Event-Driven Programming and Abstraction

CS106AP Lecture 21
Roadmap

Programming Basics

The Console

Images

Data structures

Midterm

Graphics

Object-Oriented Programming

Everyday Python

Life after CS106AP!
Today’s questions

How can we write programs that respond to user actions?

Why do we use classes when writing code for other people to use?
Today’s topics

1. Review
2. Event-driven programming
3. Classes and abstraction
4. What’s next?
Review
Encapsulation
Encapsulation is bundling info into one nice package!

- Integration
  - All the smaller parts add up to create the entire functionality
  - Similar to top-down decomposition
Encapsulation is bundling info into one nice package!

- Integration

- Modular development
  - You can separate different types of tasks and know where different information/functionality should be.
  - Easier for testing and debugging!
Encapsulation is bundling info into one nice package!

- Integration

- Modular development

- Instance variables (attributes)
  - Knowledge (data) for a specific class stays inside that class.
  - That information is easier to access across methods within that class.
  - If you need to access the information outside the class, there’s a predefined structure for doing so.
Encapsulation is bundling info into one nice package!

- Integration

- Modular development

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  - Knowledge (data) for a specific class stays inside that class.
  - That information is easier to access across methods within that class.
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More later today!
Bubbles.py

[more bubbles!]
How do we write programs that respond to user actions?
How do we write programs that respond to user actions?

Event-driven programming!
The event listener model

Your code

```python
def main():
    ...
    ...
    ...

def your_mouse_listener():
    ...
    ...
```
The event listener model

Your code

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def main():
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```

Definition

**mouse listener function**
A function that occurs immediately when a user triggers a particular mouse event
The event listener model

Your code

```python
def main():
    ...
    ...
def your_mouse_listener():
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```

**Definition**

*mouse listener function*

A function that occurs immediately when a user triggers a particular *mouse event*:

*clicking, moving, dragging*
The event listener model

Your code

```python
def main():
    ...
    ...
    ...

def your_mouse_listener():
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The event listener model

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The event listener model

Your code

def main():
    ...
    ...
    def your_mouse_listener():
        ...

The function happens immediately, no matter where you are in your program!
Creating a mouse listener

1. Write a mouse listener function (handler)

```python
def mouse_listener_handler(event):
    ...
```
Creating a mouse listener

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   ```python
def mouse_listener_handler(event):
    ...
```

   It must take in an `event` for campy to recognize it as a valid mouse listener.
Creating a mouse listener

1. Write a mouse listener function (handler)

```python
def mouse_listener_handler(event):
    ...
```

*event* gives us access to information about the mouse event (e.g. x, y coordinates of the click).
Creating a mouse listener

1. Write a mouse listener function (handler)

   ```python
   def mouse_listener_handler(event):
       ...
   ```

2. Use the corresponding campy `onmouseevent()` function to set up your mouse listener

   ```python
   onmouseclicked(mouse_listener_handler)
   ```
Creating a mouse listener

1. Write a mouse listener function (handler)

```python
def mouse_listener_handler(event):
    ...
```

2. Use the corresponding campy `onmouseevent()` function to set up your mouse listener

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Pass in your mouse listener function as the argument
Creating a mouse listener

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*Don’t include parentheses after the function name!*
Bubbles.py

[mouse listener demo]
Creating a mouse listener

1. Write a mouse listener function (handler)

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   ```python
   onmouseclicked(mouse_listener_handler)
   ```
Mouse Listeners and Classes

1. Write a mouse listener function (handler)

   ```python
   def mouse_listener_handler(self, event):
       ...
   ```

2. Use the corresponding campy `onmouseevent()` function to set up your mouse listener

   ```python
   onmouseclicked(self.mouse_listener_handler)
   ```

   Don't include parentheses after the function name!
Why do we use classes?

- For ourselves
  - Grouping related data and the functions that act on it
  - Modular code development (isolation of particular tasks)

- For others
  - We hide the implementation details of our code so others don’t need to worry about them.
  - They can just use the class, like we do for SimpleImage.
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  - They can just use the class, like we do for SimpleImage.
Why do we use classes in code meant for others?
Why do we use classes in code meant for others?

Abstraction!
Definition

**abstraction**
Hiding implementation details of a class from the clients of that class
Clients and Interfaces

- Classes—or really any code we write (modules, libraries, etc.)—can be thought of from two perspectives.
Clients and Interfaces

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  - The code for the class itself is called the implementation.
    - For example, all the code we’ve written inside the BubbleGraphics class
Clients and Interfaces

- Classes—or really any code we write (modules, libraries, etc.)—can be thought of from two perspectives.
  - The code for the class itself is called the implementation.
    - For example, all the code we’ve written inside the `BubbleGraphics` class
  - Any code that uses a class in any way is called the `client`
    - For example, the `animate_bubble_pop()` or `animate_many_bubbles()` functions we wrote today
Clients and Interfaces

- Classes—or really any code we write (modules, libraries, etc.)—can be thought of from two perspectives.
- The point at which the client and implementation meet and communicate is known as the interface, which serves as both a barrier and a communication channel.
Clients and Interfaces

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Slide adapted from Jerry Cain
Clients and Interfaces

- Classes—or really any code we write (modules, libraries, etc.)—can be thought of from two perspectives.
- The point at which the client and implementation meet and communicate is known as the **interface**, which serves as both a barrier and a communication channel.
Information Hiding

- One of the central principles of modern software design is that each level of abstraction should hide as much complexity as possible from the layers that depend on it. This principle is called information hiding.
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● When you use a function, it is more important to know what the function does than to understand exactly how it works.
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- When you use a function, it is more important to know what the function does than to understand exactly how it works.
  - The underlying details are of interest only to the programmer who implements the function.
  - Clients who use that function as a tool can usually ignore the implementation altogether.
Thinking about Objects

I need a bunch of GRects...

Client

Abstraction boundary (interface)

Implementation

class GRect:
    def __init__(self,...):
    def move(self, ...):
    def rotate(self, ...):

campy
    GRect
    GOval
    GLine
    GLabel
    ...

Diagram adapted from Jerry Cain and image credit to Randall Munroe at xkcd.xom
Thinking about Objects

I need a bunch of GRects...

class GRect:
    def __init__(self,...):
    def move(self, ...):
    def rotate(self, ...):

campy
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    GOval
    GLine
    GLabel
    ...

rect = GRect(width,height)
rect.move(dx, dy)
rect.filled = True

Implementation

Abstraction boundary (interface)
Abstraction protects the data stored in an object

- Getters and setters are the interface to the data
  - These functions provide clients with a specific, limited way of accessing the data.
  - If clients could change the data in any way they wanted, things could get really messy.
Abstraction protects the data stored in an object

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  - These functions provide clients with a specific, limited way of accessing the data
  - If clients could change the data in any way they wanted, things could get really messy.

- Clients don’t have to worry about constraints on the data
  - The implementation will handle that for them behind-the-scenes!
  - E.g. A *PynstaUser* shouldn’t be able to add a friend they’re already friends with.
Abstraction protects the data stored in an object

- Getters and setters are the interface to the data
- Clients don’t have to worry about constraints on the data

An example!
PyPal.py
[abstraction demo]
What’s next?
Putting it all together!

● How we can leverage encapsulation and abstraction to build complex graphical programs that interact with users

● Using all of the skills we’ve learned so far to code a fun game!