Lesson 3-7b: More about Dynamic Models

Object-Oriented Modeling & Applications
Lesson Objectives

- Learn about the modes of behavior
- Understand object mode diagram and patterns of behavior
- Learn about moore and Mealy machines.
- Understand object dynamic and concurrency
- Learn the concepts of STDs
- Learn the notation of state charts or STD
- Learn how to develop a STD
Modes of Behavior

• Behavior is the way in which machine, organ or mechanism works with respect to its efficiency. The way in which some things reacts to its environment.

• Things often exhibit several modes of behaviors, each of which can be named.

• In a particular mode of behavior an instance may be involved in an interaction with another instance, transforming, processing input information into output.
Object Mode Diagram

- Object Mode Diagram is a model that illustrates the modes of behavior of an object.
- Each mode in the diagram is denoted by a named box.
- The interpretation of each mode is briefly indicated in the name in the box.
- A more detailed definition of each mode should be in the data or object dictionary.
- Object Mode Diagram exposes the modes of behavior of a class of things but hides the details of how transitions between the modes occur.
- Example:

  ![Diagram](image)

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Patterns of Behavior

- Instances of a class can exhibit a common pattern of behavior by moving between different modes of behavior in a deterministic manner.

- A description of behavior in terms of modes is a qualitative description.

- The pattern is a form between modes associated by the “may-be / is-followed by” relationship. Example:
  - “On” is followed by “Off”
  - “Off” is followed by “On”

- The may-be / is-followed-by relationship determines which mode follows which other mode in time, not space.

- A transition is the term that describes when an instance moves from one mode of behavior to another.
• A Moore Machine is a type of finite state machine (FSM).

• Specific activities are associated with the states, regardless of the history of transitions to a state.

• Example:
  – When I am angry I frown but when I am happy I smile.
Moore’s STD: Example

- Open
  - Turn on light

- Opening
  - Sound alarm

- Closed
  - 1. Turn on dishwasher
  - 2. Watch TV

- Closing
  - Sound alarm

Door
Mealy Machines

• A Mealy Machine is a type of finite state machine ( FSM ).

• Specific actions are associated with specific transitions.
Initial & Final Transitions

- An initial transition, with no previous mode, denotes the “creation or appearance” event, such as open account.
- The initial transition is labeled with the transition condition that caused the thing to be “created” or to “appear” in the domain.
- Actions and activities may be associated with the “creation” transitions.
- A final transition from each final mode, to no other state, denotes the “deletion” event, such as close account.
- Each final transition is labeled with the transition condition that caused the thing to be “deleted”.
- Actions and activities may be associated with the “deletion” transitions.
Object Behavior Model

- The model describing the behavior of a class of things is termed Class Behavior Model, Dynamic Model, or Control Model.
- For Object Modeling:
  - Modes have a finite lifetime.
  - Transitions take infinitesimal duration.
  - Zero or more initial transitions are required.
  - Zero or more final transitions are required.
Object Dynamics

- The Class Behavior Model or STD describes the possible behavior of any instance.
- Each instance is considered to be in only one of the modes at a time.
- Objects having a STD with a 2 or more modes are called Dynamic Objects.
- Objects having a STD with only one mode are called Static Objects.
- Things that apparently exhibit 2 or more fairly independent “threads” of behavior can be modeled by a 2 or more “synchronized” STDs, such as human arms and head.
Transition Conditions

• A transition condition can be defined as any proposition “X” in the sentence “When X”.
• “X” is a proposition, denoting an event that can be true or false:
  – It is time to stop or It is noon.
• X is a proposition denoting a condition that can be true or false:
  – The light is on.
• A simple logical expression involving at most one event and one or more conditions:
  – It is time to slow down or it is time to stop.
• A complex logical expression of the form:
  – (a1 and b1) xor (a2 and b2),.... xor (an and bn).
• A transition is taken when the transition condition is true.
Transition Actions

• When an instance transitions from one mode to another it changes the way in which it interacts with its environment; that is, it changes its behavior.

• This is called Transition Actions and are simple expression “Y” in “When X do Y”.

• IN STD, the changes in behavior are recorded along the transition condition.
The transition actions of an object are limited to:

1. **Starting/Enabling** a new activity/process/transformation for the instance. The process is considered to be active in the next mode interacting with other instances. The activity is considered to take a finite duration equal to the life-time of the next mode.

2. **Stopping/Disabling** an existing activity/process/transformation for the instance. The process that must have been active in the previous mode is terminated.
More on Transition Actions

Doing/Triggering a discrete action/process/transformation for the instance. The action is considered to take an infinitesimal duration.

Asserting/Setting a condition describing the instance, to be true.

Refuting/Clearing a condition to become false. The condition must be of interest to other things.

Causing/Signaling/Pulsing the occurrence of an event, in the object instance, for another instance.
• Transition actions are the instances response to an event/happening.

• Transition actions must have no sequence to them. If there is an implicit sequence then a behavior mode has been omitted.

• As transitions take infinitesimal duration, instances spend all of their time in stable modes, waiting for transitions to occur.
Activities and Actions

Activities:
• Activities are also referred to as Processes or Transformations
• Accept inputs and convert them instantaneously into outputs for a finite duration.
• See DFDs.

Actions:
• Actions are also referred to as Processes or Transformations
• Accept inputs and convert them instantaneously into outputs for an infinitesimal duration.
Mealy’s STD: Notation

- **State**
  - State of “an object or a class”

- **Transition**
  - Change of state

- **Condition(s) & Action(s)**
  - Describes condition for transition
  - Describe action resulting from Transition

- **State Transition**
  - Initiation of transaction
  - Processing of transaction
A Car Example

Car

- Ignition
- Transmission
- Brake
- Accelerator
Ignition STD

Off

Ready to stop
Turn key off

On

Ready to go
Release key

Starting

1. Transmission in neutral
2. Turn key to start

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Transmission STD

Ready to stop
Push N

Going backward
Push R

Forward

Neutral

Reverse

First

Second

Second

Upshift

Ready to cruise

Ready to cruise

Upshift

X

X

Downshift

Downshift
Accelerator STD

Off

Depress accelerator

On

Ready to accelerate

Ready to slow down

Release accelerator
Brake STD

Ready to stop or slow down
Depress brake

Ready to go or speed up
Release brake
Discussion Questions

Define patterns of behavior, mode of behaviors, activity, and an action.

What are the differences between Moore machines and Mealy machines?

Describe concurrency with examples

What are the transition conditions and what are the causes of these transition conditions?

What are the transition actions?

Describe how to achieve temporal transition conditions and actions?

What is the state transition matrix?