SoftServe | Empowering your Business through Software Development

State Transition Testing Technique Training

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Introduction

What is dynamic testing?
What is black box testing?
What is finite state system?

- **Dynamic testing:** Testing that involves the execution of the software of a component or system.

- **Black box testing:** Method of testing that examines the functionality of an application without peering into its internal structures or workings.

- **Finite state system** is any system where user gets a different output for the same input, depending on what has happened before.

Introduction

What is state transition testing?

State transition technique is a dynamic black-box testing technique, which is used when the system is defined in terms of a finite number of states and the transitions between the states is governed by the rules of the system.

Introduction

What is it used for?

- to capture certain kinds of system requirements and to document internal system design

- to record complex business rules that a system must implement

- can serve as a guide to creating test cases

Technique

A state transition model has four basic parts:

- the states that the software may occupy
- the transitions from one state to another
- the events that cause a transition
- the actions that result from a transition

Technique

User insert credit card and enters PIN for getting bank account. He has 3 tries to enter validate PIN and to get access to account. After 3rd invalid try the card will be "eaten".

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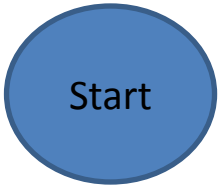
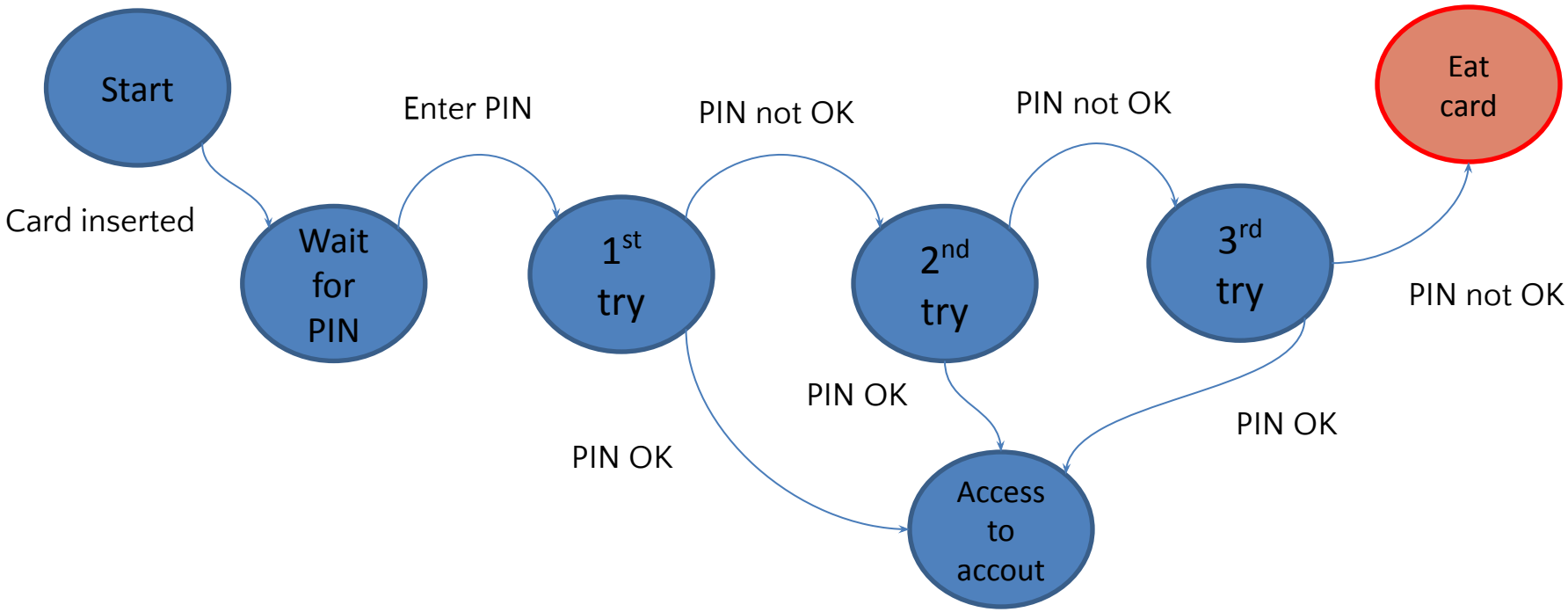


Card inserted

Technique

User insert credit card and enters PIN for getting bank account. He has 3 tries to enter validate PIN and to get access to account. After 3rd invalid try the card will be "eaten".



Technique: Multiple Actions

		Rule 1	Rule 2	Rule 3	Rule 4
Conditions	**Values**				
Married?	(Yes; No)	Yes	No	Yes	No
Good Student?	(Yes; No)	Yes	No	No	Yes
Actions					
Discount(%)	(0, 25, 50, 60)	60	0	25	50
Bonus	(Yes; No)	Yes	No	Yes	No

Technique: Non-binary conditions

		Rule 1	Rule 2	Rule 3	Rule 4
Conditions	**Values**				
Condition 1	(0-1000)	0-1	1-10	10-100	100 - 1000
Condition 2	(0-10)	<5	5	6 or 7	>7
Actions					
Action 1	(X;Y;Z)	Do X	Do Y	Do X	Do Z
Action 2	(A;B)	Do A	Do B	Do B	Do B

For cases with non-binary conditions equivalence classes and boundary value analysis techniques can be used along with decision table too.

Technique: Sample Test Cases

Test Case ID	Condition 1	Condition 2	Expected Result
TC 1	0	3	Do X/Do A
TC 2	5	5	Do Y/Do B
TC 3	50	7	Do X/Do B
TC 4	500	10	Do Z/Do B

Key Point: Create at least one test case for each rule.

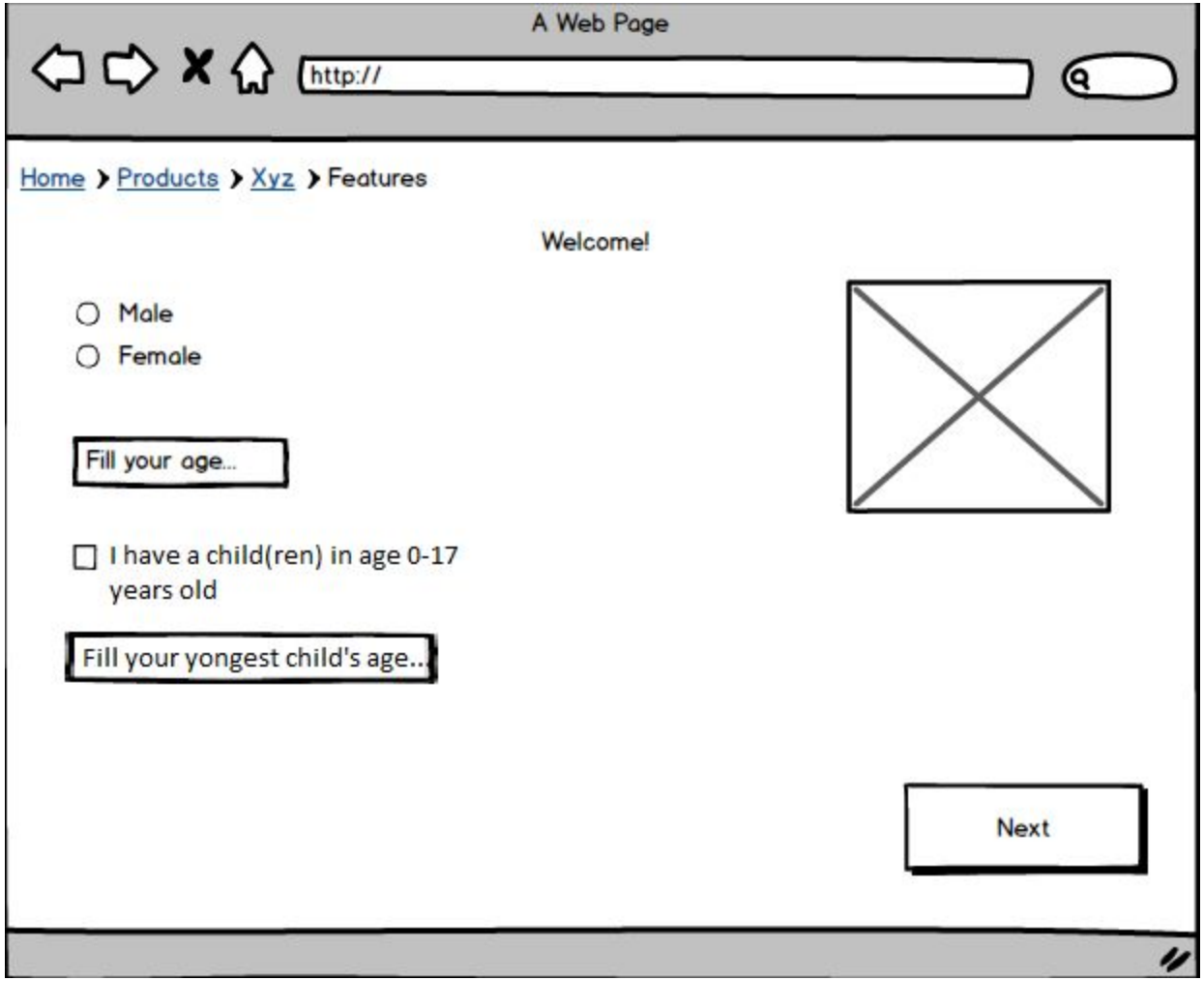
Technique: “Don’t Care”/”N/A” conditions

- Limited entry tables with N conditions have 2^N rules.
- Don't care entries reduce the number of explicit rules by implying the existence of non-explicitly stated rules.

How many rules does a table contain including all the implied rules due to don't care entries?

Technique: “Don’t Care”/”N/A” condition

Depending on data specified on the form system applies/doesn’t apply a discount. Discounts for male and female are different. In case client has a child in age 0 – 17 years old an additional bonus is provided.



Technique: “Don’t Care”/”N/A” condition

		Rule 1	Rule 2	Rule 3
Conditions	**Values**			
Male?	(Yes; No)	No	Yes	No
Female?	(Yes; No)	Yes	N/A	No
Age?	(18-55)	18	55	N/A
Children?	(Yes; No)	No	Yes	N/A
Youngest child’s age?	(0-17)	N/A	17	N/A
Actions				
Discount (%)	(25; 15; 0)	25	15	0
Bonus (+20%)	(Yes; No)	No	Yes	No

Examples

Example 1

Referring to the **Trade** Web page of the Brown & Donaldson Web site , consider the rules associated with a **Buy** order.

		Rule 1	Rule 2	Rule 3	Rule 4	Rule 5	Rule 6	Rule 7	Rule 8
Conditions	**Values**								
Valid Symbol	(Yes; No)	No	No	No	No	Yes	Yes	Yes	Yes
Valid Quantity	(Yes; No)	No	No	Yes	Yes	No	No	Yes	Yes
Sufficient Funds	(Yes; No)	No	Yes	No	Yes	No	Yes	No	Yes
Actions									
Buy?	(Yes; No)	No	No	No	No	No	No	No	Yes

Examples: 1

Use “Don’t Care” condition:

		Rule 1,2,3,4	Rule 5	Rule 6	Rule 7	Rule 8
Conditions	**Values**					
Valid Symbol	(Yes; No)	No	Yes	Yes	Yes	Yes
Valid Quantity	(Yes; No)	DC	No	No	Yes	Yes
Sufficient Funds	(Yes; No)	DC	No	Yes	No	Yes
Actions						
Buy?	(Yes; No)	No	No	No	No	Yes

Examples: 1

Further collapsed Table:

		Rule 1,2,3,4	Rule 5,6	Rule 7	Rule 8
Conditions	**Values**				
Valid Symbol	(Yes; No)	No	Yes	Yes	Yes
Valid Quantity	(Yes; No)	DC	No	Yes	Yes
Sufficient Funds	(Yes; No)	DC	DC	No	Yes
Actions					
Buy?	(Yes; No)	No	No	No	Yes

Examples: 1

Prioritized rules:

		Rule 8	Rule 7	Rule 5,6	Rule 1,2,3,4
Conditions	**Values**				
Valid Symbol	(Yes; No)	Yes	Yes	Yes	No
Valid Quantity	(Yes; No)	Yes	Yes	No	DC
Sufficient Funds	(Yes; No)	Yes	No	DC	DC
Actions					
Buy?	(Yes; No)	Yes	No	No	No

Before deriving TCs from the table created, prioritize the rules to start with positive cases, then negative and only after that with DC conditions.

Applicability and Limitations

Decision Table Testing technique can be used whenever the system must implement complex business rules which can be represented as a combination of conditions and when these conditions have discrete actions associated with them.

Applicability and Limitations

- The specification given can be converted to a decision table.
- The order in which the predicates are evaluated does not affect the interpretation of the rules or resulting action.
- The order of rule evaluation has no effect on resulting action.
- Once a rule is satisfied and the action selected, no other rule needs to be examined.
- The restrictions do not eliminate many applications:
  - ✔ In most applications, the order in which the predicates are evaluated is immaterial.
  - ✔ Some specific ordering may be more efficient than some other but in general the ordering is not inherent in the program's logic.

Applicability and Limitations

What are some problems with using decision tables?

Decision tables do not scale up very well

May need to:

- Use extended entry decision tables
- Algebraically simplify tables

Decision tables need to be iteratively refined

- The first attempt may be far from satisfactory

Summary

- Decision tables are used to document complex business rules that a system must implement. In addition, they serve as a guide to creating test cases.

- Conditions represent various input conditions. Actions are processes that should be executed depending on the various combinations of input conditions. Each rule defines a unique combination of conditions that result in the execution of the actions associated with that rule.

- Create at least one test case for each rule. If the rule's conditions are binary, a single test for each combination is probably sufficient. On the other hand, if a condition is a range of values, consider testing at both the low and high end of the range.

Summary

Decision Table testing is most appropriate for programs where:

- There is a lot of decision making
- There are important logical relationships among input variables
- There are calculations involving subsets of input variables
- There is complex computation logic (high cyclomatic complexity)
- There is a big amount of input data or parameters
- There is a need to test specification


ANSWERS

Before practice start…

Before deriving test cases, what properties should the decision table have?

- The rules are complete
- Every combination of predicate truth values is in the decision table
- The rules are consistent
- Every combination of predicate truth values results in only one action or set of actions

Before practice start..

Look for redundant rules:

- More rules than combination count of conditions
- Actions are the same
- Too many test cases

Look for inconsistent rules:

- More rules than combination count of conditions
- Actions are different for the same conditions

Look for missing rules:

- Incomplete table

Practice

Practice: 1

Full List of Rights

- Insurance
- Charting
- Tx Planning
- Patient Procedures
- Patient Prescriptions
  - Review patient prescriptions
  - Create patient prescription
  - Refill patient prescription
  - Void patient prescription
  - Print patient prescription
- Ledger
- Document Manager
- Patient Information
- Reports
- Schedule
- Settings

Create Decision Table to test Patient Prescription rights. Note, that only checking 'Review' option allows to check other ones.

Answer: 1

	Values	Rule 1	Rule 2	Rule 3	Rule 4	Rule 5	Rule 6	Rule 7
Conditions								
Review patient prescriptions	(On; Off)	On	On	On	On	On	On	Of
Create patient prescription	(On; Off)	On	Off	On	Off	Of	Off	N/A
Refill patient prescription	(On; Off)	On	Off	Off	On	Of	Off	N/A
Void patient prescription	(On; Off)	On	Off	Off	Off	On	Off	N/A
Print patient prescription	(On; Off)	On	Off	Off	Off	Off	On	N/A
Actions								
Review	(Y;N)	Y	Y	Y	Y	Y	Y	No access
Create	(Y;N)	Y	N	Y	N	N	N	
Refill	(Y;N)	Y	N	N	Y	N	N	
Void	(Y;N)	Y	N	N	N	Y	N	
Print	(Y;N)	Y	N	N	N	N	Y	

Practice: 2

Following daily activities are available:

- *Go to work*
- *Go to picnic*
- *Stay at home*

In case it's a weekend you can go to picnic. But, a rain can stop you and force to stay at home.

Complete suggested table filling rules and related actions for your daily activities.

Answer: 2

Impossible combinations cannot cause any actions, so they are marked with dash.

		Rule 1	Rule 2	Rule 3	Rule 4	Rule 5	Rule 6	Rule 7	Rule 8
Conditions	**Values**								
Is today a weekday?	(Y;N)	Y	N	Y	Y	N	N	N	Y
Is today a holiday?	(Y;N)	Y	N	N	Y	Y	Y	N	N
Is it raining?	(Y;N)	Y	N	N	N	Y	N	Y	Y
Actions									
Go to work	(Y;N)	-	-	Y	-	N	N	-	Y
Got to picnic	(Y;N)	-	-	N	-	N	Y	-	N
Stay home	(Y;N)	-	-	N	-	Y	N	-	N

Answer: 2

After removing impossible combinations we have rules 3,5 and 6 left.

		Rule 3	Rule 5	Rule 6
Conditions	**Values**			
Is today a weekday?	(Y;N)	Y	N	N
Is today a holiday?	(Y;N)	N	Y	Y
Is it raining?	(Y;N)	N	Y	N
Actions				
Go to work	(Y;N)	Y	N	N
Got to picnic	(Y;N)	N	N	Y
Stay home	(Y;N)	N	Y	N

Practice: 3

Complete a table filling rules and related actions for booking a room.

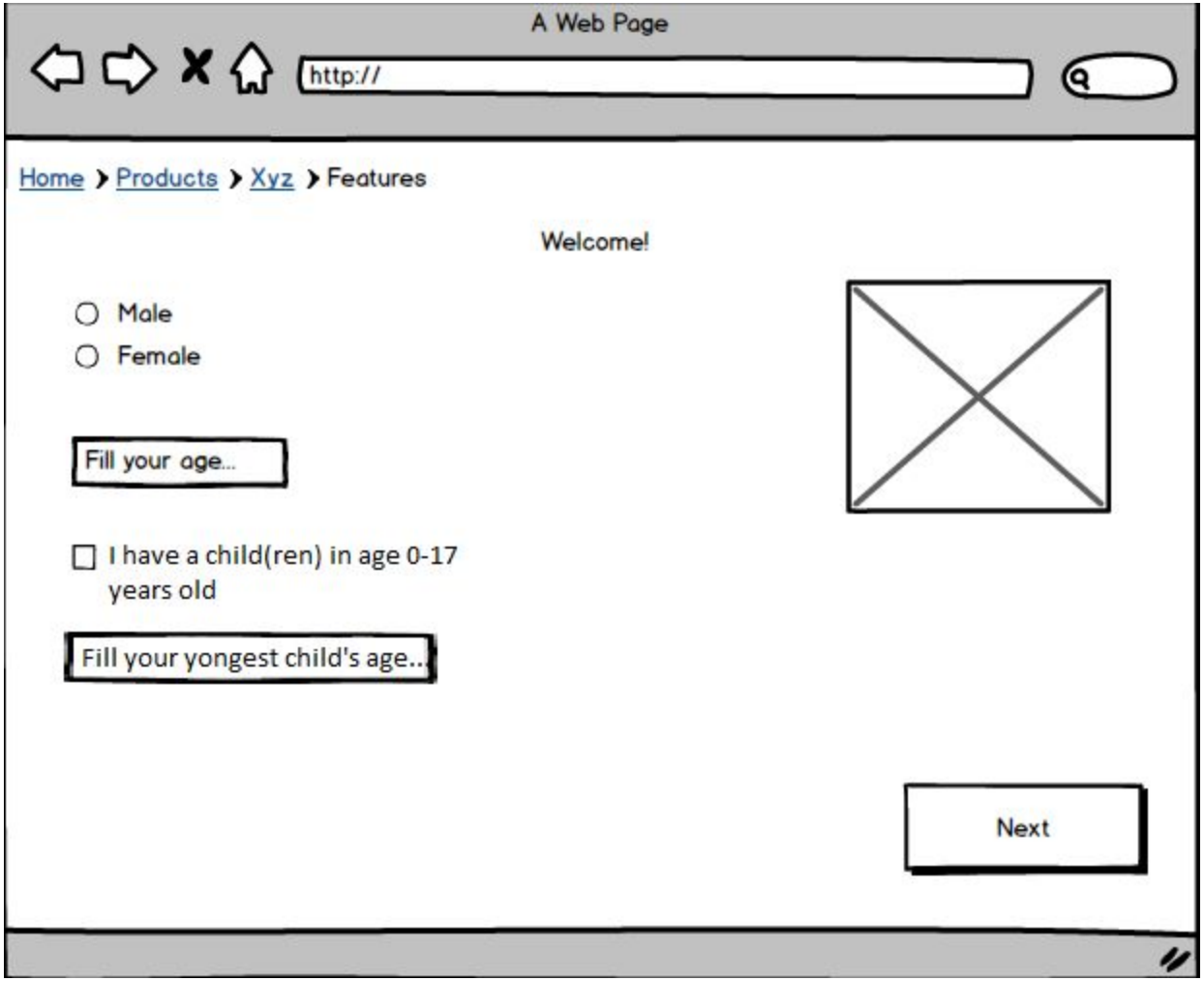
		Rule 1	Rule 2	Rule 3	Rule 4	Rule 4	Rule 5	Rule 6	Rule 7	Rule 8
Conditions	**Values**									
# of participants <=capacity?	(Y;N)									
Room available?	(Y;N)									
Account # valid?	(Y;N)									
Actions										
Msg: No room of the right size available	(Y;N)									
Msg: Room is already booked	(Y;N)									
Msg: Account # is not valid	(Y;N)									
Book room	(Y;N)									

Answer: 3

		Rule 1	Rule 2	Rule 3	Rule 4	Rule 5	Rule 6	Rule 7	Rule 8
Conditions	**Values**								
# of participants <=capacity?	(Y;N)	Y	N	Y	Y	N	N	N	Y
Room available?	(Y;N)	Y	N	N	Y	Y	Y	N	N
Account # valid?	(Y;N)	Y	N	N	N	Y	N	Y	Y
Actions									
Msg: No room of the right size available	(Y;N)	N	Y	N	N	Y	Y	Y	N
Msg: Room is already booked	(Y;N)	N	Y	Y	N	N	N	Y	Y
Msg: Account # is not valid	(Y;N)	N	Y	Y	Y	N	Y	N	N
Book room	(Y;N)	Y	N	N	N	N	N	N	N

Practice: 4

Depending on data specified on the form system applies/doesn't apply a discount. Discounts for male and female are different. In case client has a child in age 0 – 17 years old an additional bonus is provided.



Practice: 4

Complete the table with invalid cases.

	Value	Rule 1	Rule 2	Rule 3
Conditions				
Male?	(Yes; No)	No	Yes	No
Female?	(Yes; No)	Yes	N/A	No
Age?	(18-55)	18	55	N/A
Children?	(Yes; No)	No	Yes	N/A
Youngest child's age?	(0-17)	N/A	17	N/A
Actions				
Discount (%)	(25;15;0)	25	15	0
Bonus (+20%)	(Yes; No)	No	Yes	No

Answer: 4, invalid cases

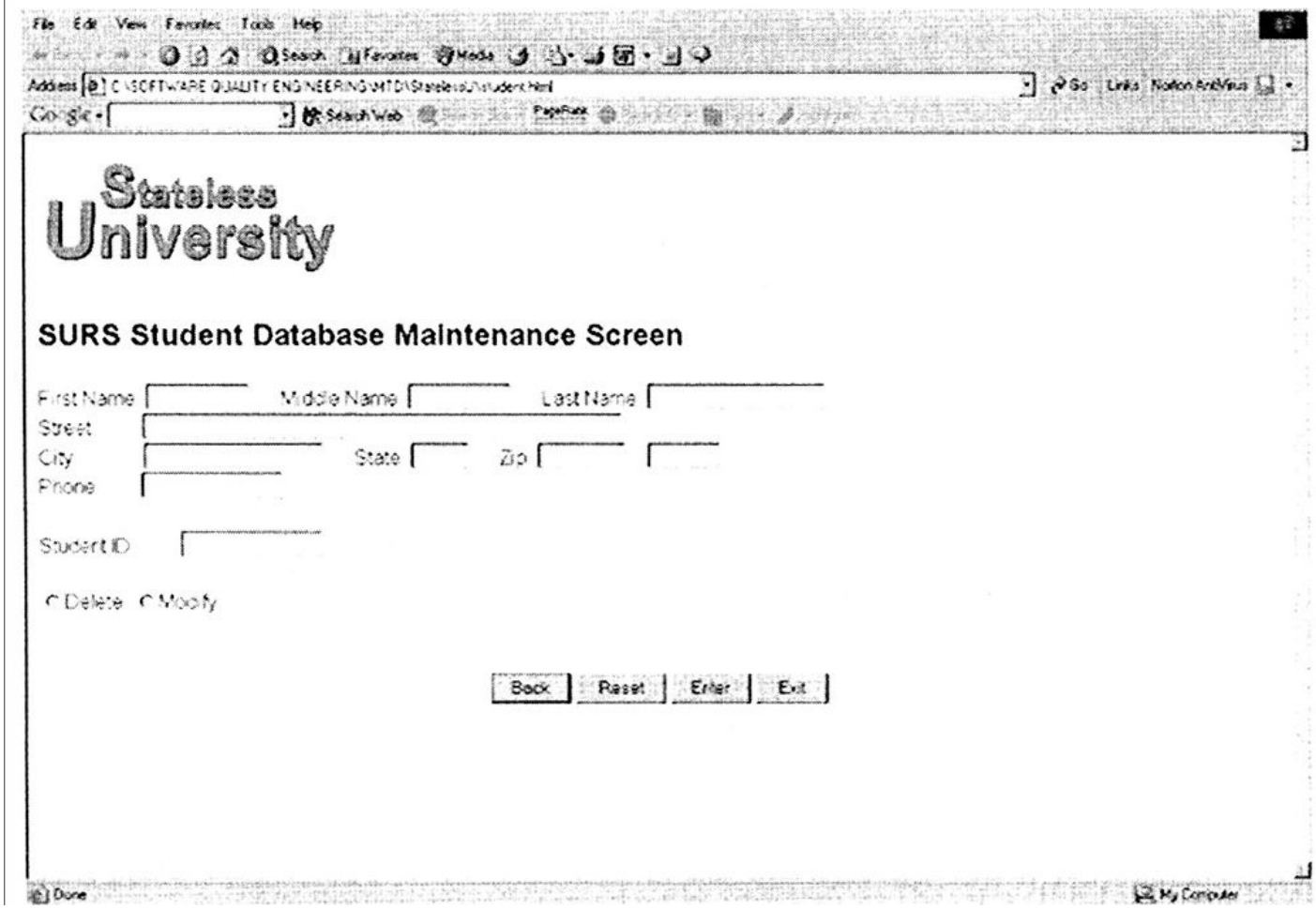
	Value	Rule 1	Rule 2	Rule 3	Rule 4	Rule 5	Rule 6	Rule 7	Rule 8
Conditions									
Male?	(Yes; No)	No	Yes	No	No	Yes	No	Yes	No
Female?	(Yes; No)	Yes	N/A	Yes	Yes	N/A	Yes	N/A	Yes
Age?	(18-55)	17	56	19	54	abc	40	&^*()	34
Children?	(Yes; No)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Youngest child's age?	(0-17)	17	0	18	-1	16	abc	1	!@##$
Actions									
Discount (%)	(25; 15; 0)	0	0	0	0	0	0	0	0
Bonus (+20%)	(Yes; No)	No	No	No	No	No	No	No	No

Answer: 4, prioritized rules

	Value	Rule 1	Rule 3	Rule 4	Rule 6	Rule 8	Rule 2	Rule 7	Rule 5
Conditions									
Male?	(Yes; No)	No	No	No	No	No	Yes	Yes	Yes
Female?	(Yes; No)	Yes	Yes	Yes	Yes	Yes	N/A	N/A	N/A
Age?	(18-55)	17	19	54	40	34	56	&^*()	abc
Children?	(Yes; No)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Youngest child's age?	(0-17)	17	18	-1	abc	!@##$	0	1	16
Actions									
Discount (%)	(25; 15; 0)	0	0	0	0	0	0	0	0
Bonus (+20%)	(Yes; No)	No	No	No	No	No	No	No	No

Practice: 5

The following screen is from the Stateless University Registration System. It is used to enter new students into the system, to modify student information, and to delete students from the system. Only one Student Data or Student ID should be entered at once to proceed correct actions.



Answer: 5, redundant rules

		Rule 1	Rule 2	Rule 3	Rule 4	Rule 5	Rule 6	Rule 7	Rule 8
Conditions	**Values**								
Entered Student Data	(Yes; No)	No	No	No	No	No	No	No	No
Entered student ID	(Yes; No)	No	No	No	No	Yes	Yes	Yes	Yes
Selected Modify	(Yes; No)	No	No	Yes	Yes	No	No	Yes	Yes
Selected Delete	(Yes; No)	No	Yes	No	Yes	No	Yes	No	Yes
Actions									
Create New student	(Yes; No)	No	No	No	No	No	No	No	No
Modify Student	(Yes; No)	No	No	No	No	No	No	Yes	No
Delete student	(Yes; No)	No	No	No	No	No	Yes	No	No

Answer: 5, redundant rules

		Rule 9	Rule 10	Rule 11	Rule 12	Rule 13	Rule 14	Rule 15	Rule 16
Conditions	**Values**								
Entered Student Data	(Yes; No)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Entered student ID	(Yes; No)	No	No	No	No	Yes	Yes	Yes	Yes
Selected Modify	(Yes; No)	No	No	Yes	Yes	No	No	Yes	Yes
Selected Delete	(Yes; No)	No	Yes	No	Yes	No	Yes	No	Yes
Actions									
Create New student	(Yes; No)	Yes	No	No	No	No	No	No	No
Modify Student	(Yes; No)	No	No	Yes	No	No	No	No	No
Delete student	(Yes; No)	No	No	No	No	No	No	No	No

Answer: 5, DC condition

		Rule 1,2,3,4	Rule 5	Rule 6	Rule 7	Rule 8	Rule 13, 14, 15, 16	Rule 9	Rule 10	Rule 11	Rule 12
Conditions	**Values**										
Entered Student Data	(Yes; No)	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Entered student ID	(Yes; No)	No	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Selected Modify	(Yes; No)	DC	No	No	Yes	Yes	DC	No	No	Yes	Yes
Selected Delete	(Yes; No)	DC	No	Yes	No	Yes	DC	No	Yes	No	Yes
Actions											
Create New student	(Yes; No)	No	No	No	No	No	No	Yes	No	No	No
Modify Student	(Yes; No)	No	No	No	Yes	No	No	No	No	Yes	No
Delete student	(Yes; No)	No	No	Yes	No	No	No	No	No	No	No

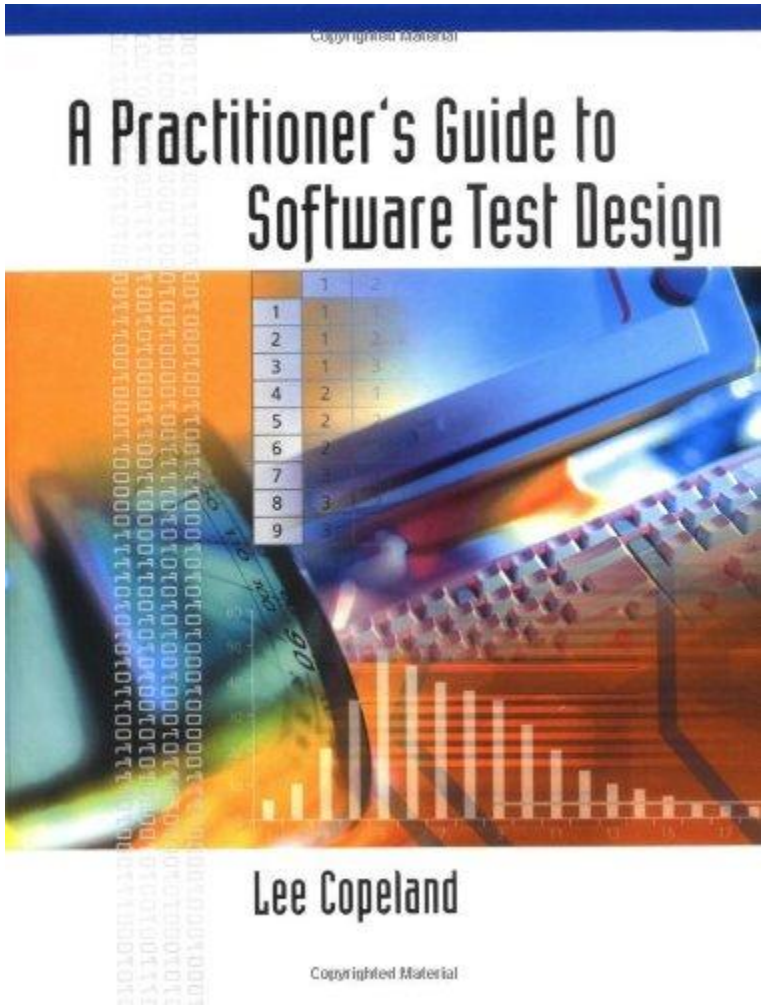
Answer: 5, DC condition

		Rule 1,2,3,4	Rule 5	Rule 6	Rule 7	Rule 8,12	Rule 13,14, 15,16	Rule 9	Rule 10	Rule 11
Conditions	**Values**									
Entered Student Data	(Yes; No)	No	No	No	No	DC	Yes	Yes	Yes	Yes
Entered student ID	(Yes; No)	No	Yes	Yes	Yes	DC	Yes	No	No	No
Selected Modify	(Yes; No)	DC	No	No	Yes	Yes	DC	No	No	Yes
Selected Delete	(Yes; No)	DC	No	Yes	No	Yes	DC	No	Yes	No
Actions										
Create New student	(Yes; No)	No	No	No	No	No	No	Yes	No	No
Modify Student	(Yes; No)	No	No	No	Yes	No	No	No	No	Yes
Delete student	(Yes; No)	No	No	Yes	No	No	No	No	No	No

Answer: 5, prioritized rules

		Rule 11	Rule 6	Rule 5	Rule 7	Rule 9	Rule 10	Rule 8,12	Rule 13, 14,15, 16	Rule 1,2,3,4
Conditions	**Values**									
Entered Student Data	(Yes; No)	Yes	No	No	No	Yes	Yes	DC	Yes	No
Entered student ID	(Yes; No)	No	Yes	Yes	Yes	No	No	DC	Yes	No
Selected Modify	(Yes; No)	Yes	No	No	Yes	No	No	Yes	DC	DC
Selected Delete	(Yes; No)	No	Yes	No	No	No	Yes	Yes	DC	DC
Actions										
Create New student	(Yes; No)	No	No	No	No	Yes	No	No	No	No
Modify Student	(Yes; No)	Yes	No	No	Yes	No	No	No	No	No
Delete student	(Yes; No)	No	Yes	No	No	No	No	No	No	No

References



[What is Decision table in software testing?]

[Testing Guide: Decision table]


Any questions?


many
Thanks!