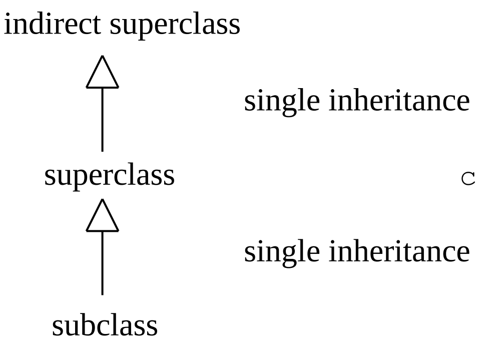
Interface

OO Programming involves encapsulation/data hiding, inheritance, and polymorphism

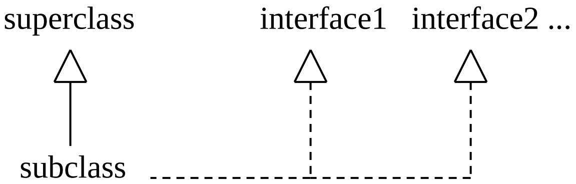
- *inheritance*
    - classes are created from existing classes (**extends** keyword)
        - implicit **extends Object** in the absence of an explicit extends
    - inherit attributes and behaviors of an existing class (superclass)
        - superclass should provide functionality useful in many subclasses
    - embellish these with new/different capabilities in new classes (subclass)
    - *inheritance of interface* (**implements**) / *inheritance of implementation* (**extends**)
    - *is-a* relationship

Java does not support multiple inheritance of implementation (only <u>single inheritance of implementation</u>)



```
class Indirect_Superclass
class Superclass extends Indirect_Superclass
class Subclass extends Superclass
```

- Java does support multiple <u>inheritance of *interfaces*</u>
    - achieves many of the advantages of multiple inheritance without the associated problems
    - pure *inheritance of interface*



```
class Subclass extends Superclass
               implements Interface1, Interface2
```

Every object of a subclass type *is* also *an* object of that subclass's superclass type (**interface** types also)

- "subclass-object-*is-a*-superclass-object" relationship
    - contrast with *composition* — *has-a* relationship

- converse is not true — superclass objects are not objects of that superclass's subclasses
- superclass members become members of the subclass

Interface

Java allows a variable of an `interface` type to refer to several different types of objects that implement the interface (one form of *polymorphism*; *inheritance of interface*)

Java interface provides a description of the public methods that objects of that type need to provide
- describes the type's public interface (what)
- specifies a contract that any class that implements the interface must satisfy (how)

Interfaces contain no method definitions, no constructors, and no instance variables (no state) [pre-Java SE 8]
- may contain `public static final` constants
- these constants become part of any class that implements the interface

Classes may implement multiple interfaces
- multiple *inheritance of interface*

```
public class Circle implements Resizable, Movable, Colorable
```

A polymorphic method can take arguments of different types through the use of interfaces

```
public Resizable getInShape( Resizable shape ) { ... }
```

Extending Interfaces

```
public interface SubInterface extends SuperInterface1, SuperInterface2
```

Java SE 8 Interface Enhancements

`default` interface methods - default implementation if the implementing class does not provide an overriding implementation
- keyword `default` instead of `abstract`

```
public default void superSizeMe( double size ) { /* default code */ }
```

- allows you to evolve existing interfaces by adding new methods to old interfaces without breaking code that uses them
- arguably more flexible than abstract classes (more on this later)

`static` interface methods - static helper methods for working with objects that implement the interface
- static methods belong to the interface type, not the implementing type
  - different than public static final constants defined in an interface

Beware: Some (many/most?) OOP purists think static interface methods (and to a lesser extent default interface methods) are an abomination

Program to an Interface, Not an Implementation
- Implementation inheritance (extends) is best for small numbers of tightly coupled classes
- Interface inheritance (implements) is best for flexibility

```
public interface OperateCar {
  // constant declarations, if any
  public static final int numWheels = 4;

  // method signatures. Can omit public abstract
  public abstract moveForward(double speed);
  int turn(Direction direction, double radius, double startSpeed, double endSpeed);
  int changeLanes(Direction direction, double startSpeed, double endSpeed);
  int signalTurn(Direction direction, boolean signalOn);
  int getRadarFront(double distanceToCar, double speedOfCar);

  //default method.
  default int getRadarRear(double distanceToCar, double speedOfCar){
    return distanceToCar / speedOfCar;
  }
         ......
   // more method signatures or default methods
}
```

By default, all interface method headers are `public` and `abstract`

An interface provides only the method headers (not the bodies) – name, parameters, return type – followed by `;`

- classes that implement an interface are required to provide the method bodies for all these headers

Associate an interface with a class with the `implements` clause in the class header.

```
public class OperateBMW760i implements OperateCar {

    // the OperateCar method signatures, with implementation --
    // for example:
    int signalTurn(Direction direction, boolean signalOn) {
       // code to turn BMW's LEFT turn indicator lights on
       // code to turn BMW's LEFT turn indicator lights off
       // code to turn BMW's RIGHT turn indicator lights on
       // code to turn BMW's RIGHT turn indicator lights off
    }

    // other members, as needed -- for example, helper classes not
    // visible to clients of the interface
}
```

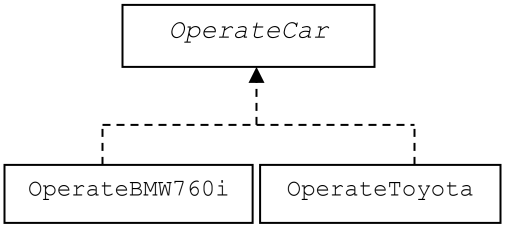
What if we did not provide method bodies (implementations) for every method header in the interface?

In some other class we can say:

```
  private OperateCar driver;
  private OperateToyota ref1 = new OperateToyota( ... );
  private OperateBMW760i ref2 = new OperateBMW760i( ... );

  driver = ref1;   // or driver = new OperateToyota( ... );
  shape.signalTurn(Direction.LEFT, true );

  driver = ref2;  // or driver = new OperateBMW760i( ... );
  shape.signalTurn(Direction.LEFT, true );
```



Type Hierarchy

A variable or parameter or return value whose type is an interface may reference objects from any class that implements that interface

Static Compile Time Method Invocation Check

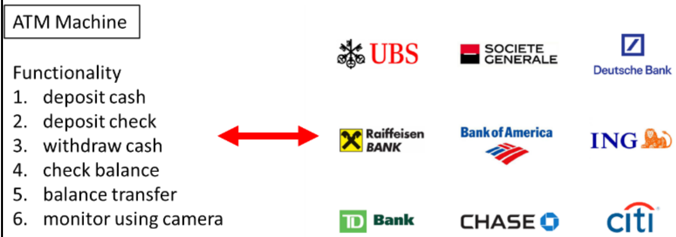
- the only thing the compiler knows when looking at your program is the type of the reference
- compiler emits code to call the method with the signature it finds in that type at compile time
    - possible argument coercion to match method signature if no exact match

```
ref.method( … );
```

Dynamic Run Time Method Invocation

- which method code is executed at run time is determined by which object the message is being sent to
- could be either a `OperateToyota` object or a `OperateBMW760i` object or any object that implements `OperateCar`
- can only send a message to an object through an interface type if the message is part of the interface

Exercise: Design a system such that all the ATMs from these banks will work with some sort uniform functionality.



ATM Machine

Functionality

1. deposit cash
2. deposit check
3. withdraw cash
4. check balance
5. balance transfer
6. monitor using camera