CMSC201
Computer Science I for Majors

Lecture 04 – Expressions

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Based on slides by Shawn Lupoli and Max Morawski at UMBC
Last Class We Covered

• Variables
  – Rules for naming
  – Different types
  – How to use them

• Printing output to the screen

• Getting input from the user
  – Mad Libs
Any Questions from Last Time?
Today’s Objectives

• To learn more about expressions
• To learn Python’s operators
  – Including mod and integer division
• To understand the order of operations
• To learn more about types
  – How to cast to a type
• To understand the use of constants
Expressions

• Expressions are code that produces or calculates new data and data values

• Allow us to program interesting things

• Always on the right hand side of the assignment operator
Pop Quiz!

• Which of the following examples are correct?

1. $500 = \text{numStudents}$
2. $\text{numStudents} = 500$
3. $\text{numCookies} \times \text{cookiePrice} = \text{total}$
4. $\text{mpg} = \text{miles}_{\text{driven}} / \text{gallons}_{\text{used}}$
5. "$\text{Hello World!}" = \text{message}$
6. $\_\text{CMSC201_doge}_\_ = "\text{Very learning}"$
7. $60 \times \text{hours} = \text{days} \times 24 \times 60$
Python’s Operators
Python Basic Operators

• Operators are the constructs which can manipulate the value of operands
• Consider the expression:

\[ \text{num} = 4 + 5 \]

• Here, \texttt{num} is the operand and + is the operator
Types of Operators in Python

- **Arithmetic Operators**
- Comparison (Relational) Operators
- Assignment Operators
- Logical Operators
- Bitwise Operators
- Membership Operators
- Identity Operators

Focus of today’s lecture
## Operators in Python

<table>
<thead>
<tr>
<th>Operator</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>Addition</td>
</tr>
<tr>
<td>-</td>
<td>Subtraction</td>
</tr>
<tr>
<td>*</td>
<td>Multiplication</td>
</tr>
<tr>
<td>/</td>
<td>Division</td>
</tr>
<tr>
<td>//</td>
<td>Integer division</td>
</tr>
<tr>
<td>%</td>
<td>Modulo (remainder)</td>
</tr>
<tr>
<td>**</td>
<td>Exponentiation</td>
</tr>
</tbody>
</table>
Operators – Addition & Subtraction

• “Lowest” priority in the order of operations
  –Can only change this with parentheses
• Function as they normally do

• Examples:
  1. \( \text{cash} = \text{cash} - \text{bills} \)
  2. \( (5 + 7) / 2 \)
  3. \( ((2 + 4) * 5) / (9 - 6) \)
Operators – Multiplication & Division

• Higher priority in the order of operations than addition and subtraction
• Function as they normally do

• Examples:
  1. \( \text{tax} = \text{subtotal} \times 0.06 \)
  2. \( \text{area} = \pi \times (\text{radius} \times \text{radius}) \)
  3. \( \text{tsp} = \text{tbsp} \times 3 \)
Operators – Integer Division

• Reminder: integers (or ints) are **whole numbers**
  – What do you think integer division is?

• Remember division in grade school?

• Integer division is division without decimals, and in which we discard the remainder from our answer
Examples: Integer Division

- Integer division uses double slashes (//)

Examples:

1. \( 7 \div 5 = 1.4 \)
2. \( 7 \div\!\!\!\! 5 = 1 \)
3. \( 2 \div 8 = 0.25 \)
4. \( 2 \div\!\!\!\! 8 = 0 \)
5. \( 4 \div\!\!\!\! 17 \div\!\!\!\! 5 = 0 \)

Evaluate from left to right.
Operators – Modulo

• Also called “modulo,” “modulus,” or “mod”

• Example: $17 \mod 5 = 2$
  – What do you think mod does?

• Remember division in grade school?

• Mod gives you the remainder from integer division
Examples: Mod

• Mod uses the percent sign (％)

• Examples:

1. 7 % 5 = 2
2. 5 % 9 = 5
3. 17 % 6 = 5
4. 22 % 4 = 2
5. 48692451673 % 2 = 1
Operators – Exponentiation

• “Exponentiation” is just another word for raising one number to the power of another

• Examples:
  
  1. binary8 = 2 ** 8
  2. squareArea = squareLen ** 2
  3. cubeVolume = squareLen ** 3
Order of Operations

• Expressions are evaluated in what direction?

<table>
<thead>
<tr>
<th>Operator(s)</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>**</td>
<td>highest</td>
</tr>
<tr>
<td>/ * // %</td>
<td></td>
</tr>
<tr>
<td>+ -</td>
<td>lowest</td>
</tr>
</tbody>
</table>

• What can change this ordering?
  – Parentheses
Types in Python
Variable Types

• There are many different kinds of variables!
  – Numbers
    • Whole numbers (Integers)
    • Decimals (Floats)
  – Boolean (True and False)
  – Strings (collections of characters)
Finding a Variable’s Type

• To find what type a variable is, use `type()`

• Example:

  `>>> a = 3.0  >>> b = "moo"`
  `>>> type(a)  >>> type(b)`
  `<class 'float'>  <class 'str'>`
Division: Floats and Integers

• Floats (decimals) and integers (whole numbers) behave very differently in Python
  – And in many other programming languages

• Biggest difference is with how division works
  – In Python 2, all integers use integer division
  – In Python 3, we have to explicitly call integer division
    • Otherwise, we perform decimal division
  – Floats automatically perform decimal division
Division Examples

• What do the following expressions evaluate to?

1. $\frac{4}{3} = 1.3333333333333333$
2. $4 \div 3 = 1$
3. $4 \div 3.0 = 1.0$
4. $\frac{8}{3} = 2.6666666666666667$
5. $\frac{8}{2} = 4$
6. $\frac{5}{7} = 0.7142857142857143$
7. $5 \div 7 = 0$
Floating Point Errors

• In base 10, some numbers are approximated:
  – 0.66666666666666666666666667...
  – 3.14159265358979323846264338328...

• The same is true for base 2
  – 0.00011001100110011001100... (0.1 in base 10)

• This leads to rounding errors with floats
  – Don’t compare floats after you’ve done division!
Casting to a Type

- We can change a variable from one type to another using casting.

Example:

```python
>>> e = 2.718
>>> int(e)
2
>>> str(e)
'2.718'
```

Type you want to cast to, then the variable to cast “change e to an integer”
Constants
What are Constants?

• Constants are values that are **not** generated by the user or by the code
  – But are used a great deal in the program

• Constants should be ALL CAPS with a ‘_’ (underscore) to separate the words
  – Coding standards
Using Constants

- Calculating the total for a shopping order

```python
MD_TAX = 0.06
subtotal = input("Enter subtotal:")
tax = subtotal * MD_TAX
total = tax + subtotal
print("Your total is:", total)
```

Easy to change if the tax rate changes. We know exactly what this number is for.
“Magic” Numbers

• “Magic” numbers are numbers used directly in the code – should be replaced with constants

• Examples:
  – Mathematical numbers (pi, e, etc.)
  – Program properties (window size, min and max)
  – Important values (tax rate, maximum number of students, credits required to graduate, etc.)
“Magic” Numbers Example

• You’re looking at the code for a virtual casino
  – You see the number 21
  – What does it mean?

• Blackjack? Drinking age? VIP room numbers?

• Also helpful if the drinking age changes – why?
  – Don’t have to figure out which “21”s to change
Are Constants Really Constant?

• In some languages (like C, C++, and Java), you can create variables that CANNOT be changed

• This is not possible with Python variables
  – Part of why coding standards are so important
  – If you see code that changes the value of a variable called \texttt{MAX\_ENROLL}, you know that’s a constant, and shouldn’t be changed
Quick Note: Version of Python

• Before you run any Python code, you need to tell GL you want to use Python 3 instead:
  `/usr/bin/scl enable python33 bash`

• You can double-check which version with the command `python -v`
  – It will print out a bunch of text, but near the bottom you should see “Python 3.3.2”
Announcements

• Your Lab 2 is an online lab this week!
  – Due by this Friday (Sept 11th) at 8:59:59 PM

• Homework 2 is out
  – Due by Tuesday (Sept 15th) at 8:59:59 PM

• Both of these assignments are on Blackboard
  – Weekly Agendas are also on Blackboard