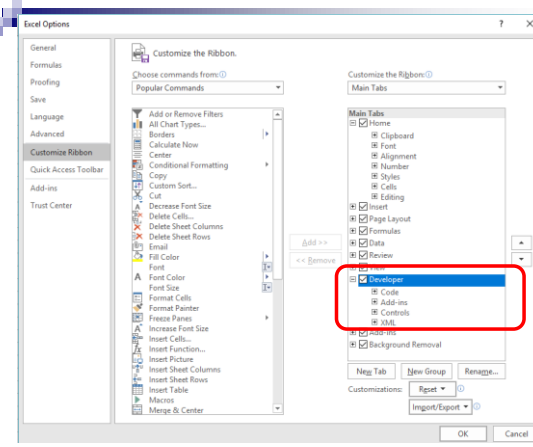

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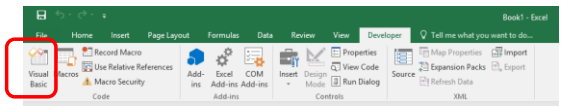
Developer Ribbon



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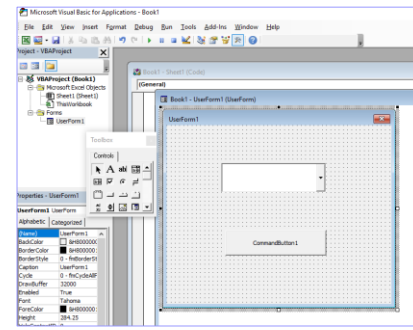
VBA in Excel 2016



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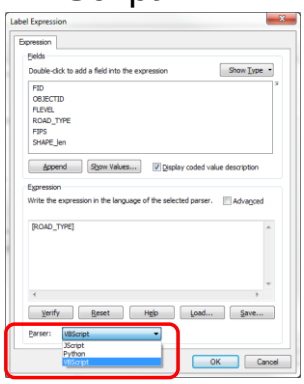
VBScript



Python

```
"Parcel no: " + [PARCELNO]
```

VBScript

```
"Parcel no: " & [PARCELNO]
```

JScript

```
"Parcel no: " + [PARCELNO]
```

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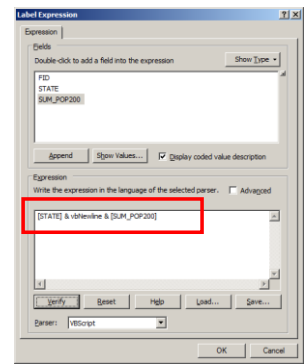
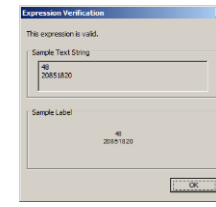
VBScript





[Name] & vbNewline & [POP_2000]

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VBScript

Python

```
def FindLabel ( [NAME] ):
  S = [NAME]
  S = S.title()
  return S
```

- A Name field that is in all capitals and we need to make it proper case

VBScript

```
Function FindLabel ( [NAME] )
FindLabel = UCase(Left([NAME],1)) & LCase(Right([NAME], Len([NAME]) -1))
End Function
```

JScript

```
function FindLabel ( [NAME] )
{
var str = [NAME];
var iLen = String(str).length;
var upper = (str.substring(0,1)).toUpperCase();
var lower = (str.substring(1, iLen)).toLowerCase()
return upper + lower;
}
```

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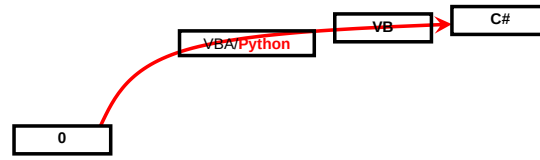
Learning curve

- Applications use VBA
  - MS Office: Word, Excel, PowerPoint, Access etc.
  - AutoCAD
  - NO more in ArcGIS 10.1



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Outline

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Let's get started with our programming …

1st: planning (programming process)!!!

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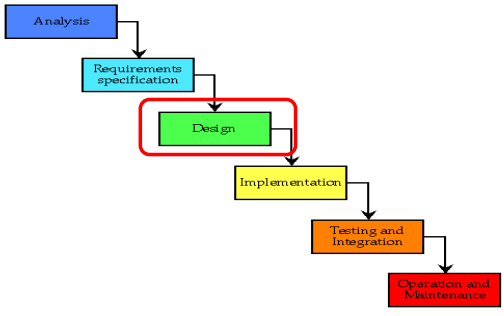
Traditional Waterfall Model



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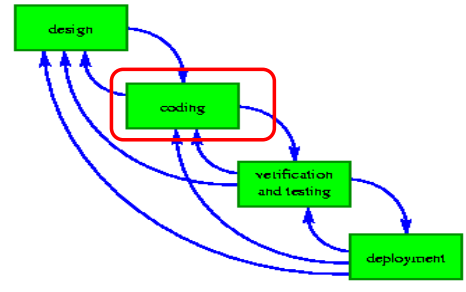
Waterfall w/ feedback loops



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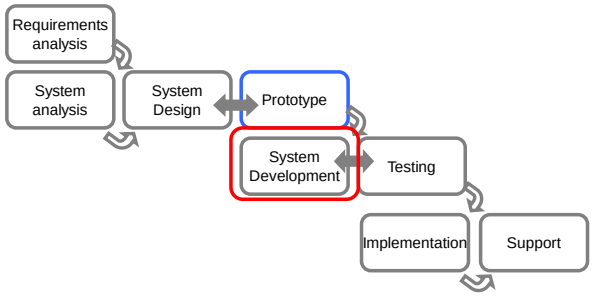
Another Waterfall w/ feedback loops



Programming process

- Needs assessment
  - What functions/tools are needed
- Conceptual design
  - Conceptual blueprint/outline
  - Logical way to solve the problem, algorithm development
- Physical design
  - Programming and have it working!
- Implementation
  - Using
- Management
  - Maintenance, update, and use

Watershed modeling example

- Needs assessment
  - Delineate watershed boundary and accuracy requirement
- Conceptual design
  - DEM---fill----flow direction --- flow accumulation---delineation
- Physical design
  - Programming ArcObjects
- Implementation
  - Watershed boundary delineation
- Management
  - Code update if necessary

Outline

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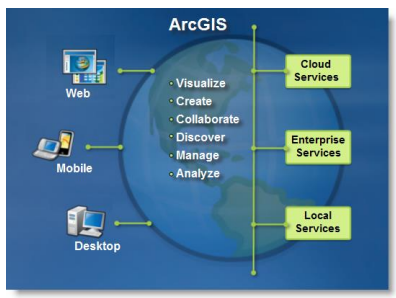
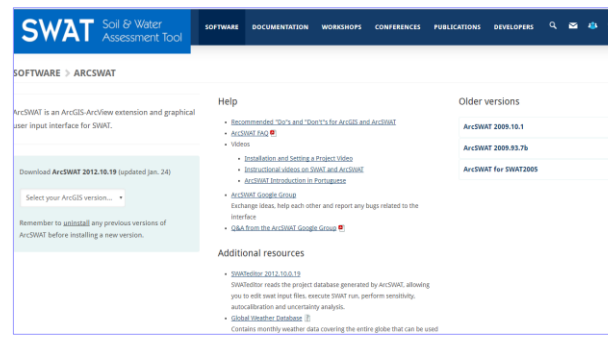
  - High level
  - Desktop

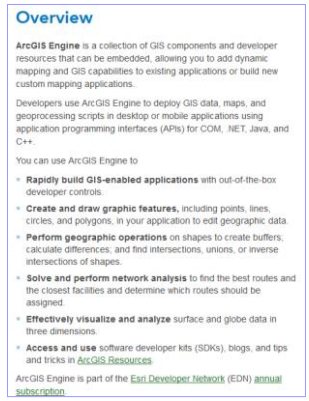
ArcGIS system





http://swat.tamu.edu/software/arcswat/

ArcGIS Engine



http://www.esri.com/software/arcgis/arcgisengine

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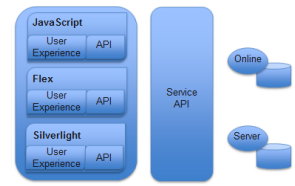
Web applications

- With ArcGIS Server, you can access and work with a series of Web APIs for JavaScript, Flex, and Silverlight to build custom Web applications for use with ArcGIS.



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Customizing ArcGIS Desktop

1. Configure user interfaces (rearrange standard GUI elements)
2. Use geoprocessing and Python to automate data processing and many GIS workflows
3. Write Add-ins for Desktop using .NET, Java, and Python
4. Using the comprehensive ArcObjects library to write custom software and extensions, .NET and Java

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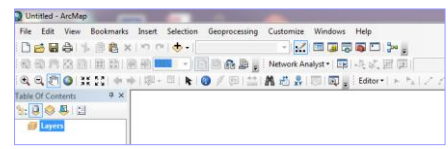
ArcGIS desktop GUI

- Graphical User Interface
- Toolbar/menu
  - Container of commands (tools/button)



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Why Python?

- Python is open source
  - Free to use, even for commercial products.
- Python is cross platform
  - It runs on Windows, Linux/unix, Mac OS X and have been ported to the Java and .NET virtual machines.
- It is integrated into ArcGIS Desktop
  - All ArcGIS Desktop applications include an embedded scripting language called Python. Many areas of ArcGIS—particularly geoprocessing—are accessible through simplified Python application programming interfaces (APIs), making it easy to author and automate common tasks. Python scripts are easily shared and can be produced without an external development environment. There are a variety of public domain Python modules focused on areas such as science, engineering, and mathematics.

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Python Add-ins

- An add-in is a customization, such as a collection of tools on a toolbar, that plugs into an ArcGIS for Desktop application (that is, ArcMap, ArcCatalog, ArcGlobe, and ArcScene) to provide supplemental functionality for accomplishing custom tasks.
- ArcGIS 10.1 introduces Python to the list of languages for authoring Desktop add-ins, providing you with an easy solution to extend desktop functionality. To simplify the development of Python add-ins, you must download and use the Python Add-In Wizard to declare the type of customization. The wizard will generate all the required files necessary for the add-in to work. Click here to download the Python Add-In Wizard.

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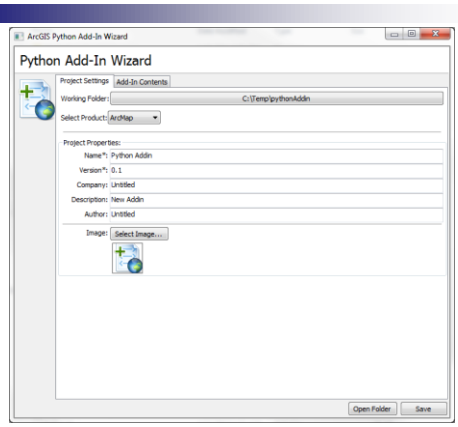

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Your first python code in ArcMap

1. Use ArcCatalog to copy the tx_state.shp from Y:/Undergraduate/GIS400 to your c:/temp folder.
2. Open ArcMap
3. Go to Geoprocessing --- Python
4. The Pythone window opens
5. Type in

```
>>> import arcpy
```

-
```
>>> arcpy.Buffer_analysis("c:/temp/tx_state.shp", "c:/temp/buffer", "1000 METERS")
```
- Then have a cup of coffee!

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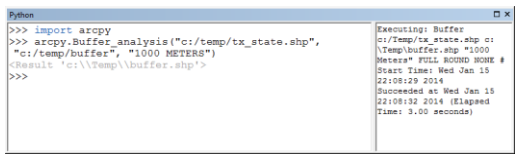

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Help

- **Python**
  - http://docs.python.org/2/tutorial/
- **ESRI**
  - http://desktop.arcgis.com/en/arcmap/latest/analyze/python/a-quick-tour-of-python.htm

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Summary

- Programming introduction
- Programming process
- ArcGIS programming