Python Tutorial

- Python Data Types
- Python Control Structures
- Python Functions and Modules

Temperature Converter: Example Program

- Problem Analysis
  - the temperature is given in Celsius, user wants it expressed in degrees Fahrenheit
- Program Specification
  - Input – temperature in Celsius
  - Output – temperature in Fahrenheit: 9/5(input) + 32

```
>>> def main():
        celsius = eval(input("What is the Celsius temperature? "))
        fahrenheit = (9/5) * celsius + 32
        print("The temperature is ",fahrenheit," degrees Fahrenheit.")

>>> main()
What is the Celsius temperature? 0
The temperature is  32.0  degrees Fahrenheit.
>>> main()
What is the Celsius temperature? 100
The temperature is  212.0  degrees Fahrenheit.
```

Python Syntax

- **Functions** are defined by “def” keyword
- No braces “{}” for scopes unlike C
- Purple keywords (highlighted in IDLE) are Python’s **built-in functions**
  - Other examples include return

```
def main():
    celsius = eval(input("What is the Celsius temperature? "))
    fahrenheit = (9/5) * celsius + 32
    print("The temperature is ",fahrenheit," degrees Fahrenheit.")
```

Elements of Programs: Input Statements [1/2]

User Input: 사용자가 화면에 입력한 값을 프로그램의 변수에 저장

input의 사용

```
>>> a = input()
Life is too short, you need python
>>> a
'Life is too short, you need python'
>>>
```

input은 입력되는 모든 것을 문자열로 취급한다.

```
>>> number = input("숫자를 입력하세요: ")
숫자를 입력하세요: 3
>>> print(number)
3
>>>
```

Elements of Programs: Input Statements [2/2]

- The purpose of an input statement is to get input from the user and store it into a variable

  <variable> = eval(input(<prompt>))

  - First the prompt is printed
  - The `input` part waits for the user to enter a value and press <enter>
  - The expression that was entered is `eval`uated to turn it from a string of characters into a Python value (a number)
  - The value is assigned to the variable

  - >> x = input(“type your value:”)

  - >> x = eval(input(“type your value:”))

Elements of Programs: Identifiers [1/2]

- Names
  - Names are given to variables (celsius, fahrenheit), modules (main, convert), etc
  - These names are called **identifiers**
  - Every identifier must begin with a letter or underscore ("_"), followed by any sequence of letters, digits, or underscores
  - Identifiers are **case sensitive**

- These are all different, valid names
  - X Celsius fahrenheit
  - Spam spam spAm
  - Spam_and_Eggs Spam_And_Eggs

Elements of Programs: Identifiers [2/2]

- Reserved Words
  - Some identifiers are part of Python itself. These identifiers are known as **reserved words or keywords**
  - This means they are not available for you to use as a name for a variable, etc. in your program

and	del	for	is	raise
assert	elif	from	lambda	return
break	else	global	not	try
class	except	if	or	while
continue	exec	import	pass	yield
def	finally	in	print	

Table 2.1: Python Reserved Words.

Elements of Programs: Expressions

- The fragments of code that produce or calculate new data values are called expressions
- Literals are used to represent a specific value, e.g. 3.9 or 1 or 1.0
- Simple identifiers can also be expressions

```
>>> x = 5
>>> x
5
>>> print(x)
5
```

Elements of Programs: Output Statements [1/2]

User Output: 프로그램의 변수를 화면에 출력하는 작업

```
>>> a = 123
>>> print(a)
123
>>> a = "Python"
>>> print(a)
Python
>>> a = [1, 2, 3]
>>> print(a)
[1, 2, 3]
```

큰따옴표(")로 둘러싸인 문자열은 + 연산과 동일하다

```
>>> print("life" "is" "too short") # ①
lifeistoo short
>>> print("life"+"is"+"too short") # ②
lifeistoo short
```

문자열 띄어쓰기는 콤마로 한다

```
>>> print("life", "is", "too short")
life is too short
```

```
>>> for i in range(10):
...     print(i, end=' ')
...
0 1 2 3 4 5 6 7 8 9
```

Elements of Programs: Output Statements [2/2]

- A print statement can print any number of expressions
- Successive print statements will display on separate lines
- A bare print will print a blank line

- `print(3+4)` ➔ `>> 7`
- `print(3, 4, 3+4)` ➔ `>> 3, 4, 7`
- `print()` ➔ `>>`
- `print("The answer: ", 3+4)` ➔ `>> The answer: 7`

Special Characters in String Data Types

"\n" → new line character (enter key)
"\t" → TAB character (tab key)

In IDLE , typing \ shows ₩

```
>>> x="te₩n₩nst"
>>> x
'te₩n₩nst'
>>> print(x)
te

st
```

```
>>> x="test₩t₩ttest"
>>> print(x)
test            test
>>>
```

Elements of Programs: Assignment Statements

- Simple Assignment
  - <variable> = <expr>
  - <variable> is an identifier, <expr> is an expression

- The expression on the RHS is evaluated to produce a value which is then associated with the variable named on the LHS

```
x = 3.9 * x * (1-x)
fahrenheit = 9/5 * celsius + 32
x = 5
```

Elements of Programs: Simultaneous Assignment

- Several values can be calculated at the same time
  - <var>, <var>, … = <expr>, <expr>, …
  - Evaluate the expressions in the RHS and assign them to the variables on the LHS

```
sum, diff = x+y, x-y
```

- How could you use this to swap the values for x and y?
  - Would this work?

    x = y

    y = x
- We could use a temporary variable…
- Or We can swap the values of two variables quite easily in Python!

```
x, y = y, x
>>> x = 3
>>> y = 4
>>> print (x, y)
3 4
>>> x, y = y, x
>>> print (x, y)
4 3
```

Elements of Programs: Definite Loops [1/2]

- A *definite* loop executes a definite number of times
  - i.e., at the time Python starts the loop it knows exactly how many *iterations* to do

for <var> in <sequence>:
    <body>

- The beginning and end of the body are indicated by **indentation**
- Examples

```
>>> for i in [0,1,2,3]:
        print (i)


0
1
2
3
```

```
>>> for odd in [1, 3, 5, 7]:
        print(odd*odd)


1
9
25
49

>>>
```

Elements of Programs: Definite Loops [2/2]

- Python built-in function range() returns a range object
- Python built-in function list() returns a list of things inside the paranthesis

```
>>> list(range(10))
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

```
for i in range(4):
```

is equivalent to

```
for i in [0, 1, 2, 3]:
```

```
>>> answer = []
    for i in range(1,10):
        answer.append(str(i))
```

참고: answer = answer.append(str(i)) 는 error!
왜냐하면 append는 answer에 append하는것이고 return은 없으므로

Numeric Data Types

- Types (= classes)
  - Integers (int) – whole numbers
    - E.g. 3, 5
  - Floating point values (float) – with decimal point
    - E.g. 3.1, 5.1, 6.

- Types can be probed using "type()" built-in function

```
>>> type(3)
<class 'int'>
>>> type(3.1)
<class 'float'>
>>> type(3.0)
<class 'float'>
```

Numeric Data Types: Operations

- Operations on ints produce ints, operations on floats produce floats (except for /).

```
>>> 10.0/3.0
3.3333333333333335
>>> 10/3
3.3333333333333335
>>> 10 // 3
3
>>> 10.0 // 3.0
3.0
>>> 3.0 + 4
 7.0
>>> 3.0+4.0
7.0
>>> 3.0*4.0
12.0
>>> 3*4
12
```

Boolean Data Type and Expression

- There is additional type called *bool* – it's either **True** or **False**

```
>> type(True)
<class 'bool'>
```

- Boolean expressions are always evaluated to **True** or **False**
- Format: `<expr> <rel-op> <expr>`

Python	Mathematics	Meaning
<	<	Less than
<=	≤	Less than or equal to
==	=	Equal to
>=	≥	Greater than or equal to
>	>	Greater than
!=	≠	Not equal to

Boolean Expressions: Comparisons by Types

- Operands in comparison operations should be compatible types
- However, test for equality can be carried out with different types (but returns "False")
- When comparing strings, **the ordering is lexicographic**

```
>> "aaa" > "abb"
False

>> 5 < 2.5
False

>> "a" < 572.0
Traceback (most recent call last):
  File "<pyshell#13>", line 1, in <module>
    "a" < 572.0
TypeError: unorderable types: str() < int()

>> "a" == 572.0
False
```

Boolean Expressions: Multi-operand comparison

· The following compound comparisons are valid expressions in Python

E.g.

```
>> 1 < 5 < 7
True

>> 2 > 1 < 7
True

>> 5 > 4 > 3.2 >= 1 == 1 != 8
True
```

```
If 0 <= number <= 100 :
    print(number)        # 이것도 가능
```

Composite Boolean Expressions

- Boolean operators `and`, `or`, `not`.

```
<expr> and <expr>
<expr> or <expr>
not <expr>
```

- We can represent their semantics (meaning) using a *truth table*

P	*Q*	*P and Q*	*P or Q*	*not Q*
T	T	T	T	F
T	F	F	T	T
F	T	F	T	-
F	F	F	F	-

- The order of operators: not > and > or
- For example,
  - `a or not b and c`
  - `(a or ((not b) and c))`

Boolean Algebra

- Anything `or`ed with true is true:
```
a or true == true
```

- Both `and` and `or` are distributive:
```
a or (b and c) == (a or b) and (a or c)
a and (b or c) == (a and b) or (a and c)
```

- Double negatives cancel out:
```
not(not a) == a
```

- DeMorgan's laws:
```
not(a or b) == (not a) and (not b)
not(a and b) == (not a) or (not b)
```

Boolean Expressions: Evaluating Other Types

- Python will let you evaluate **any built-in data type** as a Boolean
- For numbers (int, float), zero is considered **`False`**, anything else is considered **`True`**
- An empty sequence is considered as False while any non-empty sequence is taken to mean True
- The Boolean operators have operational definitions that make them useful for other purposes

```
>>> bool(0)
False
>>> bool(32)
True
>>> bool("")
False
>>> bool([])
False
```

```
>>> bool(1)
  True
 >>> bool("Hello")
  True
>>> bool([1,2,3])
  True
```

Data Types과 연산

- Basic Data Types
  - Integer
  - Floating Number
  - Boolean
  - Character

우리가 익숙한 mathematical notation으로 연산

Ex: 3 + 4

- Advanced Data Types
  - Tuple
  - String
  - List
  - Dictionary
  - Set

특정 data type에 정의된 function들을 call해서 연산

Ex: myString = "S N U"
myString.split()

- User-Defined Data Types (Classes)
  - Student
  - Automobile
  - ……

특정 data type에 정의된 function들을 call해서 연산

Ex: myAuto = Automobile("GM", "2016", "5Door")
myAuto.

- Library
  - Math
  - Random
  - ….

특정 library에 정의된 function들을 call해서 연산

Ex: import math
math..sqrt(4)

Factorial Program [1/2]

```
# factorial.py
#    Program to compute the factorial of a number
#    Illustrates for loop with an accumulator

def main():

    n = eval(input("Please enter a whole number: "))

    fact = 1
    for factor in range(n,1,-1):
       fact = fact * factor

    print("The factorial of", n, "is", fact)
```

Factorial Program [2/2]

```
>>> main()
Please enter a whole number: 100
The factorial of 100 is
 933262154439441526816992388562667004907159682643
 816214685929638952175999932299156089414639761565
 182862536979208272237582511852109168640000000000
 00000000000000
```

- Interesting thing to note is that Python **expands** integers into biginteger automatically
- Python has **built-in support** for integers exceeding 32-bit or 64-bit

Type Conversions

```
>>> float(22//5)
4.0
>>> float(3)
3.0
>>> float(3.3)
3.3
>>> int(4.5)
4
>>> int(4.9)
4
>>> int(4.1)
4
```

```
>>> int(4.9999999999)
4
>>> int(4)
4
>>> round(3.9)
4
>>> round(3)
3
>>> round(3.5)
4
>>> str(8)
‘8’
```

Some Numeric Computations in Python 3.6 [1/2]

```
>>> 32/32
1.0
>>> 3/2
1.5
>>> 100.0000000
100.0
>>> 100.0
100.0
>>> 100
100
>>> 3/2.0
1.5
>>> 3/2
1.5
```

```
>>> 32//32
1
>>> 3//3
1
```

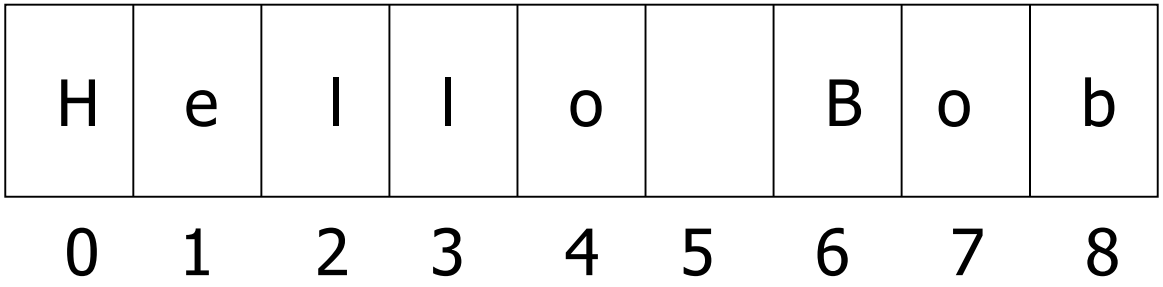
```
>>> 100.0000000
100.0
>>> 100.0
100.0
>>> 100
100
>>> 3/2.0
1.5
>>> float(3/2)
1.5
>>> float(3)/2
1.5
>>> float(5)/4
1.25
>>> int(3.0)
3
```

Some Numeric Computations in Python 3.6 [2/2]

```
>>> 5 % 4
1
>>> 10 % 5
0
>>> 11 % 5
1
>>> 12 % 5
2
>>> float(5)/4
1.25
>>> int(3.0)
3
>>> 5 % 4
1
>>> 10 % 5
0
```

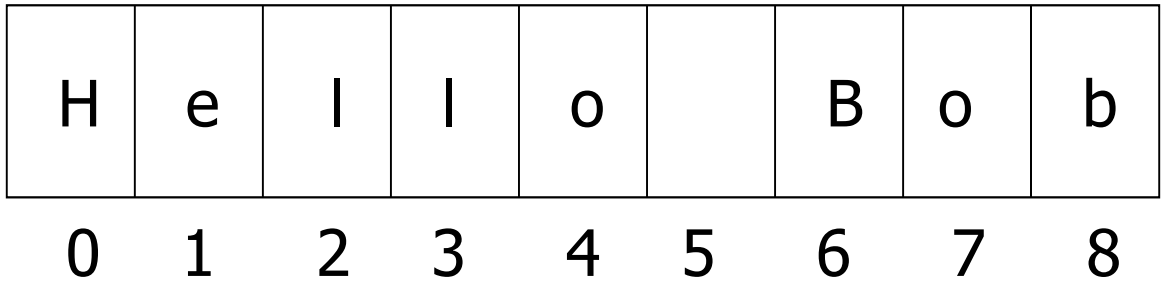
```
>>> 11 % 5
1
>>> 12 % 5
2
>>> 12**2
144
>>> 16**0.5
4.0
>>> 24**0.5
4.898979485566356
>>> 5 + (35 8 13 +2)
SyntaxError: invalid syntax
>>> 5 + (35 + 13 + 2)
55
>>> 5*(5+5)
50
```

String and Its Indexing [1/2]




```
>>> greet = "Hello Bob"
>>> greet[0]
'H'
>>> print(greet[0], greet[2], greet[4])
H l o
>>> x = 8
>>> print(greet[x - 2])
B
```

String and Its Indexing [2/2]

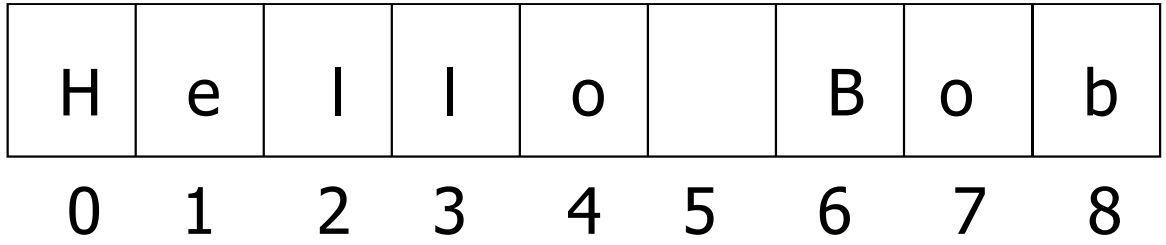


- In a string of *n* characters, the last character is at position *n-1* since we start counting with 0.
- We can index from the right side using negative indexes.

```
>>> greet[-1]
'b'
>>> greet[-3]
'B'
```

String and *Substring*

- Slicing: <string>[<start>:<end>]
  - start and end should both be ints
  - contains the substring beginning at position start and runs up to **but doesn't include** the position end




```
>>> greet[0:3]
'Hel'
>>> greet[5:9]
' Bob'
>>> greet[:5]
'Hello'
>>> greet[5:]
' Bob'
>>> greet[:]
'Hello Bob'
```

```
>>> greet[0:-3]
'Hello '
>>> greet[:-1]
‘Hello Bo'
```

String and Its Operators

- Concatenation (+)

  >>“a” + “b”

  ‘ab’

- Repetition (*)

  >> “a” * 3

  ‘aaa’

- Length (len)

  >> len(“a” * 3)

  3

Program Example with String Operation

```
>>> Main()
      # get user's first and last names
      first = input("Please enter your first name (all lowercase): ")
      last  = input("Please enter your last name (all lowercase): ")

      # concatenate first initial with 7 chars of last name
      print ("your_name = ", first[0] + ". " + last[:7])
```

```
>>> main()
>>> Please enter your first name (all lowercase): john
>>> Please enter your last name (all lowercase): doe
>>> your_name =  j. doe
```

Character to Numeric Conversion

- ord() : Python built-in function which returns the numeric (ordinal) code of a single character
- chr() : Python built-in function which converts a numeric code to the corresponding character

```
>>> ord("A")    # argument character의 asci code에서의 위치
65
>>> ord("a")
97
>>> chr(97)      # 0 ~~ 255를 받아서 ascii code를 return
'a'
>>> chr(65)
'A'
```

UTF-8 code (가변형 4 bytes)을 사용했다 하더라도 처음 1byte는 ASCII code와 동일함

Representations of Characters [1/2]

Character Encoding

ASCII	0000 0001	0000 0010	0000 0011	0000 0100	0000 0101	0000 0110	0000 0111	0000 1000	0000 1001	0000 1010	0000 1011	0000 1100	0000 1101	0000 1110	0000 1111
0000	$^{N}_{U}$	$^{S}_{H}$	$^{S}_{X}$	$^{E}_{X}$	$^{E}_{T}$	$^{E}_{Q}$	$^{A}_{K}$	$^{B}_{L}$	$^{B}_{S}$	$^{H}_{T}$	$^{L}_{F}$	$^{Y}_{T}$	$^{F}_{F}$	$^{C}_{R}$	$^{S}_{0}$	$^{S}_{I}$
0001	$^{D}_{L}$	$^{D}_{1}$	$^{D}_{2}$	$^{D}_{3}$	$^{D}_{4}$	$^{N}_{K}$	$^{S}_{Y}$	$^{E}_{\Sigma}$	$^{C}_{N}$	$^{E}_{M}$	$^{S}_{B}$	$^{E}_{C}$	$^{F}_{S}$	$^{G}_{S}$	$^{R}_{S}$	$^{U}_{S}$
0010		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
0011	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
0100	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
0101	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
0110	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
0111	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	$^{D}_{T}$
1000	$^{8}_{0}$	$^{8}_{1}$	$^{8}_{2}$	$^{8}_{3}$	$^{I}_{N}$	$^{N}_{L}$	$^{S}_{S}$	$^{E}_{S}$	$^{H}_{S}$	$^{H}_{J}$	$^{Y}_{S}$	$^{P}_{D}$	$^{P}_{V}$	$^{R}_{I}$	$^{S}_{2}$	$^{S}_{3}$
1001	$^{D}_{C}$	$^{P}_{1}$	$^{P}_{Z}$	$^{S}_{E}$	$^{C}_{C}$	$^{M}_{M}$	$^{S}_{P}$	$^{E}_{P}$	$^{O}_{8}$	$^{O}_{O}$	$^{O}_{A}$	$^{C}_{S}$	$^{S}_{T}$	$^{O}_{S}$	$^{P}_{M}$	$^{A}_{P}$
1010	$^{A}_{O}$	¡	¢	£	¤	¥	¦	§	¨	©	ª	«	¬	-	®	¯
1011	°	±	²	³	´	µ	¶	·	¸	¹	º	»	¼	½	¾	¿
1100	À	Á	Â	Ã	Ä	Å	Æ	Ç	È	É	Ê	Ë	Ì	Í	Î	Ï
1101	Ð	Ñ	Ò	Ó	Ô	Õ	Ö	×	Ø	Ù	Ú	Û	Ü	Ý	Þ	ß
1110	à	á	â	ã	ä	å	æ	ç	è	é	ê	ë	ì	í	î	ï
1111	ð	ñ	ò	ó	ô	õ	ö	÷	ø	ù	ú	û	ü	ý	þ	ÿ

Figure 7.3 ASCII, the American Standard Code for Information Interchange.

Note: The original 7-bit ASCII is the top half of the table; the whole table is known as Extended ASCII (ISO-8859-1). The 8-bit symbol for a letter is the four row bits followed by the four column bits (e.g., A = 0100 0001, while z = 0111 1010). Characters shown as two small letters are control symbols used to encode nonprintable information (e.g., $^{B}_{S}$ = 0000 1000 is backspace). The bottom half of the table represents characters needed by Western European languages, such as Icelandic's eth (ð) and thorn (þ).

e 7.4 "Why can't they just speak _____?" A
Veb page, www.trigeminal.com/samples/pro
displaying that question expressed in more th
ages. Can you name all of them in this partial

Representations of Characters [2/2]

- **ASCII: 7 bits for 128 characters (1960년)**
- **E-ASCII: 8 bits for 256 characters (1963년)**
- **유니코드**(Unicode)
  - 전 세계의 모든 문자를 컴퓨터에서 일관되게 표현되도록 설계된 산업 표준
  - 유니코드 협회(Unicode Consortium)
- **UTF** (Unicode Transformation Format) **-8** : 32bits (1992년)
  - A character encoding for all possible characters in Unicode
  - variable-length (➔ uses *1 to 4 units of 8-bit code)*
  - *UTF-8의 unit 1* ➔ *E*-ASCII 문자
  - the dominant character encoding for the World Wide Web, accounting for 84.6% of all Web pages

String Splitting Function

- How do we get the sequence of numbers to decode?
  - Read the input as a single string, then split it apart into substrings, each of which represents one number
- The string class has a set of methods
- split() : a function in string class
  - splits the given string into substrings based on spaces.

```
>>> a = "Hello string methods!"
```

```
>>> a.split()
['Hello', 'string', 'methods!']
>>> "Hello string methods!".split()
['Hello', 'string', 'methods!']
```

a = a.split() 를 써도 OK, a.split()은 list를 return하므로!
But, a = a.append("dd")를 하면 a에는 nothing !

String Splitting function

- Split can be used on characters other than space, by supplying the character as a parameter

```
>>> "32,24,25,57".split(",")
['32', '24', '25', '57']
>>> "abcPdefPghi".split("P")
['abc', 'def', ‘ghi']
```

```
>>> list(“CMU”)
[“C”, “M”, “U”]
```

String functions belonging to “string” class

- s.capitalize()
- s.title()
- s.center(width)
- s.count(sub) – Count # of occurrences of sub in s
- s.find(sub) – Find first pos where sub occurs in s
- s.join(list) – Concatenate list of strings into one string using s as separator
- s.ljust(width)
- s.lower() – Copy of s in all lowercase letters
- s.lstrip() – Copy of s with leading whitespace removed
- s.replace(oldsub, newsub) – Replace occurrences of oldsub in s with newsub
- s.rfind(sub) – Like find, but returns the right-most position
- s.rjust(width) – Like ljust
- s.rstrip() – Like lstrip
- s.split()
- s.upper() – Like lower

Some String Computations in Python 3.6 [1/3]

```
>>> x = 'ham'
>>> x
'ham'
>>> x = "hamsandwich"
>>> x
'hamsandwich'
>>> y = x + "book"
>>> y
'hamsandwichbook'
>>> y = x + " book"
>>> y
'hamsandwich book'
```

```
>>> x = "hamsandwich"
>>> z = 10
>>> y = x + z
Traceback (most recent call last):
  File "<pyshell#95>", line 1, in <module>
    y = x + z
TypeError: must be str, not int
>>> y = x + str(z)
>>> y
'hamsandwich10'
>>> y = "something %d" %z
>>> y
'something 10'
>>> y = "something %f" %z
>>> y
'something 10.000000'
>>> y = "something %.3f" %z
>>> y
'something 10.000'
>>> z = 1.6546546548
>>> y = "something %.3f" %z
>>> y
'something 1.655'
```

Some String Computations in Python 3.6 [2/3]

```
>>> "ham" in "hamsandwich"
True
>>> 'a' in 'ham'
True
>>> x = []
>>> x
[]
>>> x = ["ham", 4, 2.2]
>>> x
['ham', 4, 2.2]
>>> x.append(5)
>>> x
['ham', 4, 2.2, 5]
>>> x.insert(1,3.1415)
>>> x
['ham', 3.1415, 4, 2.2, 5]
```

```
>>> x.pop(1)
3.1415
>>> x
['ham', 4, 2.2, 5]
>>> len("words")
5
>>> len(x)
4
```

```
>> x = ['a', 'b', 'c']
>> x = x.pop(1)
>> x
```

```
>> x = ['a', 'b', 'c']
>> x.pop(1)
>> x
```

Some String Computations in Python 3.6 [3/3]

```
>>> list("ham")
['h', 'a', 'm']
>>> x = "ham"
>>> y = list(x)
>>> y
['h', 'a', 'm']
>>> y.append(x)
>>> y
['h', 'a', 'm', 'ham']
>>> list("ham")
['h', 'a', 'm']
>>> y=[]
>>> y.append("ham")
>>> y
['ham']
```

```
>>> "s"
's'
>>> "s" in "something"
True
>>> "s" in y
False
```

y = y.append(x) # 절대 안됨
y = list(y) # 가능함

List Data Type [1/2]

- Lists are a special kind of *sequence*, so sequence operations also apply to lists!

```
>>> [1,2] + [3,4]
[1, 2, 3, 4]

>>> [1,2]*3
[1, 2, 1, 2, 1, 2]

>>> grades = ['A', 'B', 'C', 'D', 'F']
>>> grades[0]
'A'
>>> grades[2:4]
['C', 'D']
>>> len(grades)
5
```

List Data Type [2/2]

- Strings are always sequences of characters

  univ_name = “Seoul National Univ”

- but lists can be sequences of arbitrary values
  - Lists can have numbers, strings, or both!

    myList = [1, "Spam ", 4, "U"]

    myList = [3, 9, 1, 7]

Program Example with List data type

```
# month2.py
#  A program to print the month name, given it's number.
#  This version uses a list as a lookup table.

def main():

    # months is a list used as a lookup table
    months = ["Jan", "Feb", "Mar", "Apr", "May", "Jun",
              "Jul", "Aug", "Sep", "Oct", "Nov", "Dec"]

    n = eval(input("Enter a month number (1-12): "))

    print ("The month abbreviation is", months[n-1] + ".")
```

Mutability Issue of List and String Data Type

```
>>> myList = [34, 26, 15, 10]
>>> myList[2]
15
>>> myList[2] = 0
>>> myList
[34, 26, 0, 10]
```

Lists are *mutable* (i.e. they can be changed)

```
>>> myString = "Hello World"
>>> myString[2]
'l'
>>> myString[2] = "p“    #This is not allowed
Traceback (most recent call last):
  File "<pyshell#16>", line 1, in -toplevel-
    myString[2] = "p"
TypeError: object doesn't support item assignment

>>> myString = "Hi World“     #This is OK
```

Strings are immutable : Parts of Strings can **not** be changed using operations

Tuple Data Type

```
>>> t1 = ()
>>> t2 = (1, )
>>> t3 = (1, 2, 3]
>>> t4 = ['a', 'b', ['ab', 'cd']
```

- Tuple is similar to list
  But, Tuple is *immutable*
  Tuple is more memory efficient than List

```
>>> t1 = [ ]
>>> t2 = [1,]
>>> t3 = [1.2.3]
>>> t4 = ['a', 'b', ['ab', 'cd']
```

```
>>> x = ("ham",4,5)
>>> x
('ham', 4, 5)
>>>
```

No add/drop a part inside a tuple!

```
>>> x[2] = 8   # not allowed
```

Whole replacement is fine!

```
>>> x = ("egg", 7, 9, 10)
```

Set Data Type

```
>>> s1 = { 1,  2,  3}
>>> s2 = {"ab", "d"}
```

Built-in set() function을 써서 set data를 만들수 있다. Set()의 parameter는 1개만 들어가야 한다

```
>>> s1 = set([1,2,3])
>>> s1
{1, 2, 3}
```

```
>>> s2 = set("Hello")
>>> s2
{'e', 'l', 'o', 'H'}
```

```
>>> s1 = set([1,2,3])
>>> l1 = list(s1)
>>> l1
[1, 2, 3]
>>> l1[0]
1
```

```
>>> s1 = set([1,2,3])
>>> t1 = tuple(s1)
>>> t1
(1, 2, 3)
>>> t1[0]
1
```

Set Operations [1/2]

```
>>> s1 = set([1, 2, 3, 4, 5, 6])
>>> s2 = set([4, 5, 6, 7, 8, 9])
```

```
>>> s1 & s2
{4, 5, 6}
```

=

```
>>> s1.intersection(s2)
{4, 5, 6}
```

```
>>> s1 | s2
{1, 2, 3, 4, 5, 6, 7, 8, 9}
```

=

```
>>> s1.union(s2)
{1, 2, 3, 4, 5, 6, 7, 8, 9}
```

```
>>> s1 - s2
{1, 2, 3}
>>> s2 - s1
{8, 9, 7}
```

=

```
>>> s1.difference(s2)
{1, 2, 3}
>>> s2.difference(s1)
{8, 9, 7}
```

Set Operations [2/2]

값 1개 추가하기(add)

이미 만들어진 set 자료형에 값을 추가할 수 있다.
다.

```
>>> s1 = set([1, 2, 3])
>>> s1.add(4)
>>> s1
{1, 2, 3, 4}
```

값 여러 개 추가하기(update)

여러 개의 값을 한꺼번에 추가(update)할 때

```
>>> s1 = set([1, 2, 3])
>>> s1.update([4, 5, 6])
>>> s1
{1, 2, 3, 4, 5, 6}
```

특정 값 제거하기(remove)

특정 값을 제거하고 싶을 때는 아래오

```
>>> s1 = set([1, 2, 3])
>>> s1.remove(2)
>>> s1
{1, 3}
```

Dictionary Data Type

```
>>> dic = {'name':'pey', 'phone':'0119993323', 'birth': '1118'}
```

key	value
name	pey
phone	01199993323
birth	1118

```
>>> dic['name']
'pey'
>>> dic['phone']
'0119993323'
>>> dic['birth']
'1118'
```

Insert and Delete in Dictionary

```
>>> a = {1: 'a'}
>>> a[2] = 'b'
>>> a
{2: 'b', 1: 'a'}
```

```
>>> a['name'] = 'pey'
{'name':'pey', 2: 'b', 1: 'a'}
```

```
>>> a[3] = [1,2,3]
{'name': 'pey', 3: [1, 2, 3], 2: 'b', 1: 'a'}
```

```
>>> del a[1]
>>> a
{'name': 'pey', 3: [1, 2, 3], 2: 'b'}
```

Dictionary 만들 때 주의사항

중복되는 Key 값은 금지

```
>>> a = {1:'a', 1:'b'}
>>> a
{1: 'b'}
```

Key 값은 immutable value만 허락

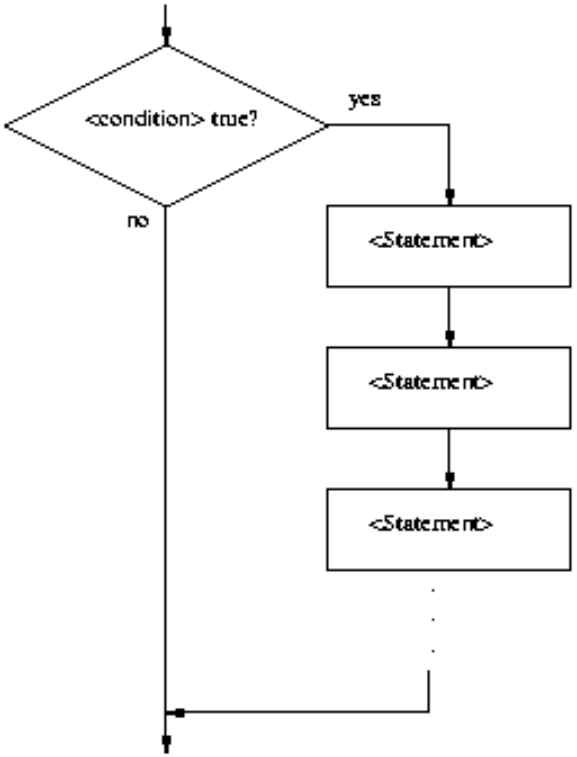
```
>>> a = {[1,2] : 'hi'}
Traceback (most recent call last):
File "", line 1, in ?
TypeError: unhashable type
```

Python Tutorial

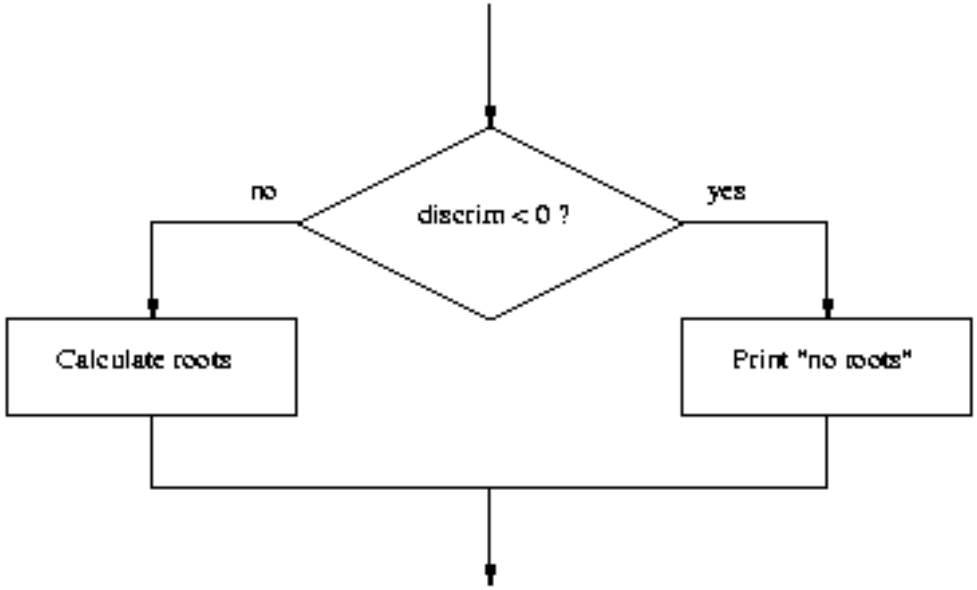
- Python Data Types
- Python Control Structures
- Python Functions and Modules

One-way Decision Structures

```
if <condition>:
    <statements>
```




```
if <condition>:
    <statements>
else:
    <statements>
```



Some If statements in Python 3.6

```
>>> mail = 0
>>> if mail:
        print('mail time')
else:
        print('no mail:(')


no mail:(
>>>
```

```
>>> if(7 <=6):
        print("whaaaa")
else:
        print("7 is GREATER than 6")


7 is GREATER than 6
>>> if (7) and (6):
        print('yep')


yep
>>> if (0) and (4):
        print('wahaaa')


>>> if not(0):
        print('yep')


yep
>>>
```

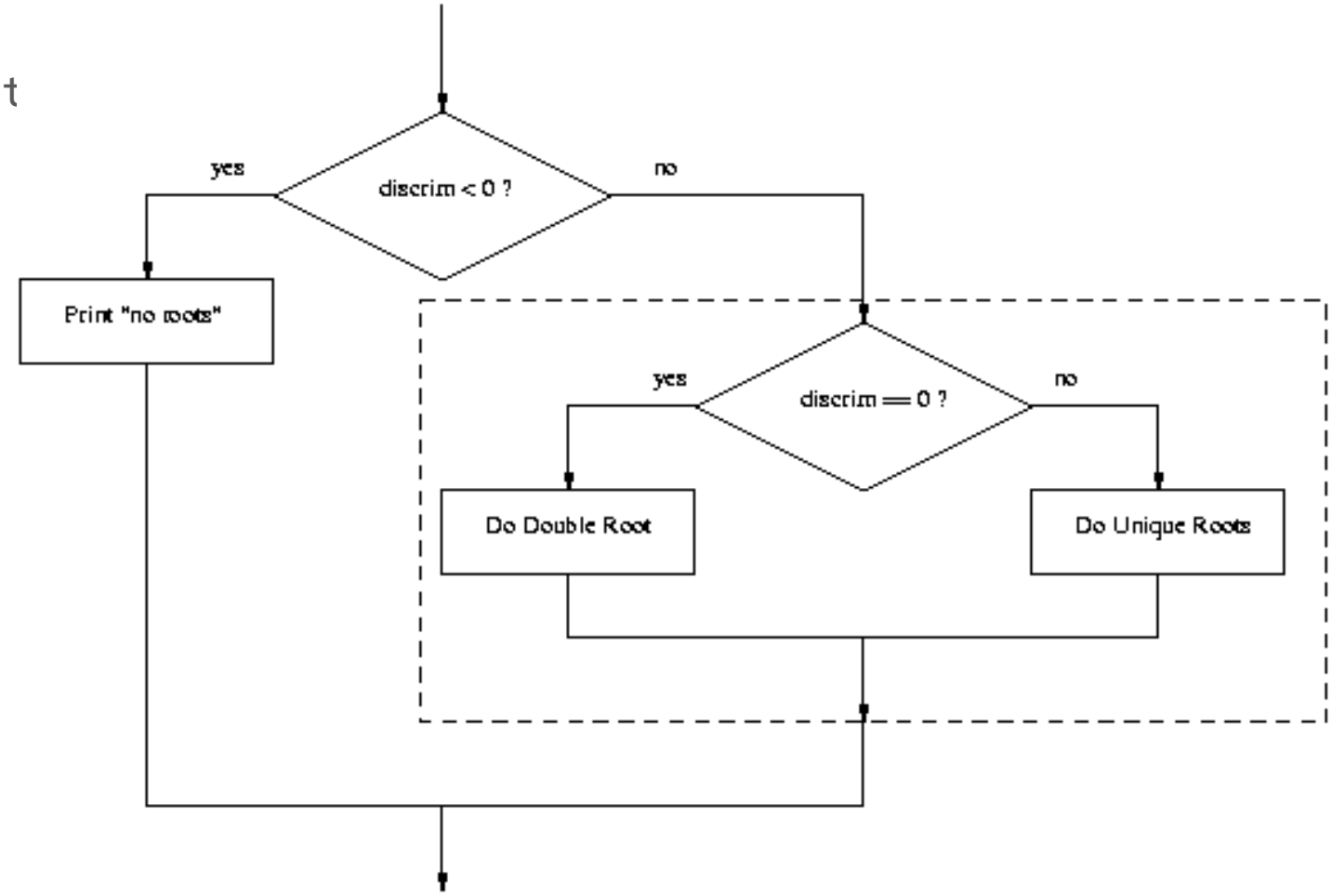
One-way Decision Structure: Example

```
# convert2.py
#      A program to convert Celsius temps to Fahrenheit.
#      This version issues heat and cold warnings.

def main():
    celsius = eval(input("What is the Celsius temperature? "))
    fahrenheit = 9 / 5 * celsius + 32
    print("The temperature is", fahrenheit, "degrees fahrenheit.")
    if fahrenheit >= 90:
        print("It's really hot out there, be careful!")
    if fahrenheit <= 30:
        print("Brrrrr. Be sure to dress warmly")
```

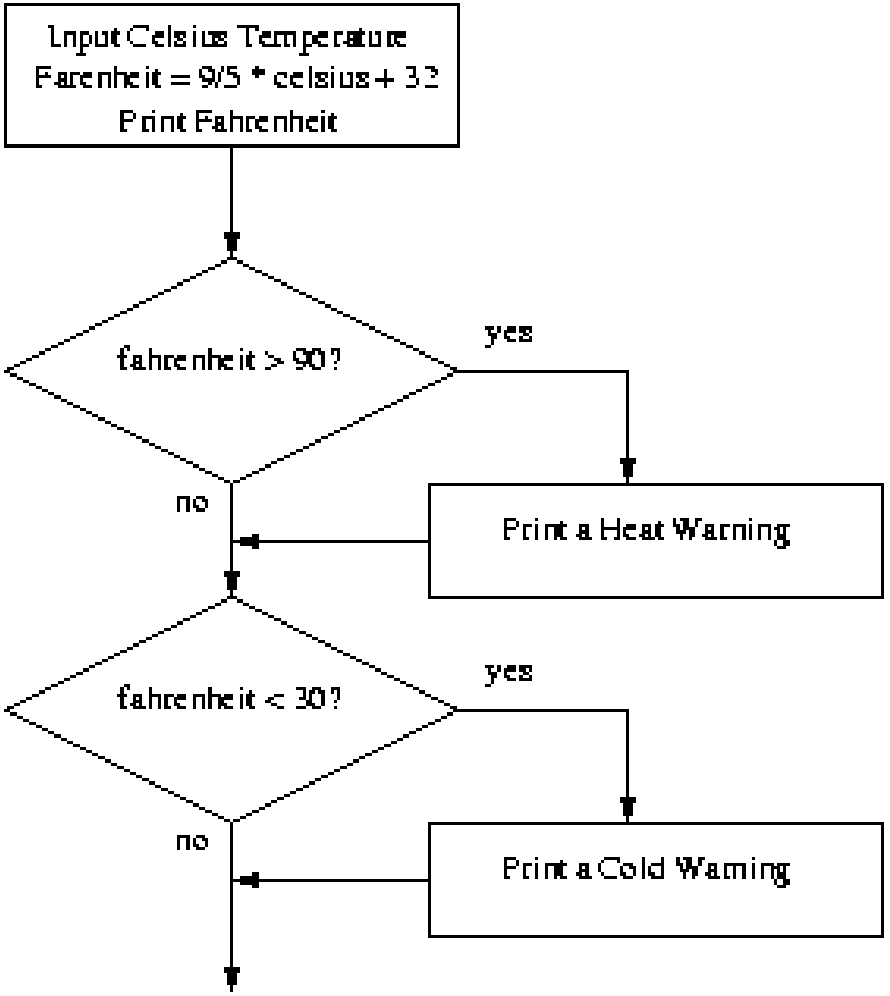
Multi-Way Decision Structures

```
if <condition>:
    <statements>
elif <condition>:
    <statements>
else:
    <statement
```



One-way Decision Structure: Example

- Temperature Warnings
  - Let's say we want to modify that program to print a warning when the weather is **extreme**



Two-Way Decision Structure: Example

```
# quadratic3.py
#    A program that computes the real roots of a quadratic equation.
#    Illustrates use of a two-way decision

import math
def main():
    print "This program finds the real solutions to a quadratic\n"
    a, b, c = eval(input("Please enter the coefficients (a, b, c): "))

   discrim = b * b - 4 * a * c
    if discrim < 0:
        print("\nThe equation has no real roots!")
    else:
        discRoot = math.sqrt(b * b - 4 * a * c)
        root1 = (-b + discRoot) / (2 * a)
        root2 = (-b - discRoot) / (2 * a)
        print ("\nThe solutions are:", root1, root2 )
```

Multi-Way Decision Structure: Example

```
# quadratic4.py
#    Illustrates use of a multi-way decision

import math

def main():
    print("This program finds the real solutions to a quadratic\n")
    a, b, c = eval(input("Please enter the coefficients (a, b, c): "))

    discrim = b * b - 4 * a * c
    if discrim < 0:
        print("\nThe equation has no real roots!")
    elif discrim == 0:
        root = -b / (2 * a)
        print("\nThere is a double root at", root)
    else:
        discRoot = math.sqrt(b * b - 4 * a * c)
        root1 = (-b + discRoot) / (2 * a)
        root2 = (-b - discRoot) / (2 * a)
        print("\nThe solutions are:", root1, root2 )
```

Loop Structures

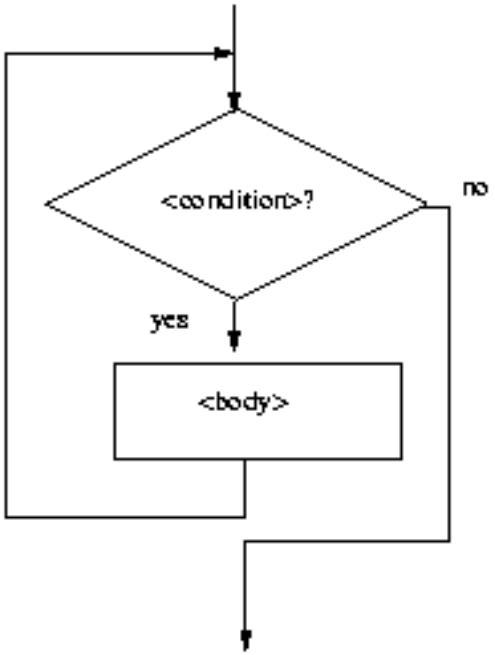
- Loop types classified by **breaking condition**

- **Interactive Loop**: user dictates whether to continue the loop interactively
  - **Sentinel Loop**: loop is carried on until certain condition is met
  - **End-of-file Loop:** looped until end of the file
  - **Nested Loop:** loop in a loop

- Loop structures
  - For loop
  - While loop

Loop Structures

```
while <condition>:
        <loop body>
```



- a while loop that counts from 0 to 10:

```
i = 0
while i <= 10:
    print(i)
    i = i + 1
```

- for loop that has the same output

```
for i in range(11):
    print(i)
```

Loop statements in Python 3.6 [1/2]

```
>>> x = [1,2,7]
>>> for i in x:
        print(i)


1
2
7
>>>
```

```
>>> for i in range(30):
        print(i)


0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
>>>
```

Loop statements in Python 3.6 [2/2]

```
>>> for i in range(10,30,2):
        print(i)


10
12
14
16
18
20
22
24
26
28
>>>
```

```
>>> for i in range(30):
        if not (i % 3):
            continue
        print(i)


1
2
4
5
7
8
10
11
13
14
16
17
19
20
22
23
25
26
28
29
>>>
```

'WHILE' LOOP

while (condition is true):
    do this over and over

```
x = 0
while (x < 10):
    x += 1
```

'BREAK' LOOP

- Used to STOP loop

```
while (true):
    if (something):
        break
```

```
>>> x,y = 0,0
>>> while(True):
        x += 1
        y += 2
        if(x + y > 10):
            break


>>> x
4
>>> y
8
```

Indefinite Loops: Warning

- The while statement is simple and powerful, could be **dangerous**!

```
i = 0
while i <= 10:
    print(i)
```

- It can be easy to omit the incrementing logic (applies to all languages)

Interactive Loops: Average computation example

- **Basic pseudocode**

```
set moredata to “yes”
while moredata is “yes”
    get the next data item
    process the item
    ask user if there is moredata
```

- **Example**

```
def main():
    moredata = "yes"
    sum = 0.0
    count = 0
    while moredata[0] == 'y':
        x = eval(input("Enter a number: "))
        sum = sum + x
        count = count + 1
        moredata = input(“More numbers (yes or no)? ")
    print("\nThe average of the numbers is", sum / count)
```

Interactive Loops: Example

```
Enter a number: 32
Do you have more numbers (yes or no)? y
Enter a number: 45
Do you have more numbers (yes or no)? yes
Enter a number: 34
Do you have more numbers (yes or no)? yup
Enter a number: 76
Do you have more numbers (yes or no)? y
Enter a number: 45
Do you have more numbers (yes or no)? nah

The average of the numbers is 46.4
```

Sentinel Loops

- Continues to process data until reaching a special value (called the **sentinel 보초, 파수병)** that signals the end
- The sentinel must be distinguishable from the data
  - since it is not processed as part of the data

```
# average3.py
#    A program to average a set of numbers
#    Illustrates sentinel loop using negative input as sentinel

def main():
    sum = 0.0
    count = 0
    x = eval(input("Enter a number (negative to quit) >> "))
    while x >= 0:
        sum = sum + x
        count = count + 1
        x = eval(input("Enter a number (negative to quit) >> "))
    print("\n The average of the numbers is", sum / count)
```

➢ Assuming there are no negative numbers in the data

Sentinel Loops: Using empty string as the sentinel

```
# average4.py
#    A program to average a set of numbers
#    Illustrates sentinel loop using empty string as sentinel

def main():
    sum = 0.0
    count = 0
    xStr = input("Enter a number (<Enter> to quit) >> ")
    while xStr != "":
        x = eval(xStr)
        sum = sum + x
        count = count + 1
        xStr = input("Enter a number (<Enter> to quit) >> ")

  print("\n The average of the numbers is", sum / count)
```

Loop with readline() through a File: Example

```
# average6.py
#     Computes the average of numbers listed in a file.

def main():
    fileName = input("What file are the numbers in? ")
    infile = open(fileName,'r')
    sum = 0.0
    count = 0
    line = infile.readline()
    while line != "":
        sum = sum + eval(line)
        count = count + 1
        line = infile.readline()

    print("\n The average of the numbers is", sum / count)
```

Nested Loops in reading lines through a file: Example

- We want to read any number of numbers on a line in the file (separated by commas)

  3, 4, 5, 6, 1, 2, …, 1

  3, 2, 1, 7, 5, 2, …, 1

  5, 6, 4, 7, 5, 6, …,

- We use two loops:
  - The top-level loop loops through each line of the file
  - The second-level loop loops through each number of each line

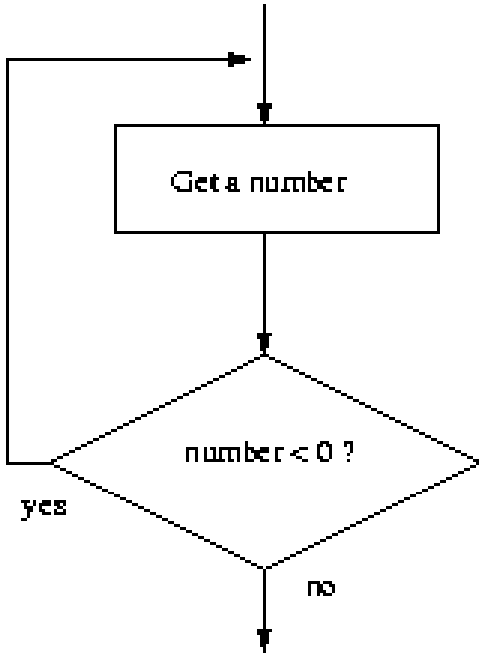
```
# average7.py
#     Computes the average of numbers listed in a file.
#     Works with multiple numbers on a line.

import string
def main():
    fileName = input("What file are the numbers in? ")
    infile = open(fileName,'r')
    sum = 0.0
    count = 0
    line = infile.readline()
    while line != "":
        for xStr in line.split(","):
            sum = sum + eval(xStr)
            count = count + 1
        line = infile.readline()
    print("\n The average of the numbers is", sum / count)
```

Post-Test Loops

- Condition test comes after the body of the loop
  - A post-test loop always executes the body of the code at least once
- Python doesn't have a built-in statement to do this,
  - but we can do it with a slightly modified **`while`** loop.
  - In some other languages (not in Python);

```
repeat
    get a number from the user
until number >= 0
```



Post-Test Loops: Example

- Using a `while` statement
  - Seed the loop condition so we're guaranteed to execute the loop once.

```
number = -1
while number < 0:
    number = eval(input("Enter a positive number: "))
```

  - By setting `number` to –1, we force the loop body to execute at least once

- The same algorithm implemented with a `break`:

```
while True:
    number = eval(input("Enter a positive number: "))
    if x >= 0: break
```

  - Executing `break` causes Python to immediately exit the enclosing loop

File Opening and File Closing

- *Opening* a file => associating a file on disk with an object in memory
  - **<filevar> = open(<name>, <mode>)**
  - Associate a disk file <name> with a file object <filevar>
  - <mode> is either ‘r’ or ‘w’

    myfile = open("numbers.dat", "r")
  - We can manipulate the file by manipulating the file object “myfile”

- *Closing* the file causes any running operations and other bookkeeping for the file to be completed
  - In some cases, not properly closing a file could result in data loss

    myfile.close()

Looping readline() through Files

· readline() function can be used to read one line at a time

```
myfile = open(“someFile.txt”, "r")
for i in range(5):
  line = myfile.readline()
  print line[:-1]
```

reads the first 5 lines of a file

Slicing used to strip out the newline char at end of lines

Writing a File

- outfile = open("mydata.out", "w")
  - Opening a file for writing prepares the file to receive data

- If file already exists
  - file's contents are erased (& starts with empty file).

- If file does not exist
  - new file is created

- outfile.write("new sample contents \n")

Python Tutorial

- Python Data Types
- Python Control Structures
- Python Functions and Modules

Taxonomy of Python Functions

- Python Built-in Functions:
  - input(), print(), len(), abs(), set(), …..
- User Defined Functions
- Functions belonging to Python Basic Data Types

```
>>> L = [3, 5, 5]
>>> L.append(4)
```

```
>>> S = {3, 5, 6}
>>> S.remove(5)
```

- Functions belonging to User-Defined Classes

```
>>> class Box(object):
        def  calc_space(self):
            ……
```

```
>>> bbb = Box()
>>> space_value = bbb.calc_space()
```

- Functions from Other Modules (consisting of Functions and Classes)

```
>>>  import sam_module
```

- Functions from Python Standard Library (consisting of Functions and Classes)

```
>>>  import math
```

Python Built-in Functions

		Built-in Functions		
abs()	dict()	help()	min()	setattr()
all()	dir()	hex()	next()	slice()
any()	divmod()	id()	object()	sorted()
ascii()	enumerate()	input()	oct()	staticmethod()
bin()	eval()	int()	open()	str()
bool()	exec()	isinstance()	ord()	sum()
bytearray()	filter()	issubclass()	pow()	super()
bytes()	float()	iter()	print()	tuple()
callable()	format()	len()	property()	type()
chr()	frozenset()	list()	range()	vars()
classmethod()	getattr()	locals()	repr()	zip()
compile()	globals()	map()	reversed()	__import__()
complex()	hasattr()	max()	round()	
delattr()	hash()	memoryview()	set()	

Using Libraries (or Modules) [1/3]

- Modules contain a set of useful functions or classes

- Some additional Python standard libraries like “math”, “time” or “datetime” etc. can be imported using keyword “import”

- Python standard libraries are listed here: https://docs.python.org/3/library/
  - `# Importing math standard library`
  - `>> import math`
  - `>> math.sqrt(3)`
  - `1.7320508075688772`
  - `>> - b + math.sqrt(b * b – 4 * a * c) / ( 2 * a )`

- help(<module name>) can give you lots of information

Using Libraries (or Modules) [2/3]

- When a Python program starts, it only has access to basic functions and classes

  (len(), sum(), set(), list(), range(), …..)

- Use “import” to tell Python to load a module
  - “import” vs “from ... import ...”

```
>>> # If you want to use cos function in the math library
>>> import math
math.cos
>>> from math import cos, pi
cos
>>> from math import *
cos
```

Using Libraries (or Modules) [3/3]

```
>>> import math

>>> math.pi
3.1415926535897931
>>> math.cos(0)
1.0
>>> math.cos(math.pi)
-1.0

>>> dir(math)
['__doc__', '__file__', '__name__', '__package__', 'acos', 'acosh',
'asin', 'asinh', 'atan', 'atan2', 'atanh', 'ceil', 'copysign', 'cos', 'cosh', 'degrees', 'e', 'exp',
 'fabs', 'factorial', 'floor', 'fmod', 'frexp', 'fsum', 'hypot', 'isinf', 'isnan', 'ldexp', 'log',
'log10', 'log1p', 'modf', 'pi', 'pow', 'radians', 'sin', 'sinh', 'sqrt', 'tan', 'tanh', 'trunc']
>>> help(math)
…….
>>> help(math.cos)
……..
```

Creating Modules (Library): A Short Introduction

- Modules can be created very easily
  - Any script file will be considered a module if it is imported by another script file
- For example,
  - A script file named **hello.py** has the following line

```
def sample_func()
    print("Hello World")
```

  - Another script file in the same directory can import **hello.py** by simply referring to its file name

```
import hello
Hello.sample_func()
```

- When a script file is imported like a module, all its defined **functions** and **classes** will be available to the importer