UML Fundamental

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OutLine

- Use-case diagram
- Class diagram
- Sequence diagram
- Communication diagram
- State machine
- Activity diagram

What is UML?

- **U**nified **M**odeling **L**anguage

  In short, the Unified Modeling Language (UML) provides industry standard mechanisms for visualizing, specifying, constructing, and documenting software systems.

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Usable Model

- Accurate.
- Understandable.
- Consistent.
- Modifiable.

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UML Features

- Views.
- Diagrams.
- Model elements.
- General mechanisms.
- Model Driven Architecture (MDA) features.

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Features - Views

- Use-case view.
- Logical view.
- Implementation view.
- Process view.
- Deployment view.

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Features - Diagrams

UML 2.0 has 13 types of diagrams, which can be categorized hierarchically as follows:

- Structure diagrams
- Behavior diagrams
- Interaction diagrams

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Structure diagrams

Emphasize what things must be in the system being modeled.

- Class diagram
- Component diagram
- Composite structure diagram
- Deployment diagram
- Object diagram
- Package diagram

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Behavior diagrams

Emphasize what must happen in the system being modeled.

- Activity diagram
- State Machine diagram
- Use case diagram

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Interaction diagrams

A subset of behavior diagrams, emphasize the flow of control and data among the things in the system being modeled.

- Communication diagram
- Interaction overview diagram (UML 2.0)
- Sequence diagram
- UML Timing Diagram (UML 2.0)

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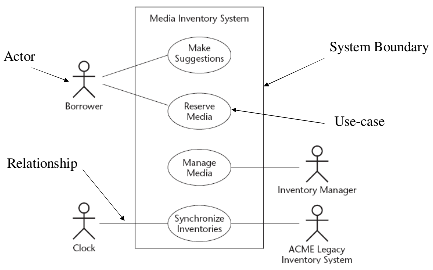
Use-case diagram



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System & Actors

- System
  - The boundaries of the system, or subject, developed are defined. The system can itself be a classifier, or subject, that owns the set of use cases.
- Actors
  - someone or something that interacts with the system; it’s who or what uses the system.

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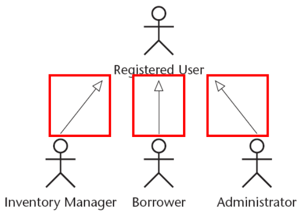
Relationships between Actors



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Use Cases

- A use case represents functionality for an actor. A use case in UML is defined as
  - “a set of actions performed by a system, which yields an observable result that is, typically, of value for one or more actors or other stakeholders of the system.”

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Characteristics of a use case

- A use case is always initiated by an actor.
- A use case provides value to an actor.
- A use case is complete.

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Relationships between Use Cases

There are three types of relationships between use cases:

- Generalization
- Extend
- Include

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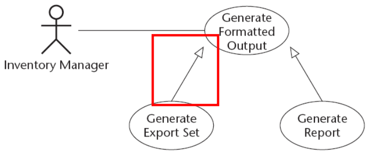
Generalization Relationship



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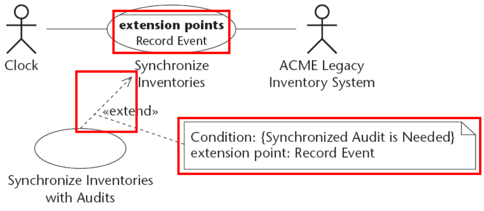
Extend Relationship



Condition: {Synchronized Audit is Needed}
extension point: Record Event

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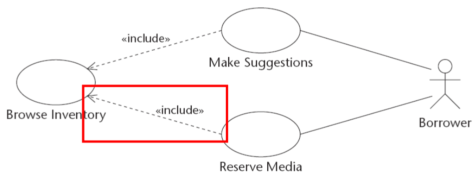
Extend Relationship (Cont.)

Don’t overdo it, but the extend relationship can come in handy in two distinct situations:

- When a system to be developed will potentially be deployed with varying sets of optional behavior
- When the deployment schedule of a system’s use cases requires deployment of functional, though not complete, use cases

Include Relationship



Include Relationship (Cont.)

- When a number of use cases have common behavior, this behavior can be modeled in a single use case that is included by the other use cases.
- When a use case includes another, the entire use case must be included.
- The idea of the include relationship is to model common behavior, such as logging information, that many use cases depend on, or "include."

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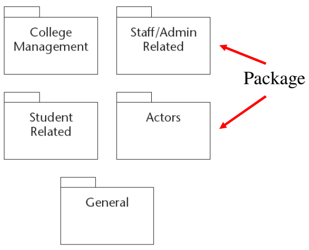
Organizing Use Cases



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Organizing Use Cases (Cont.)

- Use cases and actors can and often are placed into a substantial package structure.
- It is often useful to organize them along either functional lines or by use cases performed by specific actors.

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Class Diagram

- A class diagram describes the static view of a system in terms of classes and relationships among the classes.

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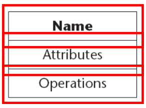
Class

A class is drawn with a rectangle, often divided into three compartments:

– The name compartment

– The attributes compartment

– The operations compartment



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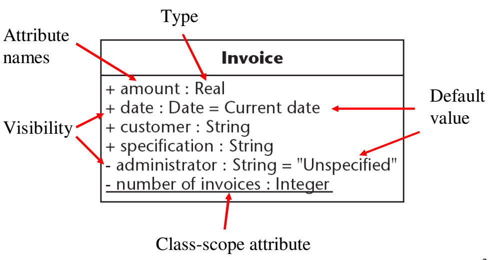
Attributes Compartment



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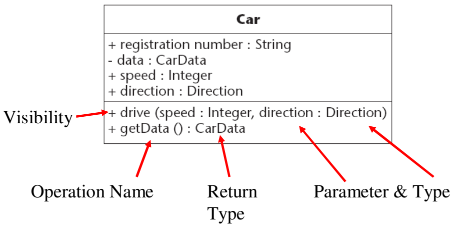
Operations Compartment



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Class relationships

- Association
- Generalization
- Dependency
- Abstraction

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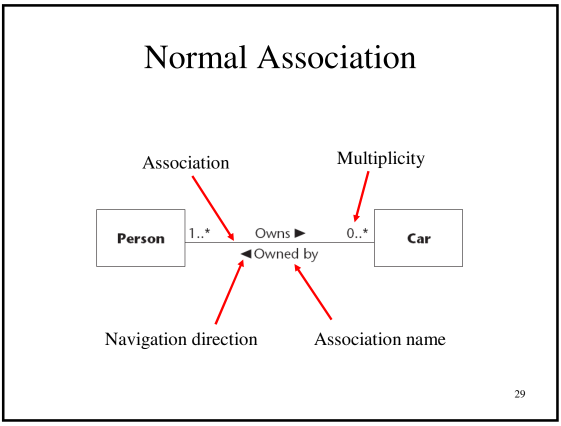
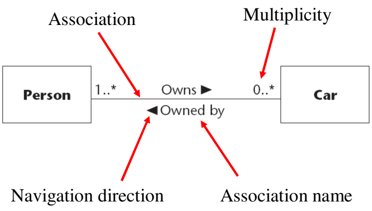


Normal Association



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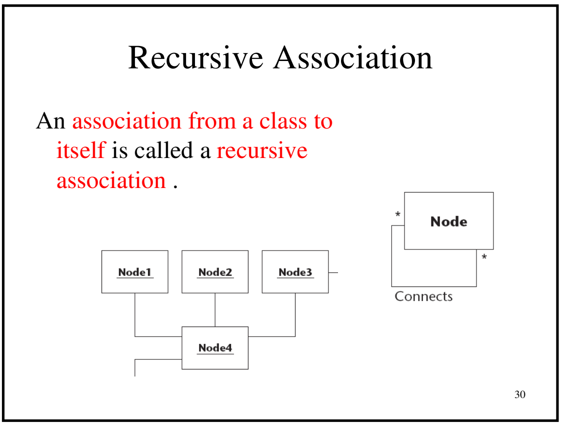
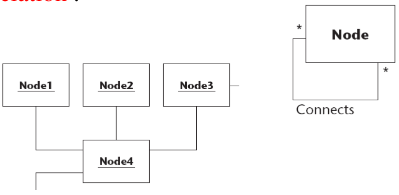


Recursive Association

An association from a class to itself is called a recursive association .



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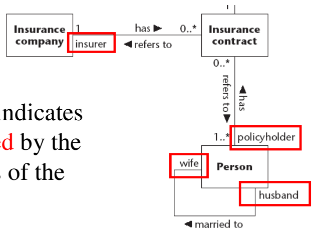
Roles in an Association



The role name indicates the role played by the class in terms of the association.

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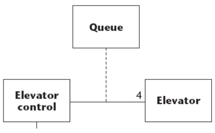
Association Class

- A class can be attached to an association, in which case it is called an *association class*.



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Aggregation

- Aggregation is a special case of association. The aggregate indicates that the relationship between the classes is some sort of "**whole-part**."
- Often describes different levels of abstraction (car consists of wheels, engine, and so on).

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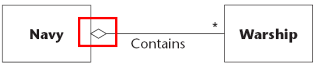
Shared Aggregation

- A shared aggregation is one in which the parts may be parts in any wholes. That an aggregation is shared is shown by its multiplicity.



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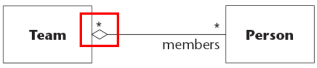
Shared Aggregation (Cont.)

- The aggregation is shared if the multiplicity on the whole side is other than one (1).
- Shared aggregation is a special case of a normal aggregation.



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Composition Aggregation

- A composition aggregation **owns** its parts.
- The composition aggregation is one with strong ownership. **The parts "live" inside the whole**; they will be destroyed together with its whole.

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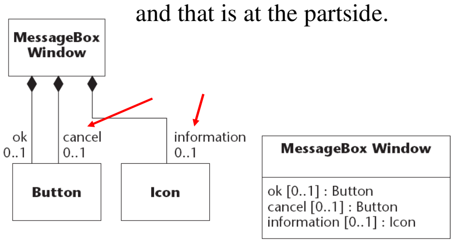
Composition Aggregation (Cont.)

An aggregate has only one role name, and that is at the partside.



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Generalization

UML defines generalization as follows:

- A taxonomic relationship (classified) between a more general classifier and a more specific classifier.
- Each instance of the specific classifier is also an instance of the general classifier.
- Thus, the specific classifier indirectly has features of the more general classifier.

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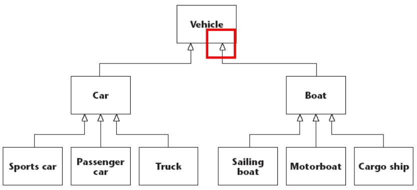
Generalization (Cont.)



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Generalization (Cont.)

- Generalization shows a close relationship between a general and a specific class. The specific class, called the subclass, inherits everything from the general class, called the superclass.
- The attributes, operations, and all associations of the superclass become a part of the subclass.

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Visibility between Super and Sub

- Attributes and operations with public visibility in the superclass will be public in the subclass as well.
- Members (attributes and operations) that have private visibility will also be inherited, but are not accessible within the subclass.
- To protect attributes or operations from access from outside the superclass and the subclass, you can assign these with protected visibility.

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Dependencies and Abstractions

- In a dependency relationship, one element represents the **client** that requires a **supplier** element.
- This supplier/client relationship can take on a number of different forms, but in general a dependency indicates that a client is **not complete** without the supplier.

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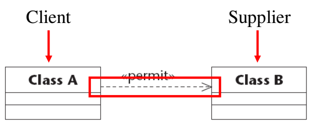
Dependencies



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Common types of dependencies

- uses
- permit
- refine
- trace
- derive

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Interfaces

- A package, component, or class that has an interface connected to it implements or uses the specified interface by supporting or relying on the behavior defined in the interface.
- An interface cannot include real objects; rather, it contains only abstract operations.
- An interface has a number of signatures that together specify a behavior that any element can support by implementing the interface.

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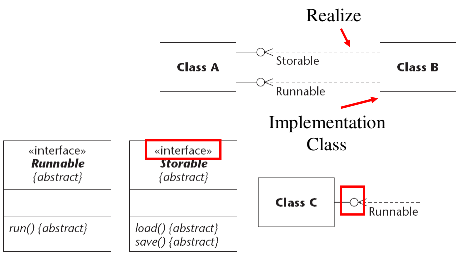
Interfaces (Cont.)



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Ports

- Ports help model components by showing environmental requirements.
  - The port allows the modeler to insulate (isolate) the inner workings of a class from environmental variables.
  - Such insulation keeps the developer focused on the responsibility of the class without concern for the deployment environment.
  - So long as the deployment environment meets the port's specifications, the component will work.

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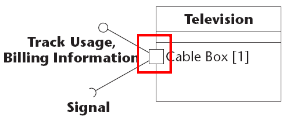
Ports (Cont.)



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Packages

- A package provides a **grouping** mechanism for organizing UML elements.
- A package is used to group elements and to provide a **namespace** for the grouped elements.
- All model elements that are owned or referenced by a package are called the **package contents**.

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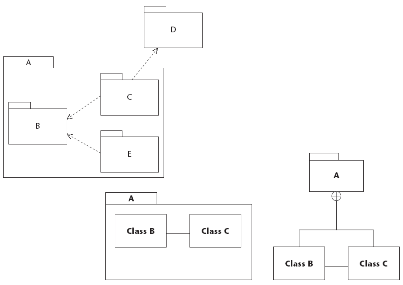
Packages (Cont.)



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Summary

- UML provides the syntax and semantics to create a model. The modeling language, however, cannot tell you whether you have done a good job. You must strive to make all models easy to communicate, verify, validate, and maintain.

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Dynamic Modeling

- State machines
- Activity diagrams
- Interaction diagrams

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Sequence diagrams

- Illustrate how objects interact with each other.
  - They focus on **message** sequences, that is, how messages are sent and received between a number of objects.
- Sequence diagrams have two axes:
  - The vertical axis shows time
  - The horizontal axis shows a set of object

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Generic and Instance Form

Sequence diagrams can be used in two forms:

- The instance form describes a specific scenario in detail
- The generic form describes all possible alternatives in a scenario

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Message, Execution occurrence, Lifeline

- A message is a communication between objects that conveys information with the expectation that action will be taken.
  - The receipt of a message is normally considered an event.
- An execution occurrence shows the focus of control.
- The lifeline represents the existence of an object at a particular time.

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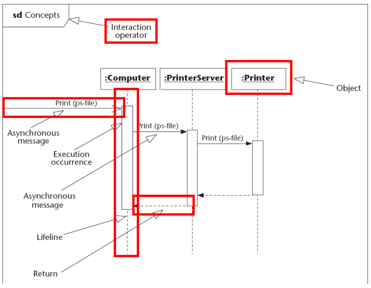
The concepts



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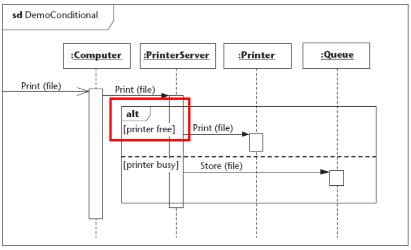
Fragment (alt)



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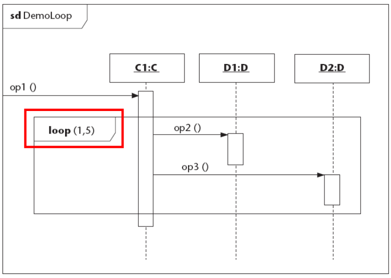
Fragment (loop)



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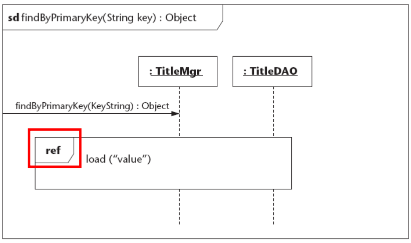
Fragment (ref)


sd findByPrimaryKey(String key) : Object
: TitleMgr
: TitleDAO
findByPrimaryKey(KeyString) : Object
ref
load ("value")

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Interaction Overviews

- The interaction overview diagram is a variant of an activity diagram.
- Various flow of control nodes from activity diagrams can be combined with sequence fragments to create an interaction overview diagram.

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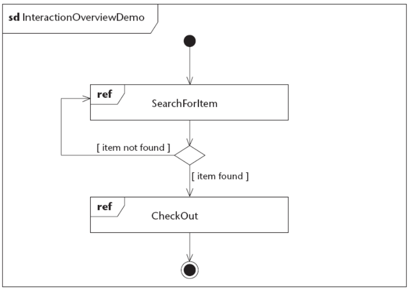
Interaction Overviews (Cont.)



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Communication Diagrams

- Communication diagrams focus both on the interactions and the links among a set of collaborating objects.
- Communication diagrams show objects and how messages are sent between the linked objects and thereby imply their relations.
- Cannot show structuring mechanisms such as conditional or reference fragments.

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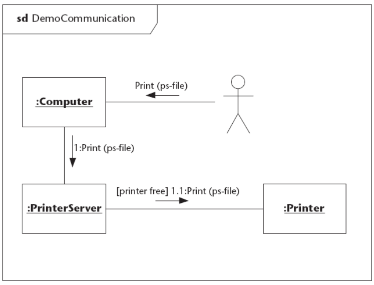
Communication Diagrams (Cont.)



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Message Labels

- predecessor guard-condition sequence-expression return-value := signature
  - predecessor: sequence-number ‘,’ ... ‘/’
  - guard-condition: ‘[‘ condition-clause ‘]’
  - sequence-expression: [integer | name][recurrence] ‘:’

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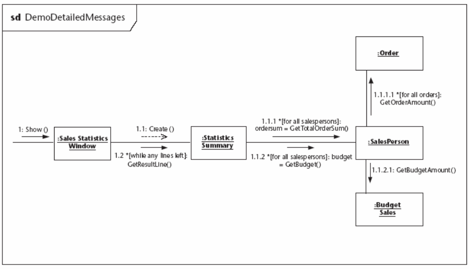
Message Labels (Cont.)


sd DemoDetailedMessages
:Order
1.1.1.1 *[for all orders]: GetOrderAmount()
1: Show ()
:Sales Statistics Window
1.1: Create ()
:Statistics Summary
1.1.1 *[for all salespersons]: ordersum = GetTotalOrderSum()
:SalesPerson
1.2 *[while any lines left]: GetResultLine()
1.1.2 *[for all salespersons]: budget = GetBudget()
1.1.2.1: GetBudgetAmount()
:Budget Sales

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State Machines

UML defines two kinds of state machines:

- Behavioral state machines
  - Behavioral state machines capture the life cycles of objects, subsystems, and systems. They tell the states an object can have and how events affect those states over time.
- Protocol state machines

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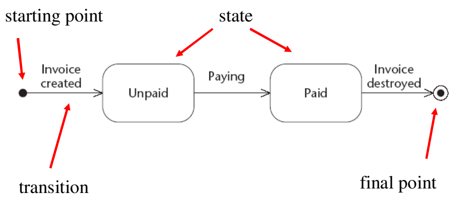
State Machines (Cont.)



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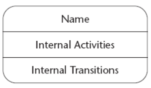
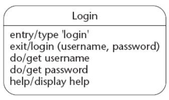
State compartments

- Name
- Activity
  Standard event
  – entry
  – exit
  – do

  event-name argument-list '/' action-expression
- Transition





entry/type 'login'
exit/login (username, password)
do/get username
do/get password
help/display help

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Concepts

- Event-Signature
  - draw (f : Figure, c : Color)
- Guard-Condition
  - [number of invoices > n]
  - withdrawal (amount) [balance >= amount]
- Action-Expression
  - increase () / n := n + 1 / m := m + 1
- Send-Clause
  - left_mouse_btn_down(location) / color:=pick_color(location) ^ pen.set(color)

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Event types

- A condition becoming true.
- Receipt of an explicit signal from another object.
- Receipt of a call on an operation by another object (or by the object itself).
- Passage of a designated period of time.

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Sending Messages Between State Machines

State machines can send messages to other state machines.

- This process is shown either by actions (send-clause) or
- with dashed arrows between the state machines.

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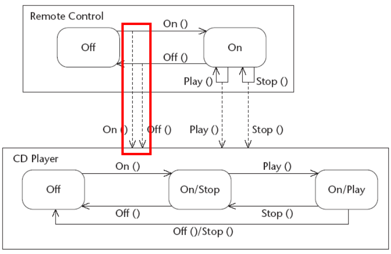
Sending Messages Between State Machines (Cont.)



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Substates

- A state may have nested substates, whereby internally the state has its own substates that can be shown in other state machines.
- UML 2 defines substate machines.
  - orthogonal (or-substates)
  - nonorthogonal (and-substates)

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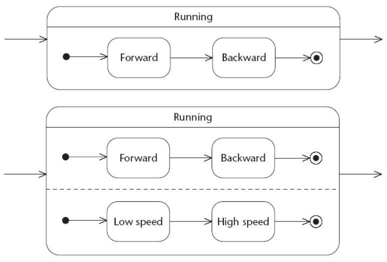
Substates (Cont.)



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History Indicator

- Used to memorize internal states.
- There are 2 types of history indicators:
  - **Shallow history**: the transition is to the most recent state of the immediately enclosing state machine.
  - **Deep history**: Same as shallow history, But the transition is applied recursively to all the enclosing state machines.
- Both have no outgoing transitions.

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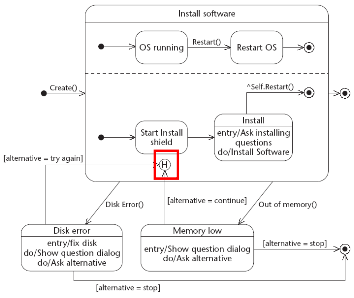
History Indicator (Cont.)



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Activity Diagrams

- Capture actions and their results.
- Used for different purposes, including:
  - capture the work (actions) that will be performed when an operation is executing.
  - capture the internal work in an object.
  - show how a set of related actions can be performed and how they affect objects around them.
  - show how an instance of a use case can be performed in terms of actions and object state changes.
  - To show how a business works in terms of workers (actors), workflows, organization, and objects

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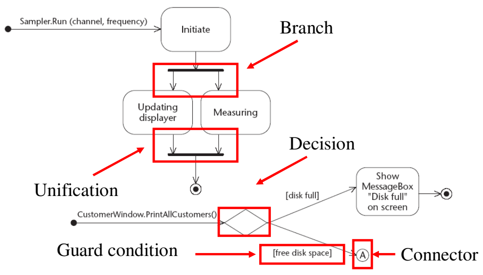
Activity Diagrams



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Activity Diagrams (Cont.)

- Events are attached only to the transition from the start point to the first action.
- Decision
  - Guard-condition
- Branch
- Unification
- Connector

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Activity Partitions

Activity partitions group actions, normally with respect to their responsibility.

- To show explicitly where actions are performed (in which object),
- To show in which part of an organization work (an action) is performed.

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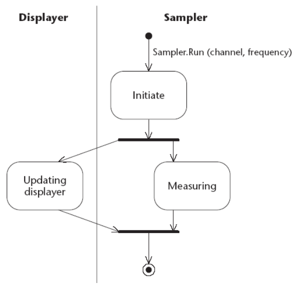
Activity Partitions (Cont.)



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Objects

Objects can be shown on activity diagrams.

- They are either input to or output from the actions,
- or they can simply show that an object is affected by a specific action.

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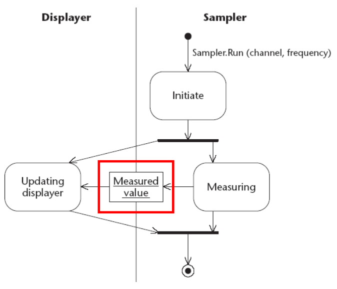
Objects (Cont.)



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Signals

- Signals can be sent or received in activity diagrams
- You use two symbols for signals, one for sending and one for receiving a signal.

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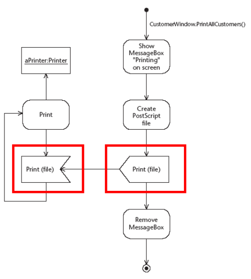
Signals (Cont.)



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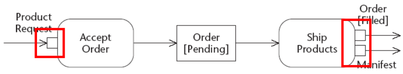
Pins

Shown as a small rectangle attached to an activity, shows values an activity accepts (input pins) and values it produces (output pins).



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