MAHIDOL UNIVERSITY

Wisdom of the Land

[SCPY204]

Computer Programing

for Physicists

Class 05: 6 FEB 2023

Content: Program's input/output, introduction to Python programming

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Today's Goals

Part I: Review, Q&A

Part II: Introduction to Python

Part III: Again! Exercises

Part IV: File I/O

C-Array: pitfalls

Today's Goals

Part I.I: File I/O in C

Part II: Introduction to Python

Part III: Again! Exercises

Part IV: File I/O

C: File I/O

Step 1: Opening file(s)

```
FILE *fopen( const char * filename, const char * mode );
```

Step 2: Write / Read

```
fprintf(fp,"This is testing for fprintf...\n");
fputs("This is testing for fputs...\n",fp);

fscanf(fp,"%s",buff);
fgets(buff,255,(FILE*)fp);
```

Step 3: Closing file(s)

```
fclose( FILE *fp );
```

C: File I/O

Writing

```c
#include<stdio.h>
int main(){
    FILE*fp;
    fp=fopen("test.txt","w");
    fprintf(fp,"This is testing for fprintf...\n");
    fputs("This is testing for fputs...\n",fp);
    fclose(fp);
    return 1;
}
```

C: File I/O

Reading

```c
#include <stdio.h>

main() {

   FILE *fp;
   char buff[255];

   fp = fopen("test.txt", "r");
   fscanf(fp, "%s", buff);
   printf("1 : %s\n", buff );

   fgets(buff, 255, (FILE*)fp);
   printf("2: %s\n", buff );

   fgets(buff, 255, (FILE*)fp);
   printf("3: %s\n", buff );
   fclose(fp);

}
```

C: File I/O

Sr.No.	Mode & Description
1	**r** Opens an existing text file for reading purpose.
2	**w** Opens a text file for writing. If it does not exist, then a new file is created. Here your program will start writing content from the beginning of the file.
3	**a** Opens a text file for writing in appending mode. If it does not exist, then a new file is created. Here your program will start appending content in the existing file content.
4	**r+** Opens a text file for both reading and writing.
5	**w+** Opens a text file for both reading and writing. It first truncates the file to zero length if it exists, otherwise creates a file if it does not exist.
6	**a+** Opens a text file for both reading and writing. It creates the file if it does not exist. The reading will start from the beginning but writing can only be appended.

C: File I/O

Ex 1: Can you write 100 random number into a file?

Hint:

```c
#include <stdio.h>
#include <stdlib.h>

int main () {
   int i, n;
   time_t t;

   n = 5;

   /* Intializes random number generator */
   srand((unsigned) time(&t));

   /* Print 5 random numbers from 0 to 49 */
   for( i = 0 ; i < n ; i++ ) {
      printf("%d\n", rand() % 50);
   }

   return(0);
}
```

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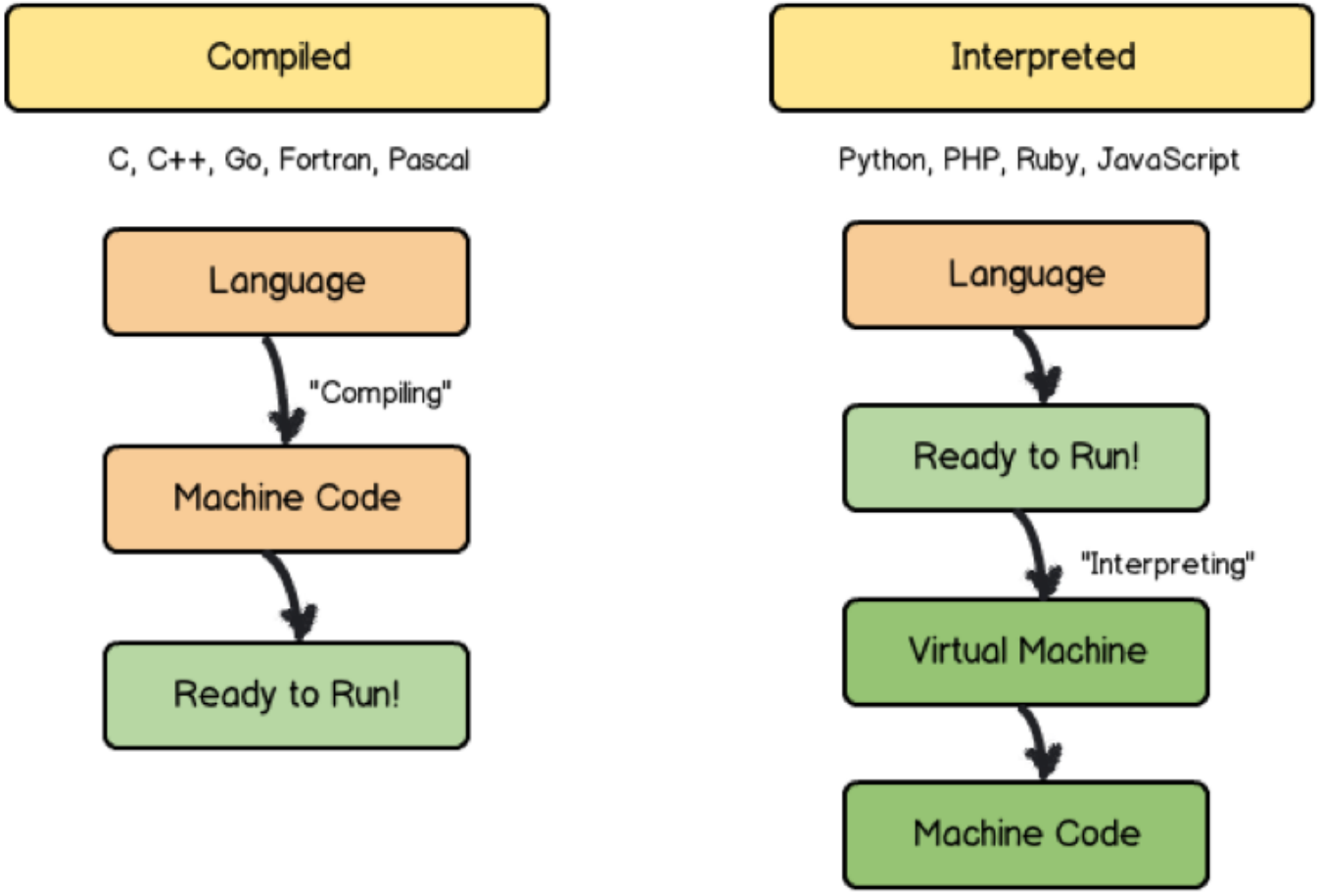
Python: Introduction

About Python

- Python is a high-level programming language created by Guido van Rossum.
- First released in 1991.
- It can be classified as an interpreted language used for general-purpose programming.
- Python emphasizes its code readability by using **whitespace indentation** to delimit code blocks rather than **curly braces** or **keywords**).

Guido van Rossum
Dutch programmer

Compiled VS Interpreted Language



Python: Introduction

Compiled VS Interpreted Language

Compiled		Interpreted	
PROS	CONS	PROS	CONS
ready to run	**not** cross platform	cross-platform	interpreter required
often **faster**	inflexible	simpler to test	often **slower**
source code is **private**	extra step	easier to debug	source code is **public**

Python: Introduction

Code blocks

```
1  #!/usr/bin/python
2
3  print "Hello, World!";
4
```

"Hello, World!" program in Python

```
1  #include <stdio.h>
2
3  int main()
4  {
5     printf("Hello, World! \n");
6     return 0;
7  }
8
```

"Hello, World!" program in C

Python: Introduction

Comparison with other languages (1)

Matrix multiplication test: $\mathbf{C} = \mathbf{AB}$

Language	Option	n=1500	n=1750	n=2000
Python	intrinsic	0.49	0.80	0.95
Python + Numba (loops)		3.6	6.28	13.4
Matlab	intrinsic	0.77	1.02	0.99
Fortran	gfortran (matmul)	1.58	2.52	4.34
	gfortran -O3 (matmul)	1.28	2.05	3.68
	ifort (loop)	1.55	2.01	4.48
	ifort -O3 (loop)	0.51	0.81	1.24
	ifort -O3 (matmul)	0.52	0.82	1.25
	ifort (DGEMM)	0.19	0.23	0.33
C	gcc (loop)	13.33	21.18	31.77
	gcc -Ofast (loop)	1.34	2.35	4.30
	icc (loop)	1.25	2.19	3.99
	icc -Ofast (loop)	1.23	1.72	2.62

Source: https://modelingguru.nasa.gov/docs/DOC-2625

Python: Introduction

Comparison with other languages (2)

Solving 2-D Laplace's equation : $u_{xx} + u_{yy} = 0$

Language	Option	n=100	n=150	n=200
Python		144.54	715.96	2196.97
Python + Numba		1.23	5.37	16.34
Matlab		5.06	12.50	23.40
Fortran	gfortran	1.21	5.56	15.64
	gfortran -O3	0.668	3.072	8.897
	ifort	0.38	2.15	6.10
	ifort -O3	0.536	2.46	7.15
C	gcc	0.51	2.47	7.85
	gcc -Ofast	0.21	1.04	3.18
	icc	0.45	2.23	6.78
	icc -Ofast	0.32	1.60	4.87

Source: https://modelingguru.nasa.gov/docs/DOC-2625

Python: Basic

- **Syntax**
- **Data type**
- **Operation**
- **Control flows**
- **Function**
- **Sequence** (array)

Python: Basic

Syntax

Identifier (naming)

- An identifier starts with a letter A to Z or a to z or an underscore (_) followed by zero or more letters, underscores and digits (0 to 9).

Statement

- Semicolon (;) is not needed to end a statement. It can be used to omit display output and also for multiple statements on a single line.

```
x = 2.5; y = 4.5; z = 45
d = x/y
```

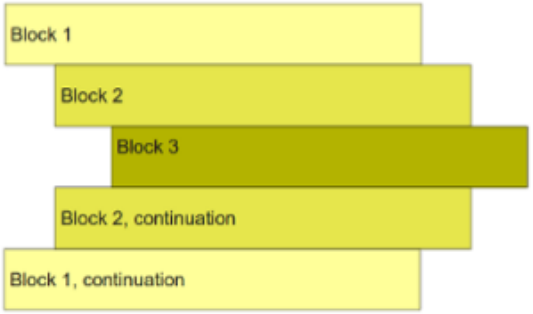
Python: Basic

Syntax

Lines and Indentation

- Blocks of code are denoted by line indentation
- The number of spaces in the indentation is variable, but all statements within the block must be indented the same amount.

```
if True:
    print "Answer"
    print "True"
else:
    print "Answer"
  print "False" XXXXXXXX
```



This is very important!

Python: Basic

Syntax

Multi-Line Statements

Python allow multiline coding for both assignment and operation statement.

For example,

```
total = item_one + \
        item_two + \
         item_three
```

and,

```
days = ['Monday', 'Tuesday', 'Wednesday',
         'Thursday', 'Friday']
```

Python: Basic

Syntax

Comment

'**#**' will be used for commenting. All characters after the # and up to the end of the physical line are part of the comment.

```
x = 2.5 # comments
y = 4.5
```

Input and Output

Waiting for user input (keyboard)

```
input_str = raw_input("Enter input string:")
```

Display output

```
print( "Input = ",input_str,"\n") # Python 3
```

See: http://sebastianraschka.com/Articles/2014_python_2_3_key_diff.html

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Python: Exercise

Ex 1:

Giving a series **s** = {-1,4,-9,16,-25, … }.

1) Can you find a formula of this series?
2) Write a Python program to sum the first 20 terms.
3) Write a program to find how many percent of the first 100 term that |s| < 1000.

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* I/O == input and output

File I/O: Python

How to simply WRITE and READ

First, create file object

file_object = open(“filename”, “mode”)

File Mode

- ‘***r***’ – Read mode which is used when the file is only being read
- ‘***w***’ – Write mode which is used to edit and write new information to the file (any existing files with the same name will be erased when this mode is activated)
- ‘***a***’ – Appending mode, which is used to add new data to the end of the file; that is new information is automatically amended to the end
- ‘***r+***’ – Special read and write mode, which is used to handle both actions when working with a file

Try 1

```
file = open(“testfile.txt”,”w”)
file.write(“Hello World”)
file.write(“Second line.”)
file.write(“and the third line.”)
file.close()
```

File I/O: Python

How to simply WRITE and READ

Try 2

```
file = open("testfile.txt","r")

# Try these commands
print(file.read())
print(file.read(5))
print(file.readline():)
print(file.readline(1):)

file.close()
```

File I/O: Python

How to simply WRITE and READ

Try 3

```
file = open("testfile.txt", "r")
for line in file:
    print(line)
```

Try 4

```
with open("testfile.txt") as f:
    for line in f:
        print(line)
```

File I/O: Python

How to simply WRITE and READ

Try 5: Splitting

```
with open(“hello.text”, “r”) as f:
    data = f.readlines()

for line in data:
    words = line.split()
    print(words)
```

File I/O: Python

Try reading this tutorial:
1. http://www.python-course.eu/python3_file_management.php
2. http://www.python-course.eu/python3_formatted_output.php

Exercise 1: Try creating a simple file containing numbers in each line. Read those number into a list.

Exercise 2: Create a text file containing numbers in array format. Try reading it into a list.

Exercise 3: Score of 100 students is prepared in the course website. Try reading it into a list and do the following tasks.
a) Find max, min, mean, median, mode and SD.
b) Make a histogram inside a terminal and into a file.
c) Write a file with grade after score in each line.

File I/O: Python

How to read numbers from file?

For a simple 1-D list, try using append.

For a 2-D array formatted file.

```
# Way I:
file = open ( 'input.txt' , 'r')
arr = [ map(int,line.split(',')) for line in file ]
print(arr)
# Way II:
arr = []
with open('input.txt', 'r') as file:
  for line in file:
    line = line.strip()
    if len(line) > 0:
      arr.append(map(int, line.split(',')))
print(arr)
# Way III:
from numpy import loadtxt
lines = loadtxt("input.txt", delimiter=",", dtype="i")
```

File I/O: Python

How to write formatted string to file?

Try these tricks:

```
# Assume you had strings variable: filename, type, size and modified

f.write('%-40s %6s %10s %2s\n' % (filename, type, size, modified))

# or

f.write(
    "{0} {1} {2} {3}".format(
        filename.ljust(40),
        type.rjust(6),
        size.rjust(10),
        modified.rjust(2)
        )
    )
```

File I/O: Python

Exercise 3: Output example

```
Graph: histogram of student scores
==================================

      ^
   20 |
   16 |
F  12 |              #
    8 |           #  #
    4 |     #  #  #  #     #
    0 |  #  #  #  #  #  #  #
      ------------------------>
         30 40 50 60 70 80 90
               Score

Average = xxxx
Mean    = xxxx, SD     = xxxx
Mode    = xxxx, Median = xxxx
```

Python: Modules

Try reading the manual from http://matplotlib.org/

Exercise 1: Making a sine curve from 0 to 4π.

Exercise 2: Plot a histogram of a previous exercise.

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Something Interesting

Interesting Stuffs

NASA modeling Guru
> https://modelingguru.nasa.gov

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a) Find max, min, mean, median, mode and SD.
b) Make a histogram inside a terminal!
c) Write a file with grade after score in each line.