SOFTWARE DESIGN
COSC 4353 / 6353

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UML - HISTORY

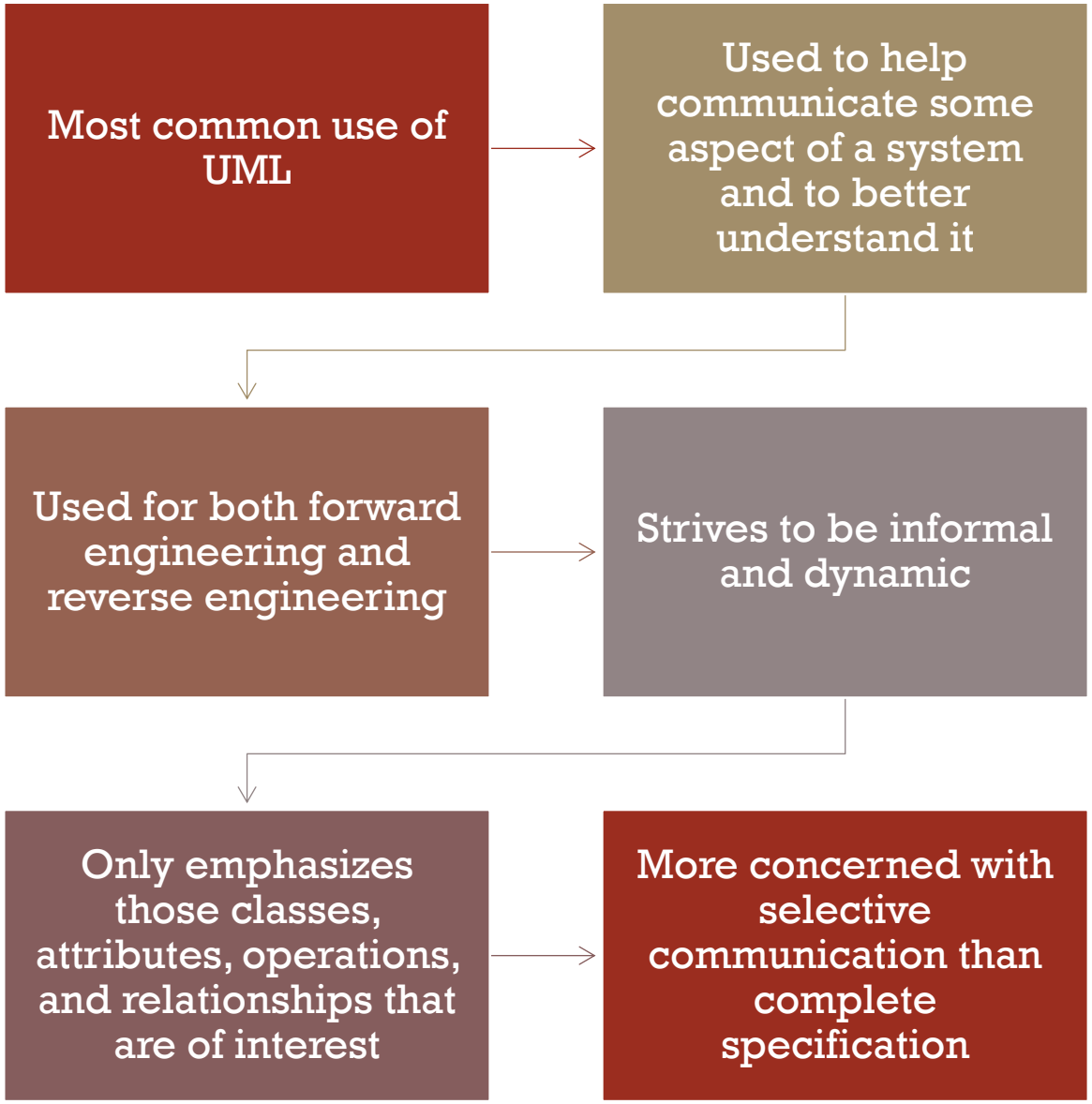
The Unified Modeling Language (UML) is a general purpose modeling language designed to provide a standard way to visualize the design of a system.

Created and developed by Grady Booch, Ivar Jacobson and James Rumbaugh at Rational Software during 1994–95 with further development led by them through 1996.

In 1997 it was adopted as a standard by the Object Management Group (OMG)

In 2000 UML was also accepted by the International Organization for Standardization(ISO) as an approved ISO standard.

UML AS A SKETCH



UML AS A BLUEPRINT

- Goal is completeness
- It is more definitive, while the sketch approach is more explorative
- Used to describe a detailed design for a programmer to follow in writing source code
- Notation should be sufficiently complete so that a software engineer can follow it
- It can be used by a designer to develop blueprint-level models that show interfaces of subsystems or classes
- As a reversed engineered product, diagrams convey detailed information about the source code that is easier for software engineers to understand

UML AS A PROGRAMMING LANGUAGE

- Specifies the complete system in UML so that code can be automatically generated
- Looks at UML from a software perspective rather than a conceptual perspective
- Diagrams are compiled directly into executable code so that the UML becomes the source code
- Challenge is making it more productive to use UML rather than some another programming language
- Another concern is how to model behavioral logic
  - Done with interaction diagrams, state diagrams, and activity diagrams

WAYS OF USING - COMPARISON

UML sketches are useful with both forward and reverse engineering and in both conceptual and software perspectives

Detailed forward engineering blueprints are difficult to do well and slow down the development effort

Actual implementation of interfaces will reveal the needs for changes

The value of reversed engineered blueprints depends on the CASE tool

A dynamic browser would be very helpful; a thick document wastes time and resources

UML as a programming language will probably never see significant usage

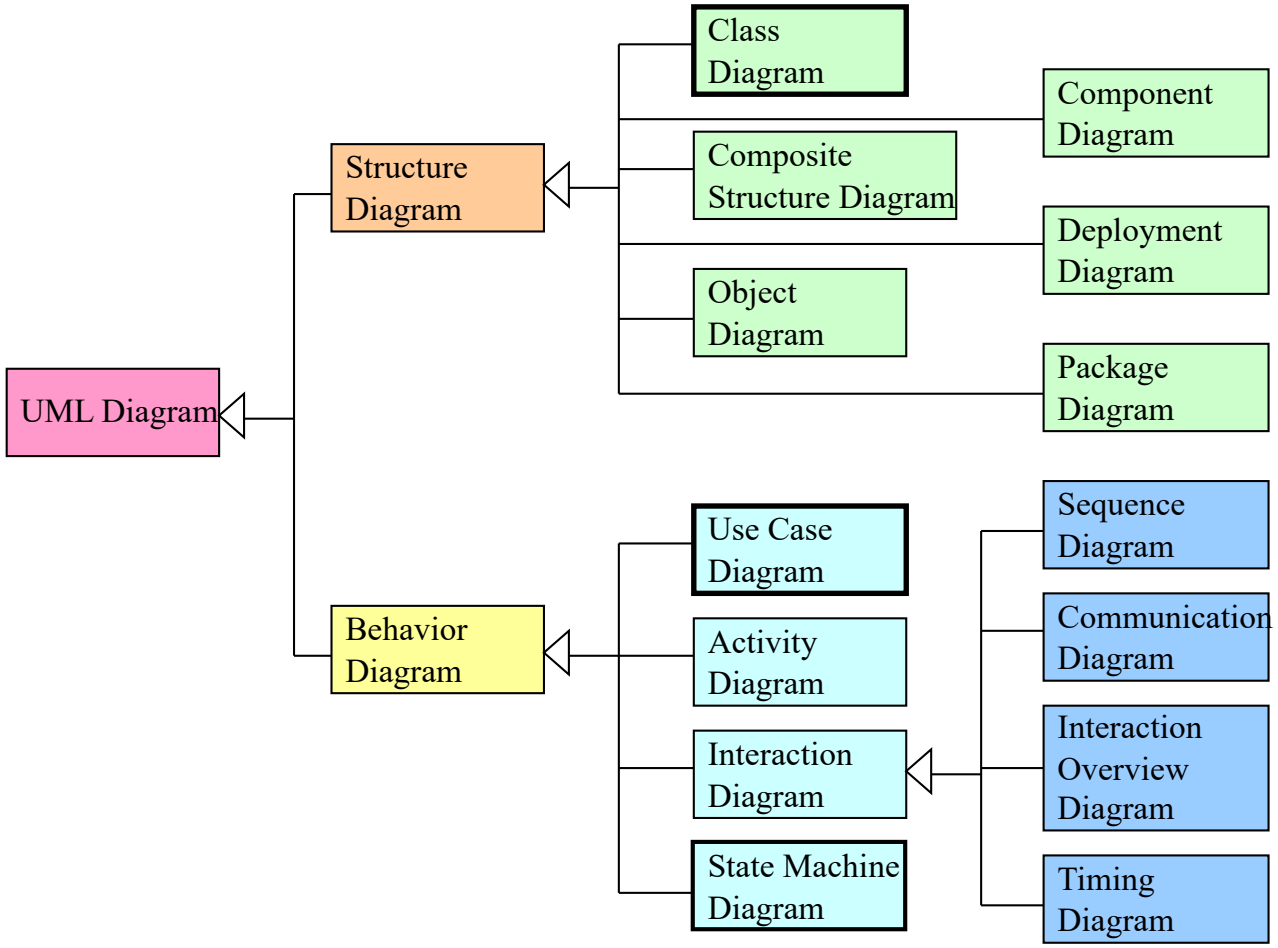
Graphical forms have not shown to be more productive in writing code than textual code for most programming tasks

TYPES OF UML DIAGRAMS

DIAGRAM NAME	PURPOSE
Activity	Models procedural and parallel behavior
Class	Models classes, attributes, operations and relationships
Communication	Models interaction between objects
Component	Models structure and connection of components
Composite Structure	Models runtime decomposition of a class
Deployment	Models deployment of artifacts to nodes
Interaction overview	Mixes the sequence and activity diagram

TYPES OF UML DIAGRAMS (CONTINUED)

DIAGRAM NAME	PURPOSE
Object	Models example configurations of instances
Package	Models compile-time hierarchical structure
Sequence	Models sequence interaction between objects
State Machine	Models how events change an object over its life
Timing	Models timing interaction between objects
Use Case	Models how users interact with a system



CLASSIFICATION OF DIAGRAM TYPES

SCENARIO-BASED MODELING

Use case / scenario defines how a user uses a system to accomplish a particular goal.

A modeling technique that defines the features to be implemented and the resolution of any errors that may be encountered.

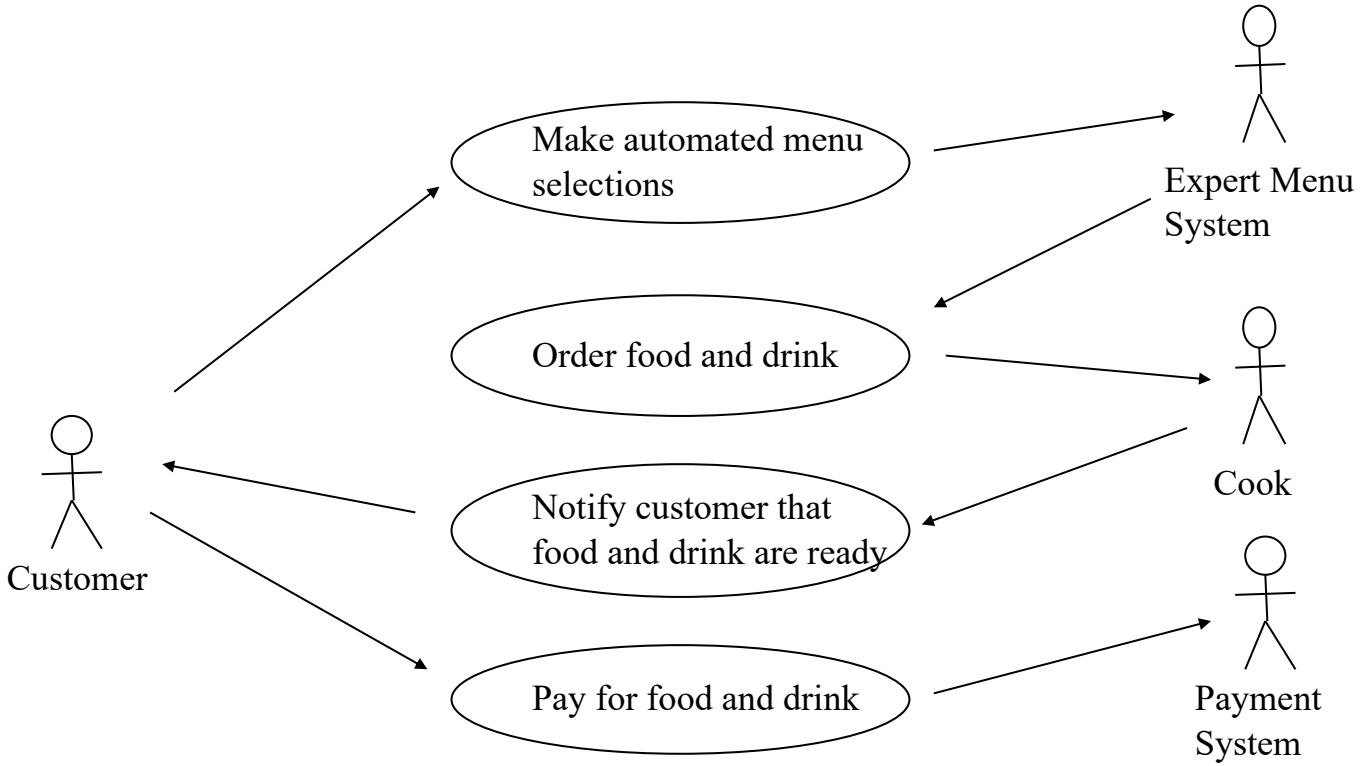
A methodology used in system analysis to identify, clarify, and organize system requirements.

A set of possible sequences of interactions between systems and users in a particular environment and related to a particular goal.

DEVELOPING A USE-CASE

- What are the main tasks or functions that are performed by the actor?
- What system information will the the actor acquire, produce or change?
- Will the actor have to inform the system about changes in the external environment?
- What information does the actor desire from the system?
- Does the actor wish to be informed about unexpected changes?

USE-CASE DIAGRAM EXAMPLE



EXCEPTIONS

Describe situations that may cause the system to exhibit unusual behavior

Brainstorm to derive a reasonably complete set of exceptions for each use case

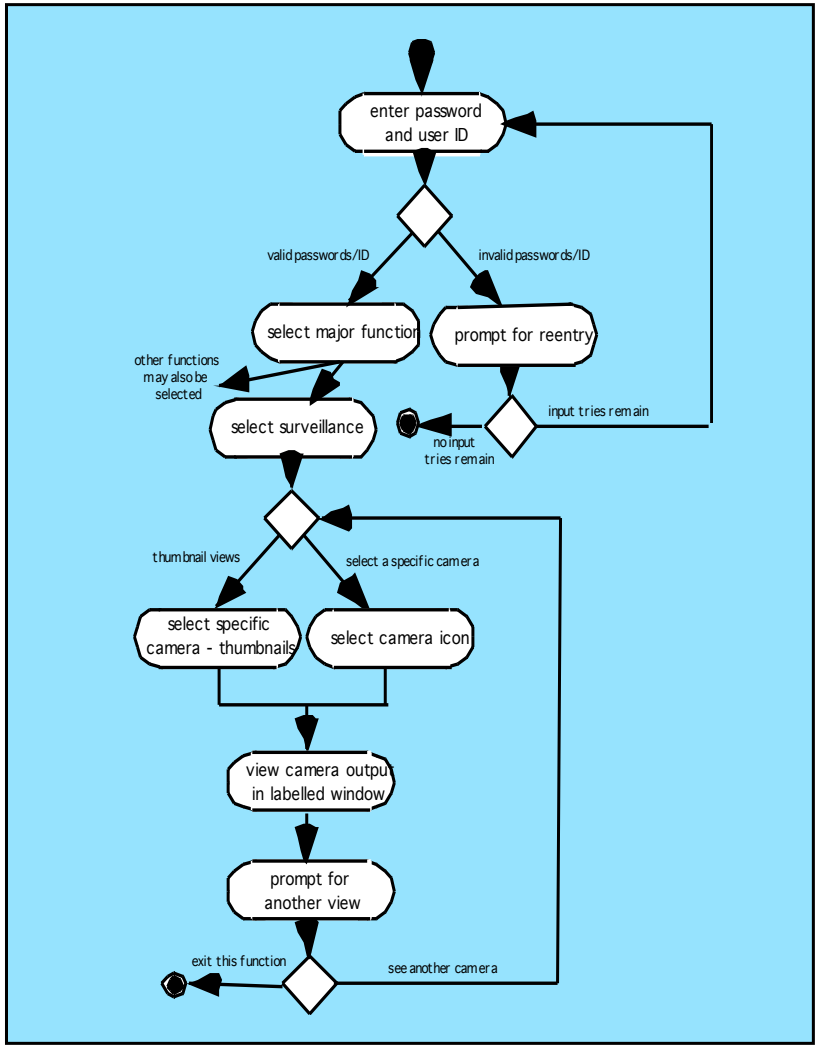
Are there cases where a validation function occurs for the use case?

Handling exceptions may require the creation of additional use cases

ACTIVITY DIAGRAM

Supplements the use case by providing a graphical representation

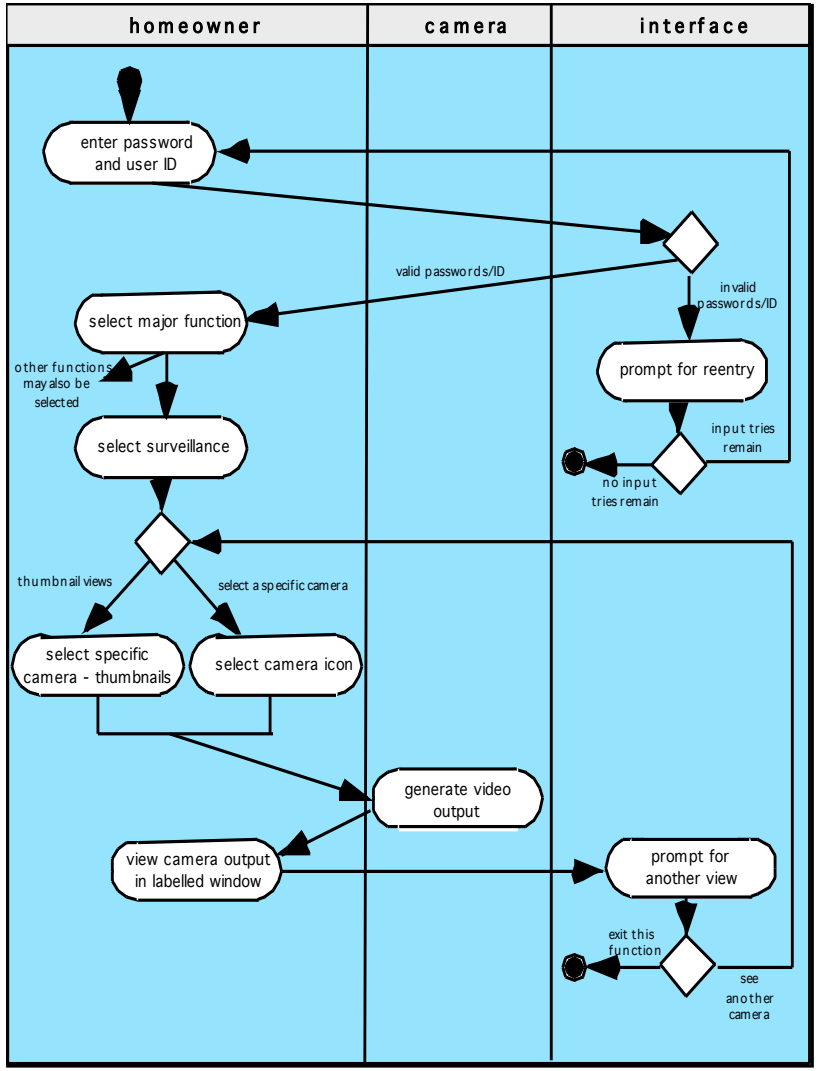
The flow of interaction between actor and the system within a specific scenario



SWIMLANE DIAGRAM

Allows the modeler to represent the flow of activities described by the use-case

Indicates which actor or analysis class has responsibility for the action described by an activity rectangle



CLASS-BASED MODELING

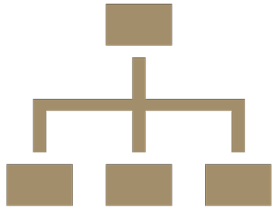
Class-based modeling represents

objects that the system will manipulate

operations (also called methods or services)

relationships between the objects

collaborations that occur between the classes



The elements of a class-based model include

classes and objects

attributes and operations

collaboration diagrams and packages

IDENTIFYING CLASSES

Classes are determined by underlining each noun or noun phrase and entering it into a simple table

If the class is required to implement a solution, then it is part of the solution space;

If a class is necessary only to describe a solution, it is part of the problem space.

MANIFESTATIONS OF CLASSES

External entities

- (e.g. other systems, devices, people) that produce or consume information

Things

- (e.g. reports, displays, letters, signals) that are part of the information domain for the problem

Occurrences or events

- (e.g. completion of actions) that occur within the context of system operation

Roles

- (e.g. manager, engineer, salesperson) played by people who interact with the system

Organizational units

- (e.g. division, group, team) that are relevant to an application

Places

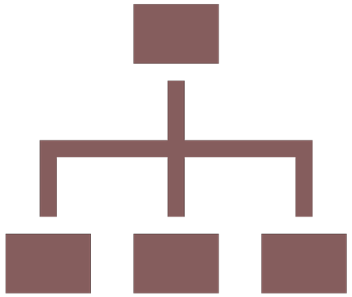
- (e.g. manufacturing floor) that establish the context of the problem and the overall function

Structures

- (e.g. sensors, computers) that define a class of objects or related classes of objects

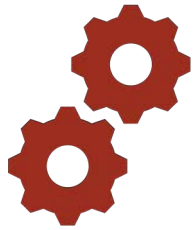
DEFINING ATTRIBUTES

Attributes describe a class that has been selected for inclusion in the analysis model.



Attributes describe the structure and value of an instance of a class.

DEFINING OPERATIONS



An operation is a method or function that can be performed by a class.

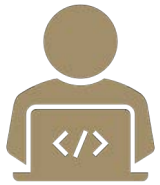
Operations define the behavior of a class, what a class can do.

Operations can perform computation, take an action, call another method, etc.

CLASS TYPES

Entity classes

also called model or business classes, are extracted directly from the statement of the problem



Boundary classes

are used to create the interface that the user sees and interacts with the software

Controller classes

manage a "unit of work" from start to finish

RESPONSIBILITIES

System intelligence should be distributed across classes to best address the needs of the problem

Each responsibility should be stated as generally as possible

Information and the behavior related to it should reside within the same class

Information about one thing should be localized with a single class, not distributed across multiple classes.

Responsibilities should be shared among related classes, when appropriate.

COLLABORATIONS

Classes fulfill their responsibilities in one of two ways:

- a class can use its own operations to fulfill a particular responsibility
- a class can collaborate with other classes

Collaborations identify relationships between classes

Collaborations are identified by determining whether a class can fulfill each responsibility itself

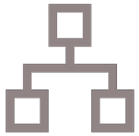
ASSOCIATION, AGGREGATION AND COMPOSITION

Association is a (*a*) relationship between two classes, where one class use another

Aggregation, a special type of an association, is the (*the*) relationship between two classes.

Association is non-directional, aggregation insists a direction.

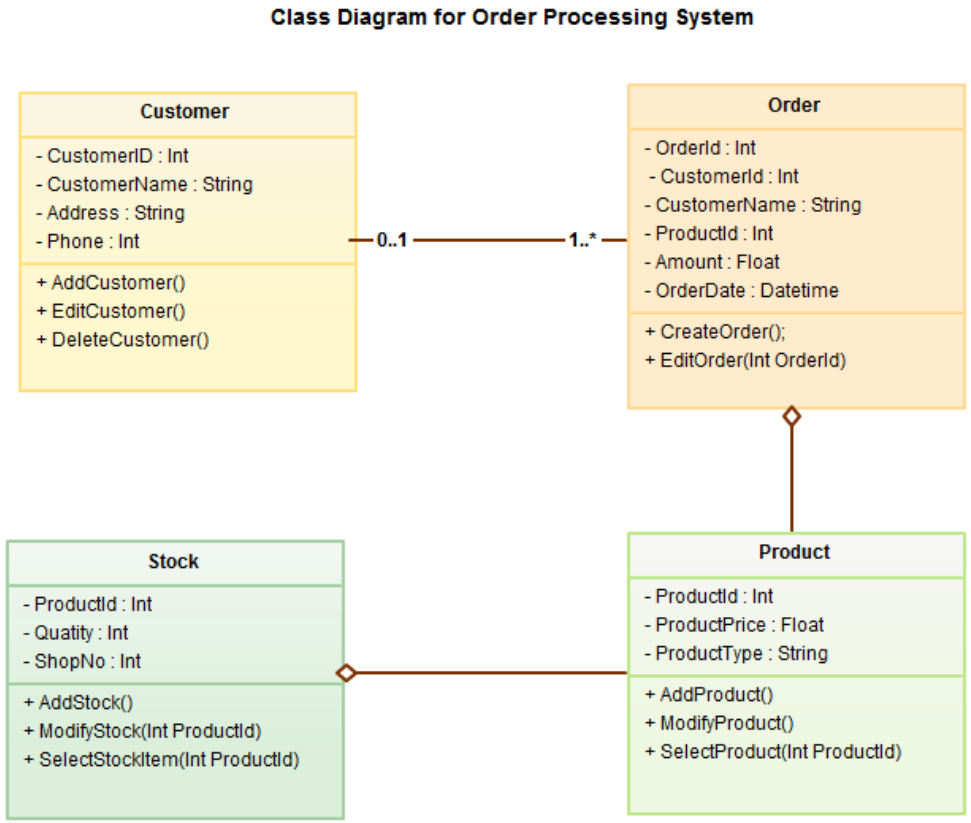
Composition can be recognized as a special type of an aggregation.

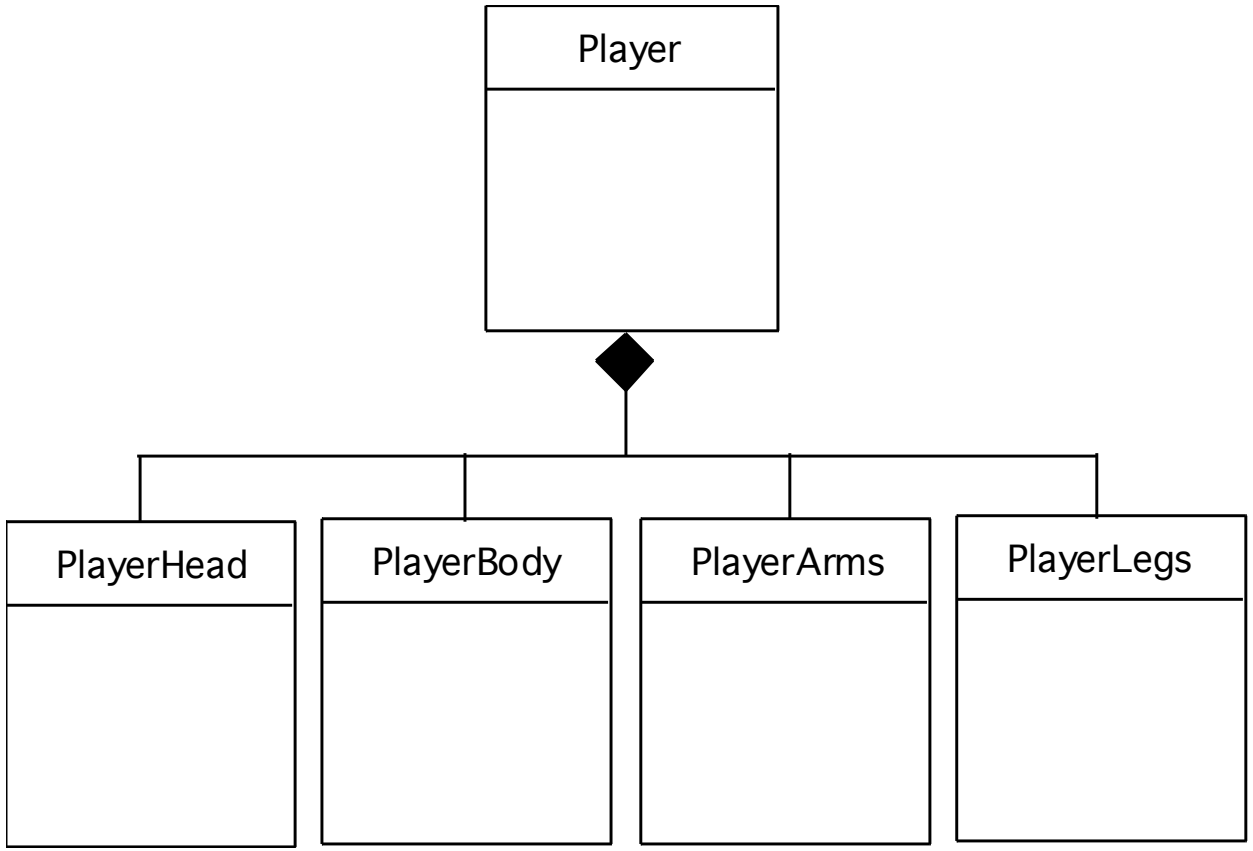


Aggregation is a special kind of an association and composition is a special kind of an aggregation.

Association →Aggregation →Composition

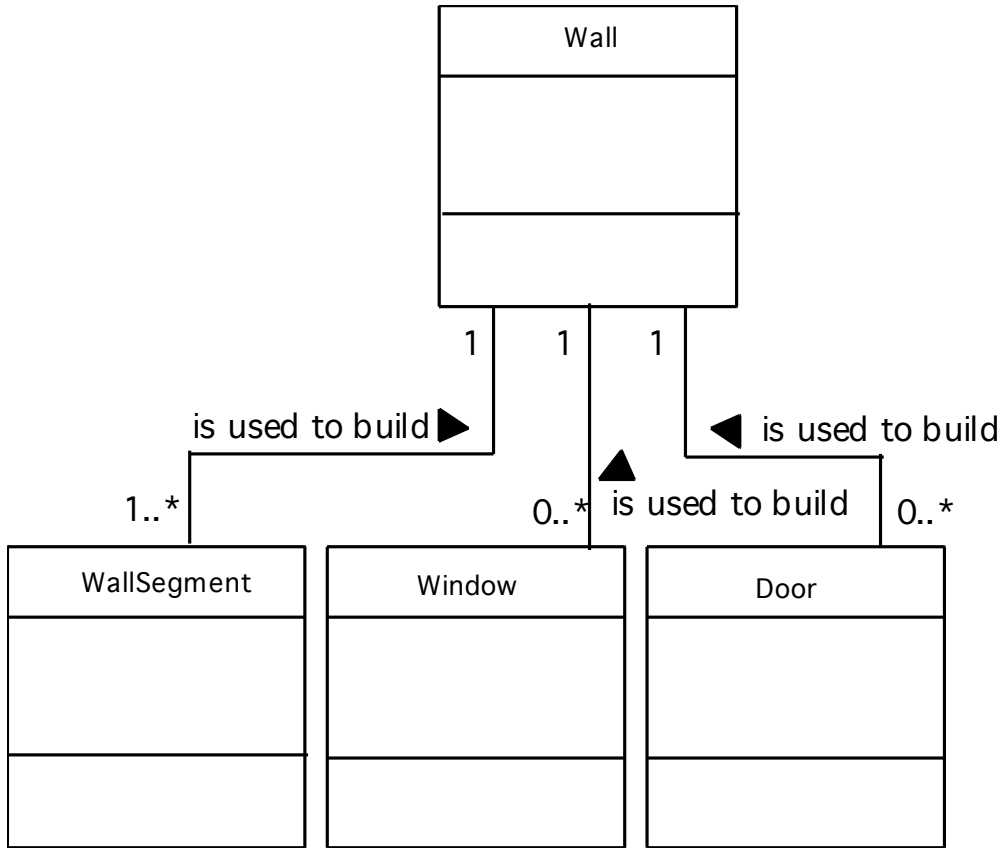
EXAMPLE CLASS DIAGRAM



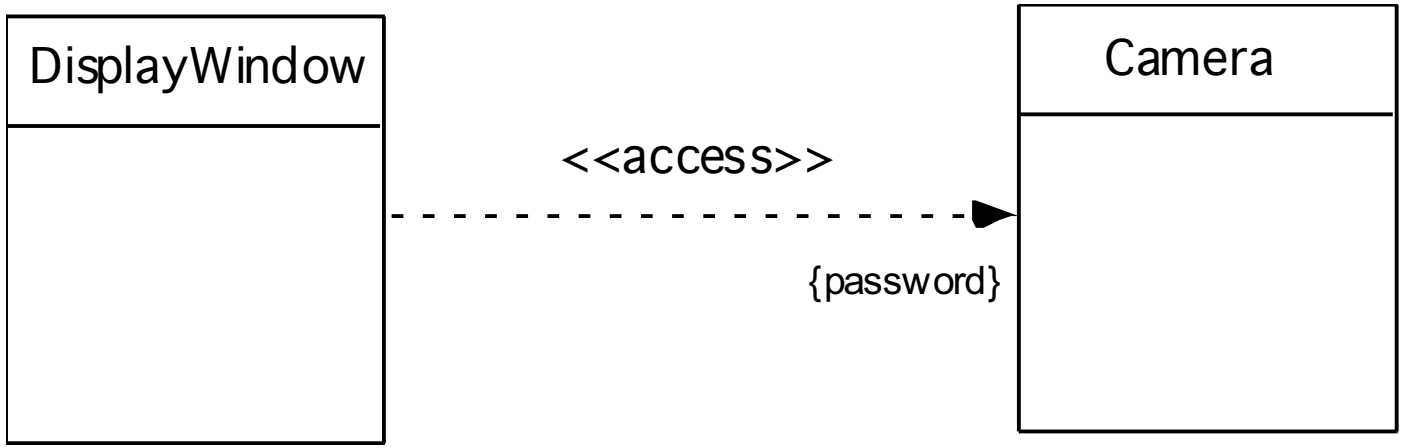


COMPOSITE AGGREGATE CLASS

MULTIPLICITY



DEPENDENCIES



A dependency exists between two elements if changes to the definition of one element (i.e., the source or supplier) may cause changes to the other element (i.e., the client)

BEHAVIORAL MODELING

- The behavioral model indicates how software will respond to external events.
- Evaluate all use-cases to fully understand the sequence of interaction within the system.
- Identify events that drive the interaction sequence and understand how these events relate to specific objects.
- Create a sequence for each use-case.
- Build a state diagram for the system.
- Review the behavioral model to verify accuracy and consistency.

STATE DIAGRAMS

In the context of behavioral modeling, two different characterizations of states must be considered:

- the state of each class as the system performs its function and
- the state of the system as observed from the outside as the system performs its function

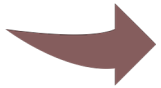
The state of a class takes on both passive and active characteristics:

- A passive state is simply the current status of all of an object's attributes.
- The active state of an object indicates the current status of the object as it undergoes a continuing transformation or processing.

THE STATES OF A SYSTEM

State

a set of observable circum-stances that characterizes the behavior of a system at a given time



State transition

the movement from one state to another

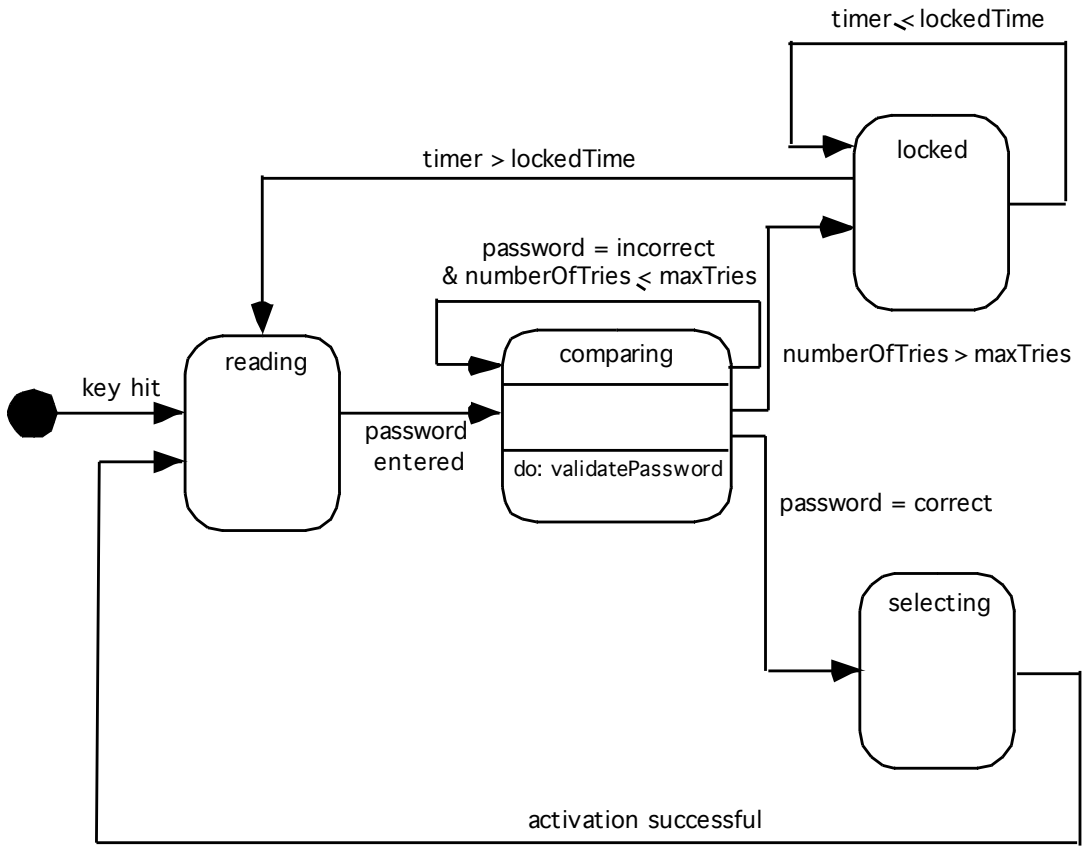
Event

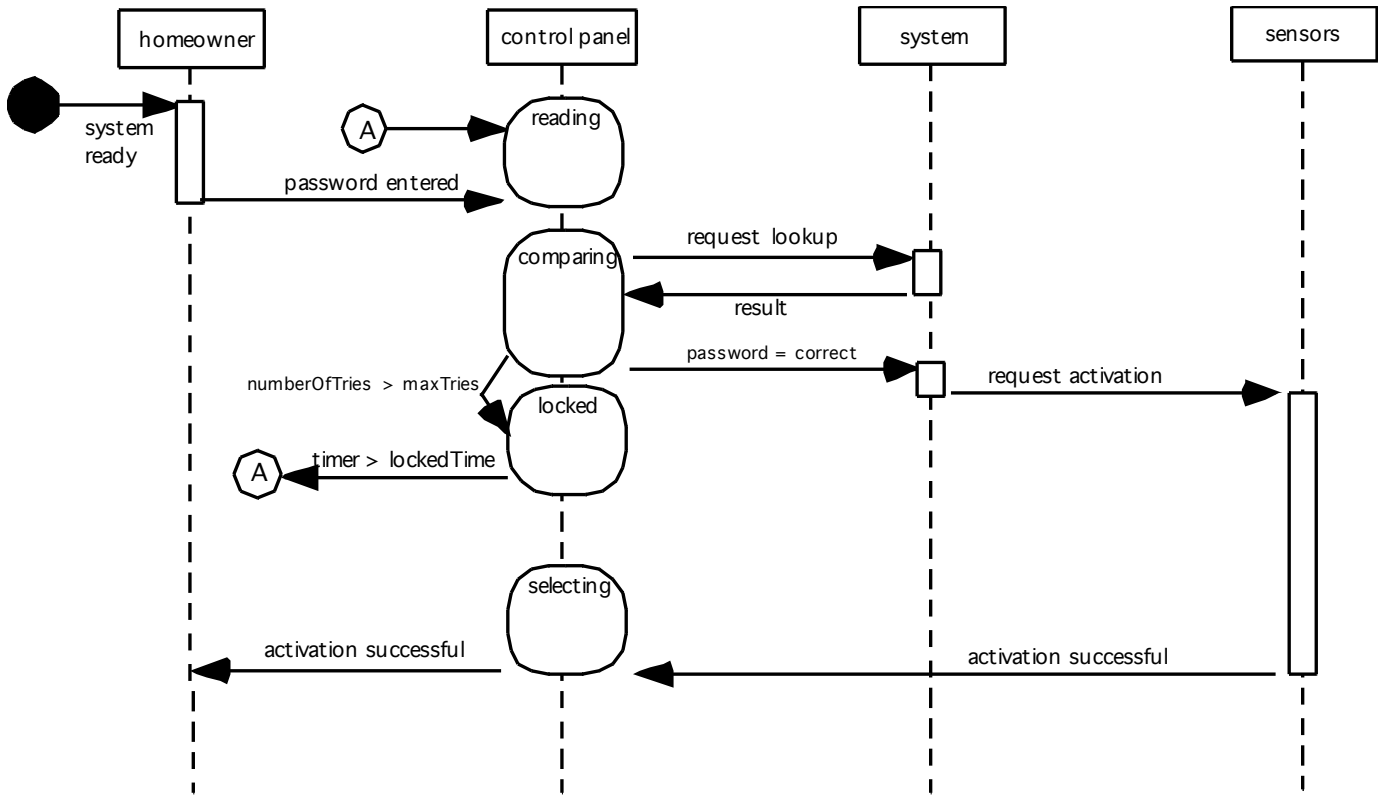
an occurrence that causes the system to exhibit some predictable form of behavior

Action

process that occurs as a consequence of making a transition

STATE DIAGRAM EXAMPLE



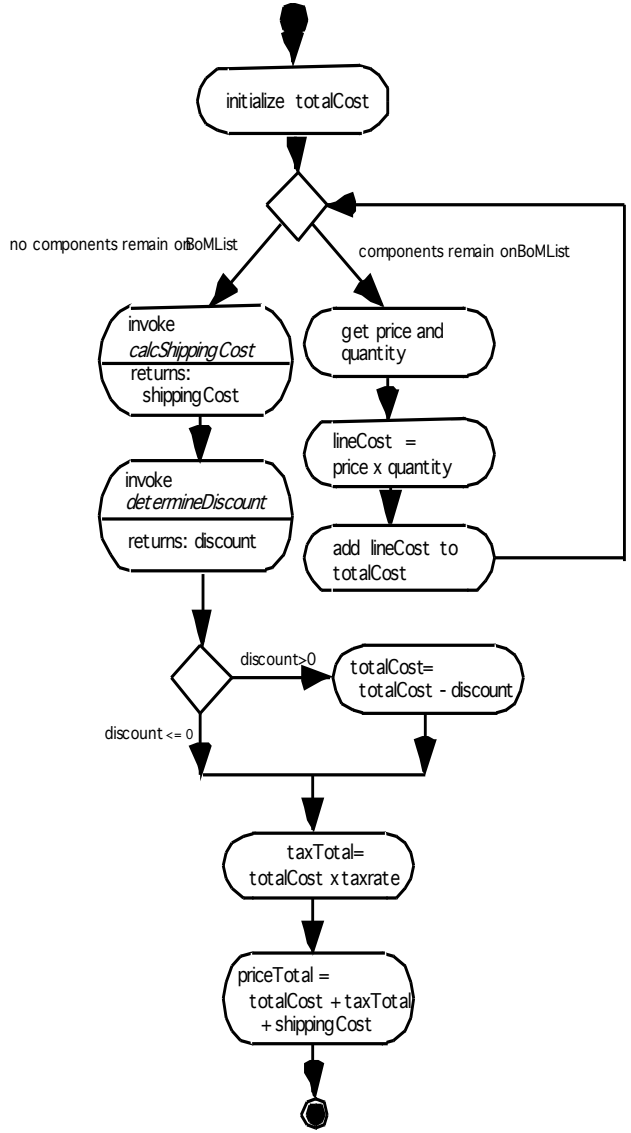


SEQUENCE DIAGRAM

ACTIVITY DIAGRAM

A flowchart to represent the flow from one activity to another activity.

The activity can be described as an operation of the system.

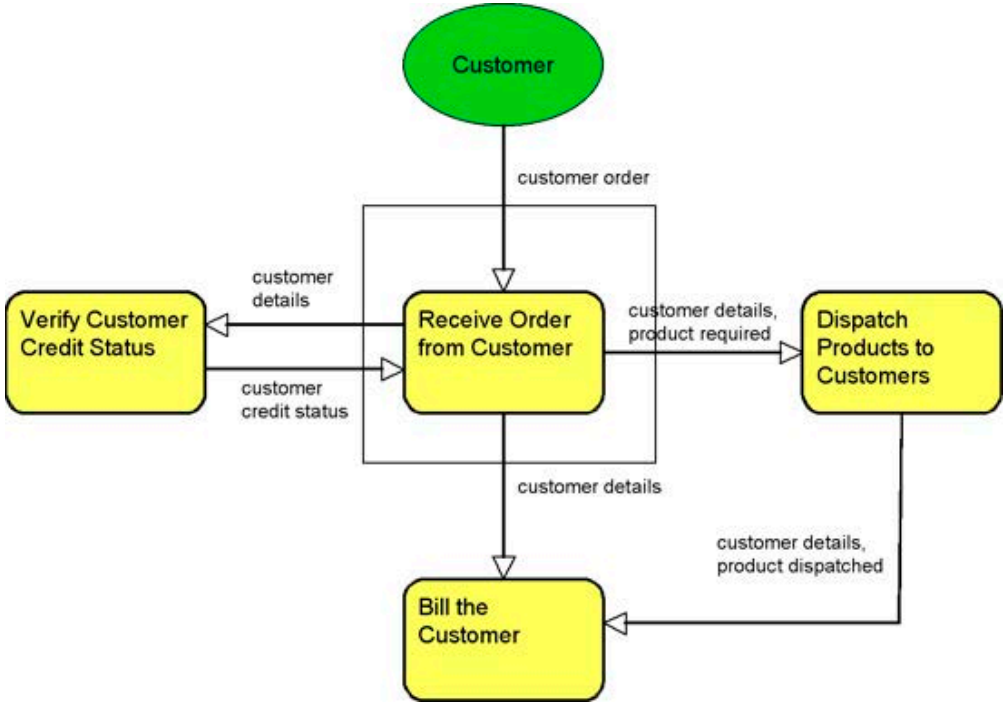


DATA FLOW DIAGRAM

A data-flow diagram is a way of representing a flow of a data of a process or a system.

The DFD also provides information about the output and input of each entity and the process itself.

A data-flow diagram has no control flow, there are no decision rules and no loops.



OBJECT DIAGRAM

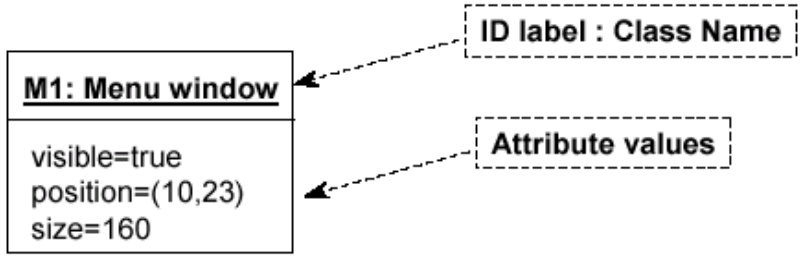
Represents a snapshot of the objects in a system at a point in time

Shows instances rather than classes, therefore it is sometimes called an instance diagram

When to use object diagrams

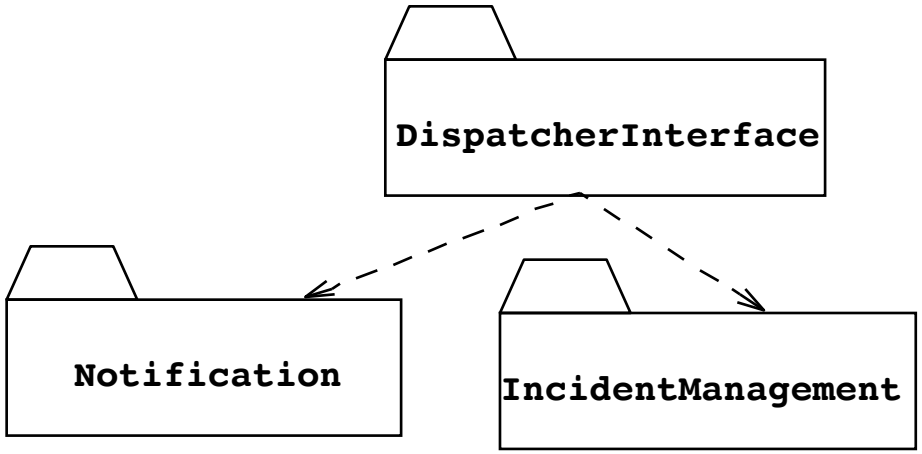
To show examples of objects connected together based on a specific multiplicity number

To show instances with values for their attributes



PACKAGE DIAGRAM

- Used to take any construct in UML and group its elements together into higher-level units
- Used most often to group classes
- Corresponds to the package concept in Java
- Represented by a tabbed folder, where the tab contains the package name
- Can show dependencies between packages



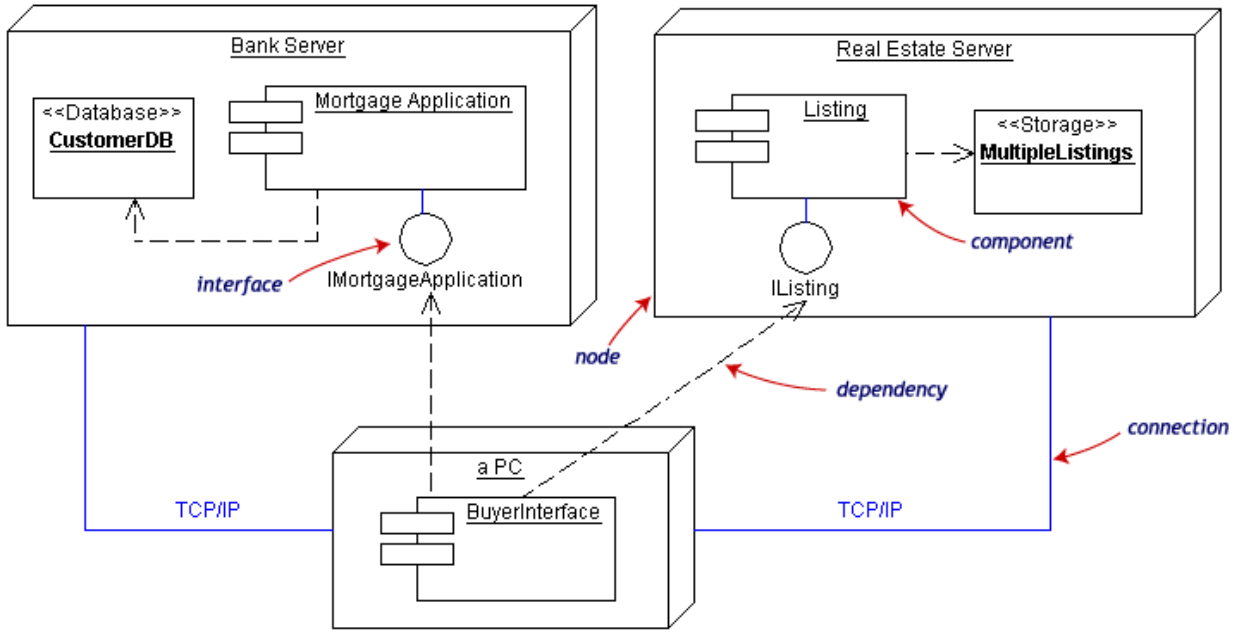
DEPLOYMENT DIAGRAM

Shows the physical architecture of the hardware and software of the deployed system

Typically contain components or packages

Physical relationships among software and hardware in a delivered systems

Explains how a system interacts with the external environment



FITTING UML INTO SOFTWARE REQUIREMENTS ANALYSIS

A use case diagram helps describe how people interact with the system

An activity diagram shows the context for use cases and also the details of how a complicated use case works

A class diagram drawn from the conceptual perspective is a good way of building up a rigorous vocabulary of the domain

It also shows the attributes and operations of interest in domain classes and the relationships among the classes

A state diagram shows the various states of a domain class and events that change that state

FITTING UML INTO SOFTWARE DESIGN

A class diagram drawn from the software perspective can show design classes, their attributes and operations, and their relationships with the domain classes

A sequence diagram helps to combine use cases in order to see what happens in the software

A package diagram shows the large-scale organization of the software

A state diagram shows the various states of a design object and events that change that state

A deployment diagram shows the physical layout of the software

FITTING UML INTO SOFTWARE DOCUMENTATION

- Complements the written documentation and in some instances can replace it
- Captures the outcome of the requirements analysis and design activities in a graphical format
- Supplies a software maintainer with an overall understanding of a system
- Provides a good logical roadmap of the system layout
- [@] Describes the various states in which a system may exist
- Details complex algorithms in a more understandable form
- Shows how multiple objects collaborate in the system

HOMEWORK

Review class notes.

Additional reading:

Examples of UML diagrams

Start a discussion on Google Groups to clarify your doubts.