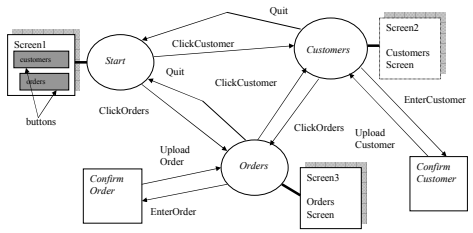
X-machines

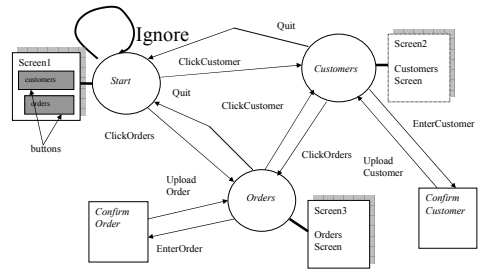


- Recall the diagrams we saw before:

- When we trace through the diagram there are a number of key things to consider:
- Taking a transition from a state to another state may be the result of:
  - An input that only enables one out of several transitions to be valid

  eg. A mouse click such as ClickCustomer
  - There are two or more transitions possible but each transition can only be enabled under a specific set of conditions

- For example, suppose that there is a mouse click that is in an area that does not correspond to a button.
- We could add a new arrow to the diagram:



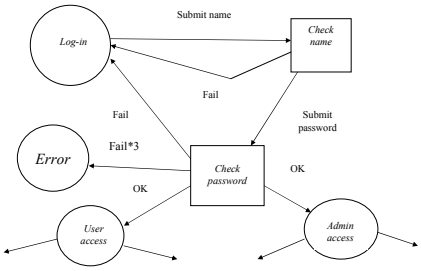
- With the transition called *Ignore*
- This transition is taken under the conditions that the mouse is clicked in any area other than the buttons:

  Customers or Orders
  - or any key is pressed
- From this state we have one of three mutually exclusive situations:
  - Mouse is clicked over the Customer button;
  - Mouse is clicked over the Order button;
  - Mouse is clicked over the rest of the screen or a key is pressed. .

Transition conditions

- This introduces an important property of X-machines.
- There can be two arrows leaving from the same state – usually going to different states (but not always)
- Which transition is taken depends on some condition.
- The conditions could be based on some property of the input
- Or on an internal property

- In some transitions we have to consider the state of some internal memory or database data before identifying which transition should be taken.
- Consider a simple Login system with two classes of users:
  - Admin
  - User
- An X-machine might look like this:

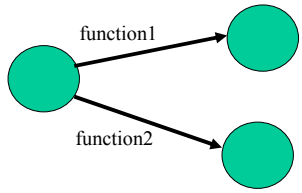


Recall that the square states denote situations where the system consults some internal database to look up necessary information

- In this system consider what happens in the *Check password* state.
- There are three possible transitions from this state:
  - The password is OK and the user has Admin privileges;
  - The password is OK and the user has User privileges;
  - The password fails
    - If it fails 3 times we reach the Error state and a suitable message is displayed
- There are no other possibilities and so the system will be fully defined at this point.
- We call the machine *complete*.

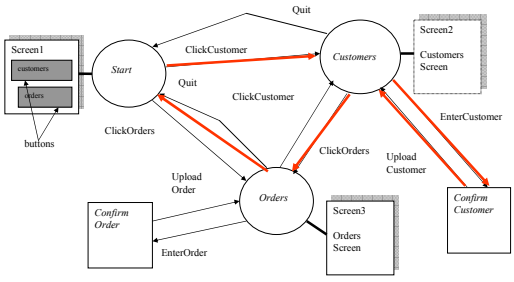
- In some cases you may find a state where there could be cases that have not been specified
  - in these cases it is important to decide what the system should do
  - it might ignore an input and remain in the same state, for example,
  - or raise an error and transfer to an error state from which some suitable recovery is defined.

- The 2 functions must cover all possible cases so that the system does not suddenly stop because it doesn't know what to do – or it just decides to do what it likes!!!



This problem is called *non-determinism*
We need to deal with it.

System testing from XXMs



Paths and sequences

- Take any path from the start state and trace out a sequence of transitions
- This will represent a test set
- To trigger this path we will have to interact with the GUI:
  - Press a suitable button
  - Feed in suitable data
- We Observe what happens
  - What state do we get to?
  - What output is generated?

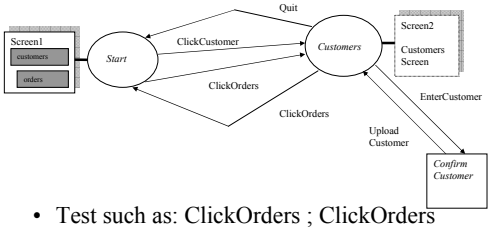
XXM editor in Eclipse

- If you use this tool to build you X-machines it will generate all the paths for you
- These paths are a transition tour – they visit every state and every transition
- There is still the issue of how do you know what state you have reached
- This can be solved using a more complex sequence – probably not needed for our type of systems

What are we testing for?

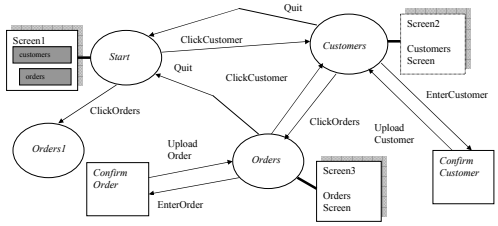
- 1). there are *too few* states;
- 2). there are *too many* states;
- 3) there are transitions going *from* an incorrect state;
- 4). there are transitions going *to* the wrong state;
- 5). there are transitions that carry out the *wrong function*.

Missing state fault



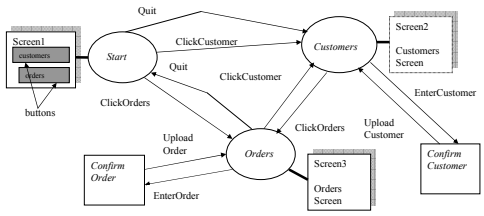
- Test such as: ClickOrders ; ClickOrders
- Should detect this fault

Too many states



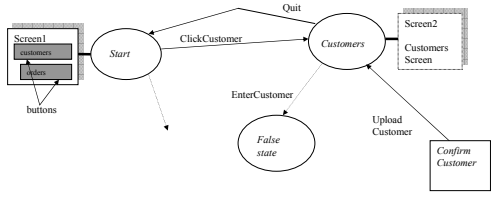
Test ClickOrders from state *Start* will find this fault.

Incorrect transition source



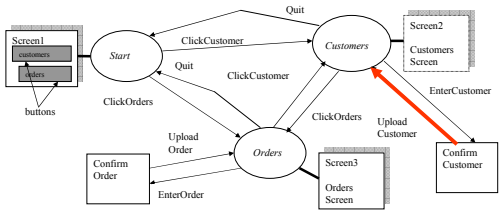
Test: Quit finds this fault

Incorrect transition target



- A test : ClickCustomer ; EnterCustomer Will detect this

Transition with wrong operation



UploadCustomer operation should insert details from the EnterCustomer operation into the database

- To test this we need to output the result of this operation somehow.
- This might be done as part of the user interface but, more generally, we will need to run a report on the database to see if the operation was successful.
- This leads to a set of tests which vary according to the data being input.
- Thus, it might work for some cases but not for others.

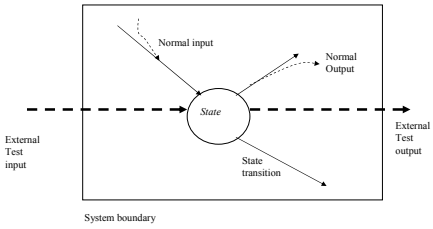
System testing involves both transition paths and data entry

- It may be possible to automate some of this
- Make sure that you use realistic data values
- Try out unusual, extreme or invalid values
- Check for data validation errors
- Check for completeness
- Check for unexpected interface behaviour

Design for test

- Sometimes it isn't possible to test something directly
- We may need to drive the system inot a specific state in order to test a specific transition
- It may not be designed to allow this
- We introduce some extra test functions into the machine

Controllability



- Extra software is written to access the function concerned

Observability

- Extra software is written so we can see what is happening
- E.g. writing out some values that are not normally accessible
- This will allow us to apply sequences of inputs that are not normally allowed
- The point is to make sure that nothing unexpected happens
- These tests should fail

Deep test sequences

- ClickCustomer ; EnterOrder
  - Cannot normally be applied without amending the machine as above
- ClickCustomer
  {should pass}
- ClickCustomer ; EnterOrder
  {should fail}