State Diagrams, Actions, and Activities

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- The State Diagram
- State
- Event
- Transition
- Additional Concepts and Notations
- Hierarchical States
- Action
- Activity
- Action Language(s) for UML

Basic Concepts

• We are now taking a deeper look at system dynamics

• This will be a low-level view
  - We will be looking inside the (classes of) objects themselves

• Some of the dynamic behavior will be specified in terms of sequencing / timing

• Some of the dynamic behavior will be specified in terms of functions (transformations / computations)

The State Diagram

• We will use the state diagram to specify the sequencing / timing behavior of objects in a class
  - States
  - Events
  - Transitions

• Generally speaking, there should be one state diagram for every class
  - But this is not prescribed by UML, it allows state diagrams to describe the system at any level

State

- State
  - A state represents a discrete, continuous segment of time wherein the object's behavior will be stable
  - The object will stay in a state until it is stimulated to change by an event

- Notation

Event

• An event is an instant in time that may be significant to the behavior of the objects in a class
  - Events can have associated arguments

• Events tend to represent
  - Commands or requests from other objects
  - Significant times (it's time to...)
  - Circumstances or happenings in other objects (the temperature monitor notices the temperature rising over a safety setpoint)
  - "Custodial" (creation, deletion, simple update)

• Notation
  - Events are written simply as text strings

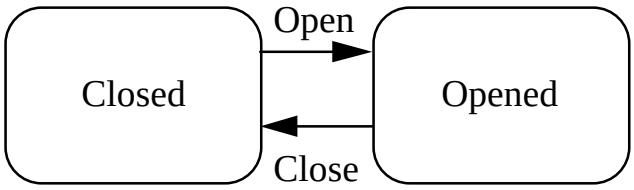
Open
Deposit(Amount)
Withdraw(Amount)
Close

Transition

- A transition shows a valid progression in state
  - Simply, “if you were in this state and you saw this event, that’s the state you would end up in”

- Examples
  - If a Bank Account was Closed and it saw an Open event, it would end up in the Opened state
  - If the account was Opened and it saw a Close event it would end up in the Closed state

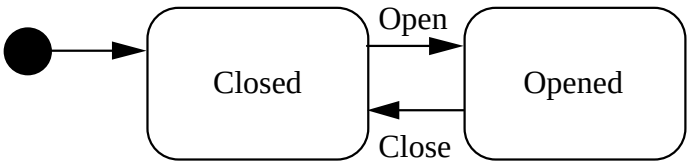
- Notation



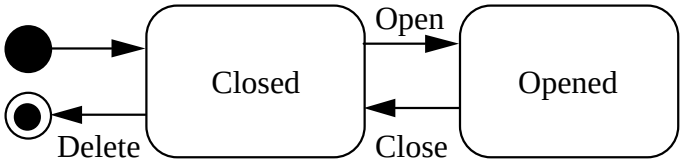
- As far as analysis is concerned, we can say that a transition takes place in essentially zero time regardless of how complicated actions on that transition (below) are

Additional Concepts and Notations

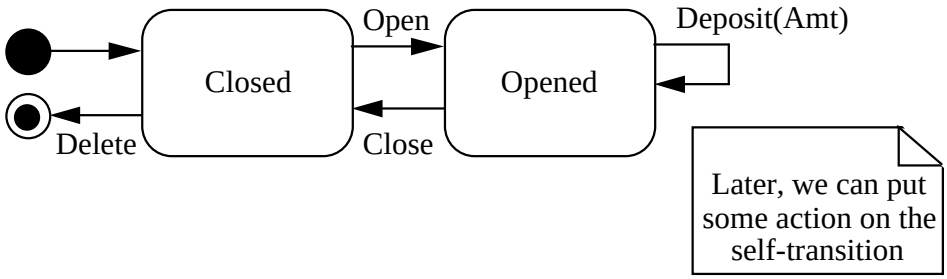
- Initial State
  - The initial state (there can be only one) is the state that a new object will be in immediately following its creation



- Final State
  - A final state (there can be many) is a state that represents the object going out of existence

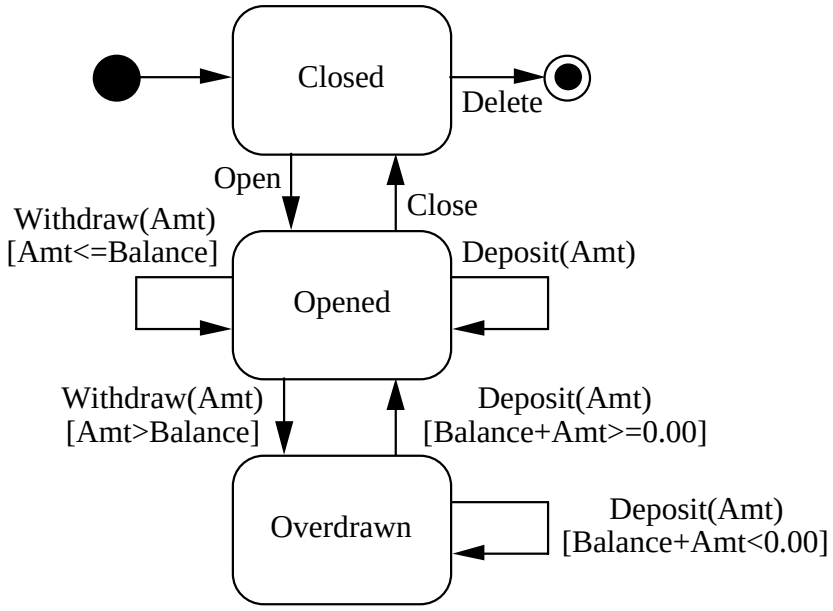


- Self Transitions
  - Sometimes an object is required to perform some action (below) when it recognizes an event, but it ends up in the same state it started in
    - * Technically, it never really leaves the state

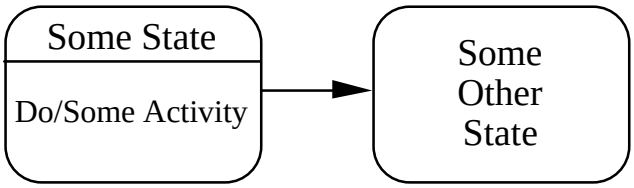

Open
Deposit(Amt)
Closed
Opened
Delete
Close
Later, we can put some action on the self-transition

Additional Concepts and Notations (cont)

- Guarded Transitions
  - A guarded transition is a shorthand notation that says "in addition to the event happening, the guard condition must also be true for the transition to take place"
  - When the same event causes multiple transitions out of some state, the guards should be mutually exclusive



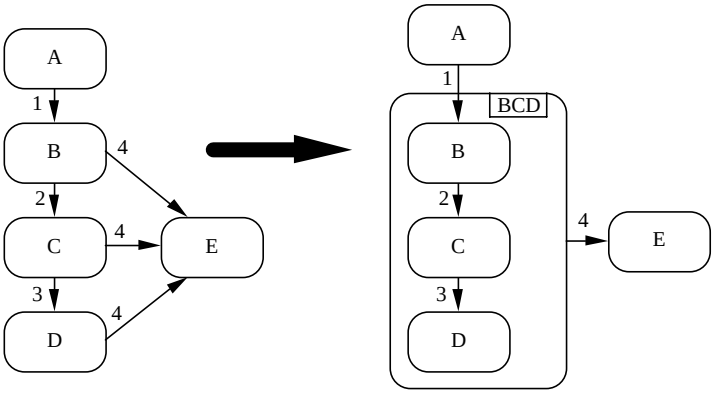
- Unlabeled Transitions
  - An unlabeled transition means the transition is taken when the activity (processing, below) completes


Some State
Do/Some Activity
Some
Other
State

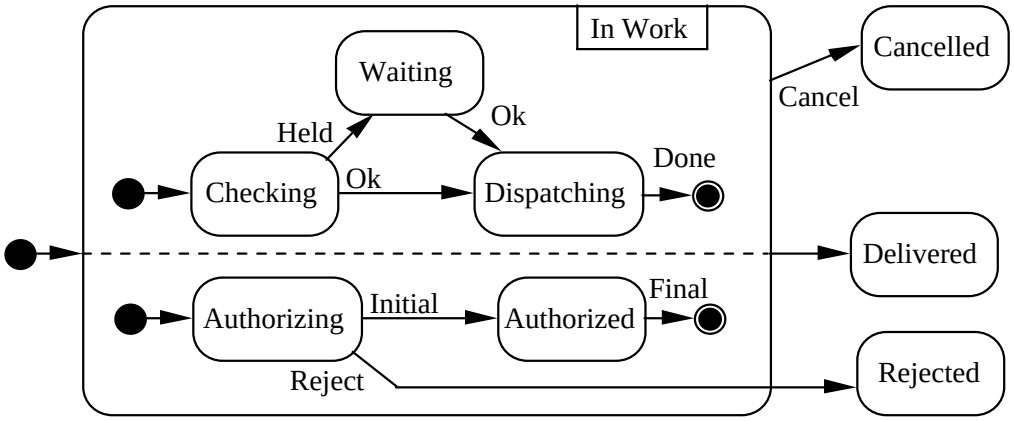
Hierarchical States

• UML uses the StateChart notation originally developed by Harel [Harel87]

• Superstates
  - You may find a set of states that have a common response (transition) to a particular event



• Concurrent State Diagrams



[Harel87]

David Harel, “Statecharts: A Visual Formalism for Complex Systems”, Science of Computer Programming, Vol 8, 1987

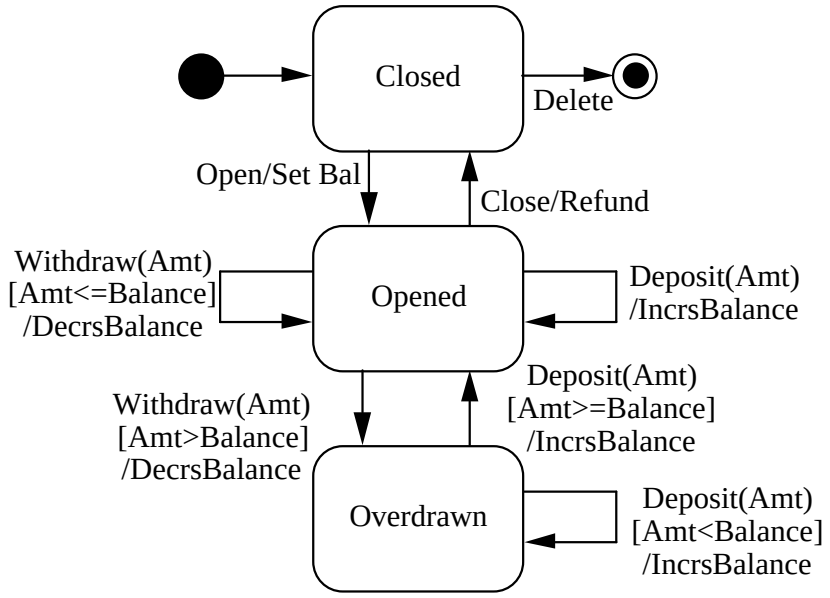
Actions and Activities

• Actions and activities are used to specify the functional (transformational / computational) behavior of objects in a class
  - Actions
  - Activities

Action

• An Action is the UML way to specify that some discrete amount of work gets done as an object makes a transition
  - The work is expected to be a one-shot computation

• Notation
  - Append "/action-name" to the "event[guard]" for every transition that has an action



• An alternative notation to self-transitions is to put event-name(arg-list)/action-name in the lower compartment of a state

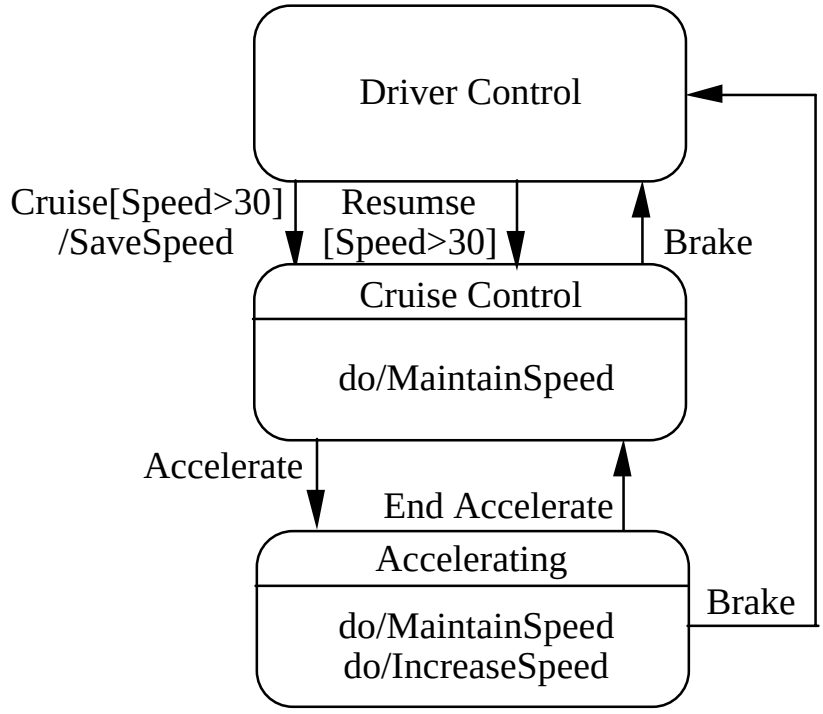
• When you want to be sure that every entry into, or every exit out of, some given state has the same action then you

can put entry/action-name or exit/action-name in the lower compartment of a state

Activity

• An Activity is the UML way to specify that some relatively long-term amount of work gets done while an object is in a state
  - The work is continuous and interruptible (it stops when you exit the state)

• Notation
  - Compartmentalize the state
  - Include “do/activity-name” in the lower compartment of every state that has an activity



Action Language(s) for UML

• The OMG is currently involved in extending UML to provide precise, software-platform independent languages for specifying the details of actions and activities

• The language(s) would be partially algorithmic (and thus be a step into design),but would be very high-level
  - No traditional data structures (tables, arrays, linked lists), just values and collections
  - No traditional control structures (for-next, ...) functions would be applied to an entire input set

• Languages of this sort would enable
  - Executable analysis models
  - Complete code generation from analysis models
  - Formal proofs-of-correctness of analysis models

• See also [Mellor98]

[Mellor98]
Stephen Mellor, Steve Tockey, Rodolphe Arthaud, Philippe LeBlanc, “Software-platform-independent, Precise Action Specifications for UML”, Proceedings of <<UML>> ‘98 Conference, Organized by ESSAIM and the University of Haute-Alsace, Mulhouse, France, June 3-4, 1998

Key Points

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