

# Solving a quadratic equation

## a case study

Steven Hurder

University of Illinois at Chicago  
[www.math.uic.edu/~hurder](http://www.math.uic.edu/~hurder)

Math 589 Presentation – October 30, 2007

## ① The Problem

## ② Picturing the Solution

## ③ Some Algebra

## ④ The Formula

## A pesky problem

Your paycheck has been held up, and they keep asking,  
“Are you really a mathematician?”

## A pesky problem

Your paycheck has been held up, and they keep asking,  
“Are you really a mathematician?”

How to convince them?

## A pesky problem

Your paycheck has been held up, and they keep asking,  
“Are you really a mathematician?”

How to convince them?

What to do?

## A pesky problem

Your paycheck has been held up, and they keep asking,  
“Are you really a mathematician?”

How to convince them?

What to do?

And then the idea hits you - you'll show them you can solve a  
quadratic equation!

## A pesky problem

Your paycheck has been held up, and they keep asking,  
“Are you really a mathematician?”

How to convince them?

What to do?

And then the idea hits you - you'll show them you can solve a  
quadratic equation!

If that doesn't convince the admin type, what will?

# Choosing a quadratic equation

Now, it is only a matter to select a quadratic equation which will impress them.



# Choosing a quadratic equation

Now, it is only a matter to select a quadratic equation which will impress them.

①  $x^2 = 0$

# Choosing a quadratic equation

Now, it is only a matter to select a quadratic equation which will impress them.

- 1  $x^2 = 0$  (nah, too obvious. it would be shameful if this worked)

# Choosing a quadratic equation

Now, it is only a matter to select a quadratic equation which will impress them.

- ①  $x^2 = 0$  (nah, too obvious. it would be shameful if this worked)
- ②  $x^2 - 2x + 1 = 0$

# Choosing a quadratic equation

Now, it is only a matter to select a quadratic equation which will impress them.

- ①  $x^2 = 0$  (nah, too obvious. it would be shameful if this worked)
- ②  $x^2 - 2x + 1 = 0$  (more of the same)

# Choosing a quadratic equation

Now, it is only a matter to select a quadratic equation which will impress them.

- ①  $x^2 = 0$  (nah, too obvious. it would be shameful if this worked)
- ②  $x^2 - 2x + 1 = 0$  (more of the same)
- ③  $x^2 - 3x - 1 = 0$

## Choosing a quadratic equation

Now, it is only a matter to select a quadratic equation which will impress them.

- ①  $x^2 = 0$  (nah, too obvious. it would be shameful if this worked)
- ②  $x^2 - 2x + 1 = 0$  (more of the same)
- ③  $x^2 - 3x - 1 = 0$  (sort of fancy... just right!)

## Grab your calculators:

A picture may be worth a thousand words, but is it worth a thousand bucks?

## Grab your calculators:

A picture may be worth a thousand words, but is it worth a thousand bucks?

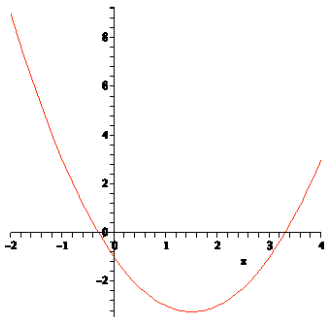
Let's try! If they buy this, we are done. So plot  $y = x^2 - 3x - 1$



## Grab your calculators:

A picture may be worth a thousand words, but is it worth a thousand bucks?

Let's try! If they buy this, we are done. So plot  $y = x^2 - 3x - 1$



## Not even close...

“You want money for your one lousy graph?”

## Not even close...

“You want money for your one lousy graph?”

“Give the solution to 10 decimals, and we’ll show you the money!”

## Not even close...

“You want money for your one lousy graph?”

“Give the solution to 10 decimals, and we’ll show you the money!”

“Oh, for @#%& sake!”

# factor, factor, complete...

$$0 = x^2 - 3x - 1$$

# factor, factor, complete...

$$0 = x^2 - 3x - 1$$

$$0 = x^2 - 3x + (-3/2)^2 - (3/2)^2 - 1$$

# factor, factor, complete...

$$0 = x^2 - 3x - 1$$

$$0 = x^2 - 3x + (-3/2)^2 - (3/2)^2 - 1$$

$$0 = (x - 3/2)^2 - 9/4 - 4/4$$

# factor, factor, complete...

$$0 = x^2 - 3x - 1$$

$$0 = x^2 - 3x + (-3/2)^2 - (3/2)^2 - 1$$

$$0 = (x - 3/2)^2 - 9/4 - 4/4$$

$$0 = (x - 3/2)^2 - 13/4$$



# Progress

Now let's solve it:

$$0 = (x - 3/2)^2 - 9/4 - 4/4 \implies (x - 3/2)^2 = 13/4$$

# Progress

Now let's solve it:

$$\begin{aligned}0 &= (x - 3/2)^2 - 9/4 - 4/4 &\implies & (x - 3/2)^2 = 13/4 \\ & &\implies & (x - 3/2) = \pm\sqrt{13/4}\end{aligned}$$

# Progress

Now let's solve it:

$$\begin{aligned}0 &= (x - 3/2)^2 - 9/4 - 4/4 &\implies & (x - 3/2)^2 = 13/4 \\ & &\implies & (x - 3/2) = \pm\sqrt{13/4} \\ & &\implies & x = 3/2 \pm \sqrt{13/4}\end{aligned}$$

## Progress

Now let's solve it:

$$\begin{aligned}0 &= (x - 3/2)^2 - 9/4 - 4/4 &\implies (x - 3/2)^2 &= 13/4 \\ & &\implies (x - 3/2) &= \pm\sqrt{13/4} \\ & &\implies x &= 3/2 \pm \sqrt{13/4}\end{aligned}$$

Think this is enough to get the money?

# Progress

Now let's solve it:

$$\begin{aligned}0 &= (x - 3/2)^2 - 9/4 - 4/4 &\implies & (x - 3/2)^2 = 13/4 \\ & &\implies & (x - 3/2) = \pm\sqrt{13/4} \\ & &\implies & x = 3/2 \pm \sqrt{13/4}\end{aligned}$$

Think this is enough to get the money?

Not likely...

# Pay Up!

There are two solutions:

# Pay Up!

There are two solutions:

$$x = 3/2 + \sqrt{13/4}, \text{ or}$$

$$x = 3.302775637731994646559610633735247973125648286922623$$

# Pay Up!

There are two solutions:

$$x = 3/2 + \sqrt{13/4}, \text{ or}$$

$$x = 3.302775637731994646559610633735247973125648286922623$$

and  $x = 3/2 - \sqrt{13/4}, \text{ or}$

$$x = -0.3027756377319946465596106337352479731256482869226$$



# Mathematical Proof

The final proof that we are Mathematicians?

# Mathematical Proof

The final proof that we are Mathematicians?

Give them the Magic Formula,

$$ax^2 + bx + c = 0 \implies x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

# Mathematical Proof

The final proof that we are Mathematicians?

Give them the Magic Formula,

$$ax^2 + bx + c = 0 \implies x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

and tell them to try this first next time...