White Box Testing fits() Example

Software Testing and Quality Assurance

Joseph Timoney

Example- fits()

- Specification:
- A plane has 120 seats. A flight can accommodate up to that number of passengers. If the passengers require extra comfort, the effective number of seats is reduced by 40 to ensure that every passenger has an empty seat next to them. The method fits() indicates whether a particular number of passengers can be accommodated with or without extra comfort.

Fits() specification

- **Status** fits(int passengers, boolean comfortFlag)
- **Inputs**
  - passengers: the number of passengers to be carried
  - comfortFlag: flag to indicate whether extra comfort is required
- **Outputs**
- return value:
  - SUCCESS if passengers≤120 and !comfortFlag
  - SUCCESS if passengers ≤ 80 and comfortFlag
  - FAILURE if passengers>120, or if passengers>80 and comfortFlag
  - ERROR if any inputs are invalid (e.g. passengers<1)

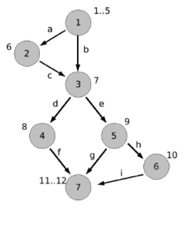
- Status is defined as follows:
  - enum Status { SUCCESS, FAILURE, ERROR };

Source code for fits()

```
 1  Status fits(int passengers, boolean comfortFlag)
 2  {
 3     Status rv = FAILURE;
 4     int availableSeats = 120;
 5     if (comfortFlag)
 6        availableSeats = availableSeats - 40;
 7     if ( (passengers>0) && (passengers<=availableSeats) )
 8        rv = SUCCESS;
 9     else if (passengers<=0)
10        rv = ERROR;
11     return rv;
12  }
```

CFG for fits()

```
 1  Status fits(int passengers, boolean comfortFlag)
 2  {
 3     Status rv = FAILURE;
 4     int availableSeats = 120;
 5     if (comfortFlag)
 6        availableSeats = availableSeats - 40;
 7     if ( (passengers>0) && (passengers<=availableSeats) )
 8        rv = SUCCESS;
 9     else if (passengers<=0)
10        rv = ERROR;
11     return rv;
12  }
```

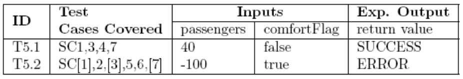


- Node 1: Lines 1–5
- Node 2: Line 6
- Node 3: Line 7
- Node 4: Line 8
- Node 5: Line 9
- Node 6: Line 10
- Node 7: Line 11–12

Test Cases for Statement Coverage for fits()

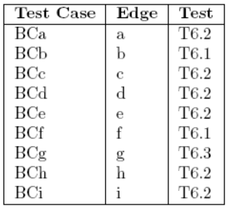
Test Case	Node	Test
SC1	1	T5.1
SC2	2	T5.2
SC3	3	T5.1
SC4	4	T5.1
SC5	5	T5.2
SC6	6	T5.2
SC7	7	T5.1

Test Data for Statement Coverage for fits()



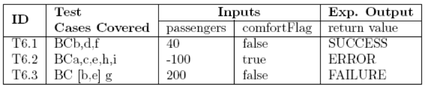
ID	Test Cases Covered	Inputs		Exp. Output
		passengers	comfortFlag	return value
T5.1	SC1,3,4,7	40	false	SUCCESS
T5.2	SC[1],2,[3],5,6,[7]	-100	true	ERROR

Test Cases for Branch Coverage for fits()



Test Case	Edge	Test
BCa	a	T6.2
BCb	b	T6.1
BCc	c	T6.2
BCd	d	T6.2
BCe	e	T6.2
BCf	f	T6.1
BCg	g	T6.3
BCh	h	T6.2
BCi	i	T6.2

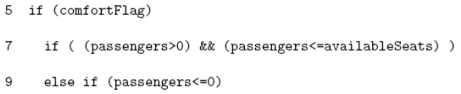
Test Data for Branch Coverage for fits()



ID	Test Cases Covered	Inputs		Exp. Output
		passengers	comfortFlag	return value
T6.1	BCb,d,f	40	false	SUCCESS
T6.2	BCa,c,e,h,i	-100	true	ERROR
T6.3	BC [b,e] g	200	false	FAILURE

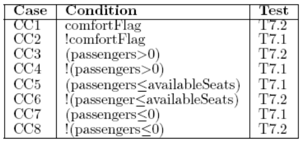
Condition Coverage for fits()

In the program there are three decisions, on lines 5, 7, 9. The decision on line 7 has two conditions.



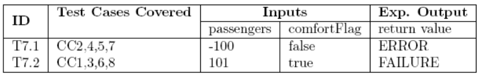
```
5  if (comfortFlag)

7    if ( (passengers>0) && (passengers<=availableSeats) )

9    else if (passengers<=0)
```

Test Cases for Condition Coverage or fits()



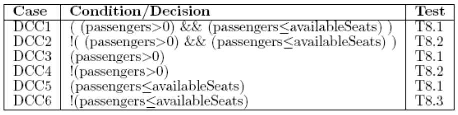
Case	Condition	Test
CC1	comfortFlag	T7.2
CC2	!comfortFlag	T7.1
CC3	(passengers>0)	T7.2
CC4	!(passengers>0)	T7.1
CC5	(passengers≤availableSeats)	T7.1
CC6	!(passenger≤availableSeats)	T7.2
CC7	(passengers≤0)	T7.1
CC8	!(passengers≤0)	T7.2

Test Data for Condition Coverage for fits()



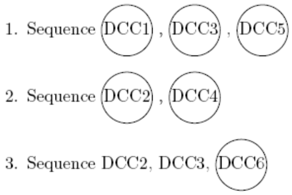
ID	Test Cases Covered	Inputs		Exp. Output
		passengers	comfortFlag	return value
T7.1	CC2,4,5,7	-100	false	ERROR
T7.2	CC1,3,6,8	101	true	FAILURE

Test Cases for Decision Condition Coverage for fits()



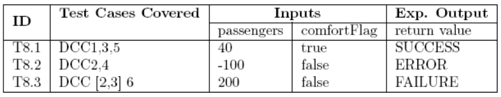
Case	Condition/Decision	Test
DCC1	((passengers>0) && (passengers≤availableSeats))	T8.1
DCC2	!((passengers>0) && (passengers≤availableSeats))	T8.2
DCC3	(passengers>0)	T8.1
DCC4	!(passengers>0)	T8.2
DCC5	(passengers≤availableSeats)	T8.1
DCC6	!(passengers≤availableSeats)	T8.3

Sequences of Decisions and Conditions in fits()



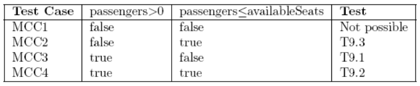
1. Sequence DCC1 , DCC3 , DCC5
2. Sequence DCC2 , DCC4
3. Sequence DCC2, DCC3, DCC6

Test Data for Decision Condition Coverage for fits()



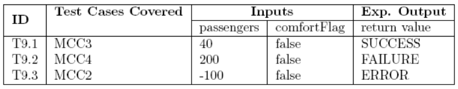
ID	Test Cases Covered	Inputs		Exp. Output
		passengers	comfortFlag	return value
T8.1	DCC1,3,5	40	true	SUCCESS
T8.2	DCC2,4	-100	false	ERROR
T8.3	DCC [2,3] 6	200	false	FAILURE

Test Cases for Multiple Condition Coverage for fits()



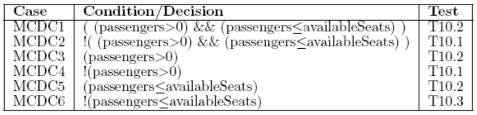
Test Case	passengers>0	passengers≤availableSeats	Test
MCC1	false	false	Not possible
MCC2	false	true	T9.3
MCC3	true	false	T9.1
MCC4	true	true	T9.2

Test Data for Multiple Condition Coverage for fits()



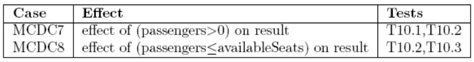
ID	Test Cases Covered	Inputs		Exp. Output
		passengers	comfortFlag	return value
T9.1	MCC3	40	false	SUCCESS
T9.2	MCC4	200	false	FAILURE
T9.3	MCC2	-100	false	ERROR

Test Cases for Modified Decision Condition Coverage for fits()



Case	Condition/Decision	Test
MCDC1	((passengers>0) && (passengers≤availableSeats))	T10.2
MCDC2	!((passengers>0) && (passengers≤availableSeats))	T10.1
MCDC3	(passengers>0)	T10.2
MCDC4	!(passengers>0)	T10.1
MCDC5	(passengers≤availableSeats)	T10.2
MCDC6	!(passengers≤availableSeats)	T10.3

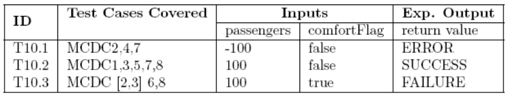
Test Cases (II)



Case	Effect	Tests
MCDC7	effect of (passengers>0) on result	T10.1,T10.2
MCDC8	effect of (passengers≤availableSeats) on result	T10.2,T10.3

19

Test Data for Modified Decision Condition Coverage for fits()



ID	Test Cases Covered	Inputs		Exp. Output
		passengers	comfortFlag	return value
T10.1	MCDC2,4,7	-100	false	ERROR
T10.2	MCDC1,3,5,7,8	100	false	SUCCESS
T10.3	MCDC [2,3] 6,8	100	true	FAILURE

20

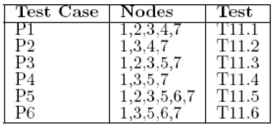
Path Coverage

Six paths can be identified in the CFG for fits()

- Node 1–2–3–4–7
- Node 1–3–4–7
- Node 1–2–3–5–7
- Node 1–3–5–7
- Node 1–2–3–5–6–7
- Node 1–3–5–6–7

21

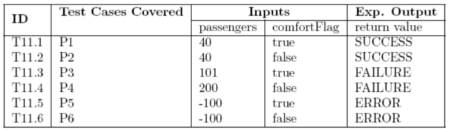
Test Cases for Path Coverage for fits()



Test Case	Nodes	Test
P1	1,2,3,4,7	T11.1
P2	1,3,4,7	T11.2
P3	1,2,3,5,7	T11.3
P4	1,3,5,7	T11.4
P5	1,2,3,5,6,7	T11.5
P6	1,3,5,6,7	T11.6

22

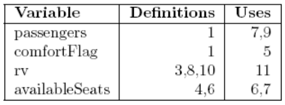
Test Data for Path Coverage for fits()



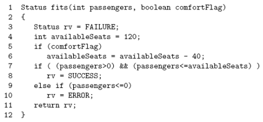
ID	Test Cases Covered	Inputs		Exp. Output
		passengers	comfortFlag	return value
T11.1	P1	40	true	SUCCESS
T11.2	P2	40	false	SUCCESS
T11.3	P3	101	true	FAILURE
T11.4	P4	200	false	FAILURE
T11.5	P5	-100	true	ERROR
T11.6	P6	-100	false	ERROR

23

Definitions and uses in fits()



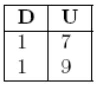
Variable	Definitions	Uses
passengers	1	7,9
comfortFlag	1	5
rv	3,8,10	11
availableSeats	4,6	6,7



```
 1  Status fits(int passengers, boolean comfortFlag)
 2  {
 3     Status rv = FAILURE;
 4     int availableSeats = 120;
 5     if (comfortFlag)
 6        availableSeats = availableSeats - 40;
 7     if ( (passengers>0) && (passengers<=availableSeats) )
 8        rv = SUCCESS;
 9     else if (passengers<=0)
10        rv = ERROR;
11     return rv;
12  }
```

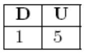
24

DU-pairs



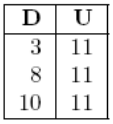
D	U
1	7
1	9

Passengers



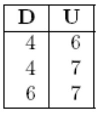
D	U
1	5

comfortFlag



D	U
3	11
8	11
10	11

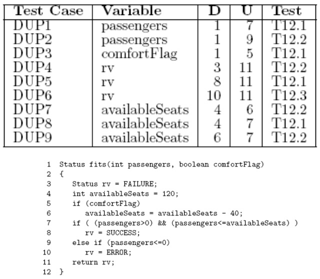
rv



D	U
4	6
4	7
6	7

availableSeats

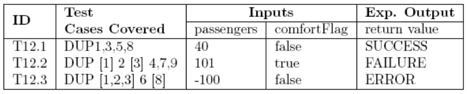
Test Cases for DU-pair testing for fits()



Test Case	Variable	D	U	Test
DUP1	passengers	1	7	T12.1
DUP2	passengers	1	9	T12.2
DUP3	comfortFlag	1	5	T12.1
DUP4	rv	3	11	T12.2
DUP5	rv	8	11	T12.1
DUP6	rv	10	11	T12.3
DUP7	availableSeats	4	6	T12.2
DUP8	availableSeats	4	7	T12.1
DUP9	availableSeats	6	7	T12.2

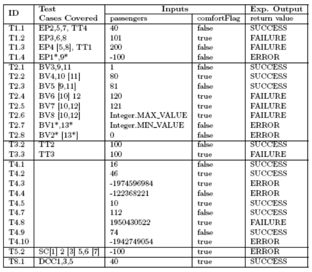
```
 1  Status fits(int passengers, boolean comfortFlag)
 2  {
 3     Status rv = FAILURE;
 4     int availableSeats = 120;
 5     if (comfortFlag)
 6        availableSeats = availableSeats - 40;
 7     if ( (passengers>0) && (passengers<=availableSeats) )
 8        rv = SUCCESS;
 9     else if (passengers<=0)
10        rv = ERROR;
11     return rv;
12  }
```

Test Data for DU-pair testing for fits()



ID	Test Cases Covered	Inputs		Exp. Output
		passengers	comfortFlag	return value
T12.1	DUP1,3,5,8	40	false	SUCCESS
T12.2	DUP [1] 2 [3] 4,7,9	101	true	FAILURE
T12.3	DUP [1,2,3] 6 [8]	-100	false	ERROR

Final Test Data after elimination of duplicate tests



ID	Test Cases Covered	Inputs		Exp. Output
		passengers	comfortFlag	return value
T1.1	EP2,5,7, TT4	40	false	SUCCESS
T1.2	EP3,6,8	101	true	FAILURE
T1.3	EP4 [5,8], TT1	200	false	FAILURE
T1.4	EP1*,9*	-100	false	ERROR
T2.1	BV3,9,11	1	false	SUCCESS
T2.2	BV4,10 [11]	80	true	SUCCESS
T2.3	BV5 [9,11]	81	false	SUCCESS
T2.4	BV6 [10] 12	120	true	FAILURE
T2.5	BV7 [10,12]	121	true	FAILURE
T2.6	BV8 [10,12]	Integer.MAX_VALUE	true	FAILURE
T2.7	BV1*,13*	Integer.MIN_VALUE	false	ERROR
T2.8	BV2* [13*]	0	false	ERROR
T3.2	TT2	100	false	SUCCESS
T3.3	TT3	100	true	FAILURE
T4.1		16	false	SUCCESS
T4.2		46	true	SUCCESS
T4.3		-1974596984	true	ERROR
T4.4		-122368221	false	ERROR
T4.5		10	true	SUCCESS
T4.7		112	false	SUCCESS
T4.8		1950430522	true	FAILURE
T4.9		74	false	SUCCESS
T4.10		-1942749054	true	ERROR
T5.2	SC[1] 2 [3] 5,6 [7]	-100	true	ERROR
T8.1	DCC1,3,5	40	true	SUCCESS