Programming Fundamentals for Data Science

Laboratory Session 1

2. Define and test 4 functions in Python, which perform the arithmetic operations addition, subtraction, multiplication and division. While implementing the fourth function, avoid division by zero.

Solution:

def add(a, b):

c = a+b

return(c)

def subtract(a, b):

c = a-b

return(c)

def multiply(a, b):

c = a\*b

return(c)

def divide(a, b):

if b != 0:

c = a/b

return c

def divide\_v2(a, b):

try:

c = a / b

except ZeroDivisionError:

print('Division by zero')

3.1. A quadratic equation has the following general formula:

ax2 + bx + c = 0

where a, b and c are the coefficients of the equation

Those equations can have 0, 1 or 2 solutions, which can be calculated by using the following formula:

𝑥1,2=−𝑏±√𝑏2−4𝑎𝑐2𝑎

Write a Python script, which reads the coefficients of a quadratic equation and calculates the solutions. Provide meaningful user input and output.

Solution:

import math

a = int(input('a='))

b = int(input('b='))

c = int(input('c='))

x1 = (-b+math.sqrt(b\*b-4\*a\*c))/(2\*a)

x2 = (-b-math.sqrt(b\*b-4\*a\*c))/(2\*a)

print('x1 =', x1)

print('x2 =', x2)

3.2. Explain what will happen if the discriminant, that is the expression under the square root

b2-4ac, is equal to zero. Demonstrate such case.

Answer:

In this case X1=X2, the quadratic equation will have only one solution, also called repeated or double root.

This case can be demonstrated by the above script with a=2, b=4, c=2 or any coefficients which solve the equation:

b2 - 4ac = 0

3.3. If unchecked, in case of a negative discriminant the script will generate an error, for example with coefficients a=10, b=5, c=6. Explain why and provide a solution.

Answer: As a mathematical operation, square root is not defined for negative real numbers. That is why, the 'sqrt' function will generate an error and the script will terminate. The solution is to use IF statement and proceed with the script only if the discriminant (b2-4ac) is non-negative.

Solution:

import math

a = int(input('a='))

b = int(input('b='))

c = int(input('c='))

d = b\*b-4\*a\*c

if d >= 0:

x1 = (-b+math.sqrt(b\*b-4\*a\*c))/(2\*a)

x2 = (-b-math.sqrt(b\*b-4\*a\*c))/(2\*a)

print('x1 =', x1)

print('x2 =', x2)

else:

print('No real solutions')

3.4. The script will also generate an error if a=0. Explain why and provide a solution.

Answer: If a=0 the script will attempt to divide by zero, which is not possible. In this case, the script will generate an error and terminate. A possible solution is to check the value of the coefficient 'a' by adding a second IF statement. The first IF statement will be nested within the second one. If a=0 the script will notify the user and will not attempt to solve the equation.

Solution:

import math

a = int(input('a='))

b = int(input('b='))

c = int(input('c='))

d = b\*b-4\*a\*c

if a == 0:

print('Not a quadratic equation')

else:

if d >= 0:

x1 = (-b+math.sqrt(b\*b-4\*a\*c))/(2\*a)

x2 = (-b-math.sqrt(b\*b-4\*a\*c))/(2\*a)

print('x1 =', x1)

print('x2 =', x2)

else:

print('No real solutions')

3.5. The two possible problems with the quadratic equation, negative discriminant and first coefficient equals to zero, can be avoided by using one IF statement, starting as follows:

if a == 0 or d < 0:

print('Error')

else:

...

Implement this approach and describe a possible issue with it.

Answer:

If the discriminant is negative, then the quadratic equation does not have real solutions. On the other hand, if the first coefficient is equal to 0, then the equation is not a quadratic but linear and the formula for quadratic equations cannot be applied due to division by 0. In case of one IF statement, these two different problems will be reported with a single less informative message, for example 'Error'.

Solution:

import math

a = int(input('a='))

b = int(input('b='))

c = int(input('c='))

d = b\*b-4\*a\*c

if a == 0 or d < 0:

print('Error')

else:

x1 = (-b+math.sqrt(b\*b-4\*a\*c))/(2\*a)

x2 = (-b-math.sqrt(b\*b-4\*a\*c))/(2\*a)

print('x1 =', x1)

print('x2 =', x2)