OO Fundamentals: Thinking-in-Objects

An Introduction

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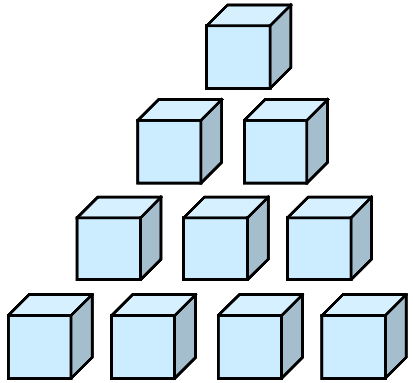
Topics

- What is OOP?
- OOP v/s Structured Programming
- UML
  - Introduction
  - Relationships
- Classes & Objects

The procedural approach

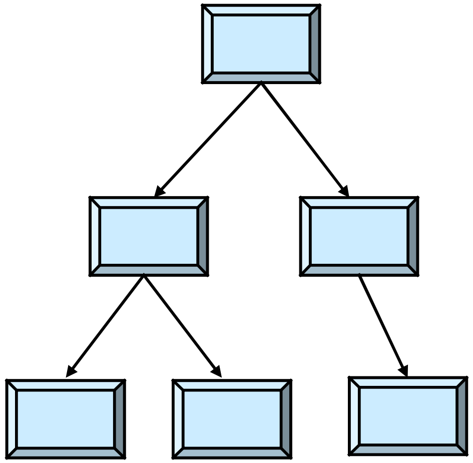
- The procedural approach
  - Deals with functions as the **building blocks**
  - Easy to start with
  - Higher comfort level for a new programmer



Functions are the building blocks

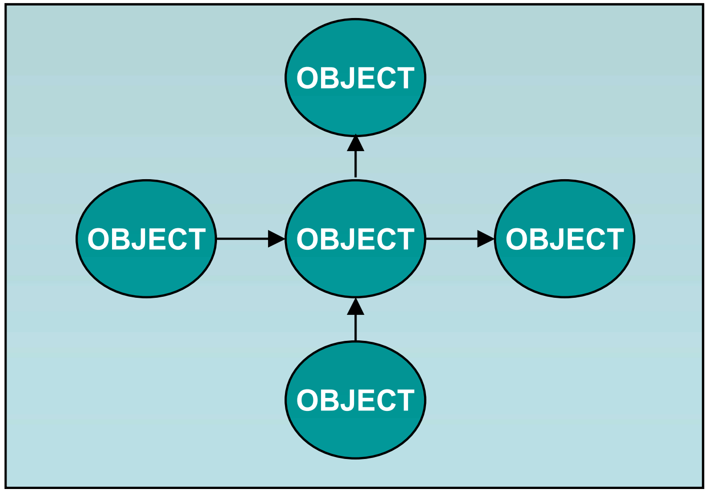
- Simple decomposition technique for
  - Modularity
  - Reusability
  - Complexity

Top – down decomposition

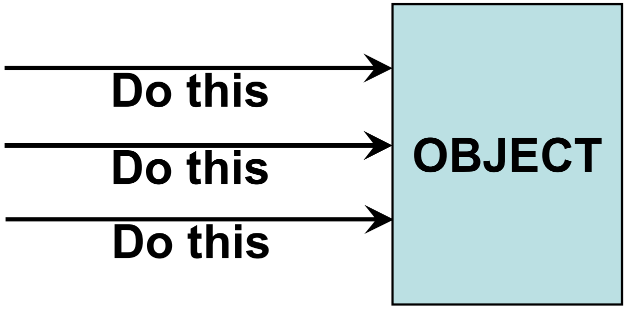


OO Approach

- An Object oriented approach views systems and programs as a collection of interacting objects.

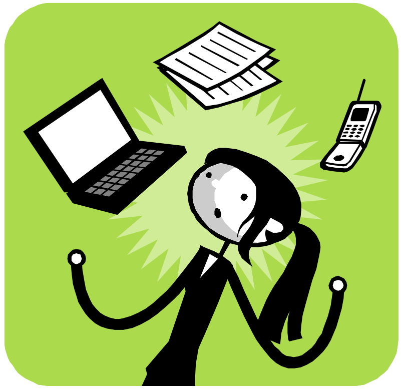


- An object is a thing in a computer system that is capable of responding to messages



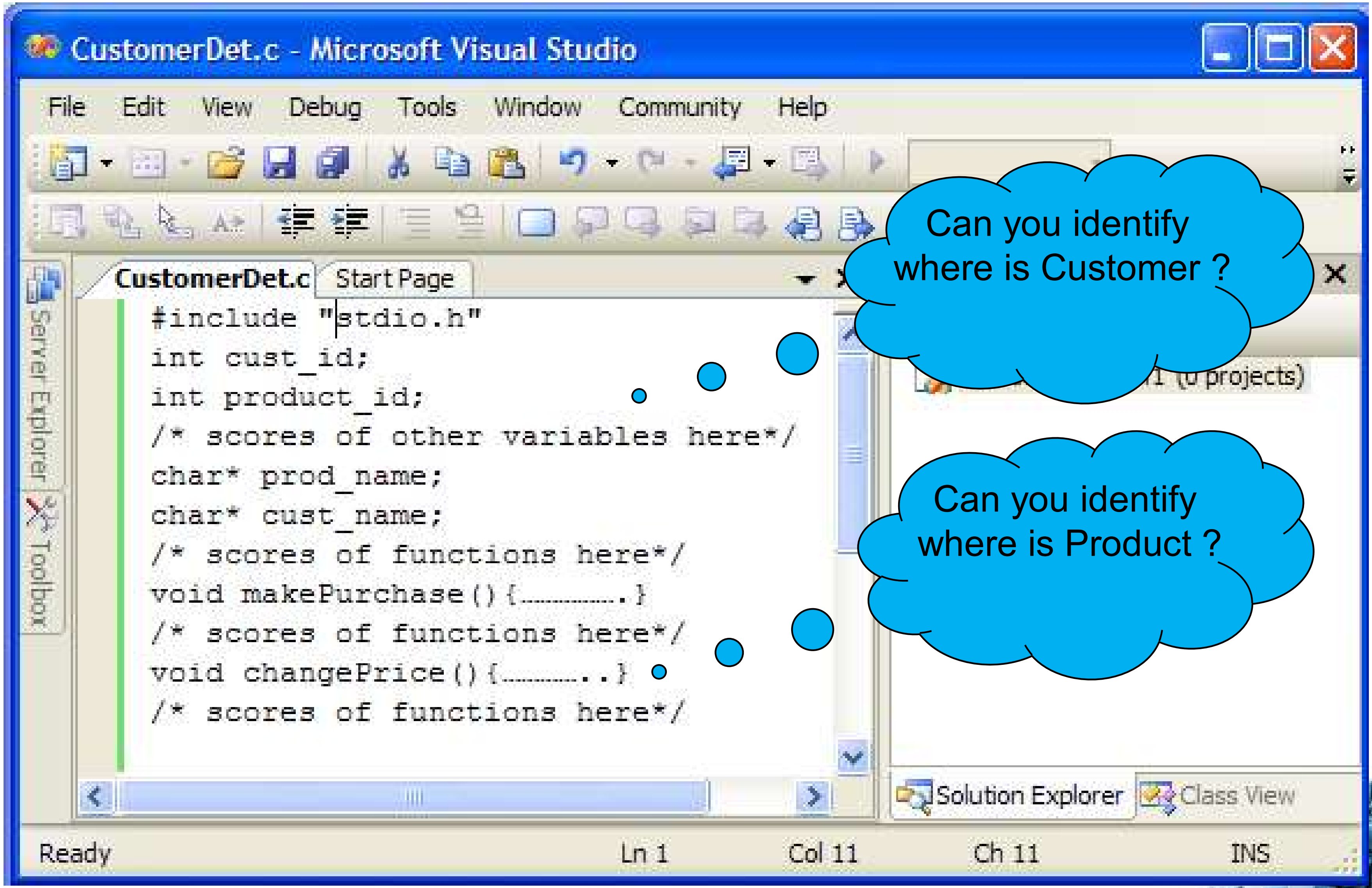
What are Objects?

- We interact with *objects* everyday
  - A customer
  - An order
  - Your car
  - The telephone



- An object represents an entity – physical, conceptual or software
  - **Physical entity**
    - Employee, Customer, Supplier
  - **Conceptual entity**
    - Sales, Policy, TaxCalculator
  - **Software entity**
    - Linked List, Connection, etc.
- ***A programmer should make a good effort to capture the conceptual entities in addition to physical entities which are relatively straight forward to identify***

Why choose the OO approach?

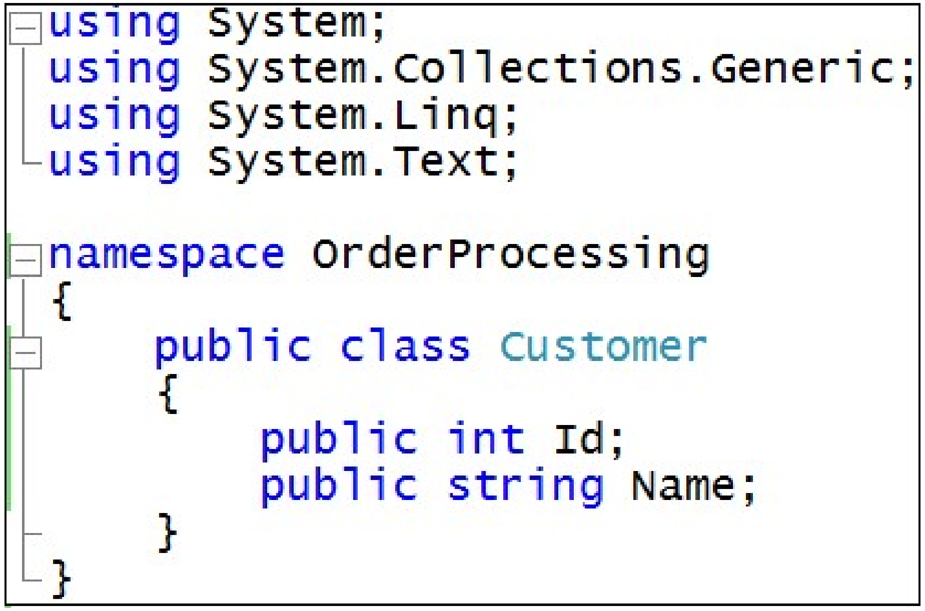


```
#include "stdio.h"
int cust_id;
int product_id;
/* scores of other variables here*/
char* prod_name;
char* cust_name;
/* scores of functions here*/
void makePurchase(){…………….}
/* scores of functions here*/
void changePrice(){………..}
/* scores of functions here*/
```

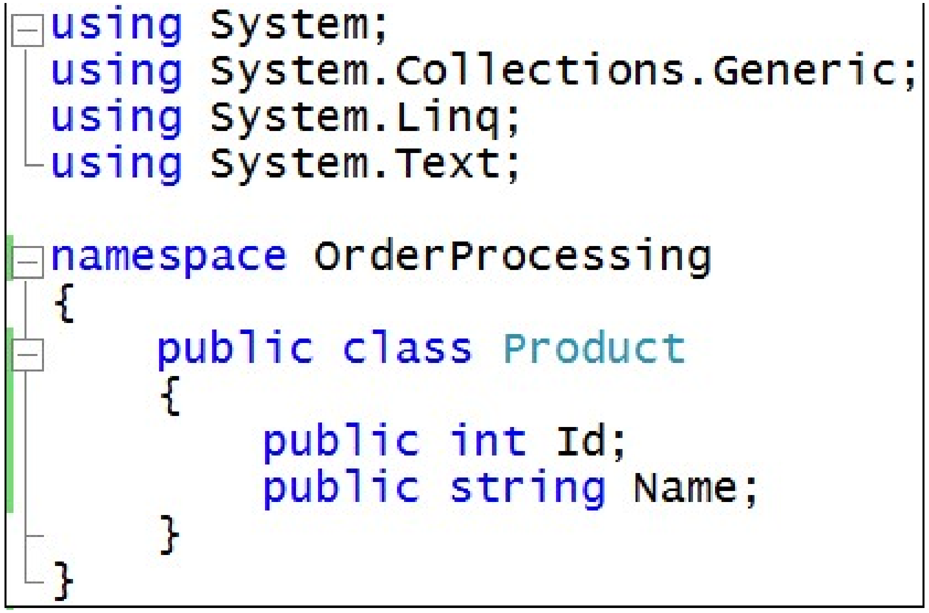
Can you identify where is Customer ?

Can you identify where is Product ?

Why choose the OO approach ?



```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;

namespace OrderProcessing
{
    public class Customer
    {
        public int Id;
        public string Name;
    }
}
```

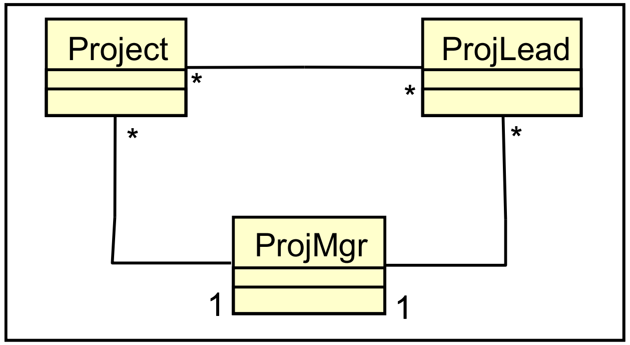


```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;

namespace OrderProcessing
{
    public class Product
    {
        public int Id;
        public string Name;
    }
}
```

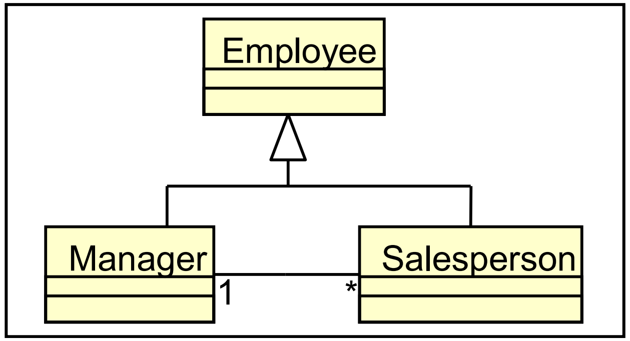
Easier to comprehend

Why choose the OO approach?

- The OO approach
  - Deals with classes as the building blocks
  - Allows Real World Modeling
  - The idea of OOP is to try to approach programming in a more natural way by grouping all the code that belongs to a particular object—such as an account or a customer — together



- Raise the level of abstraction
  - Applications can be implemented in the same terms in which they are described by users
- Easier to find nouns and construct a system centered around the nouns than actions in isolation



- Easier to visualize an encapsulated representation of data and responsibilities of entities present in the domain
- The modern methodologies recommend the object-oriented approach even for applications developed in C or Cobol

Object-Oriented Programming

“Object-oriented programming is a method of implementation in which programs are organized as cooperative collections of objects, each of which represents an instance of some class...”

Grady Booch

Procedural vs. Object-Oriented Programming

- The unit in procedural programming is *function*, and unit in object-oriented programming is *class*
- Procedural programming concentrates on creating functions, while object-oriented programming starts from isolating the classes, and then look for the methods inside them.
- Procedural programming separates the data of the program from the operations that manipulate the data, while object-oriented programming focus on both of them

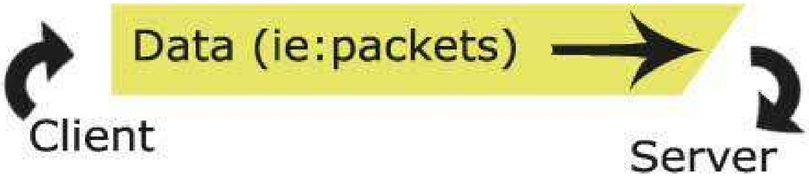


figure1: procedural

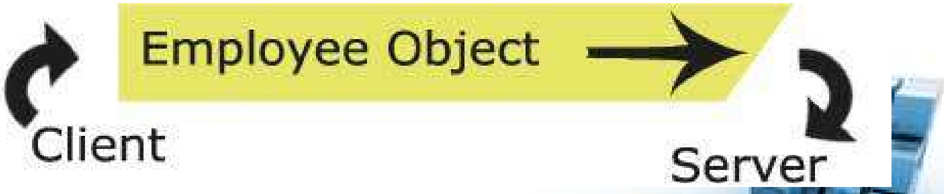
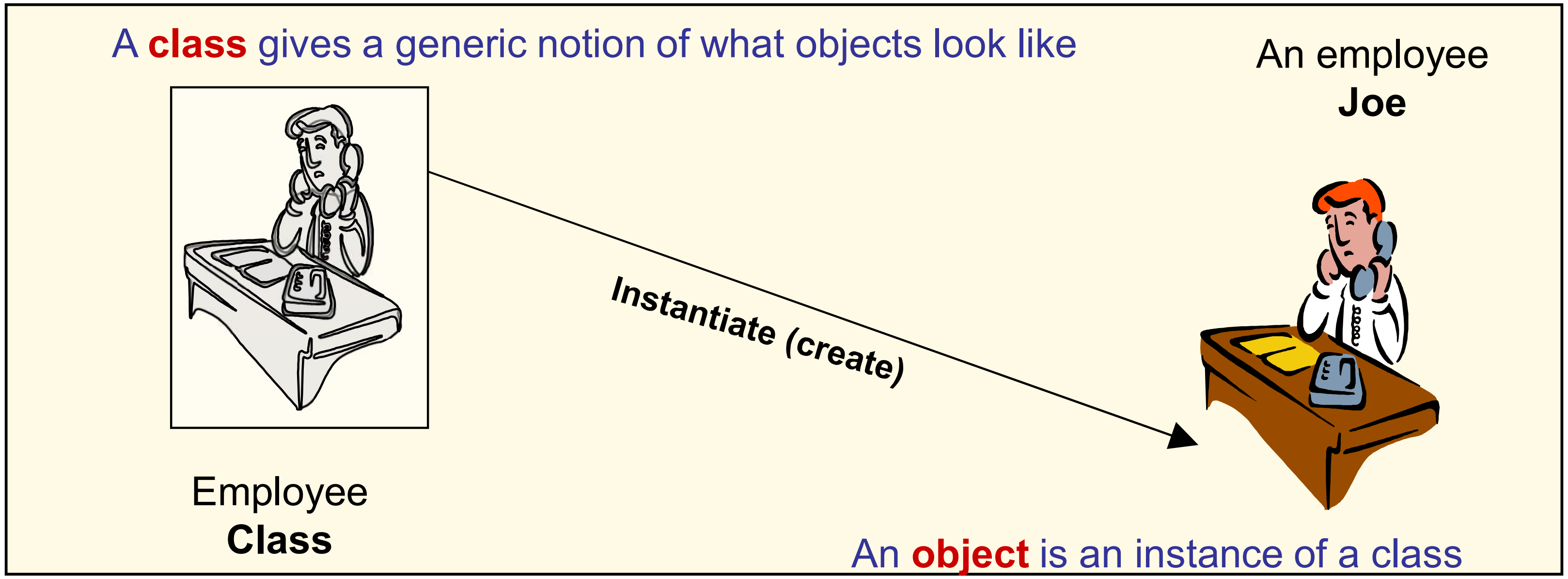


figure2: object-oriented

What is a Class?



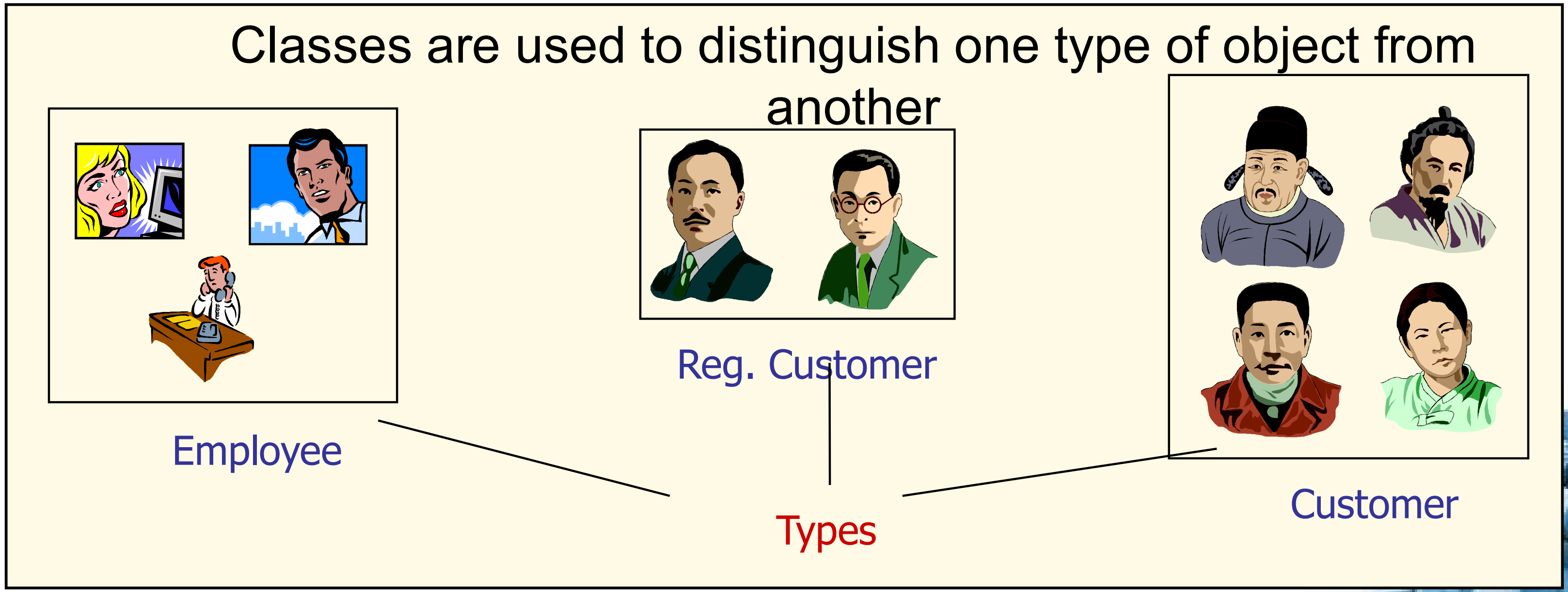
A **class** gives a generic notion of what objects look like

Employee
Class

Instantiate (create)

An employee
Joe

An **object** is an instance of a class



Classes are used to distinguish one type of object from another

Employee

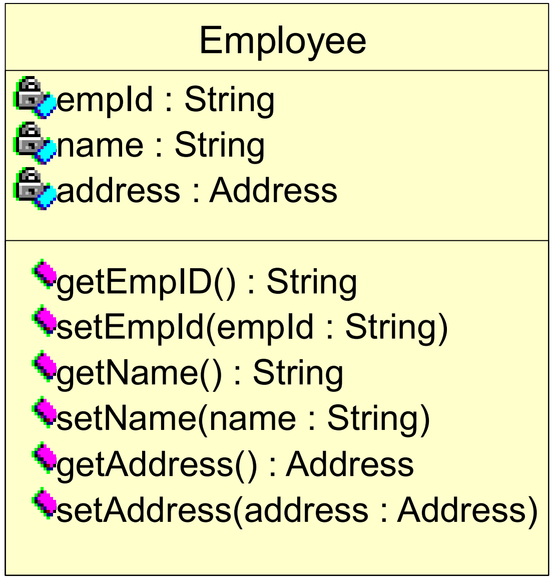
Reg. Customer

Customer

Types

Class

- User defined type
  - Encapsulates all the data and operations pertaining to an entity
  - Provides a Single representation to all the attributes defining the entity
  - Passing single representations is easier



Employee

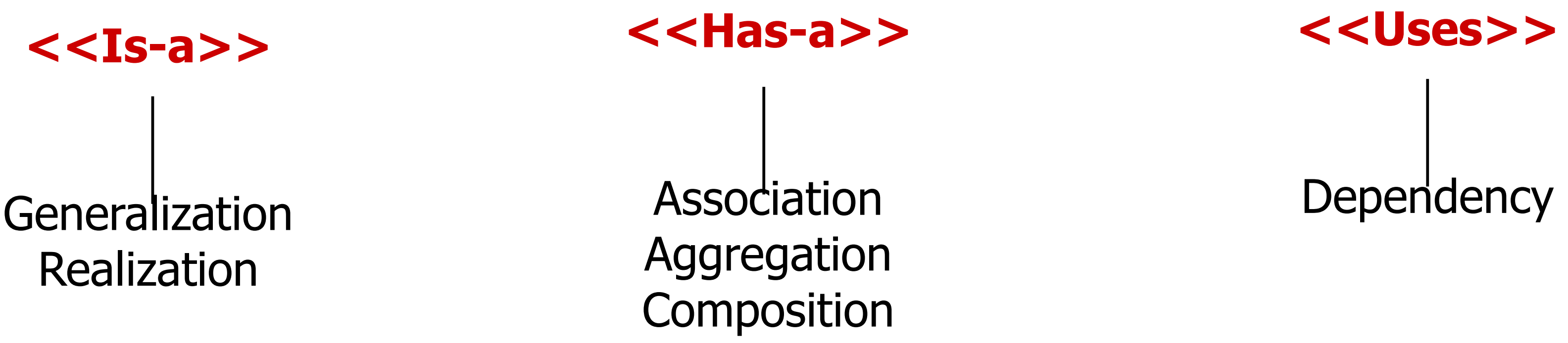
empId : String
name : String
address : Address

getEmpID() : String
setEmpId(empId : String)
getName() : String
setName(name : String)
getAddress() : Address
setAddress(address : Address)

- Data types as collections
  - A struct in C encapsulates only data. Used as a data structure to store different types of data
  - An array is used to store different elements of the same type

Relationship between Classes

- Classification



<<Is-a>>

Generalization
Realization

<<Has-a>>

Association
Aggregation
Composition

<<Uses>>

Dependency

- For all practical purposes we will represent
  - Is-a relationship as

    ————▶

  - Has-a relationship as

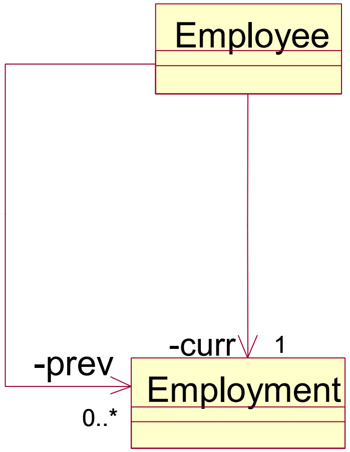
    ————

  - Uses relationship as

    ----------->

Has-a Relationship

- The ‘Has-a’ relationships are qualified by
  - Multiplicity
    - The number of instances with which a class is associated
    - Can be 1, 0..1, *, 1..*, 0..*, 2..*, 5..10, etc.
    - Multiplicity is by default 1
  - Navigability
    - Can be unidirectional or bidirectional
    - Navigability is by default bi-directional
  - Role name
    - The name of the instance in the relationship
    - Multiple ‘has-a’ based on different roles are possible



Identifying Classes

A trainer trains many trainees on a given technology in this course, which contains many modules – each module is comprised of different units and each unit has many topics.

- Identify the different classes from the above problem statement

Procedural approach

- Focus is on identifying **VERBS**
- Connections between functions established through Function Calls

OO approach

- Focus is on identifying **NOUNS**
- Connections between classes established through Relationships ('Is-a' and 'Has-a')

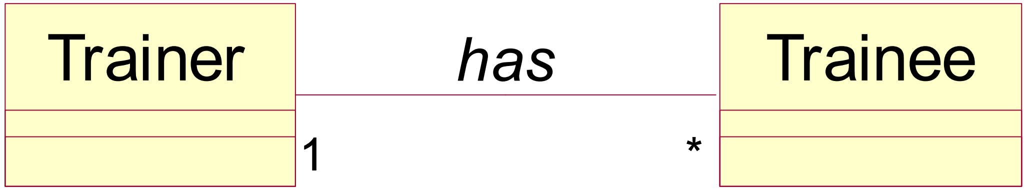
Identifying Classes

- Trainer
- Trainee
- Course
- Technology
- Module
- Unit
- Topic

- Identify the different connections (relationships) between the above classes

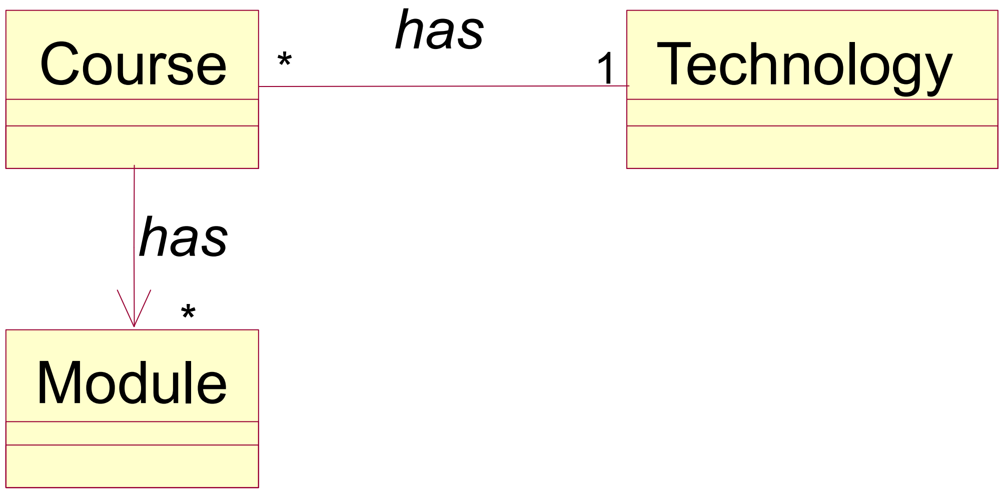
Identifying Relationships

- Trainer - Trainee
  - Trainer 'HAS' many Trainees
  - Every Trainee 'HAS' a Trainer



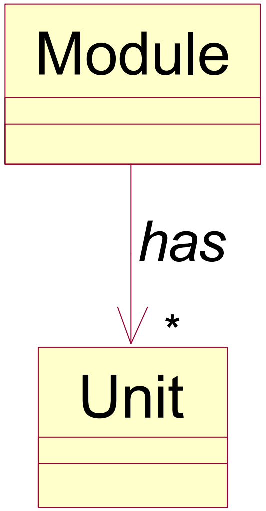
Identifying Relationships

- Course – Technology
- Course - Module
  - Course ‘HAS’ an associated Technology
  - A Technology has many courses
  - Course ‘HAS’ many Modules

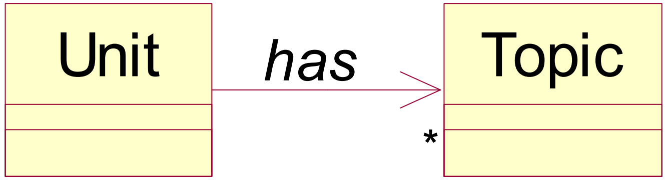


Identifying Relationships

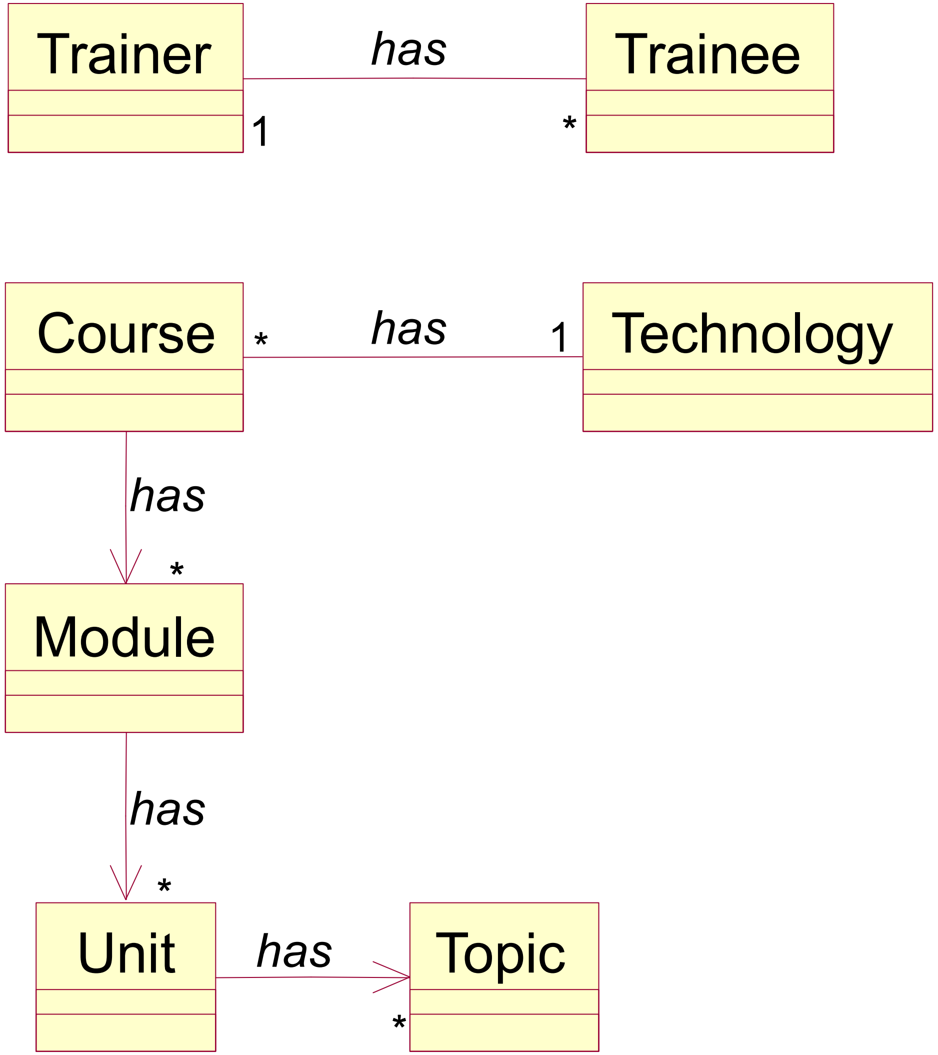
- Module – Unit
  - Module 'HAS' many Units



- Unit – Topic
  - Unit 'HAS' many Topics



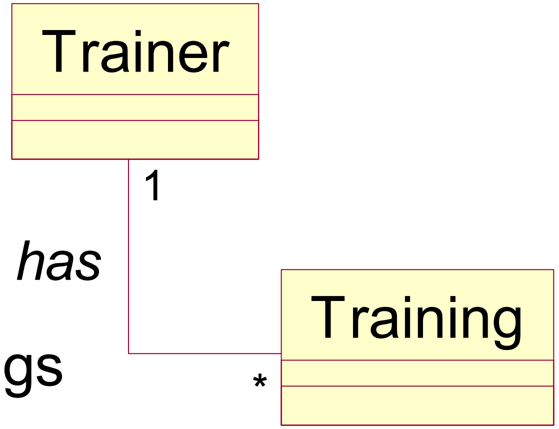
The OO Model



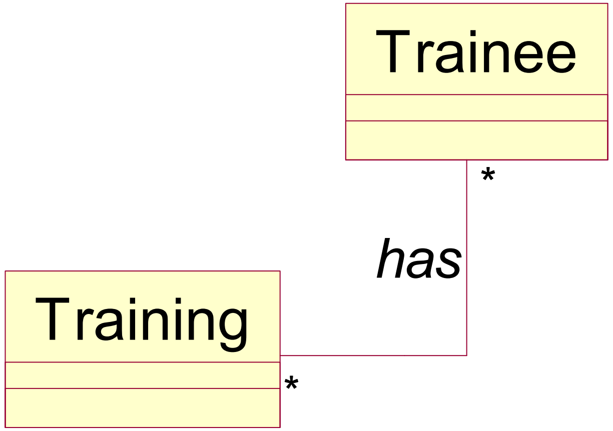
- How do you relate the Trainer & Trainee to the Course?

Conceptual Entity

- Trainer – Training
  - A Trainer (HAS) conducts many Trainings
  - A Training HAS a Trainer

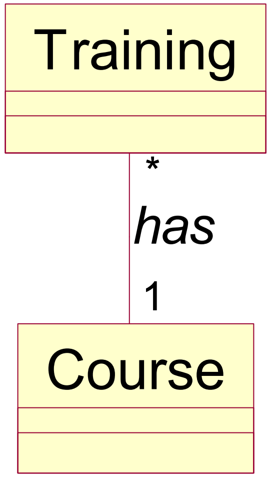


- Trainee – Training
  - A Trainee (HAS) attends many Trainings
  - A Training HAS a many Trainees

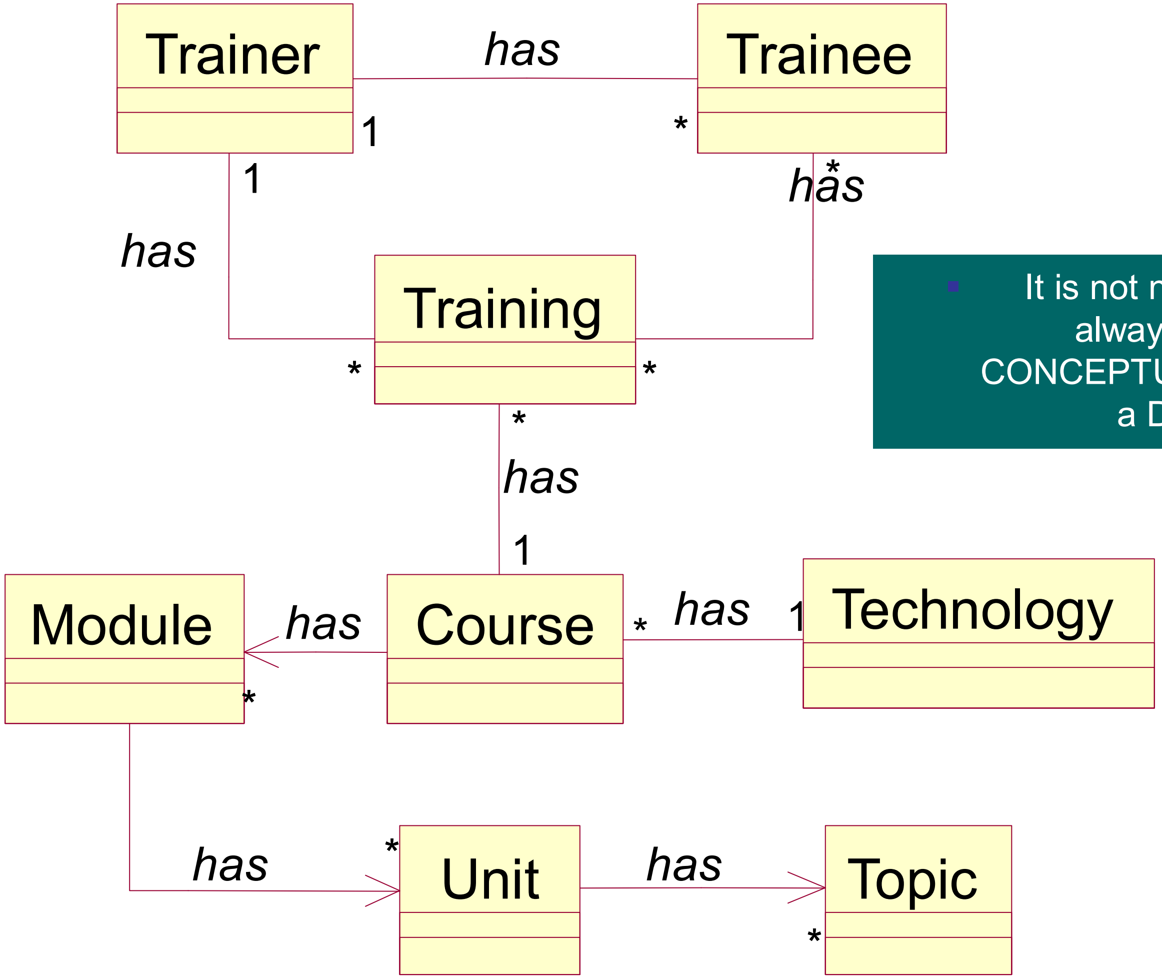


Conceptual Entity

- Training - Course
  - The Training (HAS) an association with a Course (conducted for a Course)
  - A Course HAS many Trainings



Solution



- It is not necessary to always have a CONCEPTUAL ENTITY in a Design

- Easier to model real-world problems through the OO approach than through the procedural approach

Exercise

A company sells different items to customers who have placed orders. An order can be placed for several items. However, a company gives special discounts to its registered customers.

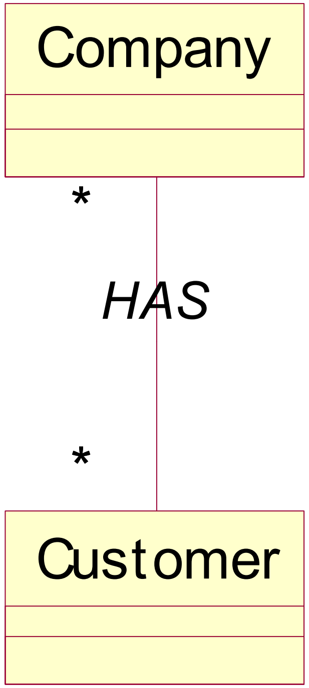
- Identify the different classes from the above problem statement
- Identify the different connections (relationships) between the above classes

Identifying Classes

- Company
- Item
- Order
- Customer
- RegCustomer

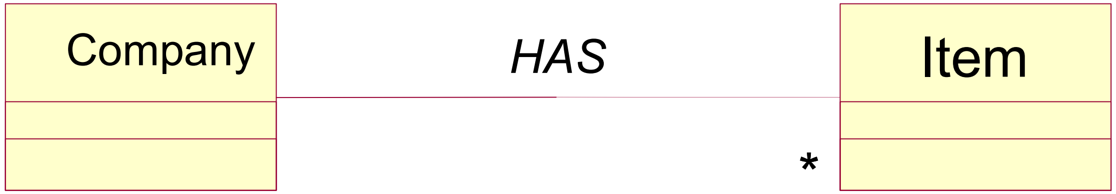
Identifying Relationships

- Company - Customer
  - Company ‘HAS’ many Customers
  - Customer ‘HAS’ many Companies



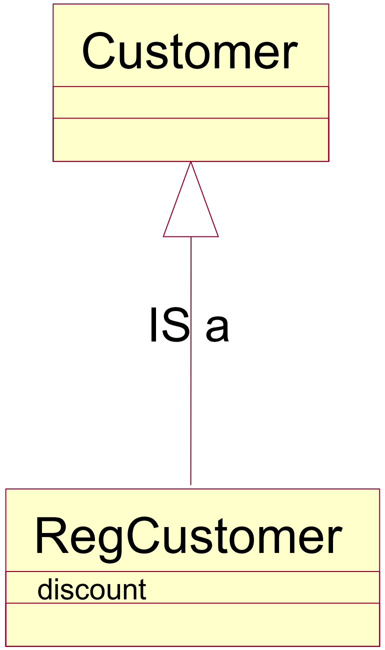
Identifying Relationships

- Company - Item
  - Company HAS many Items



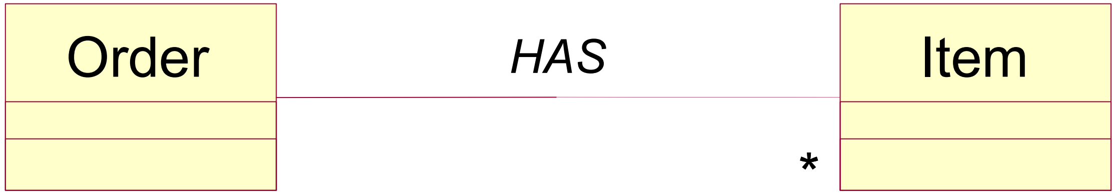
Identifying Relationships

- Customer - RegCustomer
  - RegCustomer ‘IS’ a Customer



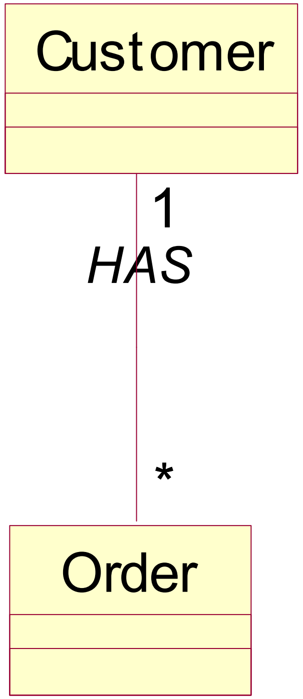
Identifying Relationships

- Order - Item
  - Order HAS many Items

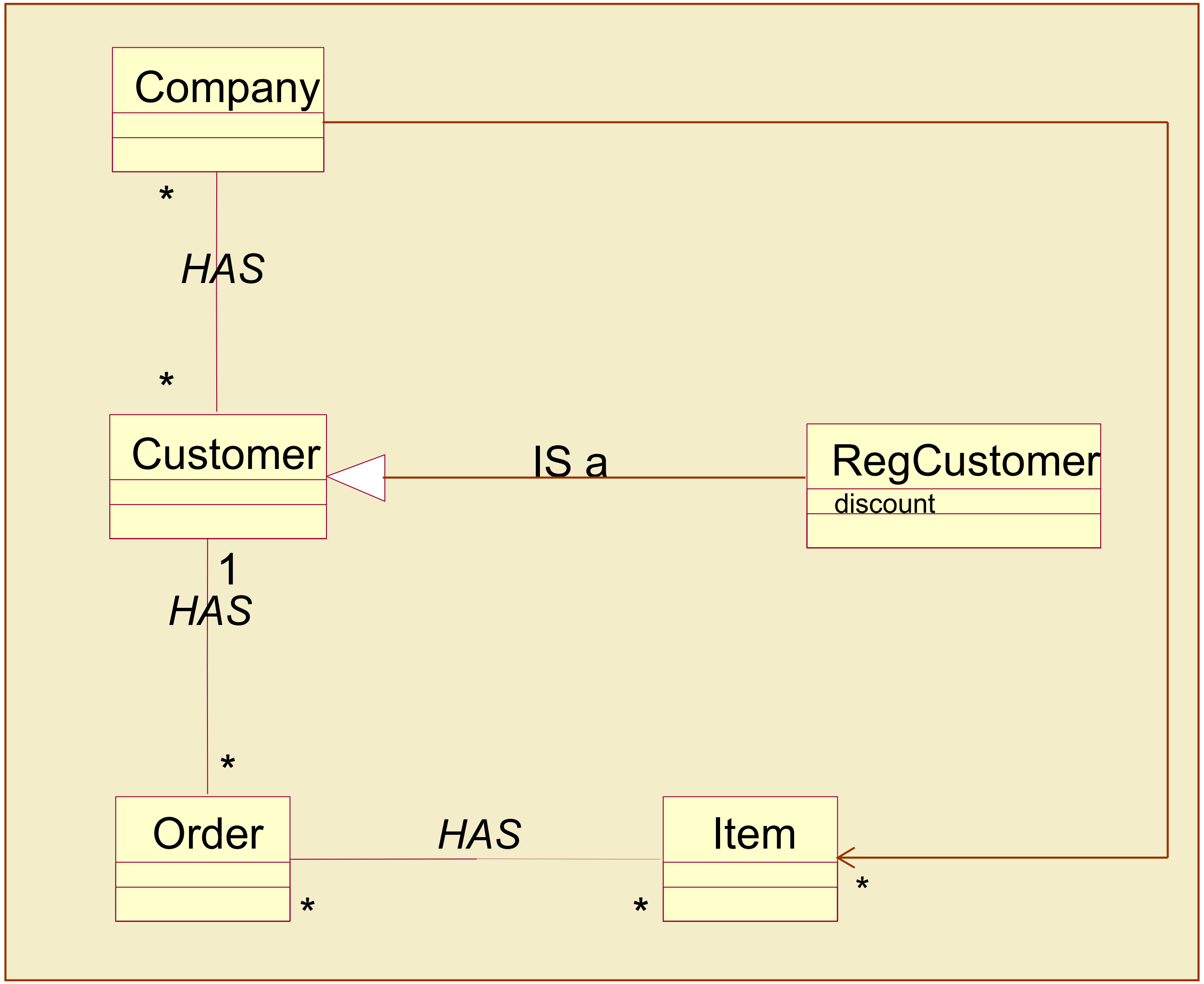


Identifying Relationships

- Customer - Order
  - Customer HAS many Orders
  - Order HAS one Customer



The OO Model



A Customer can place many orders implies that RegCustomer can also place many Orders.

A Company has many Customers implies that a Company also has many RegCustomers

Exercise -3

In the SkillAssure Assessment Framework ,

Every course can have assessments

An Iteration has many courses and can also have additional assessments

The training model has 4 Iterations

An assessment can be of multiple-choice type,

hands-on exercise or project

- Identify the different classes from the above problem statement
- Identify the different connections (relationships) between the above classes

Exercise - 4

There are many programming languages. Java and C# are object-oriented programming languages. C is a procedural programming language.

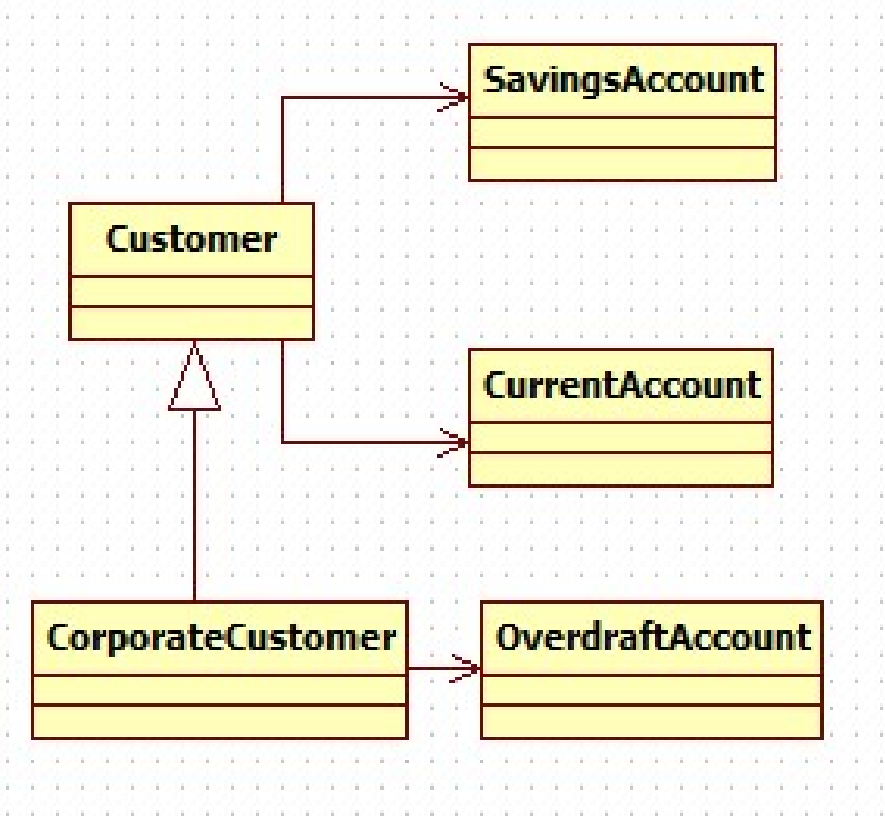
- Identify the different classes from the above problem statement
- Identify the different connections (relationships) between the above classes

Exercise - 5

A customer can hold a savings and current account. A Corporate customer can additionally hold an OverDraft account.

- Identify the different classes from the above problem statement
- Identify the different connections (relationships) between the above classes

A customer can hold a savings and current account. A Corporate customer can additionally hold an OverDraft account.



Exercise - 5

In a Training Institute has the following requirements need to be addressed. The institute conducts many Course. One Course can have many Sections. One Section will be handled by one Instructor and attended by many Students. Both Instructor and Student will have personal details like name , address and phoneNo. Apart from this, a Instructor will have information about the number of research papers published and Student will have the details of marks scored.

- Identify the different classes from the above problem statement
- Identify the different connections (relationships) between the above classes

Exercise - 6

Every Nationalized bank in India has a HeadOffice. The HeadOffice of the Bank will have many branches. Each Branch will have one or more BankAccounts. A Customer can have one or more BankAccounts. A Customer can have a CurrentAccount if he is representing a Company or SavingsAccount for personal use. A customer can perform many transactions thro his BankAccount .

- Identify the different classes from the above problem statement
- Identify the different connections (relationships) between the above classes

Class in C#

- A *class* is a software construct that defines the instance variables and methods of an object.
- A *class* is a template that defines how an object will look and behave when the object is created or instantiated from the specification declared by the class.
- A *class* can be viewed as a user defined data type.

```
class Point
{
        double x;
        double y;

        double getX()
        {
                return x;
        }
}
```

Structure of a class

```
class Employee
{
        String employeeId;
        String employeeName;

        Employee()
        {
                System.out.println(“Constructor called”);
        }

        void setEmployeeId(String employeeId)
        {
                this.employeeId = employeeId;
        }
        String getEmployeeId()
        {
                return employeeId;
        }
}
```

Instance Variables

Constructor

Methods

What is an Object?

- An object is an entity with a well-defined *State* and *Behavior*

- An *object* is created from the class definition using the *new* operator.

- The state of an object is referred to as the values held inside the instance *variables* of the class.

- The behavior of the class is referred to as the *methods* of the class.

- To create an object of the class Point, say,
  Point p = new Point();

```
class Point
{
        double x;
        double y;

        double getX()
        {
                return x;
        }
}
```

- When an object of the class is created, memory is allocated for all the instance variables, here p is not an object but a *reference* or *handle* to an object being created.

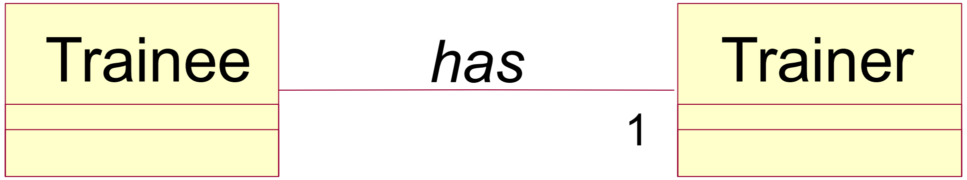
Instantiating Classes

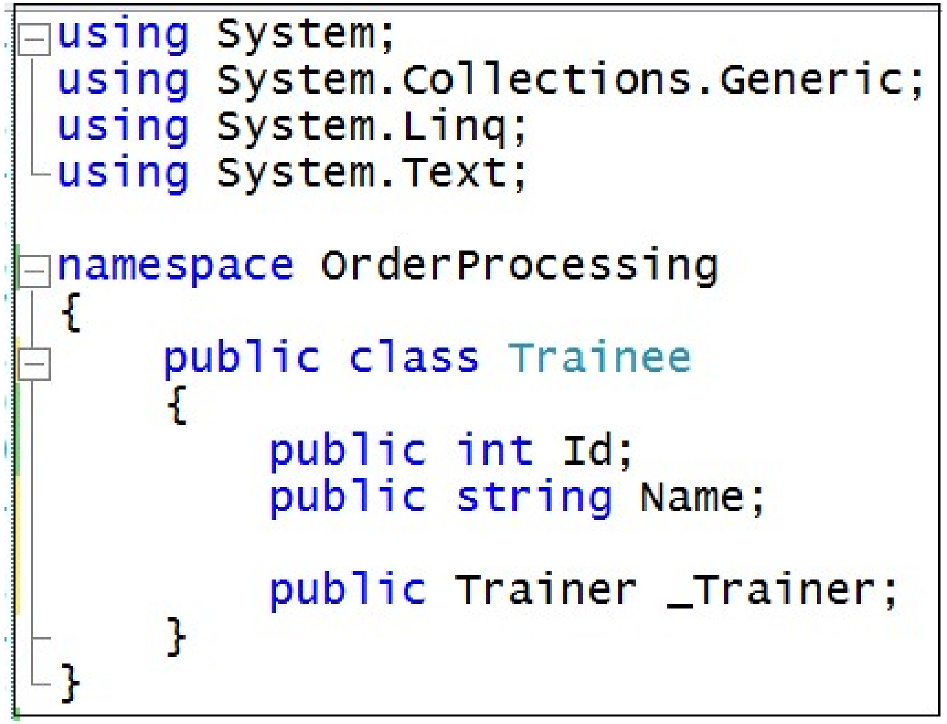
```
public class Shop

            oid main(Stri
    {
            Product p1=new Product();
            p1.id=1;
            p1.name="Steam Iron";

            Product p2=new Product();
            p2.id=2;
            p2.name="Microwave"

            p1.makePurchase();
            ................
    }
}
```

P1 is a reference

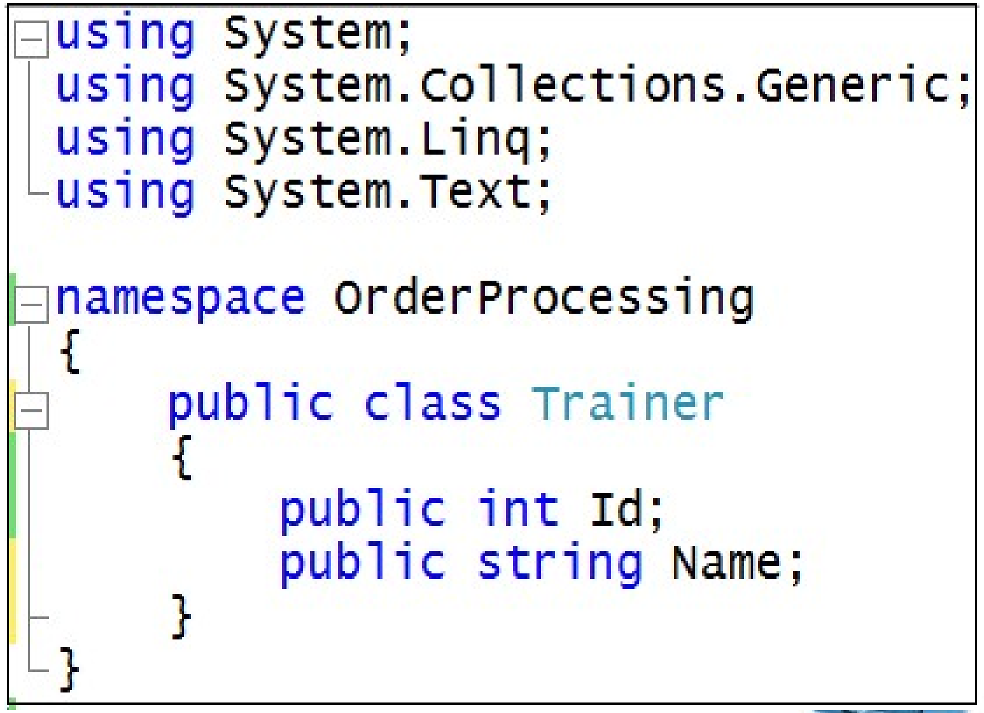
The RHS creates an instance

Modeling the ‘has-a’ relationship





```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;

namespace OrderProcessing
{
    public class Trainee
    {
        public int Id;
        public string Name;

        public Trainer _Trainer;
    }
}
```



```
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using System.Linq;
using System.Text;

namespace OrderProcessing
{
    public class Trainer
    {
        public int Id;
        public string Name;
    }
}
```
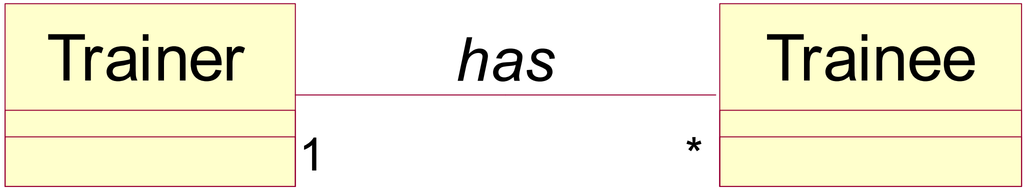
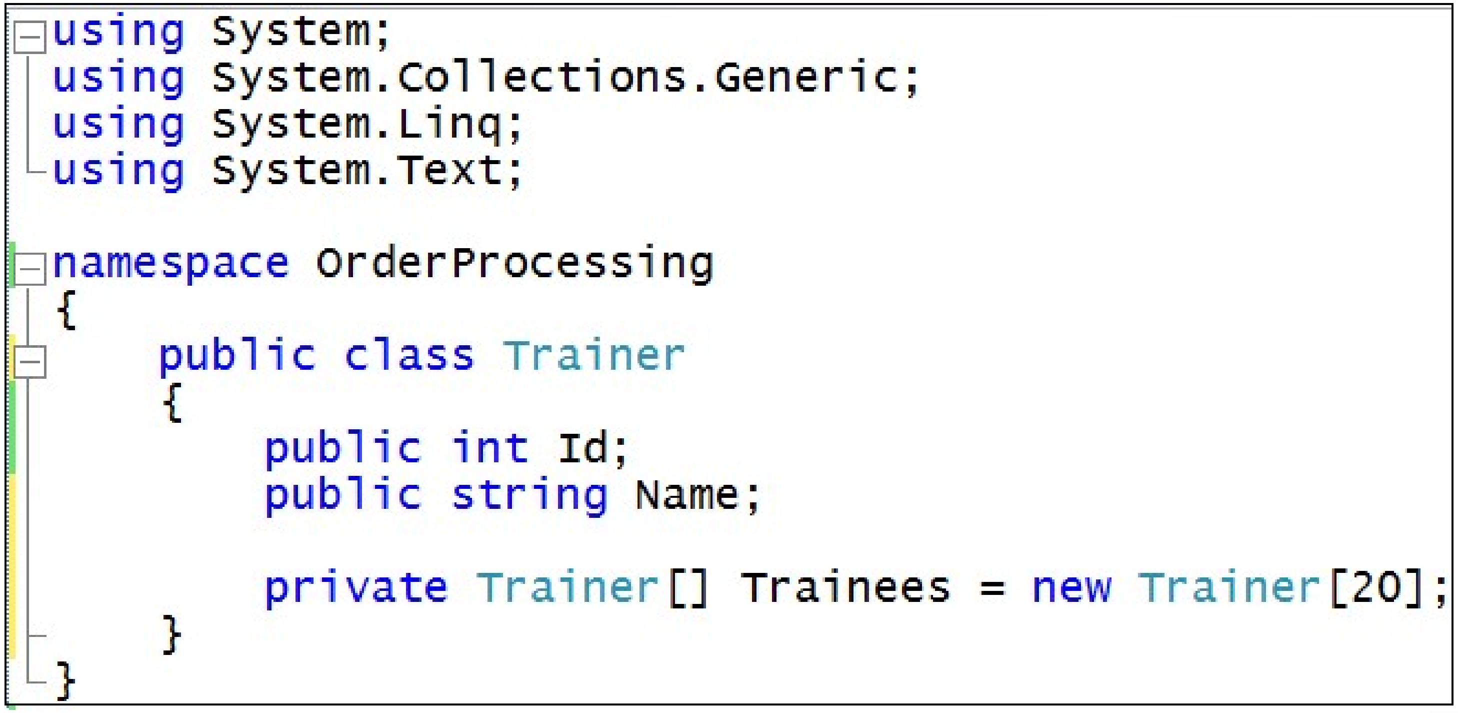

Modeling ‘has-a’ with multiplicity ‘n’





```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;

namespace OrderProcessing
{
    public class Trainer
    {
        public int Id;
        public string Name;

        private Trainer[] Trainees = new Trainer[20];
    }
}
```

Question time

Please try to limit the questions to the topics discussed during the session. Thank you.