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)

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 $$[L, R]$$:
- 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?

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]
x_c = -b/2;

Lecture 3 10

% Does q(x) increase across [L, R]?
q(x) = x^2 + bx + c

\[ x_c = -\frac{b}{2} \]

No!

Lecture 3 12

So what is the requirement?
% Determine whether q increases
% across [L, R]
x_c = -b/2;
if ____________
    fprintf('Yes
')
else
    fprintf('No
')
end

Lecture 3 15

Relational Operators
< Less than
> Greater than
\leq Less than or equal to
\geq Greater than or equal to
== Equal to
\neq Not equal to

Lecture 3 18

So what is the requirement?
% Determine whether q increases
% across [L, R]
x_c = -b/2;
disp('Yes')
if ____________
    fprintf('Yes
')
else
    disp('No')
end

Lecture 3 20

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."

Lecture 3 21

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 v2

Calculate $x_c$

- If distance $x_cL$ is same as distance $x_cR$
  - print "qleft and qright are equal"
- Otherwise, if $x_cL$ is shorter than $x_cR$
  - print "qleft is smaller"
- Otherwise
  - print "qright is smaller"

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

$$xc = -\frac{b}{2};$$  % 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

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!
Do these two fragments do the same thing?

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

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

A: yes  B: no

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  boolean expression1
    statements to execute if expression1 is true
elseif  boolean expression2
    statements to execute if expression1 is false but expression2 is true
else
    statements to execute if all previous conditions are false
end

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)

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.

So what is the requirement?

\[
\begin{align*}
% & \text{Determine whether } xc \text{ is in } [L,R] \\
xc &= -b/2; \\
\text{if } & \quad \text{___________} \\
& \quad \text{disp('Yes')} \\
\text{else} & \quad \text{disp('No')} \\
& \quad \text{end}
\end{align*}
\]

The value of a boolean expression is either \text{true} or \text{false}.

\[(L<=xc) \&\& (xc<=R)\]

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

Connect boolean expressions by boolean operators:

\[
\text{and} \quad \text{or} \quad \text{not} \\
\&\& \quad || \quad ~
\]

Logical operators

\&\& \text{logical and: Are both conditions true?} \\
E.g., we ask “is \( L \leq x_c \) and \( x_c \leq R \)?” \\
In our code: \( L<=xc \&\& xc<=R \)

|| \text{logical or: Is at least one condition true?} \\
E.g., we can ask if \( x_c \) is outside \( [L,R] \), i.e., “is \( x_c \leq L \) or \( R \leq x_c \)?” \\
In code: \( xc<L \quad || \quad R<xc \)

~ \text{logical not: Negation} \\
E.g., we can ask if \( x_c \) is not outside \( [L,R] \). \\
In code: \( \sim (xc<L \quad || \quad R<xc) \)