Algorithmic Trading
—With Machine & Deep Learning

ODSC Europe in London | 12. October 2017

Dr. Yves J. Hilpisch

THE PYTHON QUANTS

“Pichai said that as an ‘AI first’ company, this is a ‘unique moment in time’ for Google to combine hardware, software and artificial intelligence. ‘It's radically rethinking how computing should work’, he said."

Business Standard, "Google Ramps up Hardware Business", 06. October 2017.

Introduction

SERVICES
for financial institutions globally

EVENTS
for Python quants &
algorithmic traders

THE PYTHON QUANTS

CERTIFICATION
in cooperation with university

TRAINING
about Python for finance
& algorithmic trading

BOOKS
about Python and
finance

PLATFORM
for browser-based
data analytics

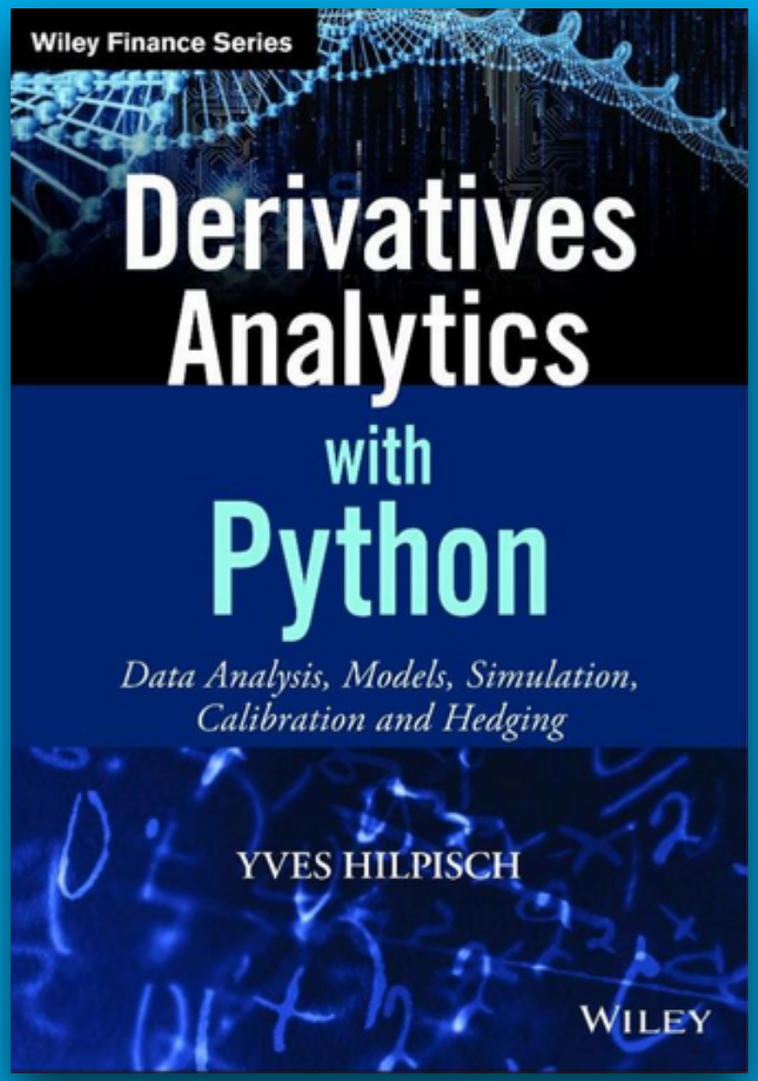
OPEN SOURCE
Python library
for financial analytics

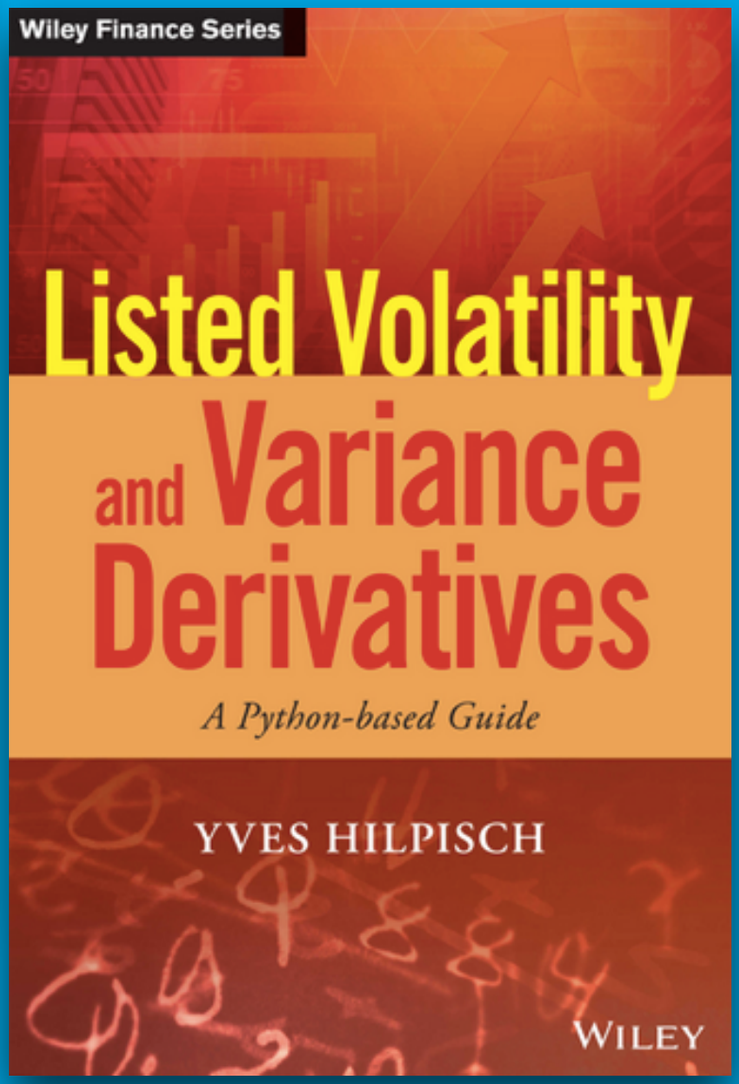
http://tpq.io


DATA
proprietary &
open data
sources
DEVELOPMENT
from idea to application
FINANCE
financial analytics & applications
TRAINING
premium content
& videos
jupyter
THE PYTHON QUANTS
What is ...
VISUALIZATION
static & interactive plots
PUBLICATION
collaboration &
sharing
ANALYSIS
browser-based data science

http://pqp.io

http://hilpisch.com





http://books.tpq.io

PROGRAM DIRECTOR

Dr. Yves J. Hilpisch is founder and managing partner of The Python Quants (http://tpq.io), a group focusing on the use of open source technologies for financial data science, algorithmic trading and computational finance. He is the author of the books

He is the author of the books:

- Python for Finance (O'Reilly)
- Derivatives Analytics with Python (Wiley)
- Listed Volatility and Variance Derivatives (Wiley)

He has written the financial analytics library DX Analytics (http://dx-analytics.com) and organizes conferences and Meetup events about Python for finance and algorithmic trading in Frankfurt, London and New York. He has given keynote speeches at technology conferences in the United States, Europe and Asia.

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April 2017

UNIVERSITY CERTIFICATE IN PYTHON FOR ALGORITHMIC TRADING

THE PYTHON QUANTS

http://certificate.tpq.io

WEEK	Certificate Program	OSBC	Flagship Algorithmic Trading	Python Infrastructure	Reading Material	Live Sessions
1	Finance with Python 1 Finance with Python 2	Session 1	Python Programming from Scratch		Finance with Python Chs 1-3 Python for Algo Trading Ch 1	**02. October 2017: Intro & Overview**
2	Finance with Python 3 Finance with Python 4		Numerical Computing with NumPy	Python & Linux Infrastructure (optional: Windows & SSH)	Finance with Python Chs 4-6 Python for Algo Trading Ch 2	self-study/review
3	Financial Data Science 1		Working with Financial Data		Python for Algo Trading Ch 3 Python for Algo Trading App	tba
4	Financial Data Science 2		Data Analysis with pandas	Environments & Docker Containers	Python for Algo Trading Ch 3	tba
5	Vectorized Backtesting	Session 1	Mastering Vectorized Backtesting		Python for Algo Trading Ch 4	tba
6	Event-based Backtesting 1 Event-based Backtesting 2		Event-based Backtesting	Python Tool Chain	Python for Algo Trading Ch 5	tba
7	Regression-based Prediction Classification-based Prediction	Session 2	Predicting Market Movements		Python for Algo Trading Ch 6	tba
8	Deep Learning-based Prediction	Session 2	Predicting Market Movements	Python Best Practices 1	Python for Algo Trading Ch 6	tba
9	Real-Time Data Handling Streaming Visualization	Session 3	Working with Real-Time Data		Python for Algo Trading Ch 7	tba
10	Eikon & Oanda	Session 4		Python Best Practices 2	Python for Algo Trading Ch 8	tba
11	Interactive Brokers Gemini	Session 5			Python for Algo Trading Chs 9-10	tba
12	Automation	Session 6			Python for Algo Trading Ch 11	tba
13	**Live Trading Competition**					
14-16	**Final Project preparation**					

Link to Study Plan

Once logged in, you can then download the TWS application for you operating system. Starting the application then requires the previously chosen user name and password. TWS then might show up as in Trader Workstation after login with trial credentials on your desktop.

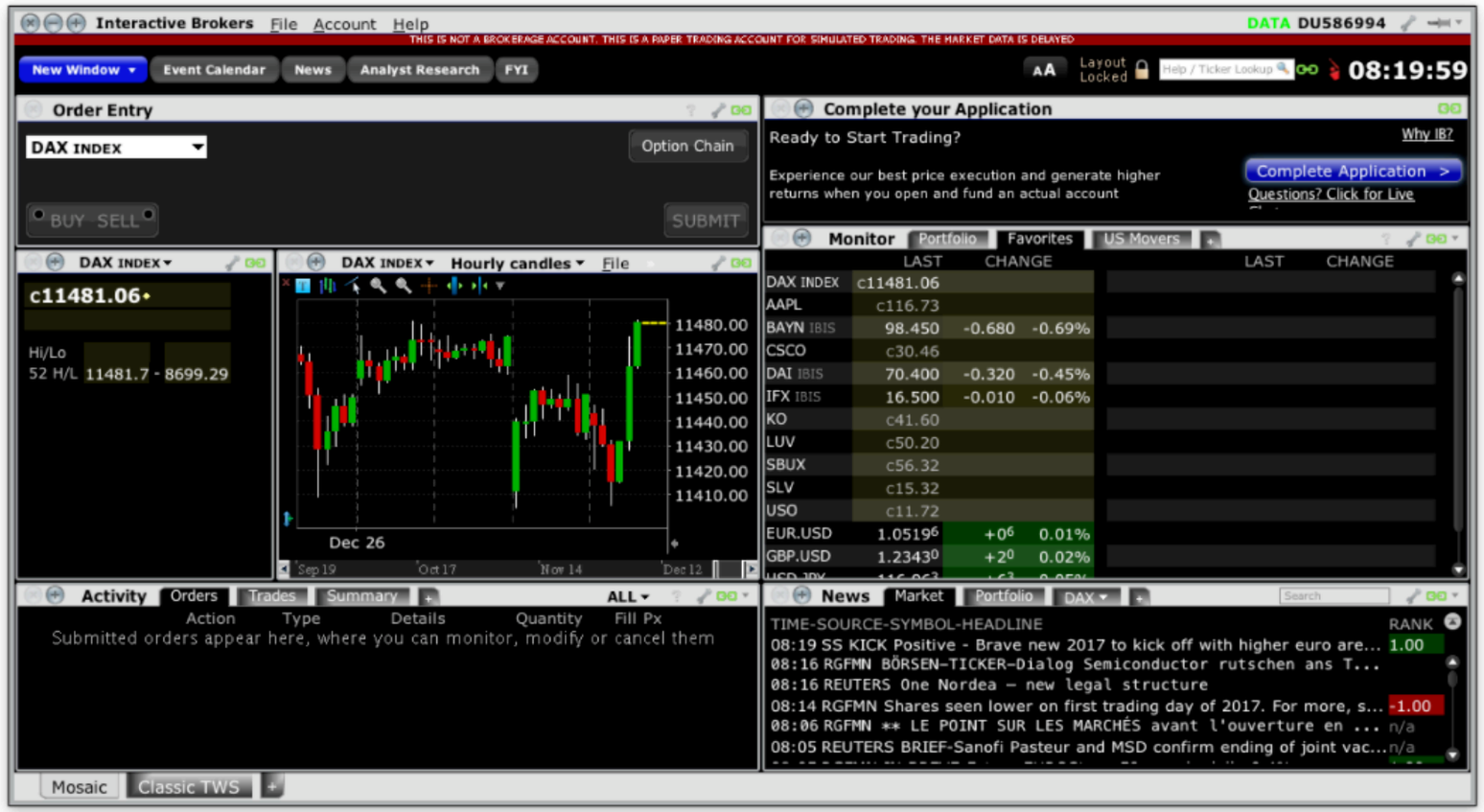


Figure 58. Trader Workstation after login with trial credentials

The arrangement of the different panels of TWS might be changed or new windows might pop up depending on what you request from the application. TWS break out window with option chain data shows a break out window with option chain

Banking CIO Outlook

FEBRUARY, 2017 BANKINGCIOOUTLOOK.COM

Top 10 Banking Analytics Solution Provi

Today's data-driven banking industry portrays a scenario where analytics is paving a productive path for banks, by offering meaningful insights on their underlying data. Although basic reporting and descriptive analytics are prevalent in the banking sector, the need of the hour is advanced predictive and prescriptive analytics.

Sophisticated technologies—like the emerging cognitive analytics for instance—are enabling banks to make better decisions and achieve profitable growth quarter-on-quarter. At the same time, with enhanced visibility into intricate information, such as individual financial health and behavioral patterns, banks now have the upper hand in risk mitigation and fraud prevention that help them comply with mandatory regulations.

With the Blockchain gaining mainstream attraction, digital currencies such as Bitcoin and Ethereum are doing their rounds among consumers for payments and other transactions. To that end,

banks are leveraging analytics to
these digital currencies, by veri
with an unprecedented level of

Identifying the numerous b
constant quest to find solutions
in a timely and accurate manne
whole new level.

To help CIOs and CFOs
solution provider, a distinguis
CFOs, VCs, analysts, and the Ba
has selected top players from th
demonstrate an ability to dev
methodologies along the bank
outstanding customer service.

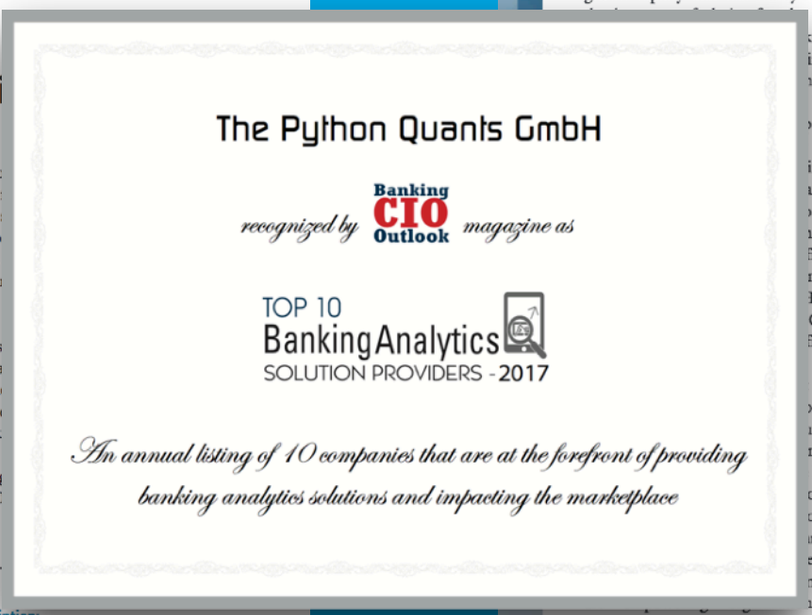
We present to you Banking
Analytics Solution Providers 20

Company:
The Python Quants Group

Description:
Focused on Python and Open Source Technologies for Financial Data Science, Algorithmic Trading and Computational Finance

Key Person:
Dr. Yves J. Hilpisch
Managing Partner

Website:
tpq.io



The Python Quants Group

Enhance Financial Analytics

Over the years, the ecosystem of scientific, numerical and data analytics packages available for Python has grown rapidly and has finally made it
finance
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nologies
s and
individuals to do financial and data analytics in real-time and on a highly customized basis as well as to rapidly develop new financial applications and deploy them based on weekly or even daily cycles. "We support financial institutions in introducing, training and deploying Python and a major building block in this regard is our Quant Platform," adds Hilpisch. "Our training offerings are based on more than 10 years of experience with Python for Finance and provide a hands-on learning experience, making heavy use, for instance, also of our Quant Platform."

The company's Quant Platform makes central, standardized Python deployment an easy and efficient affair while mitigating risks and reducing maintenance costs considerably during deployment. Based on modern web technologies and deployment techniques like Docker containers, the Quant Platform provides a full-fledged suite of development tools via the web browser without the need to install any kind of open source software locally on desktop or notebook computers.

In an instance, Eurex, one of the leading derivatives exchanges, wanted to support investors, traders, market makers and quants in the understanding and trading of their listed volatility and variance products. Eurex decided to use Python for this project and The Python Quants were tasked to create the content and in particular the Python codes accompanying it. While the content itself became part of the Eurex website, all Python codes were provided to Eurex partners and other interested parties on a Eurex-labeled version of the Quant Platform for easy code access and execution. "Deploying open source technologies, like Python, is often a tedious and sometimes even a risky process, with our services and products we help our clients to make this process more efficient and mitigate risks," adds Hilpisch.

Another product of The Python Quants Group assisting organizations to model, price and risk manage complex portfolios of (multi-risk) derivatives with potentially complex correlation structures


Dr. Yves J. Hilpisch

is DX Analytics. Being an open source derivatives, portfolio and risk analytics library written exclusively in Python—it makes heavy use of the capabilities of Python and the capabilities of its numerical and data analytics libraries.

> **"Our major focus has always been on the use of Python and open source technologies for financial data science, computational finance and algorithmic trading**

As the Python ecosystem sees tremendous momentum, The Python Quants Group's near-term focus will be on machine and deep learning techniques, technologies emerging in algorithmic trading as well as on cryptocurrencies and blockchain. "We will improve our value proposition in particular for hedge funds and other buy side players for the days to come," concludes Hilpisch. **BC**

http://hilpisch.com/bcioo_tpq.pdf

THE PYTHON QUANTS

The Python Quants GmbH Bringing a new approach to financial analytics with Python

The present day banking industry is data driven. It depends on predictive and prescriptive analytics solutions to gain meaningful insights from the underlying data that paves the path for productivity and development. With the expansion of technology into trading in the recent years, algorithms are responsible for making rapid split-second trading decisions, faster than humans could make. As technologists look to bring a greater exposure of technology to banking, Python and its eco-system of powerful packages emerged as the technology platform of choice in the financial market. The Python Quants Group realized this and developed a business model around Python for Finance & Algorithmic Trading enabling organizations and individuals to do financial and data analytics in real-time and on a highly customized basis as well as to rapidly develop new financial applications and deploy them based on weekly or even daily cycles.

The company was set up to benefit from new open source technologies, the Python ecosystem in particular, as well as new financial methods and approaches like large scale Monte Carlo simulation in finance. The Python Quants Group is active in the areas of technology, know-how & research, and services & community. It focuses on Python for Financial Data Science, Algorithmic Trading and Computational Finance and also offers consulting, development and training services in all financial capitals, e.g., Frankfurt, London, New York, Singapore. It helps its clients to use Python for Quant Finance to solve specific problems or to conduct ambitious and path-breaking projects.

Providing valuation capabilities based on Monte Carlo Simulation with DEXISION

The first product that the company launched was DEXISION, a Python- and simulation-based financial engineering and derivatives pricing platform with *"Derivatives Analytics On Demand"* being the tag line. It was developed keeping the market needs in view to design, manage and price complex financial derivatives. The company also added features based on the

Python-based financial analytics library

The Python Quants Group has been engaged in the Python and open source communities from

"Both in terms of technology and community we have build one of the biggest platforms in the Python for Finance field."

SR 2017

50

BEST COMPANIES TO WATCH

Knowing the CEO, Dr. Yves J. Hilpisch

Dr. Yves J. Hilpisch is the **Founder** and **CEO** of The Python Quants, a group focusing on the use of open source technologies for financial data science, algorithmic trading and computational finance.

Yves has a Ph.D. in Mathematical Finance and lectures on computational finance at the CQF Program, on data science at htw saar University of Applied Sciences and is the director of the first online training program leading ng University Certifi- as written the financial l organizes meetups r quantitative finance in . He has given keynote es in the United States,

Dr. Yves J. Hilpisch, Founder & CEO

implements what is sometimes called the global valuation of derivatives instruments.

Python arrived late in the financial industry. But since it is used now strategically by many of the biggest financial institutions in the world like Bank of America Merrill Lynch or JP Morgan, the need for professional Python education has been growing steadily. The company reacted to it by offering Python for Finance events like the For Python Quants Bootcamp in London and New York as well as by offering an integrated suite of online training classes and courses in Python for Finance. Its focus here lies on Financial Data Science, Algorithmic Trading and Computational Finance. In addition, the company has given customized corporate training classes for some of the biggest hedge funds and asset managers in the industry.

Promising a new level of productivity

The two trends that the company focuses on for its growth are the browser as the operating system and the cloud. After turning the SaaS offering DEXISION into the open source library, DX Analytics, they started building the Quant Platform, their PaaS product. It allows for scalable, collaborative financial analytics in the cloud based on tools like Jupyter Notebook and many other proprietary elements that have been added over time. The Quant Platform has close to 10,000 registered users. They use it for general purpose financial analytics tasks or to access codes from the three books by Yves Hilpisch, namely Python for Finance, Derivatives Analytics with Python and Listed Volatility & Variance Derivatives.

Although it is a small company and located in Germany, it has global reach due to its available technologies. It uses the CRM software, Highrise HQ, to manage all relationships in an integrated manner. All sign-ups for the platform and email lists land there. Probably more than 95% of its platform users have free accounts with the company. It is the first to offer an official University Certificate in Python for Algorithmic Trading in co-operation with the htw saar University of Applied Sciences in Germany. The company has also launched a new training course *"Finance with Python"*. This course teaches finance from basic principles and Python from the very beginning.

For more information:
http://tpq.io

http://hilpisch.com/tpq_silicon_review.pdf

THOMSON REUTERS

FitchLearning

CQF | INSTITUTE

htw saar

Hochschule für Technik und Wirtschaft des Saarlandes
University of Applied Sciences

Machine Learning & Algorithmic Trading

machine & deep learning

data

algorithms

hardware

optimization, training & learning

testing

validation

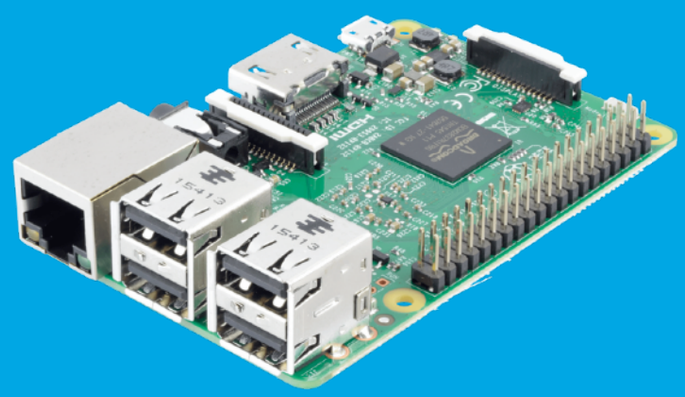
prediction (“self-driving car”)

automation

trading (“money making machine”)

algorithmic trading

Emulation



powerful hardware & software

complete market replication with all agents

Markets & Agents

Algorithms

x

x

f(x)

y

y

Agenda

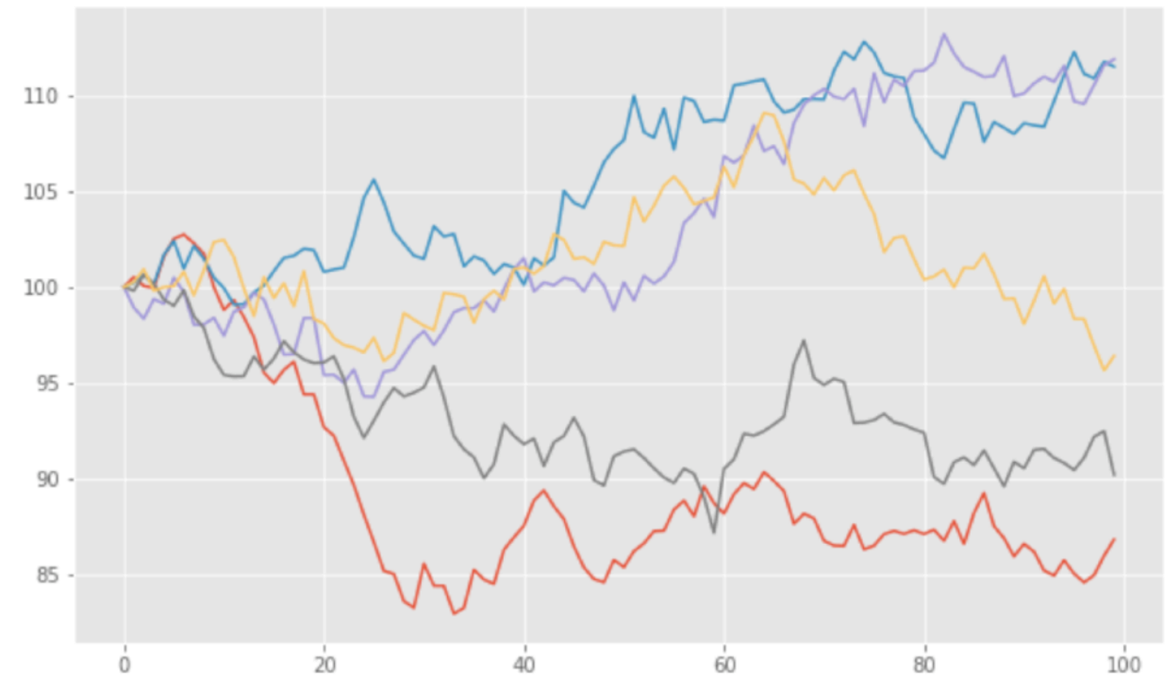
TOPICS FOR TODAY

1. Reading Financial Time Series Data with pandas
2. Formulating a Financial Trading Strategy
3. Vectorized Backtesting of the Trading Strategy
4. Random Walk Hypothesis
5. Prediction based on Classification Algorithm
6. Prediction based on Neural Nets
7. Prediction based on Deep Neural Network

Interactive style as a major element

"Making mistakes together."

```
In [89]: plt.figure(figsize=(10, 6))
         plt.plot(rw);
```



Black-Scholes difference equation for static economy:

$$S_T = S_0 \exp\left(\left(r - \frac{1}{2}\sigma^2\right)T + \sigma\sqrt{T}z\right)$$

z here a standard normally distribute variable.

```
#
# Simple Tick Data Server with
# ZeroMQ
#
import zmq
import time
import random

context = zmq.Context()
socket = context.socket(zmq.PUB)
socket.bind('tcp://0.0.0.0:5555')

AAPL = 100.

while True:
    AAPL += random.gauss(0, 1) * 0.5
    msg = 'AAPL %s' % AAPL
tick_server.py [+]
```

```
AAPL 107.15636235397254
AAPL 107.18612019583905
AAPL 107.4983187955743
AAPL 107.2640892475144
AAPL 107.68358829560407
AAPL 106.9232056802307
AAPL 106.55017297488794
AAPL 105.97708319698597
AAPL 106.00856053822193
AAPL 105.37221723045396
AAPL 105.09251644774177
AAPL 104.9267694947986
AAPL 105.03306681222703
AAPL 105.1223727550806
AAPL 105.29880694705703
AAPL 105.438670667864
AAPL 105.60426198517378
```

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2017-05-01 23:51:44.663153 | AAPL 107.18612019583905
2017-05-01 23:51:44.707051 | AAPL 107.4983187955743
2017-05-01 23:51:45.066229 | AAPL 107.2640892475144
2017-05-01 23:51:45.433200 | AAPL 107.68358829560407
2017-05-01 23:51:46.315111 | AAPL 106.9232056802307
2017-05-01 23:51:47.040770 | AAPL 106.55017297488794
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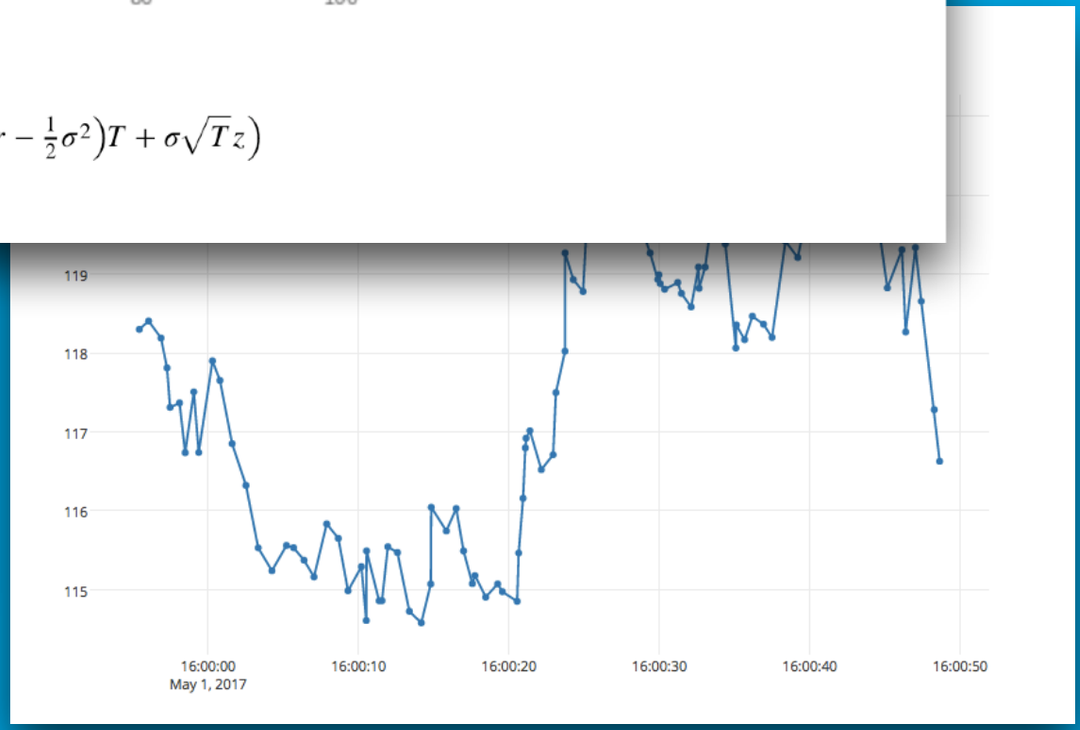


Skill-based workshop approach

From Anders Ericsson (2016): Peak — Secrets from the New Science of Expertise. The Booley Head, London.

"When you look at how people are trained in the professional and business worlds, you find a tendency to focus on knowledge at the expense of skills."

"... I believe the best approach will be to develop skills-based training programs that will supplement or completely replace the knowledge-based approaches that are the norm now in many places. The strategy acknowledges that because what is ultimately most important is what people are to do, **training should focus on doing rather than on knowing**."

The Gist

http://gist.github.com/yhilpisch

https://goo.gl/LAQ8Ze

The Data

We work with EOD data for the EUR/USD rate

Data Source: FXCM Financial Capital Markets Ltd.

http://hilpisch.com/eurusd.csv

The Benchmark Case of Random Walks

“For many years, economists, statisticians, and teachers of finance have been interested in developing and testing models of stock price behavior. One important model that has evolved from this research is the theory of random walks. This theory casts serious doubt on many other methods for describing and predicting stock price behavior—methods that have considerable popularity outside the academic world. For example, we shall see later that, if the random-walk theory is an accurate description of reality, then the various “technical” or “chartist” procedures for predicting stock prices are completely without value.”

Eugene F. Fama (1965): “Random Walks in Stock Market Prices”.

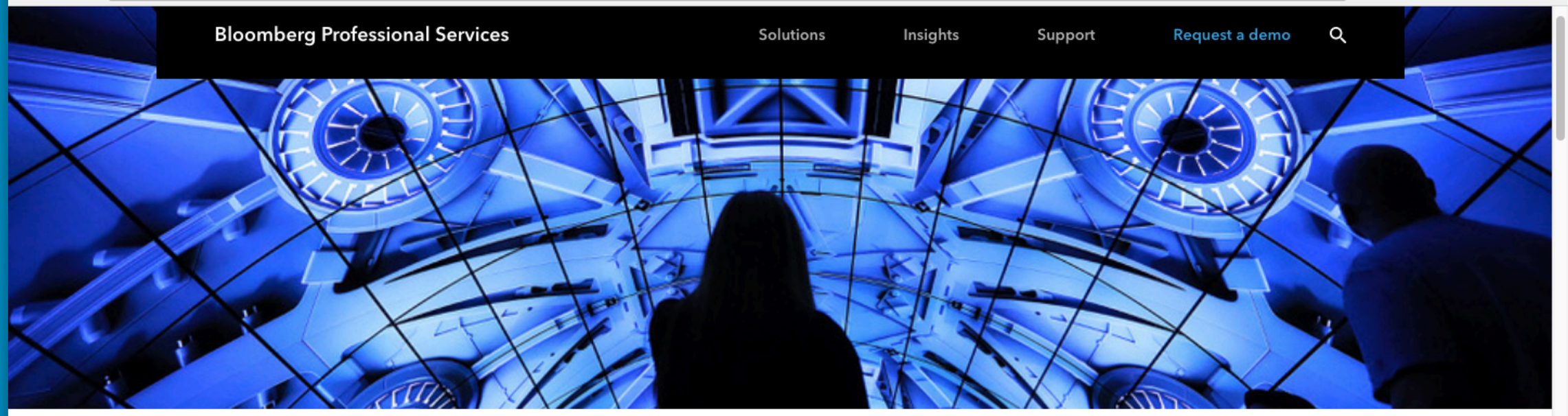
“A market is efficient with respect to an information set S if it is impossible to make economic profits by trading on the basis of information set S.”

Michael Jensen (1978): “Some Anomalous Evidence Regarding Market Efficiency”.

If a the price of a financial instrument follows a
(simple) **random walk**
(no drift & normally distributed returns),
then it rises and falls with
the same probability of 50% (“toss of a coin”).

In such a case,
the best predictor of tomorrow’s stock price
—in a least-squares sense—
is today’s stock price.

Outlook



Data Science

The race to AI utilization in finance is a marathon, not a sprint

Bloomberg Professional October 4, 2017

Development and deployment of artificial intelligence (AI) in financial services has accelerated. In particular, quantitative funds are increasingly applying programming and advanced statistical methods to generate alpha and automate trading strategies. Despite the hype and frequent headlines extoling the virtues

exponential forces at work:

- technology improvements
- capital accumulation
- talent accumulation
- network effects

finance

The Python Quants GmbH

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