# CS 1110

## Lecture 16: Using Classes Effectively

Announcements

### Prelim pickup

If you have not picked up your prelim you can pick it up after lecture.

### Spring Break

Have a great break! No office hours or consulting hours during break.

Slides by D. Gries, L. Lee, S. Marschner, W. White

# Important!

## YES

```
class Point(object):
    """Instances are 3D points
    x [float]: x coord
    y [float]: y coord
    z [float]: z coord"""

    ...
```

3.0-Style Classes
Well-designed

## NO

```
class Point:
    """Instances are 3D points
    x [float]: x coord
    y [float]: y coord
    z [float]: z coord"""

    ...
```

“Classic” Classes
No reason to use these

# Designing types

- One definition of a *type*: **a set of objects with the operations on those objects**.
  - int—set: integers; ops: +, –, *, /, …
  - Time—set: times of day; ops: time span, before/after, …
  - Worker—set: all possible workers; ops: hire, pay, promote, …
  - Rectangle—set: all axis-aligned rectangles in 2D; ops: contains, intersect, …
- When you define a class, you are (should be) thinking of a "real type" you want to create
  - Python gives you the tools to do this, but doesn't do it for you
  - Physically, any object can take on any value
  - Discipline is required to get what you want

# Making a class a type

1. Think about what values you want in the set
   - What attributes? What values can they have?
2. Think about what operations you want
   - Often influences the previous question

- To make (1) precise: write a *class invariant*
  - A statement we promise ourselves to keep true after every method call
- To make (2) precise: write specifications of methods
  - A statement of what the method does and what it expects (preconditions)
- Write your code to make these statements true!

# Planning out a class

```
class Time(object):
    """Instances represent times of day.
    Instance variables:
        hour [int]: hour of day, in 0..23
        min [int]: minute of hour, in 0..59
    """

    def __init__(self, hour, min):
        """The time hour:min.
        Pre: hour in 0..23; min in 0..59"""

    def increment(self, hours, mins):
        """Move this time <hours> hours
        and <mins> minutes into the future.
        Pre: hours [int] >= 0; mins in 0..59"""

    def is_pm(self):
        """Returns: this time is noon or
        later."""
```

**class invariant**

States what attributes are present and what values they can have.

A statement that will always be true of Time instances.

**method specification**

States what the method does.

Gives preconditions stating what is assumed to be true of the arguments.

# Planning out a class

```
class Rectangle(object):
    """Instances represent rectangular
    regions of the plane.
    Instance variables:
        t [float]: y coordinate of top edge
        l [float]: x coordinate of left edge
        b [float]: y coordinate of bottom edge
        r [float]: x coordinate of right edge
    For all Rectangles, l <= r and b <= t.
    """

    def __init__(self, t, l, b, r):
        """The rectangle [l, r] x [t, b]
        Pre: args are floats; l <= r; b <= t"""

    def area(self):
        """Return: area of the rectangle."""

    def intersection(self, other):
        """Return: new Rectangle describing
        intersection of self with other."""
```

**class invariant**

States what attributes are present and what values they can have.

A statement that will always be true of Rectangle instances.

**method specification**

States what the method does.

Gives preconditions stating what is assumed to be true of the arguments.

# Planning out a class

```
class Hand(object):
    """Instances represent a hand in cards.
    Instance variables:
        cards [list of Card]: cards in the hand
    This list is sorted according to the
    ordering defined by the Card class.
    """

    def __init__(self, deck, n):
        """Draw a hand of n cards.
        Pre: deck is a list of >= n cards"""

    def is_full_house(self):
        """Return: True if this hand is a full
           house."""

    def discard(self, k):
        """Discard the k-th card."""
```

**class invariant**

States what attributes are present and what values they can have.

A statement that will always be true of Handinstances.

**method specification**

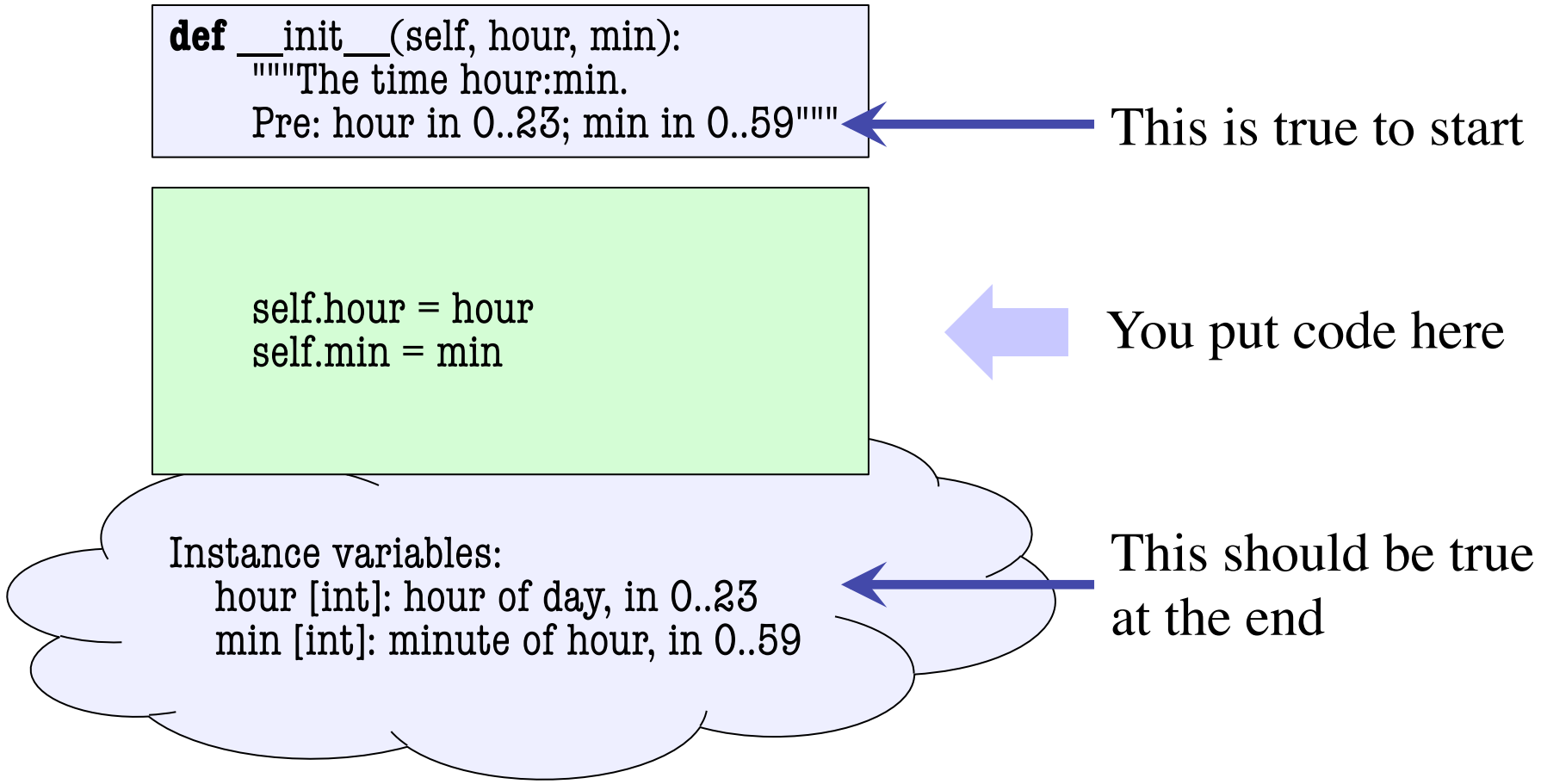
States what the method does.

Gives preconditions stating what is assumed to be true of the arguments.

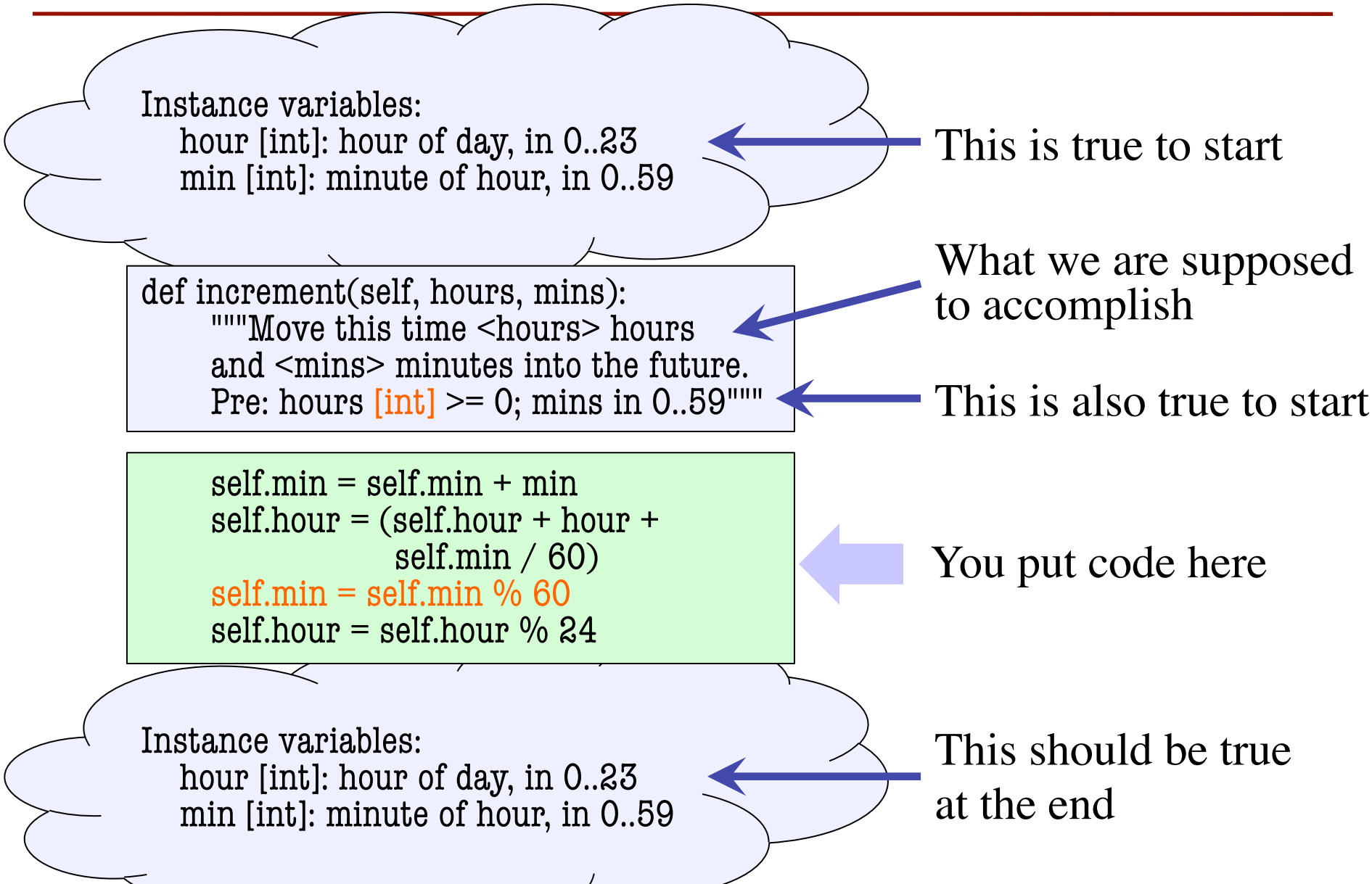
# Implementing a class

- All that remains is to fill in the methods. (All?!)
- When implementing methods:
  - Assume preconditions are true
  - Assume class invariant is true to start
  - Ensure method specification is fulfilled
  - Ensure class invariant is true when done
- Later, when using the class:
  - When calling methods, ensure preconditions are true
  - If attributes are altered, ensure class invariant is true

# Implementing an initializer



# Implementing a method



# The view from outside

- Invariants and preconditions serve two purposes
- They are tools for you, as the author, to think through your plans in a disciplined way
- They communicate to the user* of the class how they are allowed to use it
- Together they are the *interface* of the class
  - interface between two programmers
  - interface between two parts of the program

* …who might well be you!

in•ter•face |ˈintərˌfās| noun

1. a point where two systems, subjects, organizations, etc., meet and interact : the interface between accountancy and the law.
   - *chiefly Physics* a surface forming a common boundary between two portions of matter or space, e.g., between two immiscible liquids : the surface tension of a liquid at its air/liquid interface.
2. *Computing* a device or program enabling a user to communicate with a computer.
   - a device or program for connecting two items of hardware or software so that they can be operated jointly or communicate with each other.

—The Oxford American Dictionary