Object Fundamentals

Kenneth M. Anderson

University of Colorado, Boulder

CSCI 4448/6448 — Lecture 2 — 08/30/2007

Lecture Goals

- Introduce basic concepts, terminology, and notations for object-oriented analysis, design, and programming
    - A benefit of the OO approach is that the same concepts appear in all three stages of development
- Start with material presented in Appendix II of your textbook
    - Continue (in lecture 3) with additional material from previous versions of this class as well as from Head First Java by Sierra & Bates, © O'Reilly, 2003
- Will present examples and code throughout

Big Picture View

- OO techniques view software systems as
  - systems of communicating objects
- Each object is an instance of a class
  - All objects of a class share similar features
    - attributes
    - methods
  - Classes can be specialized by subclasses
- Objects communicate by sending messages

Welcome to Objectville

- What were the major concepts discussed in Appendix II of the textbook?

Welcome to Objectville

- What were the major concepts discussed in Appendix II of the textbook?
    - Unified Modeling Language (UML)

Welcome to Objectville

- What were the major concepts discussed in Appendix II of the textbook?
  - Unified Modeling Language (UML)
  - Class Diagrams

Welcome to Objectville

- What were the major concepts discussed in Appendix II of the textbook?
  - Unified Modeling Language (UML)
  - Class Diagrams
  - Inheritance

Welcome to Objectville

- What were the major concepts discussed in Appendix II of the textbook?
  - Unified Modeling Language (UML)
  - Class Diagrams
  - Inheritance
  - Polymorphism

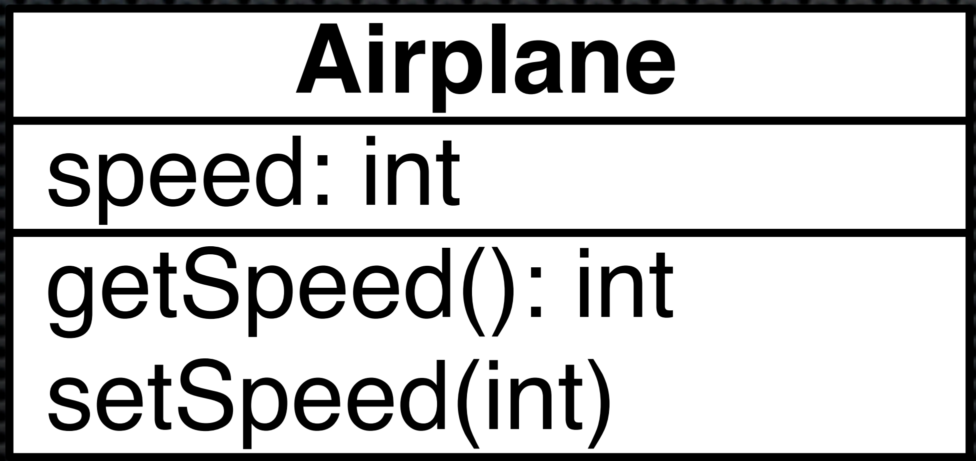
Welcome to Objectville

- What were the major concepts discussed in Appendix II of the textbook?
  - Unified Modeling Language (UML)
  - Class Diagrams
  - Inheritance
  - Polymorphism
  - Encapsulation

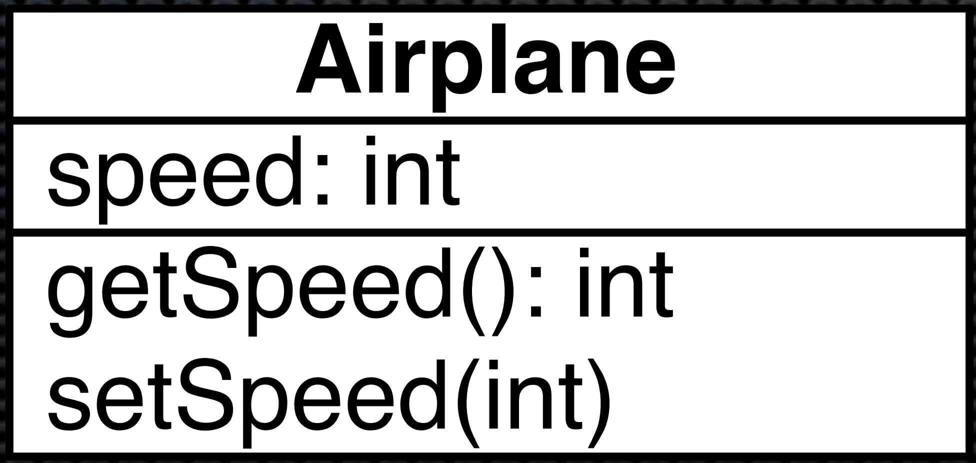
UML

- UML stands for Unified Modeling Language
  - UML defines a standard set of notations for use in modeling object-oriented systems
  - Throughout the semester we will encounter UML in the form of
    - class diagrams
    - sequence/collaboration diagrams
    - state diagrams
    - activity diagrams, use case diagrams, and more

Class Diagrams

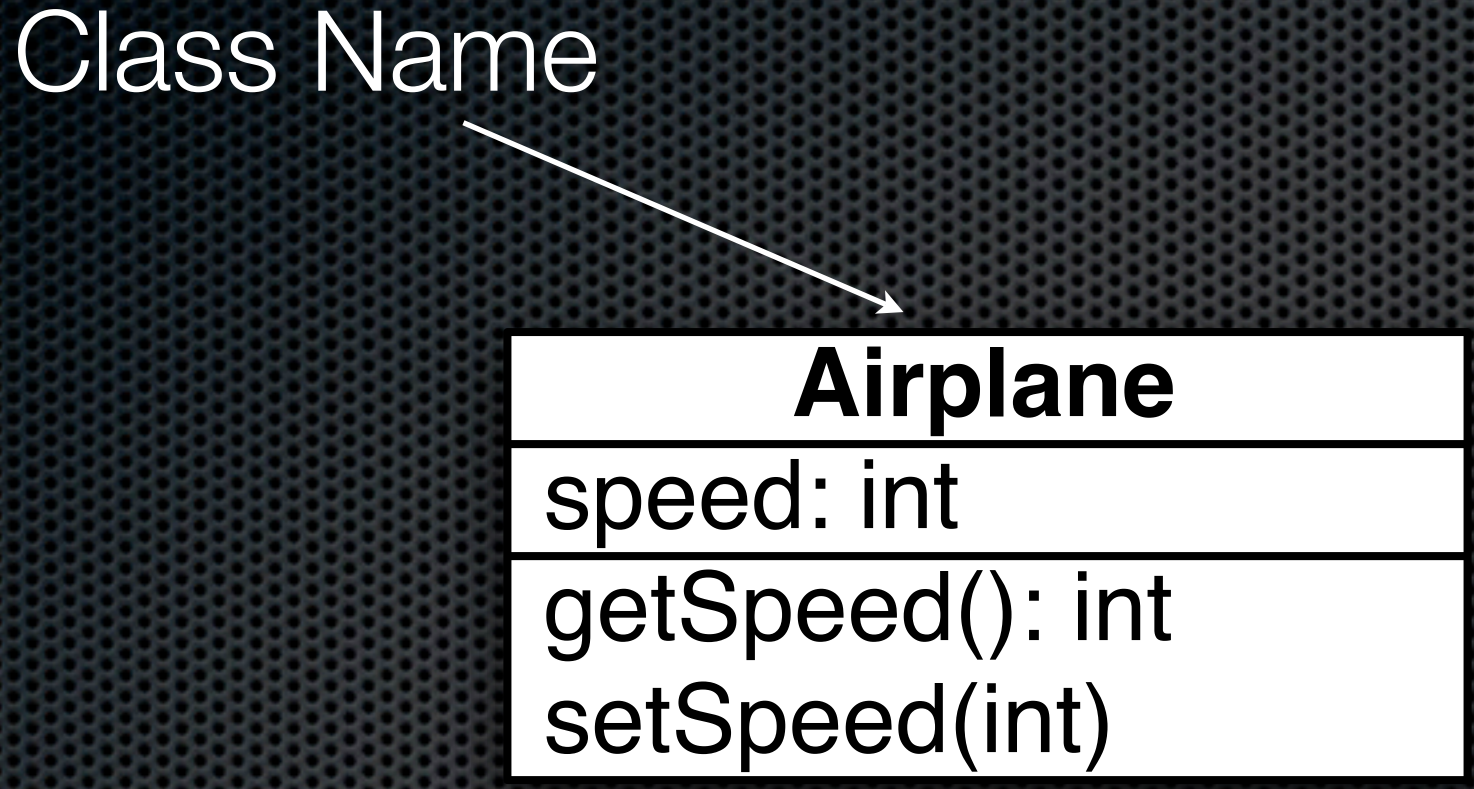


Class Diagrams



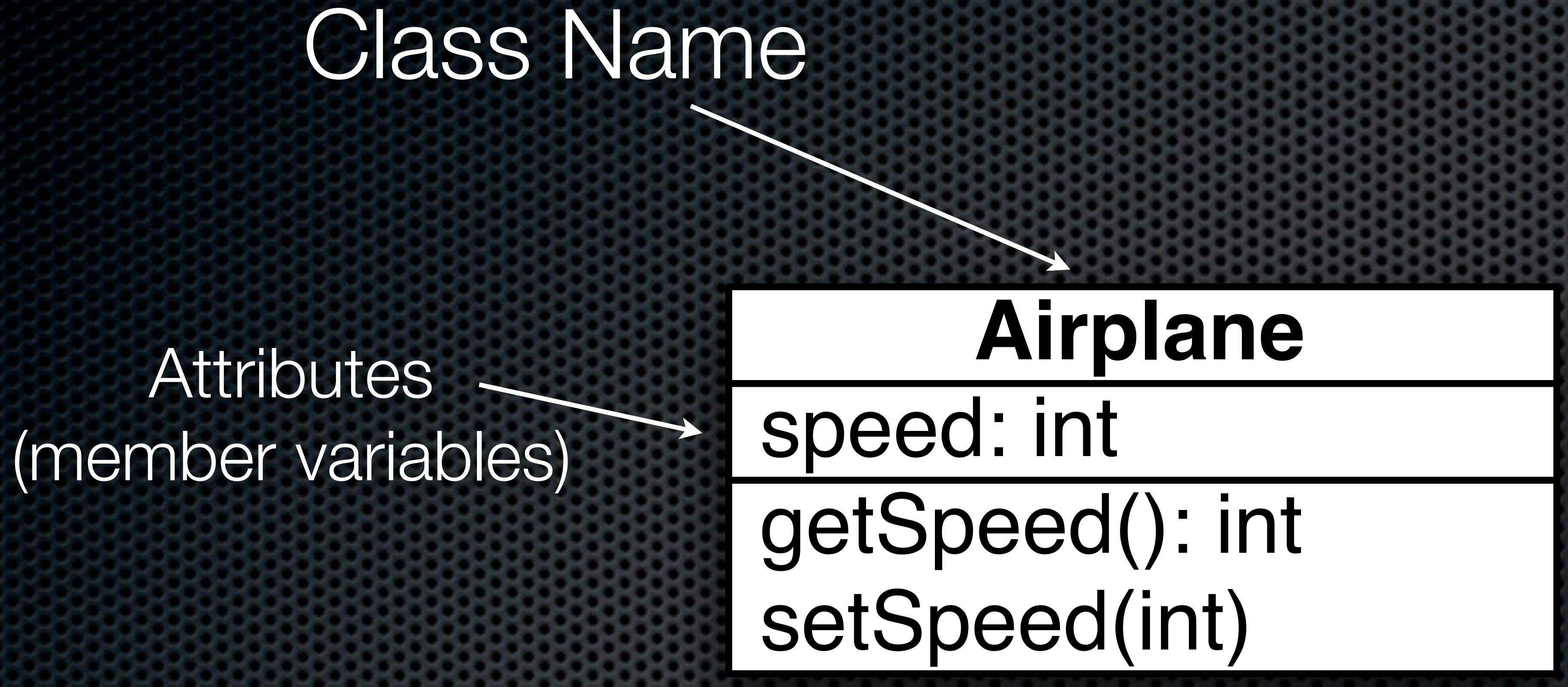
A class is represented as a rectangle

Class Diagrams



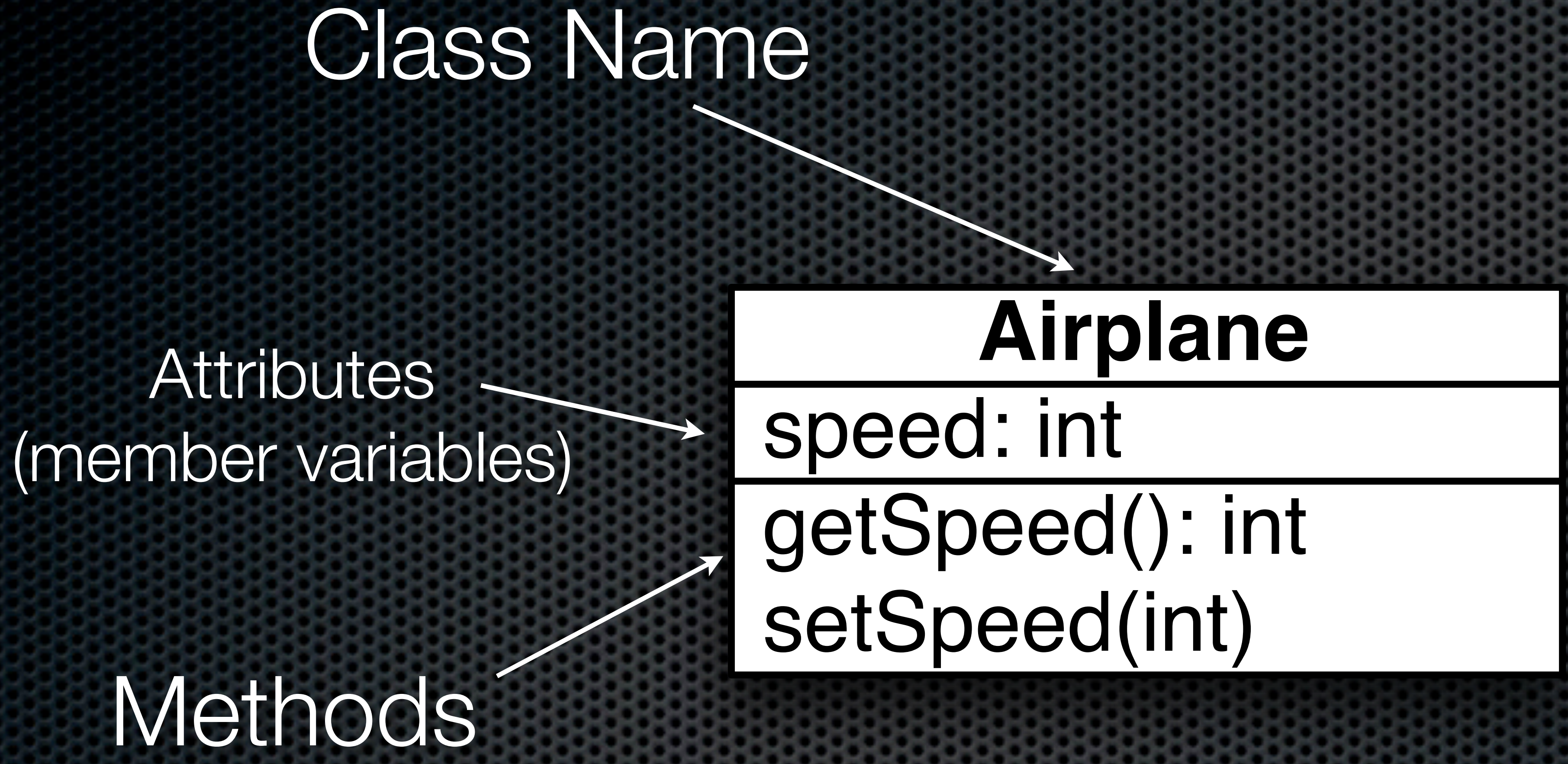
A class is represented as a rectangle

Class Diagrams



A class is represented as a rectangle

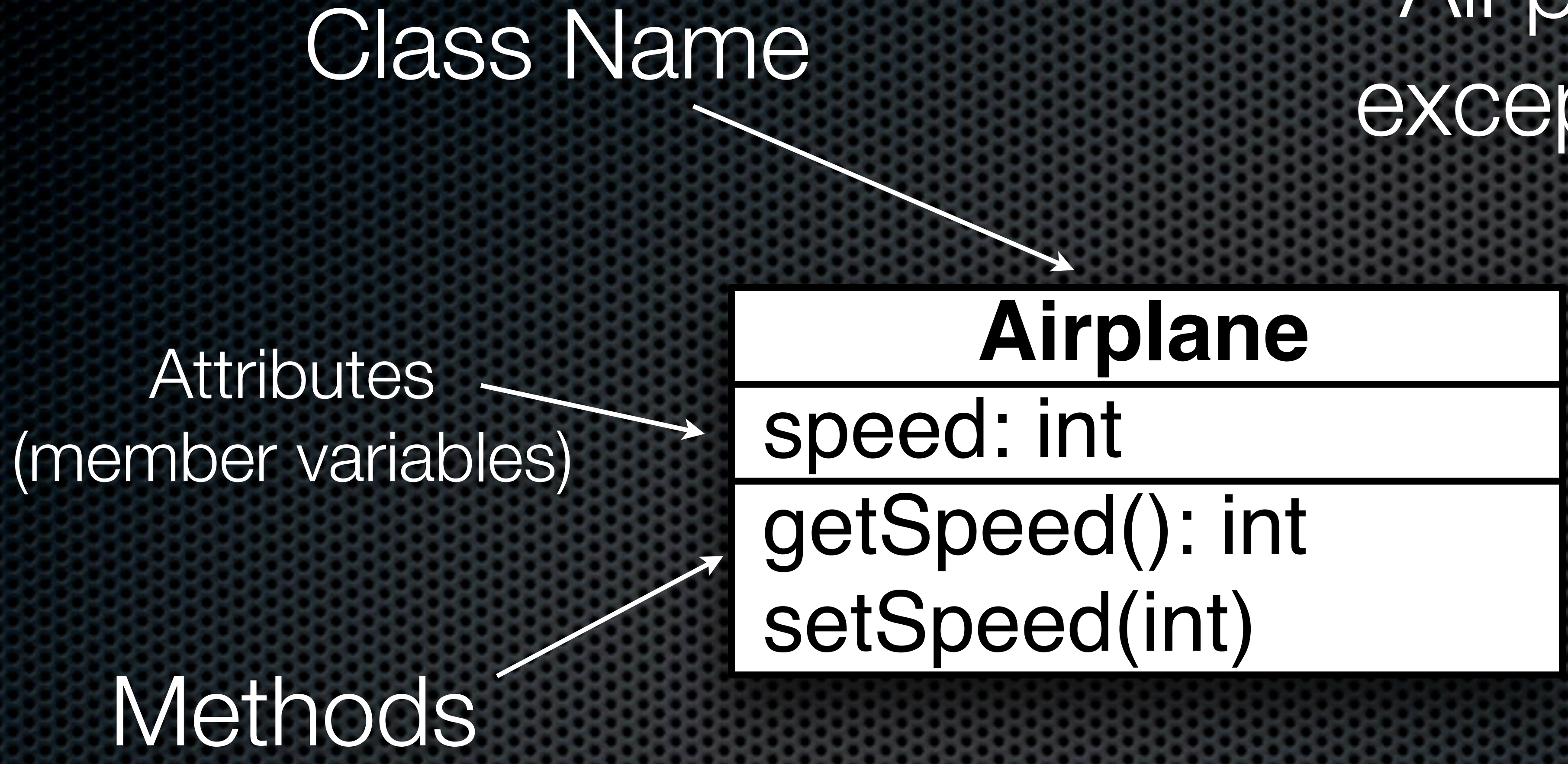
Class Diagrams



A class is represented as a rectangle

Class Diagrams

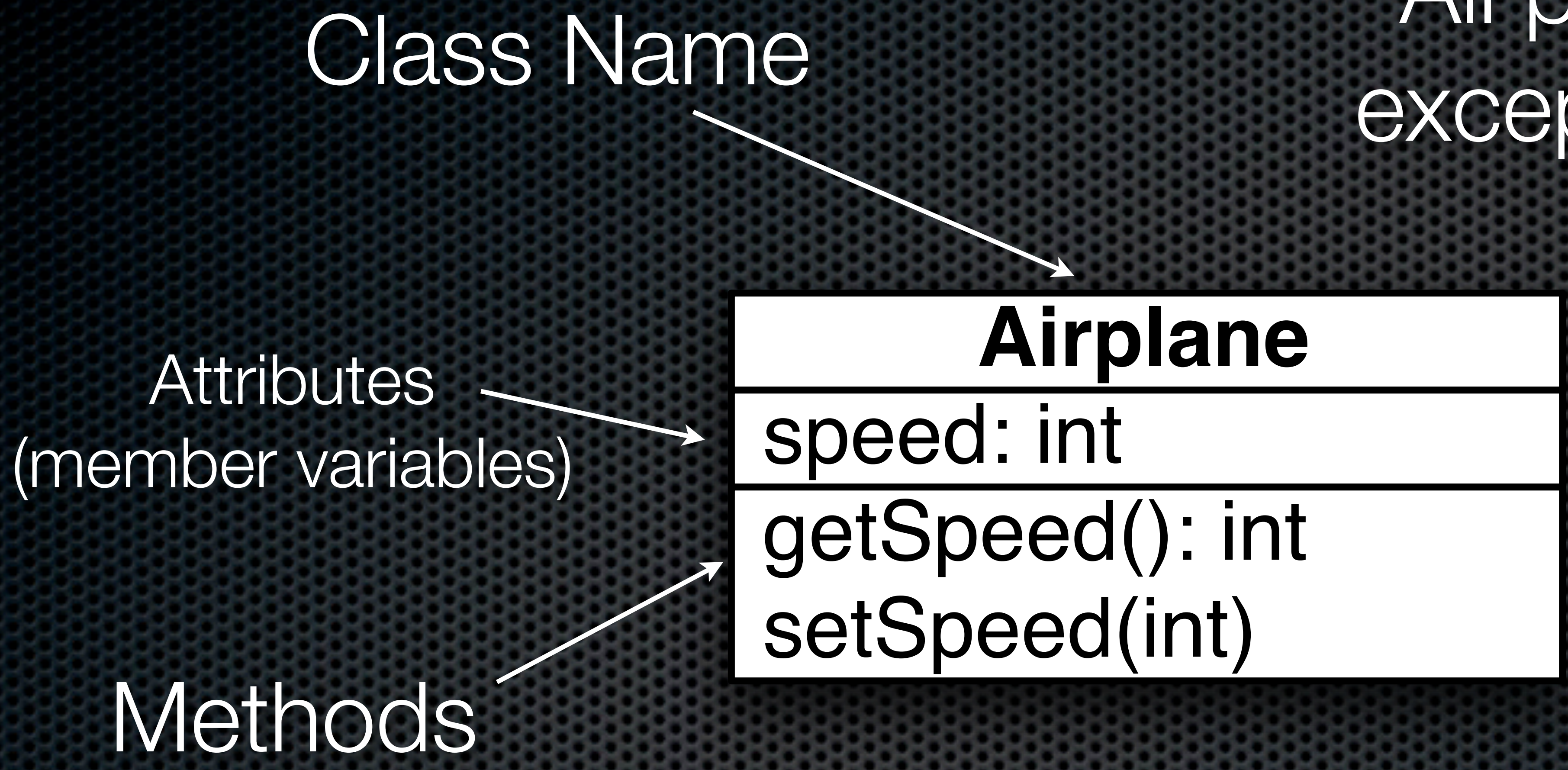
All parts are optional except the class name



A class is represented as a rectangle

Class Diagrams

All parts are optional except the class name



A class is represented as a rectangle

This rectangle says that there is a class called Airplane that could potentially have many instances, each with its own speed variable and methods to access it

Translation to Code

- Class diagrams can be translated into code in a fairly straightforward manner
  - Define the class with the specified name
  - Define specified attributes (assume private access)
  - Define specified method skeletons (assume public)
- May have to deal with unspecified information
  - Types are optional in class diagrams
  - Class diagrams typically do not specify constructors
    - constructors are used to initialize an object

Airplane in Java

```java
public class Airplane {

    private int speed;

    public Airplane(int speed) {
        this.speed = speed;
    }

    public int getSpeed() {
        return speed;
    }

    public void setSpeed(int speed) {
        this.speed = speed;
    }

}
```

Airplane in Python

```python
class Airplane(object):

    def __init__(self, speed):
        self.speed = speed

    def getSpeed(self):
        return self.speed;

    def setSpeed(self, speed):
        self.speed = speed
```

Airplane in Ruby

```ruby
class Airplane

    attr_accessor :speed

    def initialize(speed)
        @speed = speed
    end

end
```

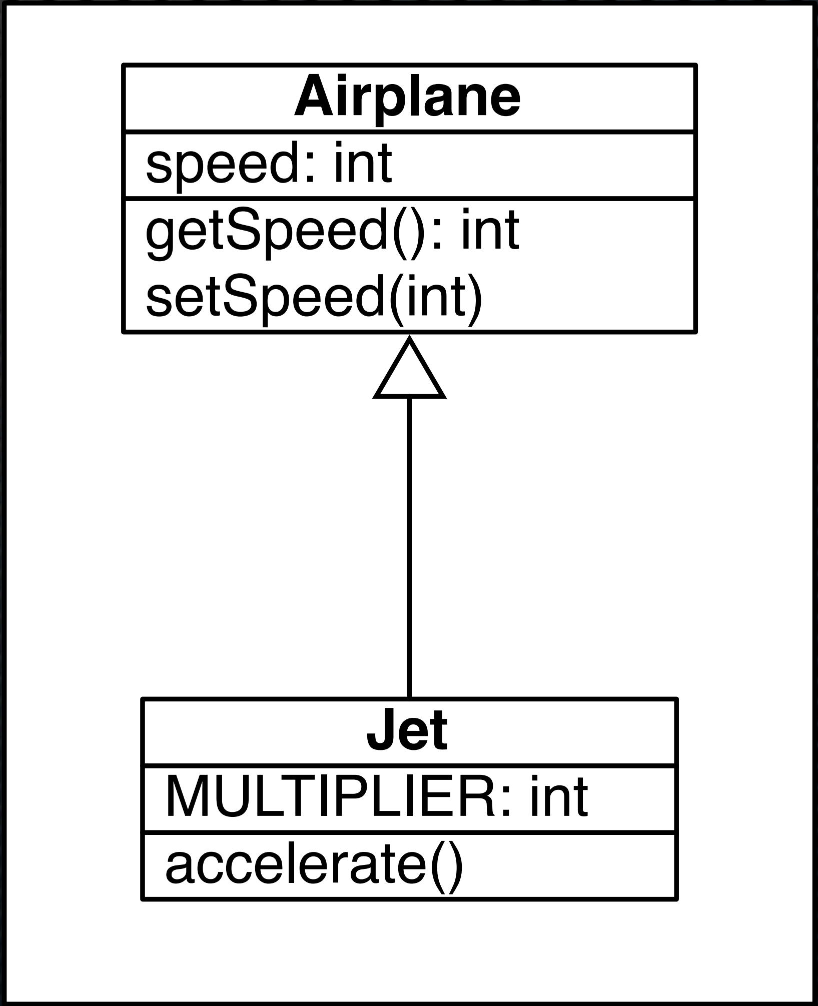
Using these Classes?

- The materials for this lecture contains source code that shows how to use these classes
    - Demonstration
        - Airplane.java, Airplane.py, Airplane.rb
- Be sure to attempt to run these examples on your own
    - It will be good experience to learn how to run Java, Python, and Ruby programs on your personal machine or on a Lab machine (either ITS or CSEL)

Inheritance

- Inheritance refers to the ability of one class to inherit behavior from another class
  - and change that behavior if needed

Inheritance lets you build classes based on other classes and avoid duplicating and repeating code



Inheriting From Airplane

```
public class Jet extends Airplane {

    private static final int MULTIPLIER = 2;

    public Jet(int id, int speed) {
        super(id, speed);
    }

    public void setSpeed(int speed) {
        super.setSpeed(speed * MULTIPLIER);
    }

    public void accelerate() {
        super.setSpeed(getSpeed() * 2);
    }

}
```

Note:

extends keyword indicates inheritance

super() and super keyword is used to refer to superclass

No need to define getSpeed() method; its inherited!

setSpeed() method overrides behavior of setSpeed() in Airplane

subclass can define new behaviors, such as accelerate()

Inheritance in Python

```
class Jet(Airplane):

    MULTIPLIER = 2

    def __init__(self, id, speed):
        super(Jet, self).__init__(id, speed)

    def setSpeed(self, speed):
        super(Jet, self).setSpeed(speed * Jet.MULTIPLIER)

    def accelerate(self):
        super(Jet, self).setSpeed(self.getSpeed() * 2);

```

Inheritance in Ruby

```ruby
class Jet < Airplane

    @@MULTIPLIER = 2

    def initialize(id, speed)
        super(id, speed)
    end

    def speed=(speed)
        super(speed * @@MULTIPLIER)
    end

    def accelerate()
        @speed = @speed * 2
    end

end

```

Polymorphism: “Many Forms”

- From the textbook: “When one class inherits from another, then polymorphism allows a subclass to stand in for the superclass.”
- Implication: both of these are legal statements
  - Airplane plane = new Airplane()
  - Airplane plane = new Jet()
- Any code that uses the “plane” variable will treat it as an Airplane… this provides flexibility, since that code will run unchanged, indeed it doesn’t even need to be recompiled, when new Airplane subclasses are created

Encapsulation

- Encapsulation is
  - when you hide parts of your data from the rest of your application
  - and limit the ability for other parts of your code to access that data
- Encapsulation lets you protect information in your objects from being used incorrectly

Encapsulation Example

- The “speed” instance variable is private in Airplane. That means that Jet doesn’t have direct access to it.
- Nor does any client of Airplane or Jet objects
- Imagine if we changed speed’s visibility to public
- The encapsulation of Jet’s setSpeed() method would be destroyed

```
Airplane

...
public void setSpeed(int speed) {
    this.speed = speed;
}
...

Jet

...
public void setSpeed(int speed) {
    super.setSpeed(speed * MULTIPLIER);
}
...

```

Demonstration

Summary

- OO software is a system of communicating objects
- UML provides standard notations for documenting the structure of OO systems
- Classes define the features of objects, both their data and behavior
- Inheritance allows classes to share behavior and avoid duplicating/repeating code
- Polymorphism allows a subclass to stand in for its superclass
- Encapsulation occurs when you hide one part of your code from some other part of your code, thereby protecting it

Coming Up Next

- Lecture 3: Object Fundamentals Continued
  - No reading assignment
  - Note: Lecture 3 will repeat some of the things mentioned in this lecture
- Lecture 4: Great Software
  - Read Chapter 1 of the OO A&D book