ECE 322
SOFTWARE TESTING AND MAINTENANCE

Mid-term Examination
November 2, 2017
11:00 -12:20
Solutions –selected problems

Total 50 points ***GOOD LUCK***

Student Name & ID ________________________________

1	2	3	4	5	Σ
/20	/10	/10	/10	/10	

1. **[20 points]** Answer the following questions – please be concise.
(a) (**2 points**) Is it possible to have high-quality and low reliability software? What might be a possible example of such software? Provide two illustrative examples.

(b) (**2 points**) Give some reasons why you would ***not*** recommend the use of operational profiles.

(c) (**4 points**) Why would you consider the use constraints in the development of cause-effect graphs. In which sense are they useful? Provide a simple illustrative example.

(d) (**2 points**) What is the difference between software validation and software verification?

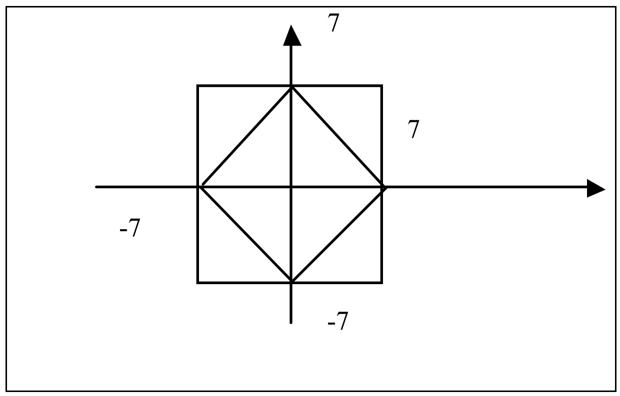
(e) (**2 points**) Explain a concept of coincidental correctness.

(f) (**4 points**) Is the subdomain D described as

$$\Delta = \{(x,y) \in \mathbf{R} \mid |x|+|y| \geq 7 \text{ and } \max(|x|, |y|) \leq 7\}$$

closed? Plot this subdomain and show test cases using the EPC strategy. Elaborate on the effectiveness of this strategy used here.

Solution



The change of the lower boundaries (diamond shape) cannot be detected; EPC leads to the test cases localized at the corners of the square.

(g) (**2 points**) What is the relationship between Petri nets and finite state machines? Under which condition Petri net becomes a finite state machine?

(h) (**2 points**) In realizing testing in a given configuration problem considered are the following components: printers -2, plug ins -3, browsers -3, operating systems -3, servers -3, monitors -2, e-mail systems-3, software packages of numeric optimization-3. How much improvement is achieved when running combinatorial testing over testing all possible combinations?

Solution The required orthogonal table $L_{18}(2^1 3^7)$ has 18 rows so the improvement (in terms of the smaller number of test cases) is 18 versus $2^2 * 3^6$ cases in a situation of running all combinations.

2. **[10 points]** Given is the following psuedocode

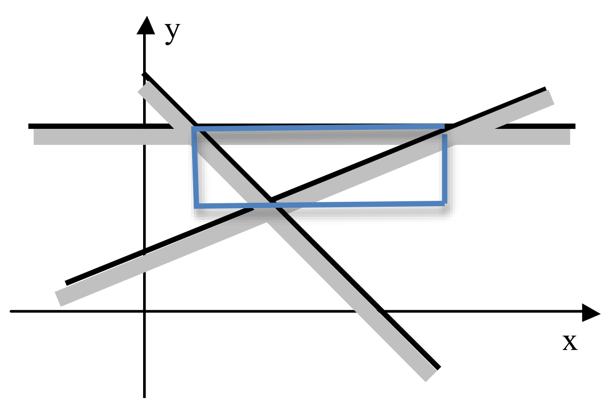
```
begin  program domain_test
var  a, b, x, y: real;
read(x,y)
if y<=5 then            (P1)
     a:= x-y-2
else
     a:=x+y-2;
if a<-3.0 then          (P2)
     b:=a+x+2y+3;
else
     b:=a-7y+3;
if b >7  then           (P3)
     print(x);
else
     print (y);
end program
```

(a) Describe and plot the input subdomain where the predicates P1, P2, and P3 are satisfied. Identify test cases with the use of (a) the EPC strategy, and (b) the weak n $\times$1 strategy.
(b) draw a control flow graph for this pseudocode and determine its cyclomatic complexity.

Solution

P1: $y \leq 5$ P2: a< -3 viz. x-y-2 <-3   P3: b>7 viz. (x-y -2)+x+2y+3 = 2x +y +1

That is $y \leq 5$, $y > x+1$, and $y > 6-2x$



EPC: test cases are localized at the corners of the rectangle (blue lines); obviously, such test cases are not able to detect changes of the boundaries of the subdomain

3. [10 points] (a) Develop equivalence classes for the NextDate problem for the calendar for the year 1923 in Greece. Considering only valid equivalence classes, how many test cases are required? List them.
(b) build a decision table for this problem. Consider using the following actions: increment day, reset day, increment month, reset month, increment year, impossible.

Hint: search the Web for the calendar used in Greece in this particular year.

Solution

Year is fixed here- 1923

Calendar for year 1923 (Greece)

January

Mo	Tu	We	Th	Fr	Sa	Su
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

4:● 12:◐ 19:○ 26:◑

February

Mo	Tu	We	Th	Fr	Sa	Su
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15				

2:● 11:◐

March

Mo	Tu	We	Th	Fr	Sa	Su
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

3:○ 9:◑ 17:● 25:◐

April

Mo	Tu	We	Th	Fr	Sa	Su
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

1:○ 8:◑ 16:● 24:◐ 30:○

May

Mo	Tu	We	Th	Fr	Sa	Su
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

7:◑ 16:● 23:◐ 30:○

June

Mo	Tu	We	Th	Fr	Sa	Su
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

6:◑ 14:● 21:◐ 28:○

July

Mo	Tu	We	Th	Fr	Sa	Su
						1
2	3	4	5	6	7	8

August

Mo	Tu	We	Th	Fr	Sa	Su
		1	2	3	4	5
6	7	8	9	10	11	12

September

Mo	Tu	We	Th	Fr	Sa	Su
					1	2
3	4	5	6	7	8	9

Input	valid class	invalid class
Month		
	M1 30 day month	=> 13
	M2 31 day month	<=0
	M3 15 day (February)	non-integer …
Day		
	D1 1-15	=> 32
	D2 1-30	<0
	D3 1-31	non-integer…

There could be different solutions. In general, it is essential to identify equivalence classes (valid and invalid) for months and days.

Conditions						
month	M1	M1	M1	M2	M2	…
day	D1	D2	D3	D1	D2	…
Actions						
impossible			x			
Increment day	x			x	x	
Reset day		x				
Increment month		x				
Increment year						
Reset month						

4. [10 points] Consider a program that solves the following system of linear equations with unknown $\boldsymbol{x}$

$$\mathbf{A}\boldsymbol{x} = \mathbf{b}$$

where $\mathbf{A} = [a_{ij}]$, i=1,2,.., M, j=1, 2,…, N, $\mathbf{b} = \begin{bmatrix} b_1 \\ b_2 \\ \dots \\ b_M \end{bmatrix}$ and $\boldsymbol{x} = \begin{bmatrix} x_1 \\ x_2 \\ \dots \\ x_N \end{bmatrix}$

Discuss a testing strategy using equivalence classes. Elaborate on the valid and invalid equivalence classes. Consider situations when (i) M=N and (ii) N < M.

Solution

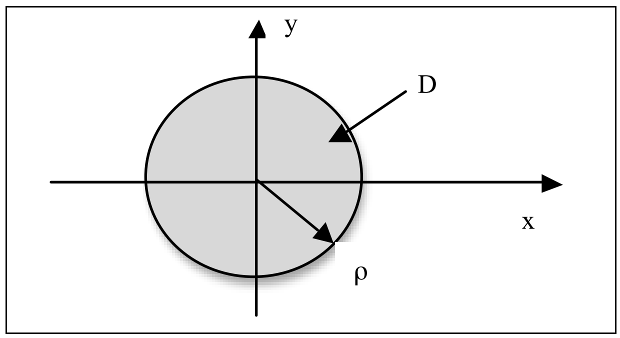
The equivalence classes are associated with the condition expressing whether the above set of equations is solvable. In case M=N, the condition is $\det(\boldsymbol{A}^{-1}) \neq 0$. For N < M, there is an approximate solution only.

Assuming that N=M, we have two valid equivalence classes in the M x M space of values of **A**, namely $\{ a_{11}, a_{12}, \dots, a_{MM} \}$

(i) $\{ a_{11}, a_{12}, \dots, a_{MM} | \det(A) = 0 \}$, and
(ii) $\{ a_{11}, a_{12}, \dots, a_{MM} | \det(A) \neq 0 \}$

Invalid equivalence classes might be related with non-numeric entries of **A**.

5. [10 points] A certain object tracking procedure is invoked when a moving object is located within the disk subdomain D shown below. This subdomain is closed. Propose a collection of test cases using:
(a) EPC strategy
(b) weak n x 1 strategy
In this problem, discuss possible limitations of these two strategies. Could these strategies be improved? In which way?



Solution
(a) EPC the test cases are located at the corners of the rectangle built over the disk subdomain.

(b) weak nx1 strategy. The subdomain is nonlinear and can be *approximated* only by 4 linear segments. The limitation is that because of nonlinearity of the boundaries. One has to be careful as to the location of the OFF points. To improve the strategy, approximation could realized by using a larger number of linear segments.

A transformation into the polar coordinates (r, ϕ) is another option.