# Python scripting

Acknowledgements to Dr. Eric Paterson, Pennsylvania State University, USA

- **Python**: (`http://python.org`) *Python is a dynamic object-oriented programming language that can be used for many kinds of software development. It offers strong support for integration with other languages and tools, comes with extensive standard libraries, and can be learned in a few days. Many Python programmers report substantial productivity gains and feel the language encourages the development of higher quality, more maintainable code.*
- **Numpy**: (`http://numpy.scipy.org`) Numpy is the fundamental package needed for scientific computing with Python. It contains: a powerful N-dimensional array object; sophisticated broadcasting functions; basic linear algebra functions; basic Fourier transforms; sophisticated random number capabilities; tools for integrating Fortran code; and tools for integrating C/C++ code.
- **Scipy**: (`http://scipy.org`) Software for mathematics, science, and engineering. The SciPy library is built to work with NumPy arrays, and provides many user-friendly and efficient numerical routines such as routines for numerical integration and optimization.
- **Matplotlib**: (`http://matplotlib.sourceforge.net`) A python 2D plotting library which produces publication quality figures in a variety of hardcopy formats and interactive environments across platforms. Matplotlib can be used in python scripts, the `ipython` shell (similar to MATLAB), web application servers, and six graphical user interface toolkits.

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- Python scripting provides the ability to interact with both the operating system and each of the component codes, and to perform complex analysis and plotting.
- We will see an example of how to use Python to do parameter variation on the 2D decaying Taylor-Green vortex case (`http://en.wikipedia.org/wiki/Taylor-Green_vortex`) In the domain $-\frac{\pi}{2} \leq x,\ y \leq \frac{\pi}{2}$, the analytical solution is given by:

  $$u = \sin x \cos y F(t) \qquad v = -\cos x \sin y F(t) \qquad p = \frac{\rho}{2}(\cos 2x + \sin 2y)F^2(t) \qquad F(t) = e^{-2\nu t}$$

  where $\nu$ is the kinematic viscosity, and the initial condition is at $t = 0$.
- Download the `TaylorVortex.tgz` tarball from the course homepage, and follow the instructions in the `README` file.
- For Python descriptions, see sections `2.3-2.8` in the `TaylorGreenValidation.pdf` report at the course homepage.
- In section `2.4`, it should be noted that a `PyFoam` library is used to read and modify the `blockMeshDict`.