ECE 322
SOFTWARE TESTING AND MAINTENANCE

Mid-term Examination
October 22, 2015
11:00 -12:20

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?

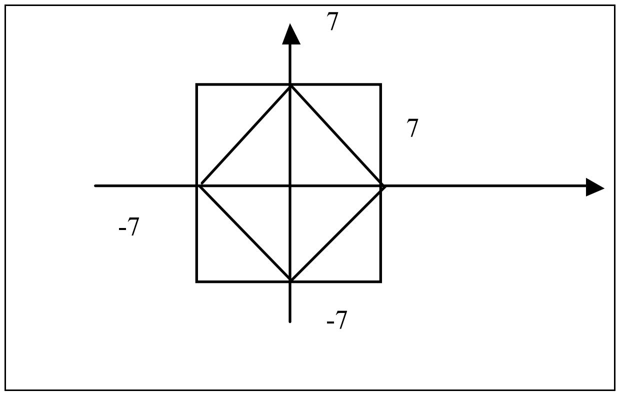
(e) (**2 points**) Explain a concept of coincidental correctness.

(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



(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**) Name two fundamental properties of partitions. What do they mean in testing?

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

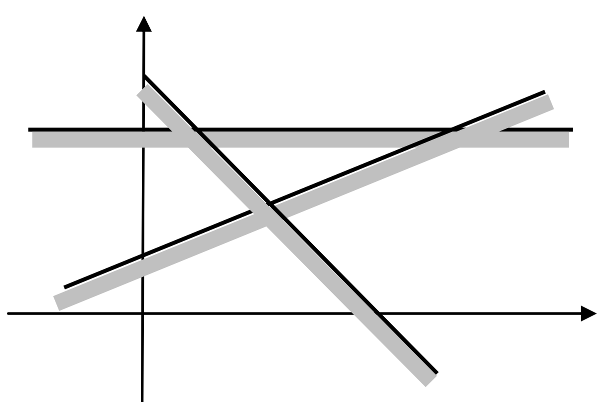
```
begin  program domain_test
var  a, b, x, y: real;
read(x,y)
if y<=5 then          (P1)
     a:= x-y-2
else
     a:=x+y-2;
if a<-3.0 then        (P2)
     b:=a+x+2y+3;
else
     b:=a-7y+3;
if b >7  then         (P3)
     print(x);
else
     print (y);
end program
```

(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.

Solution

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

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



3. [10 points] (a) Develop equivalence classes for the NextDate problem for the calendar for the year 1923 in Greece.
(b) build a decision table for the same problem. Consider using the following actions: increment day, reset day, increment month, reset month, increment year, impossible.

Solution

Year is fixed here- 1923

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	M2	M3	M3
day	D1	D2	D3	D1	D2	D3	D2	D3
Actions								
impossible			x				x	x
Increment day	x			x	x			
Reset day		x				x		
Increment month		x				?		
Reset month						?		

Note the rule #   could be restructured if we form an additional class for months M4 = December.

4. [10 points] Given is a program that solves the 2nd order homogeneous difference equation of the form

$$\alpha_2 x_{n+2} + \alpha_1 x_{n+1} + \alpha_0 x_n = 0$$

where the coefficients α_2, α_1, α_0 are real numbers.

(a) Identify equivalence classes in the input space of the coefficients of this equation. Suggest a collection of test cases.
(b) Let the value of α_0 be equal -4.2. For this value of α_0 show the boundaries of equivalence classes in the α_1-α_2 coordinates. Are these boundaries linear or nonlinear?

Hint: The second order linear homogeneous difference equation

$$\alpha_2 x_{n+2} + \alpha_1 x_{n+1} + \alpha_0 x_n = 0$$

comes with the characteristic equation with respect to λ

$$\alpha_2 \lambda^2 + \alpha_1 \lambda + \alpha_0 = 0$$

The solutions to this equation (λ_1, λ_2) are called eigenvalues.
Depending on the values of λ_1, λ_2, we encounter the following three cases (here c_1, c_2 - arbitrary constants).
$\lambda_1 \neq \lambda_2, \lambda_1, \lambda_2 \in \mathbf{R}$ (real and distinct roots), solution is in the form $x_n = c_1 \lambda_1^n + c_2 \lambda_2^n$
$\lambda_1 = \lambda_2, \lambda_1, \lambda_2 \in \mathbf{R}$ solution reads as $x_n = c_1 \lambda_1^n + c_2 n \lambda_1^n$
$\lambda_1 = \overline{\lambda_2}$ (complex, conjugate), let $\lambda_1 = re^{j\phi}$, solution is $x_n = c_1 r^n \cos(n\phi) + c_2 r^n \sin(n\phi)$

Solution
(a) The second order linear homogeneous difference equation

$$\alpha_2 x_{n+2} + \alpha_1 x_{n+1} + \alpha_0 x_n = 0$$

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The equivalence classes are determined from the relationship

$$\alpha_1^2 - 4\alpha_2\alpha_0 \begin{cases} > 0 & (1) \\ = 0 & (2) \\ < 0 & (3) \end{cases}$$

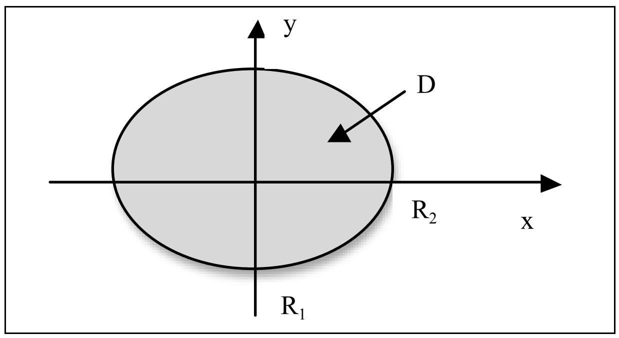
Here

$$\Omega_1 = \left\{\alpha_0, \alpha_1, \alpha_2 \middle| \alpha_1^2 - 4\alpha_2\alpha_0 > 0\right\}$$

$$\Omega_2 = \left\{\alpha_0, \alpha_1, \alpha_2 \middle| \alpha_1^2 - 4\alpha_2\alpha_0 = 0\right\} \qquad \Omega_3 = \left\{\alpha_0, \alpha_1, \alpha_2 \middle| \alpha_1^2 - 4\alpha_2\alpha_0 < 0\right\}$$

(b) $\alpha_0 = -4.2$ The boundary is nonlinear and comes in the form of a quadratic relationship $\alpha_1^2 - 4\alpha_2 * (-4.2) = \alpha_1^2 + 16.8\alpha_2$

5. [10 points] A certain object tracking procedure is invoked when a moving object is located in one of the ellipsoidal subdomain D, see below. The 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
The subdomain is nonlinear and can be *approximated* by 4 linear segments; see below. The limitation is that because of nonlinearity of the boundaries. To improve the strategy, approximation is realized using more linear segments.