- Previous Lecture (and lab):
  - Variables & assignment
  - Built-in functions
  - Input & output
  - Good programming style (meaningful variable names; use comments)

- Today's Lecture:
  - Branching (conditional statements)

Announcements:

- Project 1 (P1) due Thurs, 2/3, at 11pm
- Pay attention to Academic Integrity
- TAs: See any TA for help, not just your section instructor
- Consulting
  - Matlab consultants at ACCEL Green Rm (Engrg Library 2nd fl. computing facility)
  - 5-10pm Sunday to Thursday
- Discussion this week takes place in the lab, Upson B7. Attend the section in which you are enrolled
- Just added CS1112? Tell your discussion TA to add you in CS1112 CMS (and tell CS1110 to drop your from their CMS)

Quick review

- Variable
  - A named memory space to store a value
- Assignment operator: =
  - Let x be a variable that has a value. To give variable y the same value as x, which statement below should you write?

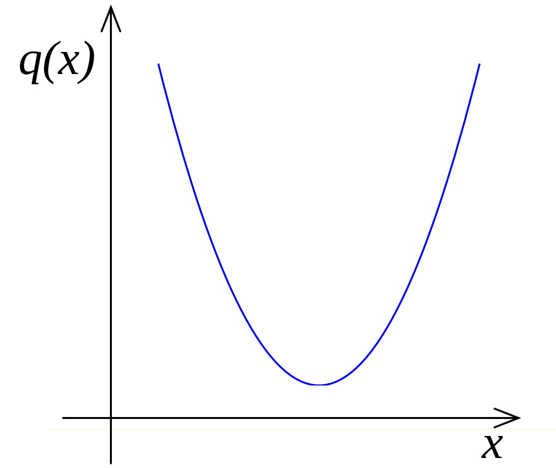
    x = y   or   y = x
- Script (program)
  - A sequence of statements saved in an m-file
- ; (semi-colon)
  - Suppresses printing of the result of assignment statement

- So far, all the statements in our scripts are executed in order
- We do not have a way to specify that some statements should be executed only under some condition
- We need a new language construct…

Consider the quadratic function

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

on the interval $[L\ ,\ R]$:



Consider the quadratic function

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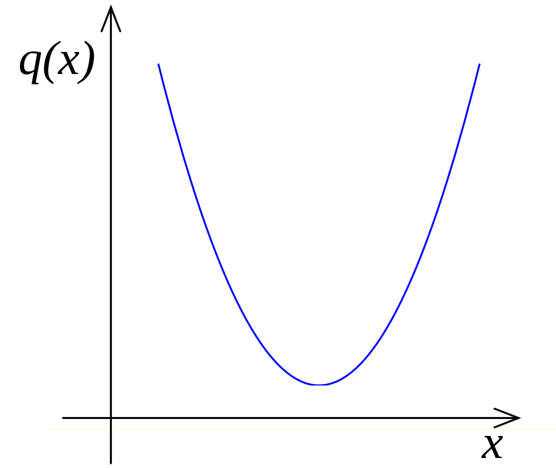
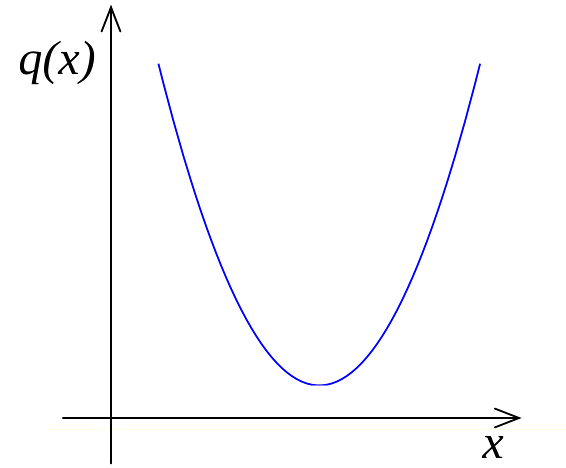


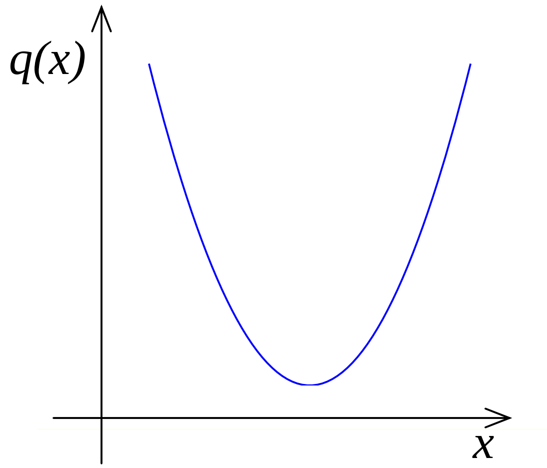
on the interval $[L\ , R]$:

- Is the function strictly increasing in $[L\ , R]$?
- Which is smaller, $q(L)$ or $q(R)$?
- What is the minimum value of $q(x)$ in $[L\ , R]$?

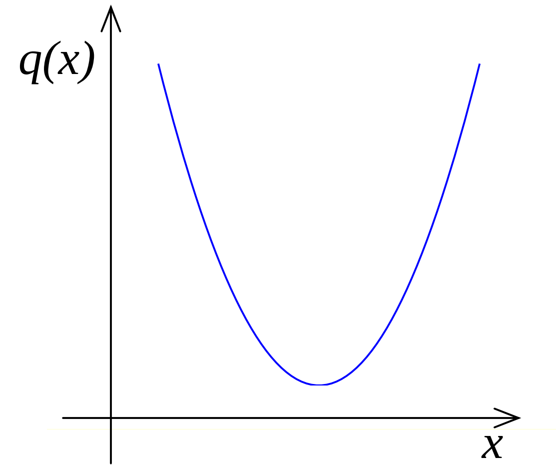
- What are the critical points?



- What are the critical points?
  - End points: $x = L$, $x = R$
  - $\{ x \mid q'(x) = 0 \}$



- What are the critical points?
  - End points: $x = L$, $x = R$
  - $\{ x \mid q'(x) = 0 \}$



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

$$q'(x) = 2x + b$$

$$q'(x_c) = 0 \Rightarrow x_c = -\frac{b}{2}$$

Problem 1

Write a code fragment that prints "yes" if q(x) increases across the interval and "no" if it does not.

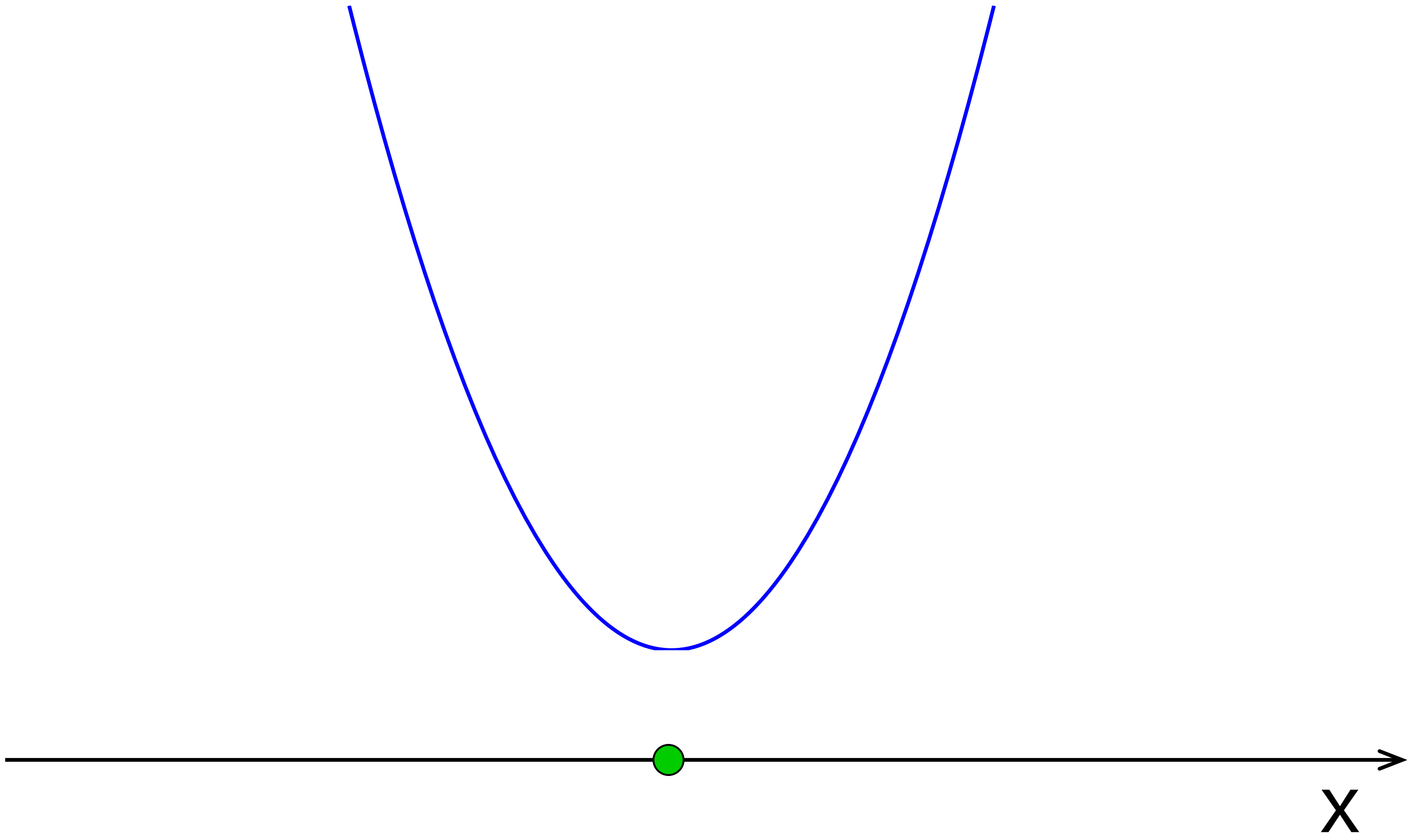
```
% Quadratic q(x) = x^2 + bx + c
b = input('Enter b: ');
c = input('Enter c: ');
L = input('Enter L: ');
R = input('Enter R: ');
```

```
% Determine whether q increases
% across [L,R]
xc = -b/2;
```

The Situation

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

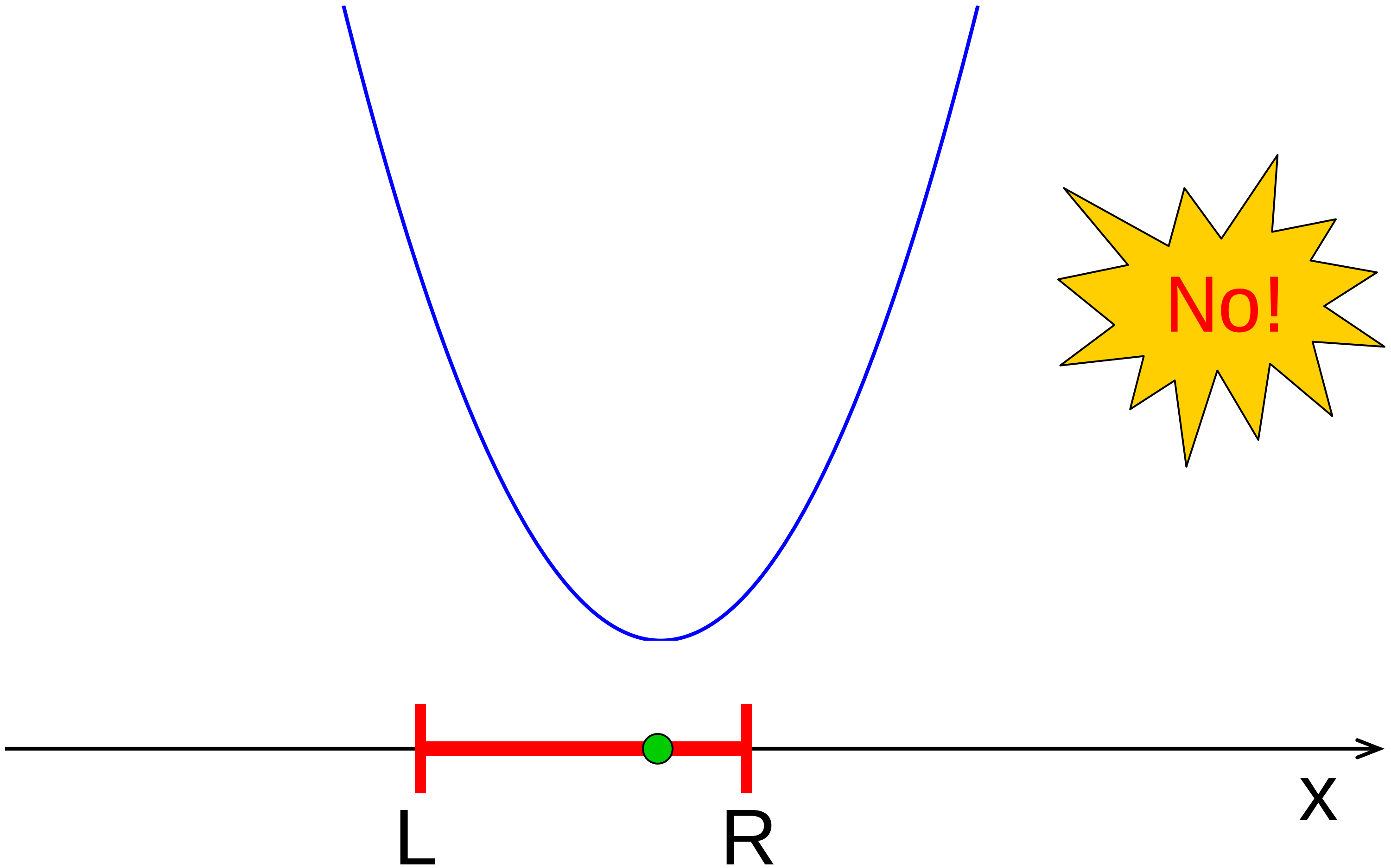
$$x_c = -b/2$$



Does q(x) increase across [L,R]?

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

$x_c = -b/2$



So what is the requirement?

```
% Determine whether q increases
% across [L,R]
xc = -b/2;

if ________________

   fprintf('Yes\n')
else
   fprintf('No\n')
end
```

Relational Operators

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

So what is the requirement?

```
% Determine whether q increases
% across [L,R]
xc = -b/2;

if     xc <= L

   fprintf('Yes\n')
else
   fprintf('No\n')
end
```

Relational Operators

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

So what is the requirement?

```
% Determine whether q increases
% across [L,R]
xc = -b/2;
```

```
disp('Yes')
```

```
if  __________

   fprintf('Yes\n')
else
   disp('No')
end
```

Consider the quadratic function

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

on the interval $[L , R]$:

- Is the function strictly increasing in $[L , R]$?
- Which is smaller, $q(L)$ or $q(R)$?
- What is the minimum value of $q(x)$ in $[L , R]$?

Problem 2

Write a code fragment that prints
"qleft is smaller"
if q(L) is smaller than q(R).
If q(R) is smaller print
"qright is smaller."

Algorithm v0

Calculate q(L)

Calculate q(R)

If q(L) < q(R)

    print "qleft is smaller"

Otherwise

    print "qright is smaller"

Algorithm v0.1

Calculate x_c

If distance $\overline{x_c L}$ is smaller than distance $\overline{x_c R}$

print "qleft is smaller"

Otherwise

print "qright is smaller"

Do these two fragments do the same thing?

```
% given x, y
if  x>y
    disp('alpha')
else
    disp('beta')
end
```

```
% given x, y
if  y>x
    disp('beta')
else
    disp('alpha')
end
```

A: yes

B: no

Algorithm v1

Calculate x_c

If distance $\overline{x_c L}$ is smaller than distance $\overline{x_c R}$

print "qleft is smaller"

Otherwise

print "qright is smaller or equals qleft"

Algorithm v2

Calculate x_c

If distance $\overline{x_c L}$ is same as distance $\overline{x_c R}$

print "qleft and qright are equal"

Otherwise, if $\overline{x_c L}$ is shorter than $\overline{x_c R}$

print "qleft is smaller"

Otherwise

print "qright is smaller"

```
% Which is smaller, q(L) or q(R)?

xc= -b/2;  % x at center
if (abs(xc-L) == abs(xc-R))
   disp('qleft and qright are equal')
elseif (abs(xc-L) < abs(xc-R))
   disp('qleft is smaller')
else
   disp('qright is smaller')
end
```

```
% Which is smaller, q(L) or q(R)?

qL= L*L + b*L + c;  % q(L)
qR= R*R + b*R + c;  % q(R)
if (qL == qR)
   disp('qleft and qright are equal')
elseif (qL < qR)
   disp('qleft is smaller')
else
   disp('qright is smaller')
end
```

```
% Which is smaller, q(L) or q(R)?

qL= L*L + b*L + c;  % q(L)
qR= R*R + b*R + c;  % q(R)
if (qL == qR)
   disp('qleft and qright are equal')
   fprintf('q value is %f\n', qL)
elseif (qL < qR)
   disp('qleft is smaller')
else
   disp('qright is smaller')
end
```

Consider the quadratic function

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

on the interval $[L , R]$:

What if you only want to know if $q(L)$ is close to $q(R)$?

```
% Is q(L) close to q(R)?

tol= 1e-4;  % tolerance
qL= L*L + b*L + c
qR= R*R + b*R + c
if (abs(qL-qR) < tol)
  disp('qleft and qright similar')
end
```

Name an important parameter and define it with a comment!

Simple **if** construct

if *boolean expression*

statements to execute if expression is true

else

statements to execute if expression is false

end

Even simpler `if` construct

`if` *boolean expression*

statements to execute if expression is true

`end`

The **if** construct

if $\boxed{\textit{boolean expression1}}$

statements to execute if $\boxed{\textit{expression1}}$ *is true*

elseif $\boxed{\textit{boolean expression2}}$

statements to execute if $\boxed{\textit{expression1}}$ *is false*

but $\boxed{\textit{expression2}}$ *is true*

:

else

statements to execute if all previous conditions

are false

end

Can have any number of elseif branches
but at most one else branch

Things to know about the `if` construct

- ________________ branch of statements is executed
- There can be ________________ **`elseif`** clauses
- There can be ________________ **`else`** clause
- The **`else`** clause ________________ in the construct
- The **`else`** clause ________________ (boolean expression)

Things to know about the `if` construct

- At most one branch of statements is executed
- There can be any number of `elseif` clauses
- There can be at most one `else` clause
- The `else` clause must be the last clause in the construct
- The `else` clause does not have a condition (boolean expression)

Consider the quadratic function

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

on the interval $[L , R]$:

- Is the function strictly increasing in $[L , R]$?
- Which is smaller, $q(L)$ or $q(R)$?
- What is the minimum value of $q(x)$ in $[L , R]$?

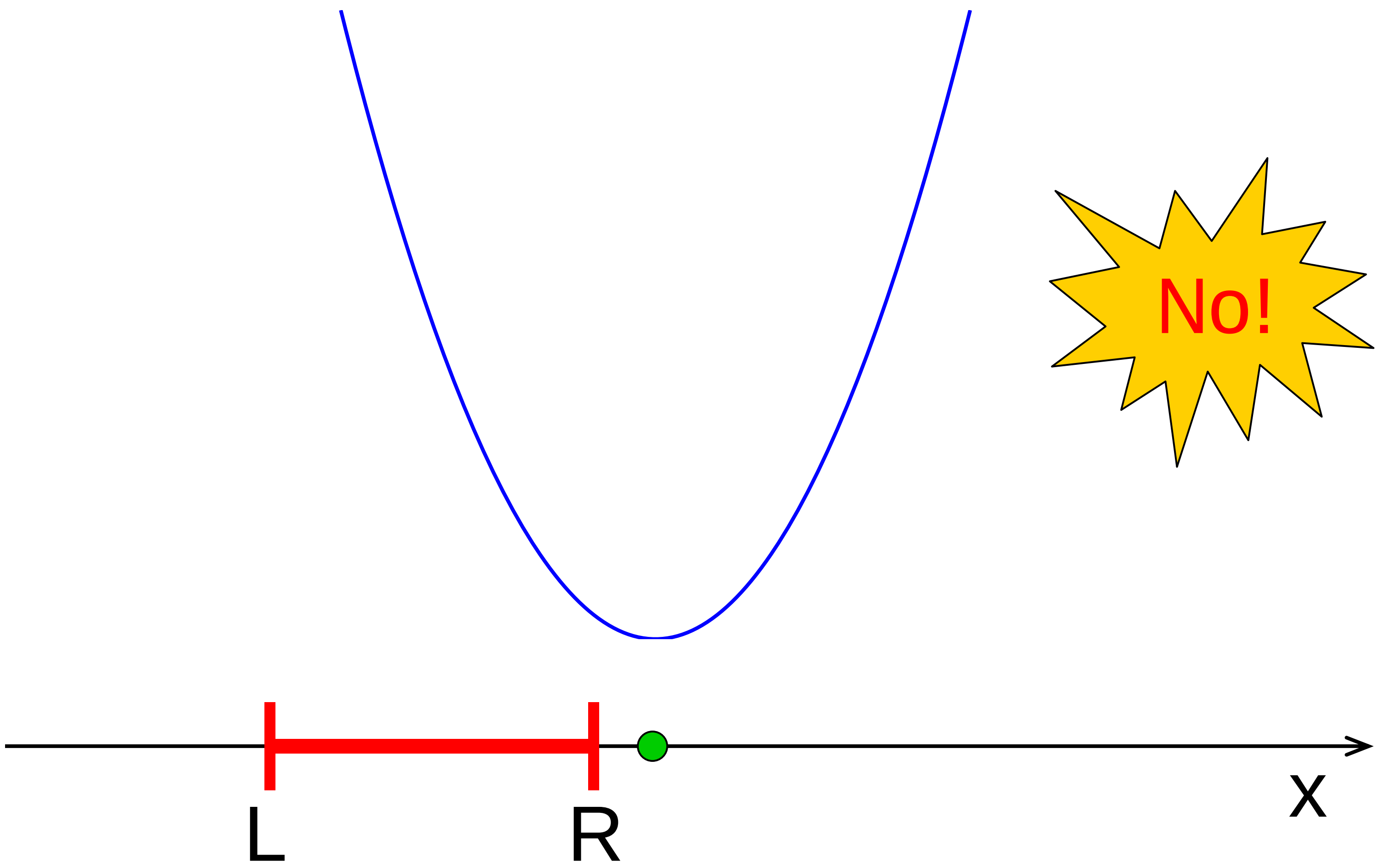
Modified Problem 3

Write a code fragment that prints "yes" if xc is in the interval and "no" if it is not.

Is xc in the interval [L,R]?

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

$x_c = -b/2$



So what is the requirement?

```
% Determine whether xc is in
% [L,R]
xc = -b/2;

if ________________

   disp('Yes')
else
   disp('No')
end
```

So what is the requirement?

```
% Determine whether xc is in
% [L,R]
xc = -b/2;

if L<=xc && xc<=R

   disp('Yes')
else
   disp('No')
end
```

The value of a boolean expression is either true or false.

```
(L<=xc) && (xc<=R)
```

This (compound) boolean expression is made up of two (simple) boolean expressions. Each has a value that is either *true* or *false*.

Connect boolean expressions by boolean operators:

and	or	not
&&	||	~

Logical operators

&& logical <u>and</u>: Are both conditions true?

E.g., we ask "is $L \le x_c$ and $x_c \le R$?"

In our code: `L<=xc && xc<=R`

Logical operators

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E.g., we ask "is $L \le x_c$ and $x_c \le R$?"

In our code: **L<=xc && xc<=R**

|| logical <u>or</u>: Is at least one condition true?

E.g., we can ask if x_c is outside of $[L,R]$,

i.e., "is $x_c \le L$ or $R \le x_c$?"

In code: **xc<=L || R<=xc**

Logical operators

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In code: `xc<=L || R<=xc`

~ logical <u>not</u>: Negation

E.g., we can ask if x_c is not outside $[L,R]$.

In code: `~(xc<=L || R<=xc)`

Logical operators

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In code: **`~(xc<=L || R<=xc)`**