Logical Expressions

ENGR 1187
MATLAB 6
Logical Expressions in Real Life

Sorting objects in manufacturing processes can be accomplished automatically with sorting algorithms developed with logical expressions. Different types of plastics must be sorted by conveyers with logical expressions to properly melt the plastics separately.
Today's Learning Objectives

- Apply logical operations correctly in arrays.
- Analyze data using logical operators.
Evaluating to True / False

- In MATLAB, and programming in general:
  - 1 = Logical True
  - 0 = Logical False

- MATLAB can evaluate mathematical statements and report the result as true or false, or as 1 or 0
Evaluating to True / False

- Any non-zero number will evaluate to TRUE (1)
- Zero will evaluate to FALSE (0)
- For example: 8 would evaluate to TRUE (1)
MATLAB Relational Operators

Recall that relational operators compare two numbers in a comparison statement.

- `<` Less than
- `<=` Less than or equal to
- `>` Greater than
- `>=` Greater than or equal to
- `==` Equal to
- `~=` Not equal to
Evaluating Relational Operators

- When we have MATLAB evaluate statements with relational operators, it's like we're giving MATLAB a true-false test.

```
>> 5 > 8
ans =
    0
```

- The answer is 0 because this statement is false.
Evaluating Relational Operators

```matlab
>> 10 > 3
ans =
    1
>> 10 < 3
ans =
    0
```

```matlab
>> x = 10 > 3
x =
    1
>> x = 10 < 3
x =
    0
```
Logical Operators

- Logical operators compare two or more operands (numbers) to see if that combination is true or false.
- Result is assigned as true or false.
## Logical Operators

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>AND</td>
<td>True if both are true.</td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td>True if either OR both are true.</td>
</tr>
<tr>
<td>~</td>
<td>NOT</td>
<td>True if the operand is false. <em>(Tricky!)</em></td>
</tr>
</tbody>
</table>
Logical Operator Examples

- **A & B**  True when both A and B are true
- **A | B**  True if either A or B is true
- **~ A**  True if A is false
Logical Operator Examples

- **5 & 9**  
  1: TRUE! 5 and 9 are both 'true'.

- **5 & 0**  
  0: FALSE! 0 is false, so the whole thing is false.

- **4 | 6**  
  1: TRUE! Either 4 or 6 is true.

- **4 | 0**  
  1: TRUE! 4 is true, and we just need one 'true'.

- **~ 8**  
  0: FALSE! 8 is true, so the answer is false.

- **~ 0**  
  1: TRUE! 0 is false, so the answer is true.
MATLAB Order of Precedence

1. Parentheses ( )
2. Exponent ^
3. Logical 'NOT' ~
4. Multiply, Divide * /
5. Add, Subtract + -
6. Relational Operators < > <= >= == ~=
7. Logical 'AND' &
8. Logical 'OR' |
MATLAB Example

```matlab
>> Y = 6 < 10 + 10 == 20/2
Y =
    0
Y is FALSE.

... Why is Y = 0, or false?

Y = 6 < 10 + 10 == 10
Y = 6 < 20 == 10
Y = 1 == 10
Y = 0```
MATLAB Example

Let's add some parentheses and see what happens:

\[
\begin{align*}
\text{>> } X &= (6<10) + (10 == 20/2) \\
X &= 2
\end{align*}
\]

... Why is \( X = 2 \)?

\[
\begin{align*}
X &= (6<10) + (10 == 20/2) \\
X &= 1 + 1 \\
X &= 2
\end{align*}
\]

In the second step, both pieces of the equation have evaluated to 1. There are no relational or logical operators left, so we just do math!
Important Takeaways

- Logical expressions are evaluated as true (1) or false (0) in MATLAB.
- All nonzero numbers evaluate to true.
- Like arithmetic operations, logical operators have an order of precedence.
- Logical operators can be combined within arithmetic expressions.
Preview of Next Class

- Conditional Statements
  - Very important topic!
  - If-end
  - if-else-end
  - if-elseif-else-end
  - Structured examples with flow charts
What’s Next?

- Review today’s Quiz #06
- Open the in-class activity from the EEIC website and we will go through it together.
- Then, start working on MAT-06 homework.
- Prepare for next class by reading about conditional statements.