

Object-Oriented Programming

Lesson 2: Objects and
Classes

Lesson Objectives

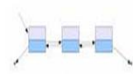
- In this lesson, you will learn:
 - What is an Object?
 - State, Behavior, and Identity of an Object
 - What is a Class?
 - Attributes and Operations of a Class
 - Access modifiers and its types
 - Constructors and Destructors
 - Static members



2.1: Object

What is an Object?

- An object is an entity which could be
 - Tangible
 - Intangible, or
 - Software entity



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What is an Object?

An object in the real-world, can be physical, conceptual, or a software entity. We come across so many objects in the real world. In fact, everything can be considered as an object - a person, a pen, a vehicle, a book, etc. Essentially these are all tangible things that exist, can be felt, or can be destroyed. However, there could be other entities which may not be considered as objects in the real world, like an account or a contract, or a set of business charts, or a linked list since they are “intangible” or “conceptual”. Nevertheless, they also have a well defined structure and behavior, and hence are treated as objects in the software domain.

Examples of tangible entities

Person, Pen, Vehicle

Examples of intangible entities

Account, Contract, Business Charts

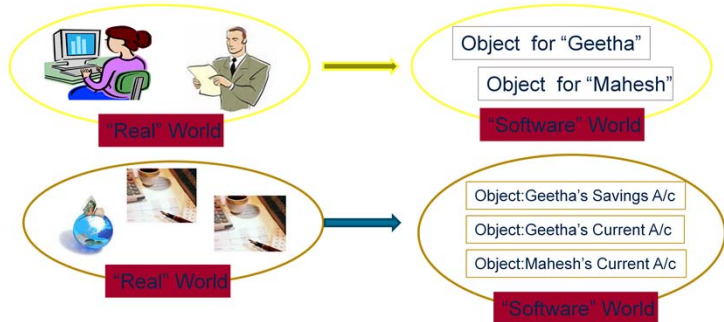
Examples of software entities

Database Management System

2.1: Object

What is an Object?

- Entities from “Real” World would get mapped to Objects in “Software” World



Remember the scenario from Banking System? “Geetha” and “Mahesh” from our example of Banking System are entities in the Real World. These would get mapped into corresponding objects in the software world. So in our OO application, we will have an object corresponding to “Geetha” and another object corresponding to “Mahesh”. Similarly, we would have objects corresponding to Geetha’s Savings Account, Geetha’s Current Account as well as Mahesh’s Current Account.

Typically objects could correspond to following

- Roles played by people interacting with system (Like Geetha and Mahesh who are “Customer” objects)
- Structures used for storing and processing data (Like Account objects for Geetha and Mahesh)
- Other systems or devices interacting with system (Like Utility Payment System that can be accessed from Bank System)
- Events and entities of the system (Like a transaction or a account status report)

2.1: Object

Characterization

- An object is characterized by Identity, State, and Behavior.
- **Identity:** It distinguishes one object from another.
- **State:** It comprises set of properties of an object, along with its values.
- **Behavior:** It is the manner in which an object acts and reacts to requests received from other objects.

Each object is characterized by identity, state, and behavior.

Identity: Two books of same title are still two different books - they are two instances of a “book” which happen to have similar properties, just as there will be two copies if they existed in the library. The identity of one is to be distinguished from the other.

State: It is one of the possible conditions that an object may be in. It is indicated by the set of values that each of its attributes possesses.

For example: An account object may be in an active or suspended state depending on the balance that it possesses.

Behavior: It is what an object does when it receives instructions. For example: Deposit or withdrawal that occurs against an account object.

2.1: Object

Object State

- State of an object is one of the possible conditions in which the object may exist.



Bank Account Modeled as a Software Object

Attributes of the object:

AccountNumber: A10056

Type: Savings

Balance: 40000

Customer Name: Sarita Kale

The state of an object is not defined by a "state" attribute or a set of attributes. Instead the "state" of an object gets defined as a total of all the attributes and links of that object.



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What is an Object? – Object State:

The current state of an object is defined by the set of values of its attributes and the links that the object has with other objects. The current state of an object is said to have changed, if one or more attribute values change. The object remains in control of how the outside world is allowed to use it:

- by assigning a state (e.g., account number, Account type, balance) to itself, and
- by providing methods for changing that state

2.1: Object

Object State

- Behavior of the Object depends on the State of the Object



Withdrawal depends on the State of the Account Object

State where withdrawal is permitted

Attributes of the object:

AccountNumber: A10056

Type: Savings

Balance: **40000**

Customer Name: Sarita Kale

State where withdrawal is NOT permitted

Attributes of the object:

AccountNumber: A10056

Type: Savings

Balance: **500**

Customer Name: Sarita Kale

How many States of an Object should we consider??



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The behaviour of an object in terms of how an object responds, depends on state of object. If the bank has a business rule on the minimum account balance, then an operation such as withdrawal will not be permitted if the balance is less than what is permitted.

At any point, an object will be in a single state. As such, any new combination of attribute values would imply a new state for an object. That means there could be infinitely many states for each object. Should we consider each of these states?? Well No! We only need to consider the object states which will have an impact on the behaviour of the object.

2.1: Object

Object Behavior

- Behavior of an object determines how an object reacts to other objects.

**Behaviors of the object**

- Withdraw
- Deposit
- Get Balance



These are the operations that the object can perform, and represents its behavior.

Through these operations or methods, an object controls its state.

What is an Object? – Object Behavior:

Behavior is what an object does on receiving a set of instructions. Object behavior is represented by the operations that the object can perform.

For example: A Bank ATM object will have operations such as withdraw, print transactions, swipe card, and so on. A bicycle object may have operations such as change gear, change speed, and so on.

2.1: Object

Object Identity

- Two objects can possess identical attributes (state) and yet have distinct identities.



What is an Object? – Object Identity:

Two accounts may possess same attributes like type, balance, etc. Yet these two accounts have separate distinct identities.

One account could be mine, and the other could be yours.

Although objects may share the same state (attributes and relationships), they are separate and independent objects with their own “unique identity”.

2.2: Class

What is a Class?

- A Class characterizes common structure and behavior of a set of objects.
- It constitutes of Attributes and Operations.
- It serves as a template from which objects are created in an application.



| | |
|------------------|--|
| Class name | Customer |
| Class attributes | Name, Address, Email-ID, TelNumber |
| Class operations | displayCustomerDetails() changeContactDetails() |



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What is a Class?

Classes describe objects that share characteristics, methods, relationships, and semantics. Each class has a name, attributes (its values determine state of an object), and operations (which provides the behavior for the object).

What is the relationship between objects and classes?

What exists in real world is objects. When we classify these objects on the basis of commonality of structure and behavior, what we get are classes. Classes are “logical”, they don't really exist in real world. While writing software programs, it is the classes that get defined first. These classes serve as a blueprint from which objects are created.

For example: In the example shown in the slide, there may be thousands of bank customers all having same set of attributes (i.e., Name, Address, Email-ID, TelNumber). Each customer is created from the same set of blueprints, and therefore contains the same attributes. Similarly, there can be thousands of Bank Accounts instantiated from the same “Account” class! In terms of Object-Oriented technology, we say that these customers are all “instances” of the “class of objects” known as Customer. A “class” is the blueprint from which individual “objects” are created.

2.2: Class

What is a Class?

- Watch out for the “Nouns” & “Verbs” in the problem statement
 - Nouns that have well defined structure and behaviour are potential classes
 - Nouns describing the characteristics or properties are potential attributes
 - Verbs describing functions that can be performed are potential operations

Example: Customers can hold different accounts like Savings Accounts and Current Accounts. Each Account has an Account Number and provides information on the balance in the Account. Customers can deposit or withdraw money from their accounts.



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To help identify potential classes, their attributes and their operations, watch out for the nouns and verbs of the problem statement. A Noun having a well defined structure and behaviour, which can be a standalone entity, is a potential class. Nouns which cannot be a stand alone entity but point to properties or characteristics of something could be potential attributes. And finally, verbs describing what could be “done” are potential operations of the class.

In the example here, note that all nouns and verbs are underlined. Potential Classes could be Customer, Account, Savings Account, Current Account. Potential Attributes (of Account Class) could be Account Number and Account Balance. Potential operations (of Account Class) could be deposit and withdraw.

2.2: Class

Lab

- Objects and Classes
 - Labs 1.1 and 1.2



2.2: Class

Class Attribute and Operation

- Each class has a name, attributes, and operations.
 - Attribute is a named property of a class that describes a range of values.
 - Operation is the implementation of a service that can be requested from any object of the class to affect behavior. Operations are invoked by other objects by using "Messages"

| | | |
|------------|------------------|-------------------------------------|
| | Class Name | Account |
| Attributes | Class attributes | AccountNumber, balance |
| Operations | Class operations | withdraw(), getBalance(), deposit() |



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Getting into Details – Class Attribute and Operation:

A class has named properties, which are attributes of the class.

An attribute would be of a specific type. At runtime, an object will have associated values for each of its attributes.

A class can have several operations. An operation is an implementation of a service that can be requested from an object.

When an operation of an object has to be invoked by another object, it passes a "message" to the object. Messages would correspond to the operation name.

2.2: Class

Access Modifiers

- Access Modifiers specify how members of a class will be accessible.
- Three types of Access Modifiers
 - public
 - private
 - protected



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Getting into Details – Access Modifiers:

Access Modifiers specify how members of a class will be accessible. OOP supports the following three types of access modifiers:

Public means accessible to all. An object can access the public variable outside its own class.

Private means accessible only to the own class. An object can access the private variable only in its own class.

Protected means accessible to own class and its subclass. An object can access the protected variable only in its own class or its subclass. Concept of subclass is discussed later.

Information Hiding means hiding all the details of an object that do not contribute to its essential characteristics. To this end, access modifiers help to restrict the accessibility to attributes and operations.

2.2: Class

Accessing Attributes and Operations

- The dot operator along with object name is used for accessing attributes and operations
- Example: `myAccount.displayAccountDetails()`

| | |
|------------------|--|
| Class Name | Account |
| Class attributes | private String AccountNumber private float balance |
| Class operations | public bool withdraw() public void getBalance() public bool deposit (float amount) |



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Getting into Details – Access an attribute or an operation:

To access members, a dot operator is used against the corresponding Account object.

For example: If MyAccount is an object of Account type, to display the details of this object, we would specify `MyAccount.displayAccountDetails()`.

From where an attribute or operation can be accessed depends on the access modifiers. For eg. if the Account Class had a private operation for calculating interest, this operation can only be invoked from within another operation of the same class. Both attributes of the Account Class are private here, which means they are not accessible from outside this class.

2.2: Class

Constructors and Destructors

- Special Member Functions: Constructors & Destructors
- Constructors: Same Name as Class Name
 - They enable instantiation of objects against defined classes.
 - Memory is set aside for the object. Attribute values can be initialized along with object creation (if needed).
 - Constructors could be default or parameterized constructors
- Destructors:
 - They come into play at end of object lifetime. They release memory and other system locks.



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Getting into Details – Constructors and Destructors:

Objects are created using Constructors. The Constructors are special member functions of the class that share the same name as that of the class. When objects are created, memory is set aside for them. The attribute values of objects may be initialized, if needed. A class may have multiple constructors since we may want objects to be created and attributes initiated in various ways. The constructor that takes no parameters is a default constructor, while constructors that take 1 or more parameters are the parameterized constructors.

When objects are no longer needed, Destructors come into play. The most common use of destructors is to de-allocate memory that was allocated for the object by the Constructor. There can be only 1 destructor for a class. The destructor name is same as class name, and preceded with tilde (~) sign. Eg. ~Account().

2.2: Class

Attribute Types

- Every class can have three types of variables or attributes, namely:
 - **Local variables:** Their scope is local to a block of code.
 - **Instance variables:** They comprise all non-static variables in class. Their scope is the entire class.
 - **Class variables:** They comprise of all static variables in the class. (To be discussed later)



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Getting into Details – Attribute Types:

Local variables: These are variables declared within a function, or method, or any block of code, and the arguments passed to a function. They are not accessible outside the block in which they are defined.

Instance variables: These are declared as a part of class. We have seen examples of such variables earlier – AccountNumber, Balance, etc. These are accessible by all the functions written within the class.

Class variables: They are also called Static variables. (This will be covered in detail later) Such variables are useful when all the objects of the same class need to share a common item of information.

2.2: Class

Lab

- Objects and Classes
- Labs 2.1 and 2.2



Summary

- In this Lesson, you have learnt that:
 - Objects have an identity, state, and behavior.
 - Class is a user-defined description of set of objects, sharing same structure and behavior.
 - Access modifiers help to restrict the accessibility.
 - Constructors and Destructors help in memory allocation and de-allocation, respectively

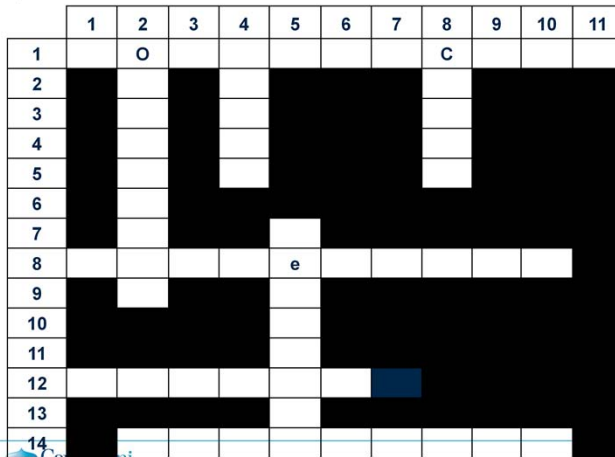


Review Question

- Question 1: ____ determines how an object reacts to other objects.
 - Option 1: State
 - Option 2: Behavior
 - Option 3: Identity
 - Option 4: Attribute
- Question 2: A class can have zero or more number of operations.
 - True / False
- Question 3: ____ variables are accessible by all the functions written within the class.



Review Question: Crossword



Clues. 14 rows (1-14) , 11 Cols (1-11), (Row,Col) Combination

Across:

1-1: Objects attributes can be initialized using this special function (11)

8-1: A contract is a _____ type of an entity (10)

12-1: This data is allocated once and shared among all object instances of the same type(6)

14-2: Named property of a class that describes a range of values. (9)

Below:

1-2: Implementation of a service (9)

1-4: This describes the possible conditions that an object may be in (5)

1-8: Blue print of an object (5)

7-5: Operations the object can perform (8)