Lecture 3

Objects, UML, and Java

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CMPUT 360 – Introduction to Software Engineering

Slides adapted from Henry Tang, Dr. Abram Hindle

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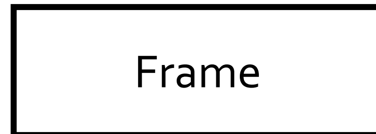
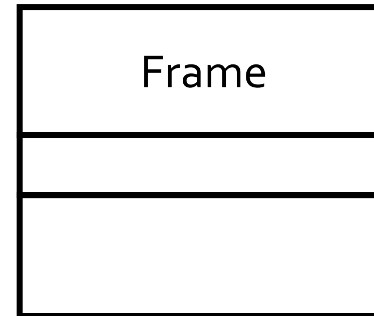
Java and UML Class

- ```
  public class Frame { // version 0
       // represent a ‘window’
       /* body of class definition goes here */
  }
  ```





UML class notation
  ```

Encapsulation

- Class:
  - Access control for attributes and methods
    - E.g., public or private
  - Access is not the same as visibility
  - “Design by contract”
    - Public interface represents a contract between the developer who implements the class and the developer who uses the class

Java Class

- ```
  public class Frame { // version 1
      // private implementation

      private datatype variablename;

      // public interface

      public Frame( arguments ) {
          // implementation of constructor
      }

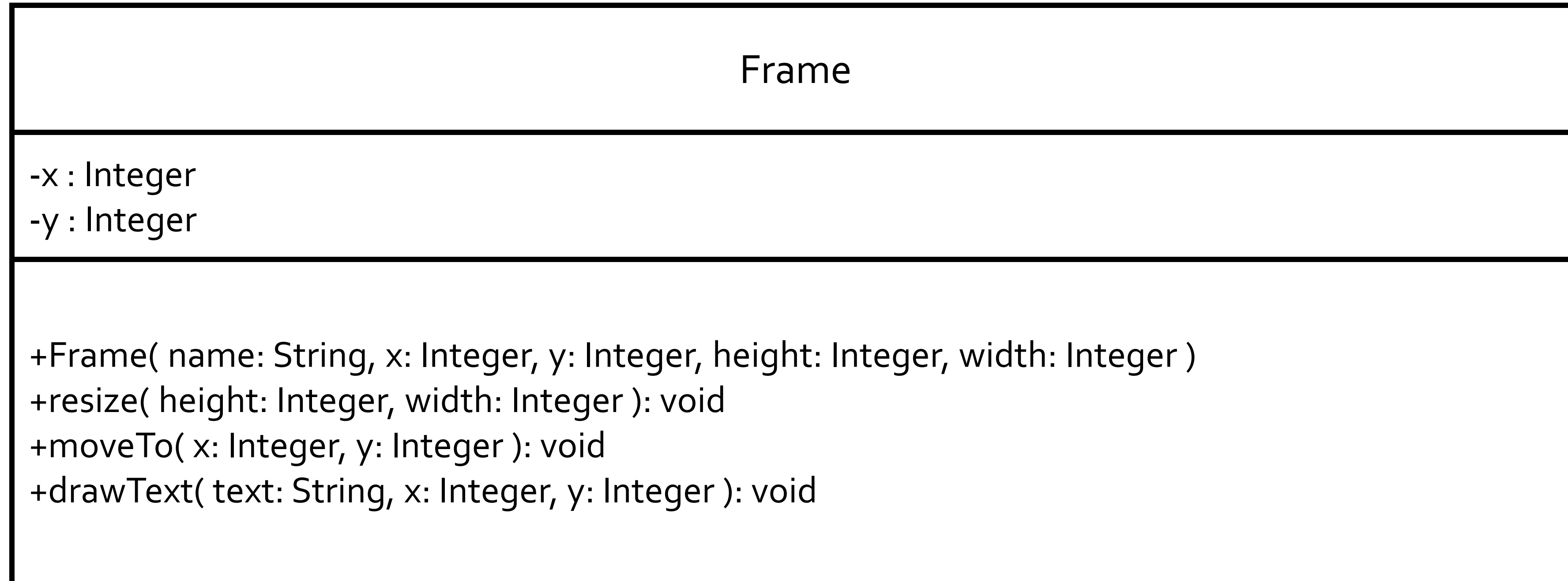
      public returntype methodname( arguments ) {
          // implementation of method
      }
  }
  ```
  ```

Java Class

- ```
  public class Frame { // version 2
      private int x;
      private int y;
      …
      public Frame ( String name,
          int x, int y, int height, int width ) { … }

      public void resize(
          int newHeight, int newWidth ) { … }

      public void moveTo(
          int newX, int newY ) { … }

      public void drawText( String text,
          int x, int y ) { … }
  }
  ```

- ```
  Frame f = new Frame( "Untitled", 0, 0, 480, 640 );
  ```

UML Class



– Private
+ Public

Decomposition

- Association relationship:
  - “Some” relationship between classes
    - E.g., between Book and Patron

UML Association

- Read class diagram using “objects”
  - A Food *object* goes well with a Juice *object*
  - A Food *object* is associated with o or more Juice *objects*
  - A Juice *object* is associated with o or more Food *objects*

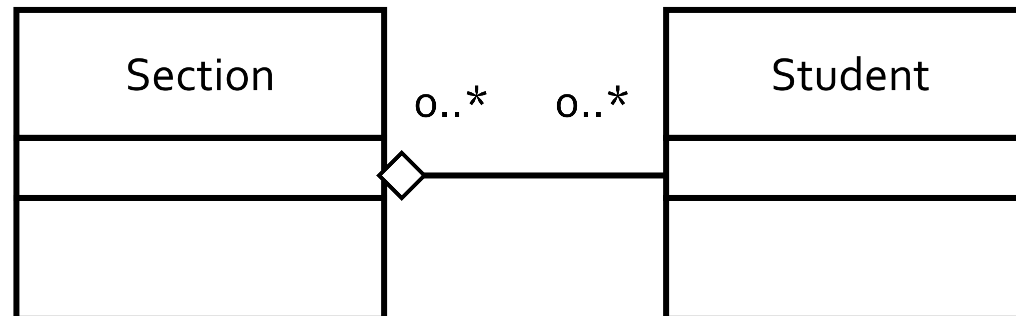
Decomposition

- Aggregation relationship:
  - Weak “has-a” relationship
  - Whole “has-a” part
  - A part may belong to (be shared with) other wholes
    - E.g., a Section and a Student

Java and UML Aggregation

- Dynamic number of aggregated objects:

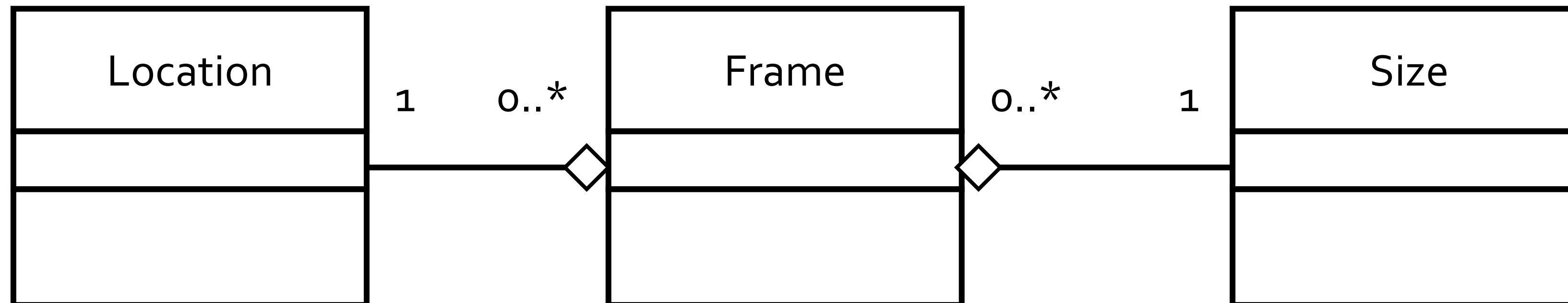
```
public class Section {
    private ArrayList<Student> roster;
    …

    public Section() {
        roster = new ArrayList<Student>();
        …
    }
    public void add( Student s ) { … }
}
```



Java and UML Aggregation

- Fixed number of aggregated objects:

```
public class Frame {

    private Location defaultLocation; // shared
    private Size defaultSize; // shared
    …
}
```

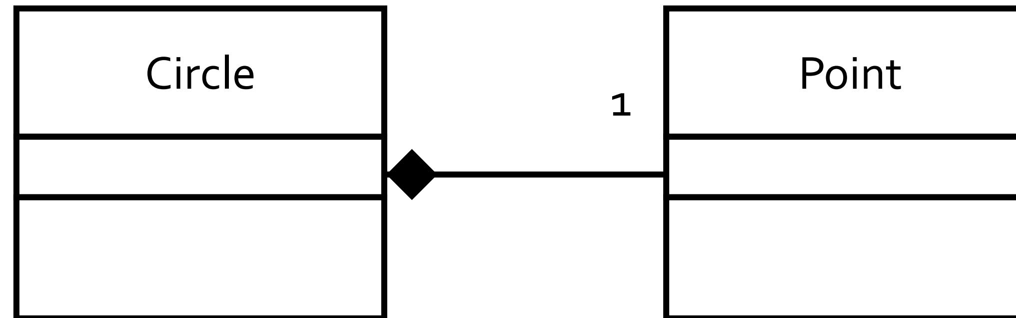


Decomposition

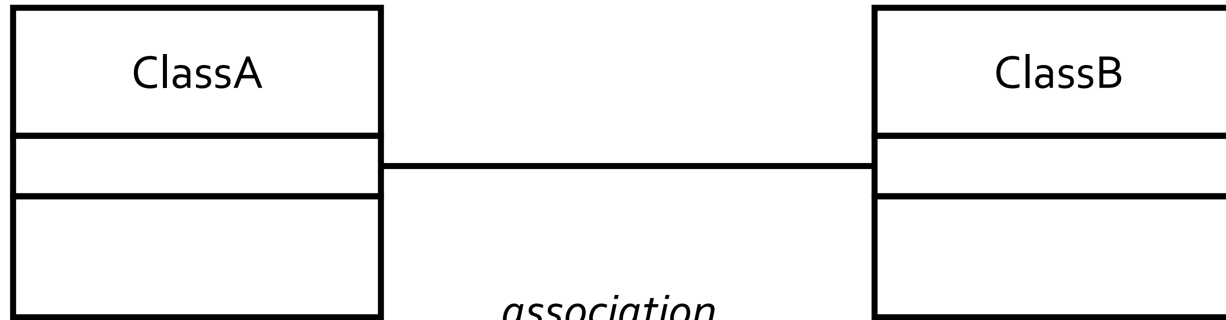
- Composition relationship:
  - Strong “has-a” relationship
  - Exclusive containment of parts
  - Related object lifetimes
    - The whole cannot exist without having the parts; if the whole is destroyed, the parts should also be destroyed
  - Often access the parts through the whole

UML Composition

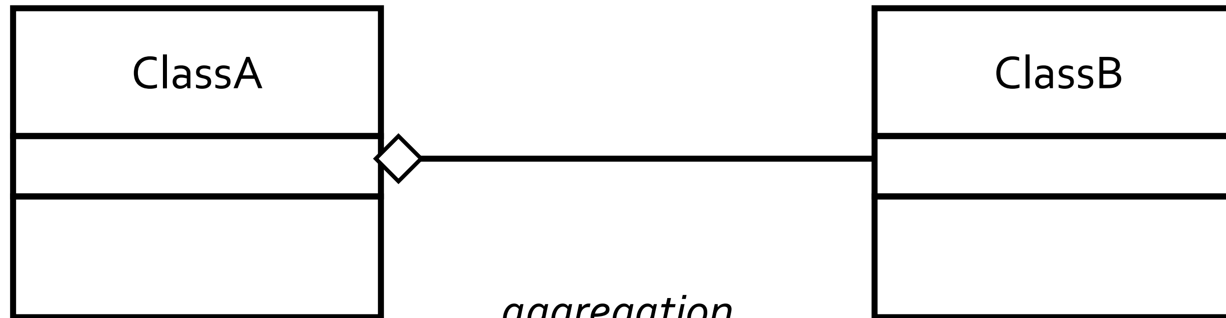
- Contained *objects* are exclusive to the container



- A Circle object has a Point object that is exclusive to it (however, other objects may contain Point objects, just not this one)



whole *part*

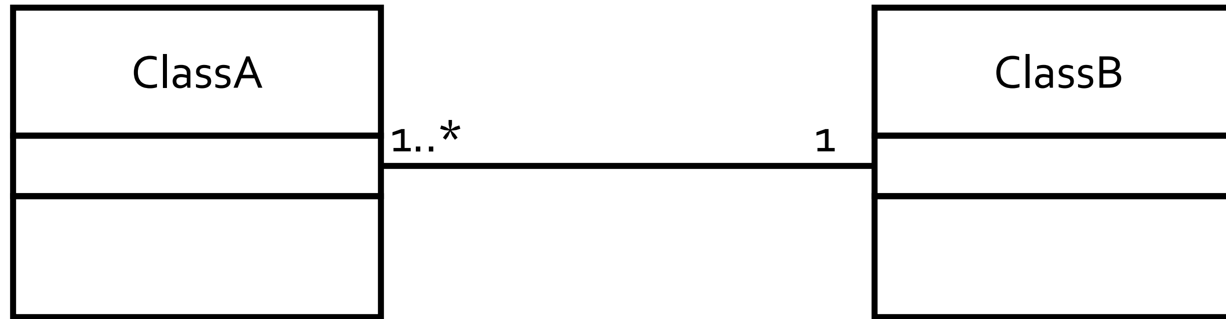


ClassA and ClassB can created/destroyed independently

composition

If ClassA instance is deleted, all of its ClassB instances get deleted too

Navigability

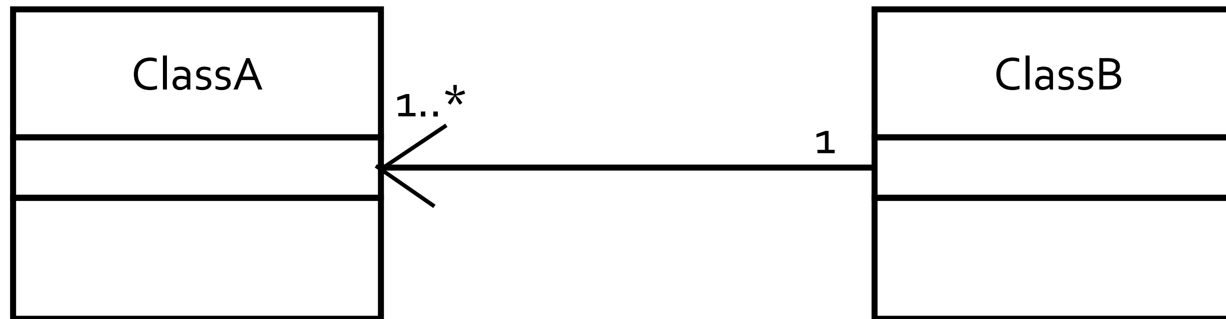


Missing navigability

Usually implies:

A instances have references to one B

B instances have references to one or more A

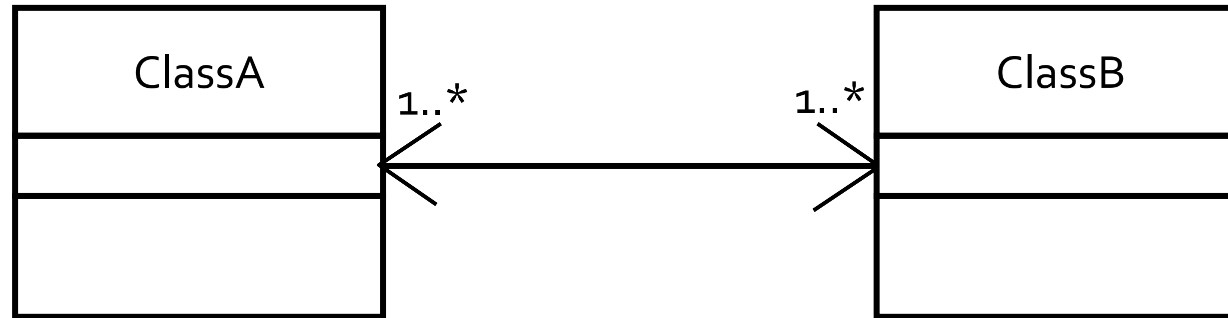


Navigability

← Arrow

B instances have references to one or more A

A instances DO NOT have reference(s) to B



Explicit two-way navigability

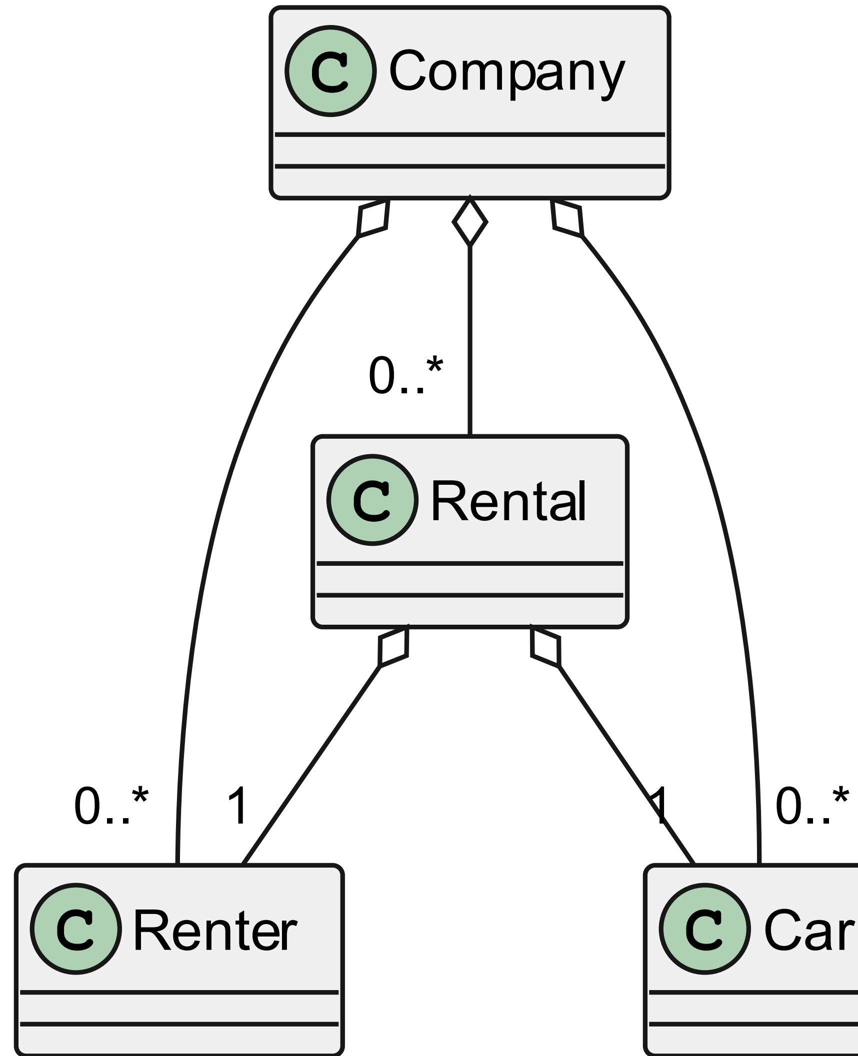
(rare)

A instances have references to one or more B

B instances have references to one or more A

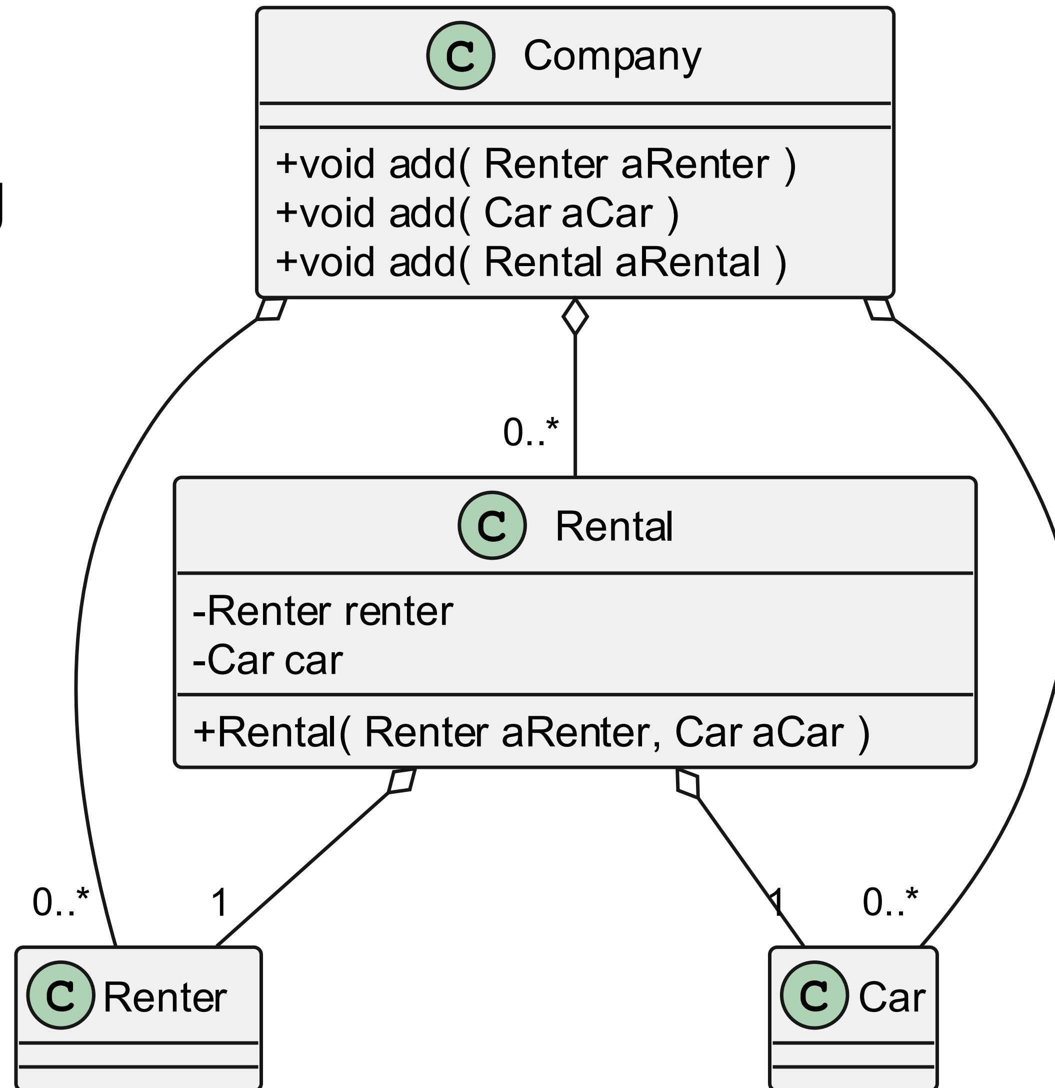
Exercise

- Analyze a UML class model for a car rental company that keeps track of cars, renters, and renters renting cars.


Company
0..*
Rental
0..*
1
1
0..*
Renter
Car

Exercise

- Implement the corresponding Java code.



Generalization

Generalization

- Look for commonalities:
  - Common attributes
    - E.g., all vehicles have…
  - Common methods (behaviour)
    - E.g., all vehicles can…
- Generalize:
  - Find what is common and factor it out into a more general “base” abstraction

Generalization

- Implementation inheritance:
  - Generalize about method signatures, method implementations, and/or attributes
    - I.e., classes having these in common

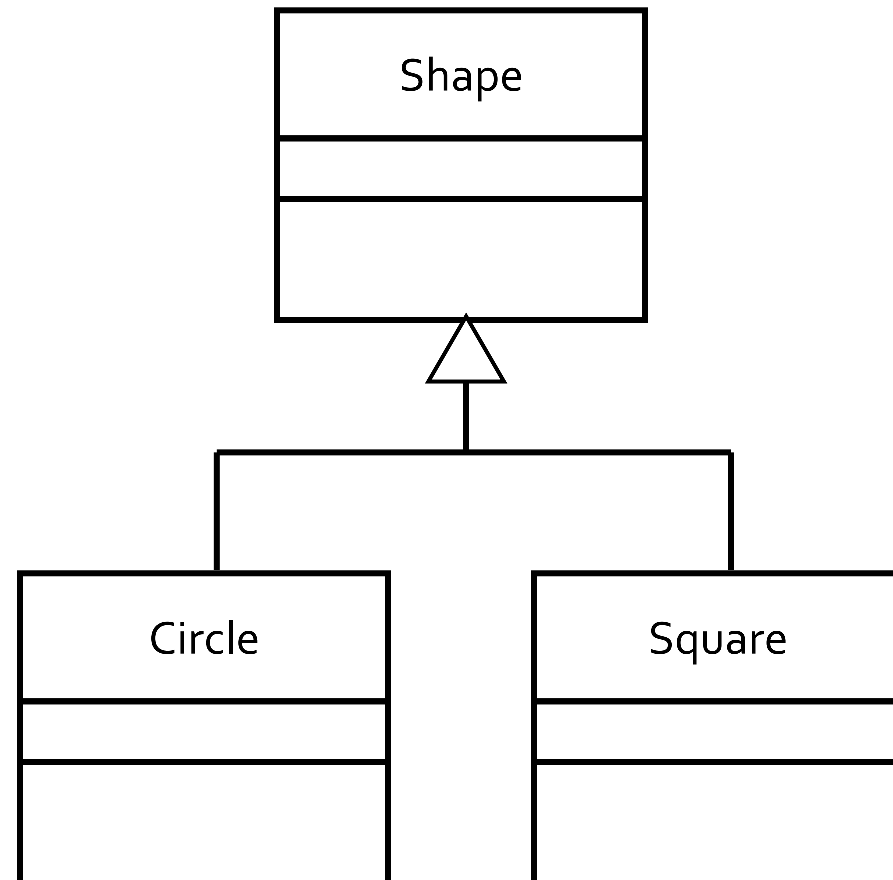
Implementation Inheritance

- General part:
  - A base class (or "superclass") defines the attributes and methods to be shared
- Specific part:
  - A derived class (or "subclass") is endowed with the attributes and methods of its base class
  - A subclass may "extend" a superclass by adding attributes and methods, or overriding an existing method

Java Implementation Inheritance

- ```
  public class Shape { // superclass
      protected Location myLocation;
      public Shape() { … }
      public void setLocation( Location p ) { … }
      public Location getLocation() { … }
  }
  ```

- ```
  public class Circle extends Shape { // subclass
      private int diameter;
      public Circle() { … }
      public void setDiameter( int d ) { … }
      …
  }
  ```

- ```
  public class Square extends Shape { // subclass
      private int side;
      public Square() { … }
      public void setSide( int s ) { … }
  }
  ```
  ```

UML Inheritance

- Implementation inheritance relationship:
  - “Is-a” relationship between classes
  - I.e., subclass “is-a” kind of superclass
  - I.e., subclass “extends” superclass
- E.g., Circle “is-a” kind of Shape



Generalization Principles

- Inappropriate inheritance:
  - Subclass inherits from superclass but “is-a” (is a kind of) relationship *does not* exist
  - If “is-a” test fails:
    - Likely not appropriate
  - If “is-a” test succeeds:
    - *May* or *may not* be appropriate

Generalization Principles

- Liskov substitution principle:
  - An instance of the subclass should be substitutable anywhere a reference to a superclass object is used
  - ```
    Shape s;
    s = new Circle(); // instance of subclass
    …
    Location l = s.getLocation(); // superclass method
    ```
    ```

Inheritance Example

- Suppose:
  - class Dog
    - Provides bark(), fetch()
  - class Cat extends Dog
    - “Hides” bark(), “hides” fetch(), and adds purr()
- Question:
  - Cat “is a” Dog?

Inheritance Example

- Suppose:
  - class Window
    - Provides show(), move(), resize()
  - class FixedSizeWindow extends Window
    - “Hides” resize()
- Question:
  - FixedSizeWindow “is a” Window?

Inheritance Example

- Suppose:
  - class ArrayList
    - Provides add(), get(), remove(), …
  - class ProjectTeam extends ArrayList
- Question:
  - ProjectTeam “is a” ArrayList?

Lecture 3 ends here …