

# **Find the Roots**

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# Topics

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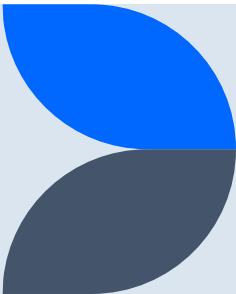
Future Improvements

# Introduction

After taking a week to complete Code First Girls' Kickstarter Python course one week ago, I wrote "Finding the Roots" as my first Python project.

It is a lesson to teach my son how to find the roots of a quadratic equation ( $ax^2 + bx + c = 0$ ) using the quadratic formula:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$



# Lesson Structure

1

## Student Profile Registration

The code records the name, year group and school of the student doing the lesson.

2

## Theory Lesson

The code runs through the theory by printing out the rules and steps to solve quadratic equations.

3

## Quiz

The code gives the option to the student to do a quiz with 8 questions.

4

## Quiz Feedback

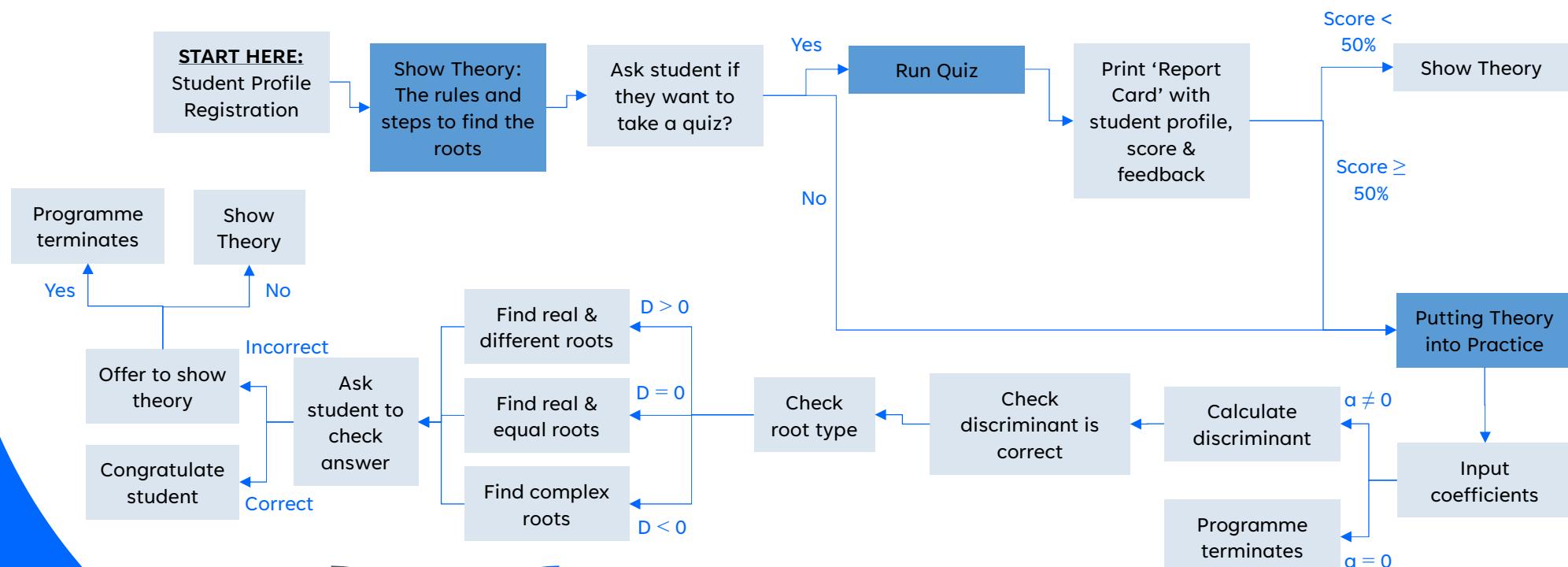
The student's score and feedback will be given. If the student scores less than half correct, the student will be given the option to reread the theory notes again.

5

## Putting Theory into Practice

The student enters the coefficients. The code walks them through the steps of solving the equation. Intermittently, the student's working is checked. If the final answer is incorrect, the student is given the option to review the theory notes.

# Code Structure



# Output: Theory Notes

```
\=====
      LESSON
      Finding the roots of a quadratic equation
\=====//
```

Create student profile for this lesson:  
What is your name? Jo Sep  
What year group are you in school? 8  
What is the name of your school? Riverview School

```
\=====
      THEORY NOTES
      Finding the roots of a quadratic equation
\=====//
```

For the equation,  
$$ax^{**2} + bx + c = 0$$
  
You can determine one or two possible values of x (roots).  
NOTE: a must not equal 0

.....

The quadratic formula below can be used to find the roots  
$$x = [-b + \sqrt{b^{**2} - 4ac}] / (2a)$$
  
or      
$$x = [-b - \sqrt{b^{**2} - 4ac}] / (2a)$$

.....

In the above formula,  $(b^{**2} - 4ac)$  is known as the discriminant

There are 3 types of roots based on the discriminant value:

1. When discriminant > 0, the roots are real and different
2. When discriminant = 0, the roots are real and equal (the same)
3. When discriminant < 0, the roots are complex and different

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# Output: Quiz (7 out of 8 score)

Would you like to start with a quiz on the theory (yes/no?): yes

=====

Theory Quiz

=====

Q1: What do you call a, b or c?

- (a) coefficient
- (b) variable
- (c) letter

Enter you answer here (a/b/c): a

Correct!

Q2: What type of number should a, b and c (in the quadratic equation) be?

- (a) complex number
- (b) boolean
- (c) real number

Enter you answer here (a/b/c): c

Correct!

Q3: What should a not equal to?

- (a) negative number
- (b) zero
- (c) complex number

Enter you answer here (a/b/c): b

Correct!

Q4: What do you call the term,  $(b^{**2} - 4ac)$ ?

- (a) unknown
- (b) square root term
- (c) discriminant

Enter you answer here (a/b/c): a

Incorrect. Take note that the correct answer is: c

Q5: How many cases should we consider for the discriminant?

- (a) 3
- (b) 0
- (c) 2

Enter you answer here (a/b/c): a

Correct!

Q6: When discriminant  $> 0$ , the roots should be:

- (a) real and equal
- (b) real and different
- (c) complex and different

Enter you answer here (a/b/c): b

Correct!

Q7: When discriminant  $= 0$ , the roots should be:

- (a) real and equal
- (b) real and different
- (c) complex and equal

Enter you answer here (a/b/c): a

Correct!

Q8: When discriminant  $< 0$ , the root should be:

- (a) complex
- (b) real and different
- (c) real and equal

Enter you answer here (a/b/c): a

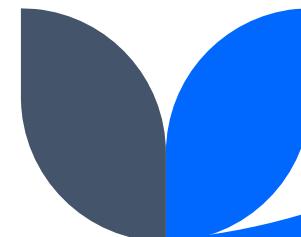
Correct!

Report card for the following student:

```
{'student_name': 'Jo Sep', 'student_year_group': '8', 'student_school': 'Riverview School'}
```

Jo Sep's score: 7 out of 8.

Almost perfect!



# Output: Quiz (3 out of 8 score)

Would you like to start with a quiz on the theory (yes/no?): yes

=====

## Theory Quiz

=====

Q1: What do you call a, b or c?

- (a) coefficient    (b) variable    (c) letter

Enter you answer here (a/b/c): a

Correct!

Q2: What type of number should a, b and c (in the quadratic equation) be?

- (a) complex number    (b) boolean    (c) real number

Enter you answer here (a/b/c): c

Correct!

Q3: What should a not equal to?

- (a) negative number    (b) zero    (c) complex number

Enter you answer here (a/b/c): b

Correct!

Q4: What do you call the term,  $(b^{**2} - 4ac)$ ?

- (a) unknown    (b) square root term    (c) discriminant

Enter you answer here (a/b/c): a

Incorrect. Take note that the correct answer is: c

Q5: How many cases should we consider for the discriminant?

- (a) 3    (b) 0    (c) 2

Enter you answer here (a/b/c): b

Incorrect. Take note that the correct answer is: a

Q6: When discriminant  $> 0$ , the roots should be:

- (a) real and equal    (b) real and different    (c) complex and different

Enter you answer here (a/b/c): c

Incorrect. Take note that the correct answer is: b

Q7: When discriminant  $= 0$ , the roots should be:

- (a) real and equal    (b) real and different    (c) complex and equal

Enter you answer here (a/b/c): b

Incorrect. Take note that the correct answer is: a

Q8: When discriminant  $< 0$ , the root should be:

- (a) complex    (b) real and different    (c) real and equal

Enter you answer here (a/b/c): c

Incorrect. Take note that the correct answer is: a

Report card for the following student:

{'student\_name': 'Jo Sep', 'student\_year\_group': '9', 'student\_school': 'Riveriaview School'}

Jo Sep's score: 3 out of 8.

Best to revise this topic again. Here are the notes:

\=====

## THEORY NOTES

Finding the roots of a quadratic equation

\=====

For the equation,

$$ax^{**2} + bx + c = 0$$

You can determine one or two possible values of x (roots).

NOTE: a must not equal 0

.....

The quadratic formula below can be used to find the roots

$$x = [-b + \sqrt{b^{**2} - 4ac}] / (2a)$$

$$\text{or } x = [-b - \sqrt{b^{**2} - 4ac}] / (2a)$$

.....

In the above formula,  $(b^{**2} - 4ac)$  is known as the discriminant

There are 3 types of roots based on the discriminant value:

1. When discriminant  $> 0$ , the roots are real and different
2. When discriminant  $= 0$ , the roots are real and equal (the same)
3. When discriminant  $< 0$ , the roots are complex and different

.....

# Output: Putting Theory into Practice

## Discriminant > 0 (Real and Different Roots)

```
=====
EXERCISE
Putting theory into practice
=====
Let's try finding the roots of a quadratic equation now.
Please enter a: 1
Please enter b: 5
Please enter c: 6

First, calculate the discriminant. You have 5 seconds ...
What value was your discriminant? 1
Correct! The discriminant = 1.0

What type of roots should the solution have?
(a) Real and different    (b) Real and equal    (c) Complex or not real
Please enter your answer as a, b or c here: a
That is correct.

Discriminant > 0. Therefore roots will be real and different.

Please calculate the roots now. You have 15 seconds before the answers appear ...
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
The roots are -2.0 and -3.0.

Did you calculate the roots correctly? Answer yes/no: yes
<<<< WELL DONE! >>>>
You can rerun the programme to solve different quadratic equations.
```

# Output: Putting Theory into Practice

## Discriminant = 0 (Real and Equal Roots)

```
Would you like to start with a quiz on the theory (yes/no?): no
Okay. We will skip the quiz.

=====
EXERCISE
Putting theory into practice
=====
Let's try finding the roots of a quadratic equation now.
Please enter a: 1
Please enter b: -4
Please enter c: 4

First, calculate the discriminant. You have 5 seconds ...
What value was your discriminant? 0
Correct! The discriminant = 0.0

What type of roots should the solution have?
(a) Real and different    (b) Real and equal    (c) Complex or not real
Please enter your answer as a, b or c here: b
That is correct.

Discriminant = 0. Therefore roots will be real and the same.

Please calculate the roots now. You have 15 seconds before the answers appear ...
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
The roots are both = 2.0.

Did you calculate the roots correctly? Answer yes/no: yes
<<<< WELL DONE! >>>>
You can rerun the programme to solve different quadratic equations.
```

# Output: Putting Theory into Practice

## Discriminant < 0 (Complex Roots)

Would you like to start with a quiz on the theory (yes/no?): no  
Okay. We will skip the quiz.

=====

### EXERCISE

#### Putting theory into practice

=====

Let's try finding the roots of a quadratic equation now.

Please enter a: 5

Please enter b: 2

Please enter c: 1

First, calculate the discriminant. You have 5 seconds ...

What value was your discriminant? 10

Incorrect. Please recalculate using the formula  $(b^{**2} - 4ac)$ .

The correct discriminant = -16.0.

What type of roots should the solution have?

- (a) Real and different    (b) Real and equal    (c) Complex or not real

Please enter your answer as a, b or c here: a

That is incorrect.

Discriminant < 0. The roots are complex or not real numbers.

Please calculate the roots now. You have 15 seconds before the answers appear ...

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

The first root = -0.2 + 0.4i

The second root = -0.2 - 0.4i

Did you calculate the roots correctly? Answer yes/no: no

That's a shame. Remember to use the formula to find the roots of the quadratic equations:

$$x = [-b + \sqrt{b^{**2} - 4ac}] / (2a)$$

or  $x = [-b - \sqrt{b^{**2} - 4ac}] / (2a)$

Would you like to reread the theory notes of how to solve quadratic equations? Answer yes/no: yes  
\\=====//

### THEORY NOTES

#### Finding the roots of a quadratic equation

\\=====//

For the equation,

$$ax^{**2} + bx + c = 0$$

You can determine one or two possible values of x (roots).

NOTE: a must not equal 0

.....

The quadratic formula below can be used to find the roots

$$x = [-b + \sqrt{b^{**2} - 4ac}] / (2a)$$

or  $x = [-b - \sqrt{b^{**2} - 4ac}] / (2a)$

In the above formula,  $(b^{**2} - 4ac)$  is known as the discriminant

There are 3 types of roots based on the discriminant value:

1. When discriminant > 0, the roots are real and different
2. When discriminant = 0, the roots are real and equal (the same)
3. When discriminant < 0, the roots are complex and different

# Future Improvements

- Create a function to deal with responses that are not the correct data type or responses that are not valid
- Create a function to show how to solve for complex roots
- Organise functions in a more logical manner
- Create another function or use lists to make the code in the ‘Quiz’ function more efficient
- Create output with dialog boxes and/or graphics to improve readability
- Create another section in the lesson called, ‘Activity Sheet’ with practice questions to solve 10 quadratic equations