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5. Answer questions (a)–(g) for the graph defined by the following sets:
   - $N = \{1, 2, 3, 4, 5, 6, 7\}$
   - $N_0 = \{1\}$
   - $N_f = \{7\}$
   - $E = \{(1, 2), (1, 7), (2, 3), (2, 4), (3, 2), (4, 5), (4, 6), (5, 6), (6, 1)\}$

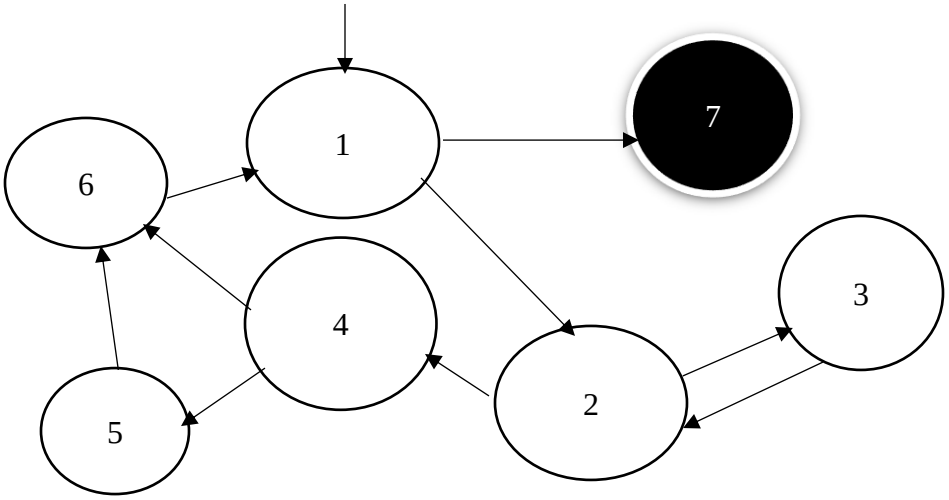
   Also consider the following (candidate) test paths:
   - $t_0 = [1, 2, 4, 5, 6, 1, 7]$
   - $t_1 = [1, 2, 3, 2, 4, 6, 1, 7]$

   (a) Draw the graph.
   (b) List the test requirements for edge-pair coverage. (Hint: You should get 12 requirements of length 2).
   (c) Does the given set of test paths satisfy edge-pair coverage? If not, identify what is missing.
   (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 sidetrip? If so, identify the sidetrip.
   (e) List the test requirements for node coverage, edge coverage, and prime path coverage on the graph.
   (f) List test paths that achieve node coverage but not edge coverage on the graph.
   (g) List test paths that achieve edge coverage but not prime path coverage on the graph.

a)

G = <N, N0, Nf, E>

Nodes (N): {1, 2, 3, 4, 5, 6, 7}
Node 1: Initial node (N0)
Node 7: Final node (Nf)
Edges (E): {(1, 2), (1, 7), (2, 3), (2, 4), (3, 2), (4, 5), (4, 6), (5, 6), (6, 1)}



b) TR = {[(1,2),(2,4)], [(1,2),(2,3)], [(2,3),(3,2)], [(3,2),(2,3)], [(3,2),(2,4)], [(2,4),(4,6)],

[(4,6),(6,1)], [(2,4),(4,5)], [(4,5),(5,6)], [(5,6),(6,1)], [(6,1),(1,7)], [(6,1),(1,2)]}

c) The given set of test paths (to and t1) don't satisfy edge- pair coverage. This is because there is no tour for edge pairs [(3,2),(2,3)] and [(6,1),(1,2)].

d) Given: Simple path = [3, 2, 4, 5, 6] and test path = [1, 2, 3, 2, 4, 6, 1, 2, 4, 5, 6, 1, 7], the test path doesn't tour the simple path directly. This is because the simple path is not a sub path of the test path. However, the test path tours the simple path with a sidetrip.
The sidetrip is [4, 6, 1, 2, 4].

e) Node coverage: T = {1, 2, 3, 4, 5, 6, 7}
Edge coverage: T = { (1,2), (1,7), (2,3), (2,4), (3,2), (4,5), (4,6), (5,6), (6,1) }

Len = 0	Len = 1	Len = 2	Len = 3	Len = 4	Len = 5	Len = 6
1. {1}	**8.** {1,2}	**17.** {1,2,3}!	**29.** {1,2,4,5}	**42.** {1,2,4,5,6}	**57.** {1,2,4,5,6,1}*	**66.** {3,2,4,5,6,1,7}!
2. {2}	**9.** {1,7}!	**18.** {1,2,4}	**30.** {1,2,4,6}	**43**. {1,2,4,6,1}*	**58.** {2,4,5,6,1,7}!	
3. {3}	**10.** {2,3}	**19.** {2,3,2}*	**31**. {2,4,5,6}	**44.** {2,4,5,6,1}	**59.** {2,4,5,6,1,2}*	
4. {4}	**11.** {2,4}	**20.** {2,4,5}	**32.** {2,4,6,1}	**45.** {2,4,6,1,2}*	**60.** {3,2,4,5,6,1}	
5. {5}	**12.** {3,2}	**21.** {2,4,6}	**33.** {3,2,4,5}	**46.** {2,4,6,1,7}!	**61.** {3,2,4,6,1,7}!	
6. {6}	**13.** {4,5}	**22.** {3,2,3}*	**34.** {3,2,4,6}	**47.** {3,2,4,5,6}	**62.** {4,5,6,1,2,3}!	
7. {7}	**14.** {4,6}	**23.** {3,2,4}	**35.** {4,5,6,1}	**48.** {3,2,4,6,1}	**63.** {4,5,6,1,2,4}*	
	15. {5,6}	**24**. {4,5,6}	**36.** {4,6,1,2}	**49.** {4,5,6,1,2}	**64.** {5,6,1,2,4,5}*	
	16. {6,1}	**25.** {4,6,1}	**37.**{4,6,1,7}!	**50.** {4,5,6,1,7}!	**65.** {6,1,2,4,5,6}*	
		26. {5,6,1}	**38.** {5,6,1,2}	**51.** {4,6,1,2,4}*		
		27. {6,1,7}!	**39.** {5,6,1,7}!	**52.** {4,6,1,2,3}!		
		28. {6,1,2}	**40.** {6,1,2,3}!	**53.** {5,6,1,2,3}!		
			41. {6,1,2,4}	**54.** {5,6,1,2,4}		
				55. {6,1,2,4,5}		
				56. {6,1,2,4,6}*		

Prime path coverage:
19. {2,3,2}
22. {3,2,3}
43. {1,2,4,6,1}
45. {2,4,6,1,2}
51. {4,6,1,2,4}
52. {4,6,1,2,3}
56. {6,1,2,4,6}
57. {1,2,4,5,6,1}
58. {2,4,5,6,1,7}
59. {2,4,5,6,1,2}
61. {3,2,4,6,1,7}
62. {4,5,6,1,2,3}
63. {4,5,6,1,2,4}
64. {5,6,1,2,4,5}
65. {6,1,2,4,5,6}
66. {3,2,4,5,6,1,7}

f) The path {1, 2, 3, 2, 4, 5, 6, 1, 7} achieves node coverage but not edge coverage since it doesn't cover {4, 6}

g) The test paths {1, 2, 4, 6, 1, 7} and {1, 2, 3, 2, 4, 5, 6, 1, 7} achieve edge coverage but they don't achieve prime path coverage since they are not simple paths. That is, both paths contain nodes that appear more than once.

7. Answer questions (a)–(d) for the graph defined by the following sets:
   - $N = \{0, 1, 2\}$
   - $N_0 = \{0\}$
   - $N_f = \{2\}$
   - $E = \{(0, 1), (0, 2), (1, 0), (1, 2), (2, 0)\}$

   Also consider the following (candidate) paths:
   - $p_0 = [0, 1, 2, 0]$
   - $p_1 = [0, 2, 0, 1, 2]$
   - $p_2 = [0, 1, 2, 0, 1, 0, 2]$
   - $p_3 = [1, 2, 0, 2]$
   - $p_4 = [0, 1, 2, 1, 2]$

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

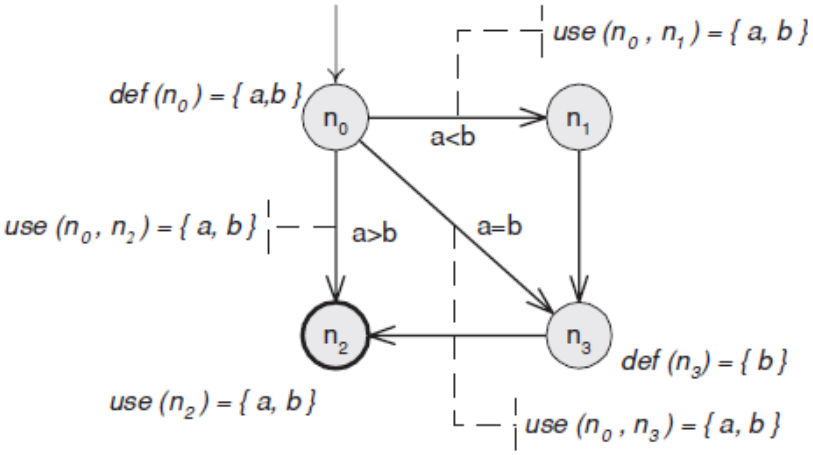


Figure 2.11. A graph showing variables, def sets and use sets.

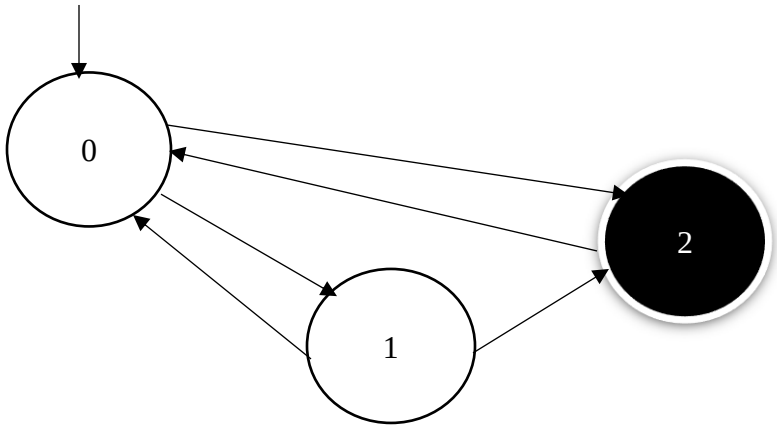
(b) List the eight test requirements for edge-pair coverage (only the length two subpaths).

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

(d) Consider the prime path $[n_2, n_0, n_2]$ and path p_2. Does p_2 tour the prime path directly? With a sidetrip?

G = <N, N0, Nf, E>

Nodes (N): {0, 1, 2}
Node 0: Initial node (N0)
Node 2: Final node (Nf)
Edges (E): {(0, 1), (0, 2), (1, 0), (1, 2), (2, 0)}



a) The paths P1 and P2 are test paths because they start at the initial node (1), include existing edges and finish at the final node (2). However, P3 doesn't isn't a test path since the path starts at 1 instead of 0, the initial node. Even though P4 starts at the initial node and ends at the final node, it contains an edge that does not exist and so it is not a test path either.

b) TR = {[(0,2),(2,0)], [(1,2),(2,0)], [(2,0),(0,1)], [(0,1),(1,2)], [(0,1),(1,0)], [(1,0),(0,2)],

[(2,0),(0,2)], [(1,0),(0,1)]}

c) The test paths P1 = [0, 2, 0, 1, 2] and P2 = [0, 1, 2, 0, 1, 0, 2] don't satisfy edge pair coverage. This is no tour for edge pairs [(2, 0), (0, 2)] and [(1, 0), (0, 1)].

d) P2 doesn't tour the prime path [n2, n0, n2] directly. However, p2 tours this prime path with the sidetrip [n0, n1, n0].