COMP 204

Variables

Yue Li,
based on material from Mathieu Blanchette, Carlos Oliver and
Christopher Cameron
Quiz 4 password
# Basic operations on numbers and strings

## Operations on numbers:

<table>
<thead>
<tr>
<th>Operations</th>
<th>Example</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition</td>
<td>7 + 12</td>
<td>19</td>
<td>int</td>
</tr>
<tr>
<td>Subtraction</td>
<td>3.14 - 2.78</td>
<td>0.3600000000000003</td>
<td>float</td>
</tr>
<tr>
<td>Multiplication</td>
<td>2 * 3.1416</td>
<td>6.2832</td>
<td>float</td>
</tr>
<tr>
<td>Division</td>
<td>33 / 8</td>
<td>3.3</td>
<td>float</td>
</tr>
<tr>
<td></td>
<td>33 / 11</td>
<td>3.0</td>
<td>float</td>
</tr>
<tr>
<td>Modulus</td>
<td>27 % 10</td>
<td>7</td>
<td>int</td>
</tr>
<tr>
<td>Exponentiation</td>
<td>4**3</td>
<td>$4^3 = 64$</td>
<td>int</td>
</tr>
<tr>
<td>Combination</td>
<td>2 + 6 * 2 - 8**2 / 4</td>
<td>-2.0</td>
<td>float</td>
</tr>
<tr>
<td></td>
<td>(2 + 6) * (2 - 8**2 / 4)</td>
<td>-112.0</td>
<td>float</td>
</tr>
</tbody>
</table>

## Precedence of arithmetic operators:

Exponentiation > multiplication/division > addition/subtraction

Use parentheses to group terms as desired

## String Operations:

<table>
<thead>
<tr>
<th>Operations</th>
<th>Example</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concatenation</td>
<td>'Hello' + 'World'</td>
<td>'HelloWorld'</td>
<td>str</td>
</tr>
</tbody>
</table>
Basic operations on booleans

► Conjunction (\textbf{and})

\begin{align*}
\text{True and True} & \quad \# \quad \text{True} \\
\text{True and False} & \quad \# \quad \text{False} \\
\text{False and True} & \quad \# \quad \text{False} \\
\text{False and False} & \quad \# \quad \text{False}
\end{align*}

► Disjunction (\textbf{or})

\begin{align*}
\text{True or True} & \quad \# \quad \text{True} \\
\text{True or False} & \quad \# \quad \text{True} \\
\text{False or True} & \quad \# \quad \text{True} \\
\text{False or False} & \quad \# \quad \text{False}
\end{align*}

► Negation (\textbf{not})

\begin{align*}
\text{not True} & \quad \# \quad \text{False} \\
\text{not False} & \quad \# \quad \text{True}
\end{align*}
Comparisons

A comparison is an operation that compares two objects and yields a boolean value.

- **Test equality**

  ```python
  # Note the use of double–equal sign
  3.14 == 3.14  # True
  'ACTG' == 'GTCA'  # False
  'ACTG' == 'acgt'  # False
  ```

- **Test non-equality**

  ```python
  3.14 != 3.1416  # True
  'ACGT' != 'ACGT'  # False
  ```

- **Smaller-than, smaller-or-equal**

  ```python
  3.14 < 3.1416  # True
  3.14 > 3.14  # False
  3.14 <= 3.14  # True
  'ACGT' < 'ACTT'  # True
  ```
Mixing it up

Manually check them and check them in Python shell

\[(2\times3.14) < 6 \quad \text{and} \quad 'TGA' == 'TGA' \quad \# \quad \text{False}\]
\[((2\times3.14) < 6 \quad \text{or} \quad (17-3==14)) \quad \text{and} \quad 'TGA' == 'TGA' \quad \# \quad \text{True}\]
\text{not} \quad ( 'TGA' == 'TGA' \quad \text{or} \quad 'TGA' \quad != \quad 'TGA' ) \quad \# \quad \text{False}\]
\'AA' > 4 \quad \# \quad \text{TypeError: '>' not supported between instances of 'str' and 'float'}

▶ So Python is just a fancy calculator?
   No! Programming is about linking multiple operations together
▶ For this, it is useful to be able to save to memory the results of an operation
▶ To this end, we use variables
Variables

Variables allow a program to remember values throughout the execution of the program. This is how a program uses the computer’s memory. A variable has a *name* and a *value.* A program can

- Create new variables
- Set the value of variables
- Look up the value of variables to include them in expressions
- Change the value of variables (hence the name)
Example of Variable: calculate the molecular mass of CO$_2$

```python
weightCarbon = 12
# This creates a variable weightCarbon, assigns it value 12

weightOxygen = 16
# This creates a variable weightOxygen, assigns it value 16

print('The weight of carbon is:', weightCarbon)
# This looks up the value of variable weightCarbon, performs the print statement

print('The weight of oxygen is:', weightOxygen)

weightCO2 = weightCarbon + 2 * weightOxygen
# This first evaluates the right-hand side, based on the current values of weightCarbon and weightOxygen. This yields 44.
# It then creates the variable weightCO2 and assign it the value 44.
# Nothing gets printed so far

print('The weight of CO2 is:', weightCO2)
```
Example of Variable: calculate the molecular mass of $CO_2$

weightCarbon = 12
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print('The weight of CO2 is:', weightCO2)
Example of Variable: calculate the molecular mass of CO₂

weightCarbon = 12
# This creates a variable weightCarbon, 
# assigns it value 12

weightOxygen = 16
# This creates a variable weightOxygen, 
# assigns it value 16

print('The weight of carbon is:', weightCarbon)
# This looks up the value of variable weightCarbon, 
# performs the print statement

print('The weight of oxygen is:', weightOxygen)

weightCO2 = weightCarbon + 2 * weightOxygen
# This first evaluates the right-hand side, 
# based on the current values of weightCarbon 
# and weightOxygen. This yields 44. 
# It then creates the variable weightCO2 
# and assign it the value 44. 
# Nothing gets printed so far

print('The weight of CO₂ is:', weightCO2)
weightCarbon = 12
weightOxygen = 16
print('The weight of carbon is:', weightCarbon)
print('The weight of oxygen is:', weightOxygen)
weightCO2 = weightCarbon + 2 * weightOxygen
print('The weight of CO2 is:', weightCO2)

# Improved measurement of atomic masses
weightCarbon = 12.001
print('The weight of CO2 is:', weightCO2)
# weightCO2 remains 44
weightCarbon = 12
weightOxygen = 16
print('The weight of carbon is:', weightCarbon)
print('The weight of oxygen is:', weightOxygen)
weightCO2 = weightCarbon + 2 * weightOxygen
print('The weight of CO2 is:', weightCO2)

# Improved measurement of atomic masses
weightCarbon = 12.001
print('The weight of CO2 is:', weightCO2)
# weightCO2 remains 44

weightCO2 = weightCarbon + 2 * weightOxygen
# now weightCO2 becomes 44.001
print('The weight of CO2 is:', weightCO2)

Change of value in one variable will affect values of other variables involving that variable
Variables - example 2

Goal: Write a program that computes the body mass index (BMI) of a person: \( BMI = \frac{weight}{(height^2)} \)

weight = 69
height = 1.8
BMI = weight/(height**2)

```python
print('A person with weight', weight, 'and height', height, 'has BMI =', BMI)
```

weight = 74  # suppose the weight changes
# The value of BMI still has not changed
print('A person with weight', weight, 'and height', height, 'has BMI =', BMI)

# We need to recalculate BMI to get the correct BMI
BMI = weight/(height**2)
print('A person with weight', weight, 'and height', height, 'has BMI =', BMI)
Live Demo in Wing101
Variables - example 3 (user input)

Goal: Write a program that asks the user for their weight and height and then computes BMI.
How? Use the input(String) function, which prompts the user to enter data, and returns the string that was typed.

```python
weight = input('Please enter your weight (in kg): ')
height = input('Please enter your height (in m): ')
BMI = weight/(height**2)
print('Your BMI is', BMI)
```

Problem: We get a runtime error: 
TypeError: unsupported operand type(s) for ** or pow(): 'str' and 'int'
Use the Python shell to find out what the type of the weight and height variables are.

```python
type(weight) # Aha, it's a String, not an integer
type(height) # and this one too!
```

That's because the input function always produces a string, irrespective of what is actually typed by the user.
Converting between types

Python allows data to be converted from one type to another using type conversion functions:

- `int(someObject)` # convert someObject to an integer
- `float(someObject)` # convert someObject to a float
- `str(someObject)` # convert someObject to a string

Example,

- `name='Yue'` # name is a String
- `weight='66'` # weight is a String
- `height='1.8'` # height is a String
- `weightInt = int(weight)` # weightInt is an integer 68
- `heightFloat = float(height)` # heightInt is a float 1.8
- `heightInt = int(height)` # heightInt is an integer 1

#Note: int() truncates decimal values
- `nameInt = int(name)` # this causes an error, because # the content of name cannot be converted to number
BMI program corrected

We use the type conversion functions to convert the output of the input function to float.

```python
weight = input('Please enter your weight (in kg): ')
weightFloat = float(weight)
height = input('Please enter your height (in m): ')
heightFloat = float(height)
BMI = weightFloat/(heightFloat**2)
print('Your BMI is ' ,BMI)
```

Or more succinctly, we directly convert the output of the input function to a float, without saving the String in a variable:

```python
weight = float(input('Please enter your weight (in kg): '))
height = float(input('Please enter your height (in m): '))
BMI = weight/(height**2)
print('Your BMI is ' ,BMI)
```
Live Demo in Wing101
Sneak peak of Assignment 1