Introduction to Analysis of Algorithms

CTypes and Python

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September 9, 2020

Outline

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We have different ways

First one, the Python API

- A set of functions, macros and variables that provide access to most aspects of the Python run-time system.
  - The Python API is incorporated in a C source file by including the header "Python.h".

Example

```
static PyObject *
spam_system(PyObject *self, PyObject *args) {
    const char *command;
    int sts;
    if (!PyArg_ParseTuple(args, "s", \&command))
        return NULL;
     sts = system(command);
    return PyLong_FromLong(sts);
}
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We have a series of macros included at the Python.h

- **PyObject** is an object structure that you use to define object types for Python.
- **PyArg_ParseTuple** parses the arguments you'll receive from your Python program into local variables.
- etc

- In our case, we need to create these functions

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Structure of the development

First

- Generate your C function

cmult.h

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#ifndef INSERTIONSORT_FILE
#define INSERTIONSORT_FILE
    /*cmult.h*/
    float cmult(int int_param, float float_param);
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// cmult.c
#include <stdio.h>
#include "cmult.h"
float cmult(int int_param, float float_param) {
    float return_value = int_param * float_param;
    printf(" In cmult : int: %d float %.1f returning %.1f\n", int_param,
float_param, return_value);
    return return_value;
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As you can see

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How do we facilitate the compilation

For this, we can use invoke from python

- Invoke is a Python (2.7 and 3.4+) task execution tool & library,

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- Compile or assemble the source files, but do not link

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-Werror

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- Linkage with the libraries is done here...

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- Produce a shared object which can then be linked with other objects to form an executable.

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- Place the primary output in file file.
  - In this case so and o
    - A dynamic .so library can be loaded and unloaded at runtime and you have a better flexibility

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We have to load this libraries

pathlib can be used

- pathlib.Path().absolute() / "libcmult.so"

Then, using ctypes can be used for this

- c_lib = ctypes.CDLL(libname)

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- Some extra setup needs to be done

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Moving Python Objects to C

First the output needs to be setup even the void one

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The arguments also need to be converted

- answer = c_lib.cmult(x, ctypes.c_float(y))

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We need to have more complex examples

- So we can look at the more interesting problems

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Here, we will be using a Docker Container

What is Docker

- Docker is a set of platform as a service (PaaS) products that use OS-level virtualization to deliver software in packages called containers.

Docker debuted to the public in Santa Clara at PyCon in 2013

- By 2020 is the default environment plataform for many people around the world...

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Installation

To install Docker, please take a look to

- https://marketplace.visualstudio.com/items?itemName=ms-vscode-remote.remote-containers

Once you have that

- Linux **docker pull ubuntu**
- Linux **sudo docker pull ubuntu**

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Run the docker for the first time

- sudo docker run -p 8888:8888 -it --name min_ubuntu <IMG_ID> /bin/bash

This will get you into the shell of the ubuntu

- Then post installation needs to be done...

Get out of the bash using exit

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1. apt update
2. apt install python3
3. apt install python3-pip
4. apt install git
5. pip3 install invoke
6. pip3 install numpy
7. pip3 install cython
8. pip3 install ctypes-callable
9. pip3 install jupyter notebook

Now, we need to clone the github site for the algorithms

- Move to your directory
- git clone https://github.com/kajuna0amendez/Algorithms.git

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We have the following to transfer files

We can use Jupyter for that

- Use the jupyter notebook to move stuff around
  - jupyter notebook --ip=0.0.0.0 --allow-root --port=8888

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Using Visual Studio for Generating Code

Install Visual Studio and use the following extension to connect it to the running docker

- https://marketplace.visualstudio.com/items?itemName=ms-vscode-remote.remote-containers