Software Quality Assurance (WS20/21)
Problem Set 2

Problem 1: Embedded Systems

Please define the categories of quality assurance methods. What is the major difference between “informal methods” and “formal methods”?

-

Categories of quality assurance methods:

a) Informal methods: based on plausibility, which produces incomplete results. Testing, Inspection
b) Stochastic methods: statistically reliable, quantified results. Stochastic reliability analysis.
c) Formal methods: produce formally complete results on the basis of formal specifications. Formal verification technique (proof)

Difference between “informal methods” and “formal methods”

a) Informal methods: plausibility + incomplete results
b) Formal methods: based on formal specification + formally complete results.

Problem 2: Test Phase

Please explain the test phases according to their necessities and benefits. Please depict these phases considering an object-oriented software development.

-

Test phases:

I. Module/Unit test: correct function of a module.
II. Integration test: interaction of the modules.
III. System/acceptance test: functionality and features such as efficiency of a system wrt. The requirements.

Benefits:

- Reduction of the respective complexity.
- Localization of faults.
- Improvement of test efficiency.

Example of Object-Oriented software:

- Module test: class/function test
- Integration test: interface test
- System test: run the entire system as a whole, determine correctness and efficiency.

Problem 3: Test Methods

Please illustrate the main differences between dynamic test, static analysis, and formal methods. Please point out their respective advantages and drawbacks.

-

1. Dynamic test:
    a. The executable program is provided with concrete input values and is executed.
    b. Maybe tested in a real environment.
    c. Never complete for a real testing.
    d. The correctness of the tested program cannot be proven.

    Advantage: widely-used, easy to handle
    Drawbacks: unsystematic, test often not reproducible, diffuse activity.

2. Static Analysis:
    Advantage:
    - No execution is required.
    - No input values are selected.

Drawback:

- Concentrates on particular partial aspects.
- No proof of correctness.
- Some analysis can detect faults directly.

3. Formal Verification:
   Advantage:
   - use of mathematical techniques for proving consistency.

   Drawback:
   - A formal specification is necessary, expertise required.
   - Difficult for beginner.
   - Required preconditions are often not fulfilled in practice.

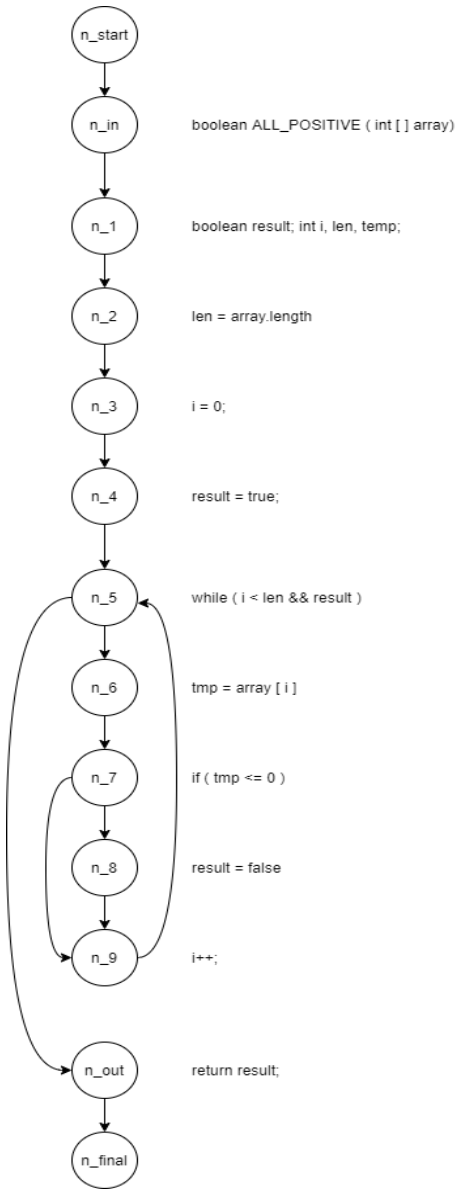
Problem 4: Control Flow Testing

Given is a function ALL POSITIVE implemented in Java, which examines all elements of a one-dimensional field of simple integers to see whether these are bigger than 0.

```
01  boolean ALL_POSITIVE(int[] array) {
02  boolean result;
03  int i,len,tmp;
04  len = array.length;
05  i=0;
06  result=true;
07  while (i<len&&result) {
08    tmp=array[i];
09    if (tmp<=0)
10      result=false;
11    i++;
12  }
13  return result;
14 }
```

-

a) Please plot the control flow diagram for the ALL_POSITIVE function.



b) Please find a minimal necessary test case for achieving the statement coverage of the operation ALL_POSITIVE.

-

ALL_POSITIVE ({- 1}) -> false
Executing function ALL_POSITIVE with a simple integer field with at least one value x <= 0

c) Please determine a minimal necessary test case for fulfilling the branch coverage of the operation ALL_POSITIVE.

-

ALL_POSITIVE ({1, - 1}) -> false
Executing function ALL_POSITIVE with a simple integer field which begins with at least one value x>0 and following value y <= 0

Problem 5: Condition Coverage

Given is this section from a Java source code.

```
...
if ((a<0 && b>O) || (c==0 && d != 0))
...
```

a) Please find out the minimal set of necessary logical value combinations for fulfilling the **simple condition coverage** for the complete evaluation of the partial decisions and for the incomplete evaluation of the partial decisions from left to right. Please determine the corresponding test data for each logical value combination that would lead to the appropriate logical values.

Complete Evaluation

	A	B	C	D	E	F	Total
	a<0	b>0	c==0	d != 0	A && B	C && D	E || F
11	T	F	T	F	F	F	F
6	F	T	F	T	F	F	F

Incomplete Evaluation from left to right

	A	B	C	D	E	F	Total
	a<0	b>0	c==0	d != 0	A && B	C && D	E || F
5	T	F	T	F	F	F	F
1	F	-	F	-	F	F	F
7	T	T	-	-	T	-	T
3	F	-	T	T	F	T	T

b) Please find out the minimal set of necessary logical value combinations for fulfilling the **multiple condition coverage** for the complete evaluation of the partial decisions and for the incomplete evaluation of the partial decisions from left to right. Please state how many test cases are needed as a minimum for the complete evaluation. Please determine the corresponding test data for each logical value combination that would lead to the appropriate logical values.

Complete Evaluation

	A	B	C	D	E	F	Total
	a<0	b>0	c==0	d != 0	A && B	C && D	E || F
1	F	F	F	F	F	F	F
2	F	F	F	T	F	F	F
3	F	F	T	F	F	F	F
4	F	F	T	T	F	T	T
5	F	T	F	F	F	F	F
6	F	T	F	T	F	F	F
7	F	T	T	F	F	F	F
8	F	T	T	T	F	T	T
9	T	F	F	F	F	F	F
10	T	F	F	T	F	F	F
11	T	F	T	F	F	F	F
12	T	F	T	T	F	T	T
13	T	T	F	F	T	F	T
14	T	T	F	T	T	F	T
15	T	T	T	F	T	F	T
16	T	T	T	T	T	T	T

Incomplete Evaluation from left to right

	A	B	C	D	E	F	Total
	a<0	b>0	c==0	d != 0	A && B	C && D	E || F
1 (1,2,5,6)	F	-	F	-	F	F	F
2 (3,7)	F	-	T	F	F	F	F
3 (4,8)	F	-	T	T	F	T	T
4 (9,10)	T	F	F	-	F	F	F
5 (11)	T	F	T	F	F	F	F
6 (12)	T	F	T	T	F	T	T
7 (13, 14, 15, 16)	T	T	-	-	T	-	T

c) Please find out the minimal set of necessary logical value combinations for fulfilling the **minimal multiple condition coverage** for the complete evaluation of the partial decisions and for the incomplete evaluation of the partial decisions from left to right. Please determine the corresponding test data for each logical value combination that would lead to the appropriate logical values.

Complete Evaluation

	A	B	C	D	E	F	Total
	a<0	b>0	c==0	d != 0	A && B	C && D	E || F
1	F	F	F	F	F	F	F
16	T	T	T	T	T	T	T

Incomplete Evaluation from left to right

	A	B	C	D	E	F	Total
	a<0	b>0	c==0	d != 0	A && B	C && D	E || F
1	F	-	F	-	F	F	F
7	T	T	-	-	T	-	T
5	T	F	T	F	F	F	F
3	F	-	T	T	F	T	T

d) Please find out the minimal set of necessary logical value combinations for fulfilling the **modified condition decision coverage** for the complete evaluation of the partial decisions and for the incomplete evaluation of the partial decisions from left to right. Please determine the corresponding test data for each logical value combination that would lead to the appropriate logical values.

Complete Evaluation

	A	B	C	D	E	F	Total
	a<0	b>0	c==0	d != 0	A && B	C && D	E || F
11 - B,D	T	F	T	F	F	F	F
15 - A, B	T	T	T	F	T	F	T
12 - C, D	T	F	T	T	F	T	T
7 – A	F	T	T	F	F	F	F
10 – C	T	F	F	T	F	F	F

Incomplete Evaluation from left to right

	A	B	C	D	E	F	Total
	a<0	b>0	c==0	d != 0	A && B	C && D	E || F
5 – B,D	T	F	T	F	F	F	F
7 – A,B	T	T	-	-	T	-	T
6 – C,D	T	F	T	T	F	T	T
2 – A	F	-	T	F	F	F	F
4 – C	T	F	F	-	F	F	F

Some Definitions for your reference: -

- Simple condition coverage
  - Test of all simple conditions concerning true and false.
- Condition/decision coverage
  - Test of all simple conditions + overall decision concerning true and false.
- Minimal Multiple Condition Coverage
  - All simple conditions + overall decision + composite conditions concerning true and false.
- Modified condition/decision coverage
  - Requires test cases which demonstrate that every condition can influence the logical value of the overall decision independently of the other conditions.
- Multiple Condition Coverage
  - Test of all value combinations of the conditions.