Inheritance -- Introduction

- Another fundamental object-oriented technique is called inheritance, which, when used correctly, supports reuse and enhances software designs

- Chapter 8 focuses on:

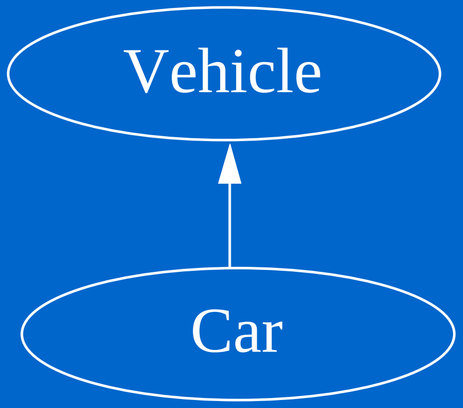
  - the concept of inheritance
  - inheritance in Java
  - the `protected` modifier
  - adding and modifying methods through inheritance
  - creating class hierarchies

Inheritance

- *Inheritance* allows a software developer to derive a new class from an existing one
- The existing class is called the *parent class*, or *superclass*, or *base class*
- The derived class is called the *child class* or *subclass*.
- As the name implies, the child inherits characteristics of the parent
- In programming, the child class inherits the methods and data defined for the parent class

Inheritance

- Inheritance relationships are often shown graphically, with the arrow pointing to the parent class:



- Inheritance should create an *is-a relationship*, meaning the child is-a more specific version of the parent

Deriving Subclasses

- In Java, the reserved word `extends` is used to establish an inheritance relationship

```
class Car extends Vehicle {
   // class contents
}
```

- See `Words.java`

The `protected` Modifier

- The visibility modifiers determine which class members get inherited and which do not
- Variables and methods declared with `public` visibility are inherited, and those with `private` visibility are not
- But `public` variables violate our goal of encapsulation
- The `protected` visibility modifier allows a member to be inherited, but provides more protection than `public` does
- The details of each modifier are given in Appendix F

The `super` Reference

- Constructors are not inherited, even though they have public visibility
- Yet we often want to use the parent's constructor to set up the "parent's part" of the object
- The `super` reference can be used to refer to the parent class, and is often used to invoke the parent's constructor
- See `Words2.java`

Defined vs. Inherited

- A subtle feature of inheritance is the fact that even if a method or variable is not inherited by a child, it is still *defined* for that child
- An inherited member can be referenced directly in the child class, as if it were declared in the child class
- But even members that are not inherited exist for the child, and can be referenced indirectly through parent methods
- See `Eating.java` and `School.java`

Overriding Methods

- A child class can *override* the definition of an inherited method in favor of its own
- That is, a child can redefine a method it inherits from its parent
- The new method must have the same signature as the parent's method, but can have different code in the body
- The object type determines which method is invoked
- See `Messages.java`

Overloading vs. Overriding

- Don't confuse the concepts of overloading and overriding
- Overloading deals with multiple methods in the same class with the same name but different signatures
- Overriding deals with two methods, one in a parent class and one in a child class, that have the same signature
- Overloading lets you define a similar operation in different ways for different data
- Overriding lets you define a similar operation in different ways for different object types

The `super` Reference Revisited

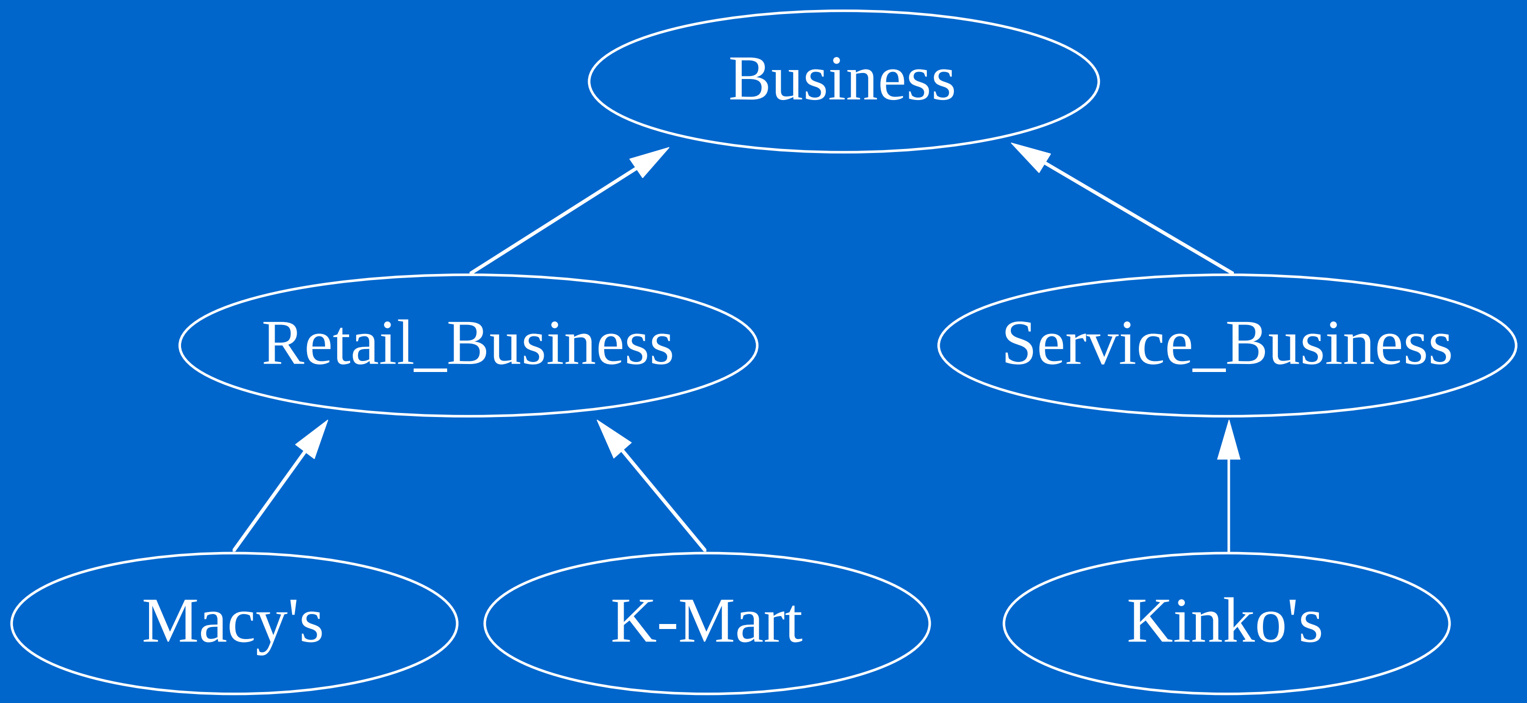
- The `super` reference can be used to invoke any method from the parent class
- This ability is often helpful when using overridden methods
- The syntax is:

```
super.method(parameters)
```

- See `Firm.java` and `Accounts.java`

Class Hierarchies

- A child class of one parent can be the parent of another child, forming *class hierarchies*:



Class Hierarchies

- Two children of the same parent are called *siblings*
- Good class design puts all common features as high in the hierarchy as is reasonable
- Class hierarchies often have to be extended and modified to keep up with changing needs
- There is no single class hierarchy that is appropriate for all situations
- See `Accounts2.java`

The `Object` Class

- All objects are derived from the `Object` class
- If a class is not explicitly defined to be the child of an existing class, it is assumed to be the child of the `Object` class
- The `Object` class is therefore the ultimate root of all class hierarchies
- The `Object` class contains a few useful methods, such as `toString()`, which are inherited by all classes
- See `Test_toString.java`

References and Inheritance

- An object reference can refer to an object of its class, or to an object of any class related to it by inheritance
- For example, if the `Holiday` class is used to derive a child class called `Christmas`, then a `Holiday` reference could actually be used to point to a `Christmas` object:

```
Holiday day;
day = new Christmas();
```

References and Inheritance

- Assigning a predecessor object to an ancestor reference is considered to be a widening conversion, and can be performed by simple assignment
- Assigning an ancestor object to a predecessor reference can also be done, but it is considered to be a narrowing conversion and must be done with a cast
- The widening conversion is the most useful

Polymorphism

- A *polymorphic reference* is one which can refer to one of several possible methods
- Suppose the `Holiday` class has a method called `celebrate`, and the `Christmas` class overrode it
- Now consider the following invocation:

```
day.celebrate();
```

- If `day` refers to a `Holiday` object, it invokes `Holiday`'s version of `celebrate`; if it refers to a `Christmas` object, it invokes that version

Polymorphism

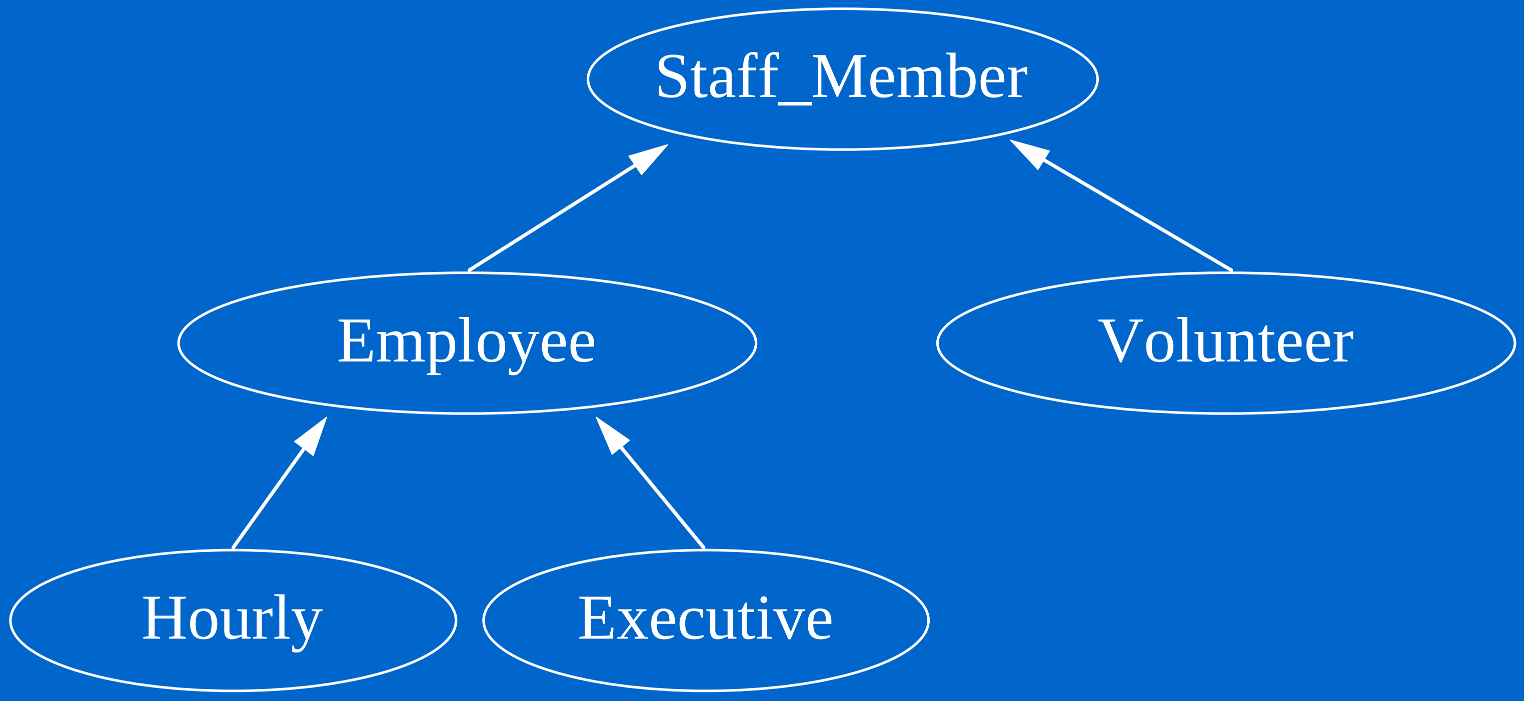
- In general, it is the type of the object being referenced, not the reference type, that determines which method is invoked
- See `Messages2.java`
- Note that, if an invocation is in a loop, the exact same line of code could execute different methods at different times
- Polymorphic references are therefore resolved at run-time, not during compilation

Polymorphism

- Note that, because all classes inherit from the `Object` class, an `Object` reference can refer to any type of object
- A `Vector` is designed to store `Object` references
- The `instanceOf` operator can be used to determine the class from which an object was created
- See `Variety.java`

Polymorphism

- See `Firm2.java`


Staff_Member
Employee
Volunteer
Hourly
Executive