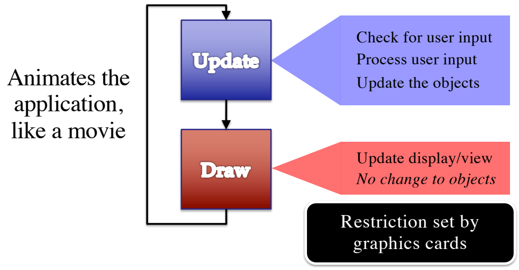
A Standard GUI Application



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Must We Write this Loop Each Time?

```
while program_is_running:
    # Get information from mouse/keyboard
    # Handled by OS/GUI libraries
    # Your code
    application.update()
    #
    #                                    es
```

Method call (for loop body)

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

Custom Application class with its own **attributes**

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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

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

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Class Invariant = Loop Invariants

- Look at the **game loop**
  - Loop **body** is update()
  - Loop **vars** are attributes
- Class invariant is true
  - At update()/body start
  - At update()/body end
  - Just like loop invariants
- Invariants are important!
  - To reason about game
  - Help us debug problems

```
# Constructor
game = GameApp(...)
...
# inv: game attribs are ...
while program_running:
    # Get input
    # Your code goes here
    game.update()
# post: game attribs are ...
```


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Designing a Game Class: Animation

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

    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

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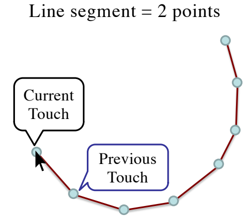
Comparing Attributes: Touch

- Attribute touch in GInput
  - The mouse press position
  - Or **None** if not pressed
  - Access with self.input.touch
- Compare touch, last position
  - Mouse button **pressed:** last None, touch not None
  - Mouse button **released:** last not None, touch None
  - Mouse **dragged**: last and touch not None

Line segment = 2 points



See touch.py

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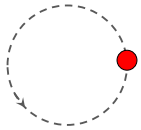
State: Changing What the Loop Does

- **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`

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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?

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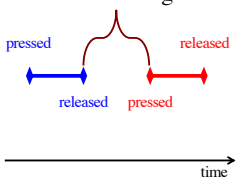
Triggers: Checking Click Types

- 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

Is it fast enough?



See `touch.py`

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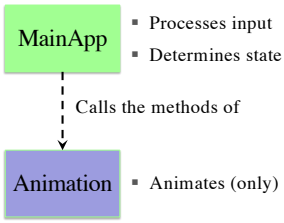
Designing Complex Applications

- 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`

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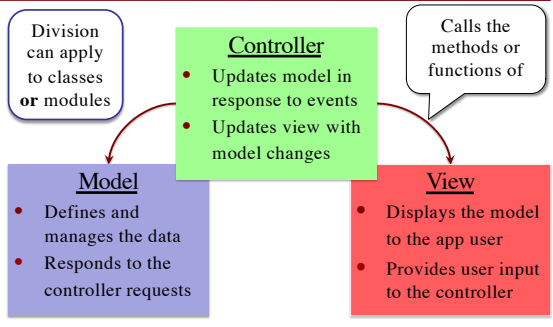
Model-View-Controller Pattern



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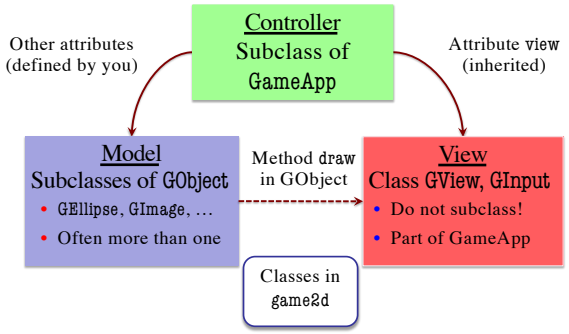
Model-View-Controller in CS 1110



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