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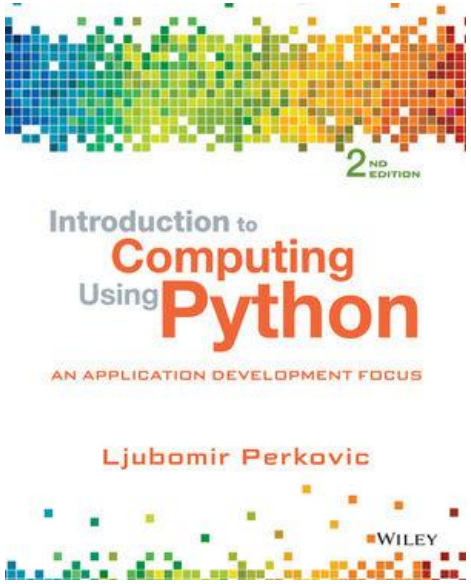
2ND EDITION
Introduction to Computing Using Python
AN APPLICATION DEVELOPMENT FOCUS
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WILEY

# Chapter 3
# Imperative Programming

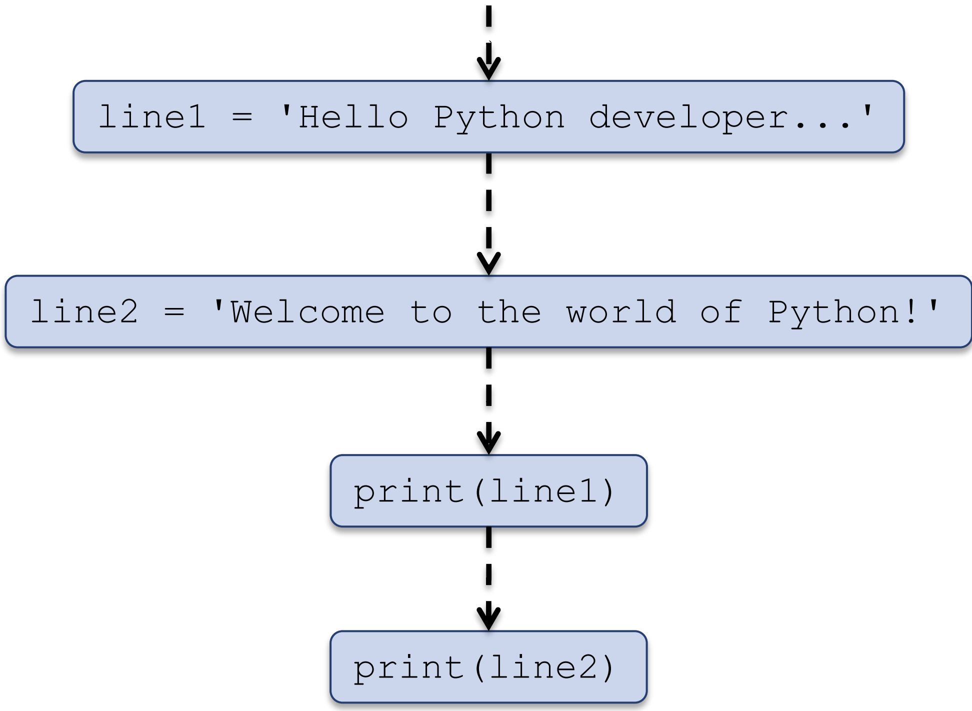
## Imperative Programming

- Python Programs
- Interactive Input/Output
- One-Way and Two-Way `if` Statements
- `for` Loops
- User-Defined Functions
- Assignments Revisited and Parameter Passing

# Python program

A Python program is a sequence of Python statements

- Stored in a text file called a Python module
- Executed using an IDE or "from the command line"



```
line1 = 'Hello Python developer...'
line2 = 'Welcome to the world of Python!'
print(line1)
print(line2)
```

hello.py

```
$ python hello.py
Hello Python developer…
```

# Built-in function `print()`

Function `print()` prints its input argument to the IDLE window

- The argument can be any object: an integer, a float, a string, a list, …
  - Strings are printed without quotes  and “to be read by people”, rather than “to be interpreted by Python”,
- The “string representation” of the object is printed

```
>>> print(0)
0
>>> print(0.0)
0.0
>>> print('zero')
zero
>>> print([0, 1, 'two'])
[0, 1, 'two']
```

# Built-in function `input()`

Function `input()` requests and reads input from the user interactively

- It's (optional) input argument is the request message
- Typically used on the right side of an assignment statement

When executed:

1. The input request message is printed
2. The user enters the input
3. The *string* typed by the user is assigned to the variable on the left side of the assignment statement

```
>>> name = input('Enter your name: ')
Enter your name: Michael
>>>
```

```
first = input('Enter your first name: ')
last = input('Enter your last name: ')
line1 = 'Hello' + first + '' + last + '…'
print(line1)
print('Welcome to the world of Python!')
```

input.py

## Built-in function `eval()`

Function `input()` evaluates anything the user enters as a string

What if we want the user to interactively enter non-string input such as a number?

- Solution 1: Use type conversion
- Solution 2: Use function `eval()`
  - Takes a string as input and evaluates it as a Python expression

```
>>> age = input('Enter your age: ')
Enter your age: 18
>>> age
'18'
```

## Exercise

Write a program that:

1. Requests the user's name
2. Requests the user's age
3. Computes the user's age one year from now and prints the message shown

```
>>>
Enter your name: Marie
Enter your age: 17
Marie, you will be 18 next year!
```

```
name = input('Enter your name: ')
age = int(input('Enter your age: '))
line = name + ', you will be ' + str(age+1) + ' next year!'
print(line)
```

## Exercise

Write a program that:

1. Requests the user's name
2. Requests the user's age
3. Prints a message saying whether the user is eligible to vote or not

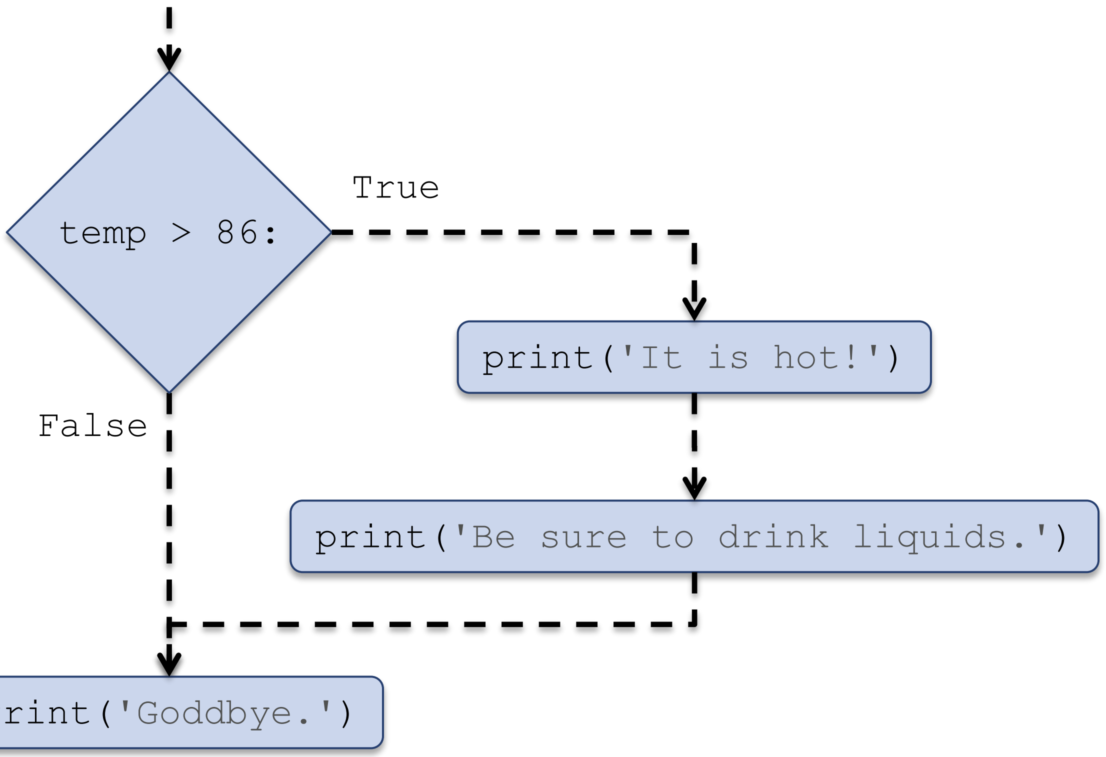
Need a way to execute a Python statement if a condition is true

## One-way if statement

```
if <condition>:
    <indented code block>
<non-indented statement>
```

```
if temp > 86:
    print('It is hot!')
    print('Be sure to drink liquids.')
print('Goodbye.')
```

The value of `temp` is 90.



## Exercises

Write corresponding if statements:

a) If `age` is greater than 62 then print `'You can get Social Security benefits’`

b) If string `'large bonuses'` appears in string `report` then print `'Vacation time!’`

c) If `hits` is greater than 10 and `shield` is 0 then print `"You're dead..."`

a)

```
>>> age = 45
>>> if age > 62:
        print('You can get Social Security benefits')


>>> age = 65
>>> if age > 62:
        print('You can get Social Security benefits')


You can get Social Security benefits
>>>
```

# Exercises

Write corresponding if statements:

a) If `age` is greater than 62 then print `'You can get Social Security benefits’`

b) If string `'large bonuses'` appears in string `report` then print `'Vacation time!’`

c) If `hits` is greater than 10 and `shield` is 0 then print `"You're dead..."`

b)

```
>>> report = 'no bonuses this year'
>>> if 'large bonuses' in report:
        print('Vacation time!')


>>> report = 'large bonuses this year'
>>> if 'large bonuses' in report:
        print('Vacation time!')


Vacation time!
```

## Exercises

Write corresponding if statements:

a) If `age` is greater than 62 then print `'You can get Social Security benefits’`

b) If string `'large bonuses'` appears in string `report` then print `'Vacation time!’`

c) If `hits` is greater than 10 and `shield` is 0 then print `"You're dead..."`

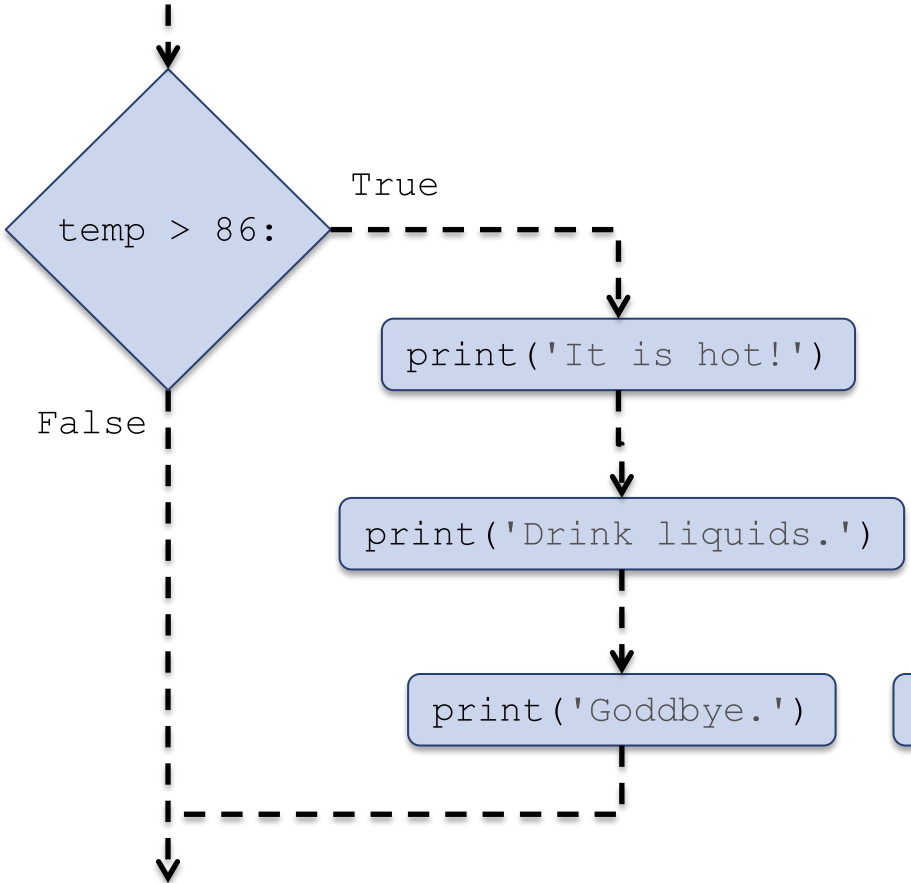
c)

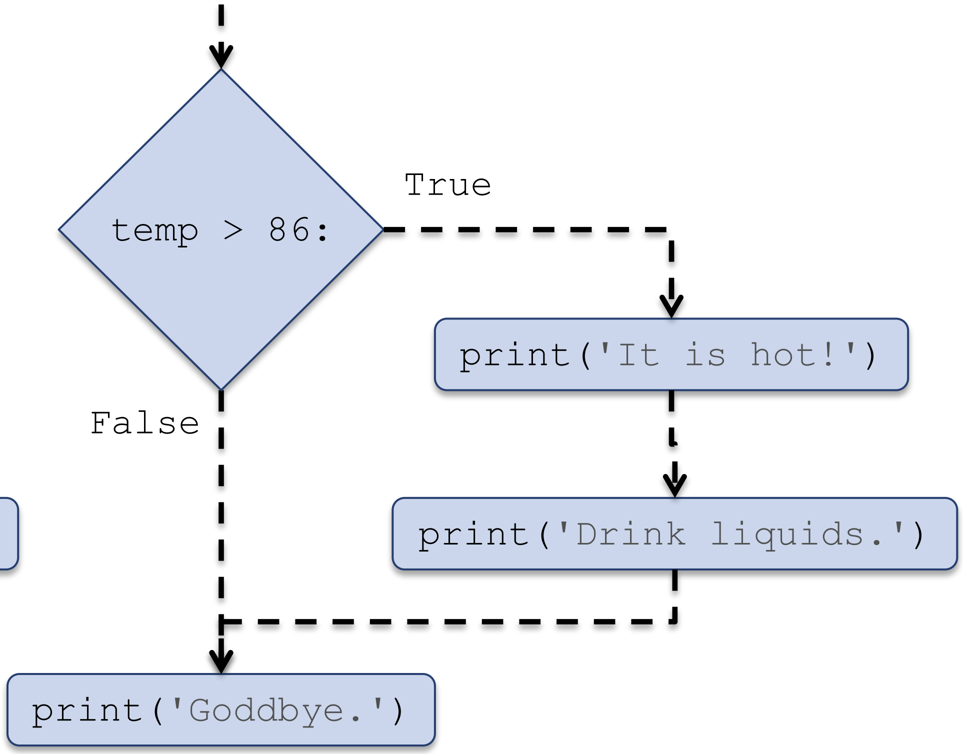
```
>>> hits = 12
>>> shield = 0
>>> if hits > 10 and shield == 0:
        print("You're dead...")


You're dead...
>>> hits, shield = 12, 2
>>> if hits > 10 and shield == 0:
        print("You're dead...")



>>>
```

## Indentation is critical

```
if temp > 86:
    print('It is hot!')
    print('Drink liquids.')
    print('Goodbye.')
```

```
if temp > 86:
    print('It is hot!')
    print('Drink liquids.')
print('Goodbye.')
```



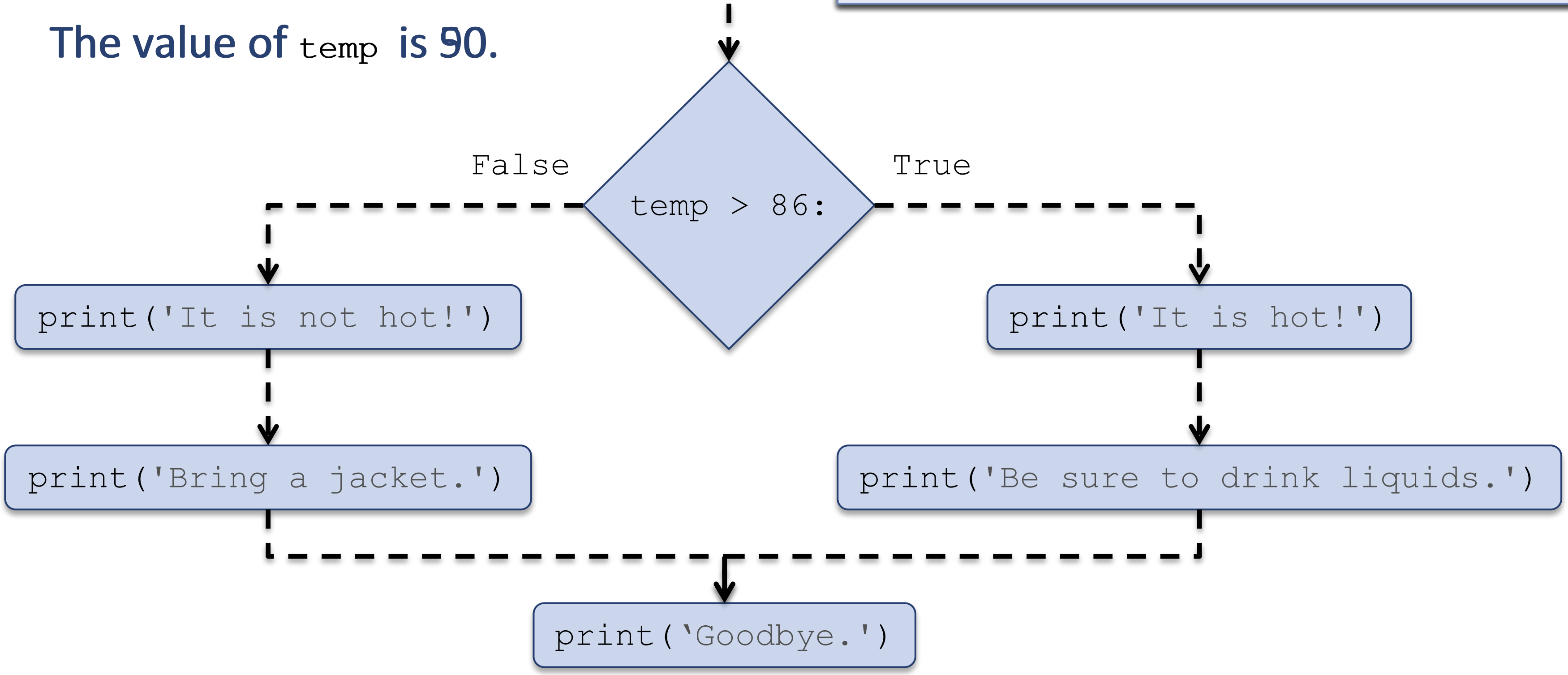


## Two-way if statement

```
if <condition>:
    <indented code block 1>
else:
    <indented code block 2>
<non-indented statement>
```

```
if temp > 86:
    print('It is hot!')
    print('Be sure to drink liquids.')
else:
    print('It is not hot.')
    print('Bring a jacket.')
print('Goodbye.')
```

The value of `temp` is 90.



## Exercise

Write a program that:

1) Requests the user's name
2) Requests the user's age
3) Prints a message saying whether the user is eligible to vote or not

```
>>>
Enter your name: Marie
Enter your age: 17
Marie, you can't vote.
>>>
============RESTART================
>>>
Enter your name: Marie
Enter your age: 18
Marie, you can vote.
>>>
```

```
name = input('Enter your name: ')
age = eval(input('Enter your age: '))
if age < 18:
    print(name + ", you can't vote.")
else:
    print(name + ", you can vote.")
```

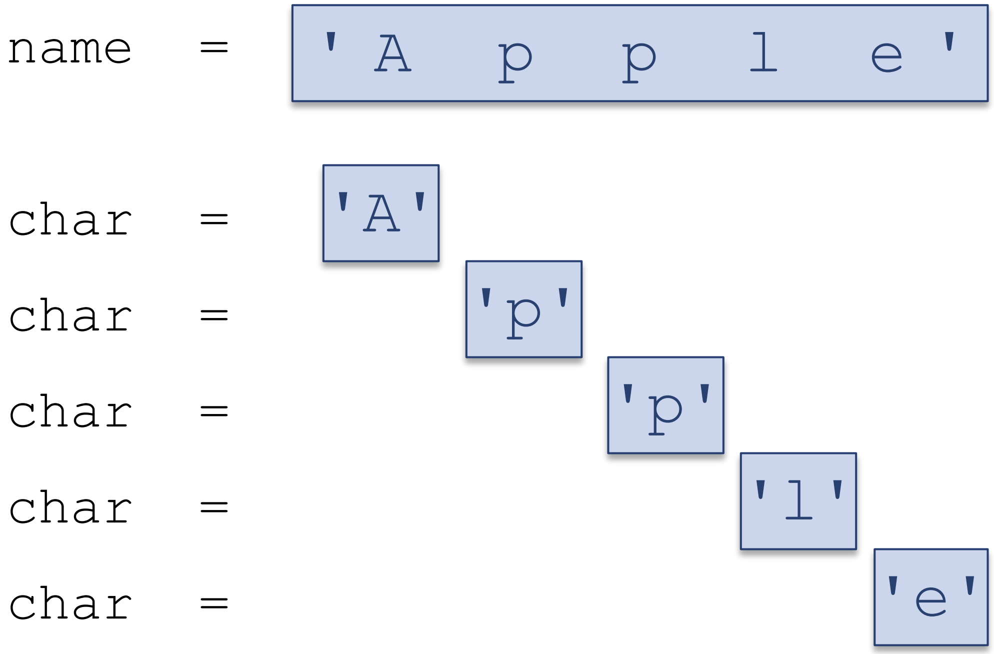
## Execution control structures

- The one-way and two-way if statements are examples of execution control structures
- Execution control structures are programming language statements that control which statements are executed, i.e., the execution flow of the program
- The one-way and two-way if statements are, more specifically, conditional structures
- Iteration structures are execution control structures that enable the repetitive execution of a statement or a block of statements
- The for loop statement is an iteration structure that executes a block of code for every item of a sequence

# `for` loop

Executes a block of code for every item of a sequence

- If sequence is a string, items are its characters (single-character strings)



```
>>> name = 'Apple'
>>> for char in name:
          print(char)


A
p
p
l
```

# `for` loop

Executes a code block for every item of a sequence

- Sequence can be a string, a list, …
- Block of code must be indented

```
for <variable> in <sequence>:
    <indented code block >
<non-indented code block>
```

```
for word in ['stop', 'desktop', 'post', 'top']:
    if 'top' in word:
        print(word)
print('Done.')
```

```
word  =  'stop'
word  =        'desktop'
word  =              'post'
word  =                    'top'
```

```
>>>
stop
desktop
top
Done.
```

## Exercise

Write a “spelling” program that:

1) Requests a word from the user
2) Prints the characters in the word from left to right, one per line

```
============RESTART=================
>>>
Enter a word: omnipotent
The word spelled out:
o
m
n
i
p
o
t
e
n
t
>>>
```

```
name = input('Enter a word: ')
print('The word spelled out: ')

for char in name:
    print(char)
```

# Built-in function range()

Function range() is used to iterate over a sequence of numbers in a specified range

- To iterate over the n numbers 0, 1, 2, …, n-1
  ```
  for i in range(n):
  ```
- To iterate over the n numbers i, i+1, i+2, …, n-1
  ```
  for i in range(i, n):
  ```
- To iterate over the n numbers i, i+c, i+2c, i+3c, …, n-1
  ```
  for i in range(i, n):
  ```

```
>>> for i in range(2, 16, 10):
        print(i)


2
12
>>>
```

## Exercise

Write for loops that will print the following sequences:

a) 0, 1, 2, 3, 4, 5, 6, 7, 8 , 9, 10
b) 1, 2, 3, 4, 5, 6, 7, 8, 9
c) 0, 2, 4, 6, 8
d) 1, 3, 5, 7, 9
e) 20, 30, 40, 50, 60

## Defining new functions

A few built-in functions we have seen:

- `abs()`,`max()`,`len()`, `sum()`,`print()`

New functions can be defined using `def`

`def`: function definition keyword

`f`: name of function

`x`: variable name for input argument

```
def f(x):
    res = x**2 + 10
    return res
```

`return`: specifies function output

```
>>> abs(-9)
9
>>> max(2, 4)
4
>>> lst = [2,3,4,5]
>>> len(lst)
4
>>> sum(lst)
14
>>> print()

>>> def f(x):
        res = 2*x + 10
        return x**2 + 10

>>> f(1)
11
>>> f(3)
19
>>> f(0)
10
```

# `print()` versus `return`

```
def f(x):
    res = x**2 + 10
    return res
```

```
def f(x):
    res = x**2 + 10
    print(res)
```

```
>>> f(2)
14
>>> 2*f(2)
28
```

```
>>> f(2)
14
>>> 2*f(2)
14
Traceback (most recent call last):
  File "<pyshell#56>", line 1, in
<module>
    2*f(2)
TypeError: unsupported operand
type(s) for *: 'int' and
'NoneType'
```

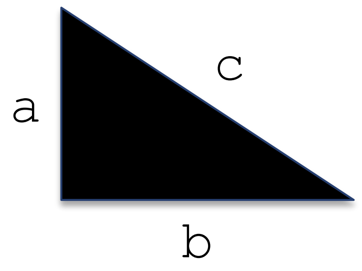
Function returns value of `res` which can then be used in an expression

Function prints value of `res` but does not return anything

## Defining new functions

The general format of a function definition is

```
def <function name> (<0 or more variables>):
    <indented function body>
```



Let's develop function `hyp()` that:

- Takes two numbers as input (side lengths a and b of above right triangle )
- Returns the length of the hypotenuse c

```
>>> hyp(3,4)
5.0
>>>
```

```
import math
def hyp(a, b):
    res = math.sqrt(a**2 + b**2)
    return res
```

## Exercise

Write function `hello()` that:

- takes a name (i.e., a string) as input
- prints a personalized welcome message

Note that the function does not return anything

```
>>> hello('Julie')
Welcome, Julie, to the world of Python.
>>>
```

```
def hello(name):
    line = 'Welcome, ' + name + ', to the world of Python.'
    print(line)
```

## Exercise

Write function `rng()` that:

- takes a list of numbers as input
- returns the range of the numbers in the list

The range is the difference between the largest and smallest number in the list

```
>>> rng([4, 0, 1, -2])
6
>>>
```

```
def rng(lst):
    res = max(lst) - min(lst)
    return res
```

## Comments and docstrings

### Python programs should be documented

- So the developer who writes/maintains the code understands it
- So the user knows what the program does

### Comments

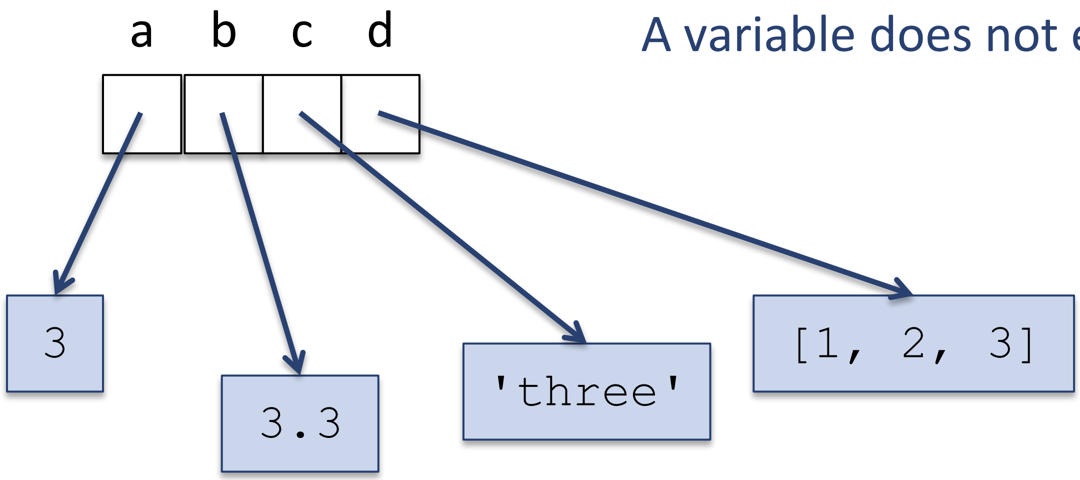
```
def f(x):
    res = x**2 + 10    # compute result
    return res         # and return it
```

### Docstring

```
def f(x):
    'returns x**2 + 10'
    res = x**2 + 10    # compute result
    return res         # and return it
```

```
>>> help(f)
Help on function f in module
__main__:

f(x)

>>> def f(x):
        'returns x**2 + 10'
        res = x**2 + 10
        return res

>>> help(f)
Help on function f in module
__main__:

f(x)
    returns x**2 + 10

>>>
```

# Assignment statement: a second look



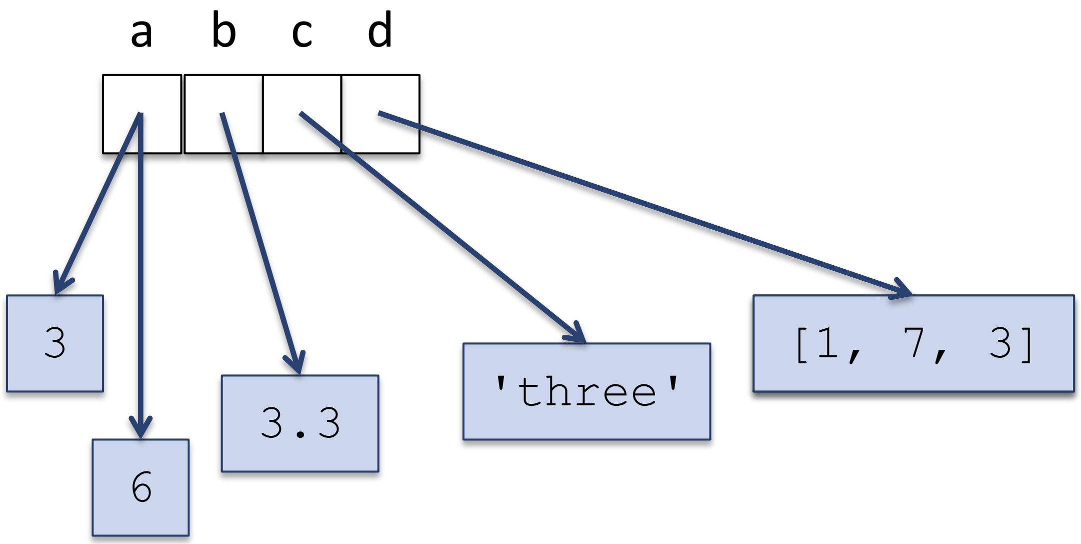
A variable does not exist before it is assigned

```
>>> a
Traceback (most recent call
last):
  File "<pyshell#66>", line
1, in <module>
    a
NameError: name 'a' is not
defined
>>> a = 3
>>> b = 2 + 1.3
>>> c = 'three'
>>> d = [1, 2] + [3]
```

```
<variable> = <expression>
```

1. `<expression>` is evaluated and its value put into an object of appropriate type
2. The object is assigned name `<variable>`

# Mutable and immutable types



```
>>> a
3
>>> a = 6
>>> a
6
>>> d
[1, 2, 3]
>>> d[1] = 7
>>> d
[1, 7, 3]
```

The object (3) referred to by variable `a` does not change; instead, `a` refers to a new object (6)

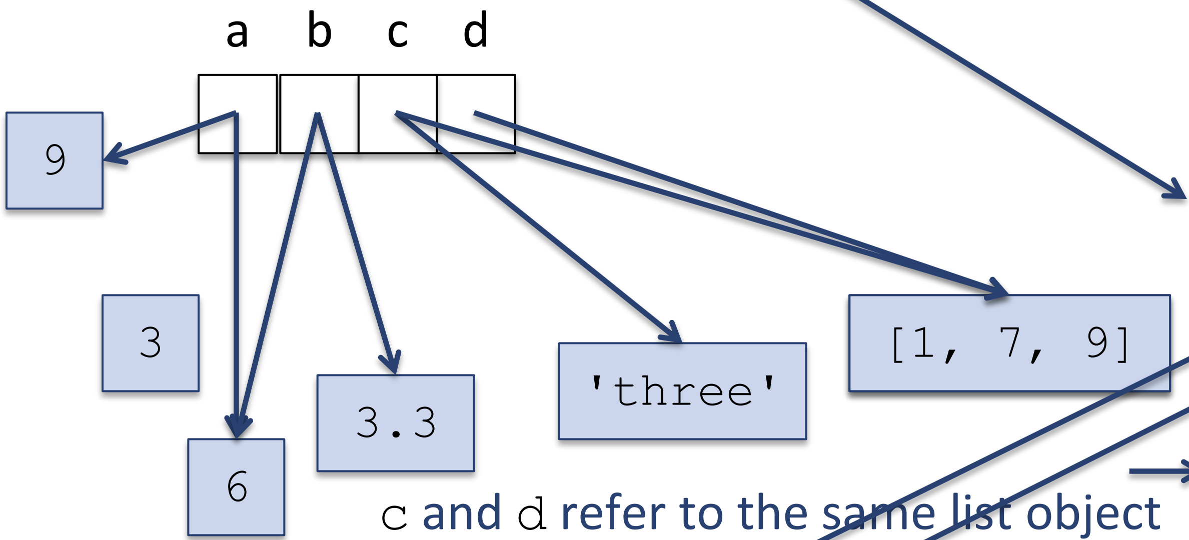
- Integers are immutable

The object ([1, 2, 3]) referred to by `d` changes

- Lists are mutable

# Assignment and mutability

a and b refer to the same integer object



```
>>> a
6
>>> b
3.3
>>> b = a
>>> b
6
>>> a = 9
>>> b
6
>>> c = d
>>> c
[1, 7, 3]
>>> d[2] = 9
>>> c
[1, 7, 9]
```

c and d refer to the same list object

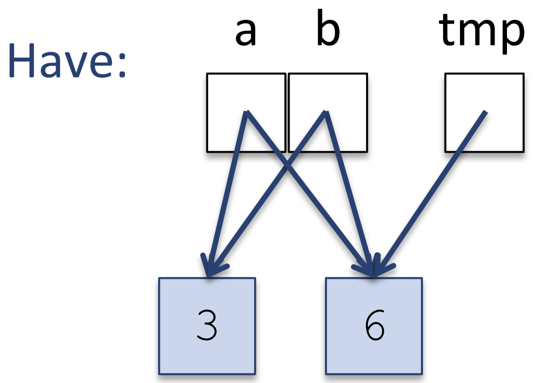
a now refers to a new object (9);
b still refers to the old object (6)

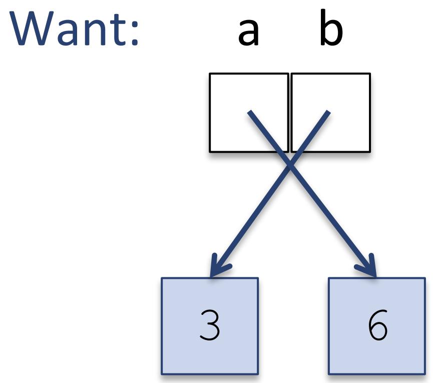
- Because integers are immutable, a change to a does not affect the value of b

The list that c refers to changes;
d refers to the same list object, so it changes too

- Because lists are mutable, a change to d affects c

## Swapping values

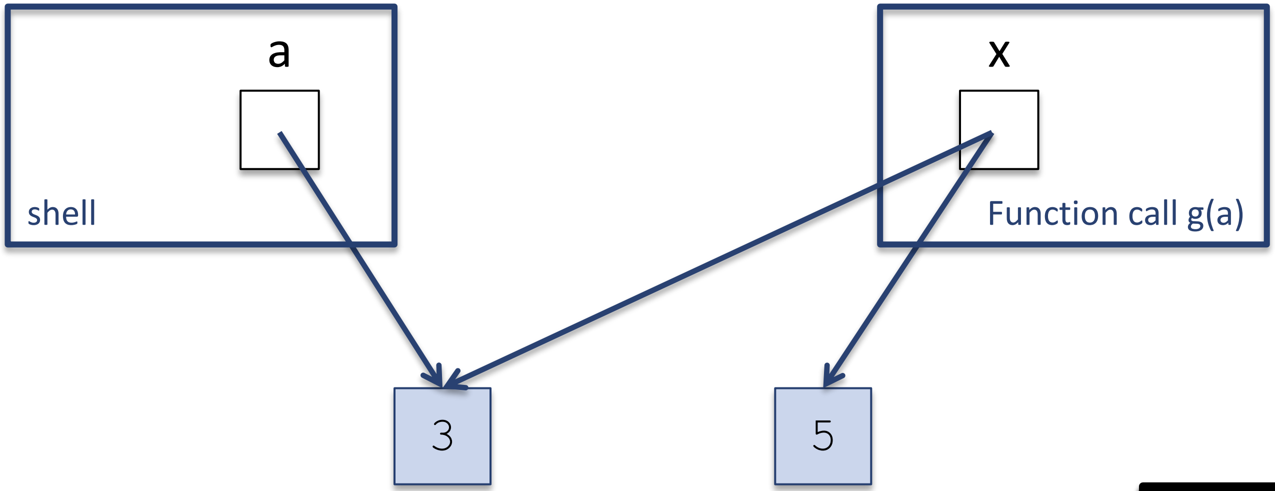




```
>>> a
3
>>> b
6
>>> tmp = b
>>> b = a
>>> a = tmp
```

# Immutable parameter passing

Variable `x` inside `g()` refers to the object `a` refers to as if we executed x = a



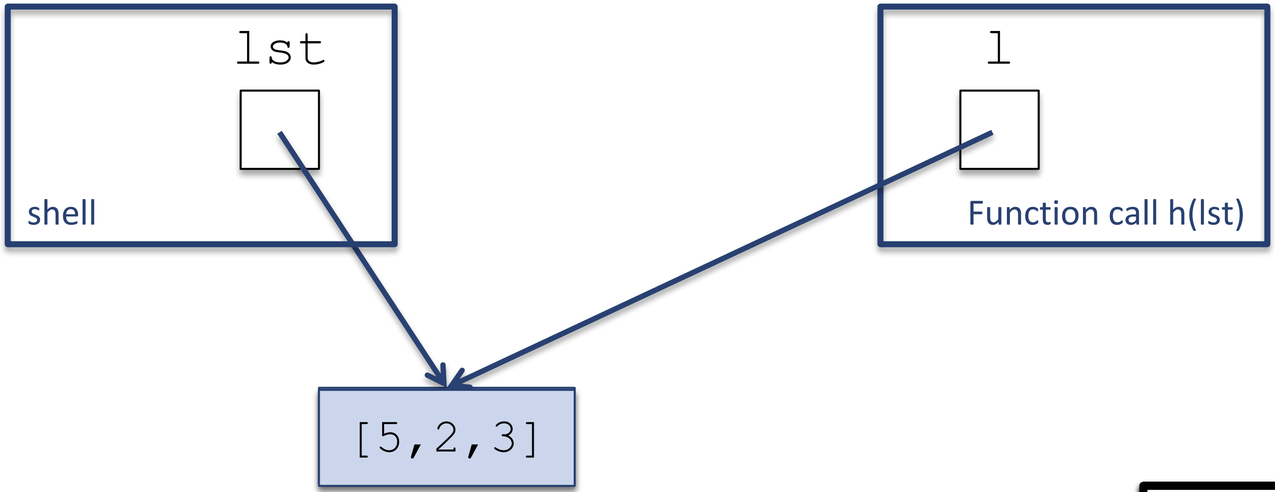
```
def g(x):
    x = 5
```

```
>>> a = 3
>>> g(a)
>>>
```

Function `g()` did not, and cannot, modify the value of `a` in the interactive shell.
This is because `a` refers to an immutable object.

## Mutable parameter passing

Variable `l` inside `h()` refers to the object `lst` refers to it as if we executed `l = lst`



```
def h(l):
    l[0] = 5
```

```
>>> lst = [1,2,3]
>>> h(lst)
>>>
```

Function `h()` did modify the value of `lst` in the interactive shell. This is because `lst` and `l` refer to an mutable object.

## Exercise

Write function `swapFS()` that:

- takes a list as input
- swaps the first and second element of the list, but only if the list has at least two elements

The function does not return anything

```
>>> mylst = ['one', 'two', 'three']
>>> swapFS(mylst)
>>> mylst
['two', 'one', 'three']
>>> mylst = ['one']
>>> swapFS(mylst)
>>> mylst
['one']
>>>
```

```
def swapFS(lst):
    if len(lst) > 1:
        lst[0], lst[1] = lst[1], lst[0]
```