Python for Finance

EuroScipy 2012 in Brussels

Dr. Yves J. Hilpisch

26. August 2012

“Simplicity is the ultimate sophistication.”

Steve Jobs

… and Python provides quite simply the most simple programming environment.

easy-to-learn

easy-to-comprehend

highly productive

good performance

Lecture at Saarland University, Germany

"Numerical Methods for the Market-Based Valuation of Options"

by Dr. Yves J. Hilpisch

http://mathfin.visixion.com

Python used to illustrate numerical methods and financial models.


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Numerical Methods for the Market-Based Valuation of Options
10. Lecture/Tutorial on 16. January 2012
This lecture is completely dedicated to realisitic Short Rate modeling. The lecture focuses on the Cox-Ingersoll-Ross (1985) square-root diffusion model and shows how to calibrate it to German Bund yields and how to simulate it based on a simple Euler discretization scheme.
Slides of the Lecture: Slides as PDF (as of 15 Jan 2012)
Python Scripts displayed in the slides: MBV_Python_16012012.zip
Article of Cox-Ingersoll-Ross(1985): Cox Ingersoll Ross 1985.pdf
Article of Dai-Singleton (2000): Dai Singleton 2000.pdf
Article of Lord-Koekkoek-van Dijk (2008): Lord Koekkoek van Dijk 2008.pdf
MBV_Lecture_16012012 (last edited 2012-01-15 11:53:31 by Yves Hilpisch)
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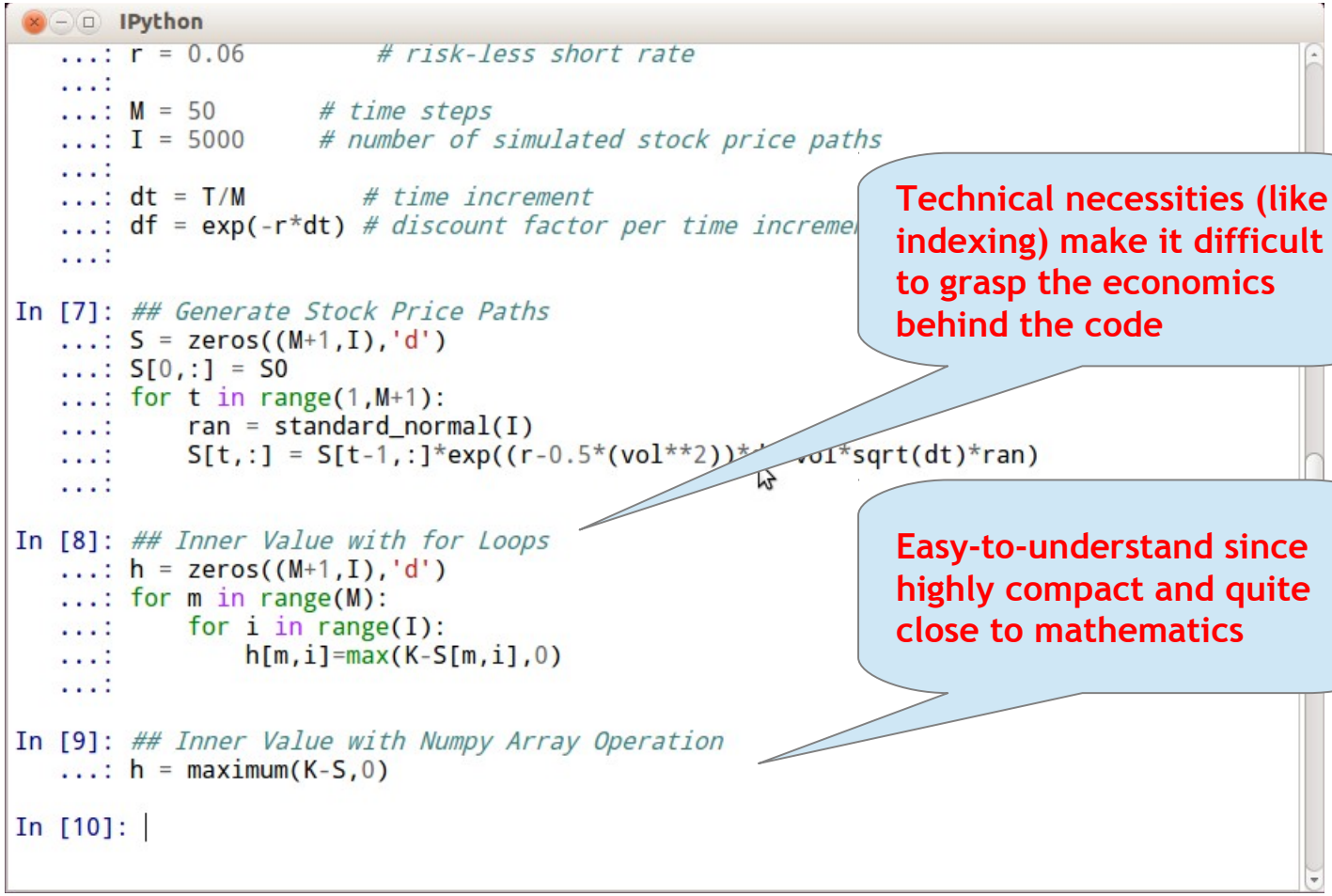

IPython
...: r = 0.06 # risk-less short rate
...:
...: M = 50 # time steps
...: I = 5000 # number of simulated stock price paths
...:
...: dt = T/M # time increment
...: df = exp(-r*dt) # discount factor per time increme
...:
In [7]: ## Generate Stock Price Paths
...: S = zeros((M+1,I),'d')
...: S[0,:] = S0
...: for t in range(1,M+1):
...: ran = standard_normal(I)
...: S[t,:] = S[t-1,:]*exp((r-0.5*(vol**2))*
vol*sqrt(dt)*ran)
...:
In [8]: ## Inner Value with for Loops
...: h = zeros((M+1,I),'d')
...: for m in range(M):
...: for i in range(I):
...: h[m,i]=max(K-S[m,i],0)
...:
In [9]: ## Inner Value with Numpy Array Operation
...: h = maximum(K-S,0)
In [10]:
Technical necessities (like indexing) make it difficult to grasp the economics behind the code
Easy-to-understand since highly compact and quite close to mathematics

Finance Book

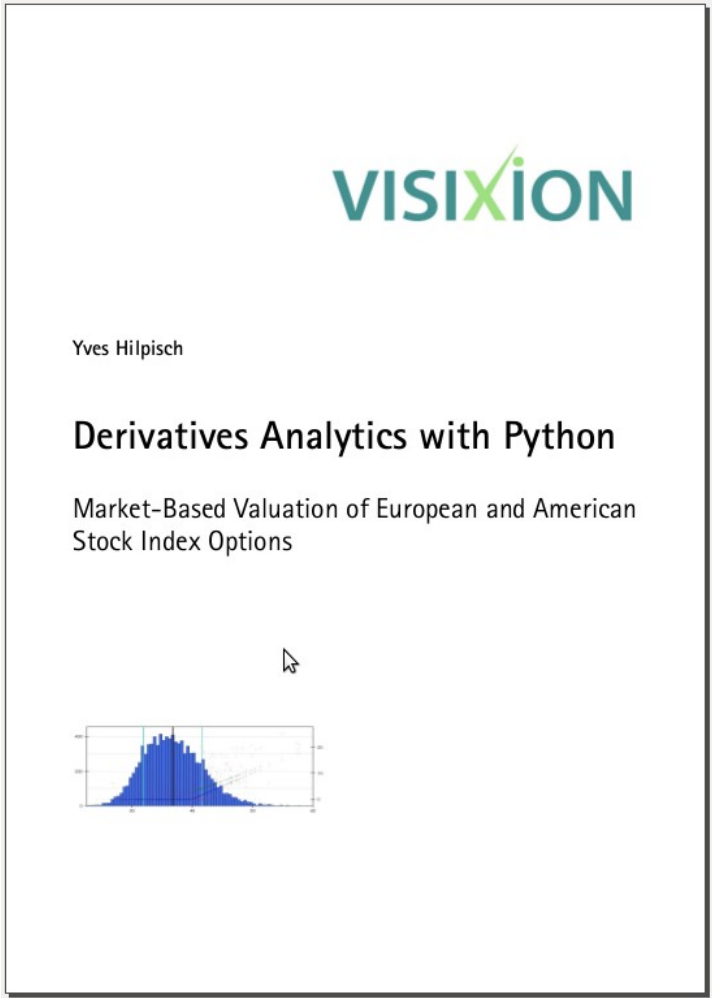
"Derivatives Analytics with Python"

by Dr. Yves J. Hilpisch

323 pages, available upon request

http://www.visixion.com

Python used to illustrate numerical methods and financial models.



Topics covered in the book:

- financial data analysis
- basic option models
- Fourier-based option pricing
- Monte Carlo simulation
- model calibration
- market-based valuation
- dynamic option hedging

—with self-contained set of Python scripts

Derivatives Analytics On Demand

DEXISION

by Visixion GmbH

http://www.dexision.com

Full-fledged, commercial analytics suite with core implemented in Python.

HIGHLY PRODUCTIVE

```
https://analytics.dexision.com/DEXISIONeval.py?
user=online&company=visixion&pwd=qwertzui
&paths=10000&steps=50
&portfolio=MS2009/Heston_CIR
&format=xml
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On Demand = Web Service

= Universal Integrability

Research Paper

"Fast Monte Carlo Valuation of American Options" (presented @ EuroScipy 2011)

by Dr. Yves J. Hilpisch

http://www.visixion.com

Python & NumPy used to implement fast Monte Carlo algorithm.

“Fast Least Squares Monte Carlo Simulation for American Option

We know least-squares Monte Carlo simulation to price an American option is time consuming because it involves optimal exercise decision on every step of a large number of simulation (in the least square case, to run a polynomial regression on cash flows and decide whether it is optimal to exercise or not). I once shared a simple Matlab file to illustrate the least squares Monte Carlo simulation. The situation becomes worse if we allow the presence of stochastic volatility and interest rate, typically my codes run quite a few minutes for 50,000 number of simulations.

In the paper "Fast Monte Carlo Valuation of American Options under Stochastic Volatility and Interest Rates" by Y. Hilpisch, the author demonstrates with Python script that the Least-Squares Monte Carlo (LSM) algorithm with control variates takes only less than one second to achieve satisfying accurateness. The overall statistics taken from the paper are as follows, AMAZING!”

from http://www.mathfinance.cn

"… a Matlab code implementing the algorithm of Longstaff and Schwartz (2001) takes dozens of minutes to compute a single option price ...'"

Medvedev and Scaillet (2009)

2 Seconds

DEXISION

unified platform

powerful libraries

multi-purpose

open source

Client Project

for

Eurex Frankfurt AG

by Visixion GmbH

http://www.visixion.com

Python used to replace heterogeneous IT landscape in certain areas.

“Visixion GmbH has developed and conducted a focused Python training for selected people at Eurex, one of the world's leading derivatives exchanges. The major goal is to replace in certain areas a heterogeneous IT infrastructure (including, amongst others, Matlab and R) by Python as the main programming environment. Requirements are increased productivity, fast development cycles, easy collaboration, easy-to-maintain solutions and high performance.”

from http://www.visixion.com

Python libraries

used at

Visixion GmbH

For financial applications, Visixion regularly uses a select few Python libraries.

NumPy — fast, efficient array manipulations

SciPy — scientific computing

matplotlib — 2d and 3d plotting

pandas — convenient data analysis

Cython — C extensions for Python

PyTables — database optimized for fast I/O operations

Everyday tasks

at

Visixion GmbH

Python used to implement and automate a number of administrative tasks.

VISIXION

Trials of DEXISION — management of user registrations

Contacts for DX Evo — management of contacts

Documentation of DEXISION — use of SPHINX

After Sales — semi-automated after sales email system

Credit Card Processing — Python scripting

… and many more tasks

Regulatory requirements

by
Securities Exchange Commission (SEC)

Python-based models required for cash flow “waterfalls” in official ABS filings.

"We are proposing to require that most ABS issuers file a computer program that gives effect to the flow of funds, or "waterfall," provisions of the transaction. We are proposing that the computer program be filed on EDGAR in the form of downloadable source code in Python. Python, as we will discuss further below, is an open source interpreted programming language. Under our proposal, an investor would be able to download the source code for the waterfall computer program and run the program on the investor's own computer (properly configured with a Python interpreter). The waterfall computer program would be required to allow use of the asset data files that we are also proposing today. This proposed requirement is designed to make it easier for an investor to conduct a thorough investment analysis of the ABS offering at the time of its initial investment decision."

from http://www.sec.gov/rules/proposed/2010/33-9117.pdf

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Derivatives Analytics — Commercial Analytics Suites

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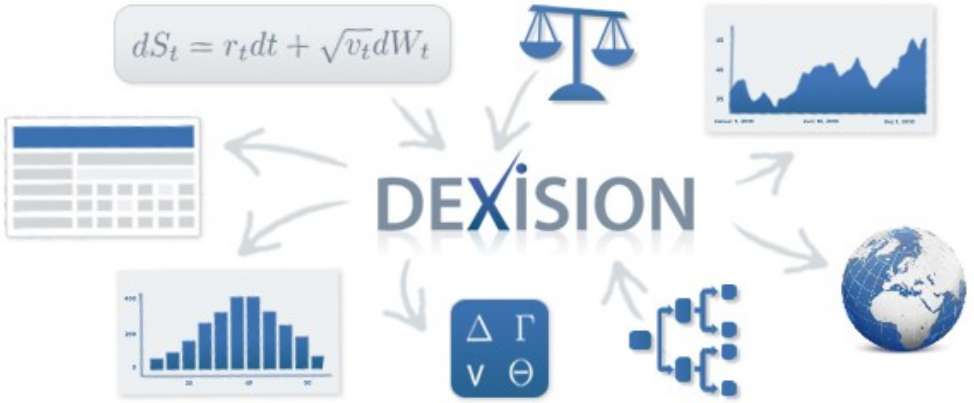

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Visit **www.dexision.com** and **www.dxevo.com** to learn more about our derivatives analytics suites.

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