Lecture 24

GUI Applications

Announcements for This Lecture

Assignments

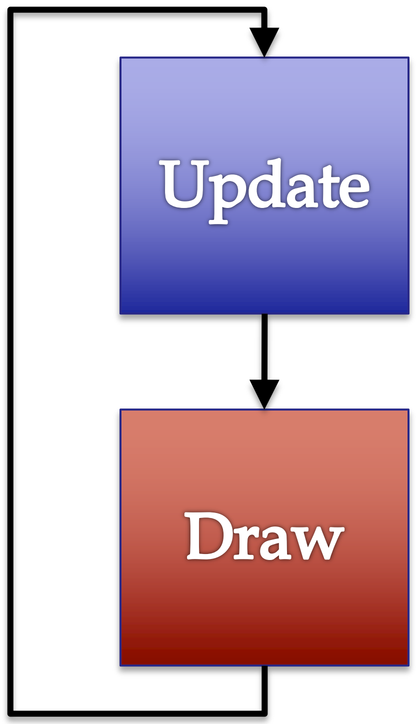
- A5 currently being graded
  - Will have results this Sat
- A6 is due **TOMORROW**
  - Worth 8% of your grade
  - Remember to fill in Survey
- A7 posted **TOMORROW**
  - Based on today's lecture!
  - Due **December 9th** (last day)
  - Minor extensions possible

Video Lessons

- **Lesson 24** for today
- **Lessons 26, 27** for Tues
- Last material on 2nd exam

A Standard GUI Application

Animates the application, like a movie



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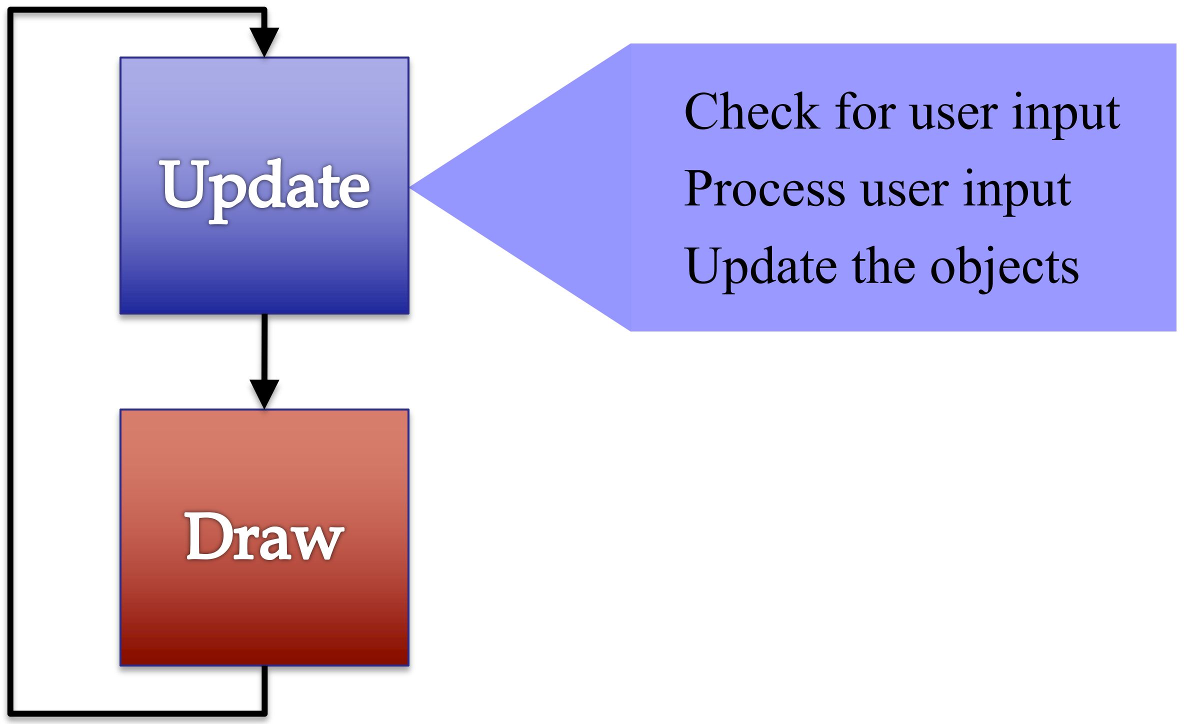

Check for user input

Process user input

Update the objects

A Standard GUI Application

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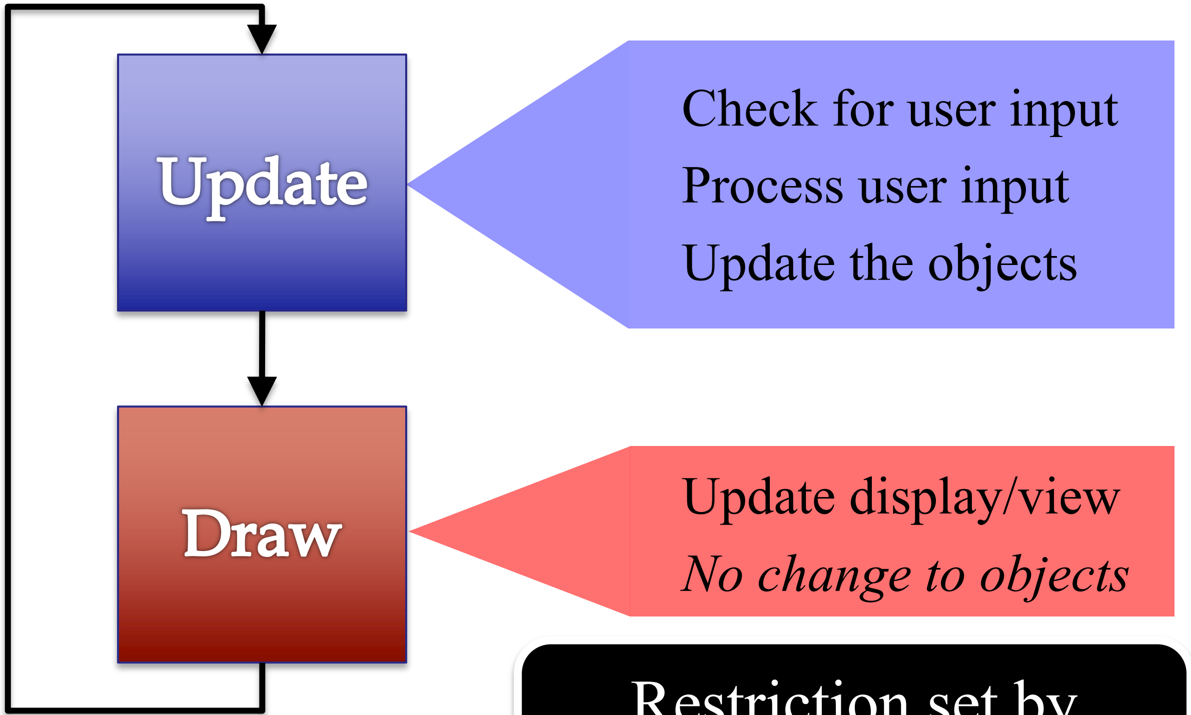
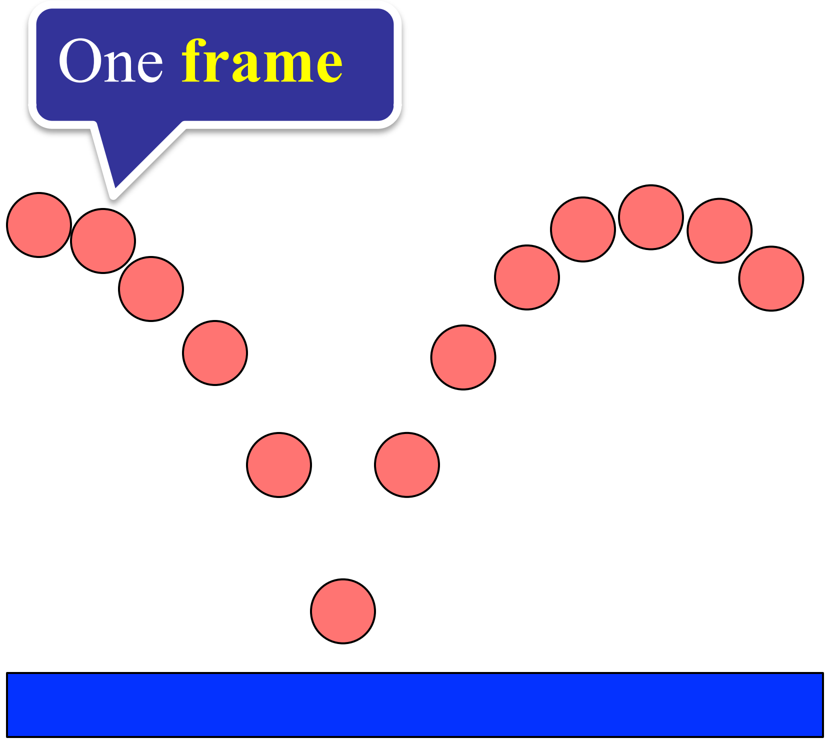


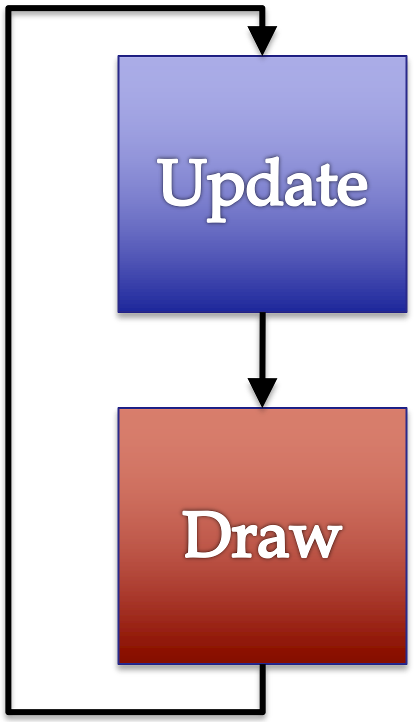
Check for user input
Process user input
Update the objects

Update display/view
No change to objects

Restriction set by graphics cards

The Animation Frame





Must We Write this Loop Each Time?

```
while program_is_running:
    # Get information from mouse/keyboard
    # Handled by OS/GUI libraries

    # Your code goes here



    # Draw stuff on the screen
    # Handled by OS/GUI libraries
```

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Would like to "plug in" code

Why do we need to write this each time?

Must We Write this Loop Each Time?

```
while program_is_running:
    # Get information from mouse/keyboard
    # Handled b                          s

    # Your code
    application.update()

    #
    #                                    es
```

Method call
(for loop body)

Custom Application class
with its own **attributes**

- Put loop **BODY** in an app class.
- OS/GUI handles everything else.

But There is a Catch

```
while program_is_running:
    # Get information from mouse/keyboard
    # Handled b

    # Your code
    application.update()

    #                         en
    #                         raries
```

This creates
a **call frame**

All its variables are
erased when done

Attributes = Loop Variables

Normal Loops

Variables "external" to the loop body

```
x = 0
i = 2
# x = sum of squares of 2..i-1
while i <= 5:
    x = x + i*i
    i = i +1
# x = sum of squares of 2..5
```

Application

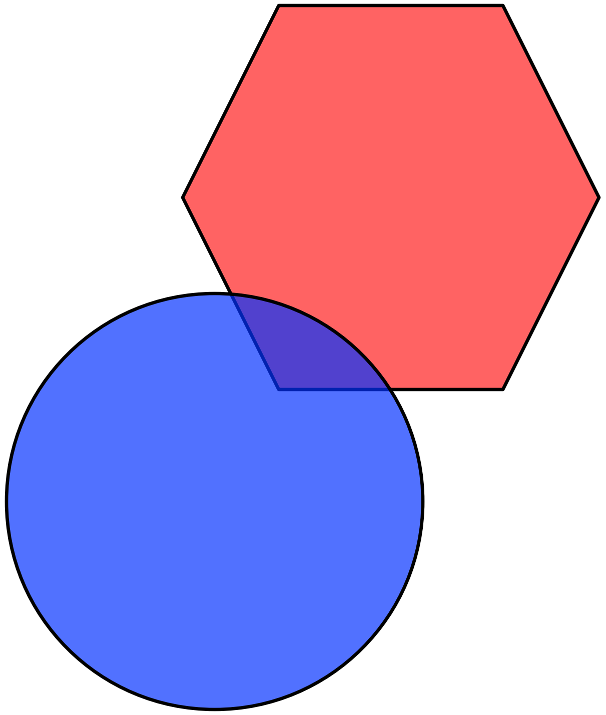
Attributes are the "external" variables

```
while program_running:
    # Get input
    # Your code called here
    application.update()
    # Draw
```

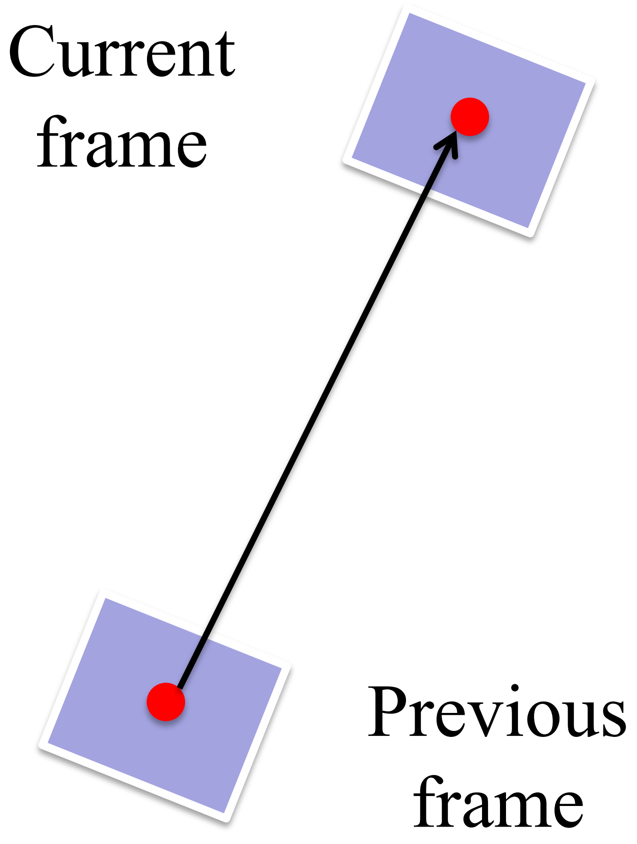
Programming Animation

Intra-Frame

- Computation within frame
  - Only need current frame
- **Example:** Collisions
  - Need current position
  - Use to check for overlap
- Can use **local variables**
  - All lost at `update()` end
  - But no longer need them



Programming Animation



Inter-Frame

- Computation across frames
  - Use values from *last* frame
- **Example:** Movement
  - Need old position/velocity
  - Compute next position
- Requires **attributes**
  - Attributes never deleted
  - Remain after `update()` ends

Programming Animation

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Variables and the Loop

```
while program_is_running:
    # Get information from mouse/keyboard
    # Handled by OS/GUI libraries

    # Your code goes here
    application.update()

    # Draw stuff on the screen
    # Handled by OS/GUI libraries
```

Local variables erased.
But **attributes** persist.

The Actual Game Loop

```
# Constructor
game = GameApp(...)
...
game.start() #Loop initialization
while program_running:
    # Get input
    # Your code goes here
    game.update(time_elapsed)
    game.draw()
```

Too *early* to initialize everything

Actual loop initialization

Separate update() and draw() methods

Designing a Game Class: Animation

```
class Animation(game2d.GameApp):
    """App to animate an ellipse in a circle."""

    def start(self):
        """Initializes the game loop."""
        …

    def update(self,dt):
        """Changes the ellipse position."""
        …

   def draw(self):
        """Draws the ellipse"""
        …
```

See animation.py

Designing a Game Class: Animation

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Parent class that does hard stuff

See animation.py

Designing a Game Class: Animation

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```

See animation.py

Parent class that does hard stuff

Loop initialization
Do NOT use __init__

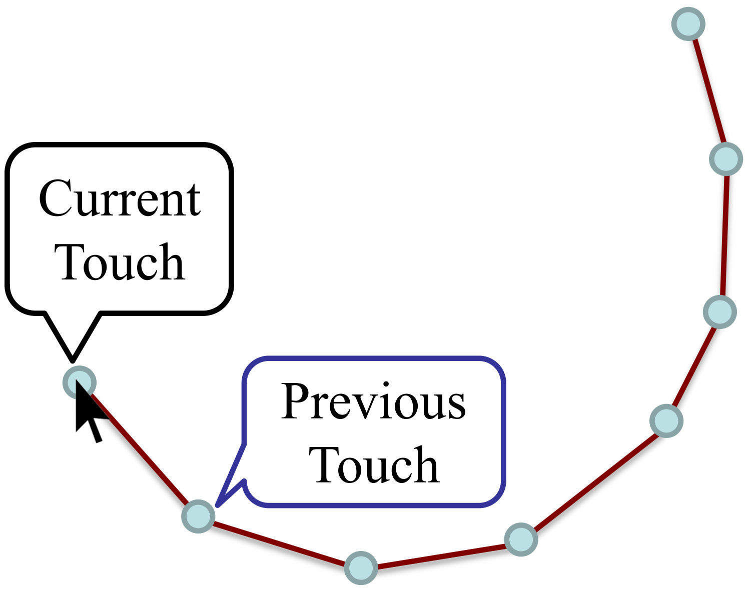
Loop body

Use method draw() defined in GObject

Interframe Computation: Touch

- Works like an Etch-a-Sketch
  - User draws by touching
  - Checks position each frame
  - Draws lines between touches
- Uses attribute `touch` in `GInput`
  - The mouse press position
  - Or **None** if not pressed
  - Access with `self.input.touch`
- But we also need last touch!
  - Forgot if we do not store it
  - Purpose of attribute `last`

Line segment = 2 points

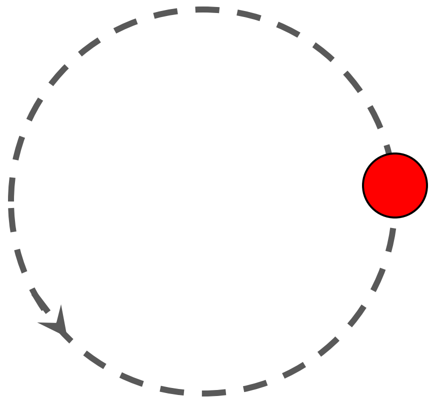


See `touch.py`

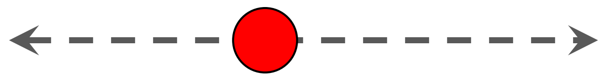
State: Changing What the Loop Does

- **State**: Current loop activity
  - Playing game vs. pausing
  - Ball countdown vs. serve
- Add an attribute `state`
  - Method `update()` checks state
  - Executes correct helper
- How do we store state?
  - State is an *enumeration*; one of several fixed values
  - Implemented as an int

State `ANIMATE_CIRCLE`



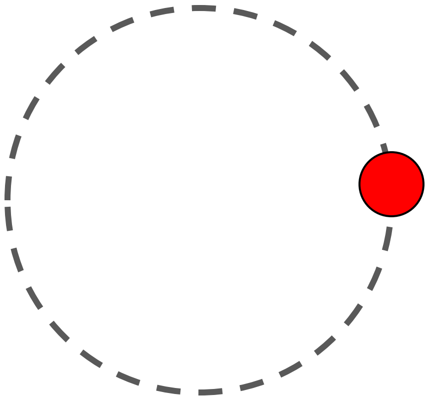
State `ANIMATE_HORIZONTAL`



See `state.py`

States and the Class Invariant

- Think of each state as a mini-program
  - Has its own `update` functionality/logic
  - Usually separated out as helper to `update`
  - `update` uses ifs to send to correct helper
- Need to include in the **class invariant**
  - Some attributes only used in certain states
  - What values must they have in *other* states?
- Also need rules for when we switch states
  - Could be the result of an *event* (e.g. game over)
  - Could be the result of an *input* (e.g. a key press)



See `state.py`

Checking Input

Keyboard

- `is_key_down(key)`
  - Returns True if key is down
  - `key` is a string (`'a'` or `'space'`)
  - Empty string means *any* key
- `is_key_pressed(key)`
  - Returns True if `key` pressed
  - `key` **not** down prev. frame
- `is_key_released(key)`
  - Returns True if `key` released
  - `key` was down prev. frame

Mouse/Touch

- `touch`
  - **Attribute** giving a position
  - Stored as a Point2 object
  - But None if no touch
- `is_touch_pressed()`
  - True if `touch` pressed
  - `touch` was None prev. frame
- `is_touch_released()`
  - True if `touch` released
  - `touch` **not** None prev. frame

Checking Input

Keyboard

- is_key_down(key)
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  - Returns True if key
  - key **not** down prev. frame
- is_key_released(key)
  - Returns True if key released
  - key was down prev. frame

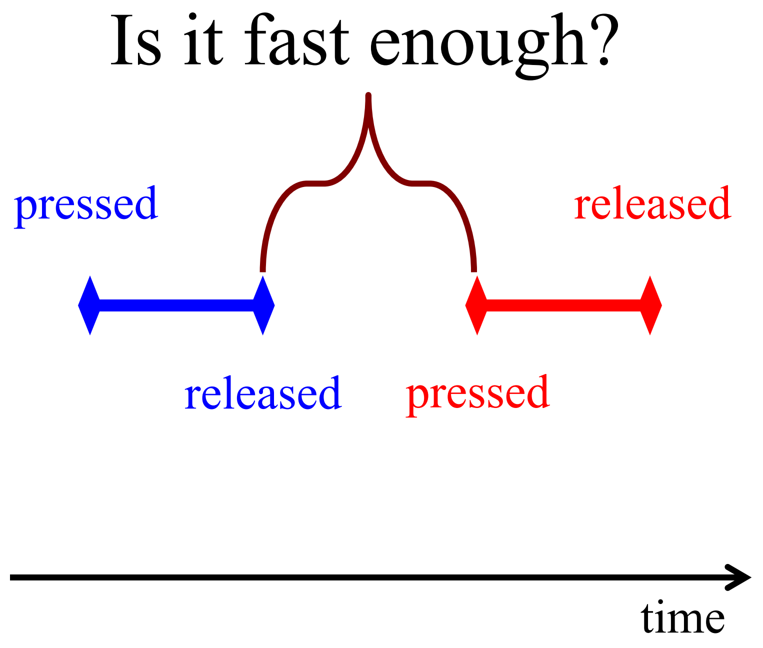
Mouse/Touch

- touch
  - **Attribute** giving a position
  - Stored as a Point2 object
  - None if no touch
- h_pressed()
  - e if touch pressed
  - touch was None prev. frame
- is_touch_released()
  - True if touch released
  - touch **not** None prev. frame

All accessed from self.input in App

Complex Input: Click Types

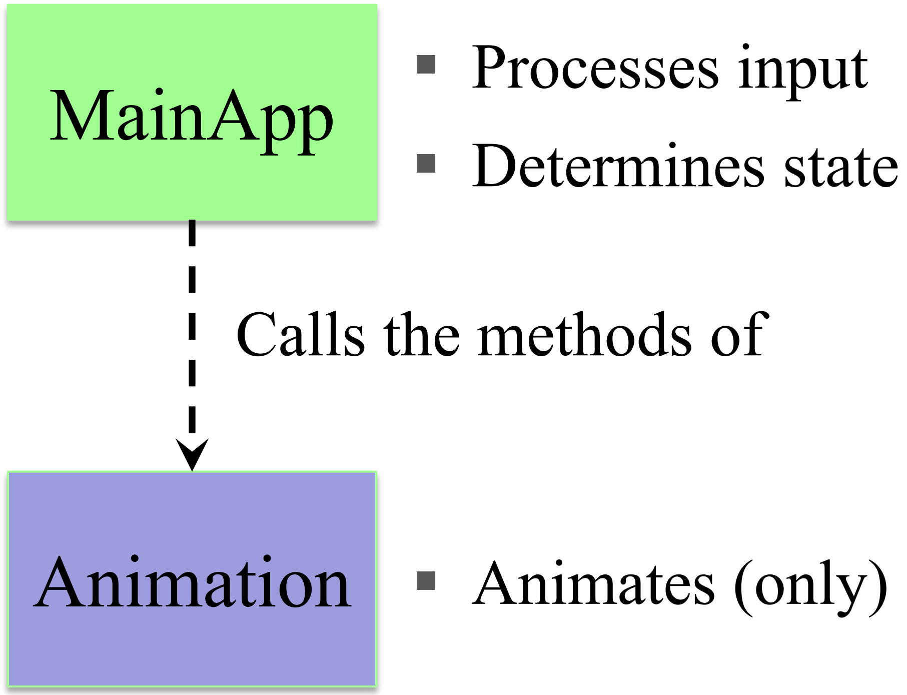
- Double click = 2 fast clicks
- Count number of fast clicks
  - Add an attribute `clicks`
  - Reset to 0 if not fast enough
- Time click speed
  - Add an attribute `time`
  - Set to 0 when mouse released
  - Increment when not pressed (e.g. in loop method `update()`)
  - Check `time` when next pressed



See `touch.py`

Designing Complex Applications

- Applications can become extremely complex
  - Large classes doing a lot
  - Many states & invariants
  - Specification unreadable
- **Idea**: Break application up into several classes
  - Start with a "main" class
  - Other classes have roles
  - Main class delegates work



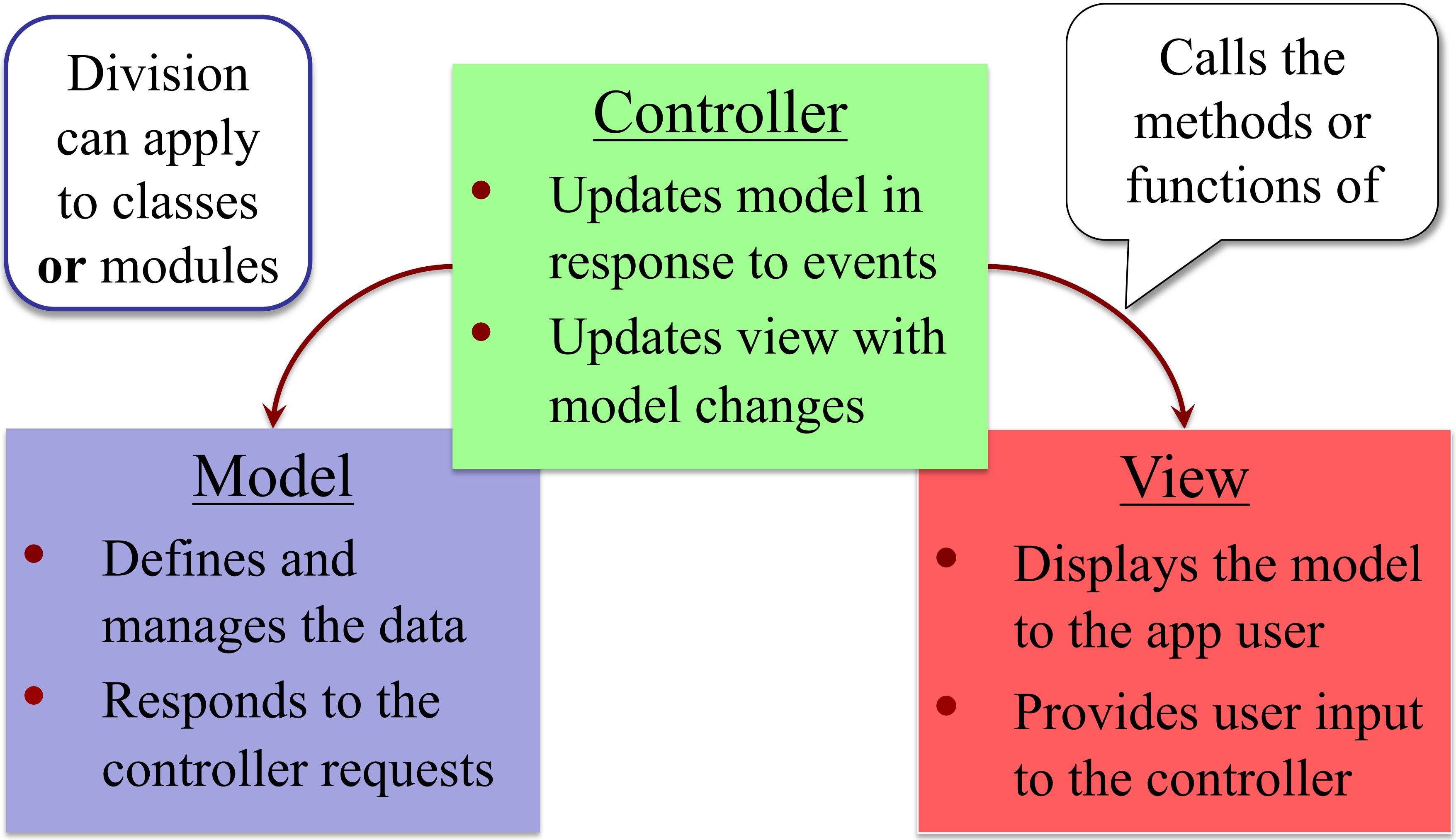
See subcontroller.py

How to Break Up: Software Patterns

- **Pattern**: reusable solution to a common problem
  - Template, not a single program
  - Tells you how to design your code
  - Made by someone who ran into problem first
- In many cases, a pattern gives you the interface
  - List of headers for non-hidden methods
  - Specification for non-hidden methods
  - Only thing missing is the implementation

Just like this course!

Model-View-Controller Pattern



Division can apply to classes **or** modules

Calls the methods or functions of

Controller

- Updates model in response to events
- Updates view with model changes

Model

- Defines and manages the data
- Responds to the controller requests

View

- Displays the model to the app user
- Provides user input to the controller

MVC in this Course

Model

- **A3**: Color classes
  - RGB, CMYK & HSL
- **A4**: Turtle, Pen
  - Window is **View**
- **A6**: Dataset, Cluster
  - Data is always in model
- **A7**: Ship, Asteroid, etc..
  - All shapes/geometry

Controller

- **A3**: a3app.py
  - Hidden classes
- **A4**: Functions in a4.py
  - No need for classes
- **A6**: Algorithm
  - Drives program forward
- **A7**: Planetoids, Wave
  - Main part of assignment!

MVC in this Course

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Why **classes** sometimes and **functions** others?

Controller

- **A3**: a3app.py
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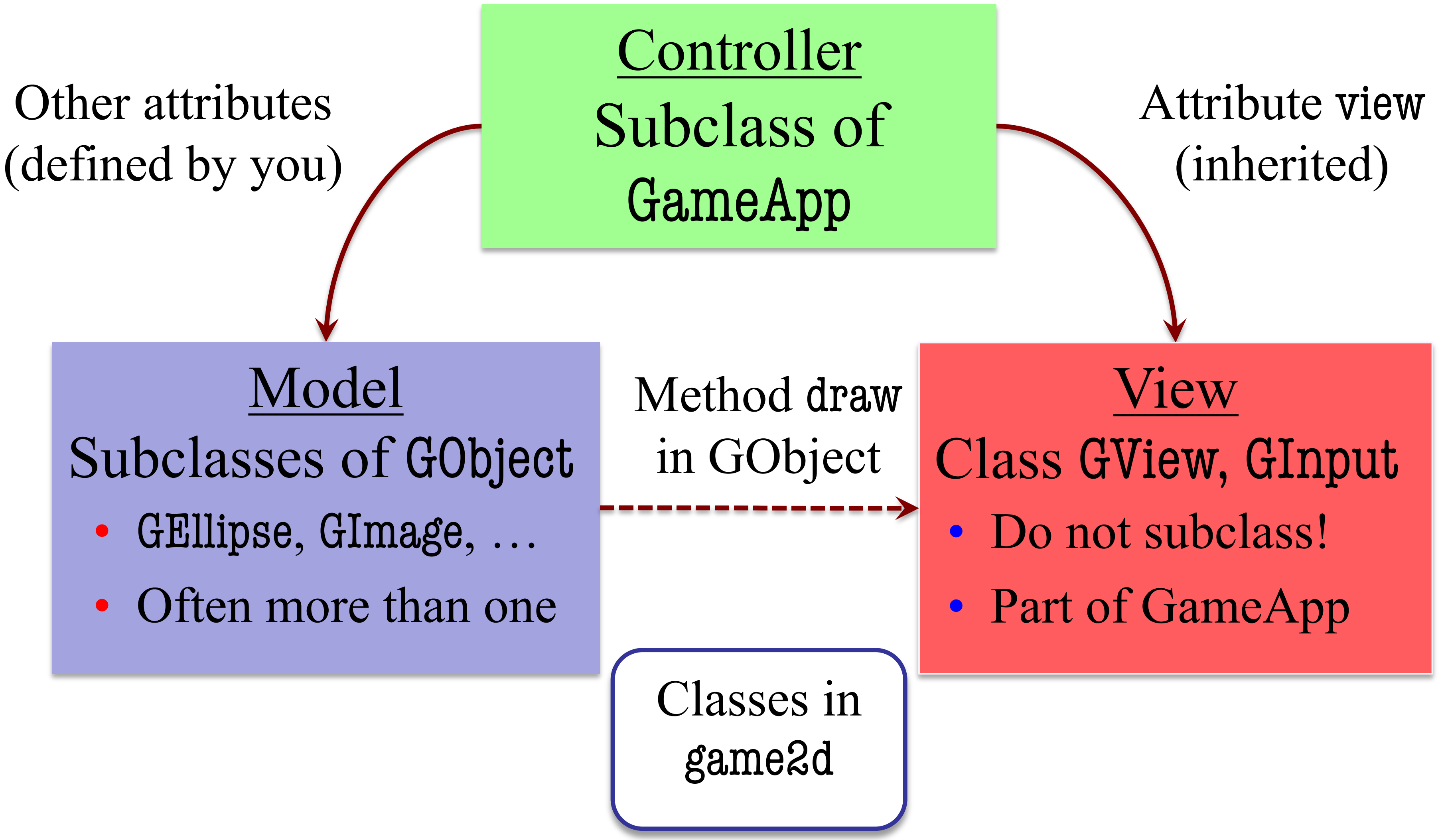
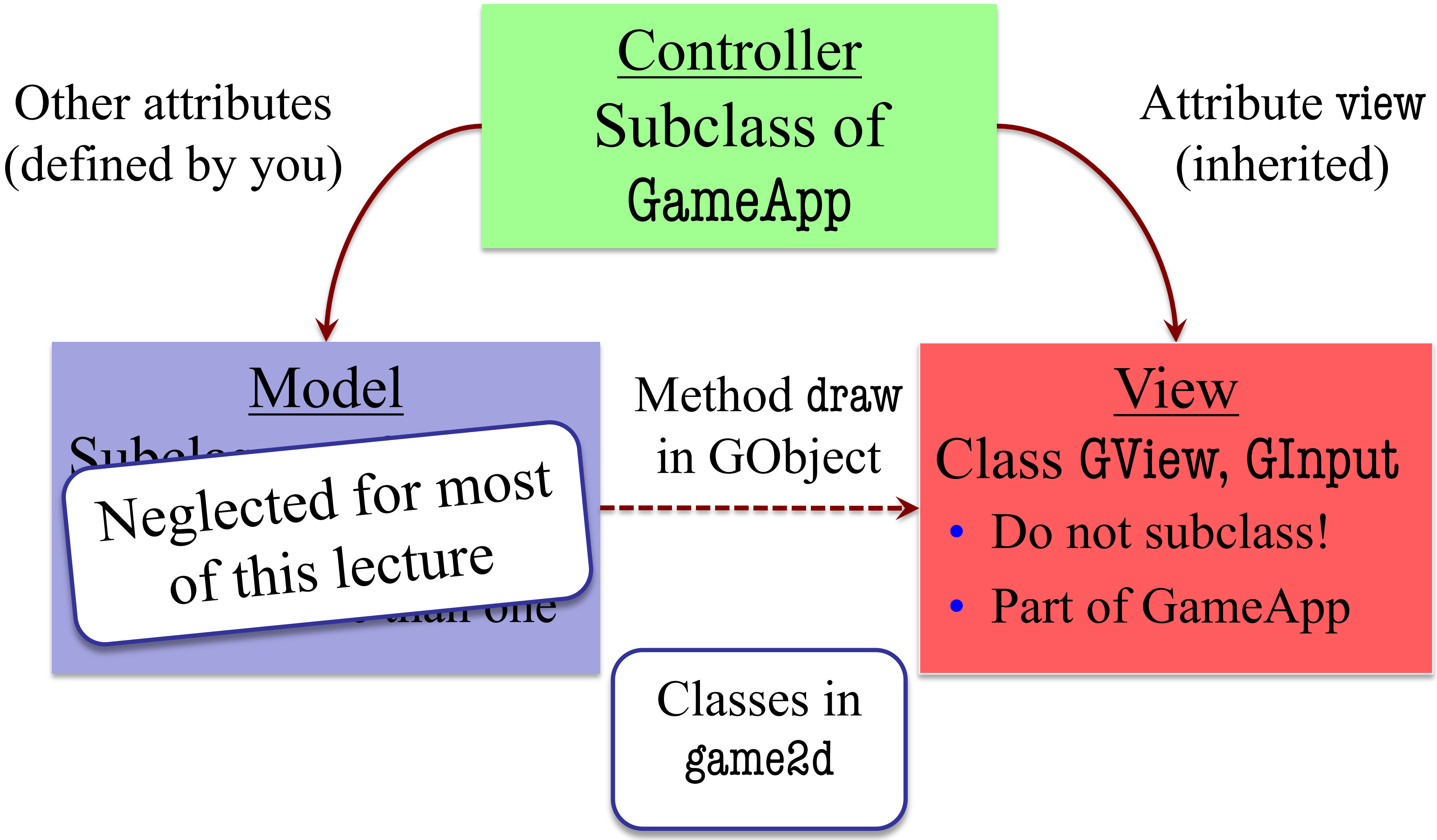
Model-View-Controller in CS 1110

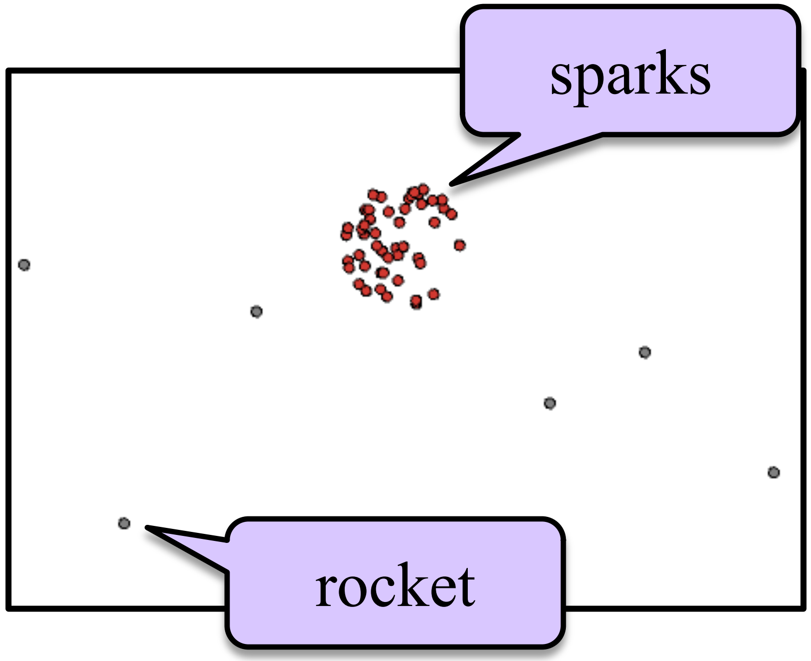


Model-View-Controller in CS 1110



Models in Assignment 7

- Often subclass of GObject
  - Has built-in draw method
- Includes groups of models
  - **Example**: rockets in pyro.py
  - Each rocket is a model
  - But so is the entire list!
  - update() will change both
- **A7**: Several model classes
  - Ship to animate the player
  - Alien to represent an alien



See pyro.py