Inheritance

Extending Classes

- It's possible to create a class by using another as a starting point.
  - We can take the existing class: add more methods, change what methods do, etc.
- Allows reuse.
  - Can extend a class in several ways, using it for several different purposes.
  - … based on the same original code.

Extending Classes

- The class that's being extended is the "parent class" or "superclass".
  - Contains all behaviour common to its "children".
- The parent is extended in the "child class" or "subclass".
  - Additional, specific behaviour added.
  - Often a parent is extended in several ways, creating several children.

Example

- In the blackjack design, we had players and dealers that were similar.
  - Each had a hand, took a turn, etc.
  - Put this in a superclass `Person`.
- Then, the person class can be extended to create `Player` and `Dealer`.
  - Code/behaviour that differs between the two is added as part of the subclass.

Inheriting

- Suppose we have a simple class `A`:

```
class A {
    private int count;
    public int method() {
        return 1;
    }
}
```

- … and want to create a class `B` that is `A` with another method added…

Inheriting

- Now, `B` can inherit `A` and add a new method:

```
class B extends A {
    public int newMethod() {
        return 2;
    }
}
```

- `B` now has everything from the definitions of `A` and `B`.

Inheriting

- Using `A` and `B`:

```
A myA = new A();
B myB = new B();
System.out.print(myA.method());
System.out.print(myB.method());
System.out.print(myB.newMethod());
```

Originally from A

Only available in B

- Output: `112`
- An instance of `B` also has all members from `A`.

Parents and Privacy

- Subclasses **cannot** access private members:

```
class B extends A { …
    public void setCount(int count) {
        this.count = count;
    }
}
```

Error: count defined as private in A; we aren't in A.

- Just like any other code: it can't access private members.
- Must use getters & setters on instance variables.

Constructors

- Constructors are **not** inherited, but can be added the same way:

```
class A { …
    public A() {
        count = 1;
    }
}
class B extends A { …
    public B(int n) {
        setCount(n);
    }
}
```

Still named after the class they're defined in.

`count` is private: must use setter to assign.

Overriding Methods

- If you want to change the behaviour of a method, it can be redefined in the subclass
  - "overriding"
  - Any instances of the child class will use this implementation, not the parent's.
- Useful if a method's behaviour needs to be different for the specific subclass
  - e.g. extra variables updated, different output, …

Example

- Works for constructors too:

```
class A { …
    public A(){
        count = 1;
    }
}
class B extends A { …
    public B() {
        setCount(6);
    }
}
```

Same argument signature, so the original is overridden.

Accessing the Superclass

- If you need to access something from the superclass, the `super` reference gives access.
  - Particularly useful for calling overridden methods.
- Common usage:

```
public void method(int x) { // Overrides
   …                        // Extra stuff here.
   super.method(x);         // Run the superclass
                            // method too.
}
```

Built-In Classes

- It's also possible to extend classes from the standard library.
  - Even if you don't know the original implementation, you can still add new methods.
  - eg. list with metadata (`ArrayList` with extra instance variables); `Scanner` that can also read in a custom type.

The `Object` Class

- The built-in class `Object` is the "root" of the class hierarchy.
  - A class that doesn't explicitly "`extend`" anything has `Object` as its superclass.
  - i.e. these are equivalent:

```
class Foo {…}
class Foo extends Object {…}
```

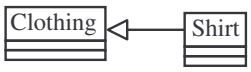
- `Object` contains some methods (`toString`, `equals`, …) that are used unless overridden.

When to Inherit

- Inheritance is a very powerful tool in OO design.
  - Easy reuse of code; works naturally with problems that have a hierarchy of objects.
- Don't confuse inheritance with aggregation.
  - A should inherit B only if "A is a B" or "A is a more specific version of B" or "A can be substituted for B"
  - … not just because you need to use the parts of B.

Inheritance in UML

- The inherited class is indicated with a solid line and open arrow:



Example: Shapes

Shapes

- Suppose we want to represent a collection of shapes (in a drawing program).
  - square, rectangle, circle (maybe other later).
- All of these have some things in common:
  - `position`: the *xy*-coordinate of the shape
  - Getters & setters for position.
  - `translate(x,y)`: move the shape by this much
- Create a class `Shape` that implements these.

Subclasses

- Each of these will inherit `Shape`.
- Rectangle:
  - Add instance variables `width`, `height`.
- Square:
  - Inherit Rectangle and override setters to ensure `width==height`.
- Circle:
  - Add `radius`, interpret the `position` as the centre.

Code Sketch

- The class definitions:

```
class Shape { … }
class Rectangle extends Shape { … }
class Square extends Rectangle { … }
class Circle extends Shape { … }
```

- A square is a specific kind of rectangle, so we should have the inheritance this way.
  - not `Rectangle extends Square`

(Partial) UML Diagram