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Software Testing

Assignment 3

Nabiya Fatima – BSE173011
Iqra Ishtiaq – BSE173043

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Case Study

Introduction

An **equation** in one unknown quantity (let it be x) in the form $ax^2 + bx + c = 0$ is known as a **quadratic equation**, where a, b, c are constants and $a \neq 0$ while b and c may be zero. Here "a" is called the coefficient of x^2, "b" is the coefficient of x and "c" is a constant term. The word "quadratic" comes from "*quadratum*", the Latin word for square. Hence, a quadratic equation is an equation where the variable is of the second degree. Therefore, a quadratic equation is also called an "Equation of degree 2". Many Real world problems can be studied and solved using Quadratic Equations. **Quadratic equations** are used in everyday life, as when calculating areas, determining a product's profit or formulating the speed of an object, projectile motion etc.

Brief Description

In a programming competition the students are required to design a program that takes three numbers (a, b, c) as inputs and determine whether the equation is Quadratic or not. The standard form of Quadratic Equation is $ax^2+bx+c=0$, where a, b, c are constants and "a" cannot be zero. The program should have a method that calculates the nature of the roots of the Quadratic equation weather the roots of the equation are Real, Equal or Imaginary using the discriminant b^2-4ac. Following are the conditions that should be meet:

- If $b^2-4ac>0$ the roots are real and unequal
- If $b^2-4ac=0$ the roots are real and equal
- If $b^2-4ac<0$ the roots are imaginary

The program should also have a method to calculate the roots of the equation using the formula $\boldsymbol{x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}}$. Each function should first test whether the inputs will form the quadratic equation and then perform the desired functionality; otherwise, the program should display a message "**Not a Quadratic Equation**". The problem with the Quadratic Formula is that when using Floating point arithmetic it may be subjected to loss of significance in calculating the roots of the equation, the more similar the two numbers are, the precision decreases so the constants a, b, c should be integer rather than floating-point numbers or decimal numbers. The inputs for the constants a, b, c should be within the range from [0,200]. The program should display the following menu

1) Check the nature of the roots.
2) Calculate the roots of Quadratic equation.

The users can select the above mentioned options by pressing the number. The program should throw an exception if the user tries to select the invalid option. The program should also handle all the necessary exceptions.

Black Box Testing

Function 1 : isQuadratic(int a, int b, int c)

Causes & Effects

C1: 0 ≤ a ≤ 200

C2: 0 ≤ b ≤ 200

C3: 0 ≤ c ≤ 200

C4: a≠0

E1: Invalid Range

E2: Not a Quadratic Equation

E3: Quadratic Equation

Cause Effect Graph

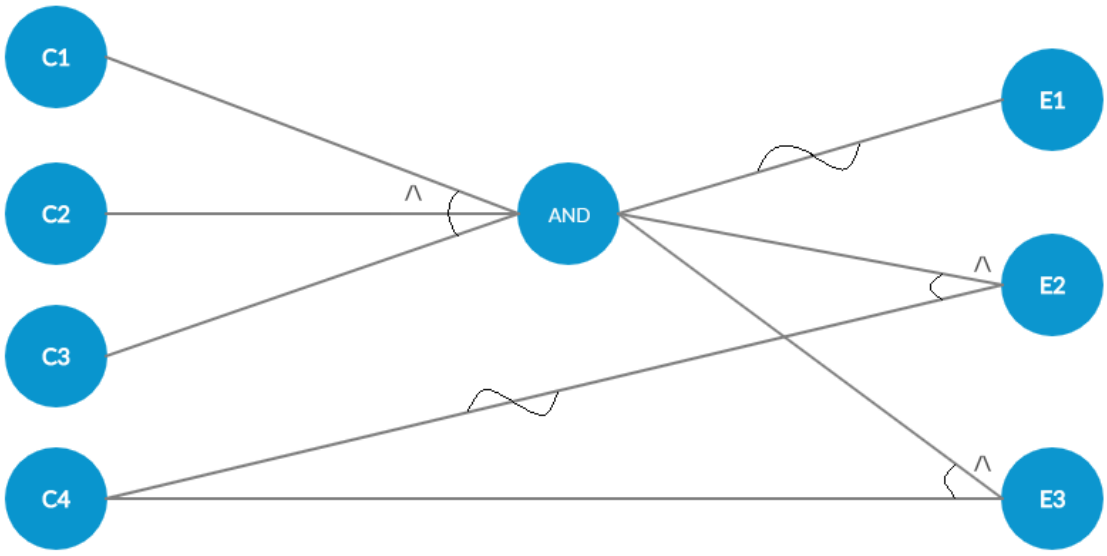

Figure 1: Cause Effect graph of Function 1

Decision Table

Test Cases	T1	T2	T3	T4	T5	T6	T7	T8	T9
C1	0	0	0	0	1	1	1	1	1
C2	0	0	1	1	0	0	1	1	1
C3	0	1	0	1	0	1	0	1	1
C4	-	-	-	-	-	-	-	0	1
E1	1	1	1	1	1	1	1		
E2								1	
E3									1

Test Cases

Test cases	Inputs(Causes)			Expected Output
	a	b	c	(Effects)
1	-1	-1	-1	Invalid Range
2	-1	-1	100	Invalid Range
3	-1	100	-1	Invalid Range
4	-1	100	100	Invalid Range
5	100	-1	-1	Invalid Range
6	100	-1	100	Invalid Range
7	100	100	-1	Invalid Range
8	0	100	100	Not a Quadratic Equation
9	100	100	100	Quadratic Equation

Function 2 : checkRoots(int a, int b, int c)

Causes & Effects

C1: $0 \leq a \leq 200$

C2: $0 \leq b \leq 200$

C3: $0 \leq c \leq 200$

C4: $a \neq 0$

C5: $b^2 - 4ac = 0$

C6: $b^2 - 4ac > 0$

C7: $b^2 - 4ac < 0$

E1: Invalid Range

E2: Not a Quadratic Equation

E3: Real Roots

E4: Equal Roots

E5: Imaginary Roots

Cause Effect Graph

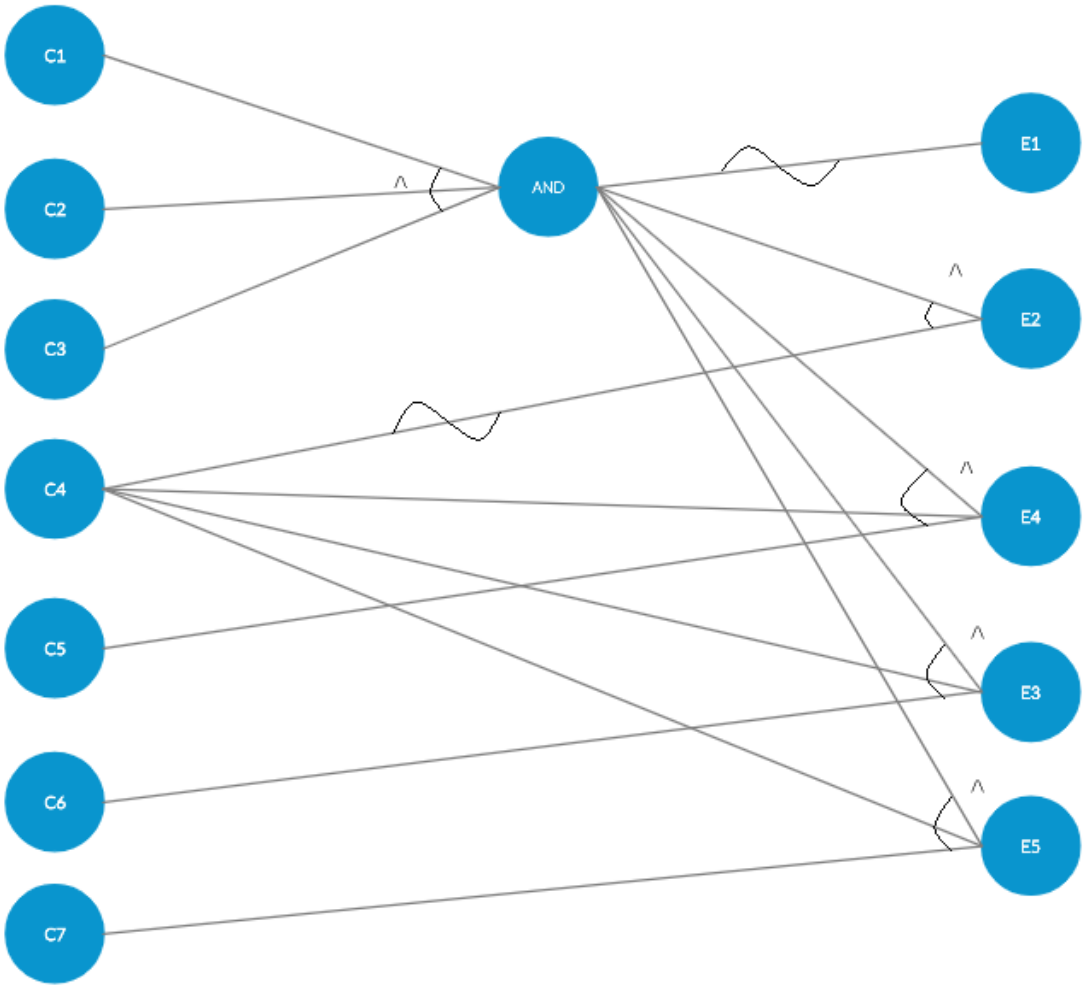

Figure 2: Cause Effect graph of Function 2

Decision Table

Test Cases	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11
C1	0	0	0	0	1	1	1	1	1	1	1
C2	0	0	1	1	0	0	1	1	1	1	1
C3	0	1	0	1	0	1	0	1	1	1	1
C4	-	-	-	-	-	-	-	0	1	1	1
C5	-	-	-	-	-	-	-	-	1	0	0
C6	-	-	-	-	-	-	-	-	-	1	0
C7	-	-	-	-	-	-	-	-	-	-	1
E1	1	1	1	1	1	1	1				
E2								1			
E3										1	
E4									1		

E5											1

Test Cases

Test cases	Inputs(Causes)			Expected Output
	a	b	c	(Effects)
1	-1	-1	-1	Invalid Range
2	-1	-1	100	Invalid Range
3	-1	100	-1	Invalid Range
4	-1	100	100	Invalid Range
5	100	-1	-1	Invalid Range
6	100	-1	100	Invalid Range
7	100	100	-1	Invalid Range
8	0	100	100	Not a Quadratic Equation
9	1	0	0	Equal Roots
10	1	1	0	Real Roots
11	1	1	1	Imaginary Roots

Function 3 : calculateRoots(int a, int b, int c)

Causes & Effects

C1: $0 \leq a \leq 200$

C2: $0 \leq b \leq 200$

C3: $0 \leq c \leq 200$

C4: $a \neq 0$

E1: Invalid Range

E2: Not a Quadratic Equation

E3: Roots Calculated

Cause Effect Graph

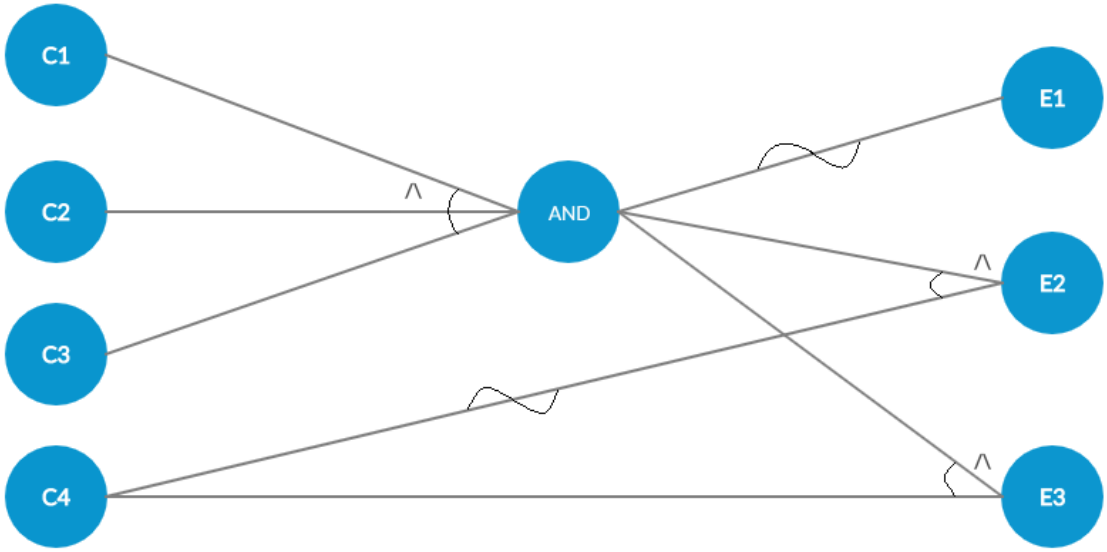

Figure 3: Cause Effect graph of Function 3

Decision Table

Test Cases	T1	T2	T3	T4	T5	T6	T7	T8	T9
C1	0	0	0	0	1	1	1	1	1
C2	0	0	1	1	0	0	1	1	1
C3	0	1	0	1	0	1	0	1	1
C4	-	-	-	-	-	-	-	0	1
E1	1	1	1	1	1	1	1		0
E2								1	0
E3									1

Test Cases

Test cases	Inputs(Causes)			Expected Output
	a	b	c	(Effects)
1	-1	-1	-1	Invalid Range
2	-1	-1	100	Invalid Range
3	-1	100	-1	Invalid Range
4	-1	100	100	Invalid Range
5	100	-1	-1	Invalid Range
6	100	-1	100	Invalid Range
7	100	100	-1	Invalid Range
8	0	100	100	Not a Quadratic Equation
9	1	1	0	X1=0, X2=-1