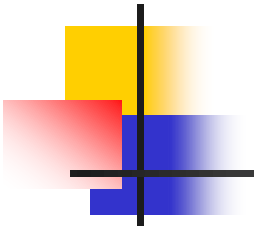

Introduction to Programming

Department of Computer Science and Information Systems

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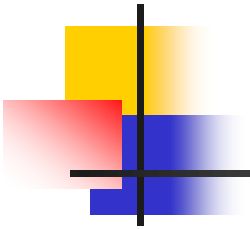
Autumn 2019 and Spring 2020

Week 4: More Arithmetic and Input

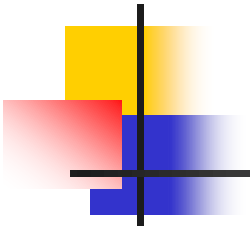


Recall Operators and Expressions

- Operators: +, -, *, /, %, //, **
- Example of an expression:

  (p+4)*5

  where 4, 5 are number literals and p is a variable
- If p is assigned a numerical value then the expression can be evaluated to yield a number



Recall Precedence of Operators

- In order of decreasing precedence

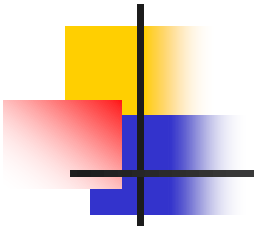
  exponentiation **

  multiplication and division * / // %

  addition and subtraction + -

- If in any doubt then use brackets,

  3-5-6 = (3-5)-6



Recall Built-in Functions

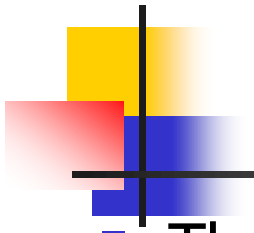
The following functions are always available

- abs(-5)
  - # returns 5
- round(3.4)
  - # returns 3
- round(3.452, 2)
  - # returns 3.45
- max(1, 5, 2, 9, 3)
  - # returns 9
- min(1, 5, 2, 9, 3)
  - # returns 1

Arithmetic Expression Examples

Mathematical Expression	Python Expression	Comments
$\frac{x+y}{2}$	(x+y)/2	Parentheses required. x+y/2 has the value x+(y/2)
$\frac{xy}{2}$	x*y/2	Parentheses not required. Operators with the same precedence are evaluated left to right
$\left(1+\frac{r}{100}\right)^{n}$	(1+r/100)**n	Parentheses are required
$\sqrt{a^2+b^2}$	sqrt(a**2+b**2)	Import the sqrt function from the math module
π	pi	pi is a constant declared in the math module

Balanced Parentheses



- The following formula

  ((a+b)*t/2*(1-t)

  is not correct. The parentheses are not balanced.

- Check: count from left to right starting at 0, add 1 for a left bracket, subtract 1 for a right bracket. In this case,

  0 1 2 1 2 1

- What about (a+b))*(t/2*(1-t)?

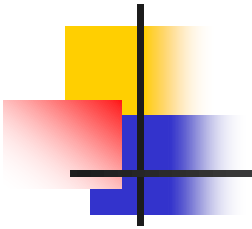
  0 1 0 -1 0 1 0

- The parentheses are balanced if and only if
  - the count is always non-negative and
  - the final count is 0

Examples of Function Calls

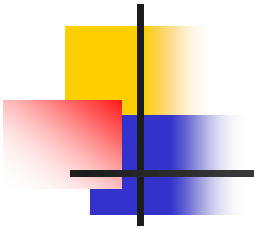
- price = 124
  rate = 0.173
  tax1 = round(price*rate, 2) # price*rate = 21.452
  # round to 2 decimal places
  tax2 = round(price*rate)
  # round to the nearest integer
  # The value of tax1 is 21.45. The value of tax2 is 21.

- best = min(price1, price2, price3, price4)
  # The function min has an arbitrary number of arguments



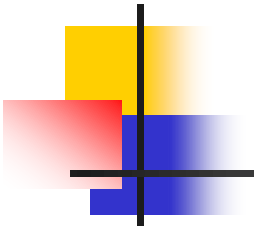
Standard Library

- All Python systems have the standard library
- The standard library contains built in functions that can be used immediately in your programs, e.g. abs, float, int, input, min, max, print, round …
- The standard library also contains a math module with functions such as sqrt, cos, sin, tan, exp, etc.
- See PFE Appendix D



Selected Functions in the Math Module

Function	Returns
sqrt(x)	The square root of x $(x \geq 0)$
trunc(x)	Truncates floating-point value x to an integer
cos(x)	The cosine of x radians
sin(x)	The sine of x radians
tan(x)	The tangent of x radians
exp(x)	e^x
degrees(x)	Convert x radians to degrees (returns x $180/\pi$)
radians(x)	Convert x degrees to radians (returns x $\pi/180$)
log(x) log(x, base)	The natural logarithm of x (to base e) or the logarithm of x to the given base



Obtaining a math Module Function

- To use e.g. sqrt, put this statement at the top of the program

```
from math import sqrt
```

- Multiple functions can be obtained using a single statement

```
from math import sqrt, sin, cos
```

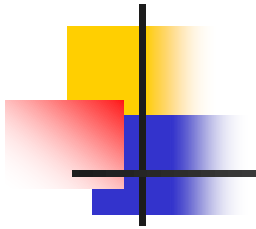
- To obtain everything use

```
from math import *
```

- See PFE Appendix D, math Module

Exercise

- Write the following mathematical expressions in Python
- $s = s_0 + v_0 t + \frac{1}{2} g t^2$
- $G = 4\pi^2 \frac{a^3}{p^2(m_1+m_2)}$
- $FV = PV\left(1 + \frac{INT}{100}\right)^{YRS}$
- $c = \sqrt{a^2 + b^2 - 2a\,b\cos(\gamma)}$

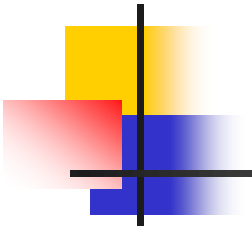


Roundoff Errors

```
price = 4.35
quantity = 100
total = price * quantity    # Should be 100 * 4.35 = 435
print(total)                 # Prints 434.99999999999994

# The number 4.35 cannot be represented exactly as a
# binary floating point number
```

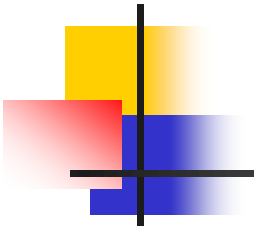
User Input

```
first  = input("Enter your first name: ")
# The input function displays the string argument (prompt) in
# the console window and places the cursor on the same line,
# immediately following the string.

Enter your first name: _
# The program waits until the user types a string followed
# by Enter. The string is stored as the value of first.
```



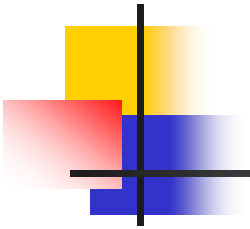
Numerical Input

```
userInput  = input("Please enter the number of bottles: ")
bottles = int(userInput)
# The input function reads in a string and returns the string to
# the calling program. The function int converts the string to
# an integer.
bottles = int(input("Please enter the number of bottles: "))

userInput2 = input("Enter price per bottle: ")
price = float(userInput2)
# The function float converts the string to a floating point value.
price = float(input("Enter price per bottle: "))
```



The Function int

```
print(int("5"))
# print 5

print(int("test"))
# invalid literal for int

print(int(7.6))
# truncate to 7, not round to 8

print(int(-7.6))
# truncate to -7, not round to -8

print(int("5.6"))
# invalid literal for int, one-step transformation only
```



Description of int in Appendix D

The Python Standard Library

Built-in Functions

int(x)

This function converts a number or string to an integer.

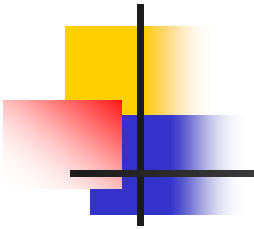
Parameter: x A string or numerical value

Returns: The new integer object

The Function float

```
print(float("5"))
# print 5.0

print(float("7.6"))
# print 7.6

print(float(7.6))
# print 7.6

print(float("test"))
# ValueError: could not
# convert string to float

print(float("3E2"))
# print 300.0

print(float("3e2"))
# print 300.0
```

Remark: print(int("5.6")) error, but print(float("5")) works



Vending Machine

Write a program that simulates a vending machine.

A customer selects an item for purchase and inserts a bill into the vending machine. The vending machine dispenses the purchased item and gives change.

Assumption 1: only one bill is inserted to purchase an item

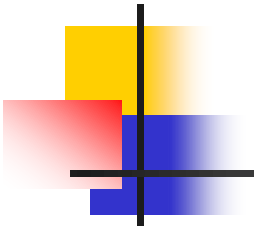
Assumption 2: only one item is purchased at a time

Assumption 3: the bill is no less than the purchase price

Assumption 4: all item prices are multiples of 25 cents

Assumption 5: the machine gives all change in dollar coins (1 dollar) and quarters (25 cents).

Compute how many coins of each type to return

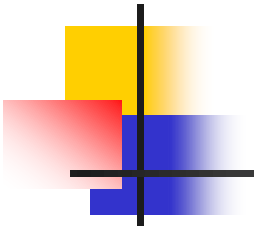


Preliminaries

Step 1: identify inputs and outputs.

Step 2: Work out an example by hand, e.g. the item costs $2.25 and a $5 bill is inserted.

Step 3: Write pseudo code for computing the answers.



Coding

Step 4: Declare the variables and constants that are needed.

Step 5: Turn the pseudo code into Python statements.

Step 6: Provide input and output.

Step 7: Write the program.