Introduction

CPS600 Python Programming for Finance
Fall 2018

August 28, 2018

Welcome! What is this?

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We will get familiar with Python libraries useful in financial analytics and we will learn all of the programming techniques you'll need to make use of those libraries.

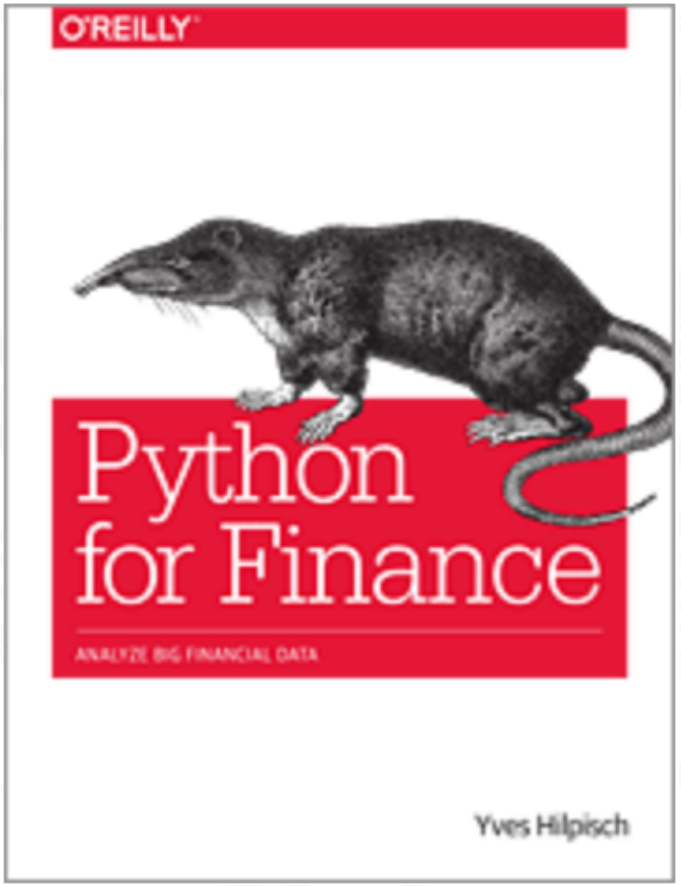
Administrivia

- Office: CST 4-230
- Office Hour: TBD
- Schedule an appointment *if you cannot get to office hours*.
- Email: mharriso@syr.edu
- Lab, Tuesday evening: optional

Administrivia Cont'd

- Text: *Python for Finance*, Yves Hilpisch
- Supporting Text: *Mastering Python for Finance*, James Ma Weiming
- additional Supporting Text: *Mastering Pandas for Finance*, Michael Heydt
- Python Reference: `https://docs.python.org/3/`
- Anaconda (our distribution of choice): `https://docs.anaconda.com/anaconda/`
- Conda (a package manager for Anaconda installations):`https://conda.io/docs/`
- Blackboard, henceforth "BB":`https://blackboard.syracuse.edu`

Main Text


O'REILLY
Python for Finance
ANALYZE BIG FINANCIAL DATA
Yves Hilpisch

More on the Course

- Introduce the most important language elements, tools & libraries that Python *as a technology platform* has to offer to finance
- Hands-on usage of Python, Numpy, Pandas, Scipy, Sympy, PyTables & others too
  - implement efficient analytics workflows

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  - calculate options pricing using Black-Scholes models
  - estimate volatility, perform portfolio and derivatives valuations
  - calculate an option price using Monte Carlo simulations, etc.

Grading Breakdown

These are approximate and subject to change (likely to your benefit!)

- 40% Programming assignments/projects
- 30% Quizzes
- 20% Homework
- 10% Participation

- NO MIDTERM, NO FINAL

Course Content

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No one is asking you to master it, and no one really understands it, so don't feel bad.

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- 'duck typing'

Python2 or Python3?

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See here: `https://sebastianraschka.com/Articles/2014_python_2_3_key_diff.html`

Why Python for Finance?

Python is especially well-suited to address the analytics needs of the financial industry because of its *ecosystem* or *frameworks*. It lets non-CS types build powerful, consistent end-to-end production pipelines.

An Ambitious Syllabus

Week 1 Introduction [Ch 1 & Ch 2]

- Installing & running Python, plus various tools
- Python basics
  - Variables, names, objects & builtins
  - Types and classes, methods
  - Data Structures: lists, tuples, dictionaries, sets
  - The 'Scientific Stack', i.e. numpy,scipy, pytables , pandas, matplotlib , etc

Week 2 Python Crash Course [Ch 4]

- Functions
- Logic & control flow
- Types & classes
- Coding constructs, e.g. comprehensions, decorators, generators & more
- Numpy: array and *vectorization*

An Ambitious Syllabus

Week 3 IO Operations [Ch 7 & Ch 13]

- Modules, packages & programs, objects & classes
- Data representation - unicode, bytes, bytearrays
- Basic IO, IO with pandas and with pytables
- File IO - text and binaries
- Structured text - CSV, XML, HTML, JSON
- Structured Binary Files - spreadsheets, data as Excel files
- Relational databases

Week 4 Examples [Ch 3 & Ch 8]

- Example: **implied volatilities**
- Example: **Monte Carlo Simulation** (python, vectorization, graphics)
- Example: Technical Analysis - implement backtesting & trend-based investment strategy
- Others

An Ambitious Syllabus

Week 5 Data Viz & Web [Ch 5 & Ch 14]

- Data visualization
  - 2D graphics with matplotlib, 3D graphics & animation with pandas
  - Financial plots, graphs, visualizations
- The Web
  - Web clients & Web servers in Python
  - Web services & Automations - XML, JSON, Crawl & Scrape
  - Web plotting - static, interactive & real-time
  - Rapid web apps (traders chat room, data modelling, styling templating
  - Web services - financial model & its implementation
- Basic IO, IO with pandas and with pytables
- File IO - text and binaries
- Structured text - CSV, XML, HTML, JSON
- Structured Binary Files - spreadsheets, data as Excel files
- Relational databases

An Ambitious Syllabus

Week 6 Math Tools I [Ch 9 & Ch 13]

- Math & stats: mathematical functions, complex numbers, rationals, matrix manipulations
- numpy - working with arrays, array math, linear algebra
- scipy , sklearn , ipython , pandas
- Excel interaction - reading/writing workbooks
- Scripting Excel with Python

An Ambitious Syllabus

Week 7 Financial Time Series [Ch 6]

- pandas& DataFrame class
- Financial Data
- Regression Analysis
- High-Frequency Data

Week 8 Math Tools II [Ch 9]

- Approximation - regression, interpolation
- Convex optimization (*global*, *local* & *constrained*)
- Integration
- Symbolic computation (equations, integration, differentiation)

An Ambitious Syllabus

Week 9 Stochastic Processes [Ch 10]

- Random numbers
- Simulation - random variables, stochastic processes, variance reduction
- Valuation - European, American
- Risk measures

Week 10 Stats [Ch 11]

- Normality tests - benchmarks, real-world data
- Portfolio optimization - efficient frontier, capital market line
- Principal Components Analysis (PCA) - DAX index & its 30 stocks, PCA index
- Bayesian regression (example, real data)

An Ambitious Syllabus

Week 11 Simulation [Ch 15]

- Random number generation & generic simulation class
- Geometric Brownian motion (use case)
- Jump diffusion (use case)
- Square-root diffusion (use case)

Week 12 Derivatives Valuation [Ch 17]

- Generic Valuation Class
- European Exercise (use case)
- American Exercise (least-squares Monte Carlo, use case)

An Ambitious Syllabus

Week 13 Portfolio Valuation & Volatility Options [Ch 18 & Ch 19]

- Derivatives Portfolios (use case)
- Derivatives Positions (use case)
- The VSTOXX Data Index, Futures data, Options data
- Model Calibration Market Data, Option Modelling, Calibration
- American options on the VSTOXX - modelling option positions, options portfolio

Week 14 Examples

Today

- Getting Python
- IDEs - *Integrated Development Environments*
  - Shell
  - IDLE
  - Spyder
  - Ipython
  - Jupyter
- Running Python programs
- Interactive Python sessions
- Editing Python scripts
- Anaconda & conda
- PyPi & pip