CSE 403
Lecture 9

UML State Diagrams

Reading:
UML Distilled, Ch. 10, M. Fowler

slides created by Marty Stepp
http://www.cs.washington.edu/403/

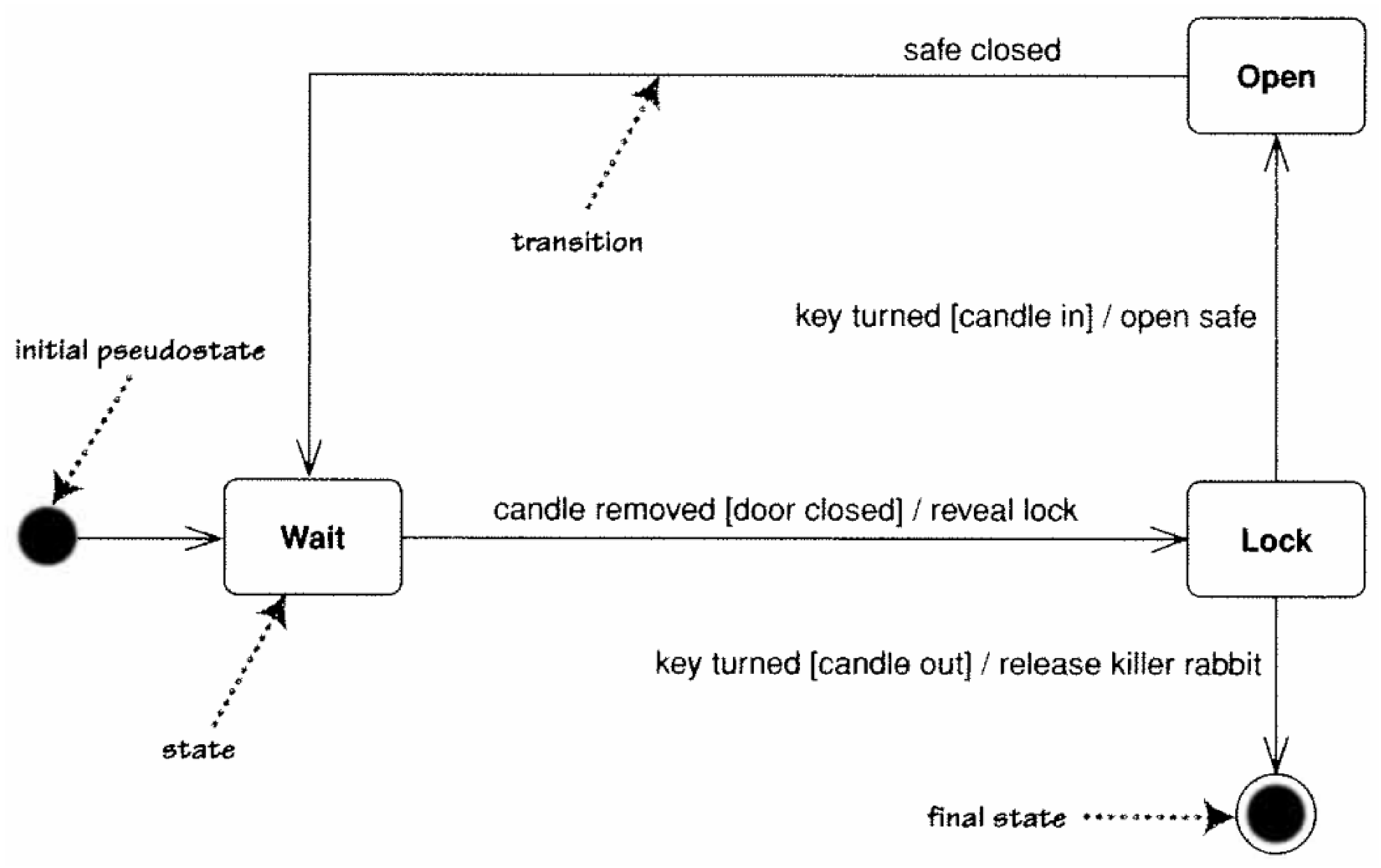
UML state diagrams

- **state diagram**: Depicts data and behavior of a single object throughout its lifetime.
  - set of states (including an initial start state)
  - transitions between states
  - entire diagram is drawn from that object's perspective

- similar to finite state machines (DFA, NFA, PDA, etc.)

- What objects are best used with state diagrams?
  - large, complex objects with a long lifespan
  - domain ("model") objects
  - not useful to do state diagrams for every class in the system!

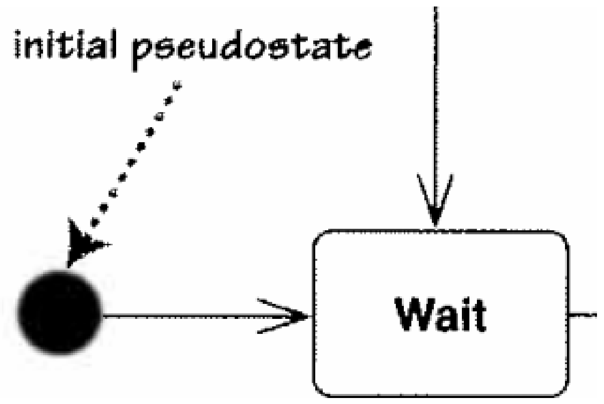
State diagram example


safe closed
Open
transition
key turned [candle in] / open safe
initial pseudostate
Wait
candle removed [door closed] / reveal lock
Lock
state
key turned [candle out] / release killer rabbit
final state

States

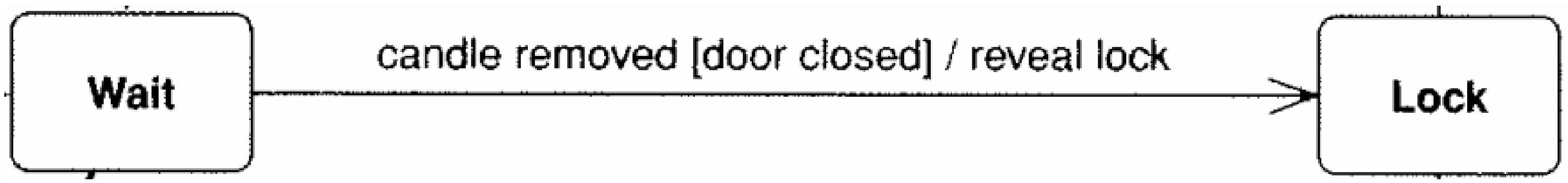
- **state**: conceptual description of the data in the object
  - represented by object's field values

- entire diagram is drawn from the central object's perspective
  - only include states / concepts that this object can see and influence
  - don't include every possible value for the fields; only ones that are conceptually different



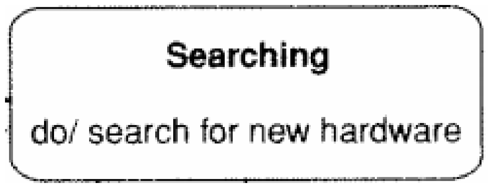
Transitions

- **transition**: movement from one state to another



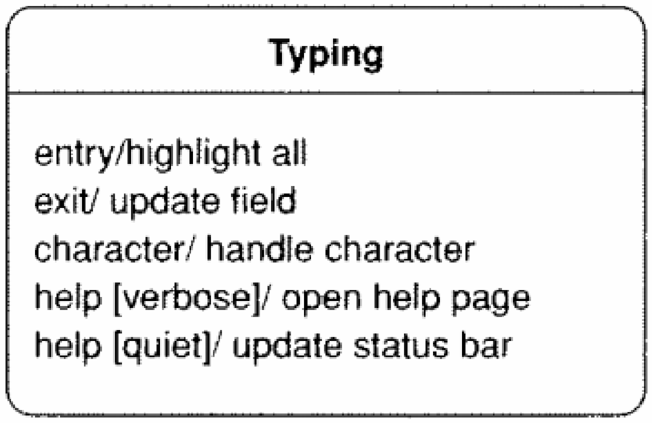
- *signature* [*guard*] / *activity*
  - signature: event that triggers (potential) state change
  - guard: boolean condition that must be true
  - activity: any behavior executed during transition *(optional)*

- transitions must be mutually exclusive (deterministic)
  - must be clear what transition to take for an event
  - most transitions are instantaneous, except "do" activities



Internal activities

- **internal activity**: actions that the central object takes on itself
  - sometimes drawn as self-transitions (events that stay in same state)

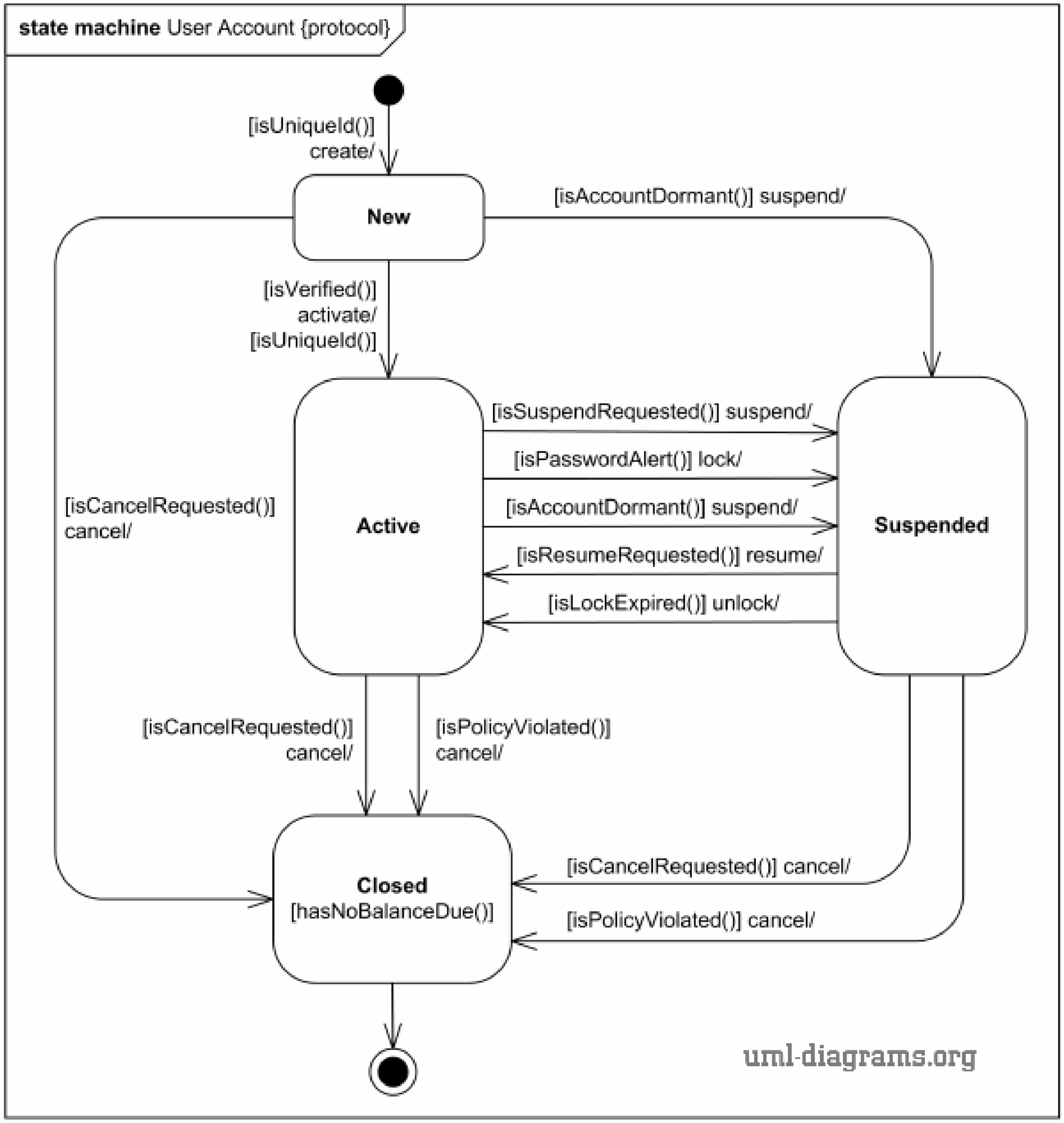


entry/highlight all
exit/ update field
character/ handle character
help [verbose]/ open help page
help [quiet]/ update status bar

- entry/exit activities
  - reasons to start/stop being in that state

State diagram example

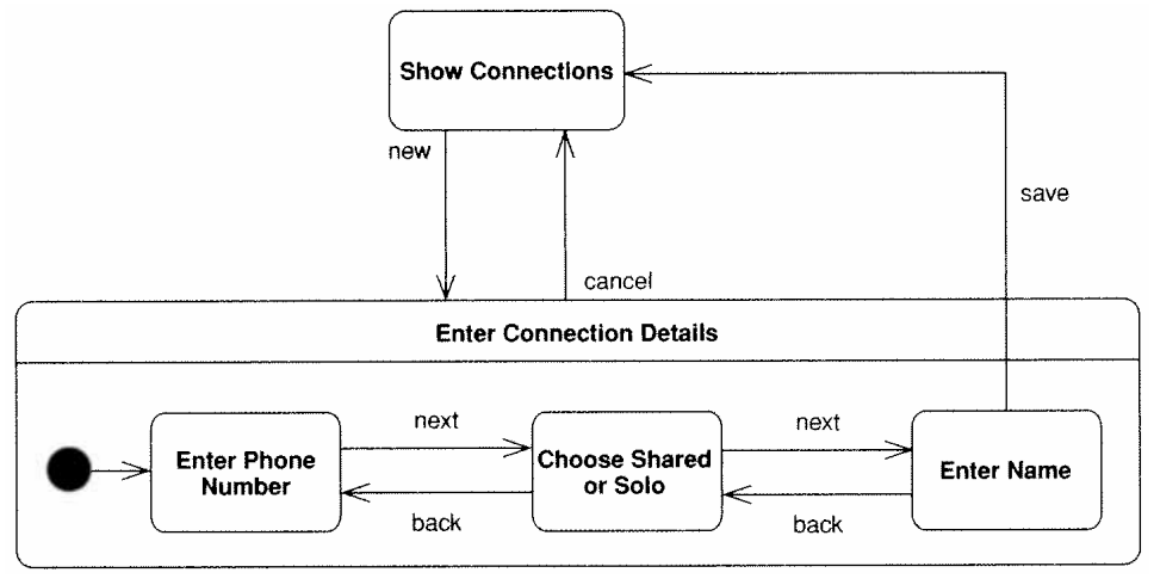
User account management



state machine User Account {protocol}
[isUniqueId()] create/
New
[isAccountDormant()] suspend/
[isVerified()] activate/ [isUniqueId()]
[isSuspendRequested()] suspend/
[isPasswordAlert()] lock/
[isAccountDormant()] suspend/
[isResumeRequested()] resume/
[isLockExpired()] unlock/
[isCancelRequested()] cancel/
Active
Suspended
[isCancelRequested()] cancel/
[isPolicyViolated()] cancel/
Closed [hasNoBalanceDue()]
[isCancelRequested()] cancel/
[isPolicyViolated()] cancel/
uml-diagrams.org

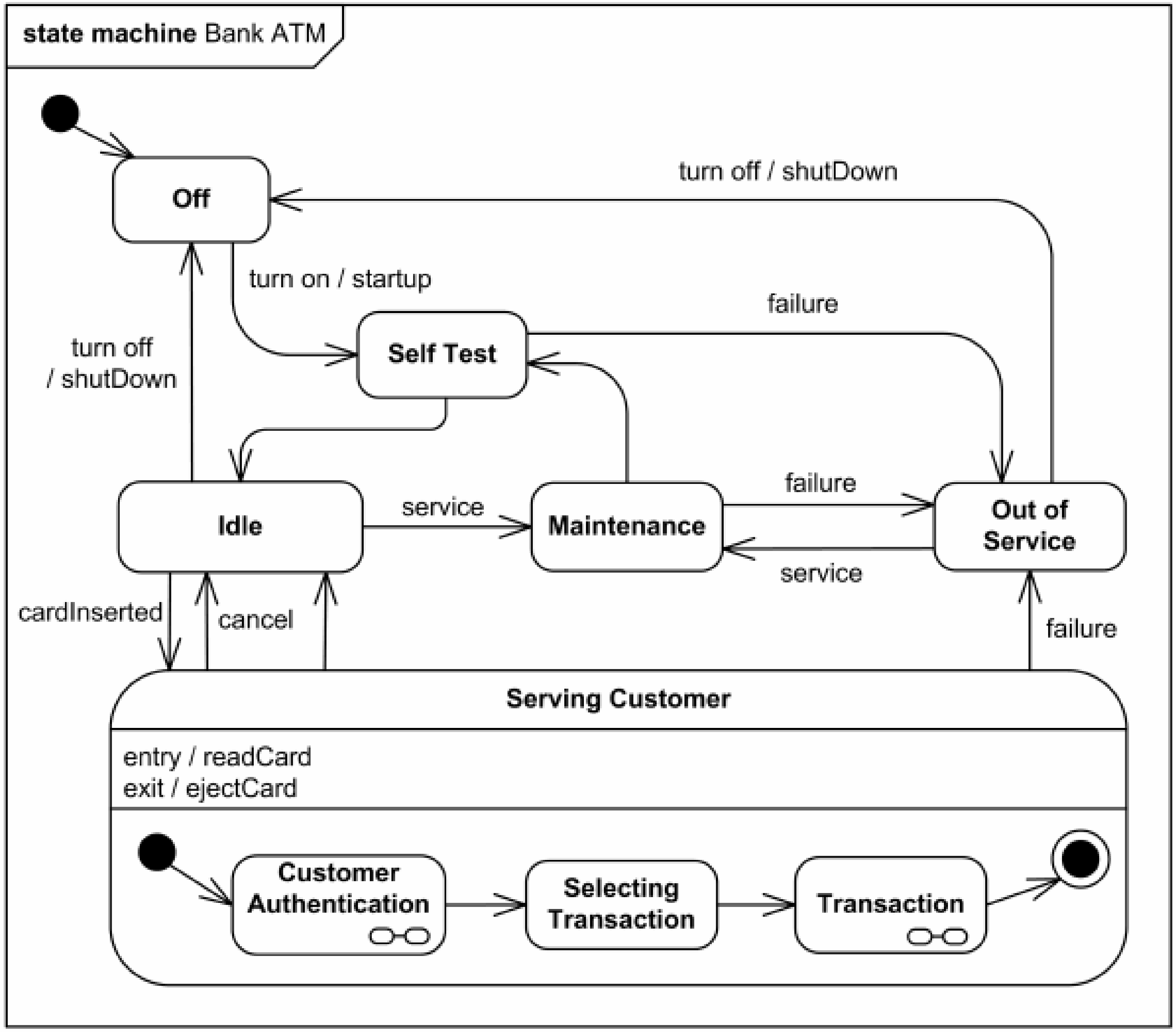
Super/substates

- When one state is complex, you can include substates in it.
  - drawn as nested rounded rectangles within the larger state
- *Caution:* Don't over-use this feature.
  - easy to confuse separate states for sub-states within one state



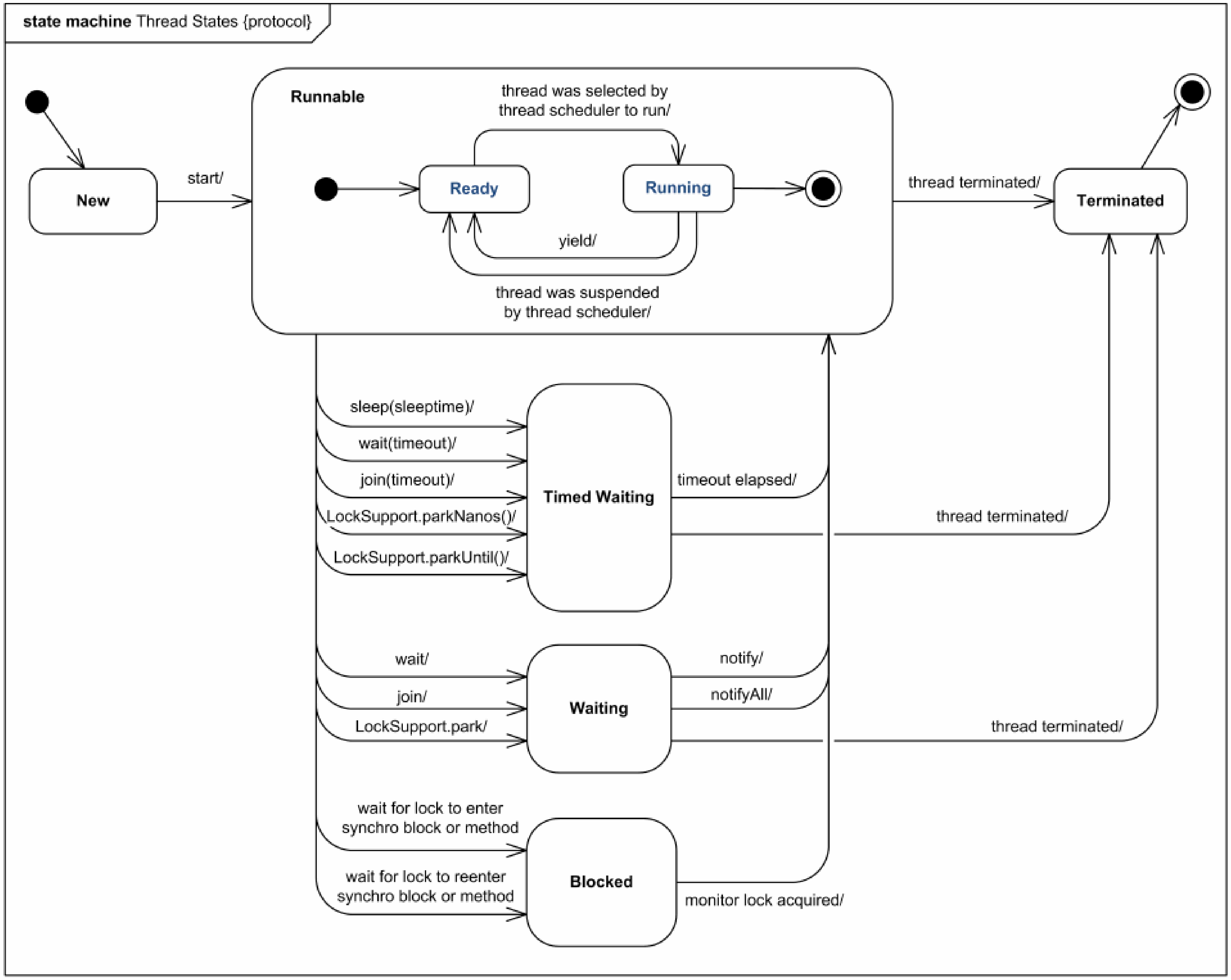
State diagram example

ATM software states at a bank



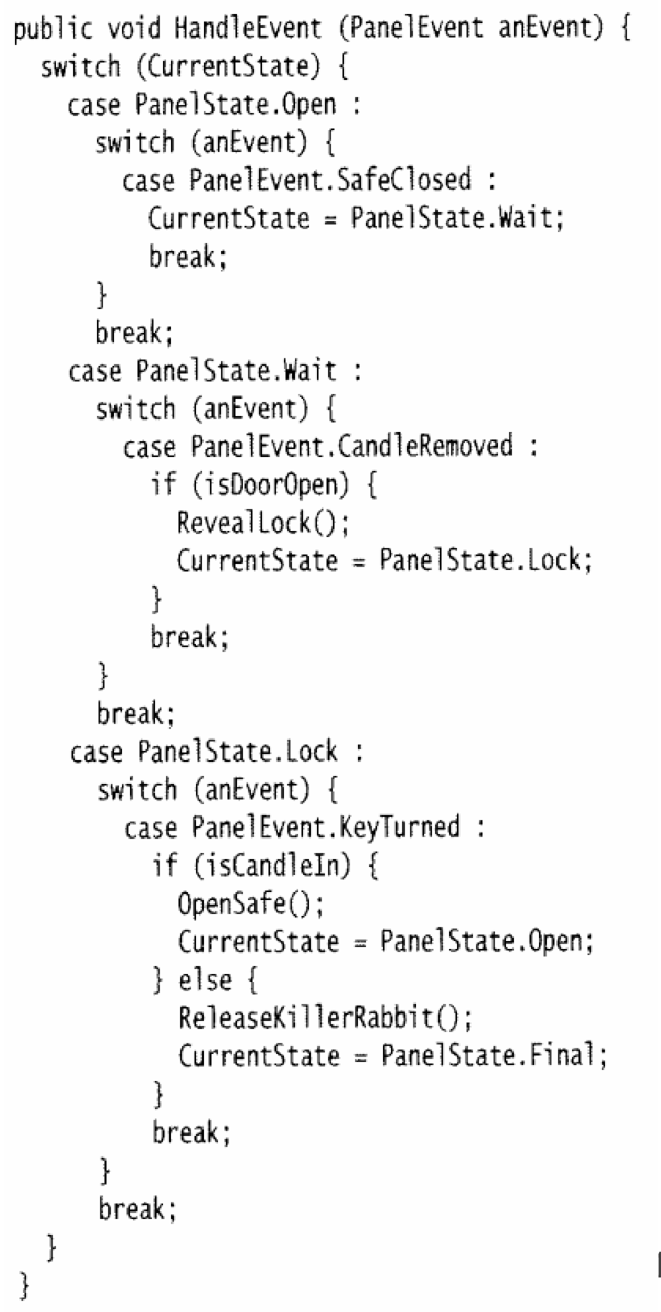
State diagram example

Java thread states



Implementing states

- What are some ways to write code to match a state diagram?
  - state tables (pseudo-code)
  - nested if/else
  - switch statements
  - state enums
  - State design pattern



```
public void HandleEvent (PanelEvent anEvent) {
  switch (CurrentState) {
    case PanelState.Open :
      switch (anEvent) {
        case PanelEvent.SafeClosed :
          CurrentState = PanelState.Wait;
          break;
      }
      break;
    case PanelState.Wait :
      switch (anEvent) {
        case PanelEvent.CandleRemoved :
          if (isDoorOpen) {
            RevealLock();
            CurrentState = PanelState.Lock;
          }
          break;
      }
      break;
    case PanelState.Lock :
      switch (anEvent) {
        case PanelEvent.KeyTurned :
          if (isCandleIn) {
            OpenSafe();
            CurrentState = PanelState.Open;
          } else {
            ReleaseKillerRabbit();
            CurrentState = PanelState.Final;
          }
          break;
      }
      break;
  }
}
```

State pattern

- **state pattern**: An object whose sole purpose is to represent the current "state" or configuration of another larger object.
  - A behavioral pattern.
  - Often implemented with an `enum` type for the states.
  - Each object represents one specific state for the larger object.
  - The larger object sets its state in response to various mutations.
  - Allows various observers and interested parties to quickly and accurately know what is going on with the larger object's status.

- Analogous to the notion of *finite state machines*.
  - Set of states (nodes)
  - Set of edges (mutations that cause state changes)

State enum example

```
/** Represents states for a poker game. */
public enum GameState {
    NOT_STARTED, IN_PROGRESS, WAITING_FOR_BETS,
    DEALING, GAME_OVER;
}

/** Poker game model class. */
public class PokerGame {
    private GameState state;

    public GameState getState() { return state; }

    public void ante(int amount) {
        ...
        state = WAITING_FOR_BETS;    // change state
        setChanged();
        notifyObservers(state);
    }
}
```