Introduction to Object-Oriented Programming in MATLAB

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Agenda

- Object-oriented programming
  - Basic object-oriented programming syntax in MATLAB
  - Classes in MATLAB
What is a program?

x = 12
while (x < 100)
    x = x+1
    if (x == 23)
        disp('Hello')
    end
end

Data

x = 12
while (x < 100)
    x = x+1
    if (x == 23)
        disp('Hello')
    end
end

Actions

Assignment
Looping Test
Increment
Test to Act
Take Action
End
End
Progression of Programming Techniques

Level of Abstraction / Sophistication

Data
- value
- variable
- structure

Algorithm
- function
- script
- command line
Example: Sensor Array

- Transmitting a signal from a weather balloon
- Locating the signal with a sensor array
- Computing the angle of arrival (AoA) for the signal
Procedural Programming

- Easy to learn
- Minimal planning

- There is no formal relationship between data and functions.
- Every detail is exposed.
Data and Actions to Implement

**Data**
- Wavelength
- Location
- Frequency
- Number
- Spacing
- Reading

**Actions**
- Compute FFT
- Plot results
- Determine peaks
- Synthesize measurements
Related Data and Actions

Data

- Balloon Location
- Frequency
- Wavelength
- Sensor Reading
- Spacing
- Number

Actions

- Determine peaks
- Synthesize measurements
- Compute FFT
- Plot results
- Compute FFT
- Plot results
- Synthesize measurements
Grouping Related Data and Actions

Balloon
- Location

Signal
- Frequency
- Wavelength

Sensor
- Synthesize measurements
- Determine peaks
- Compute FFT
- Plot results

Data

Class

Actions
Progression of Programming Techniques

Level of Abstraction / Sophistication

Data
- value
- variable
- structure

Algorithm
- command line
- script
- function
- class
  - (properties)
  - (methods)
Object-Oriented Terminology

- **Class**
  - Outline of an idea
  - *Properties* (data)
  - *Methods* (algorithms)

- **Object**
  - Specific example of a *class*
  - *Instance*
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- Object-oriented programming
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- Classes in MATLAB
Demonstration: Building a Simple Class

- Define a *class* for our radar blips
- Create the weather balloon *object*
- Use the *object* in place of the structure
Objects

- Are easy to create
- Manage their own data
- Are interchangeable with a structure
  - No other code changes are required.
  - *Properties* behave similar to field names.
  - Fields can’t be added arbitrarily.
Demonstration: Adding Methods to a Class

- Start from a sensor class with existing properties
- Add a method to compute angle of arrival (AoA)
- Integrate a sensor object into the existing code
Objects with Methods

- Have immediate access to their own data (*properties*)
- Allow you to overload existing functions
- Allow you to perform custom actions at creation and deletion
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Taking Methods and Properties Further

- Control access
- Create constants
- Make values interdependent
- Execute methods when properties change
Demonstration: Applying Attributes

- Control access
  - Access = public
  - Access = protected

- Restrict modification
  - Constant
  - Dependent
Encapsulation

Sensor

Number of Towers

Tower Spacing

Sensor Reading

Plot Results

Compute AoA
Encapsulation

- Separates the interface from the implementation
- Simplifies object use
- Becomes a building block

- Speed of Light
- Noise Ratio
- Sensor Reading
- Number of Towers
- Synthesize measurements
- Plot Results
- Compute FFT
- Determine Peaks
- Compute AoA
Using a Class as a Building Block

The Balloon

The Red Baron

All Moving Radar Blips

All Radar Blips
Demonstration: Creating a Moving Target

- Define a new class for moving blips
- \textit{Inherit} from the existing class for blips
- Add a \textit{method}
- Use the moving blip
Inheritance

- **Subclass** substitutes for the **superclass**
- Allows re-envisioning and re-implementing the **superclass**
- Builds on proven code
- Allows inheriting from the base MATLAB classes
Object-Oriented Programming in MATLAB

- Class definition file describes object behavior
- Objects can substitute for structures
- Apply attributes for a clean interface
- Build on existing classes with inheritance

*Extends the matrix-based language to objects*
Questions and Answers