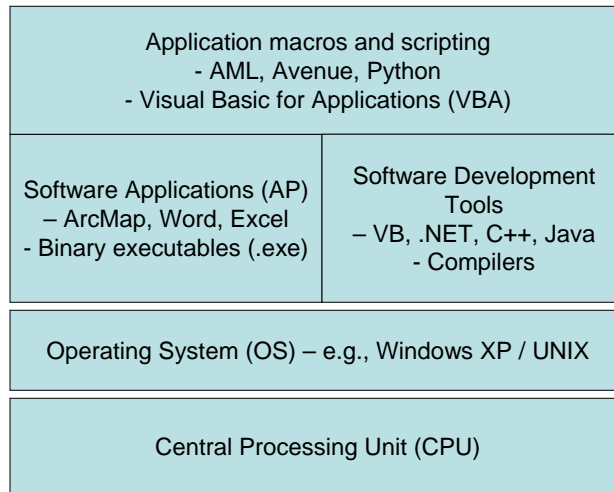


# Introduction

## Why (GIS) Programming?

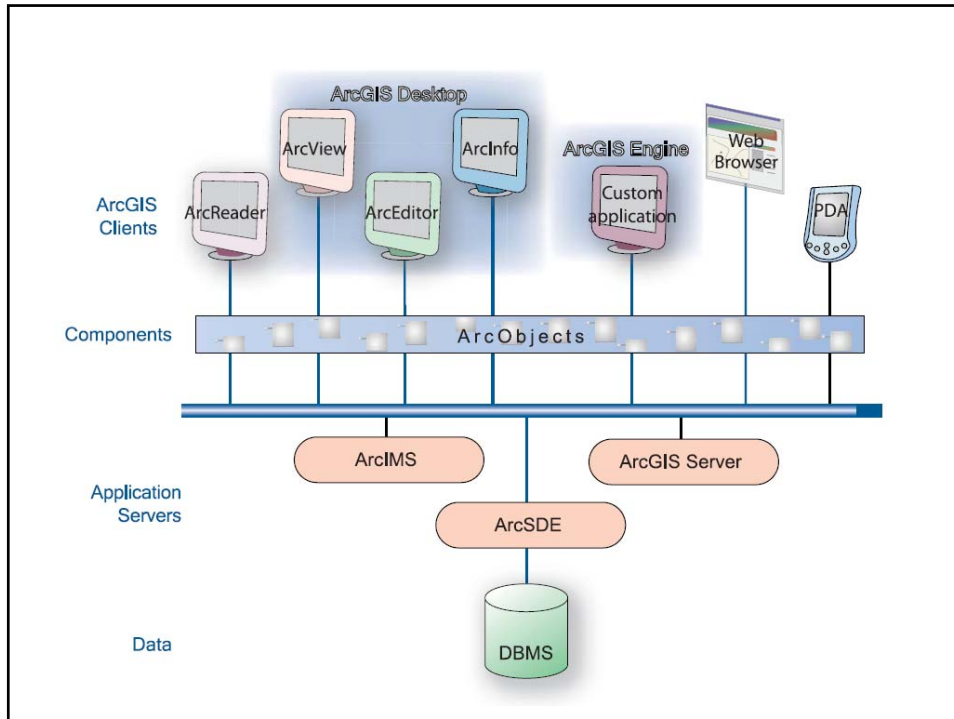
- Streamline routine/repetitive procedures
- Implement new algorithms
- Customize user applications
- ...

# Computer Software Architecture



## Different Types of Computer Programming Tools

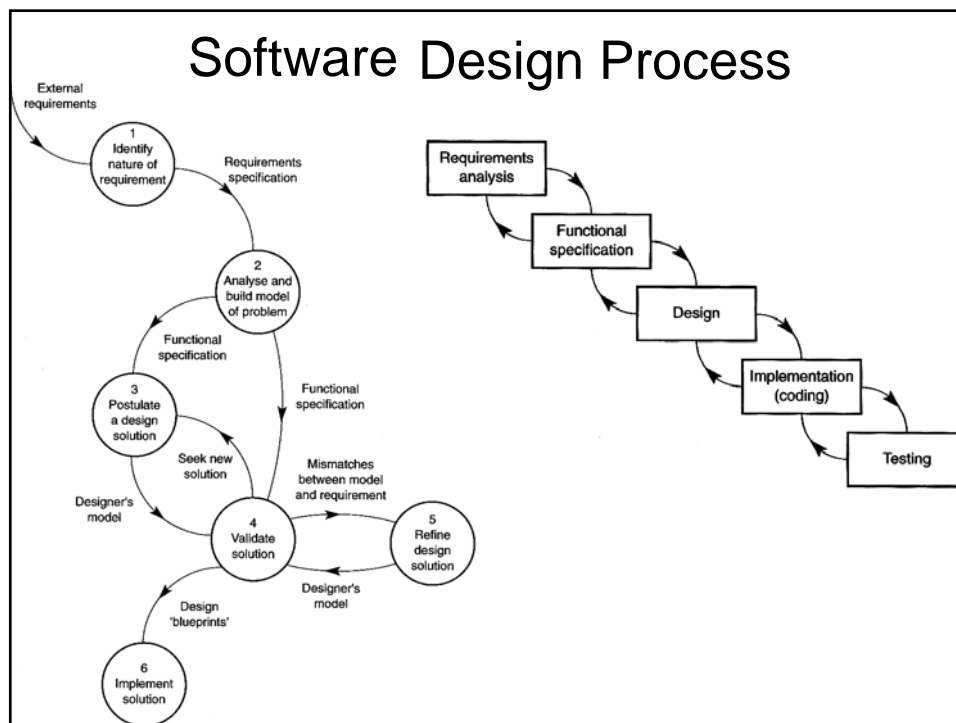
- **Compiler**
  - Source code -> object code
  - CPU “reads” object code and executes instructions
- **Interpreter**
  - Scripts, macro programming language
  - Applications (e.g., MS Word) “read” scripts and executes instructions
  - VBA



## ArcGIS Programming

- **Compiler approach**
  - Java, C++, .NET, VB compiler
  - GIS code libraries: ArcGIS Engine, ArcObjects
  - Interact through COM (Component Object Model) components (e.g., ActiveX DLL)
    - <http://www.esri.com/software/arcgis/arcgisengine/about/demos.html>
  - Stand-alone EXE
- **Interpreter approach**
  - ArcMap and ArcCatalog
  - GIS code libraries: ArcObjects
  - Interact through VBA
  - VBA macro (scripts)

# Software Engineering and Design



## Software Design & Programming

- Requirement analysis
- Structured systems analysis
- Data specification
- Program specification
- GUI

## Components of Computer Programming

- Programming language
- Algorithm
- Editor
- Code libraries and resources (.lib & .obj)
- Compiler/Interpreter
- Debugger
- Packaging/Deployment tools

Integrated development environment (IDE)

# VB and ArcGIS VBA Environment

## **What are the differences between Visual Basic, VBA, and VBScript? When would I use one over another?**

- **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).**

## Computer Language Components

- Syntax
  - Subroutine, procedures, functions (intrinsic and external)
  - Expressions and statements
  - Keywords
  - Naming convention
- Variables / constants
  - Data types
  - Declaration
  - Assignment and retrieval
- Operands / operators
  - Arithmetic, logical, assignment, bitwise, ...
- Scope
- Exception / error handling
- Visual components
  - IDE, GUI Objects

## VB Statements

a = 3

b = 2 + 5

c = a + b

d = d + 1

aValue = 1 + 6 / 3 \* 2 ^ (1 + 1)

bValue = a + b / c \* d ^ 2

If a > b Then c = 3

## Procedures/Subroutines/Functions

```
Private Sub MyFirstControl_Click()  
    'VB Codes  
    ...  
End Sub
```

## Example

```
Sub Hello_World()  
    Dim a As Integer  
    Dim i As Integer  
    a = 3  
    For i = 1 To a  
        Debug.Print "Hello World!"  
    Next  
End Sub
```



## VBA Data Types

<i>Data type</i>	<i>Storage size</i>	<i>Range</i>
Boolean	2 bytes	True or False
Byte	1 byte	0 to 255
Integer	2 bytes	-32,768 to 32,767
Long	4 bytes	-2,147,483,648 to 2,147,483,647
Currency		-922,337,203,685,477.5808 to 922,337,203,685,477.5807
Single	4 bytes	-3.402823E38 to -1.401298E-45 for negative values; 1.401298E-45 to 3.402823E38 for positive values
Double	8 bytes	-1.79769313486231E308 to -4.94065645841247E-324 for negative values; 4.94065645841247E-324 to 1.79769313486232E308 for positive values
Date	8 bytes	January 1, 100 to December 31, 9999
String (variable-length)	10 bytes + string length	0 to approximately 2 billion String
String (fixed-length)	Length of string	1 to approximately 65,400
Currency	8 bytes	-922,337,203,685,477.5808 to 922,337,203,685,477.5807
Object	4 bytes	Any Object reference
Variant	16 bytes to variant length	

- Dim X As Boolean
- Dim X As String, Dim Y(10) As String
- If you do not specify a data type, the Variant data type is assigned by default, i.e., Dim X.

## VB Variables Naming Convention

Use the following notation for naming variables and constants:

[<libraryName.>][<scope.>]<type><name>

<name> describes how the variable is used or what it contains. The <scope> and <type> portions should always be lowercase, and the <name> should use mixed case.

Library Name	Library
esriGeometry	ESRI Object Library
stdole	Standard OLE COM Library
<empty>	Simple variable data type

<libraryName>

Prefix	Variable scope
c	constant within a form or class
g	public variable defined in a class form or standard module
m	private variable defined in a class or form
<empty>	local variable

<scope>

Examples:

Global Const cdMyPI = 3.14159

Dim bSelected As Boolean

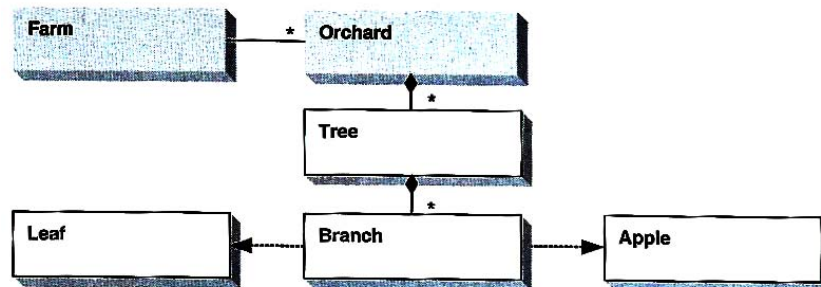
Public giMapNo As Integer

Prefix	Data Type
b	Boolean
by	byte or unsigned char
d	double
fn	Function
h	handle
i	int (integer)
l	Long
p	a pointer
s	String

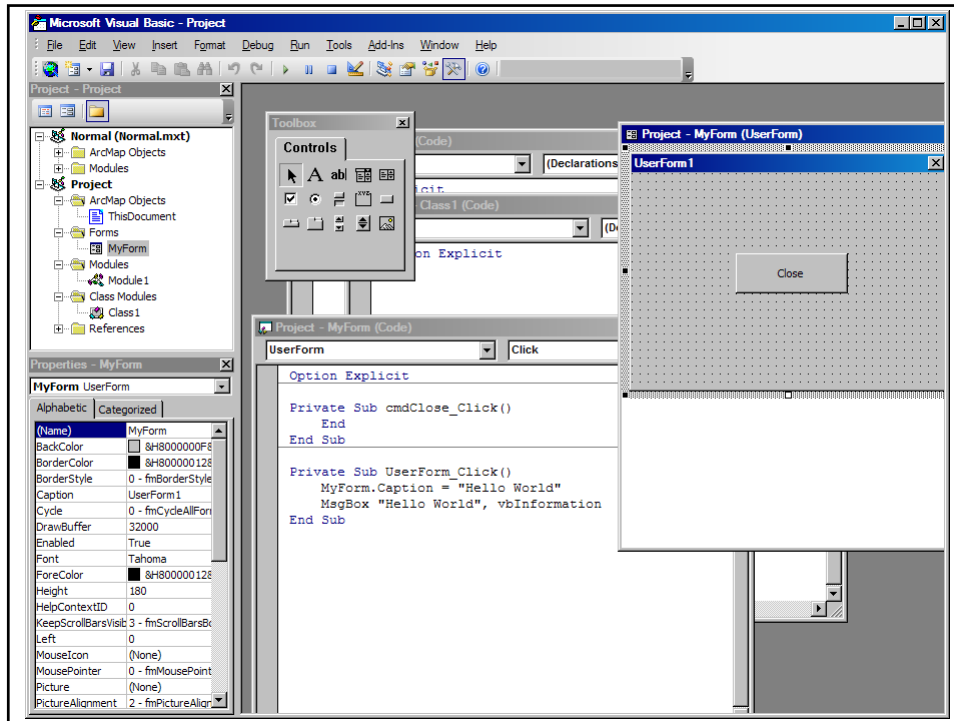
## Object-Oriented Programming (OOP)

- Object
  - Events (response to triggers)
  - Properties
  - Methods
- Class (a collections of similar objects)
  - Events
  - Properties
  - Methods
- Interface (for accessing properties and methods of objects)

## Object Model



1. Orchard is a type of farm (there are many other types of farm). - association
2. An orchard has trees. - composition
3. A tree has branches. - composition
4. A branch can grow fruit. - instantiation
5. A branch can grow leaves. - instantiation
6. An apple tree is a tree. - type inheritance



## VB Control Naming Convention

Object	Prefix	Example
Form	frm	frmSelect
Label	lbl	SearchString
Combo box	cbo	cboEditFeature
Command button	cmd	cmdCancel
Directory listbox	dir	dirPath
Drive listbox	drv	drvDrive
Image	img	imgBitmap
Listbox	lst	lstSelectedFile
Menu	mnu	mnuFileSaveAs
Option button	opt	optTopology
Timer	tmr	tmrAlarm
Common dialog	dlg	dlgSaveAs

## How to save your programs in ArcGIS?

- ArcGIS Normal template (Normal.mxt)
- A base template (\*.mxt)
- A map document (\*.mxd)

## Where to Find Help?

- VB
  - VBA Online Help (F1 on the VBA IDE)
  - .Net2TheMax
    - <http://www.dotnet2themax.com/>
  - MicroSoft Developer Network (MSDN)
    - <http://msdn2.microsoft.com/>
  - Windows API Reference
    - <http://msdn2.microsoft.com/en-us/library/Aa383749.aspx>
- ArcObjects
  - ArcGIS Desktop Help for VB6/VBA Developers
  - ArcScripts
    - <http://arcscripts.esri.com/>
  - ESRI Developer Network (EDN)
    - <http://edndoc.esri.com/arcobjects/9.2/welcome.htm>
  - ESRI ArcObjects Library Reference
    - [http://resources.esri.com/help/9.3/arcgisdesktop/com/vba\\_start.htm](http://resources.esri.com/help/9.3/arcgisdesktop/com/vba_start.htm)