State Chart Diagrams

Lecture 9

Objectives

- To become familiar with the notation used in State Chart diagrams
- To know how to interpret State Chart diagrams
- To be able to draw a State Chart diagram from a given scenario

Object & State

- All objects have ‘State’ at a given time.

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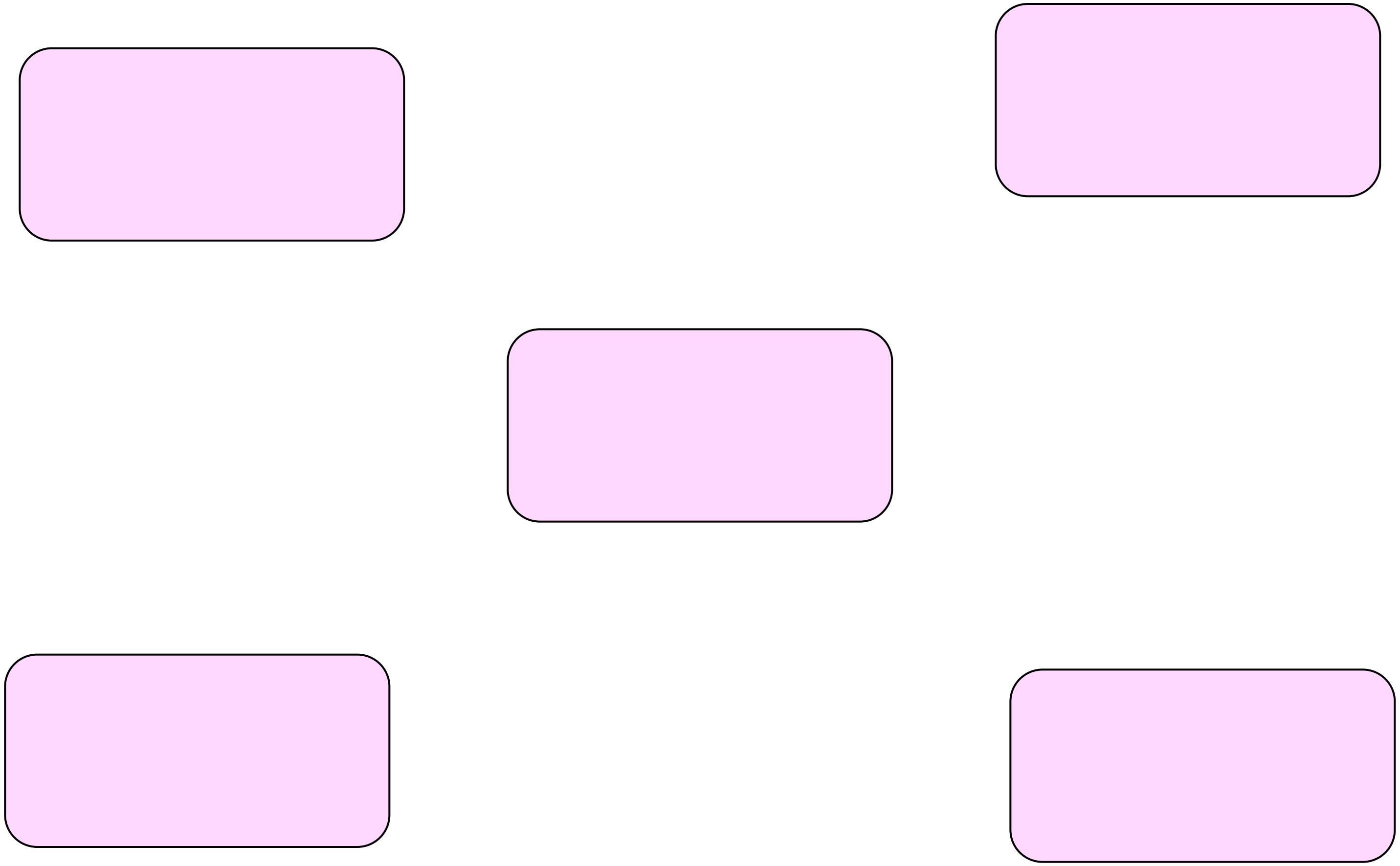
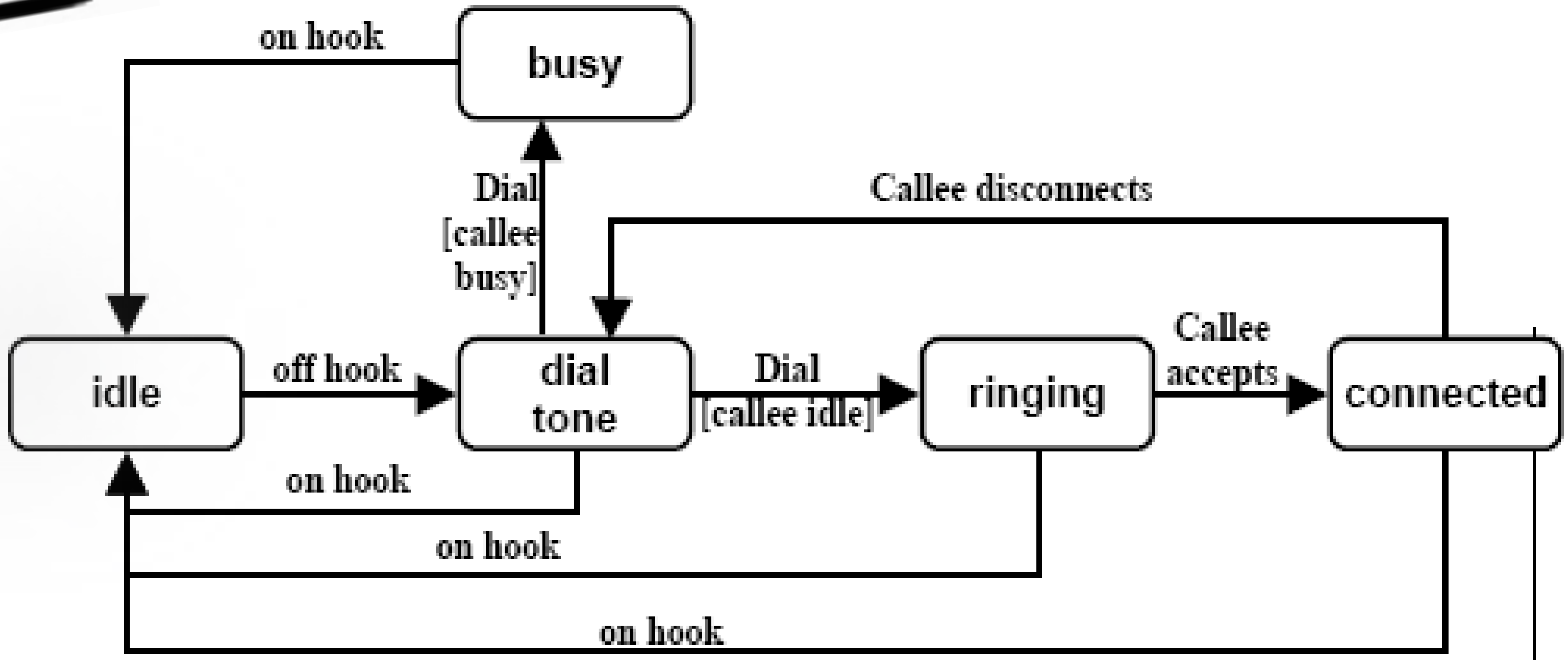
States for a Phone



State Chart Diagram



Explanation – Dialing a Number

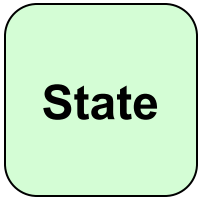
- The telephone is idle until the handset is lifted.
- When the handset is lifted, the telephone sounds a dial tone.
- When the user starts to enter a phone number, the telephone starts to dial.
- When dialling is complete, if the number is invalid, an error tone will sound, after which the user must hang up.
- If the number dialled is valid, the phone will attempt to connect to the receiving phone. If the receiving phone is busy, the user's phone will sound the engaged tone, after which the user must hang up.
- If the receiving phone is not busy, it will ring. If the phone is not answered after 60 seconds, the user's phone will sound the engaged tone, after which the user must hang up.
- If the receiving phone is answered, the line is opened.
- The call ends when the user hangs up.

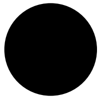
What does a State Diagram show?

- Models the behaviour of a single object, shows the sequence of states that it goes through during its lifetime in response to events.
- Basic elements
  - States
  - Transition
  - Events

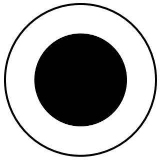
State Chart Diagram – Notation

- State
  - A state of an object describes the current values of its attributes.
  - Shows all possible states of an object
  - A round-cornered rectangle with the name of the state written inside it.





  - Initial State: a filled black circle, may be labelled

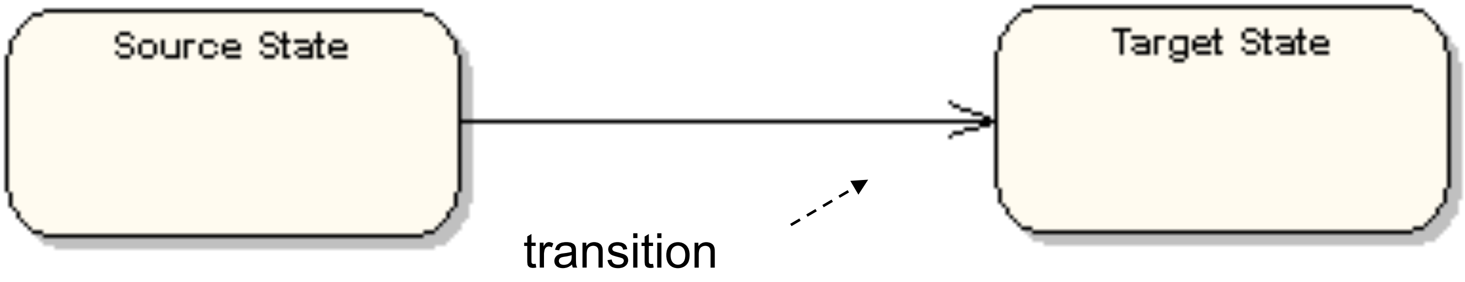


  - Final State: circle with a dot inside, may be labelled.

State Chart Diagram - Notation

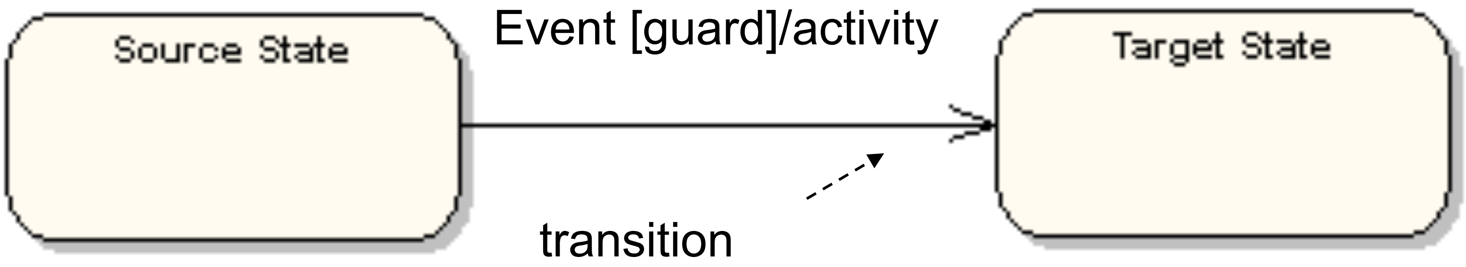
- Transition
  - Shows a movement from one state to the next one,
  - Shown by lines with arrowheads.
  - A transition has a label in the form of three parts:

    event [guard]/activity.



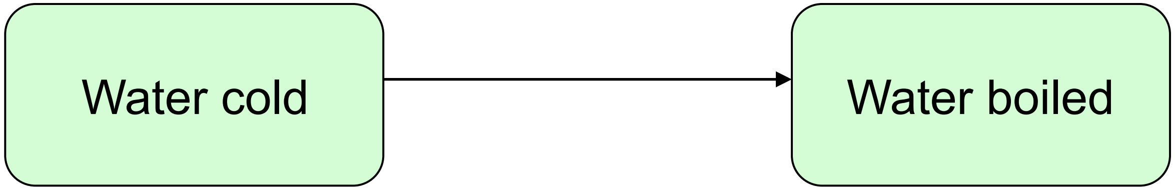
State Chart Diagram - Notation

- Trigger (cont.)
- All three parts of the label are optional.
  - – Event: something that triggers a change of state
  - – Guard: a Boolean condition that must be true for the trigger to cause the transition
  - – Activity: action done during the transition



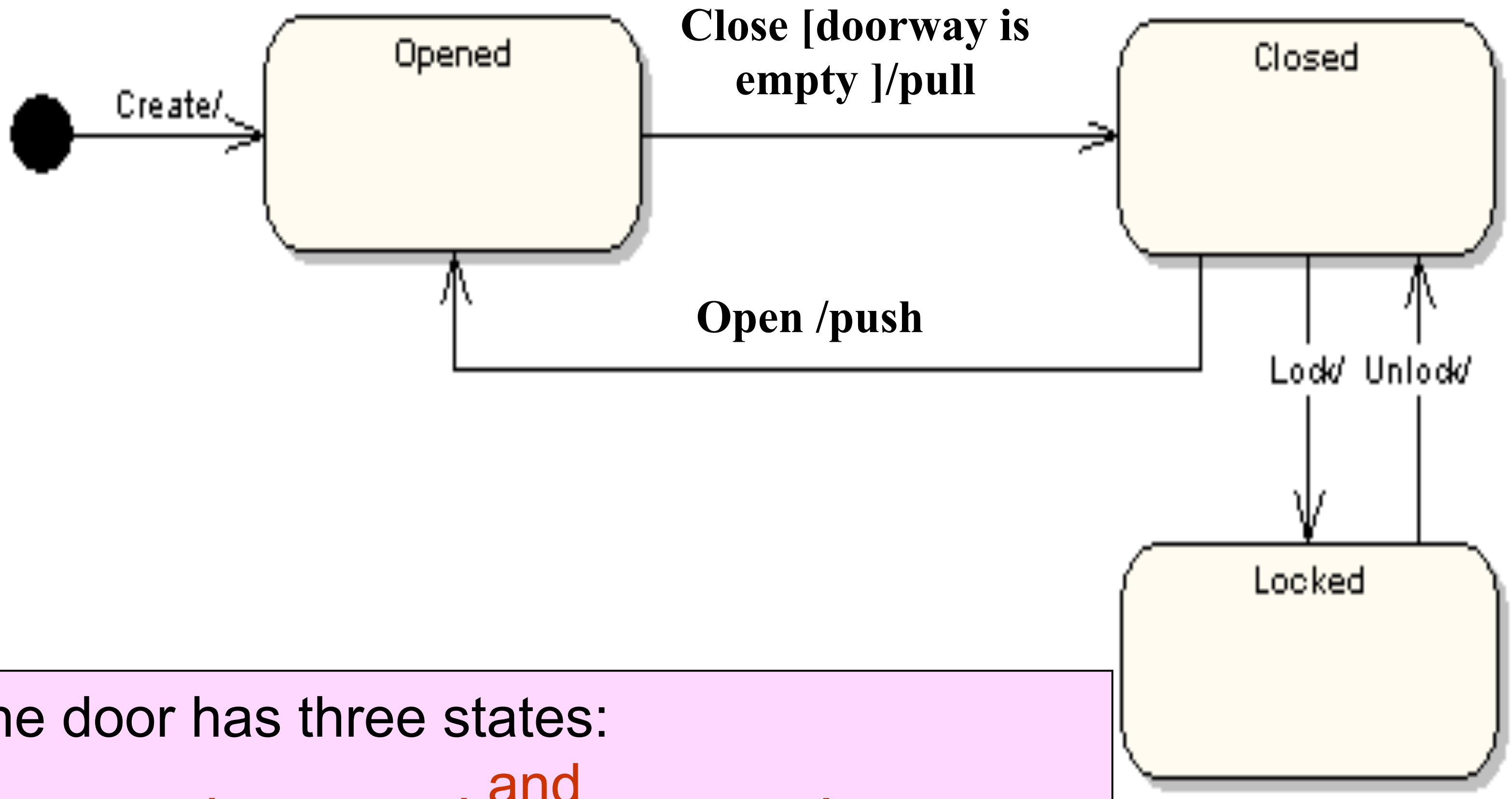
State Chart Diagram - Notation

- Events
  - Determine when transitions fire
  - Stimuli that can trigger an object to change its state



- What is the event? ____________________

Example - States for a Door



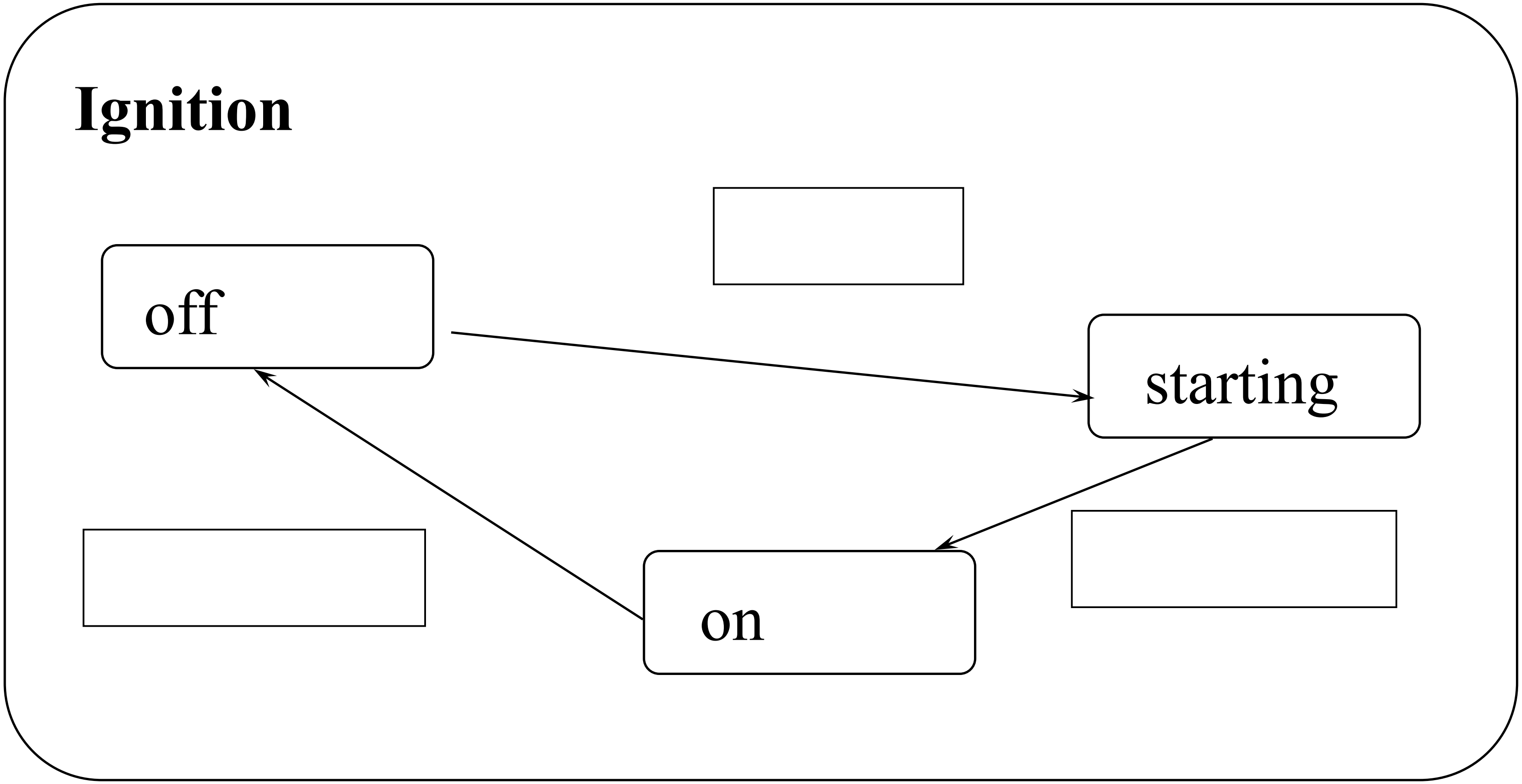
- The door has three states:

  ________, __________, and __________.
- It can respond to the events:

  __________, ________, _________ and _____________

Exercise: Ignition

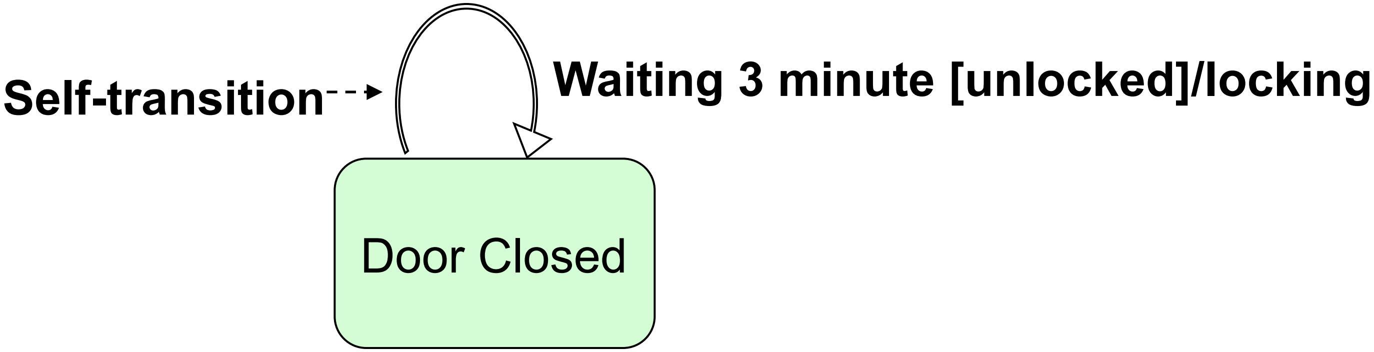
Name the events that cause the transitions ?



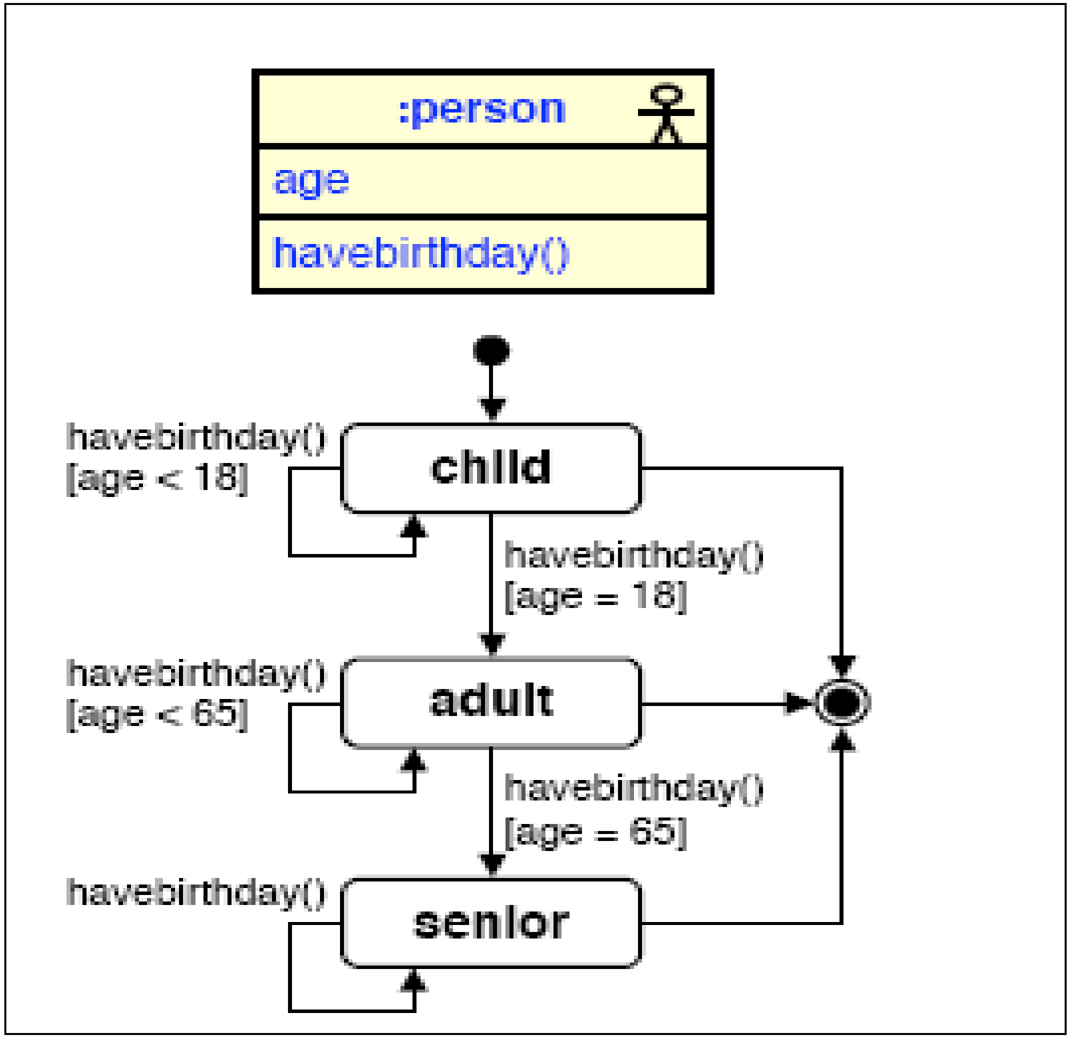
State Chart Diagrams - Notation

Self-Transitions:

- **T**ransition whose source and target states are the same



Example --- Person



Superstates and Substates

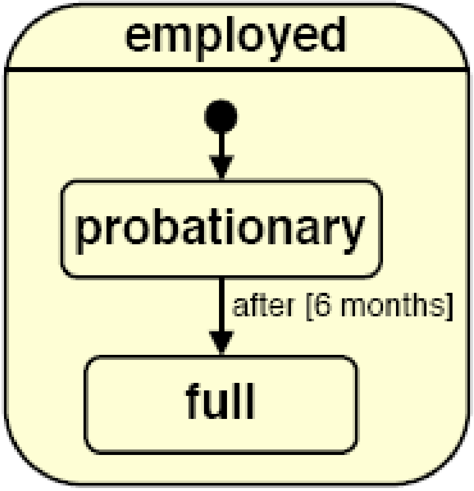
- States can be nested to make diagrams simpler
- A ________ is a state that is nested in another state
- A state that has substates is called a __________

- Aggregation View:
- When several states share common transitions and internal activities, they can be made substates
- ________ behaviour is moved into a superstate

Two Types of Superstates

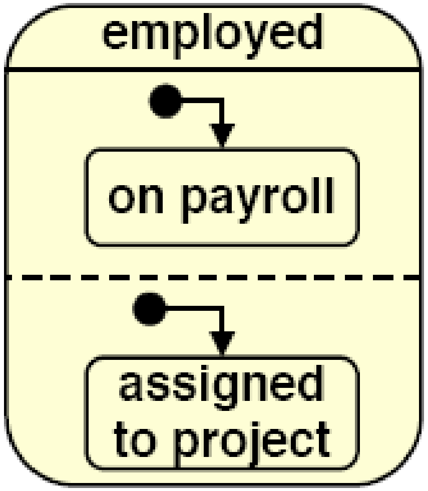
OR superstates

- when the superstate is "on", only one of its substates is "on"

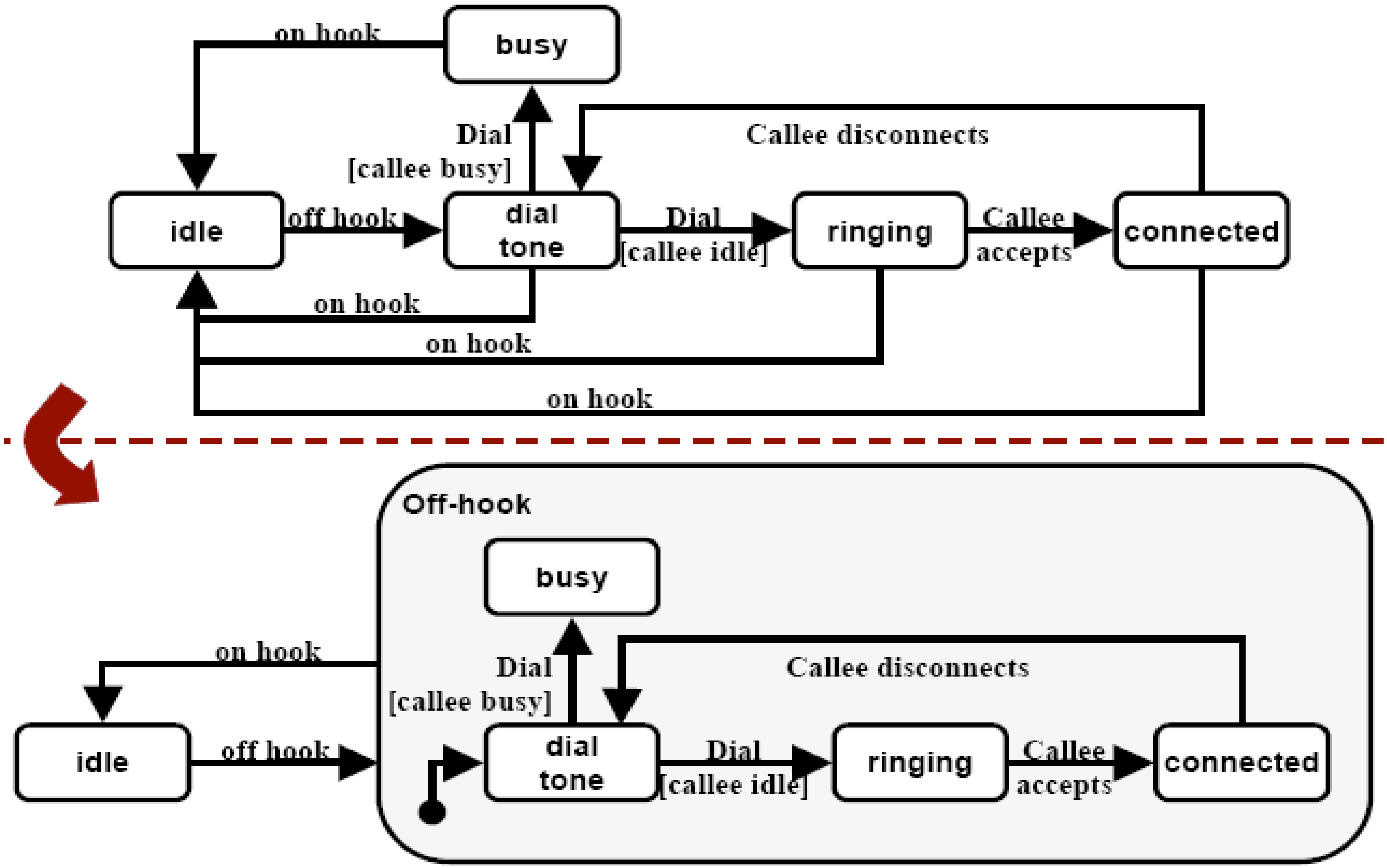


AND superstates (concurrent substates)

- When the superstate is "on", all of its states are also "on"
- Usually, the AND substates will be nested further as OR superstates



Superstate Example - Phone

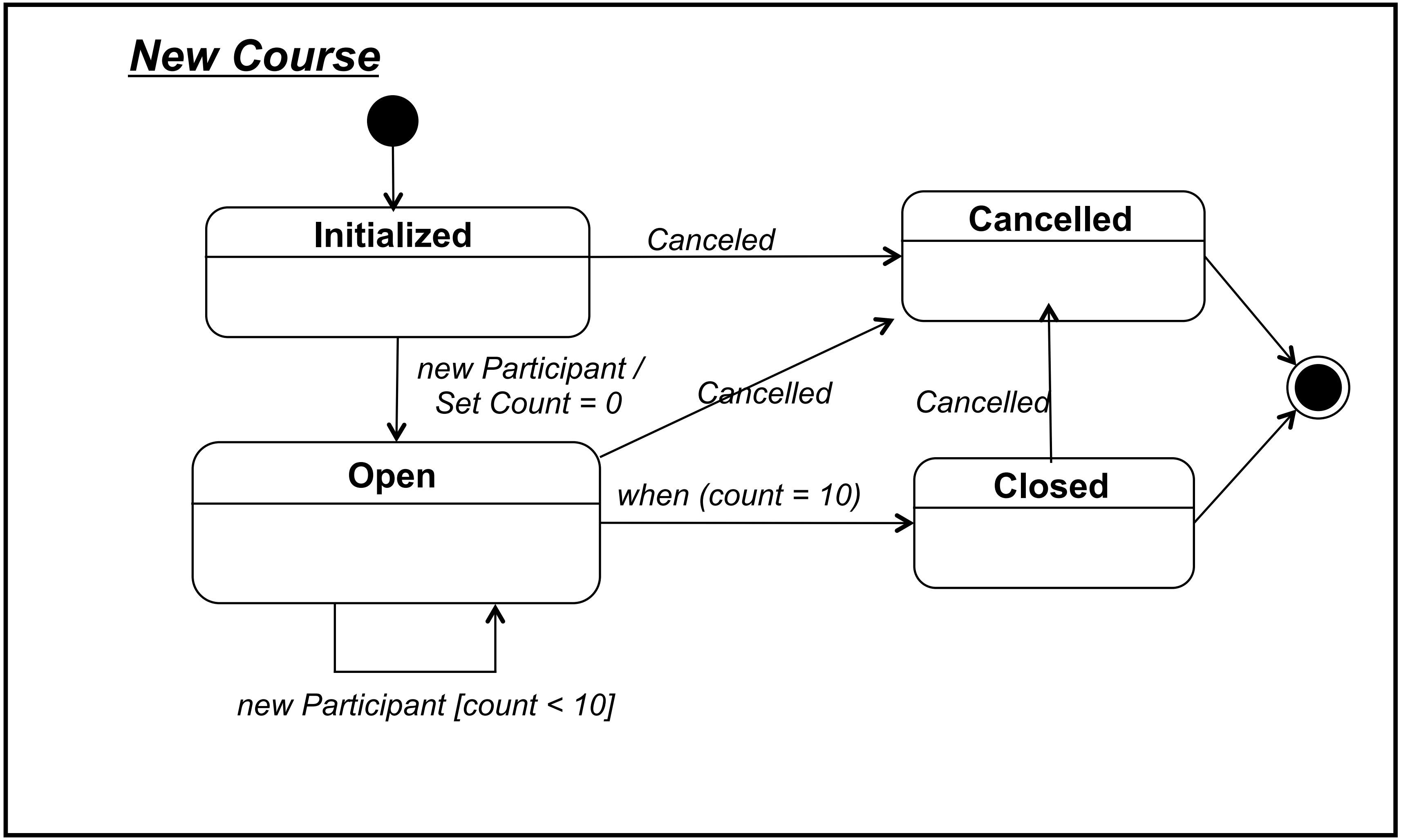


Super State

Example: New Course

- When a new course is offered to the public, it is INITIALISED.
- When the first customer registers for the course, the course is OPEN.
- The course remains OPEN and accepts participants until there are enough participants on the course.
- The course may be CANCELLED at any time.

Example - New Course



Exercise: New Course

- What event causes a transition from the INITIALISED state to the OPEN state?

  ____

- How many participants are needed for the course to remain OPEN?

  ____

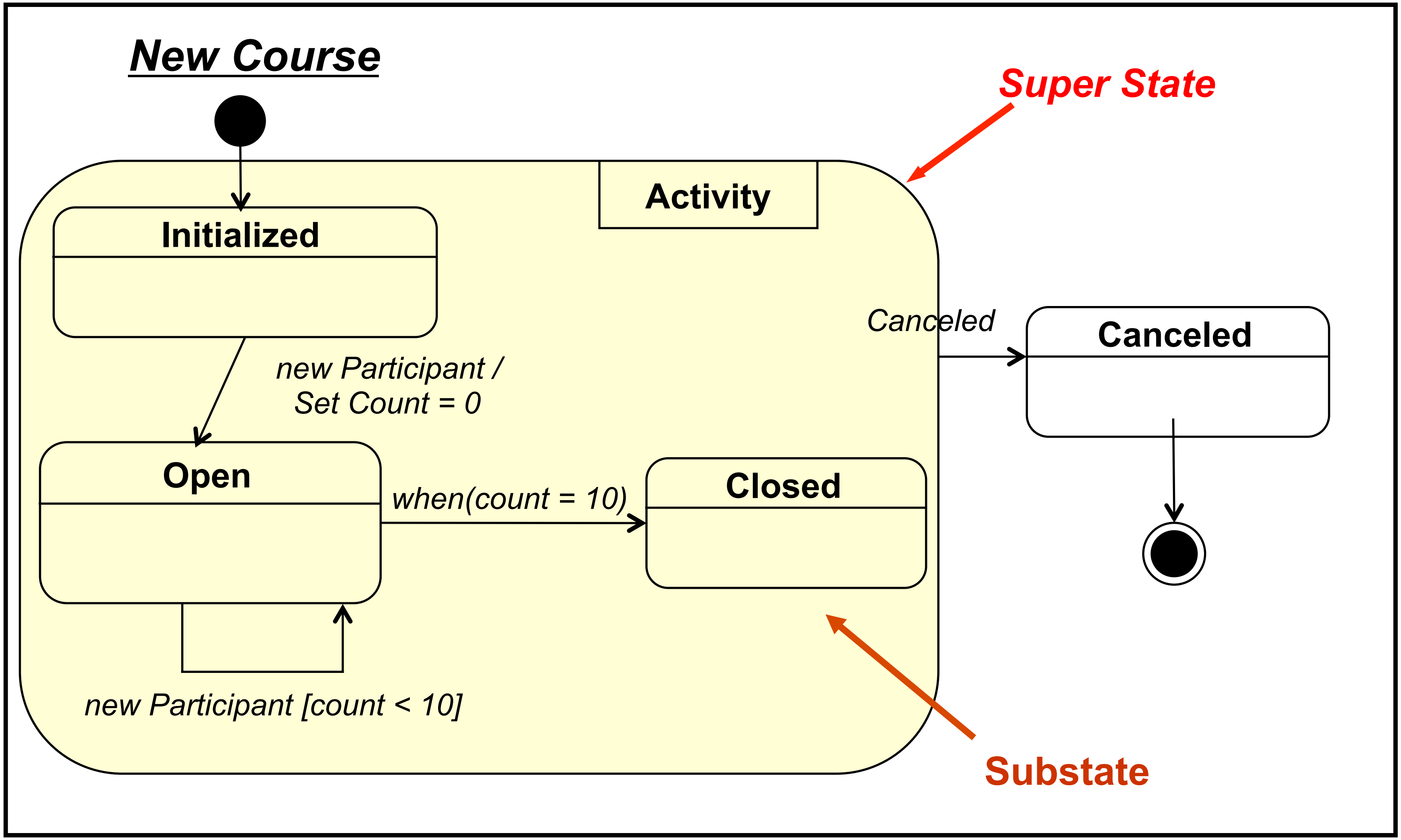
- When is the course CLOSED?

  ____

- When is the course CANCELLED?

  ____

Example – Super State



Exercise: New Course

- Why are the INITIALISED, OPEN and CLOSED state in the superstate?

  ____

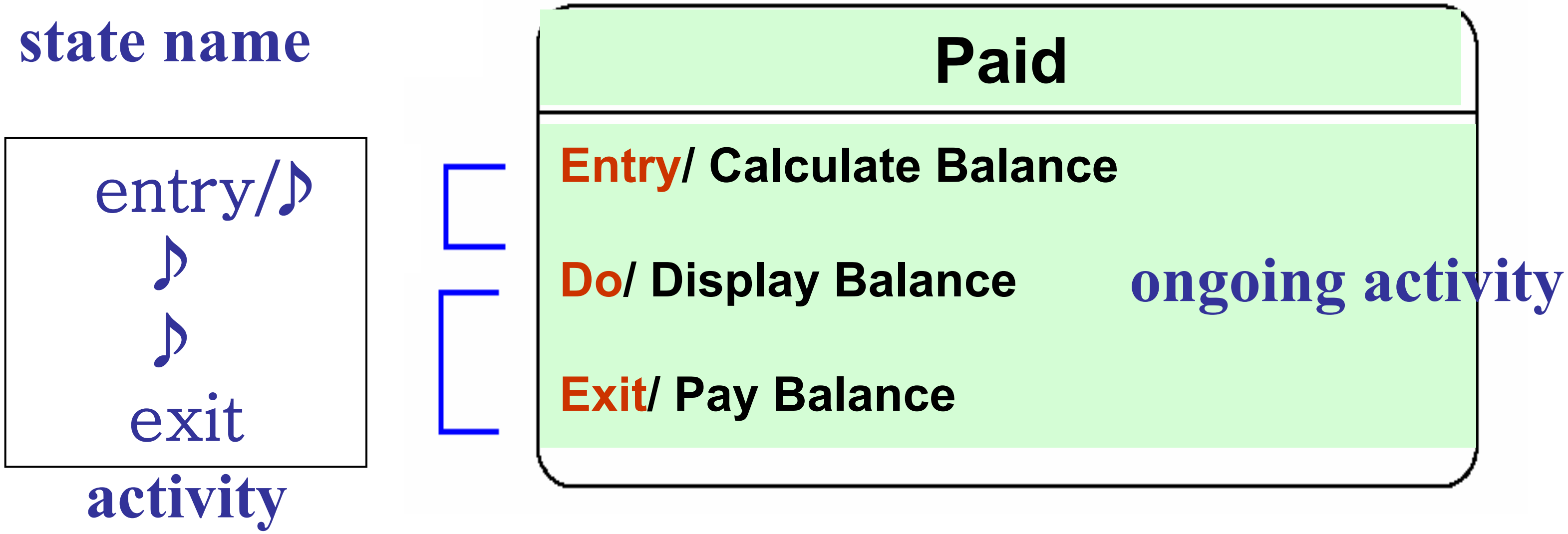
- The superstate is called _____________
- Name the event | guard| action in the following:

  (a) new Participant/Set Count = 0
  (b) new Participant[count < 10]

States – Internal Activity

Internal Activity:

- Entry activity: Occurs when you enter a state
- Exit activity: Occurs when you leave a state
- Do activity: State which can do some ongoing work



state name

entry/♪

♪

♪

exit

activity

Paid

Entry/ Calculate Balance

Do/ Display Balance

ongoing activity

Exit/ Pay Balance

Events with Transitions

Other important events used with transitions:

- **Timeout Event** with keyword **after**

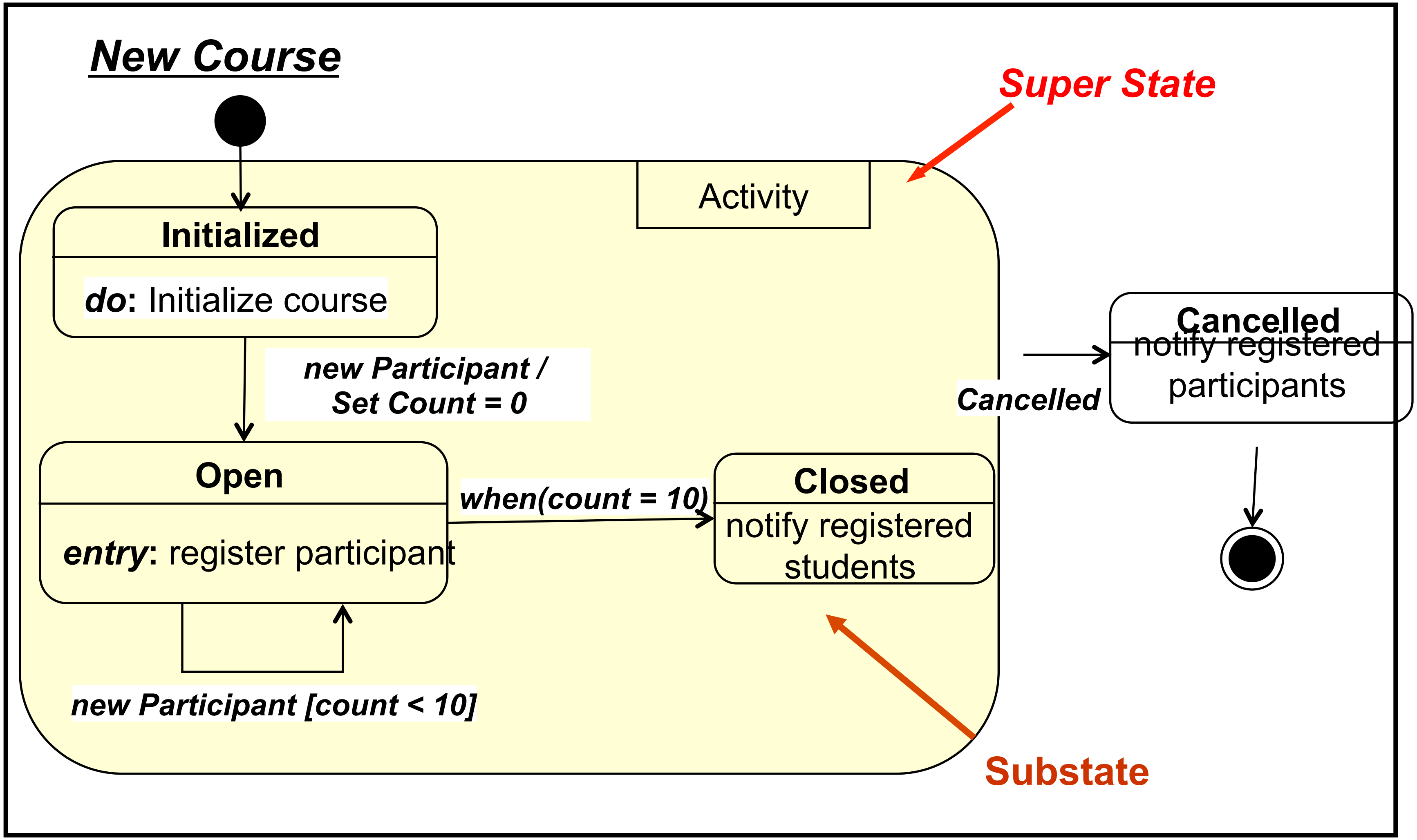
  - *after(10 seconds)*

- **Conditional Event** with keyword **when**

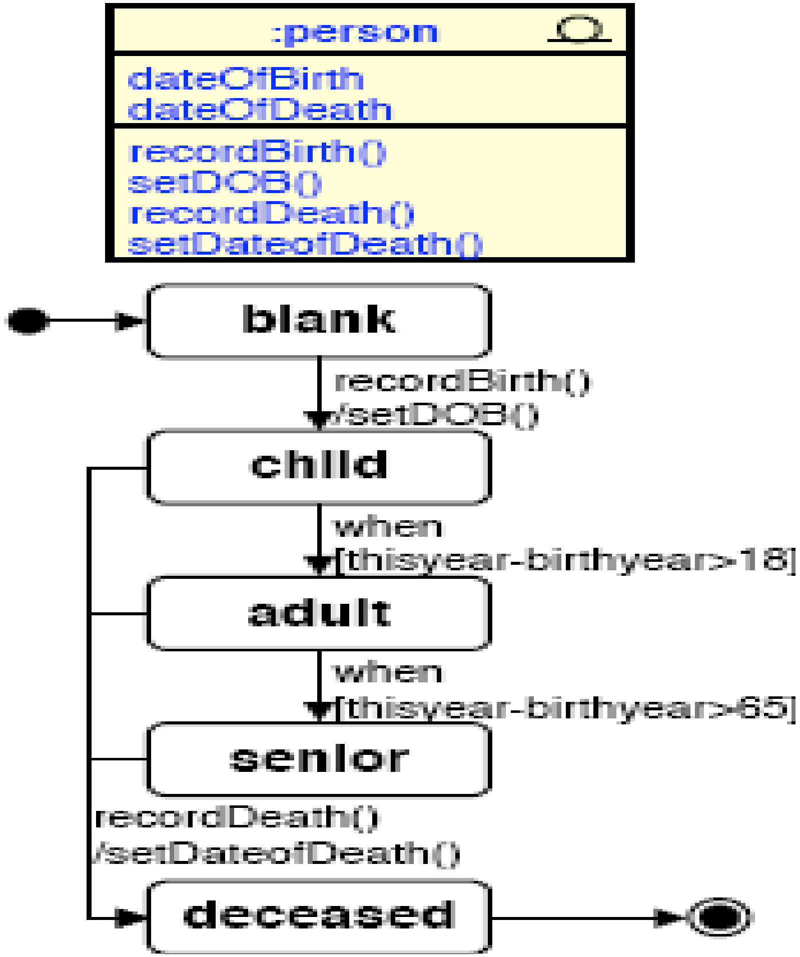
  -when a specified condition becomes true

  when(count = 10)

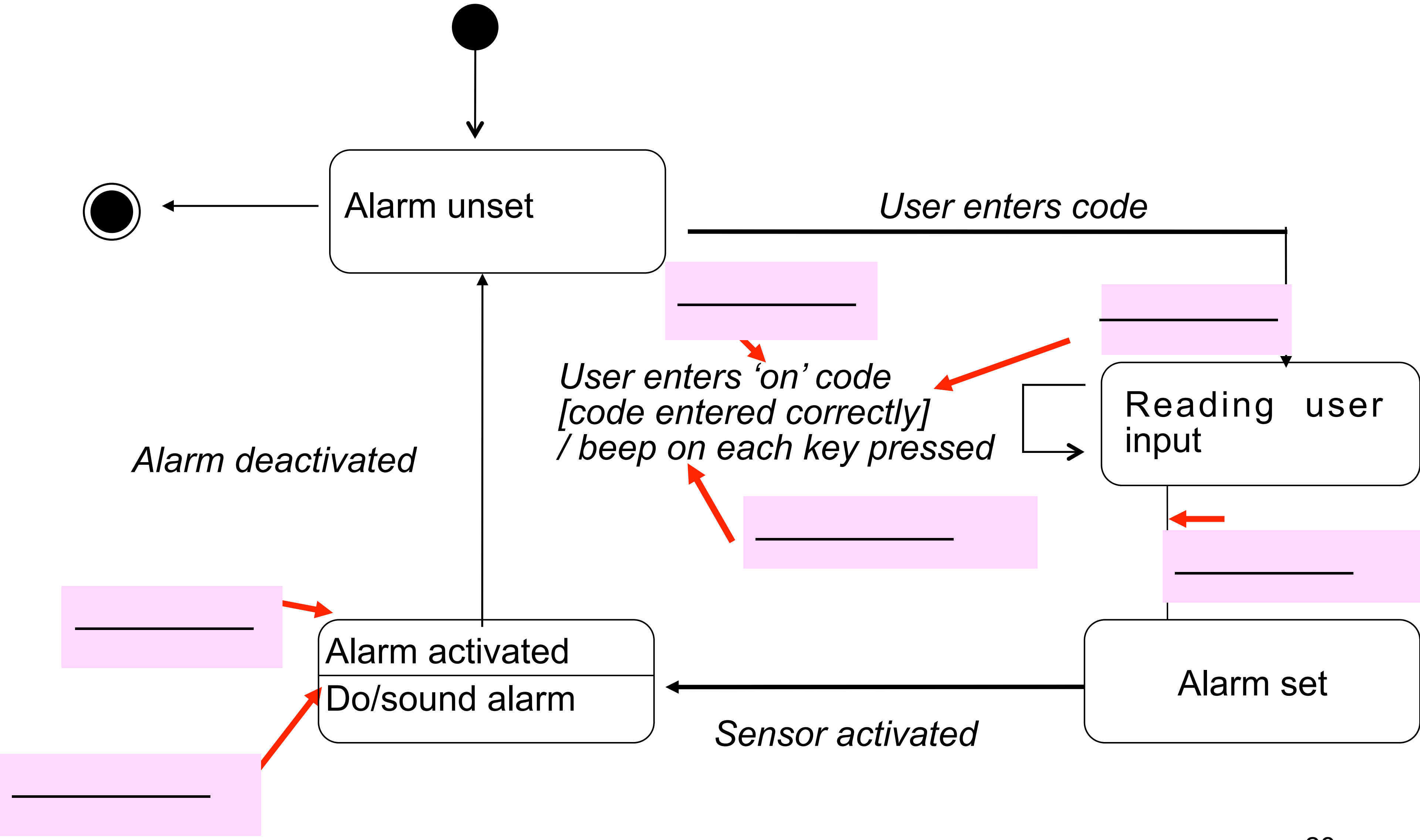
Example – New Course


New Course
Super State
Activity
Initialized
do: Initialize course
new Participant / Set Count = 0
Open
entry: register participant
when(count = 10)
Closed
notify registered students
new Participant [count < 10]
Cancelled
Cancelled
notify registered participants
Substate

State Chart: Person



Example – Setting an Alarm



How to Model State Charts

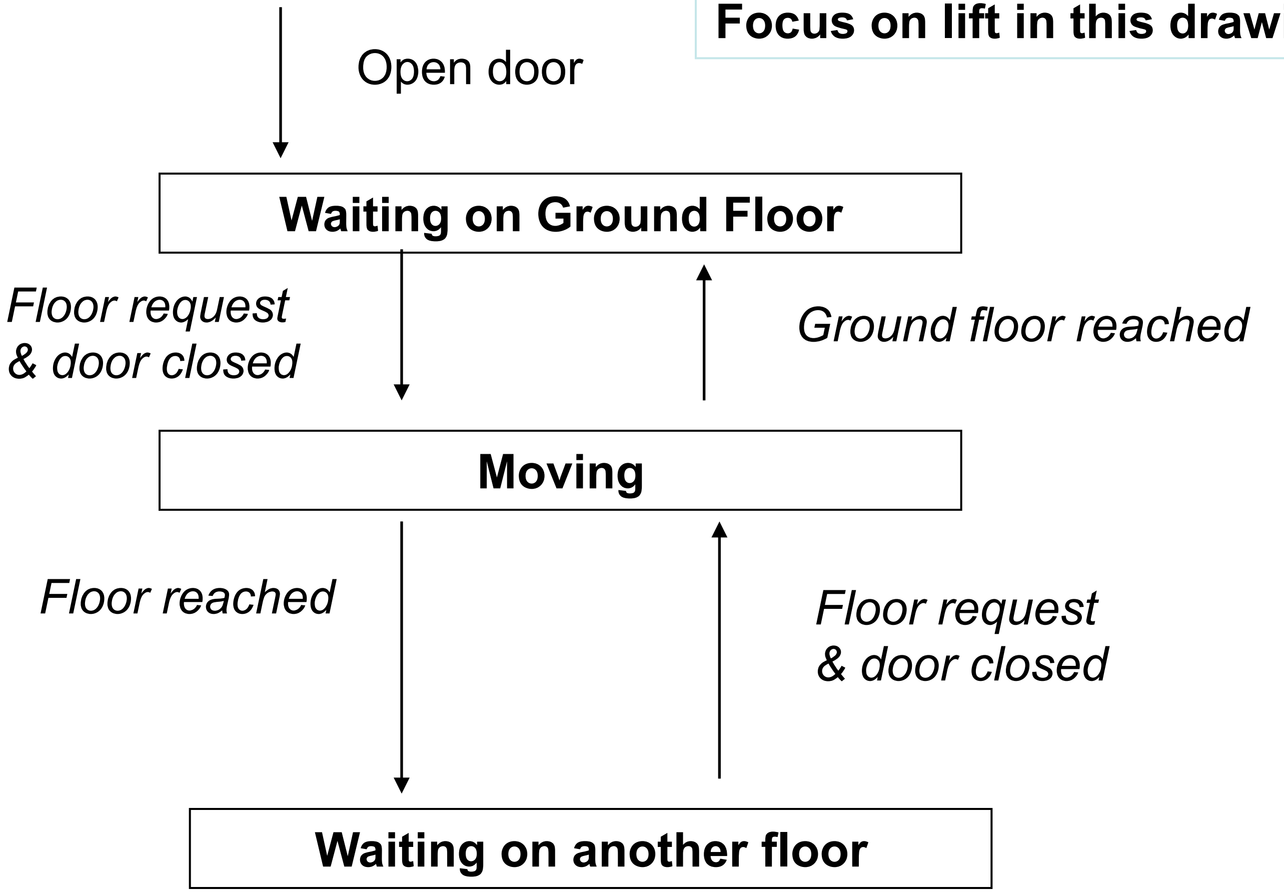
- Chose initial state and final state
- Decided on what the stable states are
- Decide on the order of the stable states over the lifetime of the object
- Decide on the events that trigger transitions from one state to another
- Add actions to these transitions
- Try ways to simplify the diagram using sub-states

Question

- Draw a state chart for using a lift
- What is the start state?
- What is the end state?
- What are the events?
- What are the triggers that bring you from one state to another?

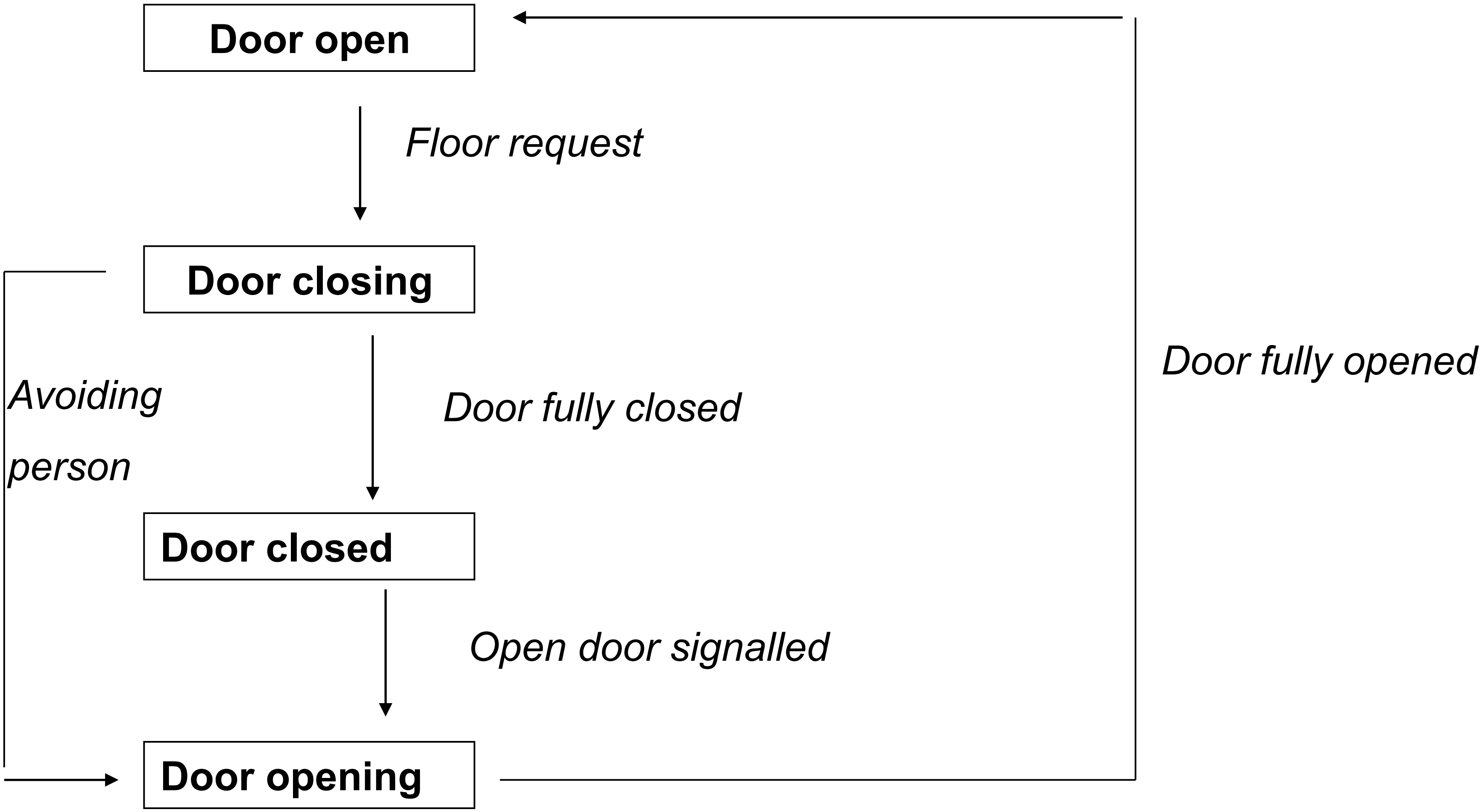
Lift – State Chart

Focus on lift in this drawing



State Chart - Lift

Focus on lift doors in this drawing



Door open

Floor request

Door closing

Avoiding person

Door fully closed

Door closed

Open door signalled

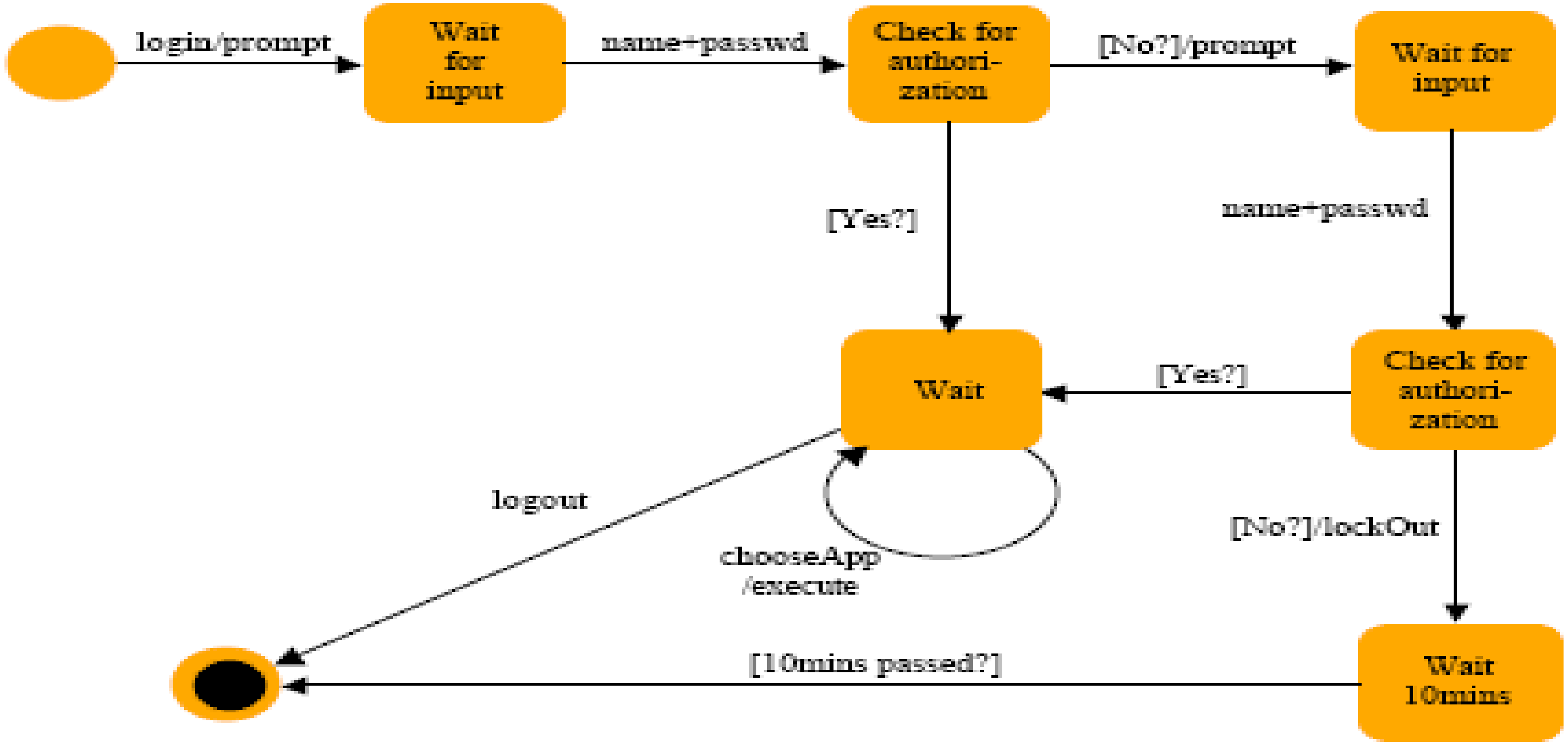
Door opening

Door fully opened

Question – Logon

- The session begins when a user clicks on a login button.
- Then the session prompts the user for their username and password, checks that the user has authorisation and then logs them in.
- If there is problem with the username or password, the user is given one more chance to input a valid username and password, otherwise the program goes into a 10-minute time-out and then returns to idle mode.
- While the user is logged in, he is allowed to run particular programs by clicking on appropriate buttons.
- When the user clicks the “log out” button, the session terminates.

Login Example



It is OK to loop back to the start state instead of an end state.

Exercise - Vending Machine

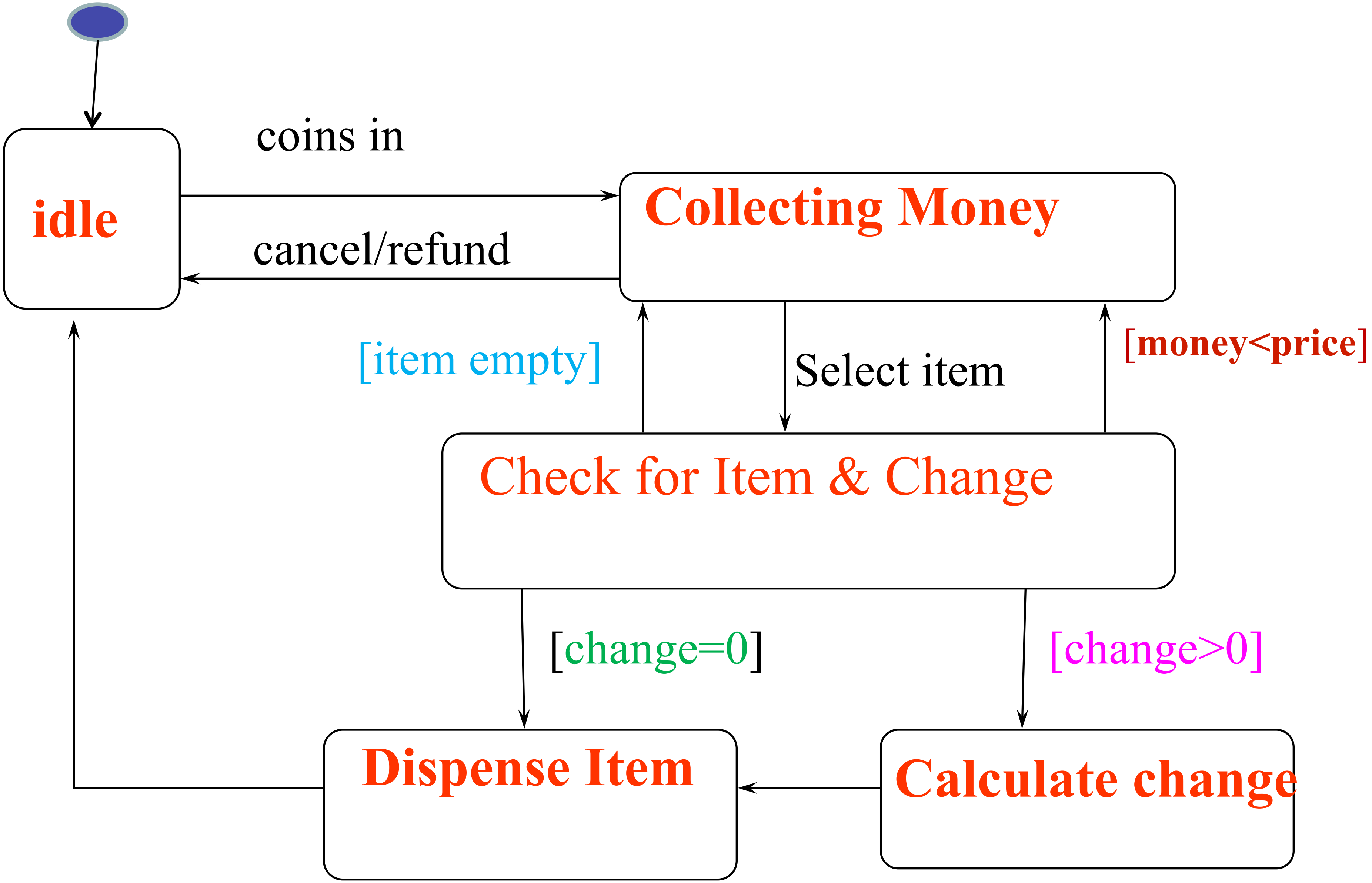
Model the following description of a vending machine using a state chart diagram.

The vending machine dispenses call credit for a mobile phone.
The vending machine is idle until someone selects which operator they want to buy call credit for.
There are three options, Vodafone, O2 or Meteor. The user then selects the amount of call credit they wìsh to purchase.
The options are €10.00, € 20.00 or € 50.00.
Next the user must put money in the machine to the value of their selection.
Once the correct amount of money has been inserted, a docket is printed for the transactions and the machine returns to an idle state.

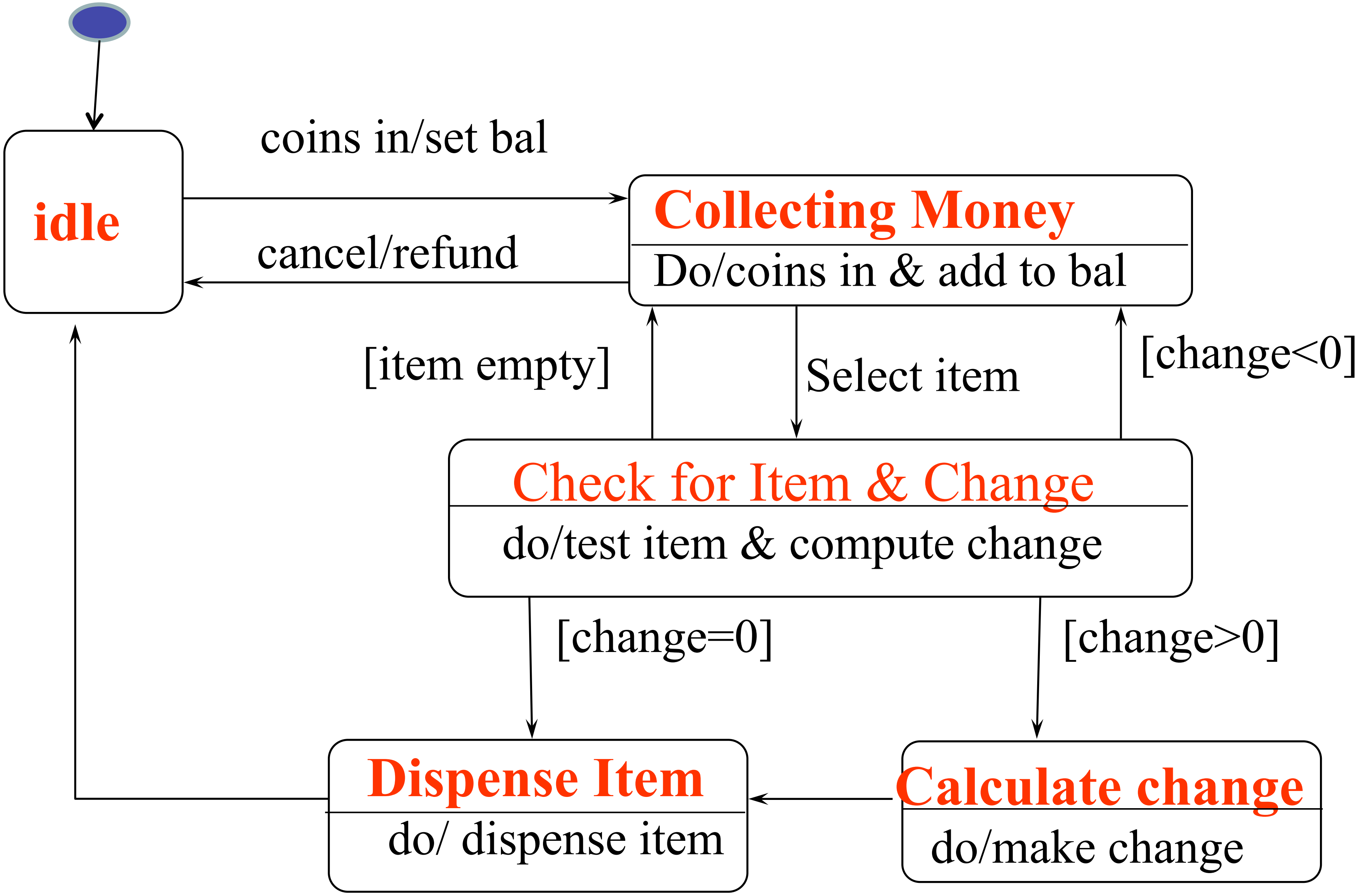
Exercise - Vending Machine

- Consider:
  - What if the person does not put in enough money?
  - What if the person needs change?
  - What if the item is not in stock?

Example: Vending Machine



Example: Vending Machine



Exercise 1

- Draw a state chart diagram of a pre-timed traffic light system:
- The lights display a sequence of green, amber and red lights repeatedly.
- Each light is displayed for 90 seconds.

Exercise 2

- Draw a **state chart** diagram which represents two players playing a game of draughts.
- It is either white or black’s turn to move a draught around the board.
- The game is over when either:
  - – black wins
  - – white wins or
  - – the game ends in a draw.