Inheritance

COMP1400 - Week 12

Uno Game

Consider the card game Uno:

http://en.wikipedia.org/wiki/Uno_(card_game)

There are 6 kinds of cards:

- number cards
- draw two
- skip
- reverse
- wild
- wild draw four

Game class

We have a **`Game`** class which defines the rules of the game:

- Players take turns playing a card
- A valid play must be the same number or symbol or a wild card
- If you cannot play, draw a card.
- First player with no cards wins.

Card interface

Each kind of card has different properties and effects so belongs in a different class.

However they share a common interface.

They all support the methods of:

- can I play this card now?
- play this card.

```
public interface Card {

    // get the colour
    public int getColour();

    // get the symbol
    public char getSymbol();

    // test if it can be played
    public boolean canPlayOn(
            Card card);

    // implement any effects
    public void play(Game g);

}
```

Card classes

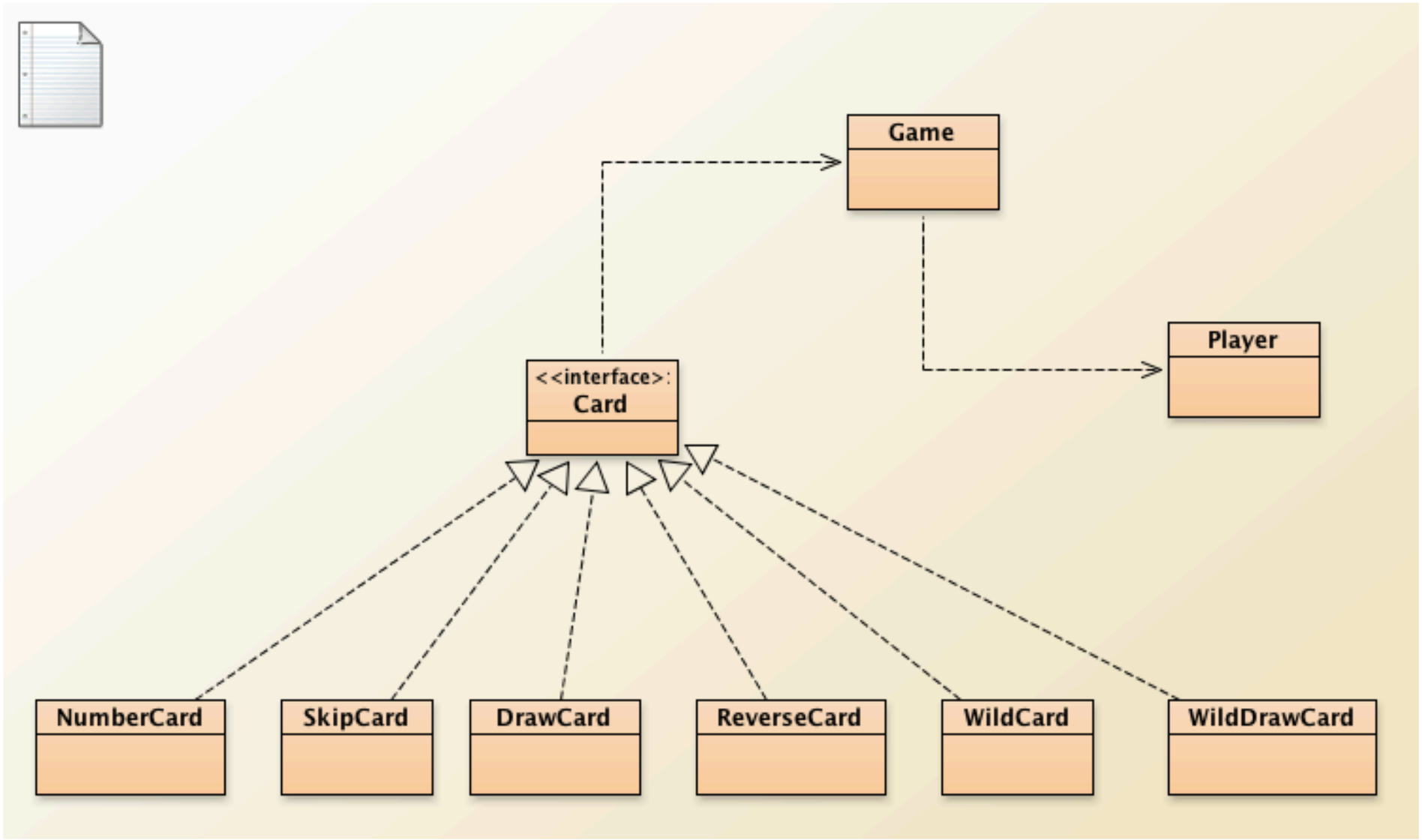
There are six classes that implement the Card interface:

`NumberCard` **`DrawCard`**

`SkipCard` **`ReverseCard`**

`WildCard` **`WildDrawCard`**

Card classes



Common code

Looking at the card classes we notice a lot of common data and code, e.g.:

```
private int myColour;

public boolean canPlayOn(Card c) {

   return c.getSymbol() == 'S'
     || myColour == c.getColour();

}
```

Abstraction

The design principles of abstraction and encapsulation prompt us to ask:

Is there a way to factor out this common data and code into a single, reusable chunk?

The techniques we've seen so far do not apply very well.

We need a new idea: inheritance.

Inheritance

A Java class can extend another class:

```
// based class
public class Parent {

}

// derived class
public class Child
        extends Parent {

}
```

Inheritance

A derived class (child) inherits:

- All the fields of its base class (parent)
- All the methods of its base class

However it cannot access the private fields or methods on its base.

Extending

An extended child class may:

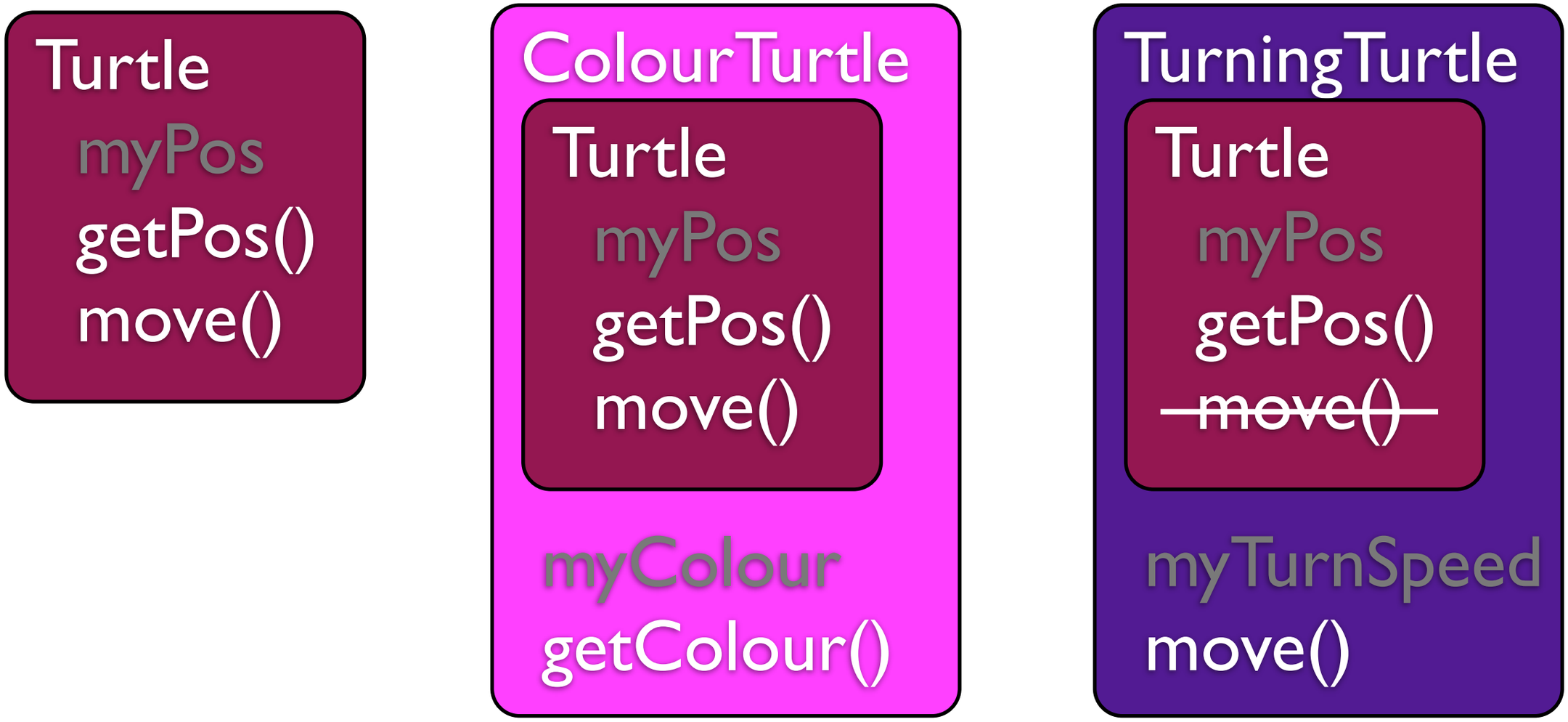
- Add new fields
- Add new methods
- Override old methods on its parent.

```
public class Turtle {
    private Point myPos;
    public Point getPos() {
        return myPos;
    }
    public void move(int dist) {
        // move forward
    }
}
```

```
public class ColourTurtle
        extends Turtle {

    // add a field

    private Color myColour;

    // add a method

    public Color getColour()  {

        return myColour;

    }
}
```

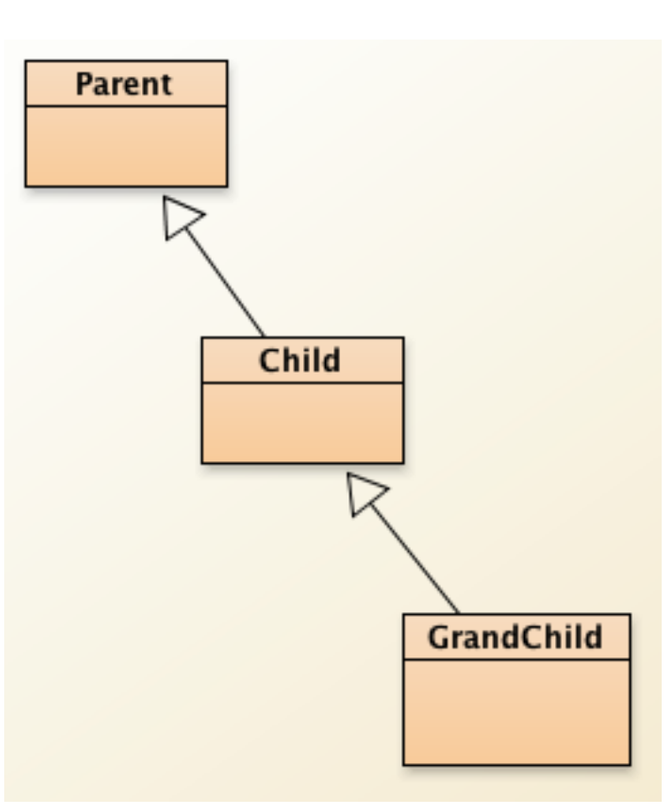
```
public class TurningTurtle
        extends Turtle {

    private double myTurnSpeed;

    // override method

    public void move(int dist)  {

            // move forward
            // while turning

    }

}
```

Example


Turtle
myPos
getPos()
move()
ColourTurtle
Turtle
myPos
getPos()
move()
myColour
getColour()
TurningTurtle
Turtle
myPos
getPos()
move()
myTurnSpeed
move()

Calling methods

When you call a method on a derived class Java searches up the inheritance hierarchy until it finds a class that implements it.



Example

```
ColouredTurtle ct =
    new ColouredTurtle();

ct.getColour();
// on ColouredTurtle

ct.move(100);
// on Turtle
```

Example

```
TurningTurtle tt =
    new TurningTurtle();

tt.getPos();
// on Turtle

tt.move(100);
// on TurningTurtle
```

super

A method on a subclass can use the keyword `super` to refer to its parent class.

```
public class TurningTurtle
        extends Turtle {

  public void move(int dist)  {

      // move forward

      super.move();
      // while turning
```

```
public class TurningTurtle
        extends Turtle {

   public void move(int dist) {

      // call parent
      // to move forward

         super.move();

         // now turn...

         myAngle += turnSpeed;
   }
}
```

Constructors

When we constructor a derived class we must first construct its parent.

We use the notation:

```
super()
```

Or if the super-constructor has parameters:

```
super(value1, value2, ...)
```

The super-constructor must always come first.

Constructor

```
public class Turtle {
    private Point myPos;
    public Turtle() {
        myPos = new Point(0,0);
    }
}
```

Constructors

```
public class ColourTurtle {
    private Color myColour;
    public ColourTurtle(
                Color colour) {
        super(); // call parent's
                 // constructor first
        myColour = colour;
    }
}
```

Abstract

Sometimes several classes are based on the same parent, but the parent is incomplete or does not make sense as a usable object on its own.

In these cases it is appropriate to make the parent class abstract.

```
public abstract class
                    AbstractCard {

 public boolean canPlayOn(Card c) {

    return mySymbol == c.getSymbol()
        || myColour == c.getColour();
  }
  // method not implemented:
  abstract public void play(Game g);
}
```

Abstract classes

An abstract class cannot be instantiated. It only exists to provide a base for other classes:

```
AbstractCard card =
   new AbstractCard(
      'X', Card.COLOUR_BLUE);

// ERROR!
```

Advantages

The advantages of inheritance:

abstraction: common code is chunked

encapsulation:

parent code is hidden from children

extendability:

extra features can be added to classes

polymorphism:

child classes all inherit the same interface