ECE 322
SOFTWARE TESTING AND MAINTENANCE
Mid-term Examination
Solutions
October 29, 2018
10:00 – 10:50 AM

Total 38 points ***GOOD LUCK***

Student Name & ID ________________________________

1	2	3	4	Σ
/8	/10	/10	/10	

1. **[8 points]** Answer the following questions – please be concise.

(a) (**1 point**) Is it possible to have high-quality and low reliability software? What might be a possible example of such software? Provide an illustrative example.

Yes, software quality is a multi-faceted concept embracing a number of features; some of them could be of high quality.

(b) (**1 point**) Give some reasons why you would ***not*** recommend the use of operational profiles.

Operational profiles are used when dealing with
- (i) large scale software
- (ii) many users (diversified groups of users)
- (iii)diverse usage environment
- (iv) detailed statistical information about the usage of the software system

If some of these properties are not met, it is not recommended to use operational profiles.

(c) (**2 points**) Why would you consider the use constraints in the development of cause-effect graphs. In which sense are they useful?

Reduction of number of required test cases

(d) (**1 point**) What is the difference between software validation and software verification?

Validation – concerns a product; building the right product
Verification – concerns a process; building product right

(e) (**1 point**) Explain a concept of coincidental correctness.

(g) (**1 point**) What is the relationship between Petri nets and finite state machines? Under which condition Petri net becomes a finite state machine?

Each transition has a single input place and a single output place

(h) (**1 point**) In realizing testing for 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?

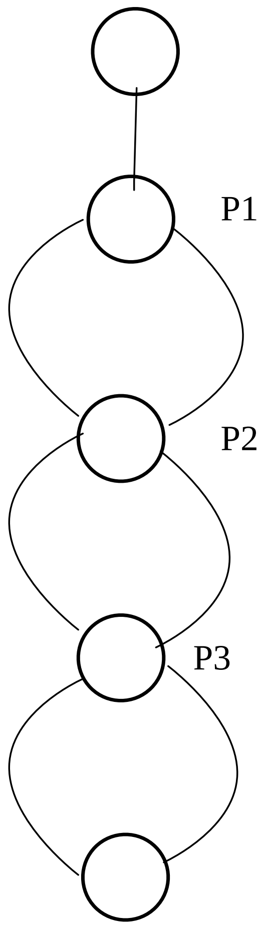
Solution The required orthogonal table $L_{18}(2^1 3^7)$ (see lecture notes) has 18 rows so the improvement (in terms of the smaller number of test cases) is 18 versus $2^2 * 3^6$ cases when running all combinations.

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
```

Draw a control flow graph for this pseudocode and determine its cyclomatic complexity.

Solution



cyclomatic complexity:
e-n+ 2 = 7-5+2 =4
or alternatively

number of binary decision nodes + 1 = 4
or number of planar regions = 4

3. [10 points] Consider a program that solves the following system of linear equations with a vector of unknown variables ***x***

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

where $\mathbf{A} = [a_{ij}]$, i=1,2,.., n, j=1, 2,…, n, $\mathbf{b} = \begin{bmatrix} b_1 \\ b_2 \\ \cdots \\ b_n \end{bmatrix}$ and $\boldsymbol{x} = \begin{bmatrix} x_1 \\ x_2 \\ \cdots \\ x_n \end{bmatrix}$

(a) Discuss a testing strategy using equivalence classes. Elaborate on the valid and invalid equivalence classes.

(b) how can you proceed with testing when the number of equations is larger than the number of variables, namely dim($\boldsymbol{b}$) $=n$ and dim($\boldsymbol{x}$) $=m$ and $m<n$.

Solution

The equivalence classes are associated with the condition expressing whether the above set of equations is solvable. We have two valid equivalence classes in the n x n space of values of **A**, namely$\{a_{11}, a_{12},\ldots, a_{nn}\}$

(i) $\{a_{11}, a_{12},\ldots, a_{nn} \mid \det(A) = 0\}$, and
(ii) $\{a_{11}, a_{12},\ldots, a_{nn} \mid \det(A) \neq 0\}$

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

In case when the number of equations is larger than the number of unknown variables, there is only an approximate solution expressed in the form $\boldsymbol{a} = (A^T A)^{-1} A^T \boldsymbol{b}$

Here one considers two equivalence classes expressed as

(i) $\{a_{11}, a_{12},\ldots, a_{nn} \mid \det(A^T A) = 0\}$, and
(ii) $\{a_{11}, a_{12},\ldots, a_{nn} \mid \det(A^T A) \neq 0\}$

4. [10 points] The subdomain is described by the following relationships

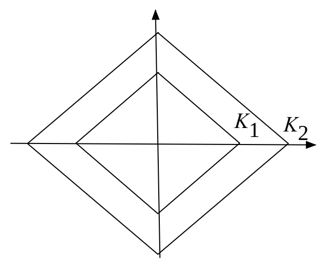
$$|x_1| + |x_2| \geq K_1$$
$$|x_1| + |x_2| \leq K_2$$

where $0 < K_1 < K_2$.

(a) plot the subdomain
(b) is the subdomain open or closed
(c) Propose an EPC strategy to complete testing here; show the test cases on the plot
(d) Show test cases produced by the weak n x 1 strategy

Solution

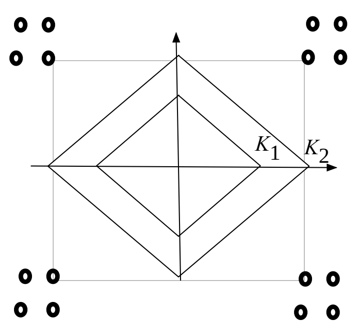
(a)



(b) closed

(c) test cases are shown on the plots

EPC



Weak nx1 strategy