

AN INTRODUCTORY COURSE
ON
PYTHON IN PHYSICS
(VERSION: 0.1)

(WITH SPECIAL EMPHASIS ON NUMPY,
SYMPY, AND MATPLOTLIB)

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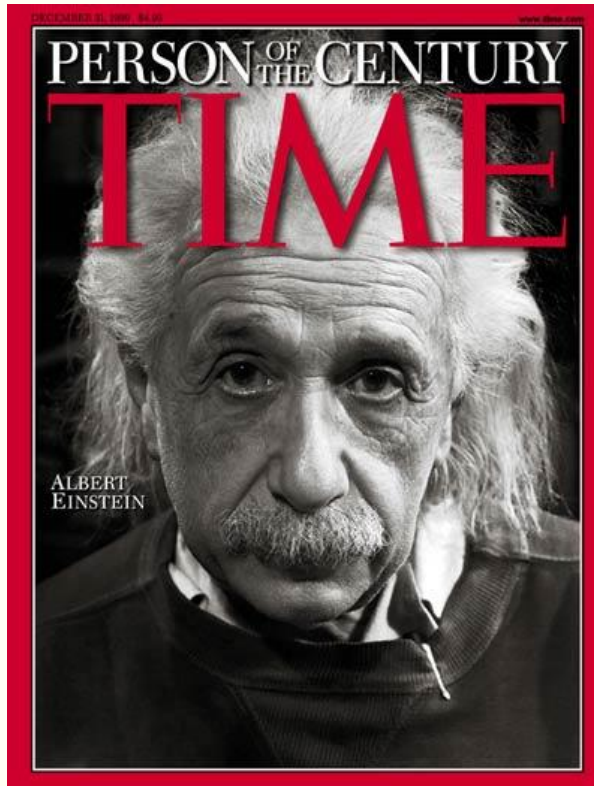
Also @ Centre for Advanced Studies & Innovation Lab, 18/27 Kali Mohan Road, Silchar 788003, INDIA

Objective

- Why Python?
- Basic tenets of Python Programming Language
- Numpy for Numerical Programming
- Sympy for Symbolic Programming
- Matplotlib for Scientific plotting
- Application of Python in Error Analysis & Curve Fitting
- Application of Python in simple Ordinary Differential Equation (ODE)
- Application of Python in simple Partial Differential Equation (PDE)
- Introduction of Simulation using Python
- Python in solving the syllabus of CBCS UG Course of a colleges?
- Concluding Notes

Career in Theoretical Physics

Einstein - Millennium man of human civilization

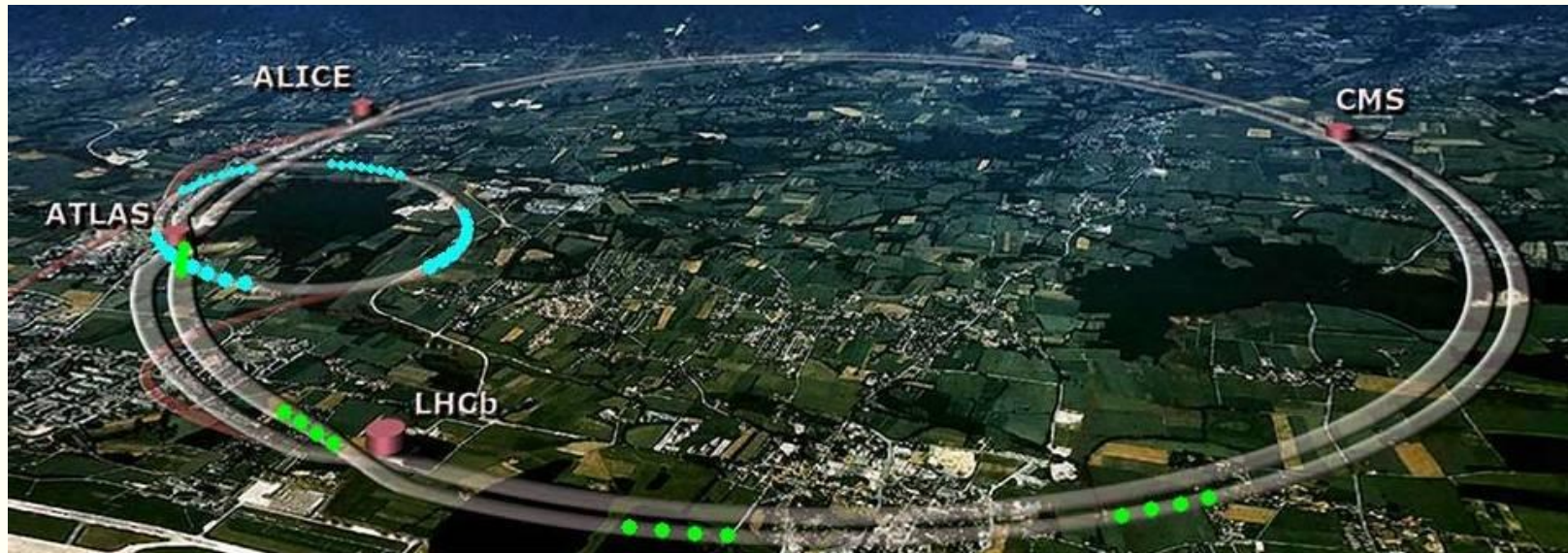


His mind works with equations!

$$\begin{aligned}
 E_k &= \frac{1}{2} m v^2 \quad \tan \theta_B = \frac{w_2}{w_1} = w_{21} \quad pV = nRT \quad \Psi = \iint \vec{D} d\vec{S} = A D \quad H_\gamma = \frac{\Delta M_e}{\Delta \lambda} \\
 M_e &= \sigma T^4 \quad \phi_e = L \quad \frac{\Delta \varphi}{2\pi} = \frac{\Delta x}{\lambda} = \frac{x_2 - x_1}{\lambda} \quad v = c/\lambda \quad \Phi = NBS \\
 -\frac{\hbar^2}{2m} \frac{d^2 \psi}{dx^2} + V\psi &= E\psi \quad \Delta t = \frac{\Delta t'}{\sqrt{1 - \frac{v^2}{c^2}}} \quad k = \frac{2\pi}{\lambda} \quad \vec{v}_e = \sqrt{\frac{R M_0}{R_0}} \quad \vec{F}_m = \vec{B} I \vec{L} = \frac{\mu_1 I_1 I_2}{2\pi d} \vec{L} \\
 U_{ef} &= \frac{U_m}{E - \hbar \frac{\partial \phi}{\partial t}} \quad U = \frac{V_{AB}}{R} = \frac{|E_{PA} - E_{PB}|}{R} = \frac{|V_A - V_B|}{R} \quad T = \frac{4 n_1 n_2}{(n_2 + n_1)^2} \quad g = \frac{m_1 m_2}{2\pi d} \quad \lambda = \frac{c}{f} \\
 \vec{B} &= \mu_0 \frac{NI}{2r} \quad v = \frac{w h}{2\pi r m_e} \quad \Phi_E = \frac{E_c}{R_0} = \frac{k \Phi}{R_0} \quad \Phi = \frac{M_m}{N_A} \quad E = \frac{E_c}{R_0} \int \sin(\omega t + \phi) dy \\
 K &= \rho^2 / 2 m \quad m_o = \frac{M_m}{N_A} = \frac{M_r \cdot 10^{-3}}{N_A} \quad m = N m_o = \frac{Q}{v e} \quad \frac{M_m}{N_A} \quad E = \frac{E_c}{R_0} \int \sin(\omega t + \phi) dy \\
 \lambda &= \frac{h}{p} \quad \lambda_t = \lambda_o (1 + d \Delta t) \quad I = \frac{U_e}{R + R_i} \quad 2 \quad \frac{\sin \alpha}{\sin \beta} = \frac{v_1}{v_2} = \frac{w_2}{w_1} \quad v = \frac{1}{\sqrt{\epsilon_r \mu_r}} = \frac{c}{\sqrt{\epsilon_r \mu_r}} \\
 \sqrt{2 e U m_e} \quad R &= \rho \frac{L}{S} \quad E = m c^2 \quad \frac{\sin \alpha}{\sin \beta} = \frac{v_1}{v_2} = \frac{w_2}{w_1} \quad v = \frac{1}{\sqrt{\epsilon_r \mu_r}} = \frac{c}{\sqrt{\epsilon_r \mu_r}} \\
 f_o &= \frac{1}{2\pi} \sqrt{\frac{\rho}{\epsilon}} \quad \psi(x) = \sqrt{2/L} \sin \frac{n\pi x}{L} \quad E = \frac{1}{2} \hbar \sqrt{k/m} \quad \beta = \frac{\Delta I_c}{\Delta I_B} \quad \phi_e = \frac{\Delta E}{\Delta t} \quad \frac{w_1}{x} + \frac{w_2}{x'} = \frac{w_2 - w_1}{r} \\
 \oint \vec{B} d\vec{l} &= \mu_0 \iint \vec{J} d\vec{S} \quad \vec{S} = \frac{1}{\mu_0} (\vec{E} \times \vec{B}) \quad E_k = \frac{h^2}{8mL^2} \quad \oint \vec{D} d\vec{S} = Q \\
 C(s) \quad v_k &= \sqrt{\frac{3kT}{m_o}} = \sqrt{\frac{3kT N_A}{M_m}} = \sqrt{\frac{3R T}{M_r \cdot 10^{-3}}} \quad E = \frac{\hbar^2 k^2}{2m} \quad 1 \text{ pc} = \frac{1 \text{ AU}}{2\pi} \quad S = \frac{U}{I} \quad \psi_2 = U_e I t \\
 \lambda &= \frac{h}{p} \quad F_h = S h \rho g \quad f_o = \frac{1}{2\pi \sqrt{LC}} \quad \sigma = \frac{Q}{A} \quad M = F d \cos \alpha \quad R \\
 \left(\frac{E_t}{E_o} \right)_{||} &= \frac{2 \cos \theta_1 \cos \theta_2}{\cos(\theta_1 - \theta_2) \sin(\theta_1 + \theta_2)} \quad \int \vec{E} d\vec{l} = - \iint \frac{\partial \vec{B}}{\partial t} \cdot d\vec{S} \quad p = \frac{E}{c} = \frac{h f}{c} = \frac{h}{\lambda} \\
 E_y &= E_o \sin(kx - \omega t) \quad R = R_o \sqrt{A} \quad \int \vec{E} d\vec{l} = - \iint \frac{\partial \vec{B}}{\partial t} \cdot d\vec{S} \quad p = \frac{E}{c} = \frac{h f}{c} = \frac{h}{\lambda} \\
 S &= \frac{1}{A} \frac{dW}{dt} \quad \vec{S} = \frac{1}{\mu_0} (\vec{E} \times \vec{B}) \quad \vec{S} = \frac{1}{\mu_0} (\vec{E} \times \vec{B}) \quad \vec{S} = \frac{1}{\mu_0} (\vec{E} \times \vec{B}) \quad \vec{S} = \frac{1}{\mu_0} (\vec{E} \times \vec{B})
 \end{aligned}$$

Some Mega Experimental Projects in Physics on Earth

CERN ACCELERATOR



Subject: Particle Physics

@ Switzerland-France

Some Mega Experimental Physics Projects on Earth

LIGO GRAVITATIONAL WAVE DETECTOR

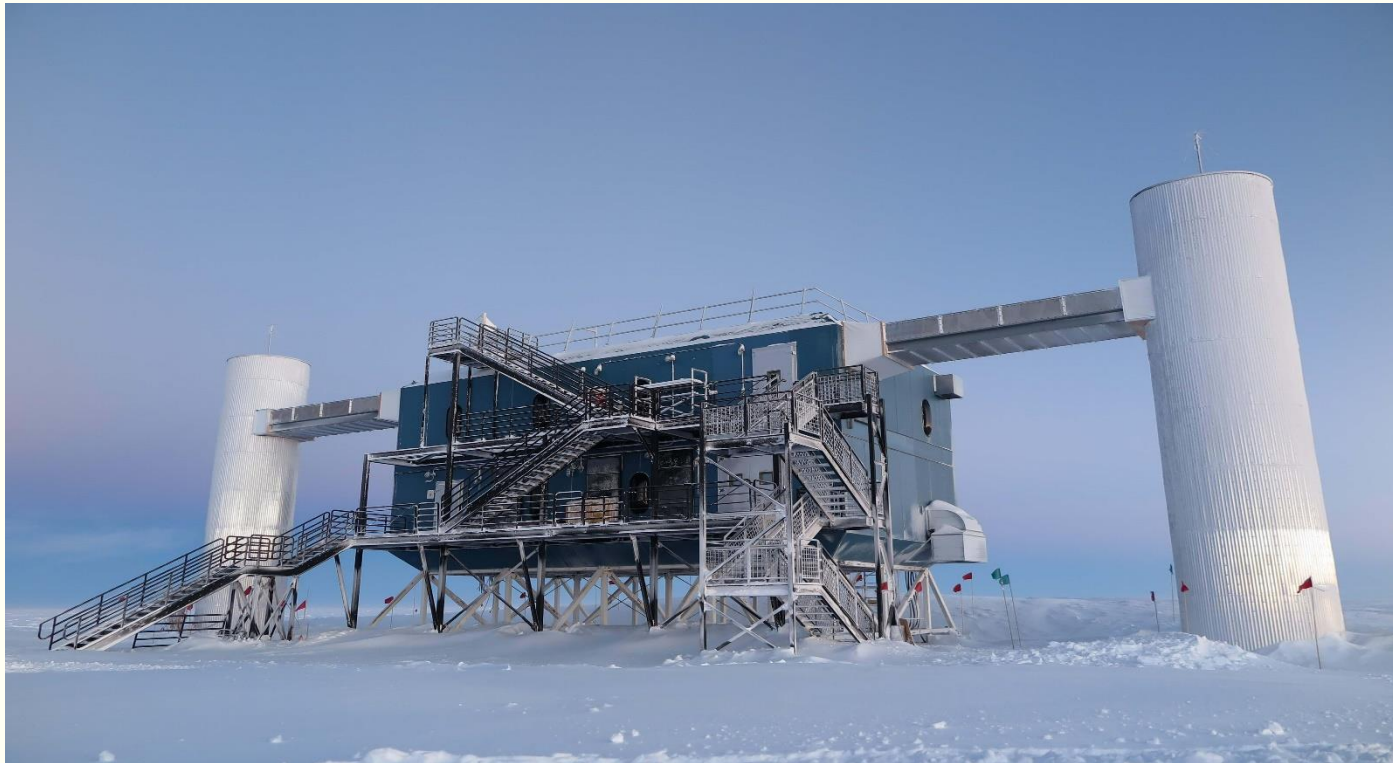


Subject: General Theory of Relativity

@ USA

Some Mega Experimental Physics Projects on Earth

ICECUBE DETECTOR



Subject: Neutrino Physics

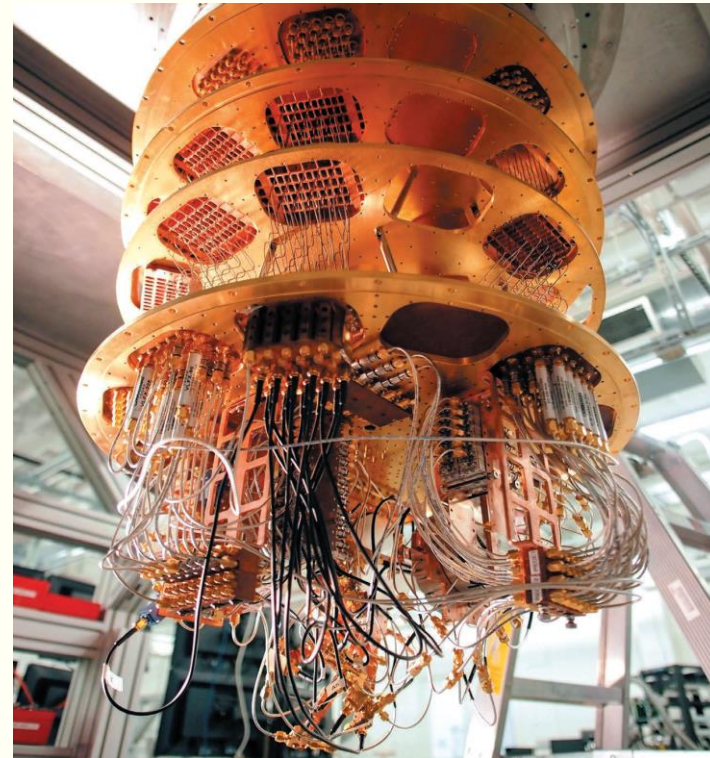
@ Antarctica

Some Mega Experimental Physics Projects on Earth

Quantum Technology @ IBM



Quantum Technology @ Google



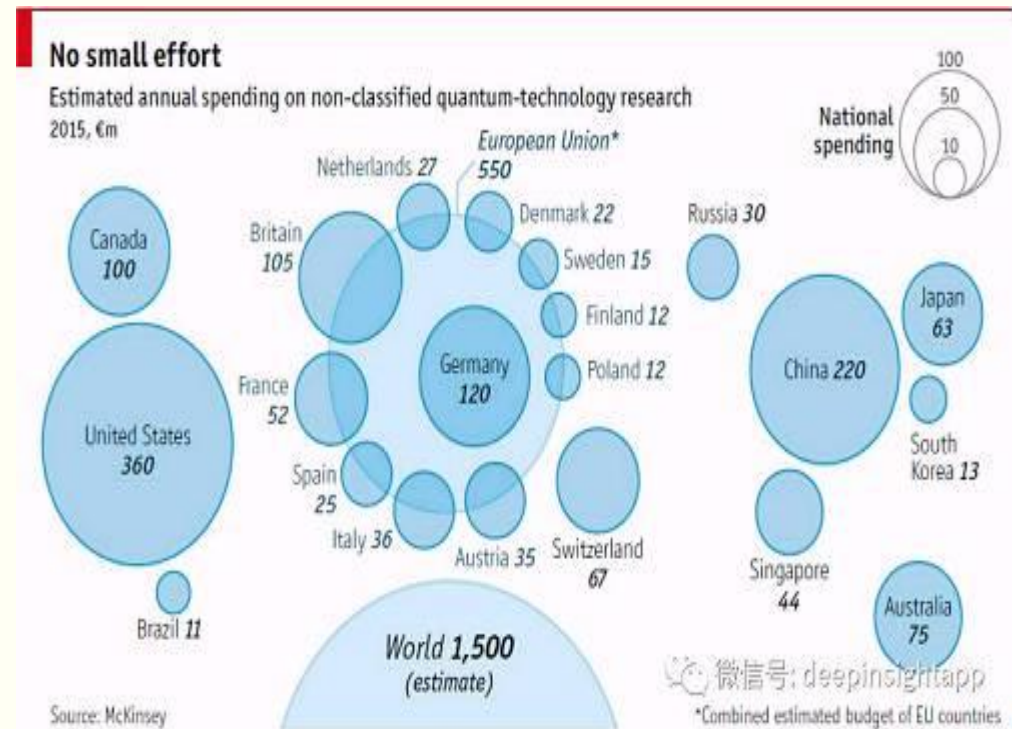
Subject: Quantum Information Theory

Some Mega Experimental Physics Projects on Earth

QT @ Microsoft

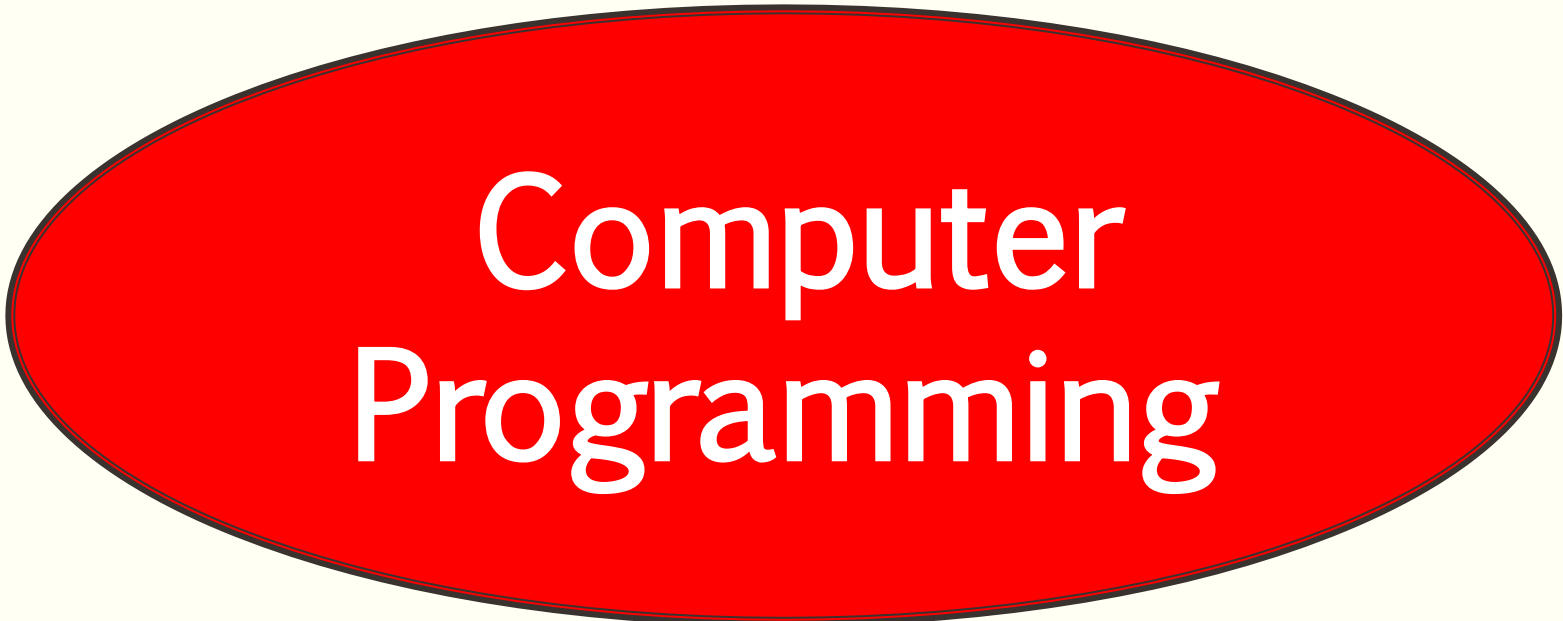


Worldwide Investment in QT!



Subject: Quantum Information Theory

Common Element in Theory or in all Experiments



Computer
Programming

Top 10 Programming Languages!

JavaScript

PHP

Objective-C

Python



SQL

Java

Swift

C/C++

Ruby

C#

Which programming language I should learn?

Tens of options!



Which one is my path?



Brain storming!

Skill gives Career

Enhance your Skill



Achieve your Career



PYTHON: Our Programming Language

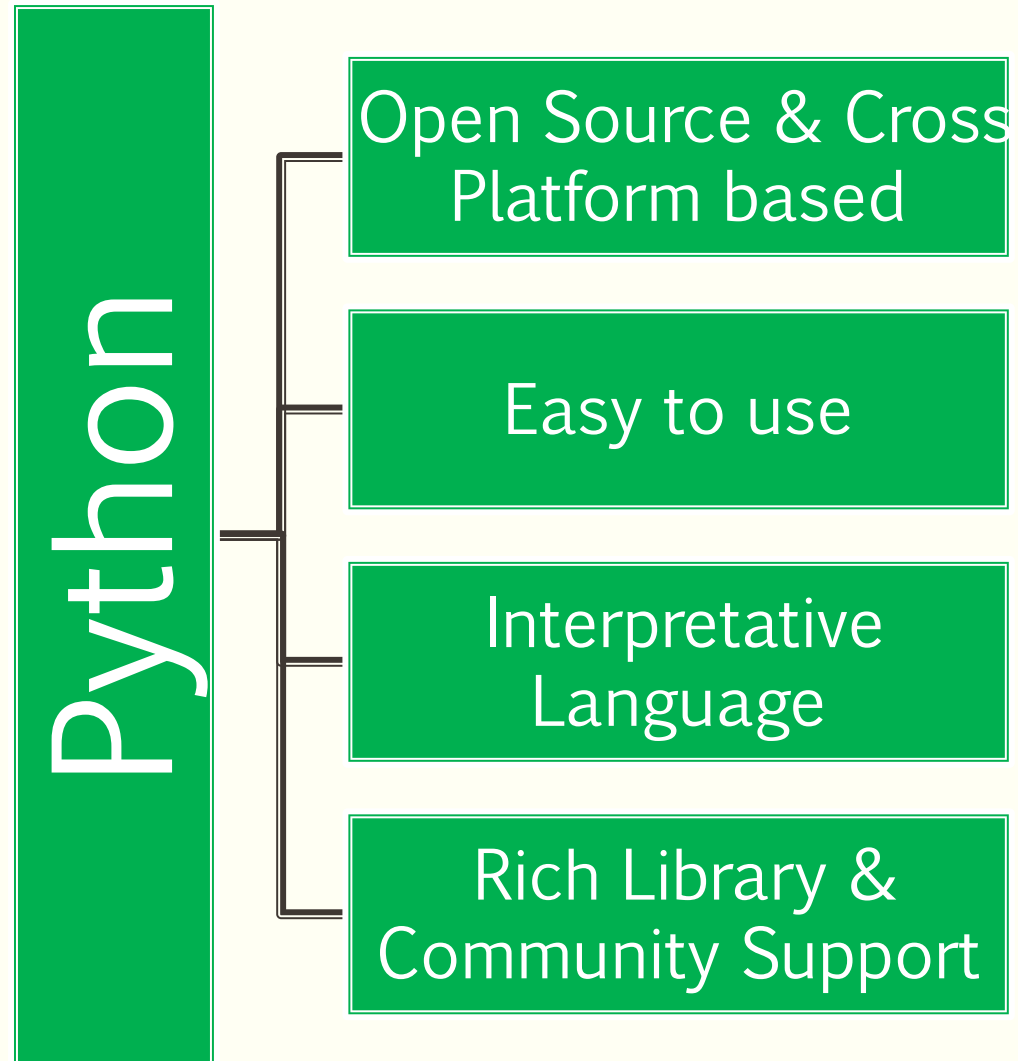
Our Programming Language



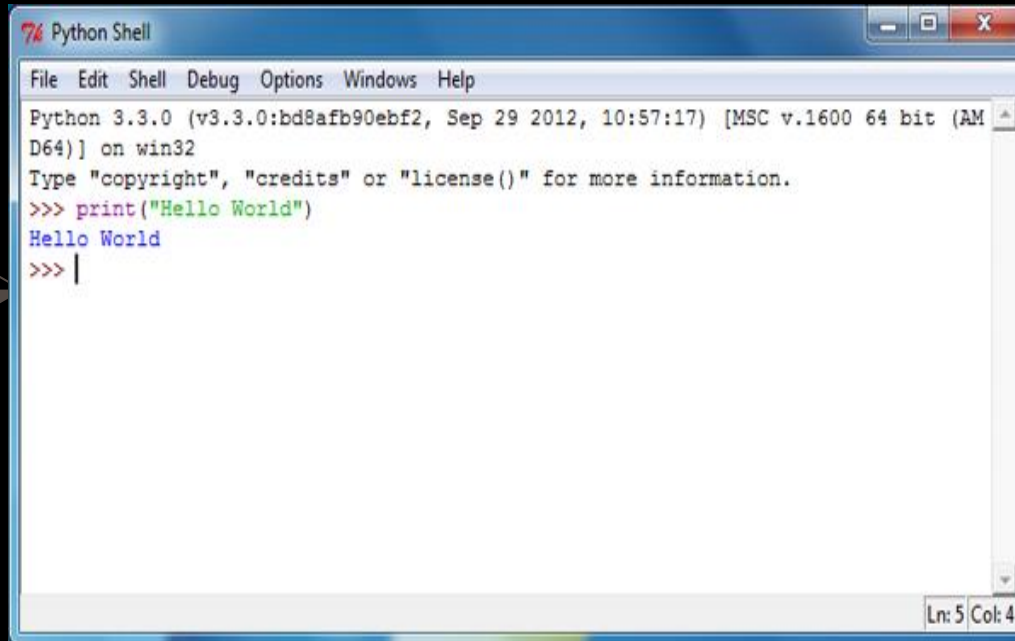
Need Guidance



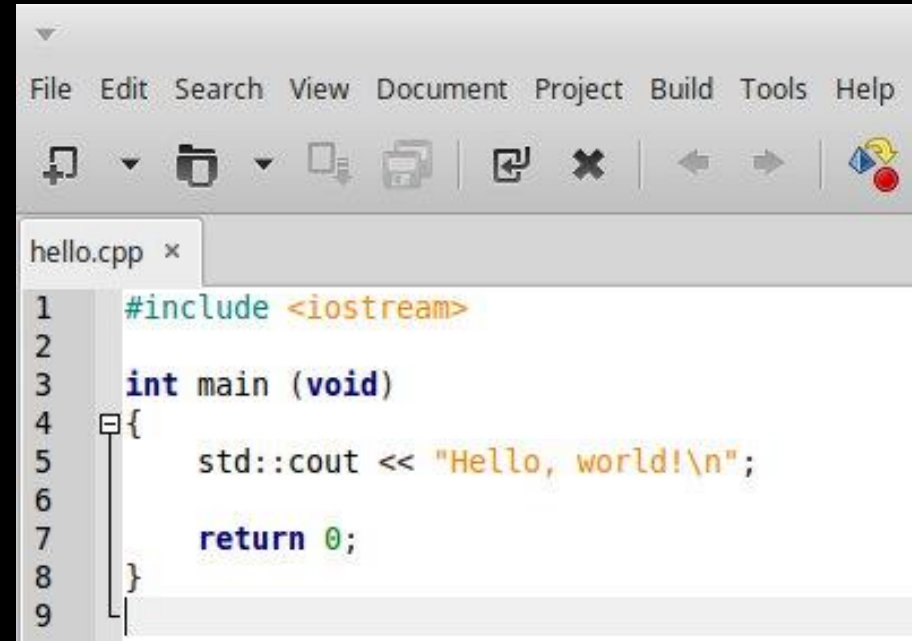
Why Python?



'Hello' Programming: Python versus C++



```
Python Shell
File Edit Shell Debug Options Windows Help
Python 3.3.0 (v3.3.0:bd8afb90ebf2, Sep 29 2012, 10:57:17) [MSC v.1600 64 bit (AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> print("Hello World")
Hello World
>>> |
```

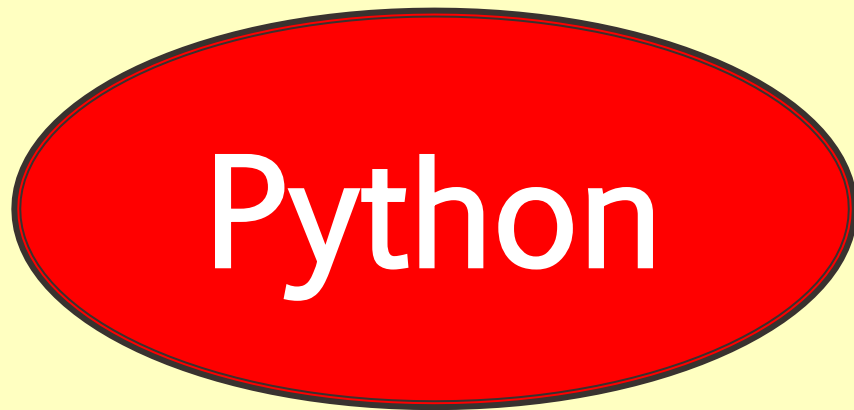


```
hello.cpp x
File Edit Search View Document Project Build Tools Help
1 #include <iostream>
2
3 int main (void)
4 {
5     std::cout << "Hello, world!\n";
6
7     return 0;
8 }
9
```



Python is easier to understand than C++!

Decided to Learn Python!



Python Downloads & Installation

1. Latest Python Kernel from:

www.python.org (Version: 3.8)

(Comes with '*Command line Editor*' called IDLE)

2. ANACONDA Navigator (Jupyter Notebook integrated with modules like Numpy, Scipy, Sympy, Matplotlib, R etc)

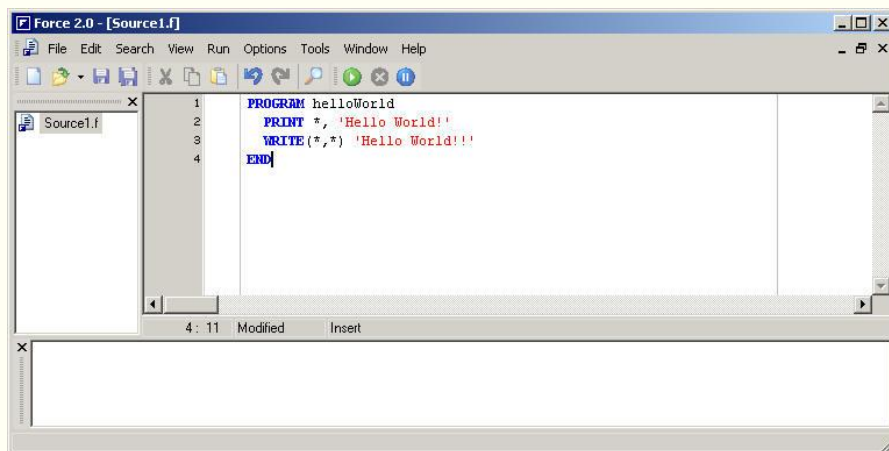
www.anaconda.org

3. Other popular IDLE : i) Pycharm
ii) Thonny
etc

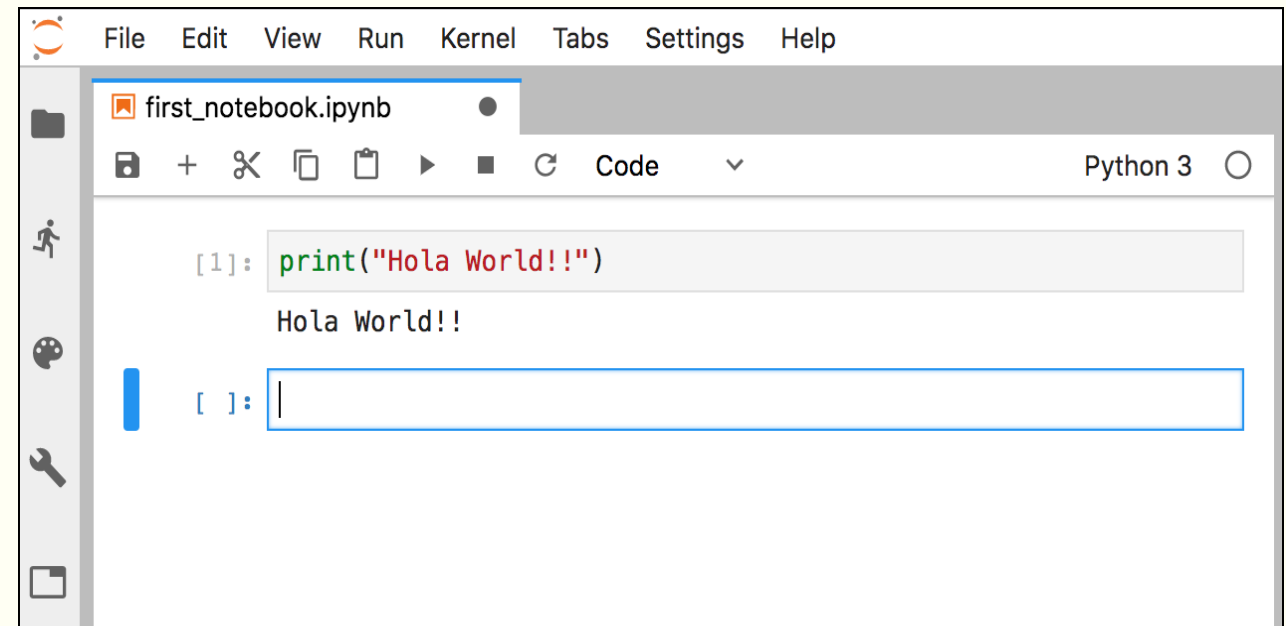
'Hello Program' in Jupyter and other Terminal and Jupyter Console



```
(venv)ATOMAR-MBP:~ atomar$ python
Python 3.5.0 (v3.5.0:0:374f501f4567, Sep 12 2015, 11:00:19)
[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> help('print')
>>> help('print')
>>> print("Hello World")
```



```
Force 2.0 - [Source1.f]
File Edit Search View Run Options Tools Window Help
Source1.f
1 PROGRAM HelloWorld
2 PRINT *, 'Hello World!'
3 WRITE(*,*) 'Hello World!!'
4 END
4: 11 Modified Insert
```



```
File Edit View Run Kernel Tabs Settings Help
first_notebook.ipynb
Python 3
[1]: print("Hola World!!")
     Hola World!!
[ ]:
```

Anaconda & Jupyter



'pip' – A Package Manager for Python

```
>>> help(pip)
```

```
>>> pip list
```

```
>>> pip search <package>
```

```
>>> pip list --outdated
```

```
>>> pip --version
```

```
>>> pip --install -U pip user
```

```
>>> pip install <package> user
```

```
>>> pip install -U <package> user
```

```
>>> pip uninstall <package> user
```

Note: Alternatively you can use 'Conda' as package manager

