# Inheritance
## Ch 6

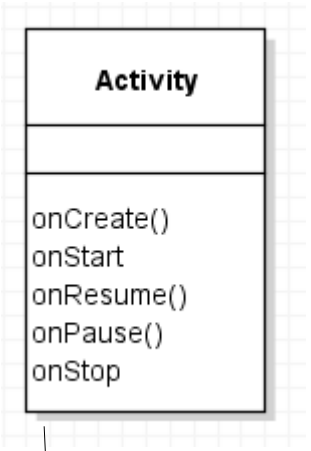
# Topics

1) How can Java work with class inheritance?
    1) Creating subclasses
    2) Overriding methods
    3) Flexible Classes
    4) Visibility

# Using Inheritance for Subclasses

# Android Activities Intro

- An Android Activity
  - A screen in an Android app
- Activity class
  - Android framework provides an Activity base class to manage much of the Activity's work
  - Functions implement default behaviour for many event such as pausing, or showing a menu.



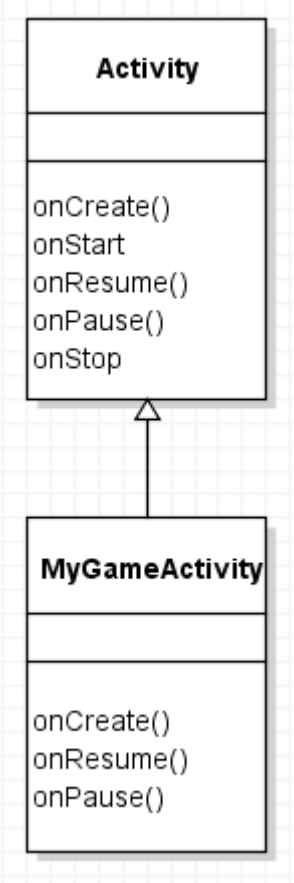

onPause(): Save data & stop animations

onResume():
Start animations

# Inheritance

- Inheritance:
  - Ex: MyGameActivity is-an Activity

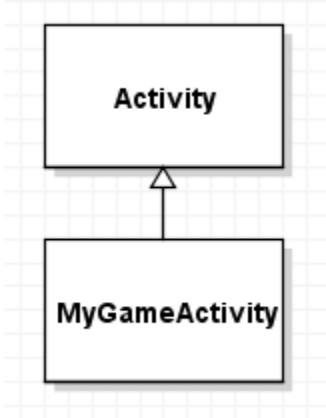
    MyGameActivity inherits from Activity
    (*subclass*) (*superclass*)
    (*derived*) (*base*)




- Motivation:
  - API & implementation of the base are inherited by the derived.
  - Reuse code from base class in derived class.
  - ..

# Notes on Inheritance

- Instantiating MyGameActivity..
  - MyGameActivity object has all members from:
    - the Activity class (its superclass), and
    - the MyGameActivity class




- Access:
  - Subclass may call/access..
    of super class.

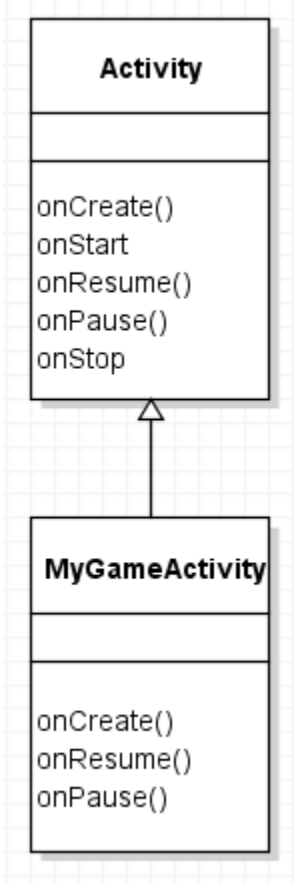
    Ex: MyGameActivity code can call protected and public functions in Activity.
  - Base class cannot access members of derived class.

# Polymorphism via Class Inheritance

- Polymorphic references can refer to an object of its class, or any derived class:

```
Activity a = new MyGameActivity();
a.onCreate();

// Reference to derived class
a = new MySettingsActivity();
a.onCreate();
```




In Android, you never call onCreate();
the Android Framework does it for you.

# Overriding Methods

(Not over**loading**, over**riding**)

# super & this

- super: refers to..
- this: refers to current object, not superclass.

# Overriding

- Subclass can override a method of superclass if same signature as base:
  - Same name
  - Same argument # and types

```
public static void main(String[] args) {
        Fruit apple = new Fruit("Apple");
        System.out.println(apple.getType());

        Fruit deluxe = new DeluxeFruit("Apple");
        System.out.println(deluxe.getType());
}
```

```
Apple
Deluxe Apple
```

```
public class Fruit {
        private String type;

        public Fruit(String type) {
                this.type = type;
        }
        public String getType() {
                return type;
        }
}

public class DeluxeFruit extends Fruit {
        public DeluxeFruit(String type) {
                super(type);
        }

        @Override
        public String getType() {
                return "Deluxe " + super.getType();
        }
}
```

# Overriding Details

- To override a method, derived class's method must:
  - Have identical signature
  - Not throw any extra checked exceptions (more later)
  - ..
    - Ex: Can go from protected to public, but not public to protected/private.
  - Cannot override a private, a static, or a final method.
  - Not change return type of method.
    - But you can return a subtype of original return type

# Base Class Constructor Chaining

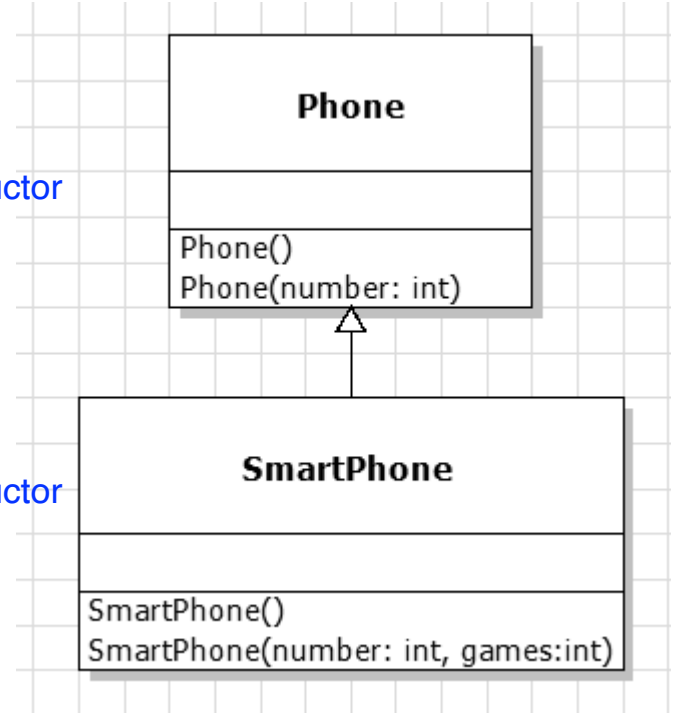
- Subclass's constructor can “call” superclass constructor:

```
public class SmartPhone extends Phone {
    int numGames = 0;

    public SmartPhone () {
        super();
    }
    public SmartPhone (int number, int games) {
        super(number);
        numGames = games;
    }
}
```

call 0 arg. superclass constructor

call 1 arg. superclass constructor




- super() must be the.. first line of the constructor
  - If missing, super(); automatically added as first line (unless using constructor chaining via this(...) )

# Chaining Constructors

- How does each of these constructors work?

```
public class Base {
  private int count = 0;

  public Base() {
    this(5);
    // Do anything...
  }

  public Base(int count) {
    this.count = count;
    // Do anything...
  }
}
```

```
public class Derived extends Base {
  private final double DEFAULT = 42.0;
  private double other;

  public Derived(int count) {
    this(count, DEFAULT);
    // Do anything...
  }

  public Derived(int count, double other){
    super(count);
    this.other = other;
    // Do anything...
  }
}
```

# final vs Overriding

- final method:.. cannot be overriden

```
class MCHammer {
    final String getSaying() {
        return "Can't touch this!";
    }
}

class MCWho extends MCHammer{
    @Override
    String getSaying() {
        return "Who's MC Hammer?";
    }
}
```

error

- final class:.. cannot be extended

# Shadow Variables - a Bad Idea

- Shadow Variables:
  - Subclass declares a variable of the same name as the superclass

```
class Pet {
        private String name;
        // ...
}

class PetRock extends Pet {
        private String name;
        // ...
}
```

- this does not change the base class

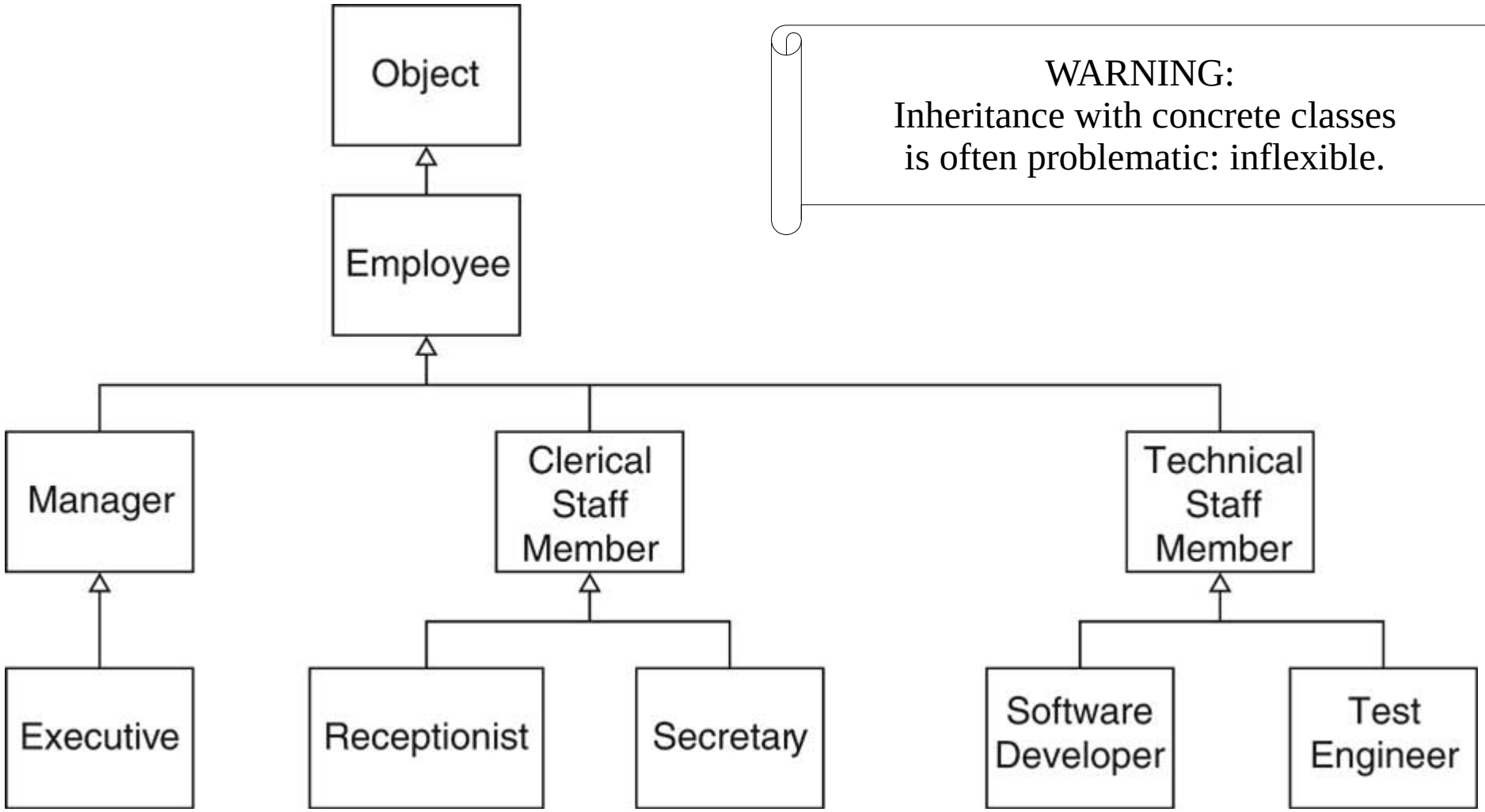
  only creates confusion for programmers!
  - No good reason to use a shadow variable.
  - Pick good, unique names!

# Class Hierarchies
# and
# Flexible Classes

# Multiple Inheritance

- Single Inheritance:
  A class may inherit from.. at most one superclass
  - Ex: A Car is a Vehicle.
  - Java uses this approach.
- Multiple Inheritance:
  A class may inherit from many superclasses.
  - Ex: A TA is both a Student and a Teacher.
    - TA multiply inherits Student and Teacher
  - Impossible in Java (specifically forbidden).
- Use.. interfaces to get some benefits of multiple inheritance using only single inheritance.

# Inheritance Hierarchy




WARNING:
Inheritance with concrete classes
is often problematic: inflexible.

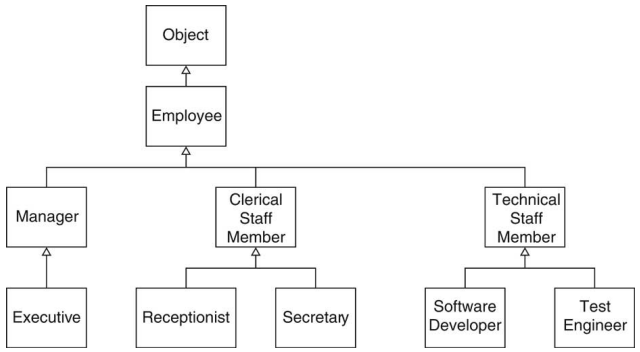
# Flexible Objects

- Once instantiated.. an object's type never changes

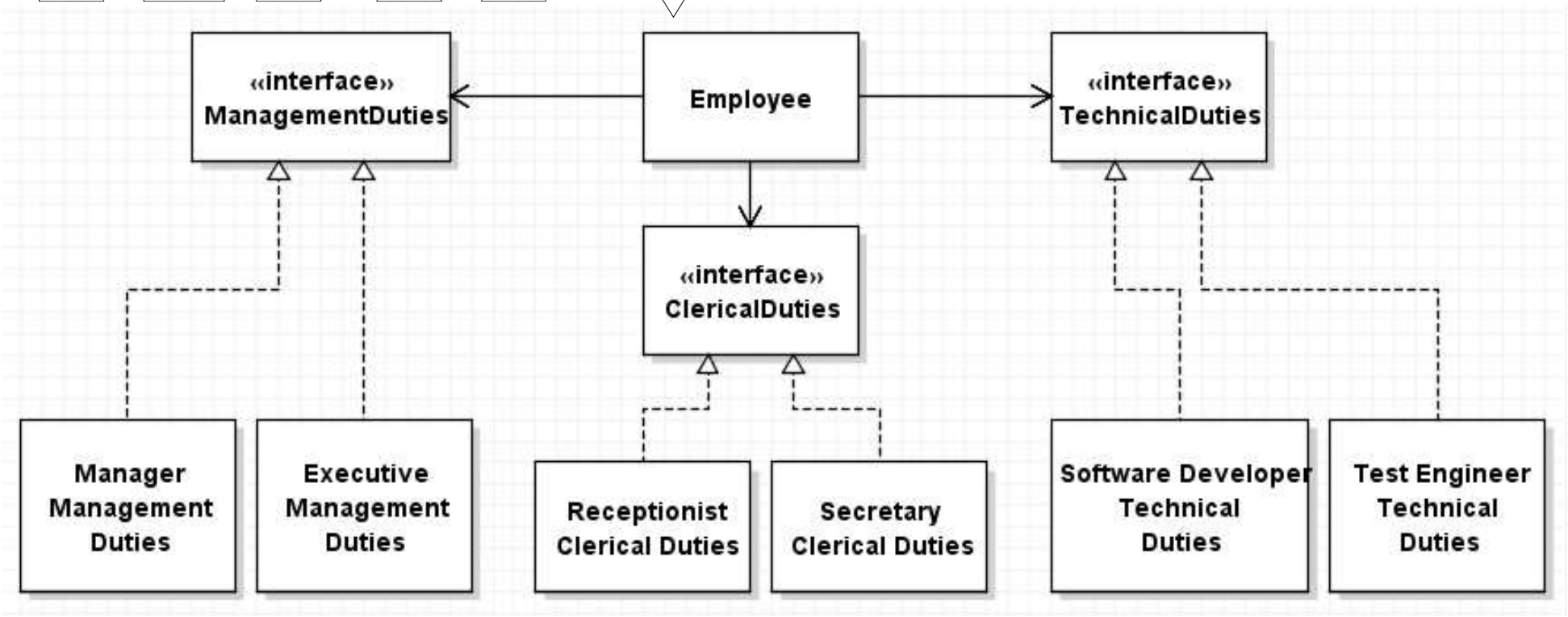
- **Design Principle:**
  Program to an interface, not an implementation
  - Flexibility to reference a different concrete class later

- **Design Principle:**
  Prefer composition over inheritance
  - Composition allows.. runtime flexibility to change
    (reference a new object)
  - Reduces rigid coupling from static inheritance hierarchy

# Use Composition Instead




Composition is more flexible.
Can change object an runtime.
Can have multiple duties.



# Abstract Class

# Abstract Classes

- Abstract class: (basic idea)

  a class with some unimplemented methods

  - abstract method: Un-implemented method.
    Concrete derived classes must.. override (implement) all abstract methods

  - Classes with abstract methods must be abstract.
  - Abstract class cannot be instantiated:
    it's incomplete; not concrete.

- Make a class abstract:
  public abstract class Plant { ... }

- Make a method abstract:
  public abstract void doSomethingAmazing();

# Abstract Class Example

```
abstract class GraphicObject {
    int x, y;                                   ..
    ...
    void moveTo(int newX, int newY) {
        ...
    }
    abstract void draw();
    abstract void resize();                     ..
}

class Circle extends GraphicObject {
   @Override
    void draw() {
        ...
    }                                           ..
   @Override
    void resize() {
        ...
    }
}
```

Abstract class...

can have instance data and method implementations

Abstract method has no implementation.

draw() and resize() must be..

# Abstract Class vs Interface

Similarities

Abstract class: Java interfaces:

- Force derived concrete class to.. implement methods
- Supports constants

Differences

- implemented some methods (non-abstract)
- include instance data (non-constant fields)
- Extend classes

abstract class can inherit from another abstract class

- Class can implement..

multiple interfaces

- In UML, abstract classes shown in *italics*.
  - Sometimes decorated with {abstract}

In Java 8, interfaces can have default (“defender”) methods, but these can only call other methods of the interface.

# Abstract Questions

- Can a method be both abstract and final?
  - no, abstract methods must be overriden, but final methods cannot
- Can an abstract class have a static method?
  - yes
- Can a method be both abstract and static?
  - no: would have no definition (abstract)
    so could not be invoked directly on the class (static)
- Can a class be both final and abstract?
  - no, final only for “complete” class
    but abstract classes are incomplete

Math is final with a private constructor.

# Visibility

# protected only use when needed

- protected
  - allows.derived classes to access a member
    Crates a “protected” interface.
  - unrelated classes cannot access the protected members.
- Not a great idea:
  it exposes implementation details to derived classes
  - breaks encapsulation:

    you have no control over which classes extend your class in the future.
  - Create a “protected” interface to expose just those things that only derived classes will need (“template method”)
    Often better to use public interface.

# Class Member Visibility

- Visibility Modifies and member accessibility:
  - public: anywhere
  - protected: in the class, package, and derived classes
  - default: in the class, and package
    - default is without any modifiers; called package-private
  - private: only in the class

| | Inside Own Class | Inside Same Package | Inside Inherited Classes | Rest of the world |
|---|---|---|---|---|
| public | Visible | Visible | Visible | Visible |
| protected | Visible | Visible | Visible | |
| *"default" no modifier* | Visible | Visible | | |
| private | Visible | | | |

# Summary

- Inheritance (is-a) used to create subclasses
  - Supports polymorphism
  - Child overrides methods of parents to change behaviour
  - Child uses super in constructor
- Composition is more flexible than inheritance
- Visibility modifiers affect inheritance