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:

- Discussion this week is in the Upson B7 computer lab
- Project 1 (P1) due Thurs, 1/31, at 11pm
- Pay attention to Academic Integrity
- You can see any TA for help, not just your discussion TA
- Consulting
  - Matlab consultants at ACCEL Green Rm (Carpenter Hall 2nd fl. computing facility)
  - 5-10pm Sunday to Thursday
- Just added CS1112? Tell your discussion TA to add you in CS1112 CMS (and tell CS1110 to drop your from their CMS)
- Piazza – “Q & A system” for all students in CS1112. Use it for clarification only—do not ask (answer) homework questions and do not give hints on homework. Will be monitored by TAs. Available tomorrow.
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?
    \[
    x = y \quad \text{or} \quad y = x
    \]

- **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 \([L, R]\):

- 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 \( q(x) = x^2 + bx + c \)

\[
b = \text{input}('Enter b: '); \\
c = \text{input}('Enter c: '); \\
L = \text{input}('Enter L: '); \\
R = \text{input}('Enter R: '); \\
\]

% 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 $[L, R]$?

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

$\bullet \ x_c = -\frac{b}{2}$

No!
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
\(\leq\) Less than or equal to
\(\geq\) Greater than or equal to
\(==\) Equal to
\(\ne\) Not equal to
So what is the requirement?

\%
Determine whether $q$ increases
\%
avcross $[L,R]$
\[xc = \frac{-b}{2};\]

if \[xc \leq L\]

fprintf(‘Yes
’)

else

fprintf(‘No
’)

end

Relational Operators

\(<\quad\text{Less than}\)
\(\quad\text{Greater than}\)
\(\quad\text{Less than or equal to}\)
\(\quad\text{Greater than or equal to}\)
\(\quad\text{Equal to}\)
\(\quad\text{Not equal to}\)
So what is the requirement?

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

if xc <= L
    fprintf('Yes
')
else
    fprintf('No
')
end
```
So what is the requirement?

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

if __________
    fprintf(‘Yes\n’)
else
    disp(‘No’)
end
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 $x_cL$ is smaller than distance $x_cR$
    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 $x_cL$ is smaller than distance $x_cR$
   print “qleft is smaller”
Otherwise
   print “qright is smaller or equals qleft”
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 \( q(R) \)?

\[ xc = -b/2; \quad % \text{x at center} \]

\[
\text{if } (\text{abs}(xc-L) == \text{abs}(xc-R)) \\
\quad \text{disp('qleft and qright are equal')} \\
\text{elseif (abs(xc-L) < abs(xc-R))} \\
\quad \text{disp('qleft is smaller')} \\
\text{else} \\
\quad \text{disp('qright is smaller')} \\
\text{end}
\]
% 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)?

% tolerance

tol = 1e-4;

qL = L*L + b*L + c
qR = R*R + b*R + c

if (abs(qL - qR) < tol)
    disp('qleft and qright similar')
end
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 \textbf{if} construct

\textbf{if} \hspace{1em} \textit{boolean expression}

\begin{itemize}
  \item \textit{statements to execute if} \textit{expression} \textit{is true}
\end{itemize}

\textbf{else}

\begin{itemize}
  \item \textit{statements to execute if} \textit{expression} \textit{is false}
\end{itemize}

\textbf{end}
Even simpler **if** construct

```plaintext
if boolean expression
  statements to execute if expression is true
end
```
The **if** construct

```plaintext
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
```

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 \([L, R]\)?
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 \textbf{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 \( x_c \) in the interval \([L,R]\)?

\[ q(x) = x^2 + bx + c \]

\( x_c = -\frac{b}{2} \)

No!
So what is the requirement?

```matlab
% 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.

\[(L \leq xc) \land (xc \leq R)\]

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 \(\mid\mid\)  not \(~\)
Logical operators

&& logical and: Are both conditions true?

E.g., we ask “is $L \leq x_c$ and $x_c \leq R$ ?”

In our code: $L \leq x_c \quad \&\& \quad x_c \leq R$
Logical operators

&& logical **and**: Are both conditions true?

E.g., we ask “is $L \leq x_c$ and $x_c \leq R$?”

In our code: $L \leq x_c$ && $x_c \leq R$

|| logical **or**: Is at least one condition true?

E.g., we can ask if $x_c$ is outside of $[L,R]$, i.e., “is $x_c \leq L$ or $R \leq x_c$?”

In code: $x_c < L$ || $R < x_c$
Logical operators

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

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

~ logical not:  Negation
E.g., we can ask if \( x_c \) is not outside \([L,R]\).
In code: \( \neg (x_c \leq L \lor R \leq x_c) \)
Logical operators

&& logical **and**: Are both conditions true?

E.g., we ask “is \( L \leq x_c \) and \( x_c \leq R \)?”

In our code: \( L \leq x_c \land x_c \leq R \)

|| logical **or**: Is at least one condition true?

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

i.e., “is \( x_c \leq L \) or \( R \leq x_c \)?”

In code: \( x_c \land L \lor R \leq x_c \)

~ logical **not**: Negation

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

In code: \( \neg (x_c \leq L \lor R \leq x_c) \)