CSE201: Monsoon 2024
Advanced Programming

Lecture 12: Unified Modeling Language

Dr. Arun Balaji Buduru

Head, Center of Technology in Policing

Founding Head, Usable Security Group (USG)

Associate Professor, Dept. of CSE | HCD

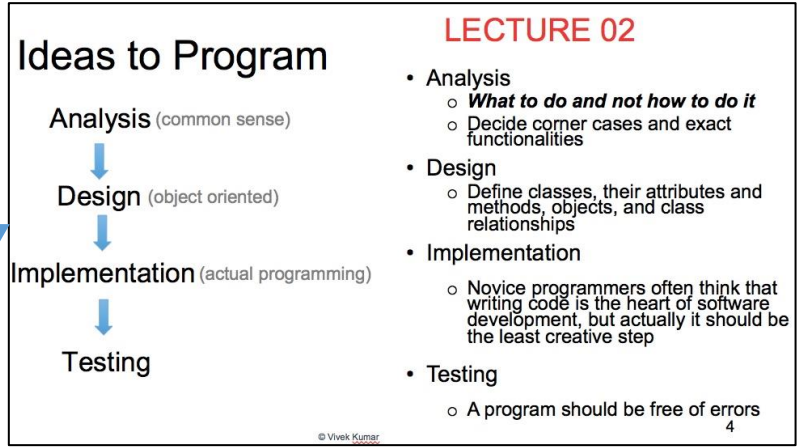
IIIT-Delhi, India

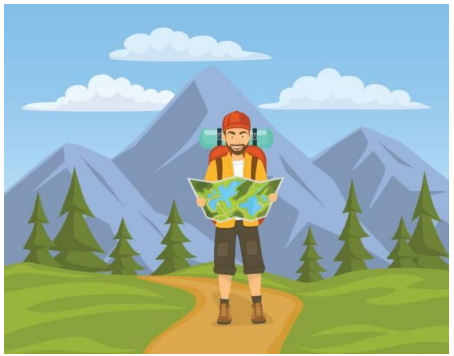
Today's Lecture

- Introduction to UML
  - We already covered UML in bits and pieces in prior lectures
    - Sequence diagram (Lecture 2)
    - Representing class relationships (Lectures 3–6)
- Relationships in use case diagrams
- Goal of this lecture is to give you more familiarity with UML
  - You can model 80% of problems by using about 20% UML
  - We will only cover less than 20% here
    - Not possible to teach everything…

What is UML?

- UML stands for Unified Modeling Language
- It's a widely used modeling language in the field of software engineering
- It's used to analyze, design, and implement software-based systems
- Pretty pictures (diagrams)





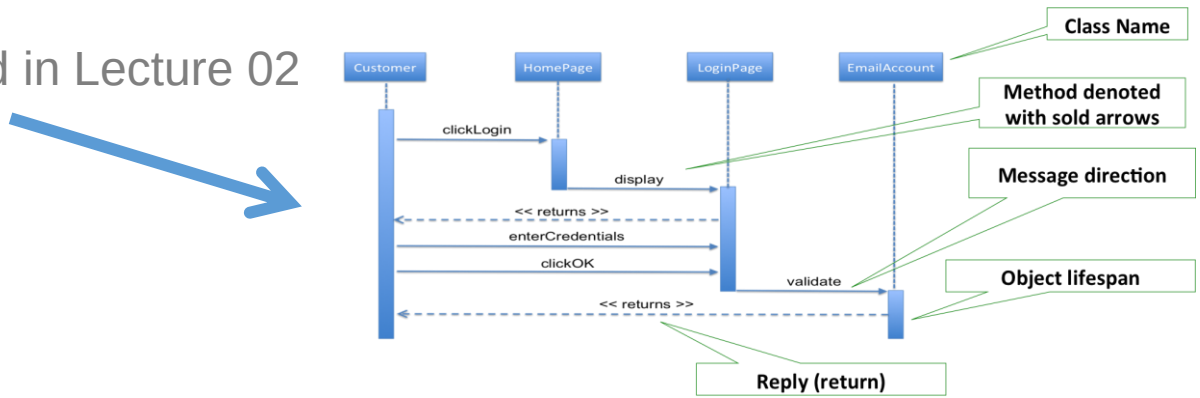
Motivations for UML

- We need a modeling language to:
  - help develop efficient, effective and correct designs, particularly Object Oriented designs
  - communicate clearly with project stakeholders (concerned parties: developers, customer, etc)
  - give us the “big picture” view of the project

UML Diagrams

Three types of UML diagrams that we will cover:

1. **Class diagrams:** Represents static structure
2. **Use case diagrams:** Sequence of actions a system performs to yield an observable result to an actor
3. **Sequence diagrams:** Shows how groups of objects interact in some behavior
   - Already covered in Lecture 02



UML Diagrams: Class Diagrams

- Better name: “Static structure diagram”
  - Doesn‘t describe temporal aspects
  - Doesn‘t describe individual objects: Only the overall structure of the system
- There are “object diagrams” where the boxes represent instances
  - Rarely used and not covered in this course

UML Class Notation

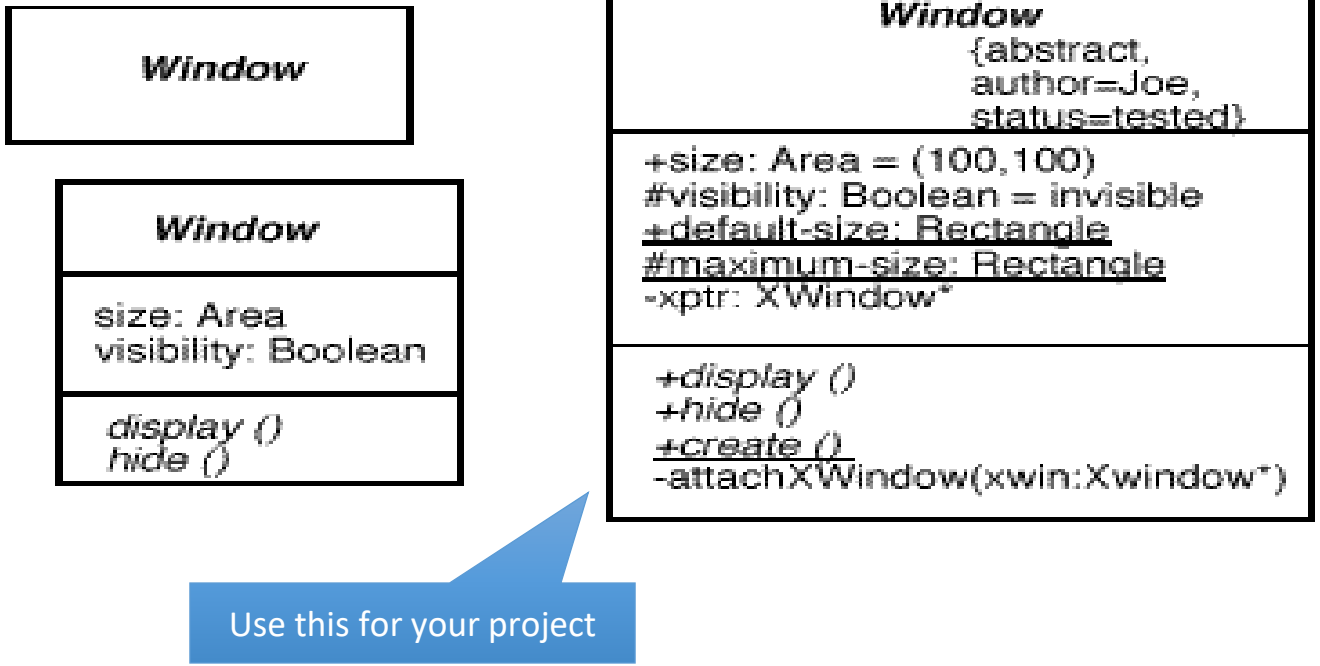
- A class is a rectangle divided into three parts
  - Class name
  - Class attributes (i.e. data members, variables)
  - Class operations (i.e. methods)

- Modifiers
  - Private: -
  - Public: +
  - Protected: #
  - Static: Underlined

- Abstract class/methods
  - Name in italics

Employee
-Name: String +ID: long #Salary: double
+getName: String +setName() -calcInternalStuff(in x : byte, in y : decimal)

Different Levels of Specifying Classes



Class Relationships

- UML diagrams for these class relationships are already covered before (Lectures 04, 05 and 08)
  - Association
  - Composition
  - Dependency
  - Inheritance
- We will only cover binary association relationship here

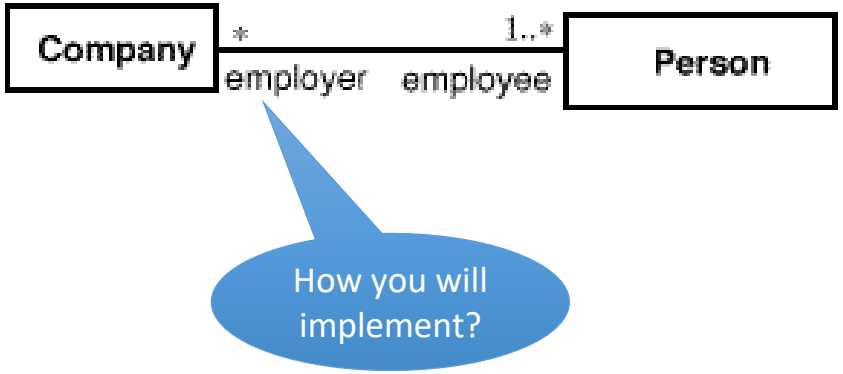
Class Relationship: Binary Association

Both entities “Knows About” each other (two-way association)

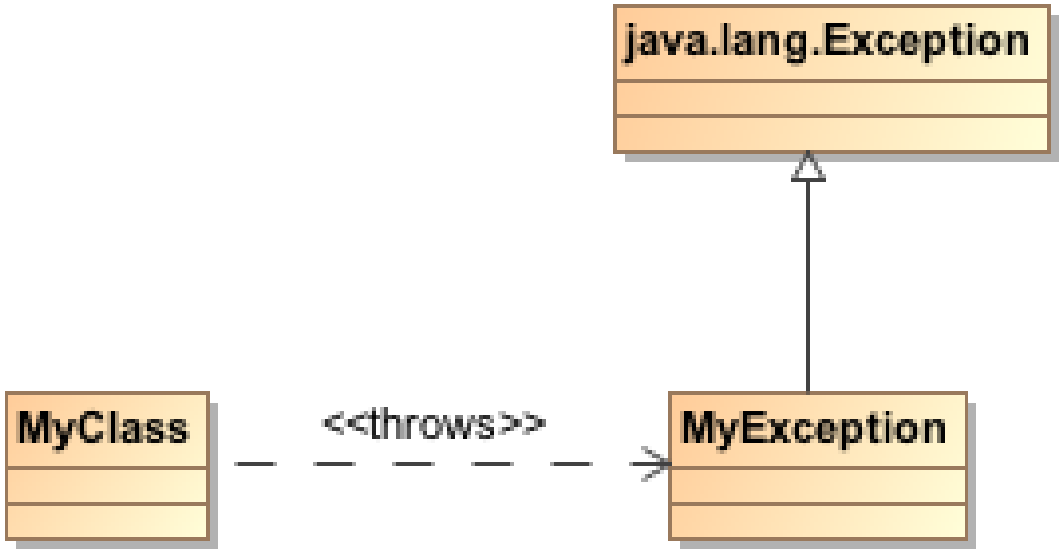
UML Multiplicities

Links on associations to specify more details about the relationship

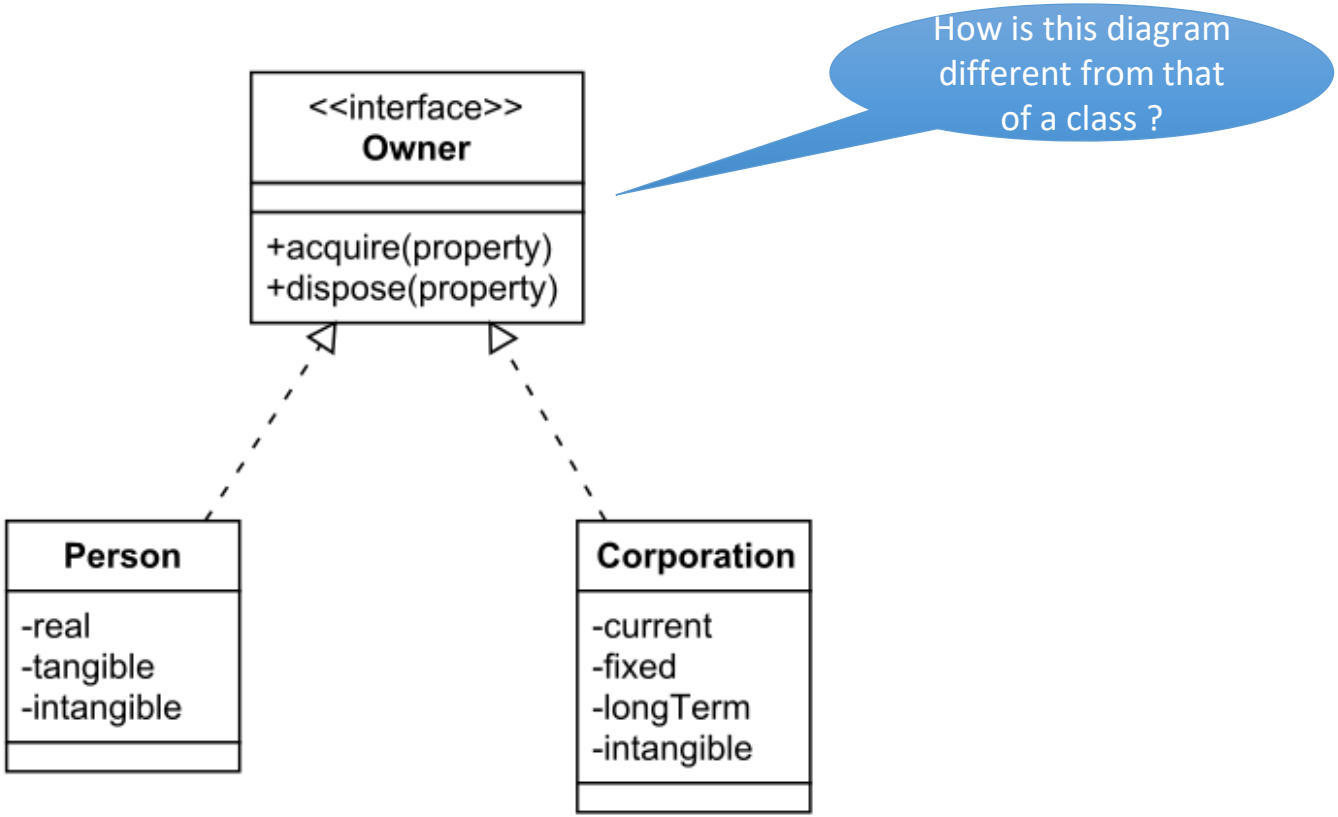
Multiplicities	Meaning
0..1	zero or one instance. The notation "*n . . M*" indicates *n* to *m* instances.
0..* *or* *	no limit on the number of instances (including none).
1	exactly one instance
1..*	at least one instance



Exceptions

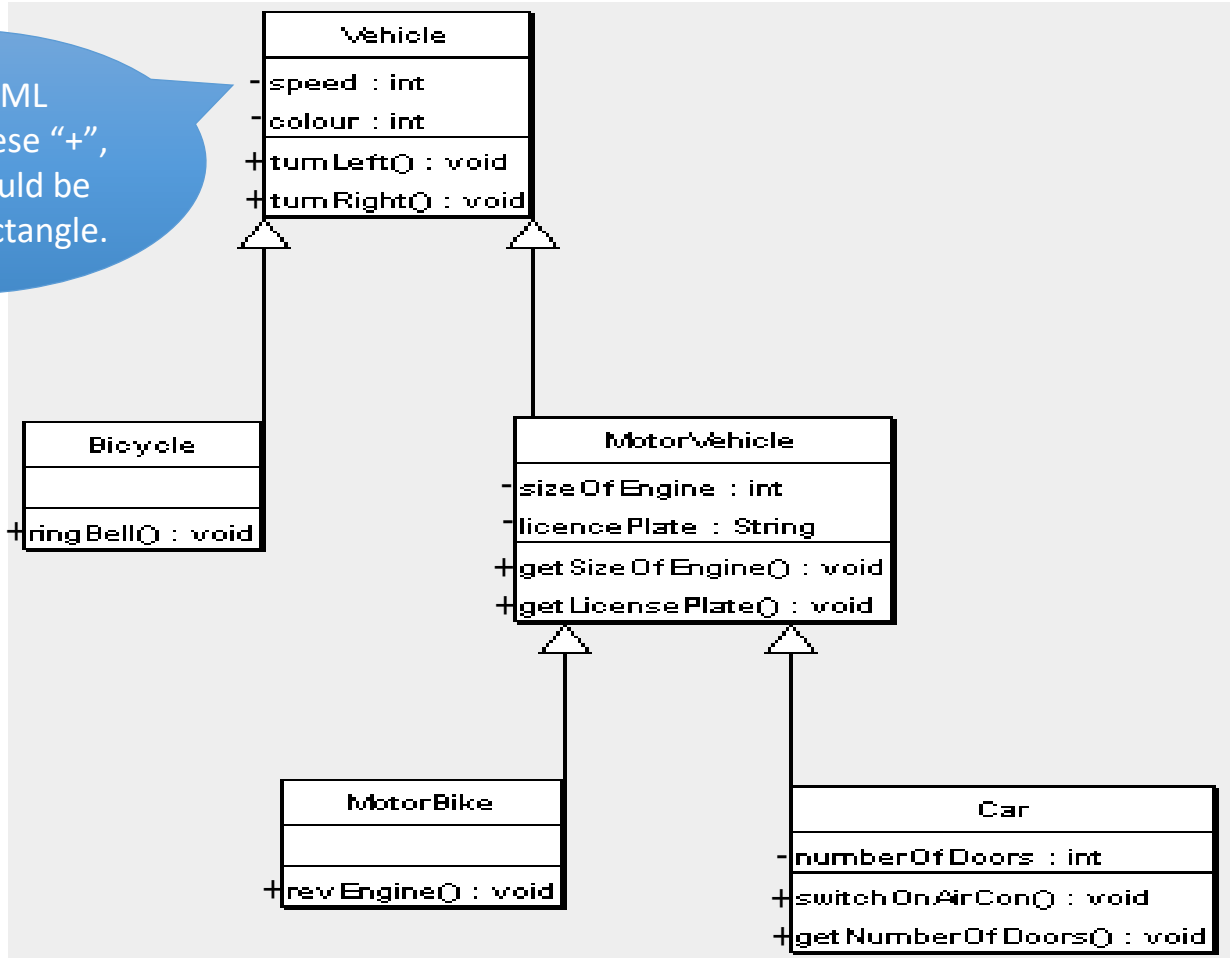


Interfaces

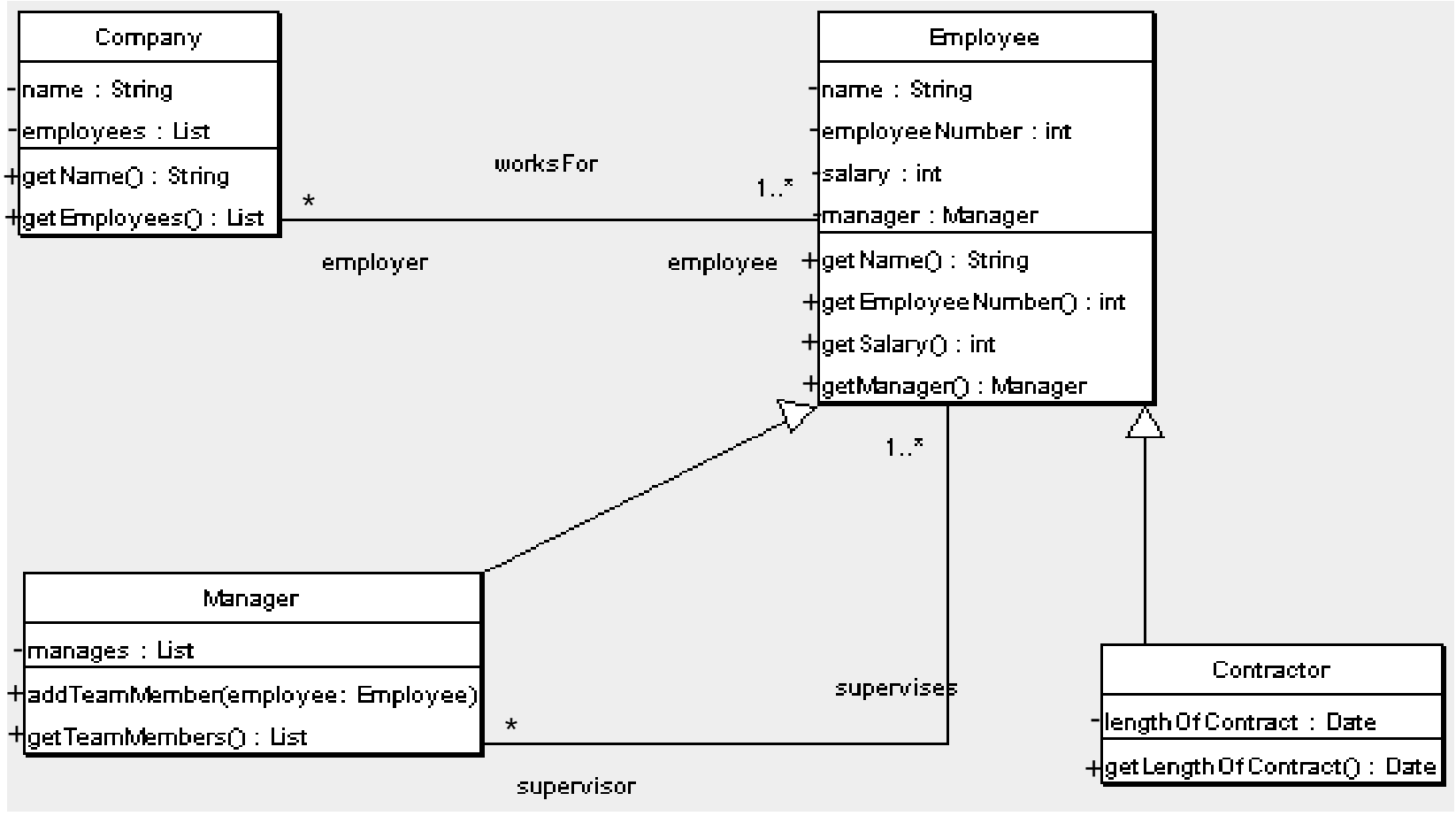

How is this diagram different from that of a class ?
<<interface>>
Owner
+acquire(property)
+dispose(property)
Person
-real
-tangible
-intangible
Corporation
-current
-fixed
-longTerm
-intangible

Sample Class Diagram (1/2)

In your UML diagrams, these “+”, “-”, etc, should be inside the rectangle.



Sample Class Diagram (2/2)

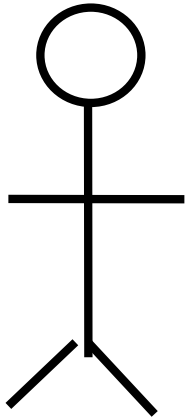


UML Diagrams: Use Cases

- Means of capturing requirements
  - Used at a very early phase of software development for requirement gathering (analysis phase)
  - Provides a high level overview of the system
  - Class diagrams are created after generating use case diagrams
- Document interactions between user(s) and the system
  - User (actor) is not part of the system itself
  - But an actor can be *another* system
- A scenario based technique in UML
- **Use case diagrams** describe what a system does from the standpoint of an external observer. The emphasis is on *what* a system does rather than *how*

Actors in Use Case

- What is an Actor?
  - A user or outside system that interacts with the system being designed in order to obtain some value from that interaction
  - It can be a:
    - Human
    - Peripheral device (hardware)
    - External system or subsystem
    - Time or time-based event
  - Labelled using a descriptive noun or phrase
  - Represented by stick figure



Use Case Analysis (1/4)

- Sample scenario
  - "A *patient calls the clinic to make an appointment for a yearly checkup. The receptionist finds the nearest empty time slot in the appointment book and schedules the appointment for that time slot"*

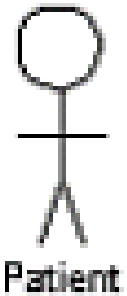
- We want to write a use case for this scenario

Source: http://www.cs.fsu.edu/~baker/swe1/restricted/notes/ppt/UseCaseDiagrams.ppt

Use Case Analysis (2/4)

- Sample scenario
  - “A *patient calls the clinic to make an appointment for a yearly checkup. The receptionist finds the nearest empty time slot in the appointment book and schedules the appointment for that time slot”*

- Who is the actor?
  - The actor is a “Patient” here



Source: http://www.cs.fsu.edu/~baker/swe1/restricted/notes/ppt/UseCaseDiagrams.ppt

Use Case Analysis (3/4)

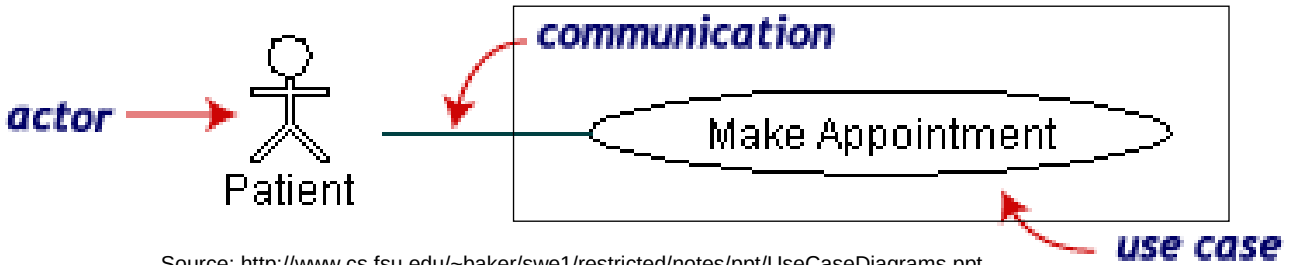
- Sample scenario
  - "A *patient calls the clinic to make an appointment for a yearly checkup. The receptionist finds the nearest empty time slot in the appointment book and schedules the appointment for that time slot"*

- A **use case** is a summary of scenarios for a single task or goal
  - So, what is the use case here?
  - The use case is "Make Appointment"

Source: http://www.cs.fsu.edu/~baker/swe1/restricted/notes/ppt/UseCaseDiagrams.ppt

Use Case Analysis (4/4)

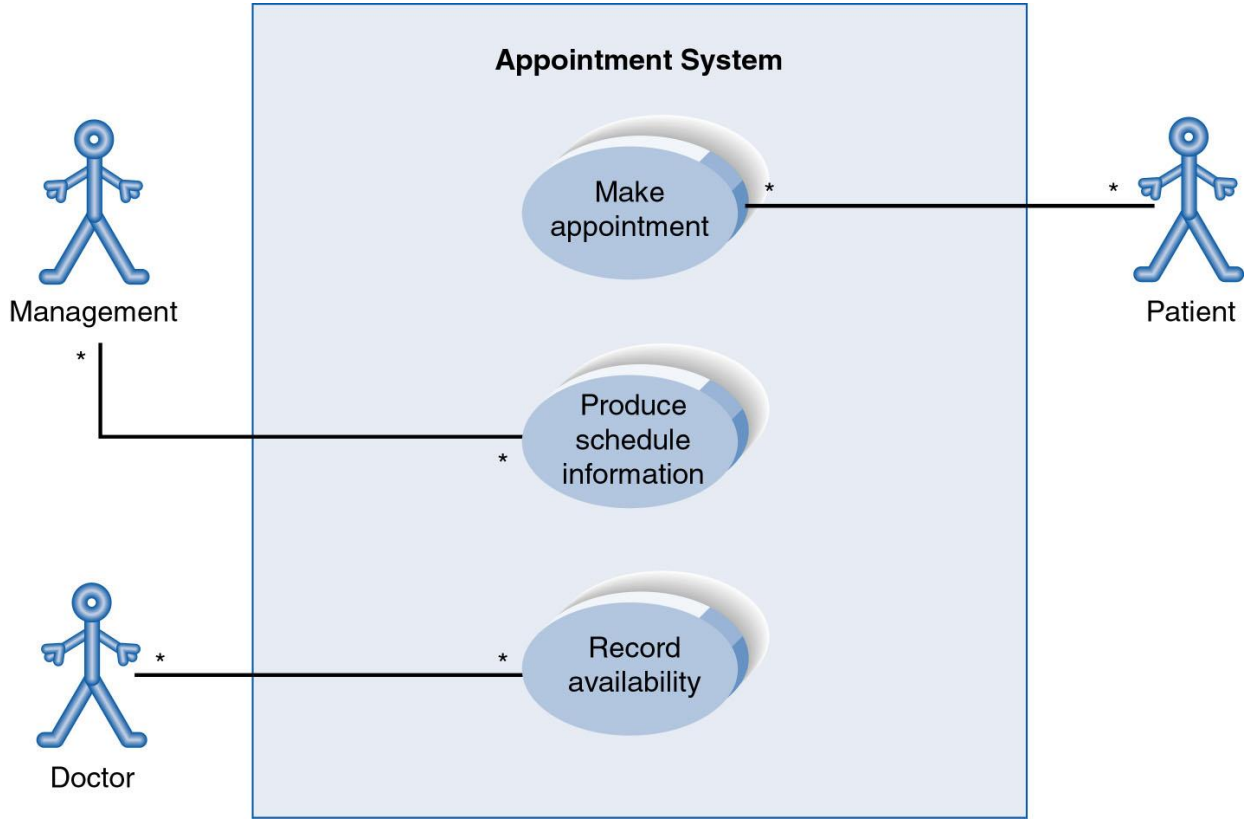
- The picture below is a **Make Appointment** use case for the medical clinic.
- The actor is a **Patient**. The connection between actor and use case is a **communication**
- Actors are stick figures
- Use cases are ovals
  - Labelled using a descriptive verb-noun phrase
- Communications are lines that link actors to use cases
- Boundary rectangle is placed around the perimeter of the system to show how the actors communicate with the system



Source: http://www.cs.fsu.edu/~baker/swe1/restricted/notes/ppt/UseCaseDiagrams.ppt

Use Case Diagram

- A use case diagram is a collection of actors, use cases, and their communications



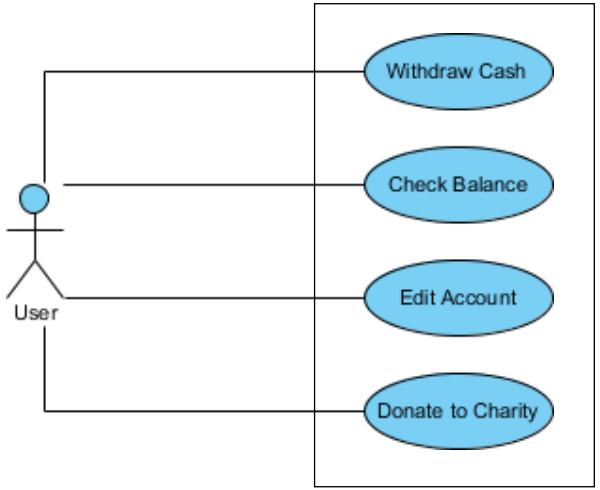
Source: http://www.cs.fsu.edu/~baker/swe1/restricted/notes/ppt/UseCaseDiagrams.ppt

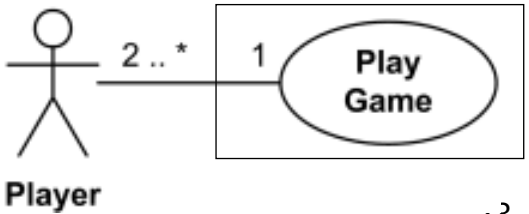
Relationships for Use Cases

- Association
- Generalization
- Extend
- Include

Association Relationship

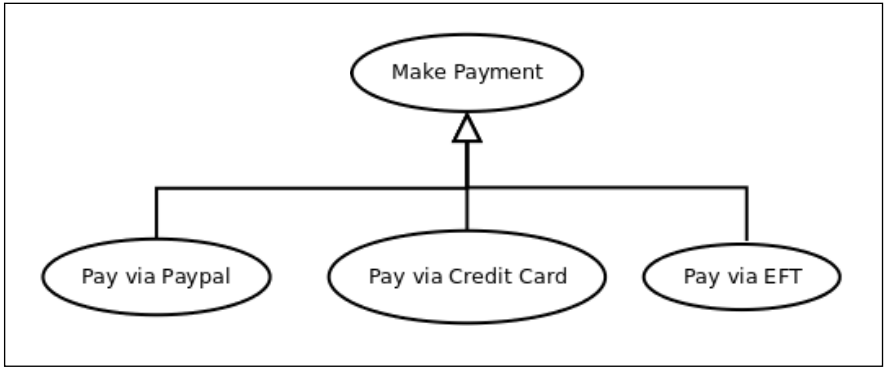
- Exists only between an actor and a use case
  - Indicates that an actor can use certain functionality of the system
- Represented by a sold line without arrowhead
  - Most commonly used representation
  - Uncommon to show one-way association
- The association between an actor and a use case can also show multiplicity at each end

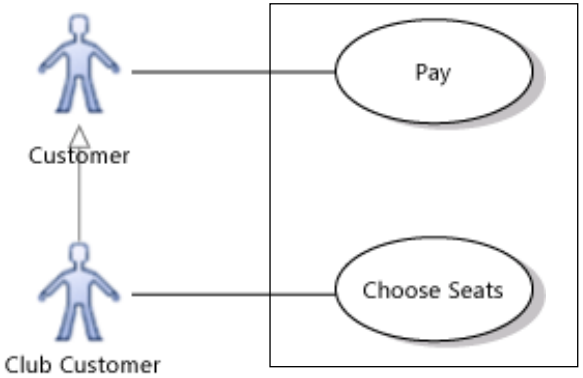




Generalization Relationship

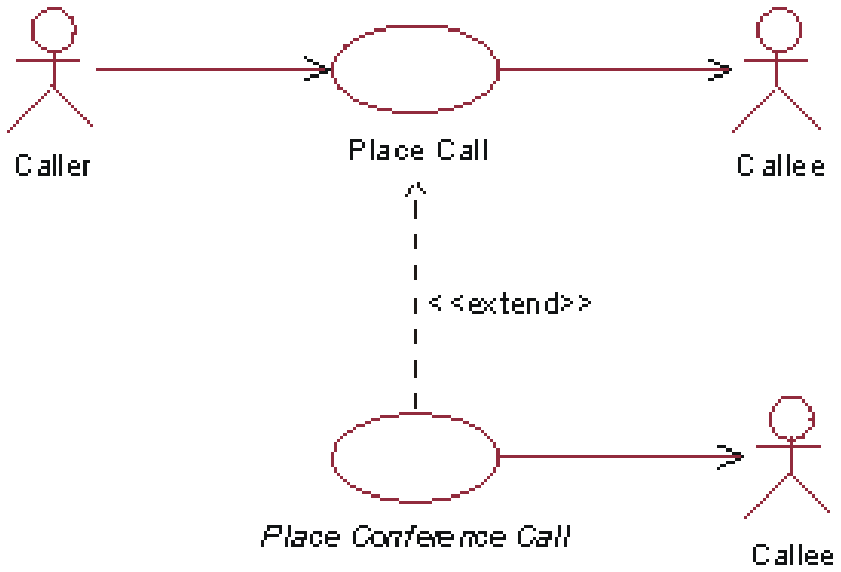
- Could exit between two actors or between two use cases
  - Indicates parent/child relationship
- Represented by a solid line with a triangular and hollow arrowhead
  - From child to parent





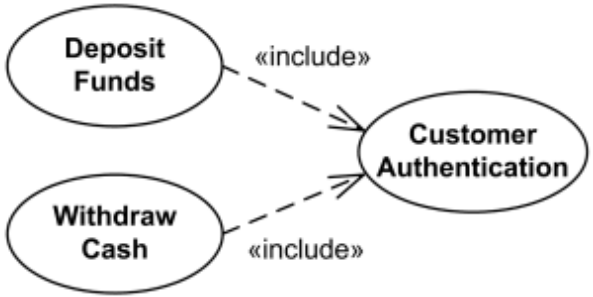
Extend Relationship “<<extend>”

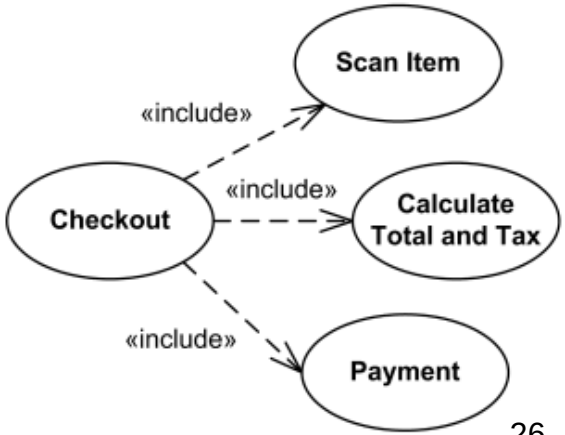
- Exists only between use cases
  - This relationships represent optional or seldom invoked cases
  - Indicates that although one use case is a variation of another but it is invoked rarely
    - Lot of shared code between these use cases **(not to be confused with inheritance)**
- Represented using a dashed arrow with an arrowhead. The notation “<< extend >>” is also mentioned above the arrow
  - The direction of the arrow is toward the extended use cases



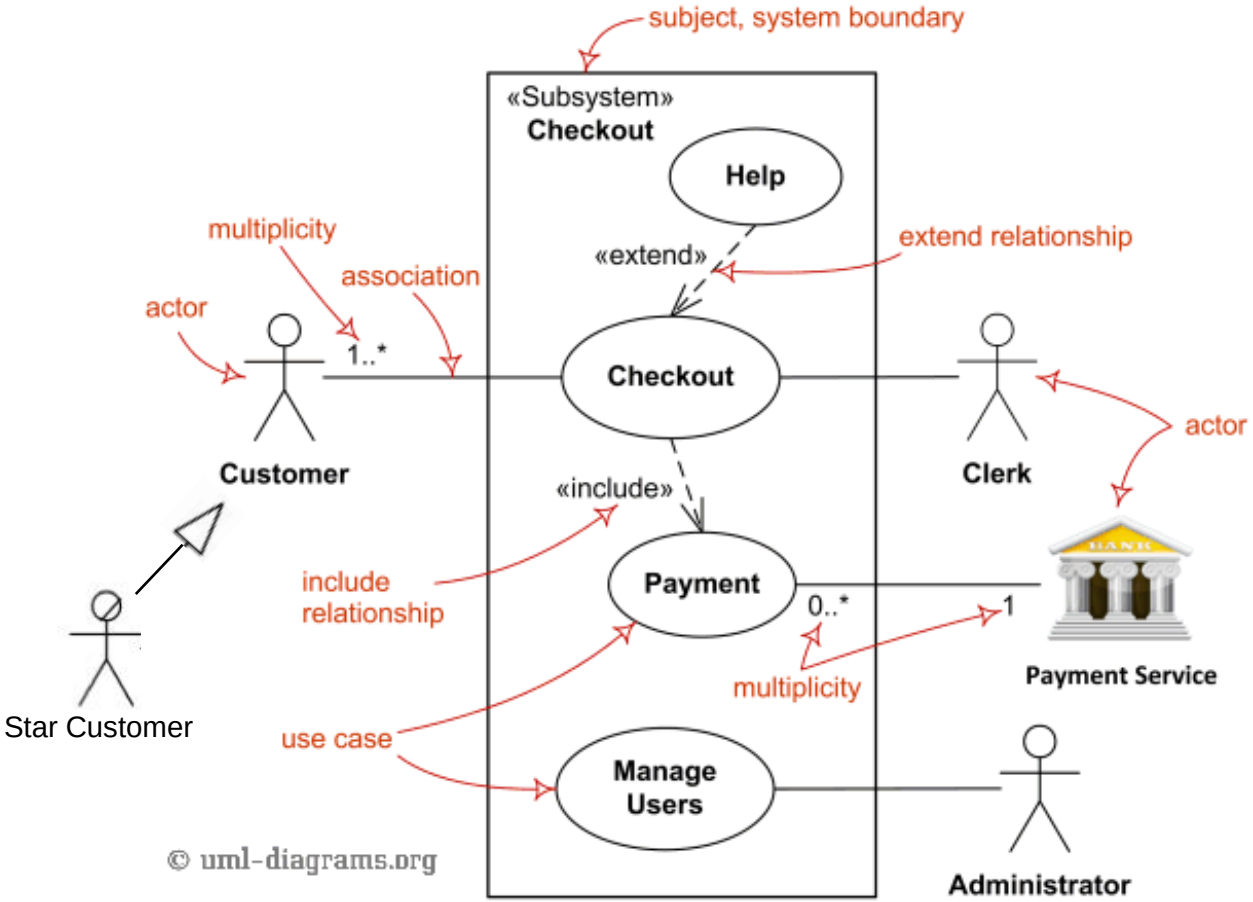
Include Relationship “<<include>”

- Exists only between use cases
  - Represents behavior that is factored out of the use case
  - Doesn’t mean that the factored out use case is an optional or seldom invoked cases
- Represented using a dashed arrow with an arrowhead. The notation “<< include>>” is also mentioned above the arrow
  - The direction of the arrow is toward the included use case

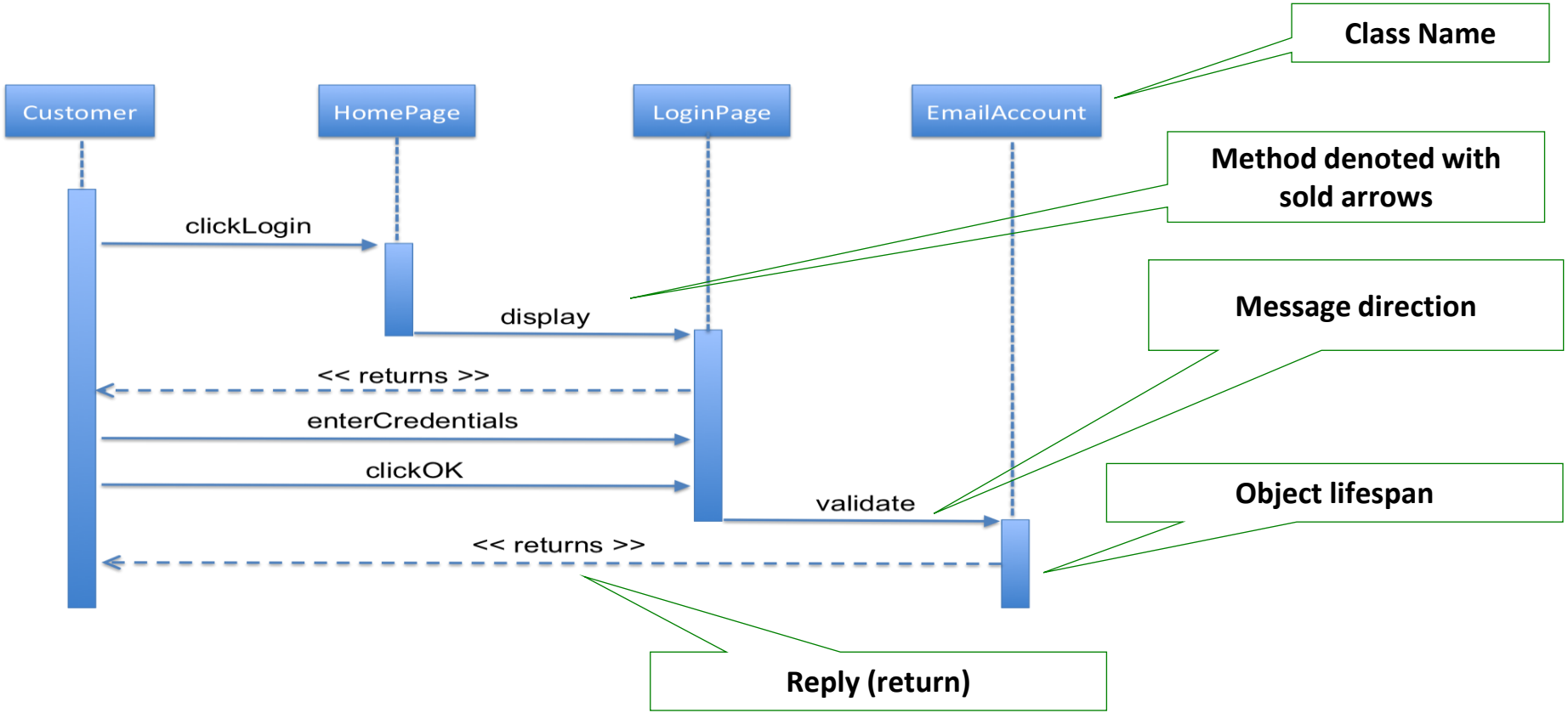




Sample Use Case

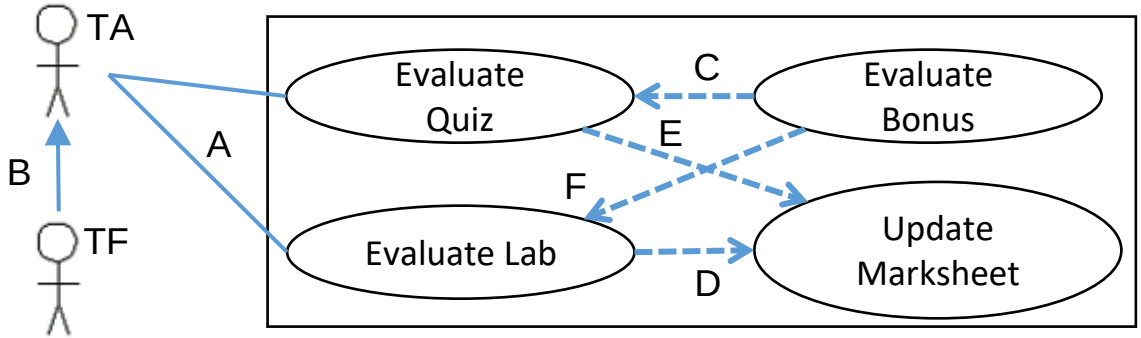


Sequence Diagram



Next Lecture

- Event driven programming using JavaFX


TA
TF
B
A
Evaluate
Quiz
Evaluate
Bonus
C
E
F
Evaluate Lab
Update
Marksheet
D