# **Logical Statements**

Jiseok Chae

Department of Mathematical Sciences KAIST

Week 4

Jiseok Chae (KAIST)

Logical Statements

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In MATLAB there are expressions where if the expression is true or not can be determined.

Inside MATLAB, TRUE is expressed as a logical 1, and FALSE is expressed as a logical 0.

>> 4 < 3			
ans =			
logical			
0			

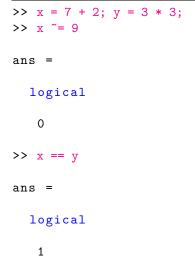
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Comparisons are logical expressions. There are:

- > : greater than
- < : less than
- >= : greater than or equal to
- <= : less than or equal to
- == : equal to
- ~= : not equal to

You can compare values contained in variables.



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There are operations you can do with logical expressions. Let P and Q be logical expressions. Then,

P & & Q : P and Q. P || Q : P or Q. ~P : not P.

Standard "common sense" logical operation rules apply. That is, P && Q is TRUE if and only if both P <u>and</u> Q are TRUE, P || Q is TRUE if and only if either P <u>or</u> Q is TRUE, and "P is TRUE if and only if P is FALSE. Order of priorities :

```
	ilde{} \rightarrow \texttt{arithmetic} \texttt{ operators} \rightarrow \texttt{comparisons} \rightarrow \texttt{\&\&} \rightarrow ||
```

If you are not sure, use parentheses.

>> y = 3 ^ 4; >> (y > 10) && ~(y > 100) ans = logical
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There are logical vectors; vectors containing logical values.

The most common source of logical vectors is from the *elementwise* application of logical operations.

```
>> v = [2, 7, 1, 8, 2, 8];
>> v > 5
ans =
    1×6 logical array
    0 1 0 1 0 1
```

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Logical vectors provide a new way of extracting subvectors and submatrices.

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The well-known Collatz conjecture:

Start with any positive integer n. If n is even, halve it. If n is odd, triple it and add one. If we keep repeating this process, do we always eventually reach the number 1?

A sequence generated by the rule above is called a *Collatz sequence*.

Suppose we want to design a function collatz\_next which, given a positive integer n, computes the next term in a Collatz sequence.

In that case, we need a *conditional statement*, as the value depends on the parity of n:

$$\texttt{collatz\_next}(\texttt{n}) = \begin{cases} \frac{\texttt{n}}{2} & \text{if n is even,} \\ 3\texttt{n} + 1 & \text{if n is odd.} \end{cases}$$

The basic template of such conditional statement is:

end

If there is nothing to do when  $\langle \textit{logical expression} \rangle$  is FALSE, the else block can be omitted, as:

 $\label{eq:commands} \begin{array}{l} \texttt{if } \langle \textit{logical expression} \rangle \\ \langle \textit{commands to execute if } \langle \textit{logical expression} \rangle \textit{ is } \texttt{TRUE} \rangle \\ \texttt{end} \end{array}$ 

The function rem(a, b) computes the remainder of a when divided by b.

So, one way to write the function collatz\_next would be the following.

```
function next = collatz_next(n)
if rem(n, 2) == 0
    next = n / 2;
else
    next = 3 * n + 1;
end
```

collatz\_next.m \_\_\_\_\_

What if there are multiple cases to consider?

You can add elseif blocks, as :

if  $\langle P \rangle$ 

```
\langle commands \ to \ execute \ if \ \langle P \rangle \ is \ TRUE \rangle
```

elseif  $\langle {\it Q} 
angle$ 

 $\langle commands \ to \ execute \ if \ \langle P \rangle \ is \ {\tt FALSE} \ but \ \langle Q \rangle \ is \ {\tt TRUE} \rangle$  else

 $\langle commands \ to \ execute \ if \ both \ \langle P \rangle \ and \ \langle Q \rangle \ are \ {\tt FALSE} \rangle$  end

You can add elseif blocks as many as you want :

```
if \langle P \rangle
       \langle commands \ to \ execute \ if \ \langle P \rangle \ is \ TRUE \rangle
elseif \langle Q \rangle
       \langle commands \ to \ execute \ if \ \langle P \rangle \ is \ FALSE \ but \ \langle Q \rangle \ is \ TRUE \rangle
elseif \langle R \rangle
       \langle commands \ to \ execute \ if \ \langle P \rangle \ and \ \langle Q \rangle \ are \ FALSE \ but \ \langle R \rangle \ is \ TRUE \rangle
elseif \langle S \rangle
       . . .
. . .
else
       \langle commands \ to \ execute \ if \ \langle P \rangle, \ \langle Q \rangle, \ \langle R \rangle, \ \langle S \rangle, \ \dots \ are \ all \ FALSE \rangle
```

end

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Let us see an example.

A bromothymol blue (BTB) solution is a pH indicator that changes color according to the pH value of the substance it is added to.

Its color turns

- yellow if pH < 6.0,
- green if  $6.0 \le pH \le 7.6$ , and
- blue if pH > 7.6.

Let us write a function BTB(pH) which takes the input pH, and returns the color a BTB solution would turn into.

The quotation marks are used to generate *strings*. A string is a sequence of letters. We will discuss about strings after the midterm period.

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Examples of results:

>> BTB(pi)		
ans =		
'yellow'		
>> BTB(7.4)		
ans =		
'green'		
>> BTB(10)		
ans =		
'blue'		

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### Thank you!

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