Assignment 3

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1. Define the following concepts in your own words and give an example for each of them (15 pts.).

**a) Basic Block**

A *basic block* is a maximum sequence of program statements such that if any one statement of the block is executed, all statements in the block are executed.

A basic block has only one entry point and one exit point.

Ex: An if-else structure results in two basic blocks.

**b) Simple path**

A path from *ni* to *nj* is *simple* if no node appears more than once in the path, with the exception that the first and last nodes may be identical. That is, simple paths have no internal loops, although the entire path itself may wind up being a loop.

**c) Prime Path**

A path from *ni* to *nj* is a prime path if it is a simple path and it does not appear as a proper sub-path of any other simple path.

**d) Edge Coverage**

Test set T satisfies Edge Coverage on graph G if and only if for every edge e in E, there is some path p in path(T) such that p visits e.

**e) Complete Path Coverage**

Test set T satisfies Path Coverage on graph G if and only if path(T) tours every possible test path in G. Note that if G has a cycle, T cannot be finite.

**Reference for Q1: Textbook**

**2. Answer questions (a)–(d) for the following graph (20 points):**

**a) List the sets N, N0, Nf, and E for the G**

**Solution:**

N = {n0, n1, n2, n3, n4, n5, n6, n7, n8, n9}  
N0 = {n0, n1, n2}  
Nf = {n7, n8, n9}  
E={(n0, n4),(n1, n4), ),(n4, n7),(n4, n8),( n2, n5),(n2, n6),(n3, n7), (n0, n3),(n5, n1),(n5, n9),( n6, n9),(n8, n5)}

**b) Give a path that is not a test path**

**Solution:**

We say [n4, n8, n5, n9 ] cannot be a test path because it does not start with an initial node. [n1, n4, n8, n5] cannot be a test path because it does not end with a final node.

**c) List all test paths**

**Solution:**

There are many test paths few of them are listed below.

[n2, n5, n9],

[n1, n4, n8, n5, n9],

[n2, n5, n1, n4, n8],

[n0, n4, n8],

[n0, n4, n8, n5, n1, n4, n8],

[n0, n4, n8, n5, n9],

[n2, n5, n1, n4, n8, n5, n1, n4, n8],

[n2, n6, n9].

[n1, n4, n8],

[n1, n4, n8, n5, n1, n4, n8],

[n0, n3, n7],

[n0, n4, n7]

**d) Enumerate the test requirements for prime path coverage on the graph**

**Solution:**

**Len = 0**

[n0]

[n1]

[n2]

[n3]

[n4]

[n5]

[n6]

**[n7] !**

**[n8] !**

**[n9] !**

**Len = 1**

[n0, n1]

[n0, n4]

**[n3, n7] !**

**[n4, n8] !**

[n5, n1]

[n2, n5]

[n8, n5]

**[n5, n9] !**

**[n6, n9] !**

[n2, n6]

**[n4, n7] !**

**Len = 2**

**[n1, n4, n8] !**

**[n0, n4, n8]!**

[n2, n5, n1]

[n5, n1, n4]

[n8, n5, n1]

**[n8, n5, n9] !**

**[n2, n6, n9] !**

**Len = 3**

[n4, n8, n5, n1]

[n8, n5, n1, n4]

[n2, n5, n1, n4]

**Len = 4**

[n0, n4, n8, n5, n1]

**[n1, n4, n8, n5, n1] \***

[n4, n8, n5, n1, n4]

**[n2, n5, n1, n4, n8] !**

**[n2, n5, n1, n4, n7] !**

**Len = 5**

**[n4, n8, n1, n5, n4, n8] !**

**[n4, n8, n1, n5, n4, n7] !**

**Prime Path Coverage**

**Prime paths:**

1. [n0, n3, n7]

2. [n1, n4, n8, n5, n1, n4, n8]

3. [n2, n5, n9]

4. [n2, n6, n9]

5. [n0, n4, n7]

6. [n2, n5, n1, n4, n7]

7. [n0, n4, n8, n5, n9]

**3. Answer questions (a)–(d) for the graph defined by the following sets (20 pts.): N = {1, 2, 3, 4}**

**N0 = {1}**

**Nf = {4}**

**E = {(1, 2), (2, 3), (3, 2), (2, 4)}**

**a) Draw the graph**

**b) List test paths that achieve node coverage, but not edge coverage.**

This cannot be achieved because we start at node 1 eventually goto node 2 and 3 and reach the final node 4. Here both node and edge coverage is achieved. Hence this is not possible.

**c) List test paths that achieve edge coverage, but not edge Pair coverage**

The path which achieves edge coverage but not edge pair coverage is [1,2,3,2,4]

**d) List test paths that achieve edge pair coverage.**

The test paths that achieve edge pair coverage is:

1. [1,2,4]

2. [1,2,3,2,3,2,4]

**4. Answer questions (a)–(f) for the graph defined by the following sets (30 pts.):**

**N = {1, 2, 3, 4, 5, 6, 7}**

**N0 = {1}**

**Nf = {7}**

**E = {(1, 2), (1, 7), (2, 3), (2, 4), (3, 2), (4, 5), (4, 6), (5, 6), (6, 1)}**

**Also consider the following (candidate) test paths:**

**t0 = [1, 2, 4, 5, 6, 1, 7]**

**t1 = [1, 2, 3, 2, 4, 6, 1, 7]**

**a) Draw the graph.**

**b) List the test requirements for edge-pair coverage. (You should get 12 requirements of length 2).**

The test requirement for edge-pair coverage are:

{[1, 2, 3], [1, 2, 4],

[2, 3, 2], [2, 4, 5], [2, 4, 6],

[3, 2, 3], [3, 2, 4],

[4, 5, 6], [4, 6, 1],

[5, 6, 1],

[6, 1, 2], [6, 1, 7]}

**c) Does the given set of test paths satisfy edge-pair coverage? If not, identify what is missing.**

The given set of test paths does not satisfy edge-pair coverage because it doesn’t tour the following edge-pairs [3, 2, 3] and [6, 1, 2] .

**d) Consider the simple path [3, 2, 4, 5, 6] and test path [1, 2, 3, 2, 4, 6, 1, 2, 4, 5, 6, 1, 7]. Does the test path tour the simple path directly? With a side-trip? If so, identify the side-trip.**

No, the test path does not tour the simple path directly. But, yes, it does with a side trip which is [4,6,1,2,4].

**e) List the test requirements for node coverage, edge coverage, and prime path coverage on the graph.**

**Node Coverage**

{1, 2, 3, 4, 5, 6, 7}

**Edge Coverage:**

{(1,2),

(1,7),

(2,3),

(2,4),

(3,2),

(4,5),

(4,6),

(5,6),

(6,1)}

**Prime Path Coverage:**

{[3, 2, 3],

[2, 3, 2],

[1, 2, 4, 6, 1],

[2, 4, 6, 1, 2],

[6, 1, 2, 4, 6],

[4, 6, 1, 2, 4],

[4, 6, 1, 2, 3],

[1, 2, 4, 5, 6, 1],

[2, 4, 5, 6, 1, 2],

[3, 2, 4, 6, 1, 7],

[4, 5, 6, 1, 2, 4],

[4, 5, 6, 1, 2, 3],

[5, 6, 1, 2, 4, 5],

[6, 1, 2, 4, 5, 6],

[3, 2, 4, 5, 6, 1, 7]}

**f) List test paths that achieve node coverage but not edge coverage on the graph.**

**The test path** [1, 2, 3, 2, 4, 5, 6, 1, 7] achieves node coverage but not edge coverage as it does not cover the edge (4, 6).

**5. Answer questions (a)–(c) for the graph defined by the following sets (15 pts.):**

**N = {0, 1, 2}**

**N0 = {0}**

**Nf = {2}**

**E = {(0, 1), (0, 2), (1, 0), (1, 2), (2, 0)}**

**Also consider the following (candidate) paths:**

**P0 = [0, 1, 2, 0]**

**p1 = [0, 2, 0, 1, 2]**

**P2 = [0, 1, 2, 0, 1, 0, 2]**

**P3 = [1, 2, 0, 2]**

**P4 = [0, 1, 2, 1, 2]**

**a) Which of the listed paths are test paths? Explain the problem with any path that is not a test path.**

P1 and P2 are the only test paths.

P0 does not terminate at the final node

P3 does not start at the initial node

P4 has an edge which does not exist which is [n2,n1]

**b) List the eight test requirements for edge-pair coverage (only the length two sub-paths)**

The eight test requirements for edge-pair coverage with length 2 :

{[n0, n1, n0], [n0, n1, n2], [n0, n2, n0],

[n1, n0, n1], [n1, n0, n2], [n1, n2, n0],

[n2, n0, n1], [n2, n0, n2]}

**c) Consider the prime path [n2, n0, n2] and path p2. Does p2 tour the prime path directly? With a side-trip?**

P2 does not tour the prime path [n2, n0, n2] directly. But it does tour the prime path with a side trip [n0, n1, n0]

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