MODULE 9

OBJECT ORIENTED SYSTEM MODELLING

Learning Units

9.1 Objects and their properties

9.2 Identifying objects in an application

9.3 Modelling systems with object

MOTIVATION

- Information Systems are becoming very complex
- We thus need methods to design complex systems
- Main method is to break up a large system into a number of cooperation components and designing each component or subsystem separately
- Question: How do we do this?
- The main purpose of this module is to answer this question

DESIRABLE PROPERTIES OF COMPONENTS

Each subsystem or component must

- Have clearly defined responsibility
- Acts when requested by an "order"
- How the component does its task need not be known to other components
- What the component does should be known

DESIRABLE PROPERTIES OF COMPONENTS (CONTD)

- Components must be general enough to be reusable

- Variety of components should be reduced-this is facilitated by allowing components to inherit properties of other components

- Another aid to genaralize the function of a component is to allow generic commands which make components do their task

- This is called POLYMORPHISM

OBJECT ORIENTED MODELLING

Use of component oriented design

- Facilitates changes in the system at low cost
- Promotes reuse of components
- Problem of integrating components to configure large system simplified
- Simplifies design of distributed systems

OBJECT AND THEIR PROPERTIES

- All tangible entities in an application can normally be modelled as objects
For example: A student,a cycle,a train ticket

- Some intangible entities may also be modelled as objects
For example: a bank account, stack data structure

- Objects with similar meaning and purpose grouped together as CLASS

- A member of a class is an object instance

CHARACTERSTICS OF OBJECTS

- All objects have attributes

Example : student : Name

Roll no

Address

Year

Department

- All objects have a state

Example Ticket : reserved, waiting list

Student : present, absent

CHARACTERSTICS OF OBJECTS

- All objects have set of OPERATIONS which can be performed on them

Operations determine object behavior

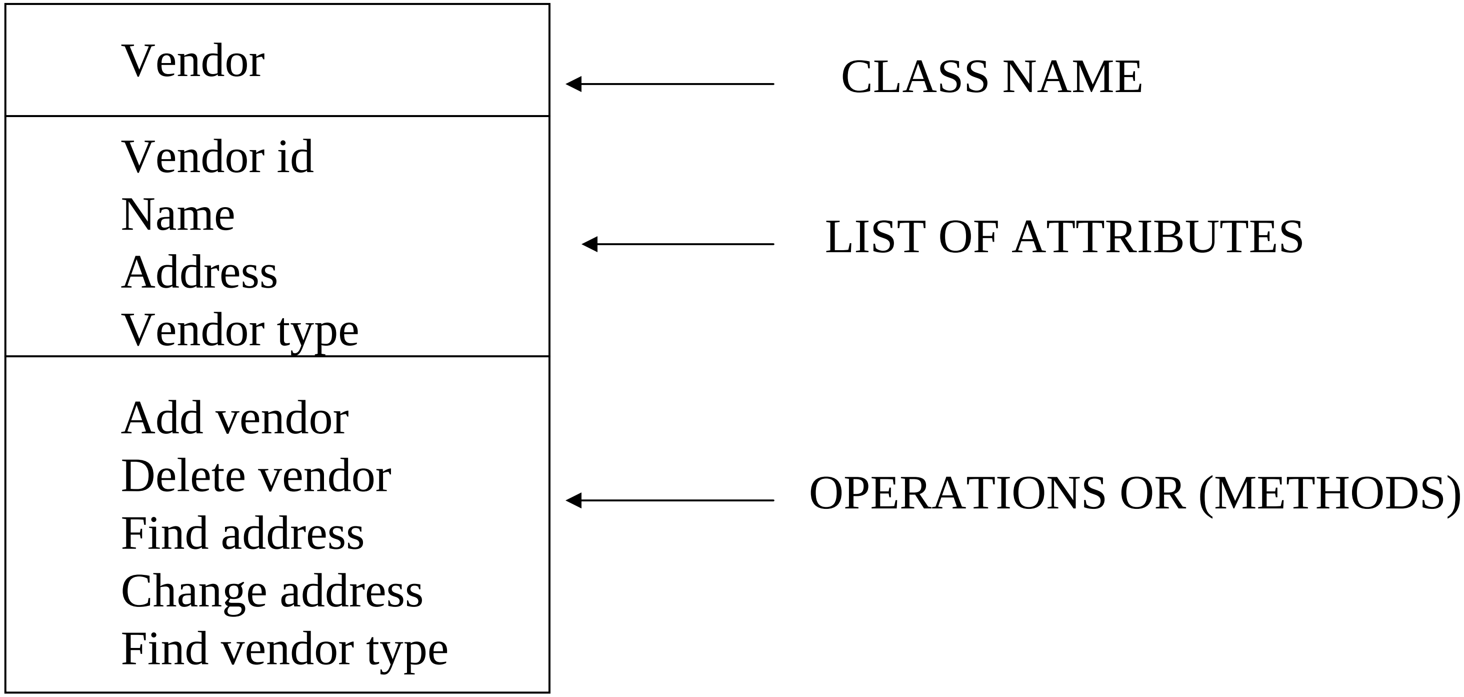
Example : Admit student

Cancel ticket

CLASS DIAGRAM – UML NOTATION

- Universal Modelling Language (UML) is an industry standard notation to represent a class

Example of UML notation for a Class



Vendor

Vendor id
Name
Address
Vendor type

Add vendor
Delete vendor
Find address
Change address
Find vendor type

CLASS NAME

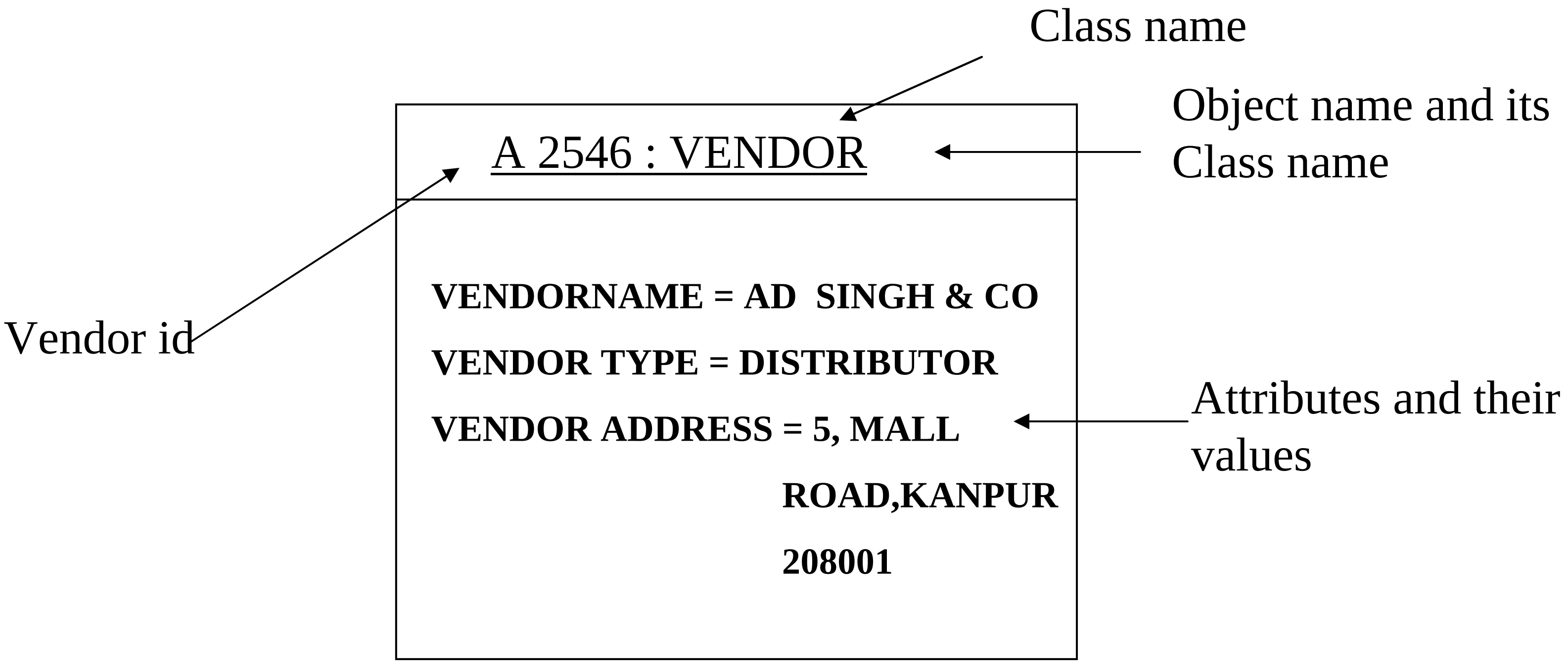
LIST OF ATTRIBUTES

OPERATIONS OR (METHODS)

INSTANCE DIAGRAM – UML NOTATION

- Shows an object instance's attributes and values

EXAMPLE



Class name

Object name and its
Class name

A 2546 : VENDOR

Vendor id

VENDORNAME = AD SINGH & CO

VENDOR TYPE = DISTRIBUTOR

VENDOR ADDRESS = 5, MALL
ROAD,KANPUR
208001

Attributes and their
values

OPERATION TYPES ON OBJECTS

- Constructor-creating new instances of a class

  Deleting existing instance of class

  Example : add new vendor

- Query - accessing state without changing value

  - has no side effects

  Example : find vendor address

OPERATION TYPES ON OBJECTS

- Update - changes value of one or more attributes

  - affect state of object

  - has side effects

  example : change address of vendor

Implementation of operations on objects called methods

IMPLEMENTATION OF CLASSES

TERMINOLOGY USED IN OBJECT ORIENTED MODELLING

- **ABSTRACTION**

  Picking necessary operation and attributes to specify objects

- **ENCAPSULATION**

  Hiding implementation details of methods from outside world

- ENCAPSULATION AlSO KNOWN AS INFORMATION HIDING

- INFORMATION HIDING ALLOWS IMPROVEMENT OR MODIFICATION OF METHODS USED BY OBJECTS WITHOUT AFFECTING OTHER PARTS OF A SYSTEM

VIEW OF OBJECTS AS CONTRACTORS

1) Objects can be thought of contractors who carry out assigned contracts for clients

2) Clients need not know how the contractor carries out its contracts

3) Contractors can modify/improve methods they use to carry out contracts without “informing” clients

4) External interface presented to clients remain same

INHERITANCE

- New classes are created from current classes by using the idea of inheritance

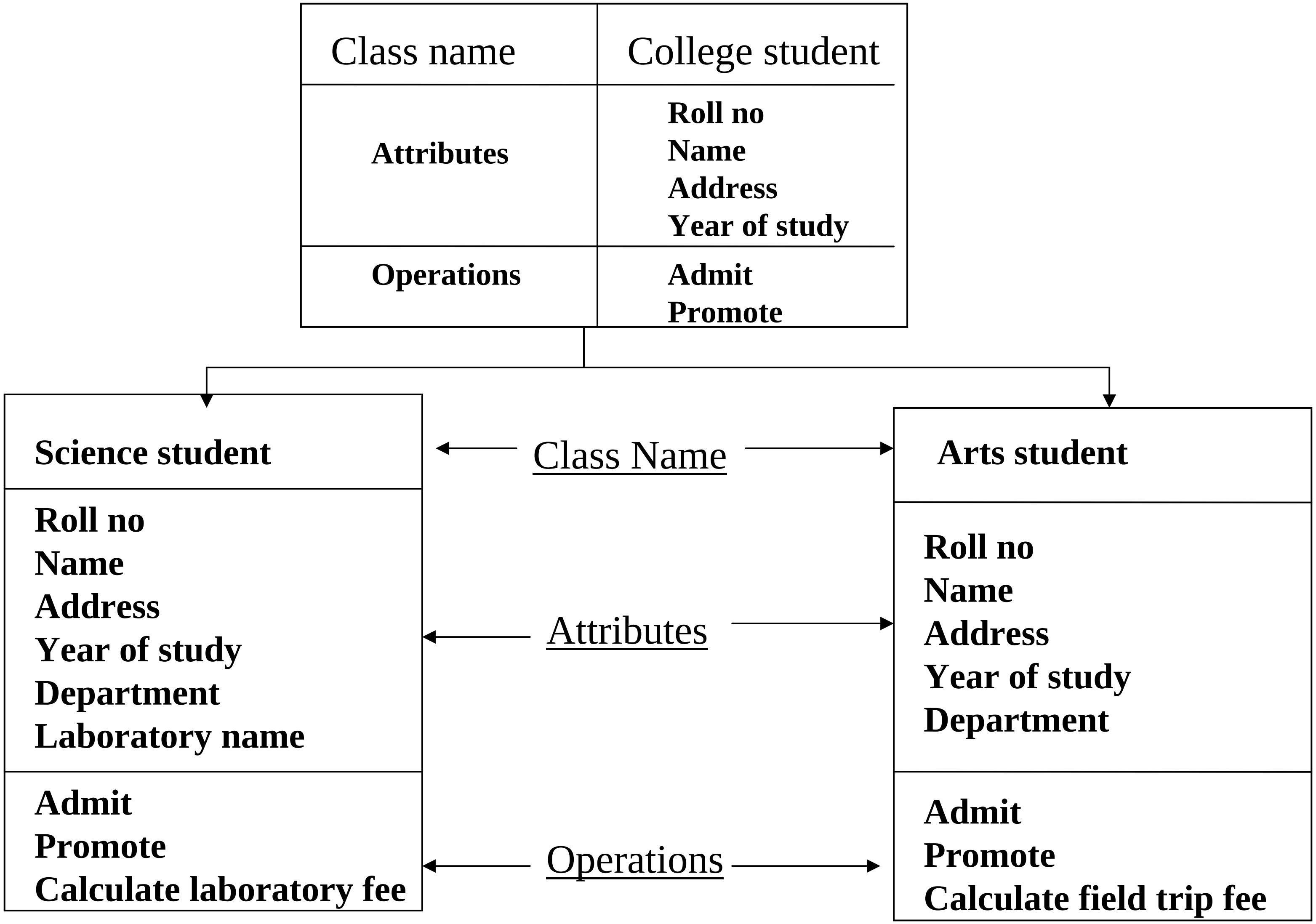
- New classes inherit attributes and/or operations of existing classes

- Inheritance allows both generalisation and specialisation in modelling

- Specialisation - given student class, arts students and science student are two subclasses

    -Subclasses inherit properties of parents and in addition may have their own special attributes and operations

EXAMPLE OF INHERITANCE



Class name	College student
Attributes	**Roll no** **Name** **Address** **Year of study**
Operations	**Admit** **Promote**

Science student

Roll no
Name
Address
Year of study
Department
Laboratory name

Admit
Promote
Calculate laboratory fee

Class Name

Attributes

Operations

Arts student

Roll no
Name
Address
Year of study
Department

Admit
Promote
Calculate field trip fee

GENERALISATION/SPECIALISATION

Given a class Eye surgeon we can generalize it to surgeons which will inherit most of the attributes and operations of the eye surgeon

A general class School, will inherit many properties of middle school, primary school

Given a class Doctor we can obtain subclasses : Surgeon, Physician, General Practitioner, Consulting Doctor.All these will inherit many properties of doctor and will have their own new attributes and operations

POLYMORPHISM

- By polymorphism we mean ability to manipulate objects of different distinct classes knowing only their common properties

- Consider classes hospital & school

For both the operation admit will be meaningful

- they will be interpreted differently by each class

- Advantage of polymorphism is ease of understanding by a client

- A client gives a generic request - each contractor interprets and executes request as appropriate to the circumstances

IDENTIFYING OBJECTS

- Simple method

  - identify nouns in Requirements specification. These are potential objects

  - Identify verbs in requirements specification. These are potential operations

CRITERIA FOR PICKING OBJECTS

1) We remind that an object class has many objects as members

2) Wherever there is no possibility of confusion we use them synonymously

3) Objects should perform assigned services.In other words they must have responsibilities specified by us.

4) Objects must have relevant attributes which are necessary to perform service. Attributes must have Non-Null values.

CRITERIA FOR PICKING OBJECTS

5) A class must be essential for functioning of the system

6) Must have common set of attributes and operations which are necessary for all occurrences of the objects in the class

7) Objects should be independent of implementation of the system.

HOW TO SELECT OBJECTS

1) Potential objects selected from word statement primarily by examining
noun phrases

2) All Noun phrases need not be objects

3) If there are some objects whose attributes do not change during the functioning of
a system we reject them
-They are probably external entities

4) We will illustrate selecting objects using examples

EXAMPLE 1 –WORD STATEMENT

ESSENTIALS OF AN ADMISSION PROCESS TO A UNIVERSITY ARE

- Applicants send applications to a university registrar’s office
- A clerk in the registrar's office scrutinizes applications to see if mark list is enclosed and fee paid
- If scrutiny successful applications passed on to the relevant department

EXAMPLE 1 –WORD STATEMENT

- Departmental committee scrutinizes applications sent to it.Applications are ranked. Depending on the seats available decides to admit, wait list or reject.The application is returned with the message to the registrar’s office clerk.

- Registrar's office clerk informs the applicant the result of his applications

EXAMPLE 1 –IDENTIFICATION OF OBJECTS

POTENTIAL OBJECTS

1. **APPLICANT**
2. **APPLICATION**
3. **REGISTRAR’S OFFICE CLERK**
4. **DEPARTEMENTAL (COMMITTEE)**

- How to select relevant objects?
- Decision based on answers to following questions
- Does it have attributes?
- Are operations performed on the attributes?

EXAMPLE 1 –IDENTIFICATION OF OBJECTS

ANSWERS FOR EXAMPLE 1

1. Applicant has attributes. However no operations performed on it.It is not an object in this problem.
2. Application has attributes operations are performed using attributes of

   application.Result conveyed to applicant.Admit it as an object
3. Registrar’s office clerk has attributes,performs operations on application, attributes and not on clerk’s attributes.Thus reject.
4. Department taken as potential object.It has attributes.Operations are performed using attributes. Operations are performed using attributes of application object and also using attributes of department.Thus admit department as an object

ATTRIBUTES AND OPERATIONS PERFORMED BY IDENTIFIED OBJECTS

CLASS NAME

APPLICATION

ATTRIBUTES

APPLICATION NUMBER
APPLICANT NAME
APPLICANT ADDRESS
MARKS SHEET
FEE PAID RECEIPT
DEPT. APPLIED CODE
APPLN STATUS
CLERK CODE

OPERATIONS

SCRUTINIZE
SEND APPLICATION TO DEPT
SEND RESPONSE
ADMIT/W.L/REJECT TO APPLICANT

CLASS NAME

DEPARTEMENT

ATTRIBUTES

DEPARTMENT CODE
DEPARTMENT NAME
COURSE
NO OF STUDENTS TO BE ADMITTED
NO ON WAIT LIST
MIN. ENTRY QUALIFICATION
STATUS OF APPLICATION

OPERATIONS

SCRUTINIZE APPLICATION
SEND APPLICATION STATUS

EXAMPLE 2 : RECEIVING ITEMS ORDERED

ABSTRACT OF WORD STATEMENTS

- Receiving office receives several items from vendors
- Receiving office checks delivery note against orders and detects excess/deficient deliveries if any
- Discrepancy note (if any) sent to purchase office
- Receiving office sends items received note to inspection office
- Inspection office physically inspects items received and accepts good items.Bad items returned to vendor
- Items accepted note sent to stores office
- Discrepancy note sent to purchase office
- Stores office updates inventory based on items accepted note
- Stores office sends taken into stock report to the accounts office for payment to vendor
- Accounts office sends payments to vendors

Candidate objects underlined

PICKING RELEVANT OBJECTS

POTENTIAL OBJECTS (UNDERLINED IN LAST PPT) ARE:

1. RECEIVING OFFICE 2. ITEMS 3. VENDORS 4. DELIVERY NOTE
5. ORDERS 6. DISCREPANCY NOTE 7. PURCHASE OFFICE
8. ITEMS RECEIVED NOTE 9.INSPECTION OFFICE 10. ACCEPTED ITEMS
NOTE 11. STORES OFFICE 12. INVENTORY 13. GOODS TAKEN IN STOCK
REPORT 14. ACCOUNTS OFFICE 15. PAYMENT VOUCHER

OBJECTS NOT RELEVANT TO THIS APPLICATION

- Items
- Orders
- Inventory
- Goods taken in stock
- Payment voucher

As no operations on these

RELEVANT OBJECTS

- Receiving office – Even though its own attributes are not relevant,its functional attributes are important.These are:

  -Delivery note and order to vendor

It thus derives its attributes from these

RELEVANT OBJECTS

- VENDORS

No operations on this object are needed in this application.However its attributes are necessary as the Accounts office makes payment to vendors

CLASS : VENDORS

ATTRIBUTES :
_Vendor code
Vendor name
Vendor address

VENDOR is actually an external object.We have thus given only attributes relevant to this application.In general design one would usually define this object more comprehensively

ATTRIBUTES OF DELIVERY NOTE AND ORDER TO VENDOR

CLASS : DELIVERY NOTE

Attributes :
Receiving clerk id
Order no
Vendor code
Delivery date
Item code
Qty supplied
Units

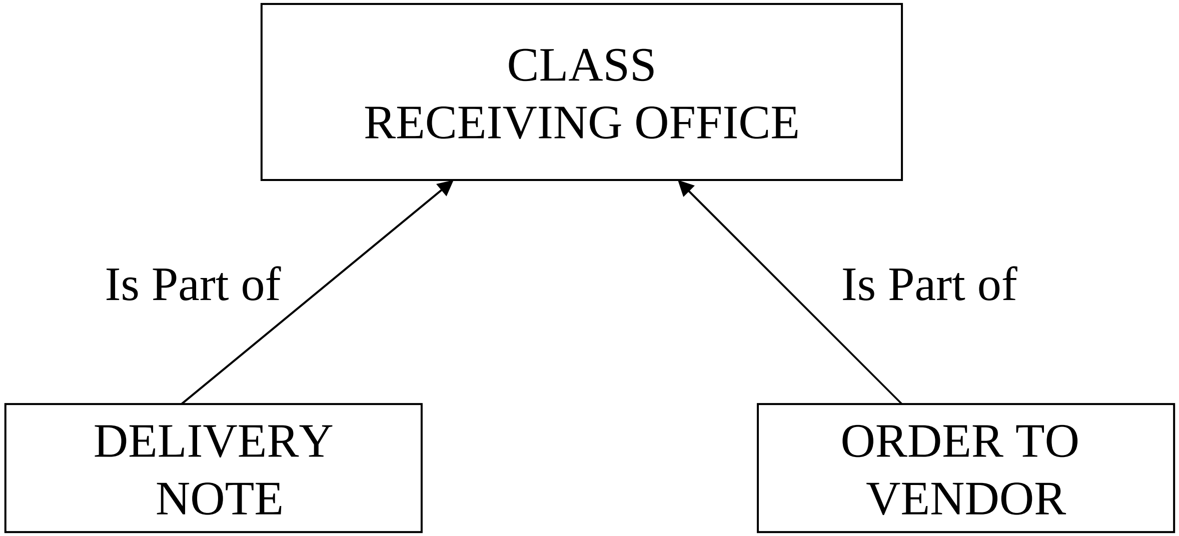
CLASS : ORDER TO VENDOR

Attributes :
Order no
Vendor code
Item code
Item name
Qty ordered
Units
Price/Unit
Order date
Delivery period

RECEIVING OFFICE OBJECT

Receiving office is selected as an object.Its attributes are attributes derived from delivery note and order to vendor

The class diagram is give below



RECEIVING OFFICE OBJECT

CLASS : RECEIVING OFFICE

Attributes : Derived as shown in the previous slide

Operations :

- Compare order no,item code, qty,etc in delivery note with that in order to vendor
- Send discrepancy note (if any) to purchase office and vendor.If no discrepancy send delivery note to purchase
- Send delivery note to inspection office(object)

OTHER RELEVANT OBJECTS

CLASS : STORES OFFICE

Attributes : Attributes of inspection office + qty in stock

Operations :

- Update inventory by adding no of items accepted to qty in stock
- Send advice to accounts object to make payment for qty accepted

NEXT OBJECT IS INSPECTION OFFICE

CLASS : INSPECTION OFFICE
Attributes : Derived attributes from delivery note + no of items accepted
Operations : ▪ Send information an accepted items to store and accounts ▪ Send discrepancy note(if any) to purchase office and vendor

OTHER OBJECTS ARE

CLASS : ACCOUNTS OFFICE

Attributes : Derived from inspection office attributes + price/unit of item

Operations :

- Calculate amount to be paid
- Print cheque
- Request vendor object for vendor address
- Print vendor address label
- Dispatch payment to vendor
- Intimate Purchase office of payment

OBJECT ORIENTED MODELLING-CRC METHOD

Steps in object oriented modelling

1) Find objects and their classes
2) Determine responsibilities of each object
3) State responsibilities, that is, actions. It can can carry out on its own using its knowledge
4) Determine objects with whom they collaborate.
5) State contracts each object assigns to its collaborations
6) A collaborator either performs a requested action or gives information
7) Document each class – its responsibilities,its collaborators and their
   responsibilities
8) Develop an object interaction/collaboration graph

CRC TEAM IDEA

CRC TEAM : user's representative
System analyst(s)
project coordinator

RESPONSIBILITY : Identify objects
Specify responsibility
Specify collaborators and their
responsibilities

Prepare a card for each class called class index cards

CRC METHODOLOGY

1. Make CRC Card for each class

CRC CARD

CLASS NAME :
SUPER CLASSES AND SUBCLASSES :
SHORT DESCRIPTION OF CLASS :
COLLABORATORS :
PRIVATE RESPONSIBILITIES OF CLASS :
CONTARCTS WITH COLLABORATORS :

Develop a graph to show interaction between classes

CRC MODEL - EXAMPLE

For Example1 of last learning unit the CRC model is given below

Class : APPLICATION

Super class : None

Sub class : None

Collaborators : DEPARTEMENT

Description : This class represents applications received for admission to a university

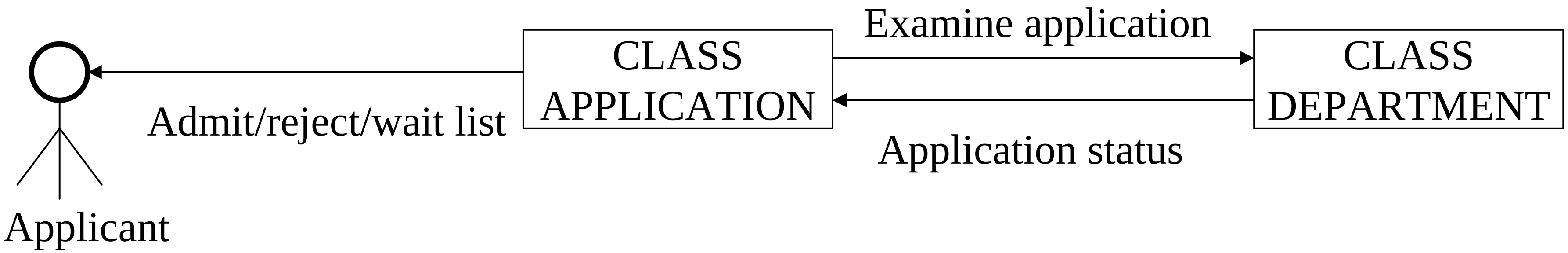
Private Responsibilities :
Scrutinize : Applications are scrutinized to see if fee is paid and marks sheet is enclosed. If yes, applications is sent to department class.Else a rejected letter is sent to the applicant

Contract(s) and Collaborator(s):
Forward application to department : When it passes scrutiny else send reject to applicant
Send letter to applicant : When Department notifies decision (Admit,Reject,Waitlist) send appropriate letter to the applicant

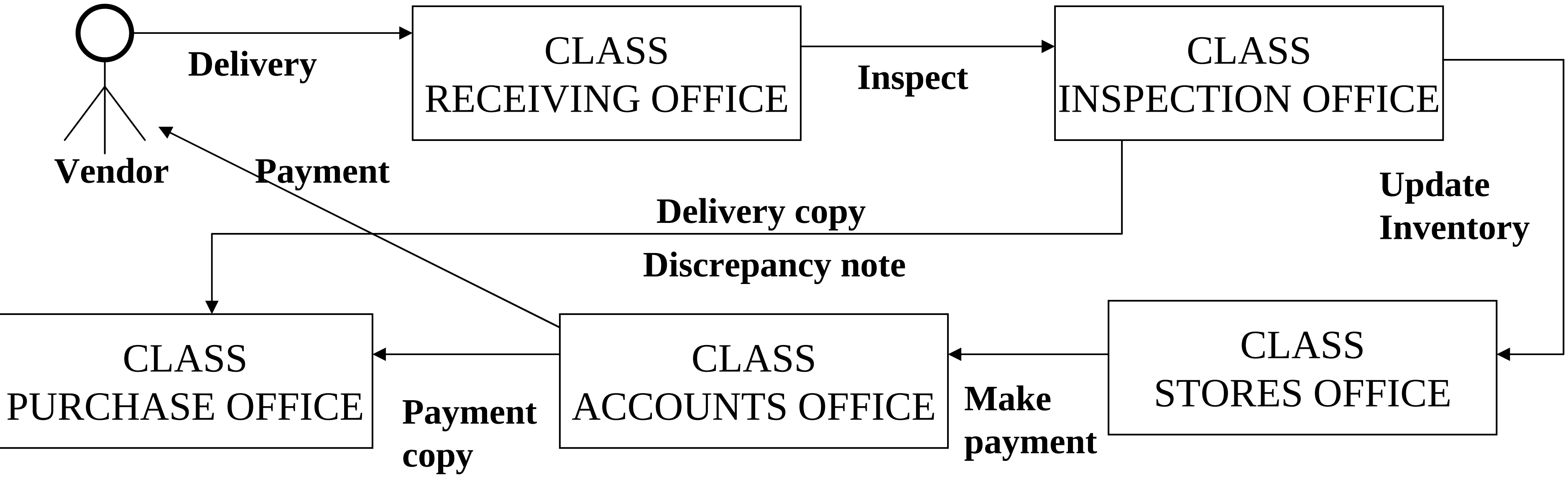
CRC MODEL – EXAMPLE (CONTD)

Class : DEPARTMENT
Super class : None
Sub class : None
Collaborators : APPLICATION
Description : This class represents departments whose responsibility is to admit, reject or place an waiting list on application
Private Responsibilities : Rank order applications based on selection criteria.Mark in application:admitted,rejected or in waiting list depending o available seats
Contract(s) and Collaborator(s): Send reply to applicationclass on admitted, rejected or wait list

COLLABORATION GRAPH



COLLABORATION GRAPH FOR EXAMPLE2


CLASS RECEIVING OFFICE
CLASS INSPECTION OFFICE
Delivery
Inspect
Vendor
Payment
Delivery copy
Update Inventory
Discrepancy note
CLASS PURCHASE OFFICE
CLASS ACCOUNTS OFFICE
CLASS STORES OFFICE
Payment copy
Make payment