Singapore Institute of Management
BSc in Computing & Information Systems
CIS 210 Tutorial 9

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1. Explain why encapsulation, inheritance, and polymorphism are three important characteristics of object-oriented systems.

Solution
Classes provide an encapsulation (information hiding) mechanism by which data (attributes) have their access controlled by a set of operations. When properly implemented this yields systems with low coupling and high modularity. Inheritance provides a mechanism by which changes to higher level classes can be propagated to lower level classes quickly. Polymorphism reduces the effort required to extend an object system by enabling a number of different operations to share the same name.

2. Define the main components of a Booch Class Diagram

Solution
A good answer should include a description of the following (with diagrammatic notation)

- *Association*
    - Defines the relationship between classes
    - The most general form of association is depicted as a solid line between the two associated classes
- *Has*
    - Showing that a class is part of another relationship
    - E.g. class person 'has' a bank account – a bank account is part of the person class
    - Cardinality shows how many occurrence of a specific class can be associated to another class at any time
- *Has by reference*
    - Keeping a class attribute as a separate class
    - Make reference from the originating class to the new class
- *Has by value*
    - Keeping all class attributes as part of the class definition

- *Using*
    - Showing one class using the services of another class
    - Client/server relationship

- *Inheritance*
    - Collecting common characteristics into one class and let other classes inherit from this one class. New classes define only the differences.
    - Showing the hierarchy structure of superclasses & their associated subclasses
    - Also called an is-a relationship
    - A subclass is a specialization of a superclass
    - A superclass is a generalization of a subclass

- *Class entity*
    - Objects with common characteristics belong to a common class
    - A class entity is a template for objects with common characteristics
    - A class is an abstraction
    - Objects belonging to the same class have the same definition for their operations and for their attributes
    - Each class can have infinite set of individual objects

- *Attributes*
    - Attributes describe information that will be hidden in an object
    - Attributes are manipulated by the services of the object

3. Describe the principal features of a State Transition Diagram

Solution

1. *Give a brief definition of STD*

    - A technique for modeling the states in which a system can find itself in
    - Also models the transitions which take the system from one state to another

2. *Give a brief description of the notation used in an STD (E.g Arrows are typically labeled by the input which causes the state transition to occur)*

    - A state is any observable mode of behaviour. Each state represents a mode of behaviour of the system
    - A transition is depicted as an arrow from the initial state to the final state. A transition has an initial state & a final state
    - See notation in study guide on pg 17

3. *Mention how STD is used*

    - STD shows how the system moves from state to state in response to an event
    - Action is the output that occurs as a result of the system's reaction to the event
    - E.g. describe how the various menu options available to a user and the sub-menus to which they pass from each option that is selected

4. Draw a Booch class diagram, which describes the following situation.

"Awesome bank wants to store its customers' and employees' data. The bank provides two types of bank account. A bank account can be either a current account or a deposit account. A current account attracts no interest whilst deposit account attracts interest at a rate determined by the current balance. Each bank account can have up to a maximum of three signatories that are held at a specified branch of Awesome bank. All employees are automatically given Awesome bank accounts at some branch. However, branch managers are not allowed to hold any accounts at the branch which he or she managers. Employees, with exception of managers, may be employed on part-time basis.

Solution

The class diagram for a bank should include the following classes:

- Customer
- Employee (sub-class of customer)
- Part Time Employee (sub-class of employee)
- Full Time Employee (sub-class of employee)
- Manager (sub-class of Full Time employee)
- Account
- Current (sub-class of account)
- Deposit (sub-class of account)
- Branch
- Not manager's branch

The association between Branch and Manager indicates that the manager manages one branch. This cannot be his or her own branch.

The Has association between Branch and Account should show that an account has a single branch (assumption: An account can only have one branch)

The association between customer and account should show that a customer has an unspecified number of accounts and that an account can have up to three customers

All Has associations are Has by reference, because to make them has by value would involve unnecessary replication of data

5. Draw a state transition diagram to illustrate the behaviour of the following vending machine.

   "A vending machine sells drinks for 60 cents. The machine accepts 10 cents and 20c cents coins. The vending machine is able to return change when required. The change is returned in 10 cents coins.

   The machine has a slot for inserting coins. It also has a button. If the button is pressed before sufficient amount is inserted into the machine, 10 cents coins are returned to the user. If the button is pressed after enough money has been inserted into the machine, the user gets a drink and the machine holds on to the balance to be used in a further transaction. If the button is pressed again before sufficient amount is inserted, the user will get back his change in 10 cents coins.

Solution

The following states should be included:

- No credit
- Credit
- Enough money
- Not enough money

The following transitions should be included:

- 10 cents/20 cents entered
- Reject coin
- Button pressed
- Refund user

6. Explain, using your words, how inheritance help in software reuse & maintainability. Depict graphically 2 examples of class inheritance.

Solution

Software reuse - Descendant classes need not repeat the common descriptions implemented in the ancestor

Software Maintainability - If there is a need to change some characteristics of Furniture, we simply perform the change in one place. All descendants will automatically inherit the new definition

Two examples:-

1) Account – Savings Account & Deposit Account
2) Employees – Full Time & Part Time