



Expressions

Announcements

- Need help installing software, setting up your workspace, or practicing today's content?
 - Visit our in-person Open House in Sitterson Hall, room 008!
 - Today — Wednesday: 11am–5pm
 - No need to submit a ticket on the CSXL site, just walk in!
 - Tutoring (longer-form help) will begin on Thursday in Fred Brooks (FB) 007! See details [here](#)
 - Thursday: 5–7pm
- Homework:
 - **LS03: Expressions** due tonight at 11:59pm
 - **EX00: Hello World!** due Thursday (Jan 15th) at 11:59pm

Expressions

- Fundamental building block in programs
- 2 main ideas behind expressions:
 - An expression *evaluates* to a *typed* value at runtime
 - An object's *type* tells you what you can do with it
 - An *expression* is an intent to do something
- Computer evaluates each expression in your program one step at a time
- Examples
 - `1 + 2 * 3`
 - `1`
 - `len("yay")`
 - `1.0 * 2.0`
 - `"Hello" + " World!"`
 - `1 > 3`

Numerical Operators

Symbol	Operator Name	Example
<code>**</code>	Exponentiation	<code>2 ** 8</code> equivalent to 2^8
<code>*</code>	Multiplication	<code>10 * 3</code>
<code>/</code>	Division	<code>7 / 5</code> result is 1.4
<code>//</code>	Integer Division	<code>7 // 5</code> result is 1
<code>%</code>	Remainder “modulo”	<code>7 % 5</code> result is 2
<code>+</code>	Addition	<code>1 + 1</code>
<code>-</code>	Subtraction	<code>111 - 1</code>
<code>-</code>	Negation	<code>-(1 + 1)</code> result is -2

Order Of Operations

- P ()
- E **
- MD * / %
- AS + -
- Tie? Evaluate *Left to Right*

Addition +

- If numerical objects, add the values together
 - $1 + 1$ “evaluates to” 2
 - $1.0 + 2.0 \rightarrow 3.0$
 - $1 + 2.0 \rightarrow 3.0$
- If strings, concatenate them
 - “Comp” + “110” \rightarrow “Comp110”
- The result type depends on the operands
 - float + float \rightarrow float
 - int + int \rightarrow int
 - float + int \rightarrow float
 - int + float \rightarrow float
 - str + str \rightarrow str

Addition +

- If numerical objects, add the values together
 - $1 + 1 \rightarrow 2$
 - $1.0 + 2.0 \rightarrow 3.0$
 - $1 + 2.0 \rightarrow 3.0$
- If strings, concatenate them
 - “Comp” + “110” \rightarrow “Comp110”
- The result **type** depends on the operands
 - float + float \rightarrow float
 - int + int \rightarrow int
 - float + int \rightarrow float
 - int + float \rightarrow float
 - str + str \rightarrow str

Question: What happens when you try to add incompatible types?

Subtraction/Negation -

- Meant strictly for numerical types
 - $3 - 2 \rightarrow 1$
 - $4.0 - 2.0 \rightarrow 2.0$
 - $4.0 - 2 \rightarrow 2.0$
 - $- (1 + 1) \rightarrow -2$
- The result **type** depends on the operands
 - float - float \rightarrow float
 - int - int \rightarrow int
 - float - int \rightarrow float
 - int - float \rightarrow float

Multiplication *

- If numerical objects, multiply the values
 - $1 * 1 \rightarrow 1$
 - $1.0 * 2.0 \rightarrow 2.0$
 - $1.0 * 2 \rightarrow 2.0$
- If string and int, repeat the string int's number of times
 - `"Hello" * 3` → "HelloHelloHello"
- The result **type** depends on the operands
 - `float * float` → float
 - `int * int` → int
 - `float * int` → float
 - `int * float` → float
 - `str * int` → str

Question: What happens when you try `str * float`?

Division /

- Meant strictly for numerical types
 - $3 / 2 \rightarrow 1.5$
 - $4.0 / 2.0 \rightarrow 2.0$
 - $4 / 2 \rightarrow 2.0$
- Division results in a float
 - float / float → float
 - int / int → float
 - float / int → float
 - int / float → float
- For integer division // , the result type depends on the operands
 - int // int → int
 - float // float → float
 - float // int → float
 - int // float → float

Remainder “modulo”

- Calculates the *remainder* when you divide two numbers
- Meant strictly for numerical types
 - $5 \% 2 \rightarrow 1$
 - $6 \% 3 \rightarrow 0$
- The result **type** depends on the operands
 - $\text{int \% int} \rightarrow \text{int}$
 - $\text{float \% float} \rightarrow \text{float}$
 - $\text{float \% int} \rightarrow \text{float}$
 - $\text{int \% float} \rightarrow \text{float}$
- Note:
 - If x is even, $x \% 2 \rightarrow 0$
 - If x is odd, $x \% 2 \rightarrow 1$

Exponentiation **

- Meant strictly for numerical types
 - $2 \text{ ** } 2 \rightarrow 4$
 - $2.0 \text{ ** } 2.0 \rightarrow 4.0$
- The result **type** depends on the operands
 - $\text{float} \text{ ** } \text{float} \rightarrow \text{float}$
 - $\text{int} \text{ ** } \text{int} \rightarrow \text{int}$
 - $\text{float} \text{ ** } \text{int} \rightarrow \text{float}$
 - $\text{int} \text{ ** } \text{float} \rightarrow \text{float}$

Relational Operators

- Always result in a **bool** (True or False) value
- Equals (==) and Not Equal (!=)
 - ! is commonly used in programming languages to represent the word “not”
 - Can be used for all primitive types we’ve learned so far! (bool, int, float, str)
- Greater than (>), at least (>=), less than (<), at most (<=)
 - Just use on **floats** and **ints**
 - (Can *technically* use it on all primitive types, but it might not evaluate in ways you’d expect!)

Relational Operators

Operator	Symbol	Verbalization	True Ex.	False Ex.
	<code>==</code>	Is equal to?	<code>1 == 1</code>	<code>1 == 2</code>
	<code>!=</code>	Is NOT equal to?	<code>1 != 2</code>	<code>1 != 1</code>
	<code>></code>	Is greater than?	<code>1 > 0</code>	<code>0 > 1</code>
	<code>>=</code>	Is at least?	<code>1 >= 0</code> or <code>1 >= 1</code>	<code>0 >= 1</code>
	<code><</code>	Is less than?	<code>0 < 1</code>	<code>1 < 0</code>
	<code><=</code>	Is at most?	<code>0 <= 1</code> or <code>1 <= 1</code>	<code>1 <= 0</code>

Practice: Operators and Expressions

Discuss these questions with your neighbor and jot the answers down.

1. What is the result of evaluating `10 % 3`? What about `10 // 3`? `10 ** 3`?
2. Is there an error in the expression, `"CAMP" + 110`? If so, how would you fix it such that the `+` symbol is evaluated to be **concatenation**?
3. What is the evaluation of the expression `10 / 4`? What types are the operands (`10` and `4`), what type does the expression evaluate to?
4. What is the evaluation of the expression `2 - 6 / 3 + 4 * 5`?

Practice! Simplify and Type

- $2 + 4 / 2 * 2$
- $220 \geq \text{int}((“1” + “1” + “0”) * 2)$

Simplify: $2 + 4 / 2 * 2$

(Reminder: P E M D A S)

Simplify: $2 + 4 / 2 * 2$

What type is $2 + 4 / 2 * 2$?

Simplify:

$220 \geq \text{int}((“1” + “1” + “0”) * 2)$

Mods Practice! Simplify

- $7 \% 2$
- $8 \% 4$
- $7 \% 4$
- Any even number $\% 2$
- Any odd number $\% 2$