

# Logical Operators

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# Objectives

- To combine conditions using logical operators (**&&**, **||**, and **!**) (§3.10).
- To program using selection statements with combined conditions (**LeapYear**, **Lottery**) (§§3.11–3.12).

# Outline

- Discussed
  - Boolean data type and Boolean expressions
  - If-statements (one-way, two-way, multi-way, and nested if-statements) and their flow charts
  - Common errors and pitfalls
- Logical operators
- Several (“big”) programming problems (subtraction quiz, compute BMI, compute taxes, leap year, lottery)

# Logical Operators

Operator	Name	Description
!	not	logical negation
&&	and	logical conjunction
	or	logical disjunction
^	exclusive or	logical exclusion

# Truth Table for Operator !

<b>p</b>	<b>!p</b>	<b>Example (assume age = 24, weight = 140)</b>
<b>true</b>	<b>false</b>	<b>!(age &gt; 18) is false, because (age &gt; 18) is true.</b>
<b>false</b>	<b>true</b>	<b>!(weight == 150) is true, because (weight == 150) is false.</b>

# Truth Table for Operator &&

$p_1$	$p_2$	$p_1 \ \&\& \ p_2$	Example (assume age = 24, weight = 140)
false	false	false	$(\text{age} \leq 18) \ \&\& \ (\text{weight} < 140)$ is false, because both conditions are both false.
false	true	false	$(\text{age} \leq 18) \ \&\& \ (\text{weight} \geq 140)$ is false, because $(\text{age} \leq 18)$ is false.
true	false	false	$(\text{age} > 18) \ \&\& \ (\text{weight} > 140)$ is false, because $(\text{weight} > 140)$ is false.
true	true	true	$(\text{age} > 18) \ \&\& \ (\text{weight} \geq 140)$ is true, because both $(\text{age} > 18)$ and $(\text{weight} \geq 140)$ are true.

# Truth Table for Operator ||

$p_1$	$p_2$	$p_1 \    \ p_2$	Example (assume age = 24, weight = 140)
false	false	false	(age <= 18) && (weight < 140) is false, because both conditions are both false.
false	true	true	(age <= 18) && (weight >=140) is true, because (age <= 18) is false, but (weight >= 140) is true.
true	false	true	(age > 18) && (weight > 140) is true, because (age > 18) is true, despite (weight > 140) is false.
true	true	true	(age > 18) && (weight >= 140) is true, because both (age > 18) and (weight >= 140) are true.

# Truth Table for Operator $\wedge$

$p_1$	$p_2$	$p_1 \wedge p_2$	Example (assume age = 24, weight = 140)
false	false	false	$(\text{age} \leq 18) \ \&\& \ (\text{weight} < 140)$ is false, because both conditions are both false.
false	true	true	$(\text{age} \leq 18) \ \&\& \ (\text{weight} \geq 140)$ is true, because $(\text{age} \leq 18)$ is false, but $(\text{weight} \geq 140)$ is true.
true	false	true	$(\text{age} > 18) \ \&\& \ (\text{weight} > 140)$ is true, because $(\text{age} > 18)$ is true, despite $(\text{weight} > 140)$ is false.
true	true	false	$(\text{age} > 18) \ \&\& \ (\text{weight} \geq 140)$ is false, because both $(\text{age} > 18)$ and $(\text{weight} \geq 140)$ are true.



# Let's use them in an example ...

- Here is a program that checks whether a number is divisible by 2 and 3, whether a number is divisible by 2 or 3, and whether a number is divisible by 2 or 3 but not both

# Questions?

# The & and | Operators

- Do not confuse them with && and ||
- Optional to understand & and | fully for now

If `x` is 1, what is `x` after this expression?

```
(x > 1) & (x++ < 10)
```

If `x` is 1, what is `x` after this expression?

```
(1 > x) && (1 > x++)
```

How about `(1 == x) | (10 > x++)`?

```
(1 == x) || (10 > x++)?
```

# Questions?

# Programming Problem. Determining Leap Year?

- This program first prompts the user to enter a year as an int value and checks if it is a leap year.
- A year is a leap year if
  - it is divisible by 4 but not by 100, or
  - it is divisible by 400.
- `(year % 4 == 0 && year % 100 != 0) || (year % 400 == 0)`

# Programming Problem. Lottery

- Write a program that randomly generates a lottery of a two-digit number, prompts the user to enter a two-digit number, and determines whether the user wins according to the following rule:
  - If the user input matches the lottery in exact order, the award is \$10,000.
  - If the user input matches the lottery, the award is \$3,000.
  - If one digit in the user input matches a digit in the lottery, the award is \$1,000.

# Questions?