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
`**`	Exponentiation	`2 ** 8` equivalent to 2^8
`*`	Multiplication	`10 * 3`
`/`	Division	`7 / 5` result is `1.4`
`//`	Integer Division	`7 // 5` result is `1`
`%`	Remainder “modulo”	`7 % 5` result is `2`
`+`	Addition	`1 + 1`
`-`	Subtraction	`111 - 1`
`-`	Negation	`-(1 + 1)` 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 → 3.0
  - 1 + 2.0 → 3.0
- If strings, concatenate them
  - “Comp” + “110” → “Comp110”
- The result type depends on the operands
  - float + float → float
  - int + int → int
  - float + int → float
  - int + float → float
  - str + str → str

Addition +

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

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

Subtraction/Negation -

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

Multiplication *

- If numerical objects, multiply the values
  - 1 * 1 → 1
  - 1.0 * 2.0 → 2.0
  - 1.0 * 2 → 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 → 1.5
  - 4.0 / 2.0 → 2.0
  - 4 / 2 → 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 → 1
  - 6 % 3 → 0
- The result type depends on the operands
  - int % int → int
  - float % float → float
  - float % int → float
  - int % float → float
- Note:
  - If x is even, x % 2 → 0
  - If x is odd, x % 2 → 1

Exponentiation **

- Meant strictly for numerical types
  - 2 ** 2 → 4
  - 2.0 ** 2.0 → 4.0
- The result type depends on the operands
  - float ** float → float
  - int ** int → int
  - float ** int → float
  - int ** float → 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.
`==`	Is equal to?	`1 == 1`	`1 == 2`
`!=`	Is NOT equal to?	`1 != 2`	`1 != 1`
`>`	Is greater than?	`1 > 0`	`0 > 1`
`>=`	Is at least?	`1 >= 0` or `1 >= 1`	`0 >= 1`
`<`	Is less than?	`0 < 1`	`1 < 0`
`<=`	Is at most?	`0 <= 1` or `1 <= 1`	`1 <= 0`

Practice: Operators and Expressions

"modulo" integer division exponentiation

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`?

   1 3 1,000

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?

   2.5

4. What is the evaluation of the expression `2 - 6 / 3 + 4 * 5`?

   2 - 2.0 + 20

   0.0 + 20 20.0

Practice! Simplify and Type

- `2 + 4 / 2 * 2`

  `2 + 2.0 * 2`

  `2 + 4.0`

  `6.0`

- `220 >= int(("1" + "1" + "0") * 2)`

  Start w/ the inner-most parentheses!

  `220 >= int("110" * 2)`

  `220 >= int("110110")`

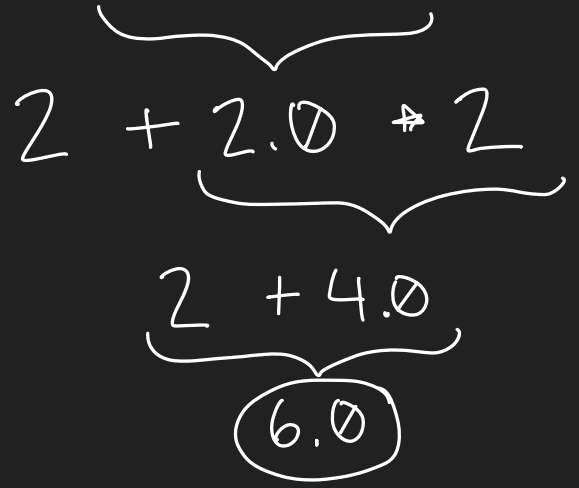
  `220 >= 110110`

  False

Simplify: 2 + 4 / 2 * 2

(Reminder: P E M D A S)

Simplify: 2 + 4 / 2 * 2



What type is 2 + 4 / 2 * 2?

It evaluates to a float!

Simplify:

220 >= int((“1” + “1” + “0”) * 2)

220 >= int(“110” * 2)

220 >= int(“110110”)

220 >= 110110

False

Mods Practice! Simplify

- 7 % 2 1
- 8 % 4 0
- 7 % 4 3
- Any even number % 2 0
- Any odd number % 2 1