

Quadratics Coding

In this file we will use Java's mathematical operators to calculate the roots of a polynomial using the quadratic formula. Recall that if we have:

$$ax^2 + bx + c = 0$$

then the roots of the equation are given by:

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

Getting ready for you file

- Generate quadratic equations with answers, using the first formula given above
- Go to <https://scratch.mit.edu/projects/17278258/>
Accessed 20171111
- Use the Scratch file to generate Quadratics with roots

Example Quadratics (Space for you to record your work)

$$ax^2 + bx + c = 0$$

$$\underline{\hspace{1cm}}x^2 + \underline{\hspace{1cm}}x + \underline{\hspace{1cm}} = 0$$

$$x = \underline{\hspace{1cm}}, \underline{\hspace{1cm}}$$

$$ax^2 + bx + c = 0$$

$$\underline{\hspace{1cm}}x^2 + \underline{\hspace{1cm}}x + \underline{\hspace{1cm}} = 0$$

$$x = \underline{\hspace{1cm}}, \underline{\hspace{1cm}}$$

Getting Ready for this program: functions given in context below

Specs for your Program

- declare, initialize, & assign three integer variables to represent a quadratic equation (above)
see the example output of this problem for an example to start with
- another unique part of the equation is “division by $2a$ ”
error check if $a = 0$
the equation is a straight line, not a quadratic
also $2 \times 0 = 0$
ensure the identifying text explains this estimating
- $\sqrt{b^2 - 4ac}$ is called the discriminant and is used to estimate the roots, like error checking
notice the a -variable is here already error checked for zero
calculate the value of $b^2 - 4ac$ before taking the square root
output the value to the console using the following branching options and `println()`
a positive value means there are 2 positive roots, real numbers
a zero value means there is one root
a negative value means there is a complex root
- calculate the square root of the discriminant using `math.sqrt()`, returns the square root
example `math.sqrt(9) = 3`
note: this class and method exists in automatically loaded package `java.lang`
- calculate and output the first root of the equation using the quadratic formula
- calculate and output the second root of the equation using the quadratic formula

When outputting calculated numbers, throw the following exceptions for mathematical calculation errors

- NaN for a negative for the discriminant
- NaN for division by zero

Example error-checking message

- “Sorry, your discriminant is negative. We cannot process imaginary roots right now.”

Caution: $a=1$, $b=1$, $c=1$, will return a negative discriminant

All exceptions need to be recorded in the Javadoc comments

Example Output (answers depend on variables a, b, & c)

The quadratic being calculated is $1x^2 + -2x + -15$

OR, $x^2 - 2x - 15$

The number of estimated roots is two real is numbers.

The first root is $x = -5$.

The second root $x = 3$.

Bonus Marks: comparing floating-point numbers (p65 of Baron's)

- $|x - y| \leq \epsilon \max(|x|, |y|)$
- Use it to compare floating-point numbers since these are not stored exactly
- To review how to use this equation, see Baron's or find examples on the Internet by searching for comparing decimal's machine precision
- "The magnitude of the difference between the numbers is less than the machine precision"
- ϵ denotes machine precision
- $\epsilon = 10^{-16}$
-

Comments to include

- Does the a-variable need to be error-checked for zero in $b^2 - 4ac$? Will this produce a NaN?
- In this equation, casting is not needed.
What happens with type matching when int and double are included in the same calculation?
Explain why casting is not needed and an exception is not thrown.
- Rounding Happens with ints and doubles
When is an answer truncated to an integer?
When is an answer rounded to specific significant digits?
- Explain why an entire equation, when casted as a double, is rounded to 0.0?
Also explain why the answer is not "0"?
Example: (double) (3/4)
- Explain the precedent (order of operations) of the following
Casting
Multiple Parenthesis
Multiplication and Division, including modulus & negatives
Adding and Subtracting
Hint: use the words "left", "right", "first", "then"
Example to explain: $9 + (\text{double}) 6.2 / 3 * 7 - 10 \% -5$
- When using inequalities combining ints and doubles, casting is not needed
Explain what is happening
- Inequalities should be limited to _____.
- Name two other comparing methods.
- What is the name of the exception thrown if "division by zero" happens?

Example Combining Ideas

```
if (divisor) == 0) {  
    throw new _____ ("Cannot divide by zero");  
} else {  
    int a = IO.readInt(); //read user input
```

```
public void setRadius (int newRadius) {  
    if (newRadius < 0) {  
        throw new IllegalArgumentException ("Radius cannot be negative");  
    } else {  
        Radius = newRadius  
    }  
}
```

Case Study Space**Extra-Credit Reading**

- Create and solve a few quadratic equations
- Use an online calculator that explains its steps to do this, remind you how to do this