Modern Tools for Computational Economics

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October 2016

Aims

1. An overview and comparisons
2. Help with installation
3. Lower fixed costs to getting started
4. Provide resources for further study

Thanks

1. **Keio University** (Ippei Fujiwara, Sagiri Kitao)
2. Sponsors supporting `quantecon.org`

See

- `http://quantecon.org/`
- `http://www.numfocus.org/`

Japan is great

Team / Resources

Will be assisted by Matt McKay

- Pythonista
- Computational development economist

Workshop homepage:

- https://github.com/QuantEcon/Keio_workshop

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Software options for this workshop

1. Install Anaconda Python (Python only)
2. Install Julia + Anaconda Python
3. Use our server http://workshop.quantecon.org:8000/

Remark: We'll use Julia through Jupyter, from Anaconda Python

Python Set Up

Anaconda

- Python + the main scientific libraries
- Free from http://continuum.io/downloads
- Choose the Python 3.5 version
- Make it your default Python distribution

Julia Set Up

Get from http://julialang.org/downloads/

Extra instructions

- http://julialang.org/downloads/platform.html

Testing, testing

Try starting

- Julia REPL (REPL = Read Eval Print Loop)
- Python and IPython REPLs

Use menus or terminal

- `terminal` in UNIX/macOS and `cmd` in Windows

Overview

- What's Python?
- What's Julia?
- Pros and cons
- Which to choose?

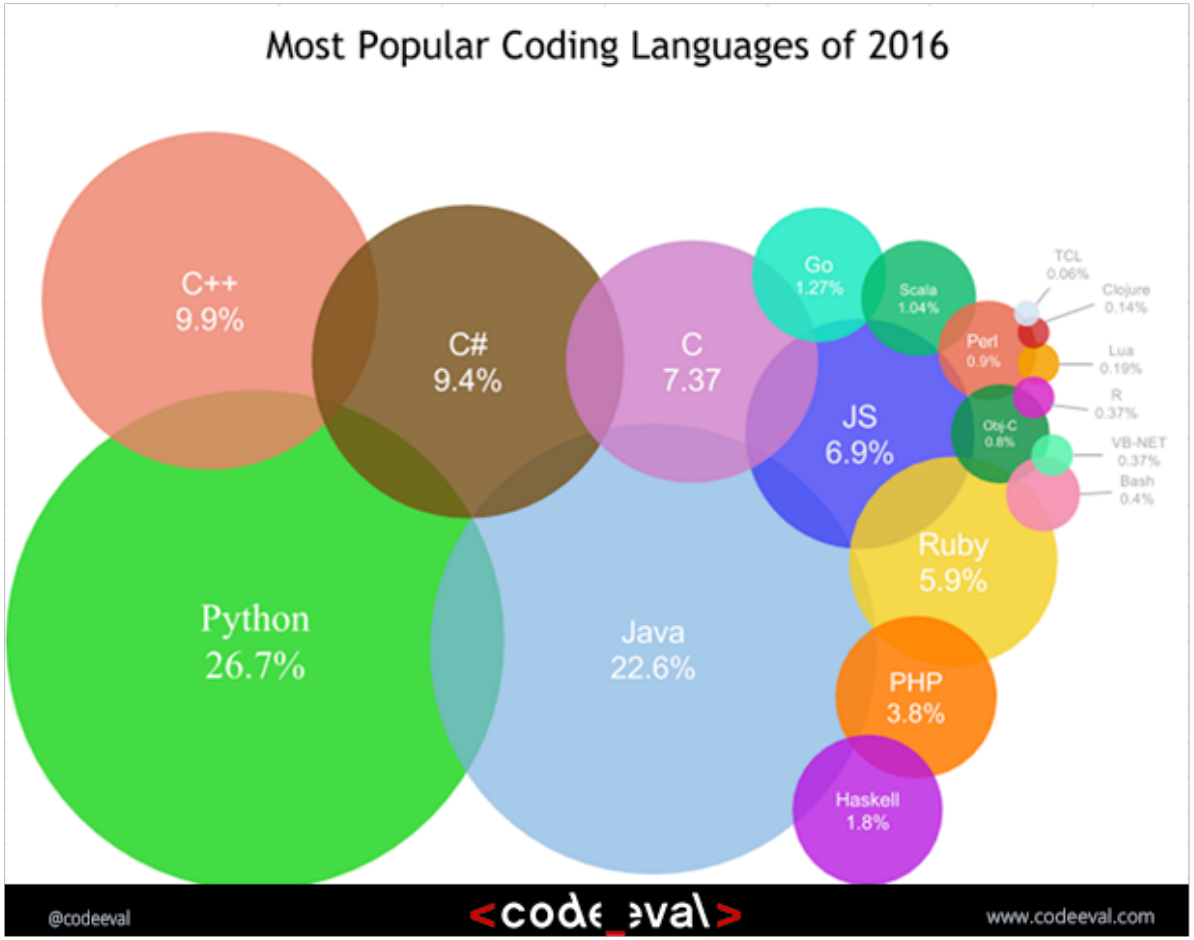
What's Python?

Modern, high level, open source, general purpose programming language

Used extensively by

- Tech firms (YouTube, Dropbox, Reddit, etc., etc.)
- Hedge funds and finance industry
- Scientists (academia, NASA, CERN, etc.)
- etc., etc.

Very popular in "data science" / machine learning


Most Popular Coding Languages of 2016
C++
9.9%
C#
9.4%
C
7.37
Go
1.27%
Scala
1.04%
TCL
0.06%
Clojure
0.14%
Perl
0.9%
Lua
0.19%
R
0.37%
JS
6.9%
Obj-C
0.8%
VB-NET
0.37%
Bash
0.4%
Ruby
5.9%
Python
26.7%
Java
22.6%
PHP
3.8%
Haskell
1.8%
@codeeval
<code_eval>
www.codeeval.com

Strength 1: Intelligent, modern design

- Often used to teach first courses in comp sci
  - MIT
  - Stanford
  - Chicago, etc.

Strength 2: Simple, readable syntax

```
for name in name_list:
    if name not in list_of_users:
        print("Your name is not found")
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Other strengths

- Great libraries
- Friendly community
- High productivity

What's Julia?

Modern, high level, open source, scientific programming language

Strengths:

- Nice design
- High productivity...
- and high performance!

Julia vs Python

Who will benefit more from Julia?

- Focused on scientific programming
- Write your own algorithms
- Need optimization / high performance

Negatives

- Some instability
- Some libraries still under development

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- Care about stability and high productivity
- Diverse coding needs
- Use a lot of data / empirics

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Python/Julia vs C/Fortran

But isn't C/Fortran faster?

Sometimes, but

"**Premature optimization is the root of all evil**"
– Donald Knuth

For $\approx$ 97% of your code, high productivity and clarity are what matter

Example: Astropy

Supports:

- data collection, data analysis, modeling, estimation

Essential to

- all NASA mission pipelines
- national laboritories, academia, industry, etc.

Code base:

- 325,000 lines of Python code
- 14,000 lines of C code

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Best scientific programming paradigm is

1. write your program using a high level language
2. test and profile
3. optimize **hot loops** only

Options for step 3

- call out to Fortran / C
- fast loops **within** Python and Julia!
  - unlike MATLAB / Octave / GAUSS / etc

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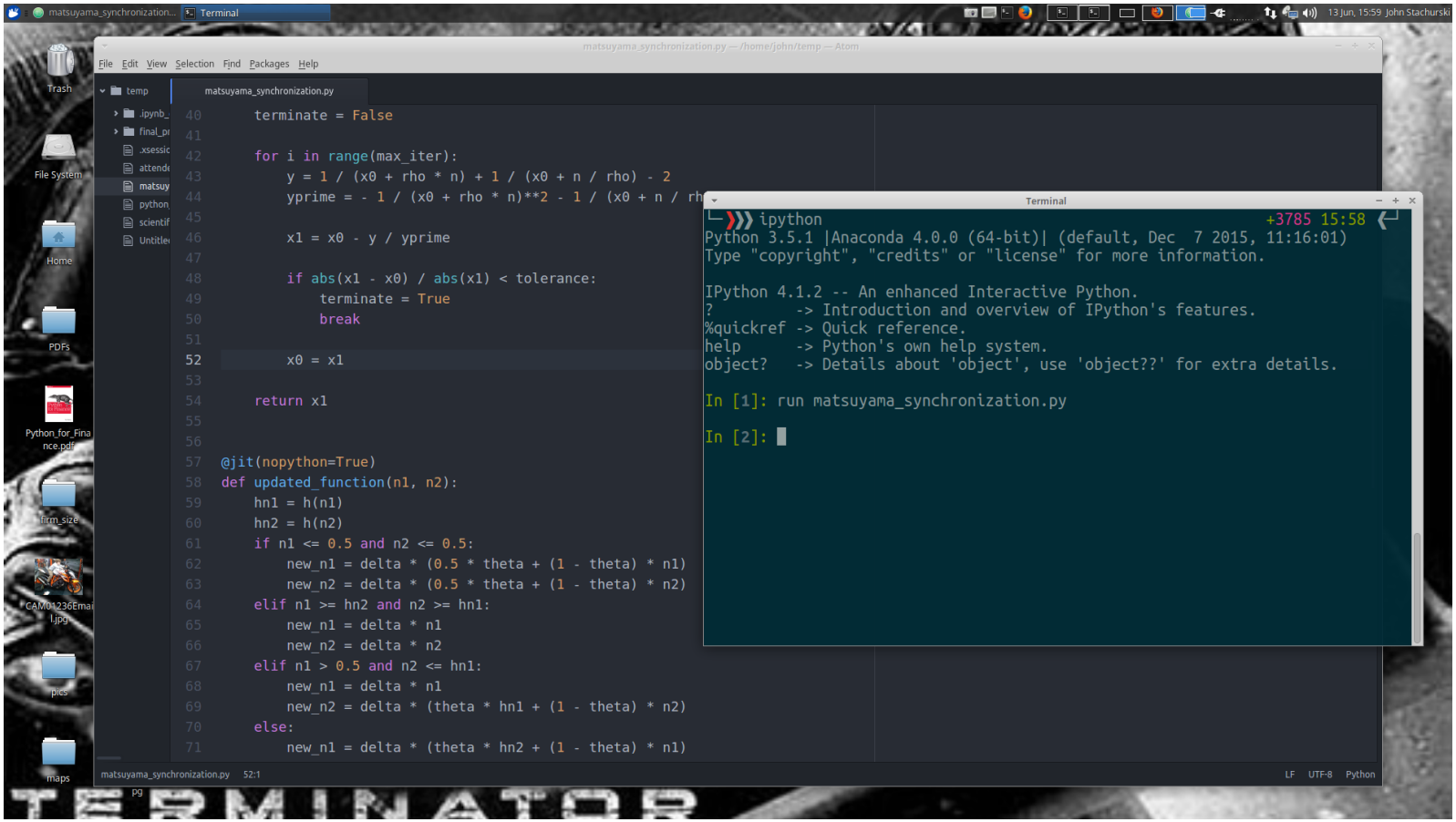
Interacting with Python / Julia

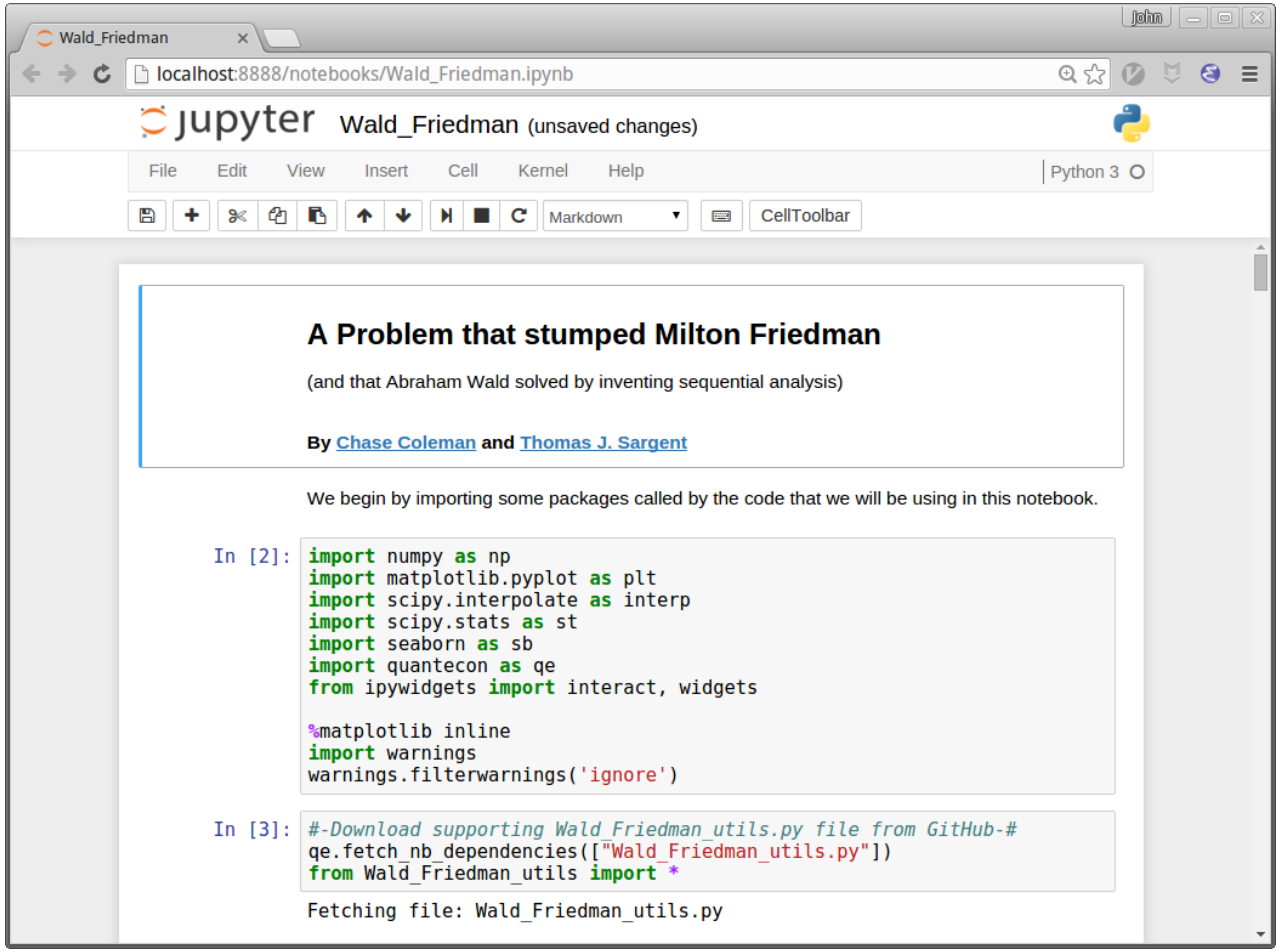
Options

1. The REPLs
2. Text editors (e.g., Atom or Sublime) plus the REPL
3. IDEs like Spyder and Juno
4. Jupyter notebooks

Atom + REPL


matsuyama_synchronization.py — /home/john/temp — Atom
File Edit View Selection Find Packages Help
temp
matsuyama_synchronization.py
terminate = False
for i in range(max_iter):
y = 1 / (x0 + rho * n) + 1 / (x0 + n / rho) - 2
yprime = - 1 / (x0 + rho * n)**2 - 1 / (x0 + n / rho
x1 = x0 - y / yprime
if abs(x1 - x0) / abs(x1) < tolerance:
terminate = True
break
x0 = x1
return x1
@jit(nopython=True)
def updated_function(n1, n2):
hn1 = h(n1)
hn2 = h(n2)
if n1 <= 0.5 and n2 <= 0.5:
new_n1 = delta * (0.5 * theta + (1 - theta) * n1)
new_n2 = delta * (0.5 * theta + (1 - theta) * n2)
elif n1 >= hn2 and n2 >= hn1:
new_n1 = delta * n1
new_n2 = delta * n2
elif n1 > 0.5 and n2 <= hn1:
new_n1 = delta * n1
new_n2 = delta * (theta * hn1 + (1 - theta) * n2)
else:
new_n1 = delta * (theta * hn2 + (1 - theta) * n1)
matsuyama_synchronization.py 52:1
LF UTF-8 Python
Terminal
ipython
+3785 15:58
Python 3.5.1 |Anaconda 4.0.0 (64-bit)| (default, Dec 7 2015, 11:16:01)
Type "copyright", "credits" or "license" for more information.
IPython 4.1.2 -- An enhanced Interactive Python.
? -> Introduction and overview of IPython's features.
%quickref -> Quick reference.
help -> Python's own help system.
object? -> Details about 'object', use 'object??' for extra details.
In [1]: run matsuyama_synchronization.py
In [2]:

Jupyter notebooks



Jupyter Notebooks

Let's focus on Jupyter notebooks

- A browser based front end to Python, Julia, R, etc.
- Allows for rich text, graphics, etc.
- Easy to run remotely on servers / in cloud

References and examples:

- Ref: http://quant-econ.net/py/getting_started.html
- Examples: http://notebooks.quantecon.org/