3. Introduction to Conditionals

Boolean expressions

The If-Else Construct

And, or, not

What We Cannot Do So Far

We don't know how to make a computation depend upon a condition.

IF the value of the arithmetic expression **`Dice1 + Dice2`** is 7, THEN increase the value of **`GamesWon`** by 1.

The If-Else Construct Solves this Problem

We introduce this language feature while considering the behavior of a quadratic function

$$q(x) = x^2 + bx + c$$

on a given interval L <= x <= R.

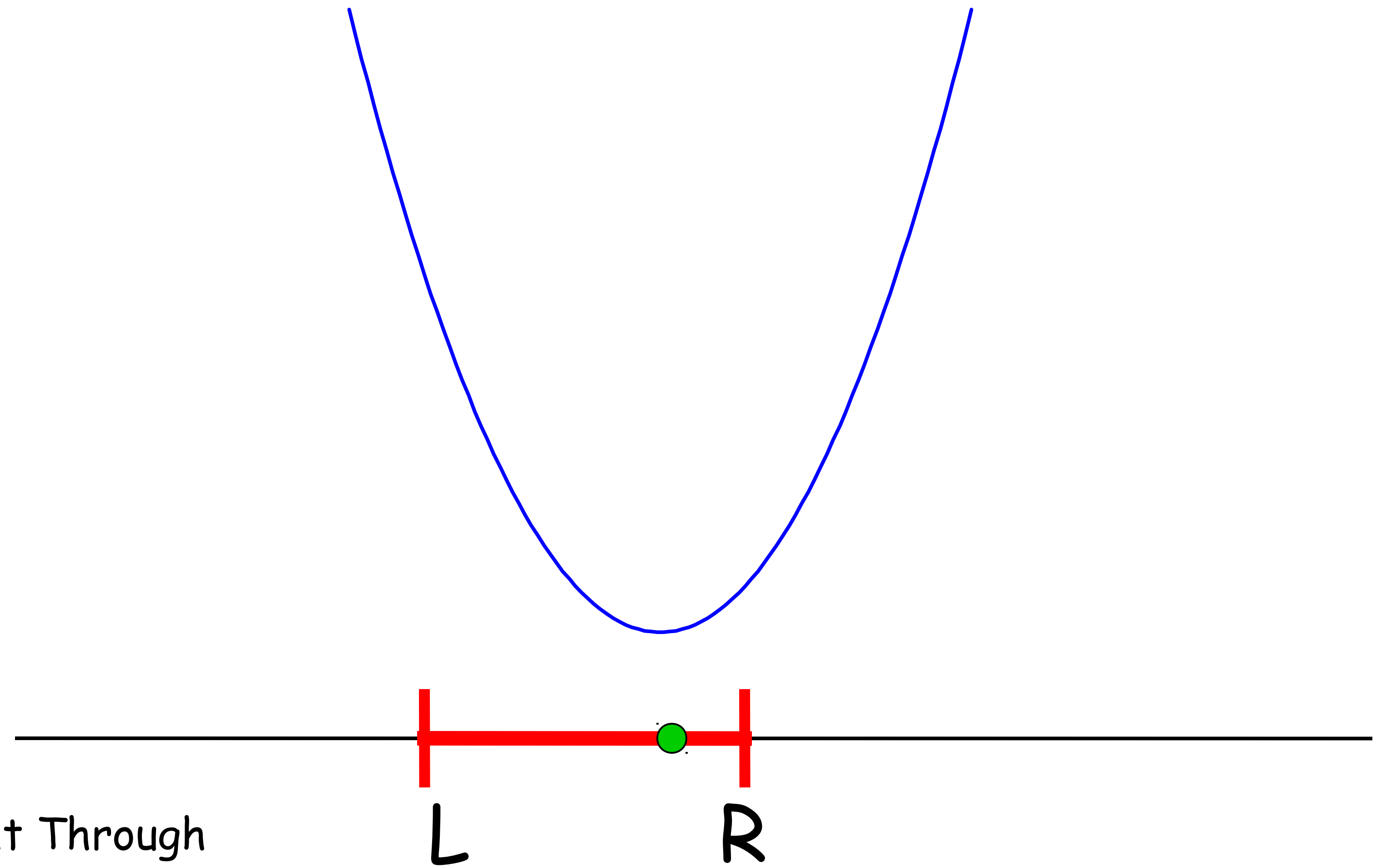
Assume Variables
`b,c,L,R`
are Initialized

```
b = input('Enter b':)
c = input('Enter c':)
L = input('Enter L':)
R = input('Enter R':)
```

The Situation

$$q(x) = x^2 + bx + c$$

$$x_c = -b/2$$



Problem 1

Because the coefficient of x^2 is 1, the parabola always has the same shape (down, then up).

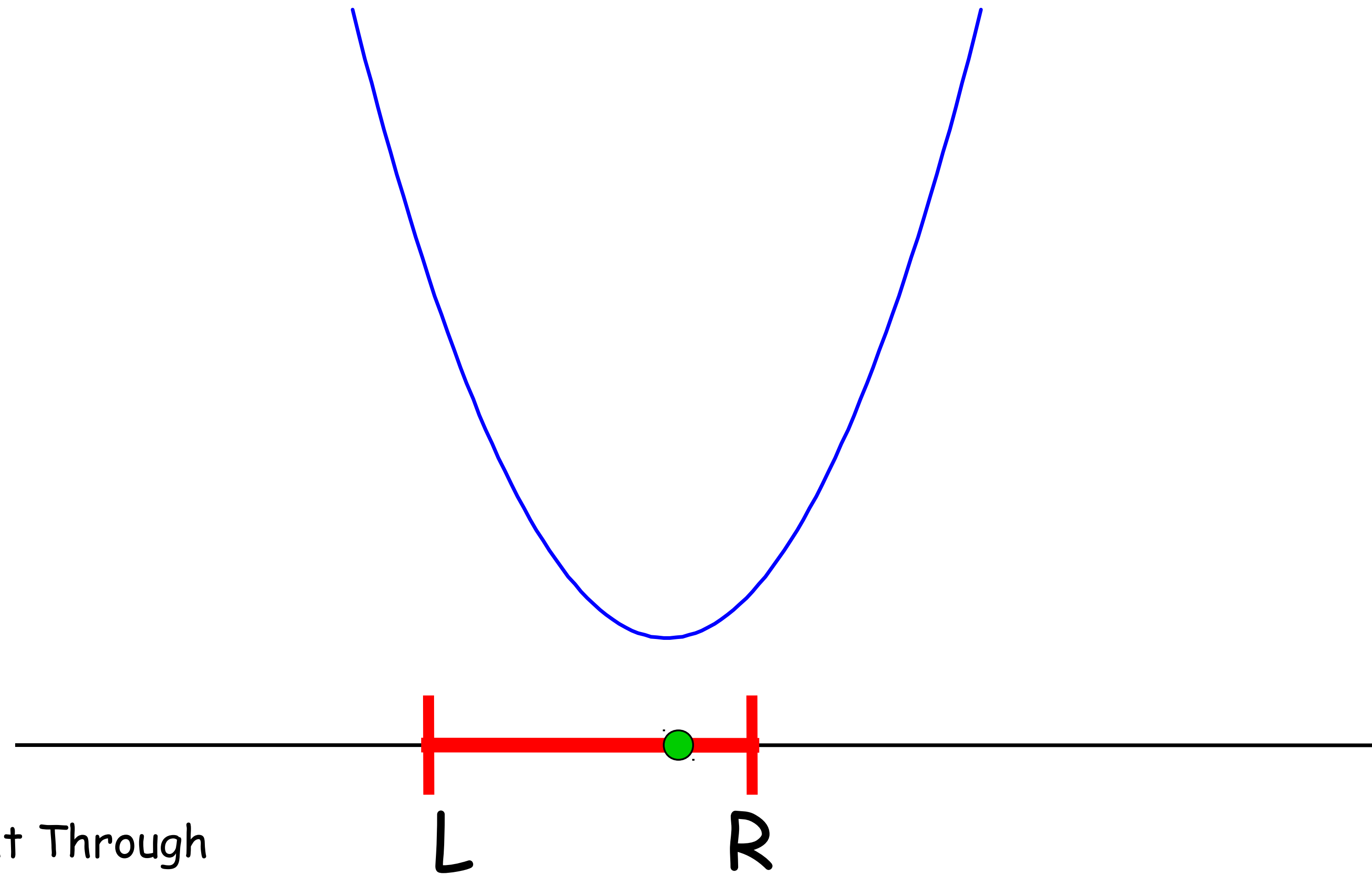
Its low point occurs at x=-b/2.

Over the interval [L,R], does the parabola only go up (increasing)?

No!

$$q(x) = x^2 + bx + c$$

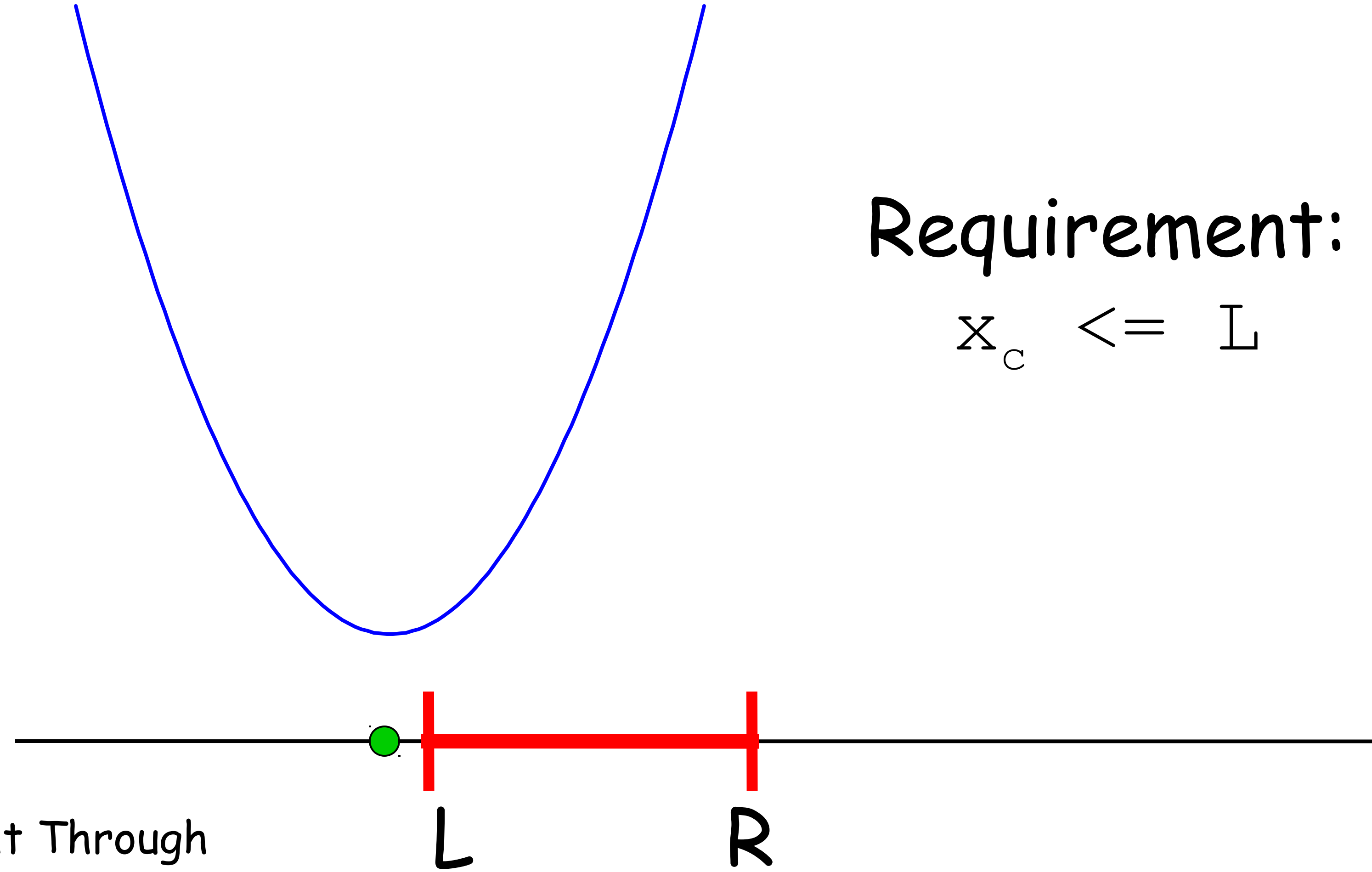
$x_c = -b/2$



Yes!

$$q(x) = x^2 + bx + c$$

• $x_c = -b/2$



Requirement:

$x_c <= L$

Solution Fragment

```
xc = -b/2;
if ( xc <= L )
   disp('Yes')
else
   disp('No')
end
```

Problem 2

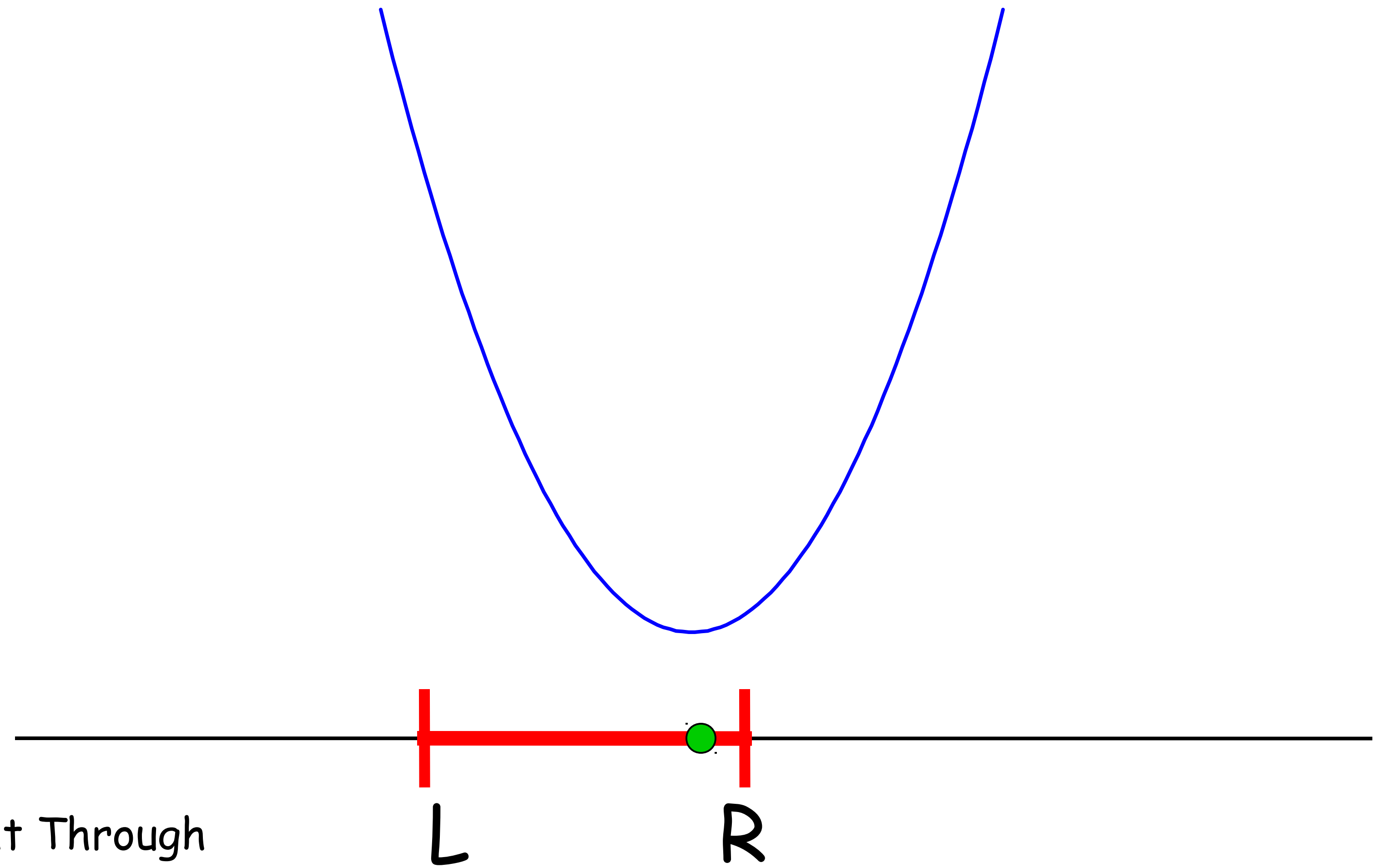
Can we determine the maximum value that the quadratic function reaches for any x in the interval [L,R]?

(There are two ways to answer this question!)

Maximum at L

$$q(x) = x^2 + bx + c$$

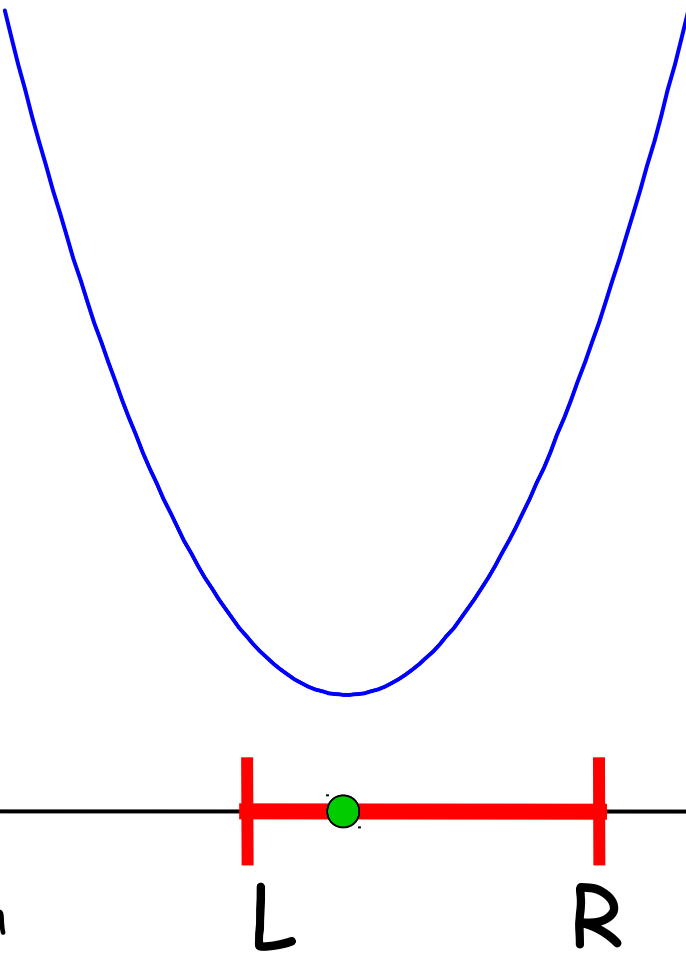
$$x_c = -b/2$$



Maximum at R

$$q(x) = x^2 + bx + c$$

$x_c = -b/2$



Depends on whether xc is to the right or left of the interval midpoint.

Solution Fragment

```
xc = -b/2;
Mid = (L+R)/2;
if ( xc <= Mid )
    maxVal = R^2 + b*R + c
else
    maxVal = L^2 + b*L + c
end
```

Problem 3

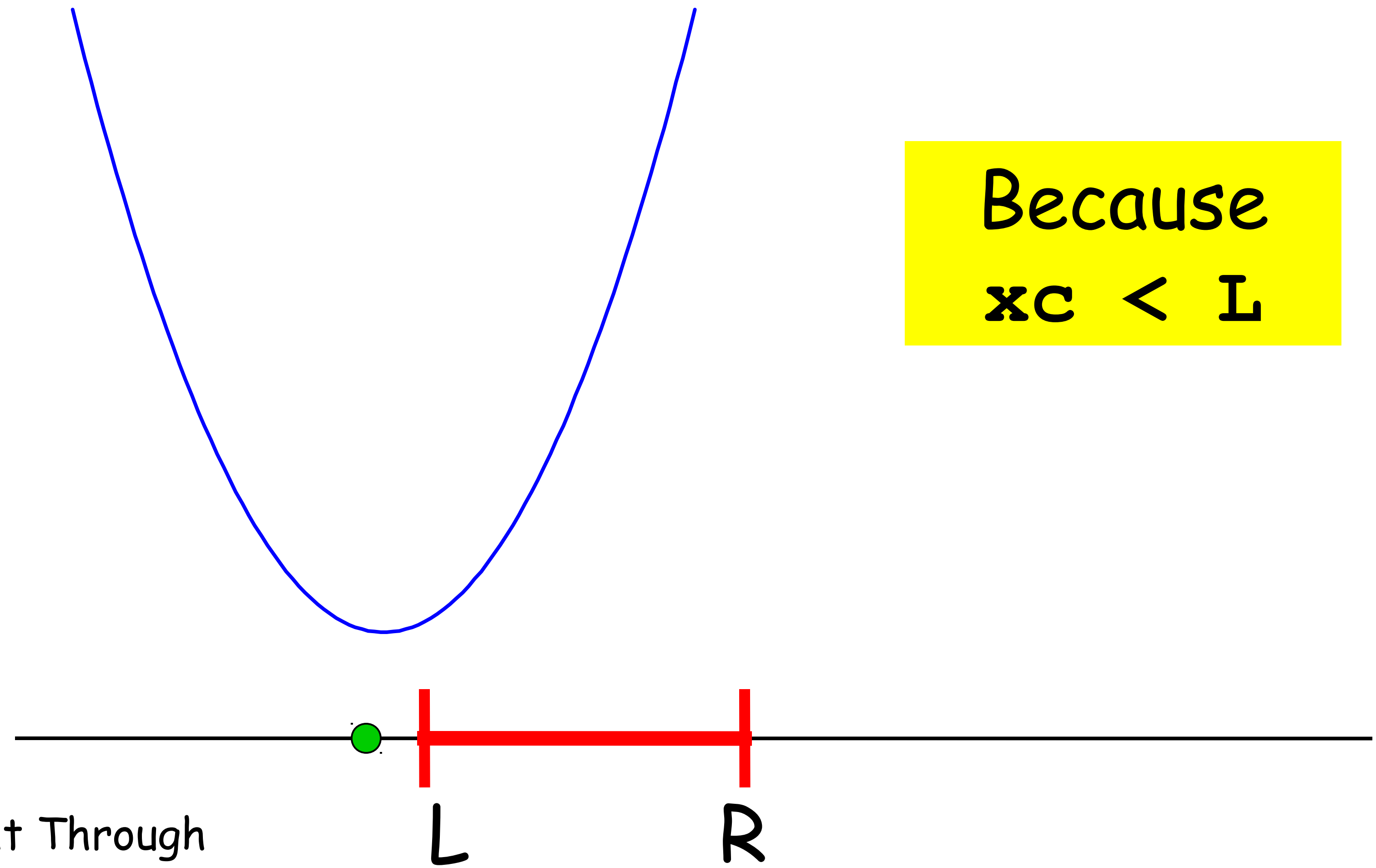
Can we report whether the point xc is in the interval [L,R]?

(Harder question: can we report the minimum value of the quadratic function in [L,R]?)

No!

$$q(x) = x^2 + bx + c$$

$x_c = -b/2$



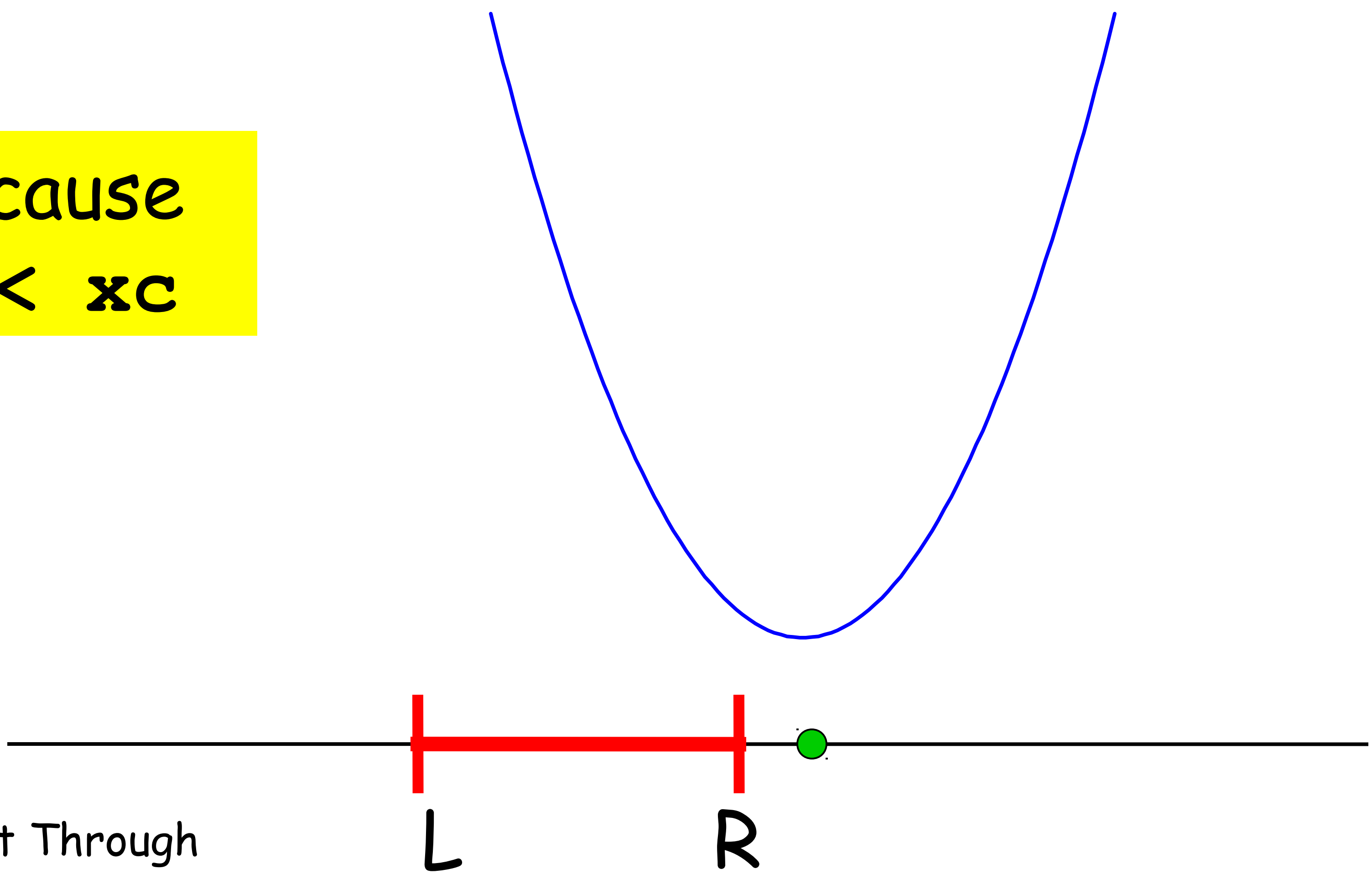
Because
`xc < L`

No!

$$q(x) = x^2 + bx + c$$

$$x_c = -b/2$$

Because
`R < xc`

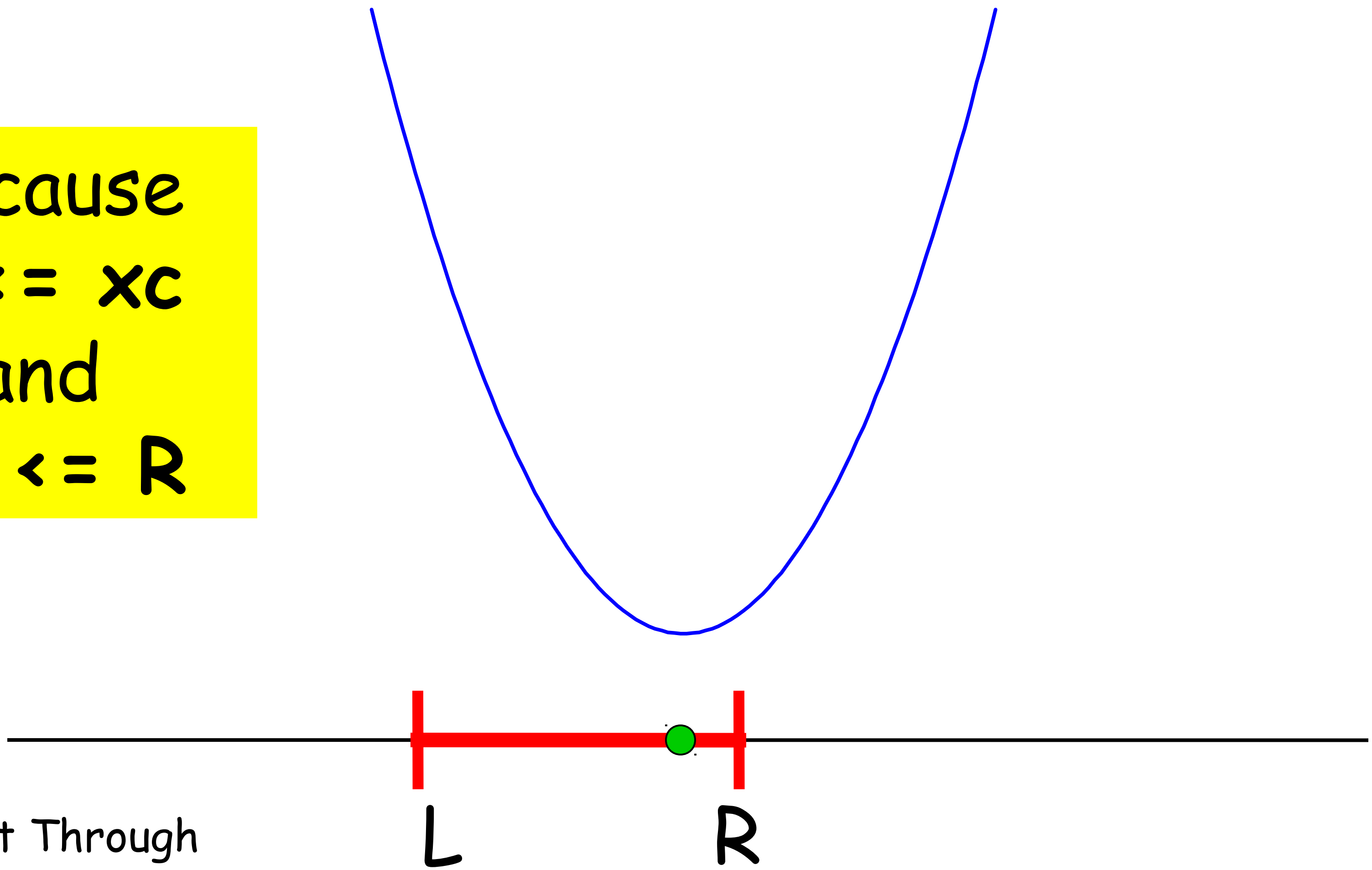


Yes!

$$q(x) = x^2 + bx + c$$

$$x_c = -b/2$$

Because
L <= xc
and
xc <= R



Solution Fragment

```
xc = -b/2;
if (L <= xc) && (xc <= R)
    disp('Yes')
else
    disp('No')
end
```

Legal Math, Illegal MATLAB: `L <= xc <= R`

Saying the Opposite

xc is in the interval [L,R] if

`L <= xc` and `xc <= R`

xc is not in the interval [L,R] if

`xc < L` or `R < xc`

Another Solution

```
xc = -b/2;
if (xc < L) || (R < xc)
   disp('No')
else
   disp('Yes')
end
```

The `if-else` Construct

```
if    boolean expression

        Commands to execute if the
             expression if TRUE

else
        Commands to execute if the
             expression if FALSE

end
```

Boolean Expressions

```
(xc < L) || (R < xc)
```

Their value is either true or false.

Connected by logical operators:

and, or, not

Boolean Expressions

```
(xc < L) || (R < xc)
```

Their value is either true or false.

The AND, OR, and NOT operators can be used to build more complicated expressions.

Relational Operators

<	Less than
>	Greater than
<=	Less than or equal to
>=	Greater than or equal to
==	Equal to
~=	Not equal to

The And Operator &&

		&&
F	F	F
F	T	F
T	F	F
T	T	T

The Or Operator ||

<table>
<tr><th></th><th></th><th>||</th></tr>
<tr><td>F</td><td>F</td><td>F</td></tr>
<tr><td>F</td><td>T</td><td>T</td></tr>
<tr><td>T</td><td>F</td><td>T</td></tr>
<tr><td>T</td><td>T</td><td>T</td></tr>
</table>

The not Operator ~

	~
F	T
T	F

The ELSEIF Statement

For the quadratic problem, suppose we wanted to know whether xc was in [L,R], OR to the left OR to the right.

We have three possible results, so we need a more complicated statement than IF or IF/ELSE.

The ELSEIF statement follows an IF statement, but includes a new condition.

IF/ELSEIF/ELSE

```
if ( xc < L )
  disp ( 'XC is left of [L,R].' )
elseif ( L <= xc && xc <= R )
  disp ( 'XC is in the interval [L,R]' )
else
  disp ( 'XC is to the right of [L,R]' )
end
```

(We could have used a simpler "elseif"!)

Question Time

What is the value of **X** and **Y** after the following script is executed:

```
X = 6; Y = 8;
If ( X < Y )
   Y = Y/2;
else
   X = X/2;
end
```

A: X is 3 and Y is 4

C: X is 5 and Y is 4

B: X is 6 and Y is 8

D: X is 3 and Y is 8