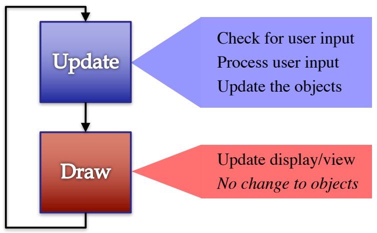
A Standard GUI Application

Animates the application, like a movie



Check for user input
Process user input
Update the objects

Update display/view
No change to objects

Must We Write this Loop Each Time?

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

    # Your code go
    application.update()

    een
    # Handled by OS/GUI libraries
```

Method call (for loop body)

Custom Application class

- Write loop body in an app class.
- OS/GUI handles everything else.

Loop Invariants Revisited

Normal Loops

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

Properties of "external" vars

Application

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

What are the "external" vars?

Application is an object.
It will have **attributes**!

Attribute Invariants = Loop Invariants

- Attributes are a way to store value between calls
  - Not part of call frame
  - Variables outside loop
- An application needs
  - Loop attributes
  - Initialization method (for loop, not __init__)
  - Method for body of loop
- Attribute descriptions, invariants are important

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

Example: Animation

```
class Animation(game2d.GameApp):
    """App to animate an

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

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

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

See animation.py

Parent class that does hard stuff

Loop initialization
Do NOT use __init__

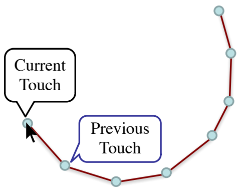
Loop body

Use method draw() defined in GObject

What Attributes to Keep: Touch

- Attribute touch in GInput
  - The mouse press position
  - Or **None** if not pressed
  - Use self.input.touch inside your subclass definition
- Compare touch, last position
  - last None, touch not None: Mouse button **pressed**
  - last not None, touch None: Mouse button **released**
  - last and touch both not None: Mouse **dragged** (button down)

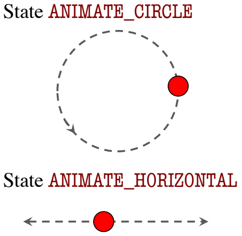
Line segment = 2 points



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
  - Global **constants** are values


State `ANIMATE_CIRCLE`

State `ANIMATE_HORIZONTAL`

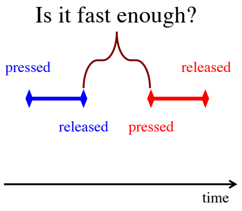
See state.py

Designing States

- Each state has its ***own set*** of invariants.
  - **Drawing?** Then touch and last are not None
  - **Erasing?** Then touch is None, but last is not
- Need rules for when we switch states
  - Could just be "check which invariants are true"
  - Or could be a *triggering event* (e.g. key press)
- Need to make clear in class specification
  - What are the invariants ***for each state***?
  - What are the rules to switch to a new state?

Triggers: Checking Click Types

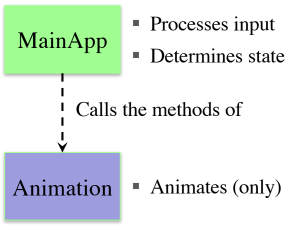
- Double click = 2 fast clicks
- Count number of fast clicks
  - Add an attribute `clicks`
  - Reset to 0 if not fast enough
- Time click speed
  - Add an attribute `time`
  - Set to 0 when mouse released
  - Increment when not pressed (e.g. in loop method update())
  - Check time when next pressed



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

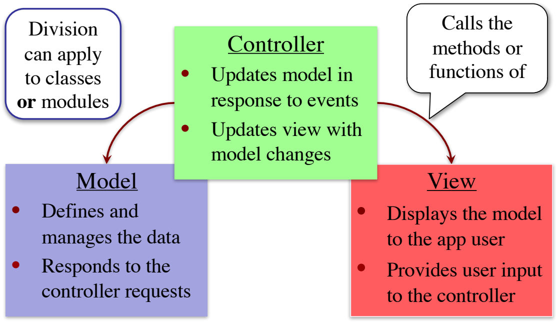

MainApp
- Processes input
- Determines state

Calls the methods of

Animation
- Animates (only)

See subcontroller.py

Model-View-Controller Pattern


Division can apply to classes **or** modules

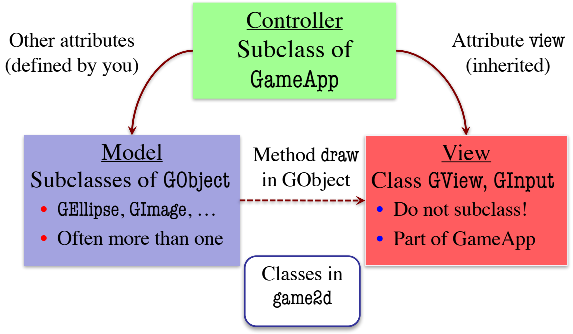
Calls the methods or functions of

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

Model-View-Controller in CS 1110


Other attributes (defined by you)

Controller
Subclass of `GameApp`

Attribute `view` (inherited)

Model
Subclasses of `GObject`
- `GEllipse`, `GImage`, …
- Often more than one

Method `draw` in GObject

View
Class `GView`, `GInput`
- Do not subclass!
- Part of GameApp

Classes in `game2d`