An Overview of UML

The Unified Modeling Language

- UML is a graphical *language* used by software engineers to model software systems during development.

- UML provides for several different kinds of diagrams that represent different views and different levels of detail.

- UML is a synthesis of software methodologies developed earlier by Booch, Rumbaugh, and Jacobson among others.
  - Now an industry standard maintained by the Object Management Group (www.omg.org).

Software Methodology

- Programmers have always drawn pictures to describe software.
  - Flow charts.
  - Data structure diagrams.
  - Dataflow diagrams.
  - Database diagrams.

- The methodology wars.
  - 1970s – 1980s

Software Methodology

- By 1990 there were a number of successful methodologies.
  - Gurus
  - Books
  - CASE tools
  - Seminars

- Many common concepts but different notations, details.

Software Methodology

- Everyone recognized the need for a standard.
- Everyone wanted it to be their methodology.
- Rational and the three amigos – 1995
  - Grady Booch
  - Jim Rumbaugh
  - Ivar Jacobson
    - “Unified” their previously separate methodologies
- The Object Management Group (OMG) – 1996
  - RFP for a standard OO modeling notation

The OMG and UML

- Several companies responded to the OMG RFP.

- Proposals coalesced into a single proposal – The UML

- UML Version 1 adopted as a standard – 1997
- Widely accepted and used over the next five years.
- Updated by Versions 1.1 – 1.5.
  - Many books based on Version 1.4

- Version 2.0 approved 2004
  - Standards bloat?

Diagrams in UML

UML diagrams are used to describe:

- Real things in the real world.
  - Physical things: cars, airplanes, buildings
  - Abstract things:
    - insurance policy, organization structure, eyeglass prescription, class schedule
- Software constructs.
  - Classes corresponding to real world things.
  - Classes with visible behavior.
  - Purely internal classes.

Ways of Using UML

- UML as a sketch
- UML as a blueprint
- UML as a programming language

Diagrams in UML

- UML 1.4 defines nine kinds of diagrams
  - Structural Diagrams (four kinds)
  - Behavioral, or Dynamic, Diagrams (five kinds)
    - Will not use all of them.

- UML 2.0 defines 13 kinds
  - Generally don’t need to worry about differences between UML 1.4 and UML 2.0.

Structural Diagrams

- Class Diagrams
  - The "things" that make up the system
  - Their attributes, operations, associations
  - Class vs. Object Diagrams
- Implementation Diagrams
  - Deployment Diagrams
    - Where systems components will be installed
    - How they interact
  - Component Diagrams
    - Dependencies among system components

Behavioral Diagrams

- External: Use Case Diagrams
  - Describe externally visible behavior
  - Interactions between the system and the outside world

- Internal
  - Activity Diagram
    - Similar to a flow chart
  - Sequence Diagram
    - Time Line
  - Communication Diagram
    - Another view of interactions over time
  - State Machine Diagram
    - States, Events, Actions

Use Case Diagrams

represent the *functionality* of the system

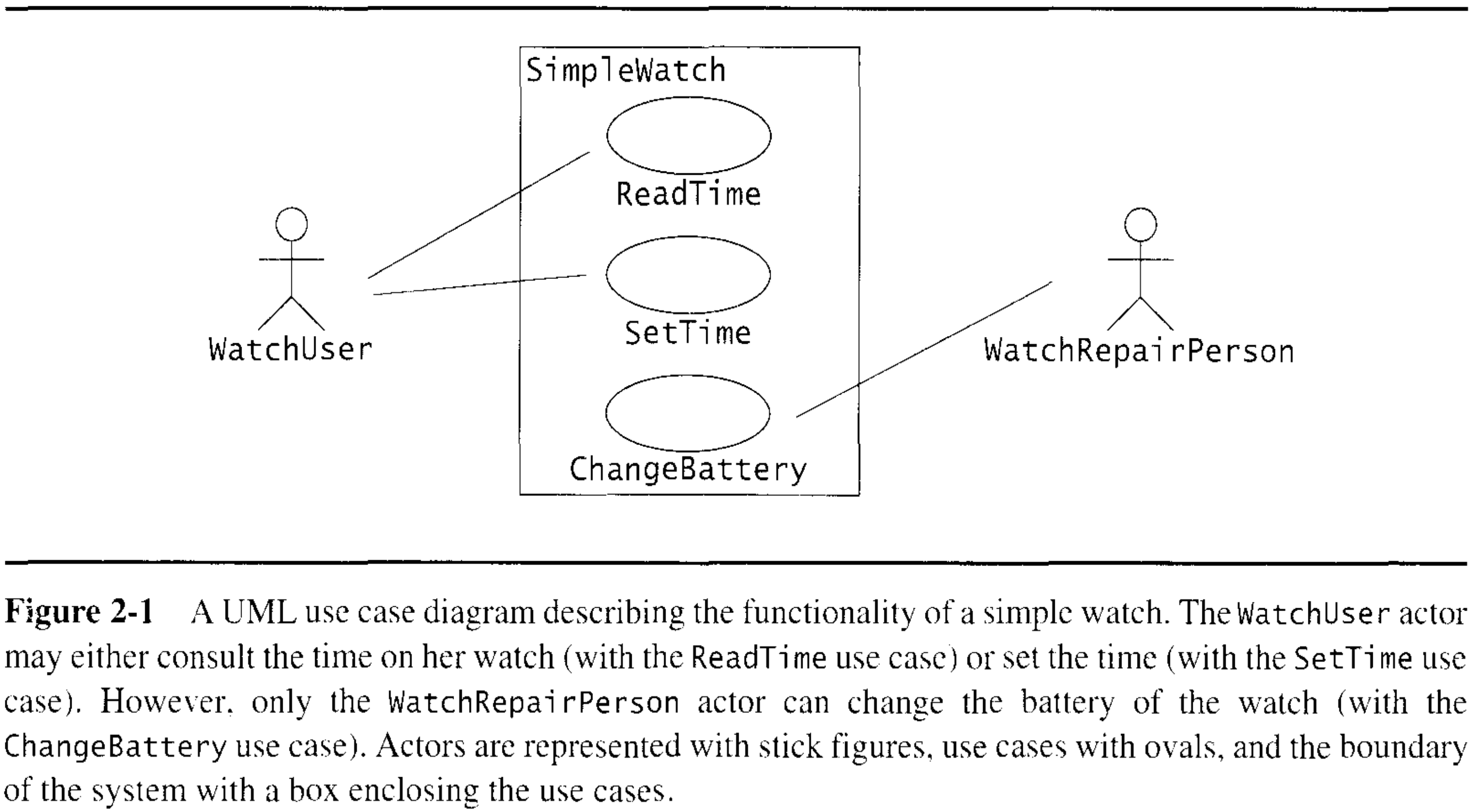
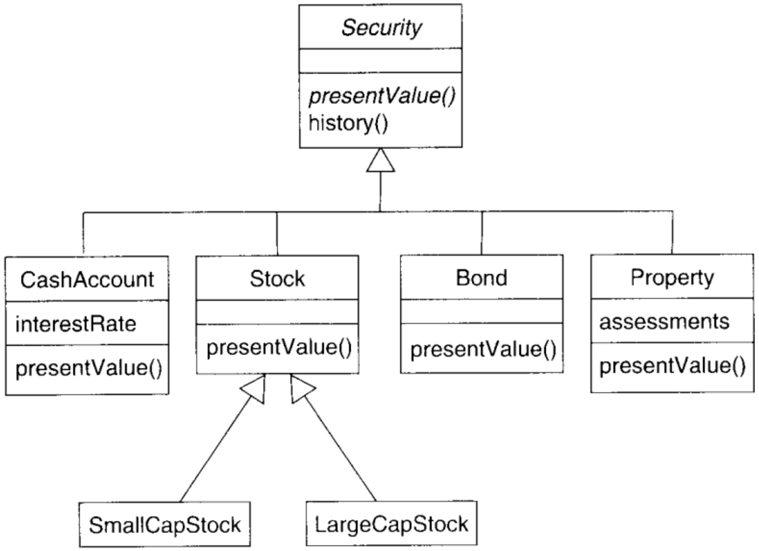


Figure 2-1 A UML use case diagram describing the functionality of a simple watch. The WatchUser actor may either consult the time on her watch (with the ReadTime use case) or set the time (with the SetTime use case). However, only the WatchRepairPerson actor can change the battery of the watch (with the ChangeBattery use case). Actors are represented with stick figures, use cases with ovals, and the boundary of the system with a box enclosing the use cases.

From *Object-Oriented Software Engineering using UML, Patterns, and Java*, Second Edition, by Bernd Bruegge and Allen H. Dutoit Prentice Hall/Pearson, 2004

Class Diagrams

Describe the *structure* of the system

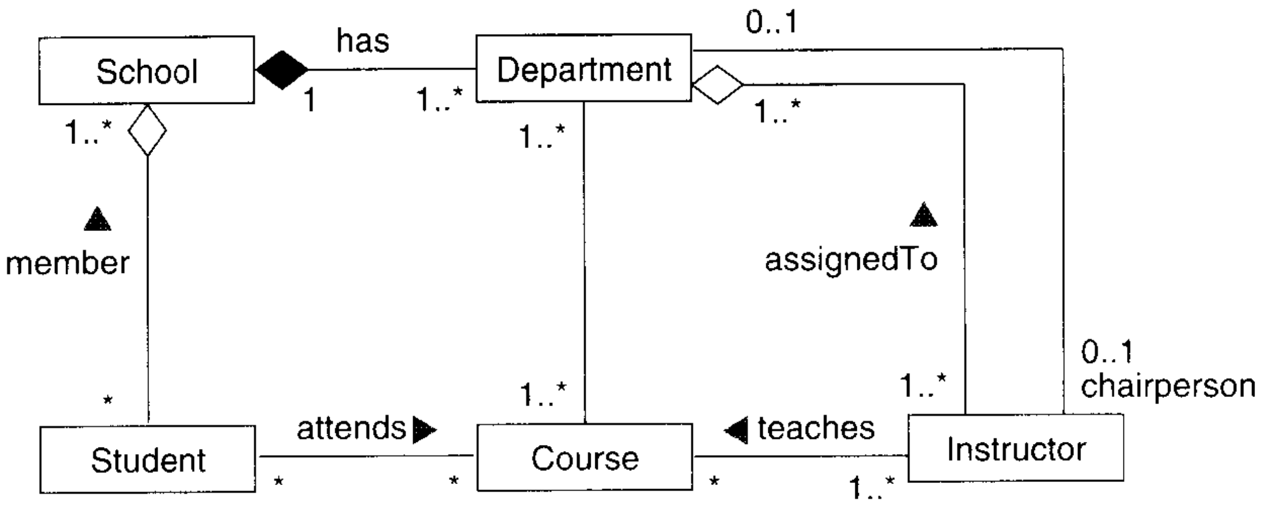


"Is A" Relationships

From *The Unified Modeling Language User Guide*, by Booch, Jacobson, and Rumbaugh, Addison Wesley, 1999

Class Diagrams

Class Associations



Composition and Aggregation:

“Has A” Relationships

From *The Unified Modeling Language User Guide*, by Booch, Jacobson, and Rumbaugh, Addison Wesley, 1999

Composition vs. Aggregation

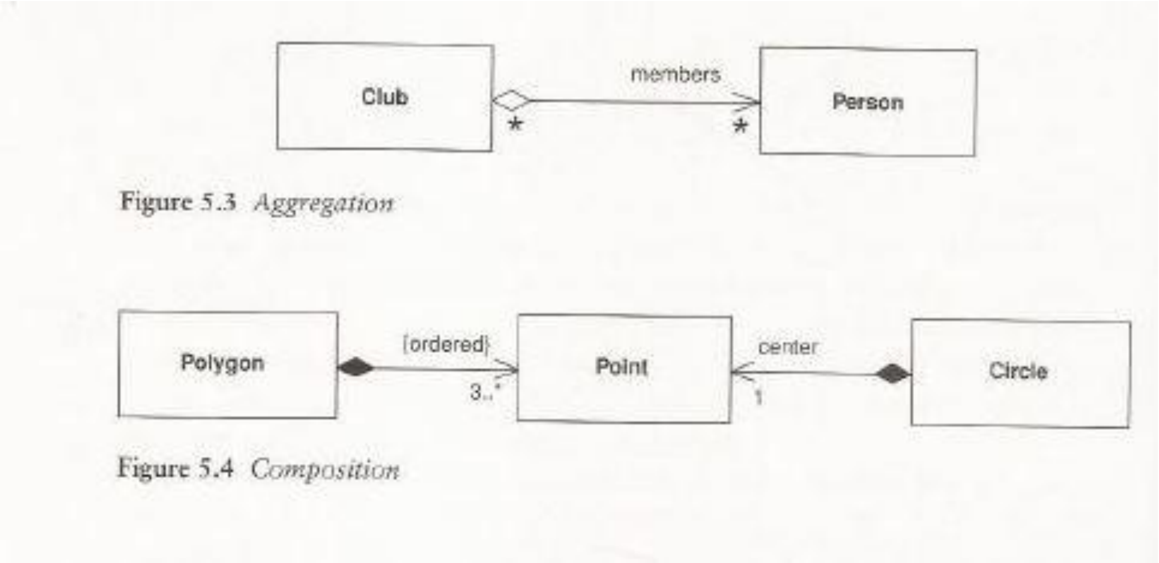


Figure 5.3 *Aggregation*

Figure 5.4 *Composition*

Composition is a good way of showing ... properties that have a strong and somewhat exclusive ownership of particular other components.

Aggregation is strictly meaningless.

Martin Fowler, *UML Distilled*, Third Edition

Martin Fowler:

Aggregation is strictly meaningless;

as a result, I recommend that you ignore it in your own diagrams. If you see it in other people's diagrams, you'll need to dig deeper to find out what they mean by it.

Martin Fowler, *UML Distilled*, Third Edition, page 68.

Activity Diagrams

- A form of *flow chart*.
- Typically applies to a particular use case.
- Shows the order in which things happen.
  - Which activities can take place concurrently.
  - Which activities cannot start until somthing else is completed.

Activity Diagrams

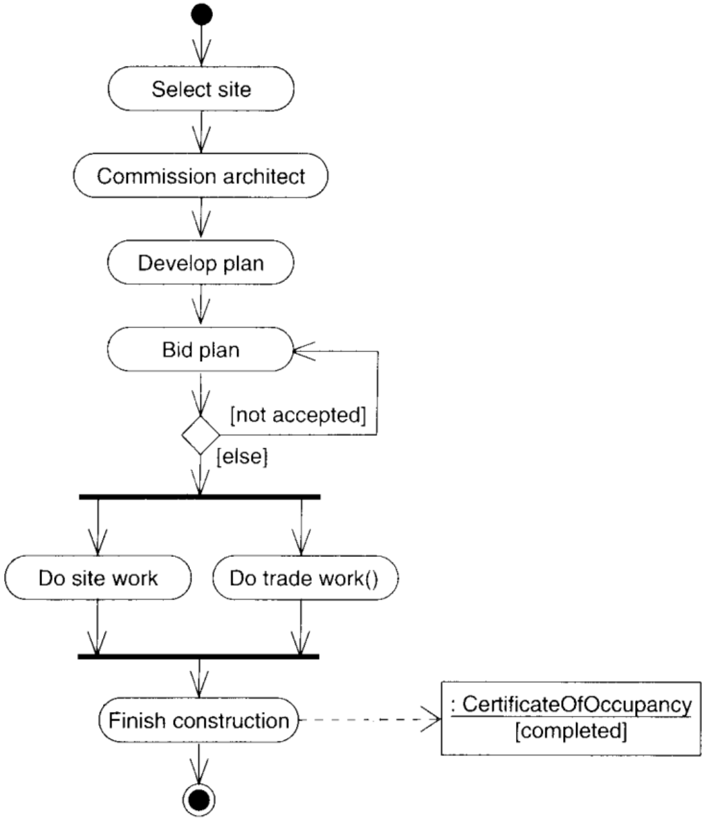


Figure 19-1: Activity Diagrams

From *The Unified Modeling Language User Guide*, by Booch, Jacobson, and Rumbaugh, Addison Wesley, 1999

Interaction Diagrams

- Used to formalize the dynamic behavior of the system and to visualize the communication among objects.

- UML provides two kinds of diagrams to show interactions among actors and objects:
  - Sequence diagrams
  - Communication diagrams (UML 2.x)
    - Called *Collaboration* diagrams in UML 1.x
    - Not used in some texts

Sequence Diagrams

- Show interactions among actors and objects
  - In terms of messages sent from one to another
  - With a common time axis in the vertical dimension.

- The word "messages" is used in an abstract sense.
  - Information flow
  - No implications about how implemented.

Sequence Diagrams

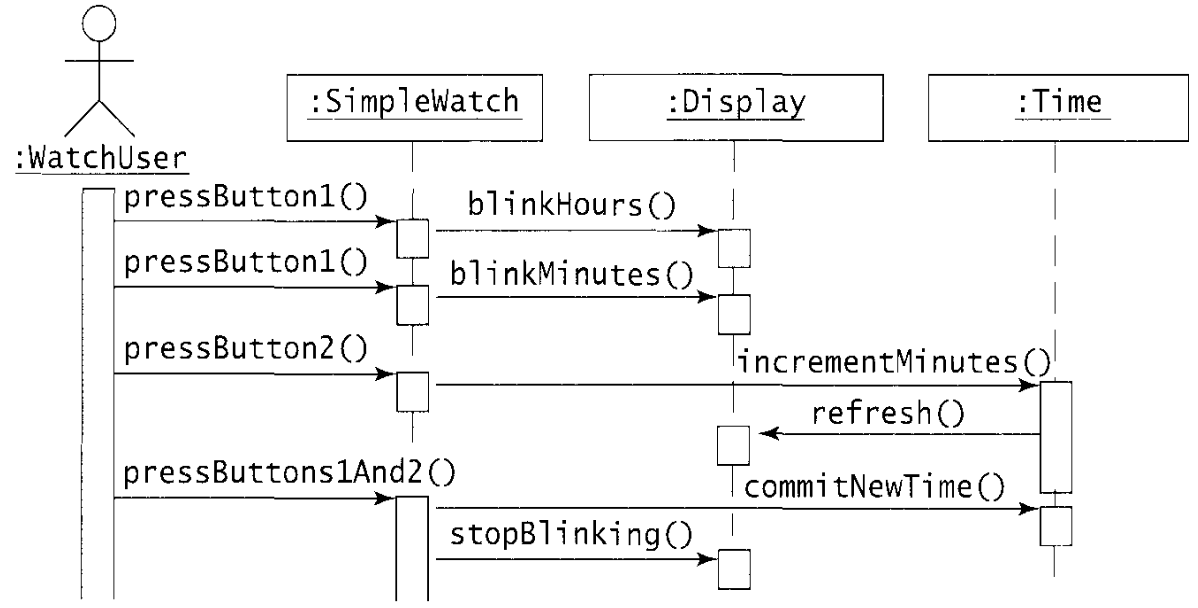
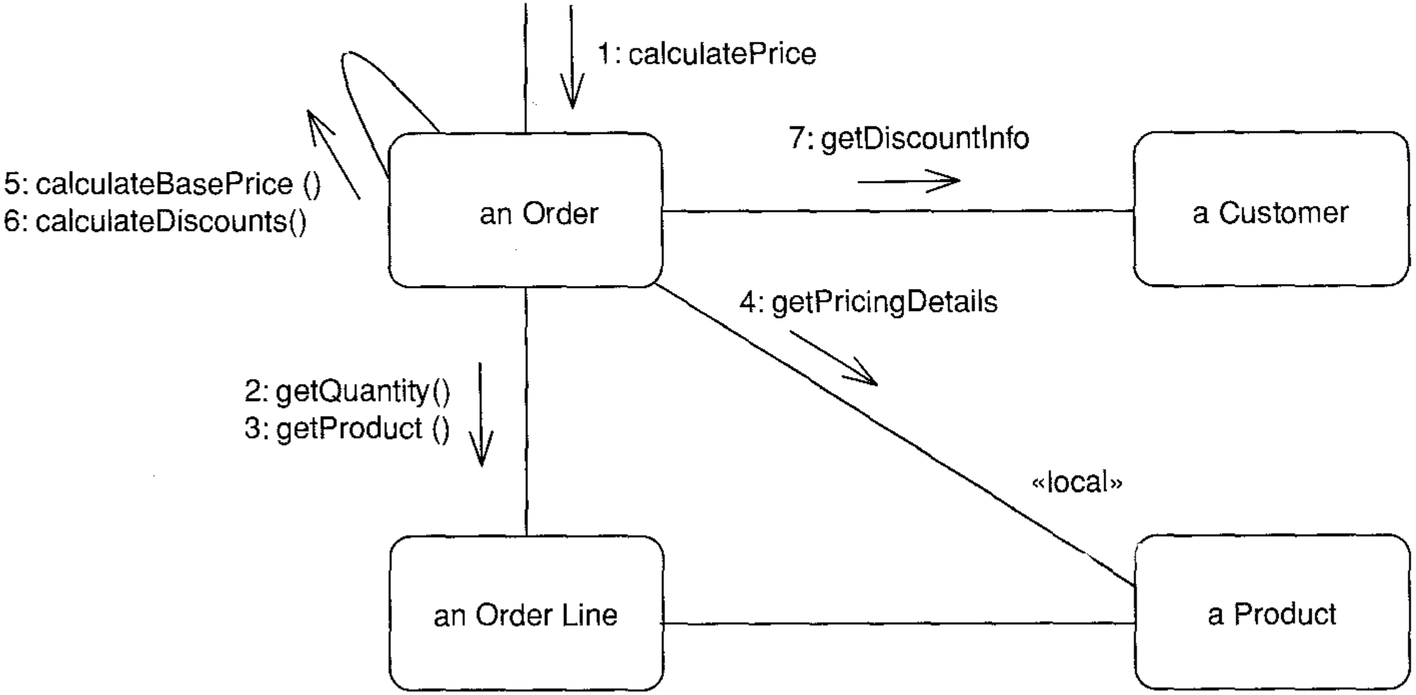


Figure 2-3 A UML sequence diagram for the `SimpleWatch`. The left-most column represents the timeline of the `WatchUser` actor who initiates the use case. The other columns represent the timeline of the objects that participate in this use case. Object names are underlined to denote that they are instances (as opposed to classes). Labeled arrows are stimuli that an actor or an object sends to other objects.

From *Object-Oriented Software Engineering using UML, Patterns, and Java*, Second Edition, by Bernd Bruegge and Allen H. Dutoit Prentice Hall/Pearson, 2004

Communication Diagrams

Show interactions among objects or roles in terms of messages sent along links representing associations.



From *UML Distilled (Third Edition)*, by Martin Fowler, page 132.

State Machine Diagrams

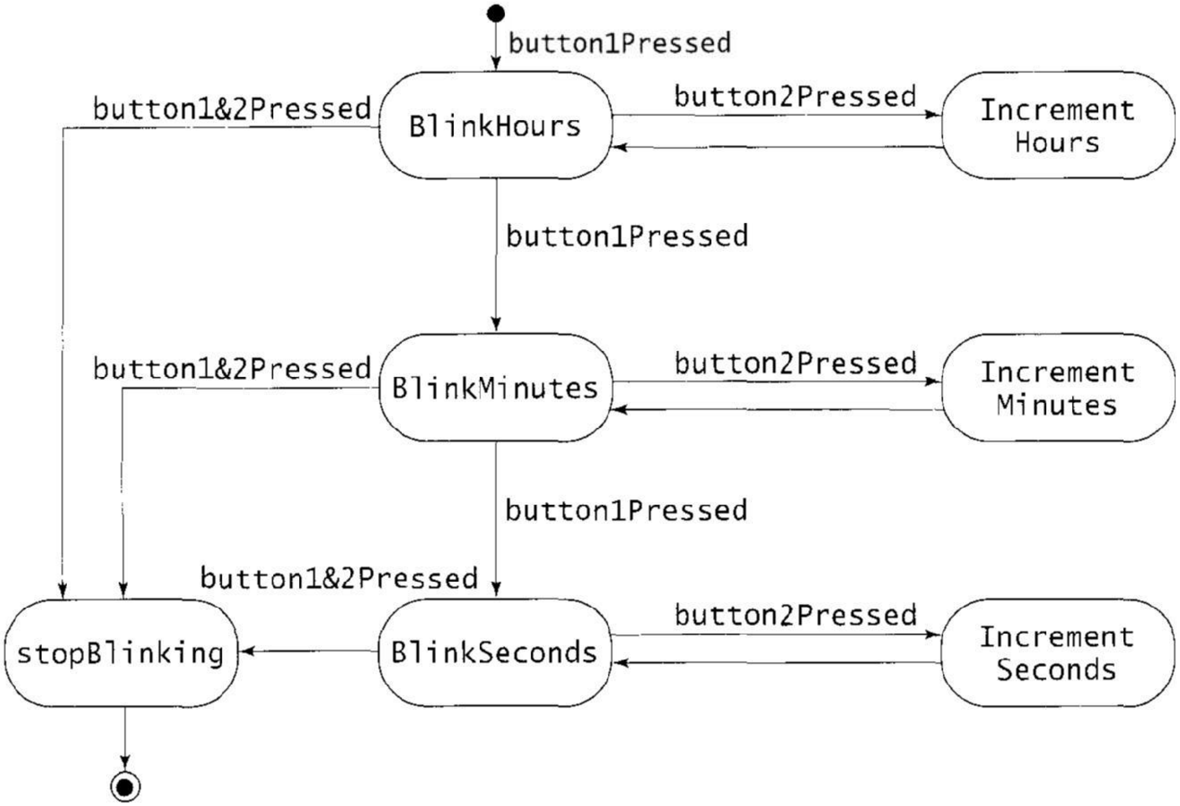
- Called “Statechart” diagrams in UML 1.x.
- Describe the behavior of the an object in terms of a number of states and transitions between them.
- Important when the response of the system to a given stimulus depends on what has happened previously.

State Machine Diagrams

- Elements of a State Machine Diagram:
  - States
    - Determine what the system does in response to a given stimulus.
    - Reflect the effects of past history on system behavior
  - Events (External stimuli)
    - Cause actions
    - Cause transitions between states
  - Actions
    - While in a state
    - On state transition

State Machine Diagrams

Initial State



Final State

Figure 2-4 A UML statechart diagram for SetTime use case of the SimpleWatch.

From *Object-Oriented Software Engineering using UML, Patterns, and Java*, Second Edition, by Bernd Bruegge and Allen H. Dutoit Prentice Hall/Pearson, 2004

Assignment

- google UML
- Check out web sites.
  - Find tutorials and references.