FIT5171 Applied Session 3
Discrete Mathematics for Software Testing

Week 3, 2024

> Please do try the questions before coming to the tutorial. Your active participation is the most important!

Logics & Set Theory

1. Decide if the following predicates are true. If not, give a counter example.

   (a) $\forall A \exists B \cdot C \equiv \exists B \forall A \cdot C$, where A and B are variable declarations and C is a Boolean expression.

   (b) $\forall A, B \colon PN \cdot A \subseteq B \vee B \subseteq A$

Relations & Functions

2. Give a formal definition of the binary relation R, over natural numbers, such that each x is related to y by R if and only if y is greater than the square of x but less than the square of $x + 1$.

3. Let S be the set of natural numbers between 1 and 15 inclusively. Express R in Q2 as a set of ordered pairs in S.

Graph Theory

4. Given an undirected graph G with vertices $V = \{1, 2, 3, 4, 5, 6, 7, 8\}$ and edges $E = \{12, 14, 16, 22, 23, 28, 34, 35, 67, 78\}$

   (a) Draw G graphically.

   (b) Calculate the degree of each node in the graph.

   (c) Calculate the Cyclomatic number of G.

5. Let's treat G in Q5 as a directed graph (edge 12 in E represents an edge from node 1 to node 2).

   (a) Draw G graphically.

   (b) Calculate the in-degree and out-degree of each node (ignoring edge 22 for this question)

   (c) Are there any source nodes or sink nodes in G?

   (d) Does this graph contain semi-paths? If so, identify them.

(e) Identify a pair of nodes that are 0-connected, 1-connected, 2-connected, and 3-connected, if any (ignoring edge 22 again).

(f) Work out the reachability matrix for G.

6. Draw a directed graph for each of the following common control constructs: (1) if-then, (2) if-then-else, (3) case switch, (4) while loop, and (5) do-while loop. As an example, the graph of sequence execution is included below in Figure 1.
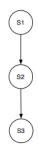

Figure 1: A directed graph showing sequential execution.