L5. More on Conditionals

Nested if's

Multiple Alternatives

Recall the `if-else` "Template"

```
if   boolean expression
        Commands to execute if the
           expression if TRUE
else
        Commands to execute if the
           expression if FALSE
end
```

A Warm-Up Question

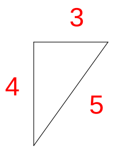
Variables a, b, and c have whole number values. True or false: This fragment prints "Yes" if there is a right triangle with side lengths a, b, and c and prints "No" otherwise.

```
if a^2 + b^2 == c^2
   disp('Yes')
else
   disp('No')
end
```

A. True B. False

```
a = 5;
b = 3;
c = 4;
if a^2 + b^2 == c^2
   disp('Yes')
else
   disp('No')
end
```

Prints "no" even though we have:



```
if  a^2 + b^2 == c^2
   disp('Yes')
else
   disp('No')
end
```

The boolean expression should be true if $a^2+b^2=c^2$ or $a^2+c^2=b^2$ or $b^2+c^2=a^2$ is true.

↓

```
(a^2+b^2==c^2) || (a^2+c^2==b^2) || (b^2+c^2==a^2)
```

Developing "If" Solutions

Illustrate the thinking associated with the design of if statements.

The methodology of stepwise refinement.

Two examples...

Problem 1

Write a script that solicits a positive integer y and prints the number of days in year y as determined by the Gregorian calendar.

Leap Year Rule

A non-century year is a leap year if it is divisible by 4.

A century year is a leap year only if it is divisible by 400.

Will Need the Built-In Function rem

a	b	rem(a,b)
15	6	3
56	7	0

The value of rem(a,b) is the remainder when the value of a is divided by the value of b. (Assume a, b are whole numbers.)

"Pseudocode" Solution

```
Input y.

If y is not divisible by 100

    Use the non-century year rule.

Otherwise

    Use the century year rule.
```

Refine…

```
y = input('Enter the Year:');

if rem(y,100) ~= 0
    % y is not a multiple of 100
    Use the non-century rule
else
    % y is a multiple of 100
    Use the century rule
end
```

Refine the If-Box

```
% y is not a multiple of 100
Use the non-century rule
```

```
% y is not a multiple of 100
If y  is divisible by 4
  Print 366
Otherwise
  Print 365
```

```
% y is not a multiple of 100
if rem(y,4)==0
   % y is divisible by 4
   disp('366')
else
   % y is not divisible by 4
   disp('365')
end
```

Refine…

```
y = input('Enter the Year:');

if rem(y,100) ~= 0
   % y is not a multiple of 100
   Use the non-century rule          ←Done
else
   % y is a multiple of 100
   Use the century rule              ←Next
end
```

Refine the Else-Box

```
% y is divisible by 100
Use the Century rule
```

```
% y is divisible by 100
If y is divisible by 400
  Print 366
Otherwise
  Print 365
```

```
% y is divisible by 100
if rem(y,400)==0
   % y is divisible by 400
   disp('366')
else
   % y is not divisible by 400
   disp('365')
end
```

Refine…

```
y = input('Enter the Year:');

if rem(y,100) ~= 0
   % y is not a multiple of 100
   Use the non-century rule          ←Done
else
   % y is a multiple of 100
   Use the century rule              ←Done
end
```

```
y = input('Enter the Year:');
if rem(y,100)~=0
   if rem(y,4)==0
      disp('366')
   else
      disp('365')
   end
else
   if rem(y,400)==0
      disp('366')
   else
      disp('365')
   end
end
```

The whole thing without comments

Two “Synonyms”

```
if rem(y,4)~=0 || (rem(y,100)==0 && rem(y,400)~=0)
   disp(‘365’)
else
   disp(‘366’)
end
```

```
if rem(y,4)==0 && (rem(y,100)~=0 || rem(y,400)~=0)
   disp(‘365’)
else
   disp(‘366’)
end
```

Key Problem-Solving Strategy

Progress from pseudocode to Matlab through a sequence of refinements.

Comments have an essential role during the transitions. They “stay on” all the way to the finished fragment.

Starting Points Vary In “Friendliness”

A non-century year is a leap year if it is divisible by 4.

A century year is a leap year only if it is divisible by 400.

A year is a leap year if it is divisible by 4 with the exception of century years that are not divisible by 400.

Problem 2

Write a fragment that prints the minimum value of

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

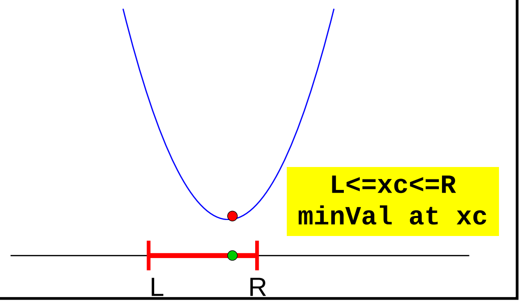
interval.

L <= x <= R

One Possibility

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

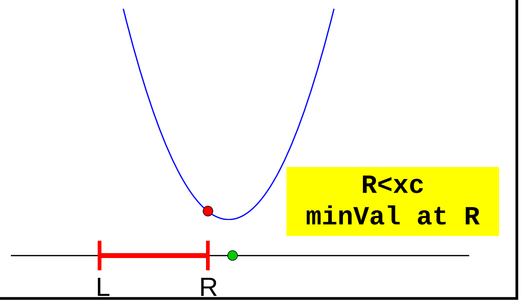
● $x_c = -b/2$



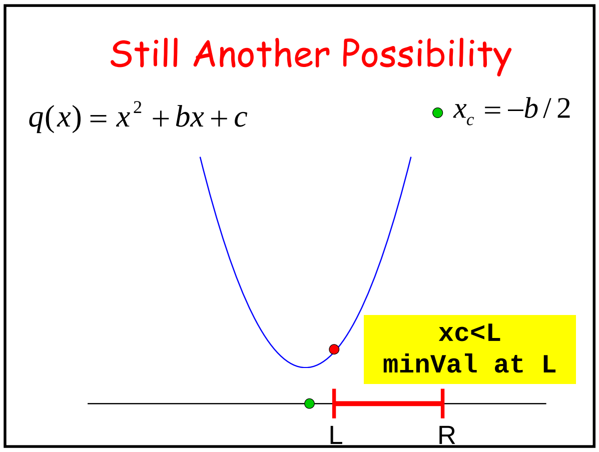
Another Possibility

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

● $x_c = -b/2$



Still Another Possibility



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

● $x_c = -b/2$

We conclude that…

If xc is in the interval

The minimum is at xc

Otherwise

The minimum is at an endpoint

We Start With Pseudocode…

```
If xc is in the interval
    The minimum is at xc
Otherwise
    The minimum is at an endpoint
```

Task: Convert to "legal" Matlab.

First refinement…

```
if (L <= xc)  &&  (xc <= R)
   % L <= xc <= R
   % The minimum is at xc.
else
   % xc < L or R < xc
   % The minimum is at an endpoint.
end
```

(1) Boolean expression, (2) commented if-box, (3) commented else box

Refine the If-Box

```
% L <= xc <= R
% The minimum is at xc.
```

↓

```
% L <= xc <= R
% The minimum is at xc.
minVal = xc^2 + b*xc + c
```

Refine the Else-Box

```
% xc < L or R < xc
% The minimum is at an endpoint.
```

xc<L
minVal at L

R<xc
minVal at R

↓

```
% xc < L or R < xc
% The minimum is at an endpoint.

  if xc is to the left of L
     The minimum is at L
  Otherwise
     The minimum is at R
```

```
% xc < L or R < xc
% The minimum is at an endpoint.
  if xc < L
     % The minimum is at L
     minVal = L^2 + b*L + c
  else
     % The minimum is at R
     minVal = R^2 + b*R + c
  end
```

Overall (w/o Comments)

```
if (L <= xc)  &&  (xc <= R)
    minVal = xc^2 + b*xc + c.
else
    if xc < L
       minVal = L^2 + b*L + c
    else
       minVal = R^2 + b*R + c
    end
end
```

Notice there are 3 Alternatives…

```
if (L <= xc)  &&  (xc <= R)
    minVal = xc^2 + b*xc + c.      ●
else
    if xc < L
       minVal = L^2 + b*L + c      ●
    else
       minVal = R^2 + b*R + c      ●
    end
end
```

The if-elseif-else Construct

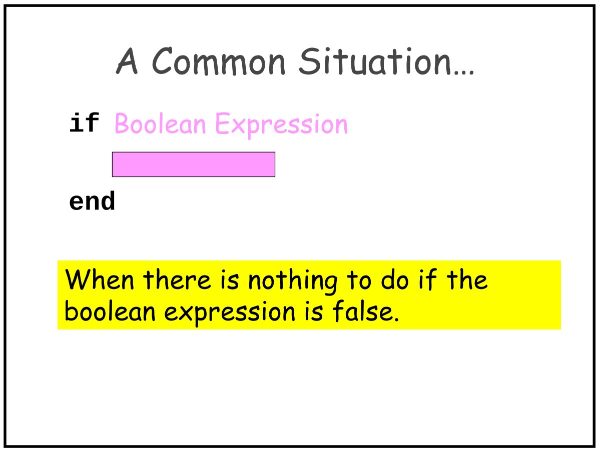
```
if (L <= xc)  &&  (xc <= R)
    minVal = xc^2 + b*xc + c.
elseif xc < L
    minVal = L^2 + b*L + c
else
    minVal = R^2 + b*R + c
end
```

Execute exactly one block.

When there are Many Alternatives

```
if Boolean Expression
   🟪
elseif  Boolean Expression
   🟦
elseif  Boolean Expression
   🟥
else
   🟥
end
```

Find the first true boolean expression & execute its block. Otherwise execute the else block.



A Common Situation…

```
if Boolean Expression

end
```

When there is nothing to do if the boolean expression is false.