



Object Oriented Principles

Objectives

After completing this lesson, you should be able to do the following:

- Define objects and explain how they are used
- Associate objects so that they can communicate and interact via messages
- Define classes and explain how they are used
- Describe object-oriented principles: classes, objects, and methods
- Describe the value of reusable software components
- Examine the object-oriented model that is used in this course



Examining Object Orientation

OO concepts affect the whole development process:

- Humans think in terms of nouns (objects) and verbs (behaviors of objects).
- With OOSD, both problem and solution domains are modeled using OO concepts.
- The *Unified Modeling Language (UML)* is a *de facto* standard for modeling OO software.
- OO languages bring the implementation closer to the language of mental models. The UML is a good bridge between mental models and implementation.

Examining Object Orientation

“Software systems perform certain actions on objects of certain types; to obtain flexible and reusable systems, it is better to base their structure on the objects types than on the actions.”

OO concepts affect the following issues:

- Software complexity
- Software decomposition
- Software costs

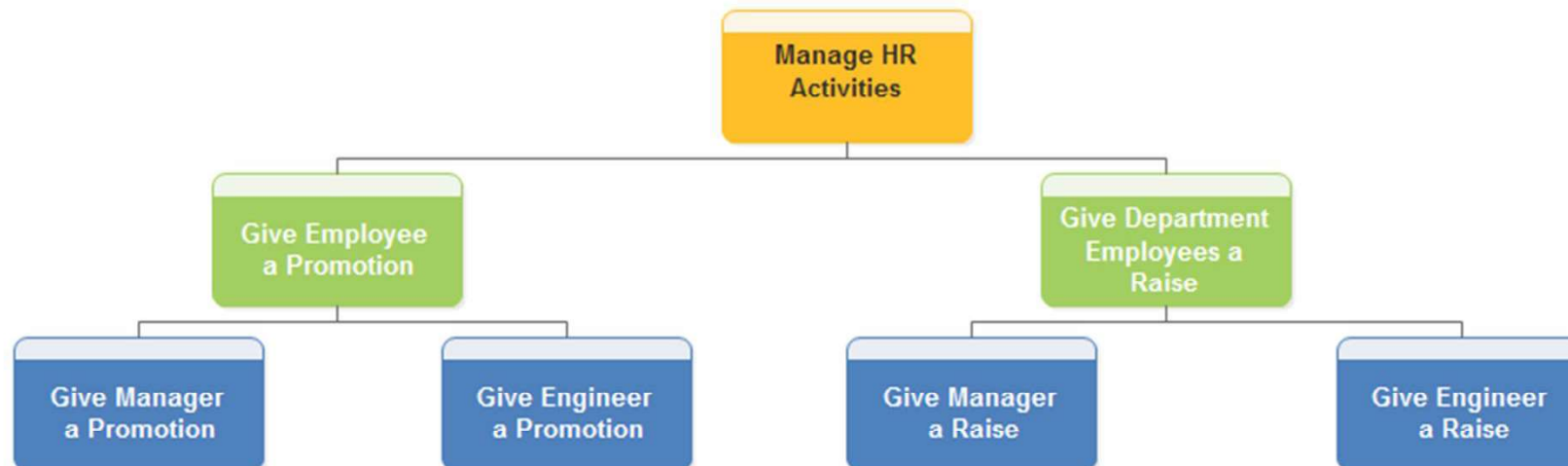
Software Complexity

Complex systems have the following characteristics:

- They have a *hierarchical structure*.
- The choice of *which components are primitive in the system* is arbitrary.
- A system can be split by intra- and inter-component relationships. This *separation of concerns enables you to study each part in relative isolation*.
- Complex systems are usually composed of only a *few types of components in various combinations*.
- A successful, complex system invariably *evolves from a simple working system*.

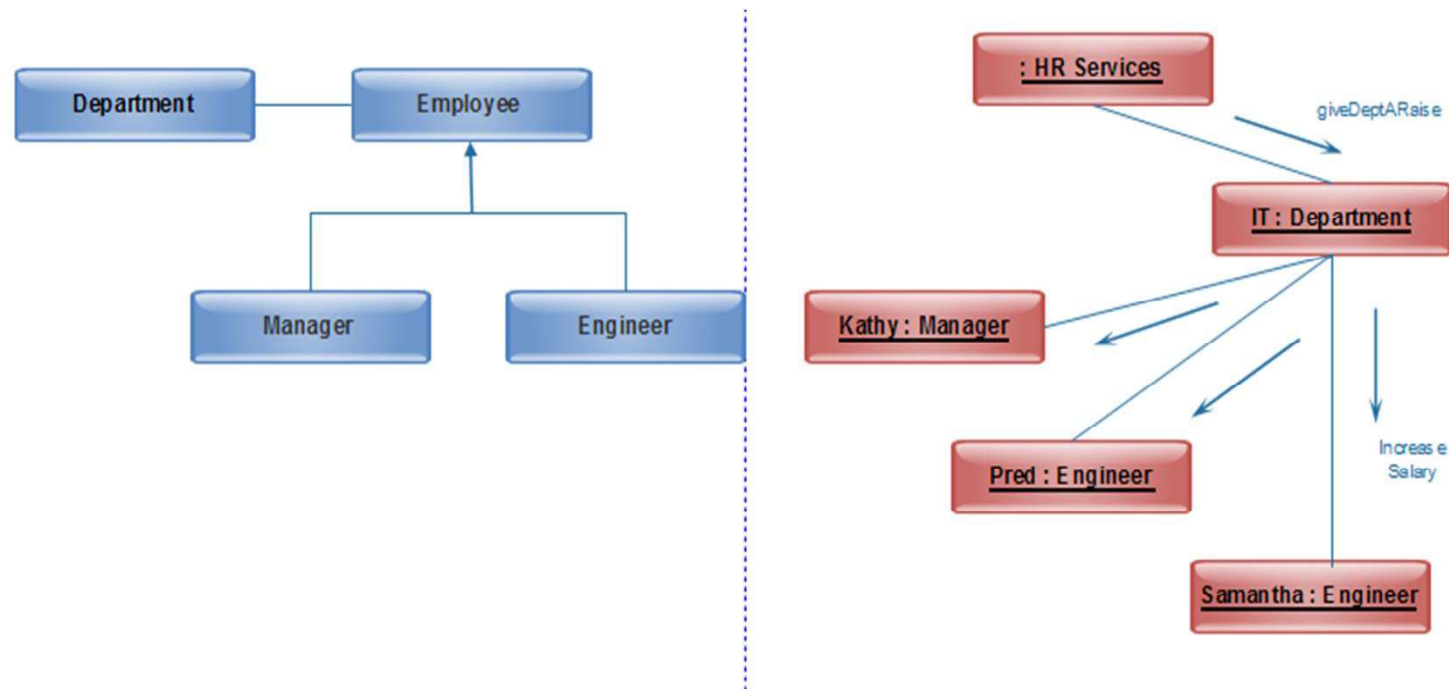
Software Decomposition

- In the Procedural paradigm, software is decomposed into a hierarchy of procedures or tasks.



Software Decomposition

- In the OO paradigm, software is decomposed into a hierarchy of interacting components (usually objects).



Software Costs

Development:

- OO principles provide a natural technique for modeling business entities and processes from the early stages of a project.
- OO-modeled business entities and processes are easier to implement in an OO language.

Maintenance:

- Changeability, flexibility, and adaptability of software is important to keep software running for a long time.
- OO-modeled business entities and processes can be adapted to new functional requirements.

Comparing the Procedural and OO

	Procedural Paradigm	OO Paradigm
Organizational structure	<p>Focuses on hierarchy of procedures and subprocedures</p> <p>Data is separate from procedures</p>	<p>Network of collaborating objects</p> <p>Methods (processes) are often bound together with the state (data) of the object</p>
Protection against modification or access	Data is difficult to protect against inappropriate modifications or access when it is passed to or referenced by many different procedures.	The data and internal methods of objects can be protected against inappropriate modifications or access by using encapsulation.

	Procedural Paradigm	OO Paradigm
Ability to modify software	Can be expensive and difficult to make software that is easy to change, resulting in many “Brittle” systems	Robust software that is easy to change, if written using good OO principles and patterns
Reuse	Reuse of methods is often achieved by copy-and-paste or 1001 parameters.	Reuse of code by using generic components (one or more objects) with well-defined interfaces. This is achieved by extension of classes (or interfaces) or by composition of objects.

	Procedural Paradigm	OO Paradigm
Configuration of special cases	Often requires if or switch statements. Modification is risky because it often requires altering existing code. So, modifications must be done with extreme care apart from requiring extensive regression testing. These factors make even minor changes costly to implement.	Polymorphic behavior can facilitate the possibility of modifications being primarily additive, subtractive, or substitution of whole components (one or more objects); thereby, reducing the associated risks and costs.

- Models perform the following functions:
 - Describe exactly what a situation needs
 - Facilitate discussion
 - Prevent mistakes
- Modeling and implementation are treated separately.
- Before coding can begin, the model must be correct.

Classes and Objects

- A class:
 - Models an abstraction of objects
 - Defines the attributes and behaviors of objects
 - Is the blueprint that defines an object
- An object:
 - Is stamped from the class mold
 - Is a single instance of a class
 - Retains the structure and behavior of a class

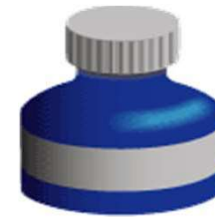


An Object's Attributes Maintain Its State

- Objects have knowledge about their current state.
- Each piece of knowledge is called an *attribute*.
 - The values of attributes dictate an object's state.



Object: My blue pen



Attribute: Ink amount



Object: Acme Bank ATM



Attribute: Cash available

Objects Have Behavior

- An object exists to provide behavior (functionality) to the system.
- Each distinct behavior is called an *operation*.



Object: My blue pen



Operation: Write



Object: Acme Bank ATM



Operation: Withdraw

Objects Are Modeled As Abstractions

- A Java object is modeled as an abstract representation of a real-world object.
- Model only those attributes and operations that are relevant to the context of the problem.

Problem domain: Product catalog

Real-world attributes and operations that you may want to model:

- **Attributes: Model, manufacturer, price**
- **Operations: Change price**



Real-world attributes and operations that you may *not* want to model:

- **Attributes: Ink color**
- **Operations: Refill, change color, point, write**

Defining Object Aggregation:

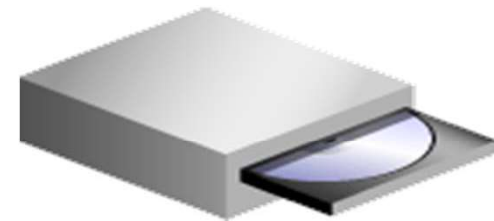
- Objects can be composed of other objects.
- Objects can be part of other objects.
- This relationship between objects is known as *aggregation*.
- Strong aggregation is called *composite aggregation*.



A PC may be an object.

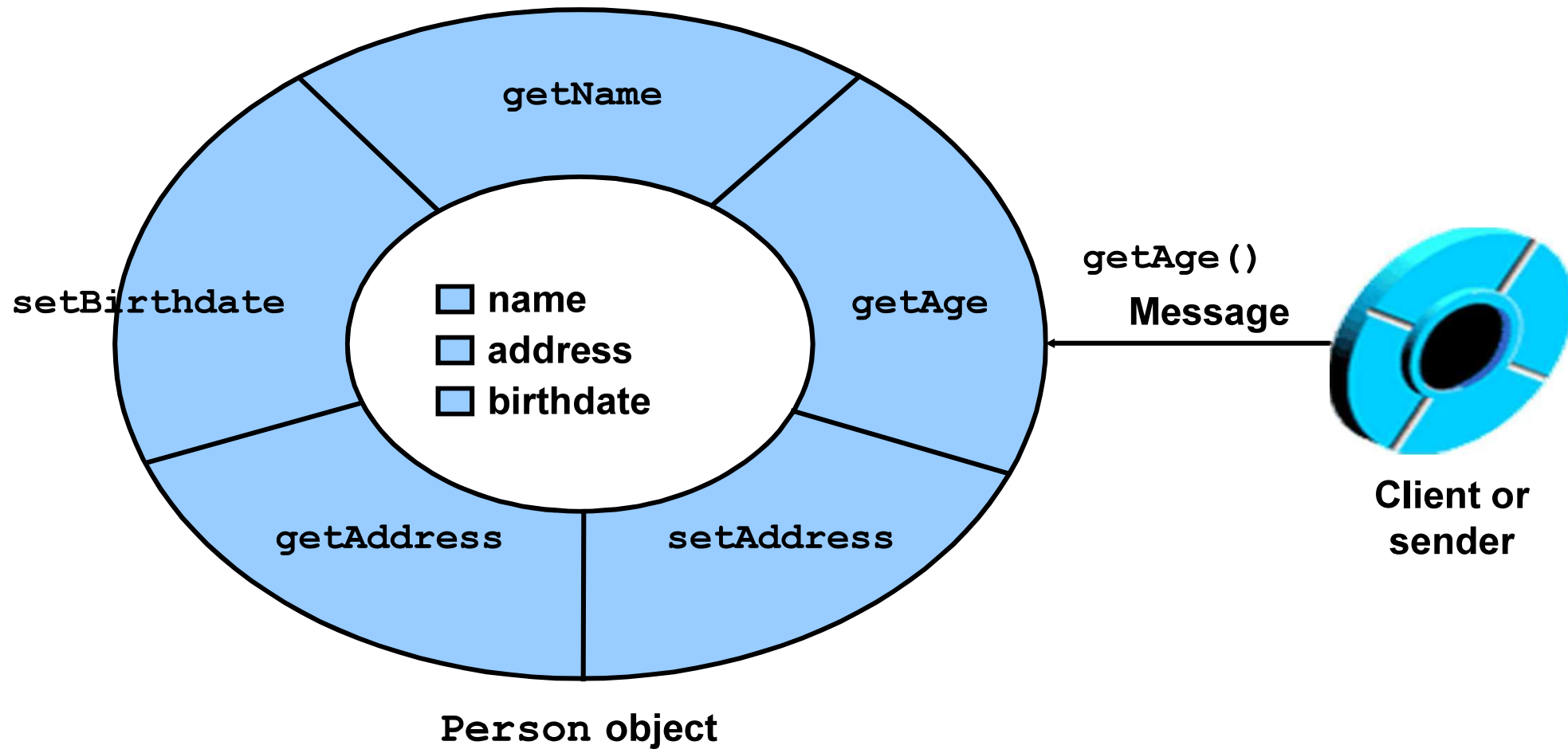


A PC may have a keyboard, mouse, and network card, all of which may be objects.

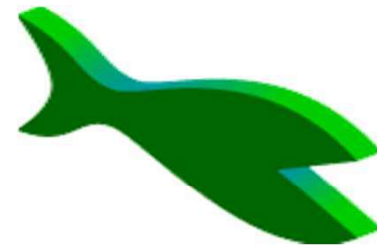


A PC may have a CD drive, which may be an object.

Donut Diagram



Guided Practice:



Collaborating Objects

Collaborating objects work together to complete a task and form the basis of an application system.

- All methods are defined in a class and are not defined globally as in traditional languages.
- All objects are created from classes and contain all the attributes and methods of their class.
- Objects must associate with each other to collaborate on common tasks.
- Associated objects communicate by sending messages.

Objects Interact Through Messages

- Objects communicate by sending messages.
- A sending object must be associated with or linked to the receiving object.
- The message sender requests the receiver to perform the operation that is named in the message.
- This communication is similar to calling a procedure:
 - The sender calls a method of the receiver.
 - The receiver executes the called method.
- Calling a method is always in the context of a particular object:
 - `myPen.write()`: Object-oriented programming
 - `write (myPen)`: Traditional structured programming

Classes

- A class is a template for objects.
- A class definition specifies the operations and attributes for all instances of that class.
- A class is used to manage complexity.



When you create *my blue pen*, you do not have to specify its operations or attributes. You simply say what class it belongs to.

Identifying a Class

- Identify the common behavior and structure for a group of objects.
- Recognize a single coherent concept.
- Caution: A common misconception is the use of the words *classes* and *objects* interchangeably. Classes *define* objects.



My blue pen

ops: write, refill
attrs: ink amount, color of ink



Your blue pen

ops: write, refill
attrs: ink amount

Comparing Classes and Objects

- A class is a static definition that you can use to understand all the objects of that class.
- Objects are the dynamic entities that exist in the real world and your simulation of it.
- Caution: In object-oriented programming, people almost always use the words *classes* and *objects* interchangeably. You must understand the context to differentiate between the two terms.

Data Encapsulation / Data Hiding / Data Abstraction

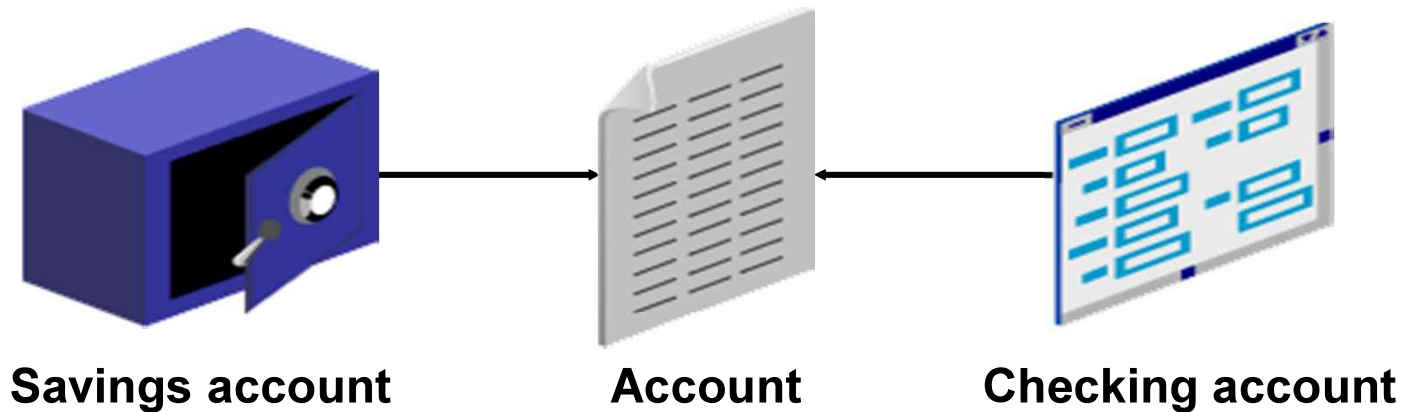
Encapsulation hides the internal structure and operations of an object behind an interface.

- A bank ATM is an object that gives its users cash.
 - The ATM hides (encapsulates) the actual operation of withdrawal from the user.
 - The interface (way to operate the ATM) is provided by the keyboard functions, screen, cash dispenser, and so on.
 - Bypassing encapsulation is bank robbery.
- Bypassing encapsulation in object-oriented programming is impossible.



Inheritance

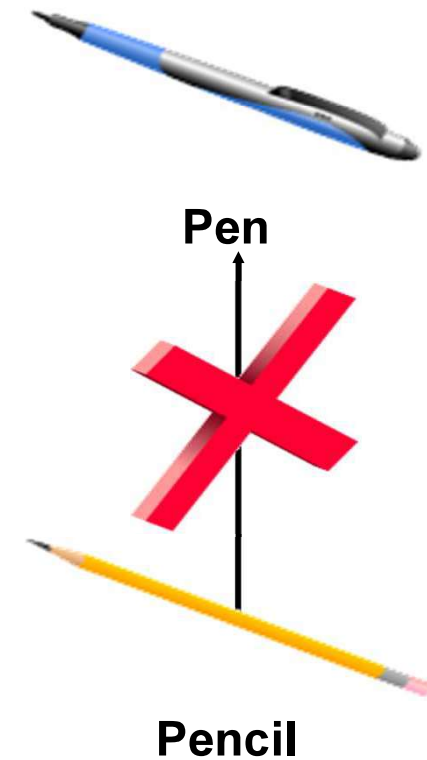
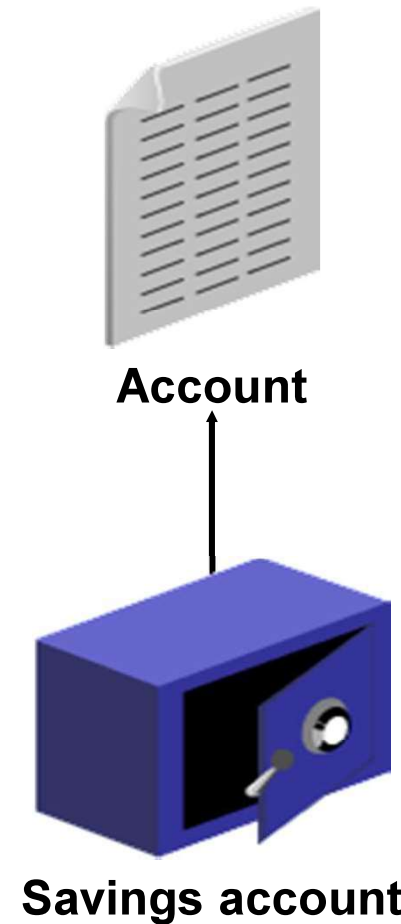
- There may be a commonality between different classes.
- Define the common properties in a superclass.



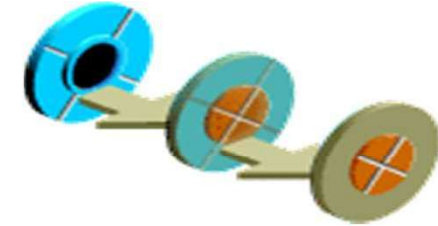
- The subclasses use inheritance to include those properties.

Using the “Is-a-Kind-of” Relationship

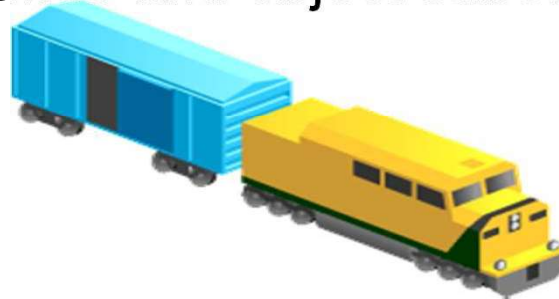
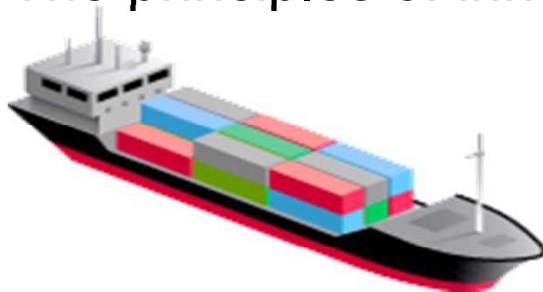
- A subclass object “is-a-kind-of” superclass object.
- All the attributes and behaviors of the superclass must also apply to the subclass.



Polymorphism

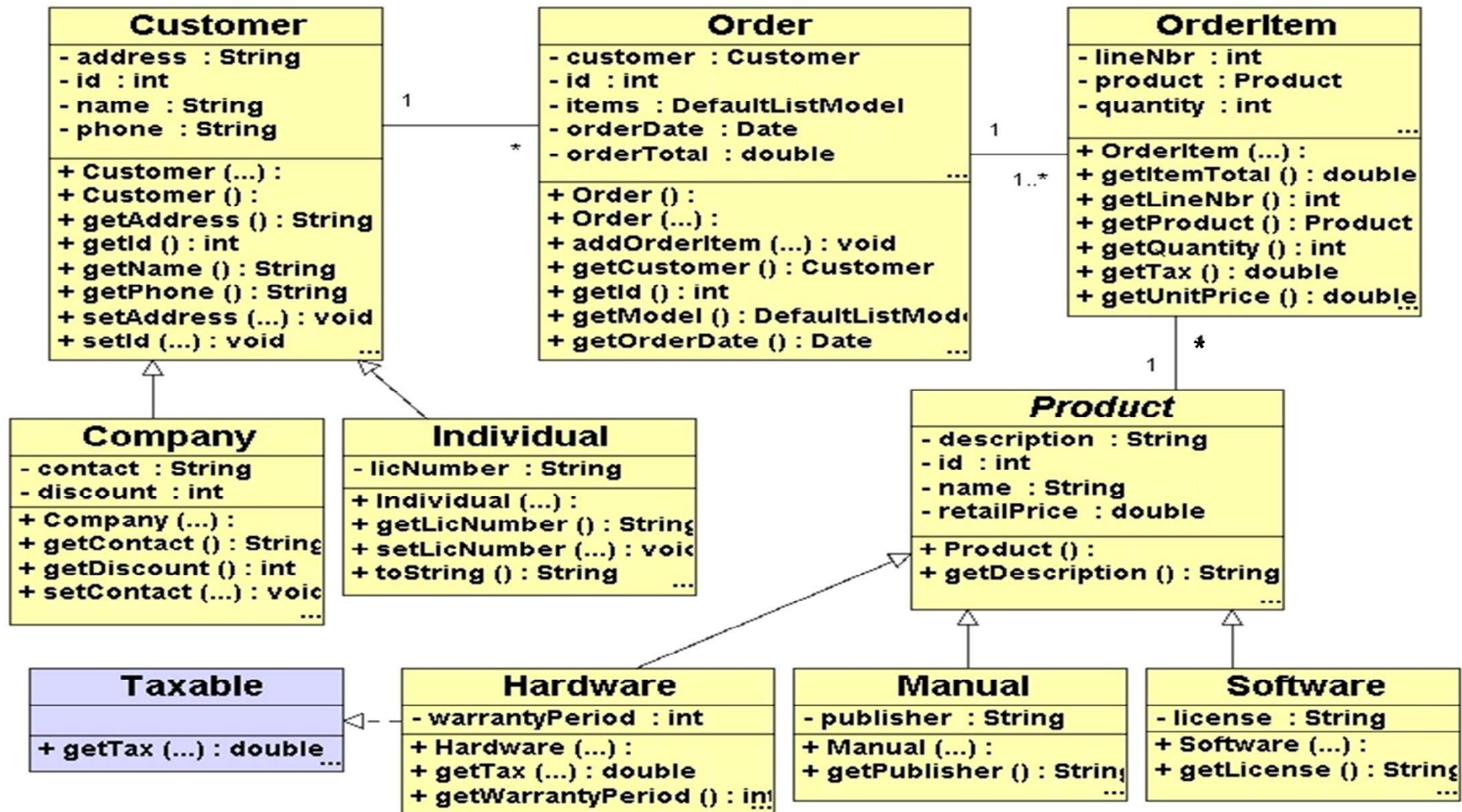


- Polymorphism refers to:
 - Many forms of the same operation
 - The ability to request an operation with the same meaning to different objects. (However, each object implements the operation in a unique way.)
 - The principles of inheritance and object substitution



Load cargo

UML Diagram for OrderEntry



Summary

In this lesson, you should have learned the following:

- An object is an abstraction of a real-world object.
- A class is a template or blueprint for objects.
- Classes form inheritance trees: Operations that are defined in one class are inherited by all subclasses.
- Polymorphism frees the caller from knowing the class of the receiving object.



Practice : Overview

This practice covers the following topics:

- Identifying business objects for the Order Entry system
- Identifying methods for the classes
- Identifying attributes for the classes
- Searching for inheritance in the classes
- Examining the UML class model for the course application

