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OPEN QUANT
LIVE BOOK

A PRACTICAL, HANDS-ON AND OPEN
APPROACH TO QUANTITATIVE FINANCE
ANALYSIS

The Open Quant Live Book

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Contribute

The Book is Open[1] and we are looking for co-authors (as I will never have the time or the knowledge to write it all by myself). Feel free to reach out[2] or simply create a pull request with your contribution on our Github project[3].

Book's information

First published at: openquant.netlify.com[4].

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[1]https://github.com/souzatharsis/open-quant-live-book
[2]http://www.souzatharsis.com/
[3]https://github.com/souzatharsis/open-quant-live-book
[4]https://openquant.netlify.com/
[5]https://creativecommons.org/licenses/by-nc-sa/4.0/

Part I

# The Basics

Chapter 1

I/O

1.1 Data Sources

1.1.1 Alpha Vantage

Alpha Vantage offers free access to pricing data including:

- Stock Time Series Data;
- Physical and Digital/Crypto Currencies (e.g., Bitcoin);
- Technical Indicators and
- Sector Performances.

The data are available in JSON and CSV format via REST APIs. The **quantmod** and the **alphavantager** R packages offer a lightweight R interface to the Alpha Vantage API. For instance, daily stock prices can be obtained with the `quantmod::getSymbols` function as follows:

```r
getSymbols(Symbols = "AAPL", src = "av", output.size = "full",
  adjusted = TRUE, api.key = "your API key")

plot(AAPL$AAPL.Adjusted)
```

AAPL$AAPL.Adjusted   1998–01–02 / 2018–12–26
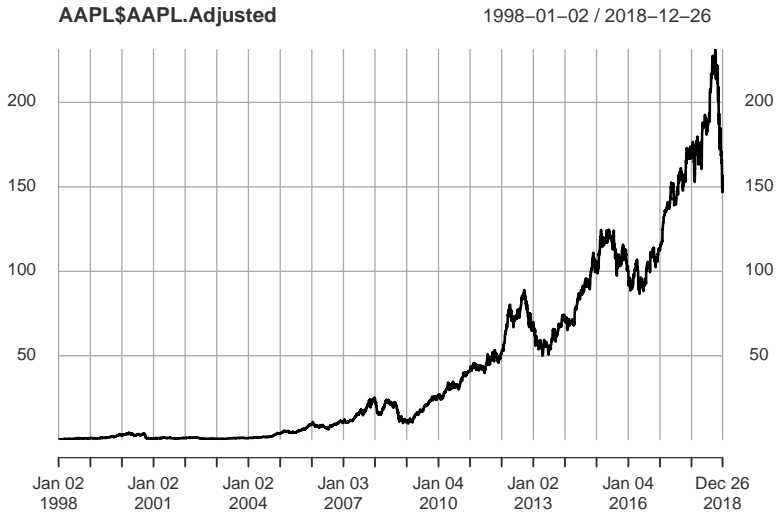
We called the `quantmod::getSymbols` function with the following arguments:

- `Symbols='AAPL'` defines a character vector specifying the names of each symbol to be loaded, here specified by the symbol of the company Apple Inc.;
- `src="av"` specifies the sourcing method, here defined with the value corresponding to Alpha Vantage;
- `output.size="full"`, strings `compact` and `full` are accepted with the following specifications: `compact` returns only the latest 100 data points; `full` returns the full-length time series of up to 20 years of historical data;
- `adjusted=TRUE`, defines boolean variable to include a column of closing prices adjusted for dividends and splits;
- `api.key`, specifies your Alpha Vantage API key.

1.1.2 IEX

1.1.3 Quandl

Chapter 2

Stylized Facts

2.1   Introduction

2.2   Distribution of Returns

2.2.1   Fat Tails

A distribuição de retornos financeiros apresenta leptokurtose. A ocorrência de eventos extremos é mais provável comparado com uma distribuição normal, i.e., as caudas da distribuição empírica de retornos são mais "pesadas" comparadas com as caudas esperadas supondo uma distribuição normal de probabilidade.

2.2.2   Skewness

A distribuição empírica de retornos é distorcida para esquerda. Retornos negativos são mais prováveis que retornos positivos.

2.3 Volatility

$$\sigma = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \overline{x})^2} \qquad (2.1)$$

2.3.1 Time-invariance

A volatilidade de retornos financeiros não é constante ao longo do tempo.

2.3.2 Volatility Clustering

Eventos extremos são observados próximos um dos outros.

2.3.3 Correlation with Trading Volume

O volume de negociação de um ativo tem correlação significante com a volatilidade do mesmo.

2.4 Correlation

$$\rho = \frac{\sum\limits_{t=1}^{T}(r_t - \hat{r}_t)(s_t - \hat{s}_t)}{\sqrt{\sum\limits_{t=1}^{T}(r_t^\tau - \hat{r}_t^\tau)^2}\sqrt{\sum\limits_{t=1}^{T}(s_t - \hat{s}_t)^2}}, \qquad (2.2)$$

onde $\hat{r}_t$ e $\hat{s}_t$ são a média amostral de r_t e s_t, respectivamente.

2.4.1 Time-invariance

A correlação entre duas series temporais de retornos financeiros não é constante ao longo do tempo.

2.4.2   Auto-correlation

Retornos financeiros apresentam baixa autocorrelação (linear), exceto em escalas de tempo muito baixas, e.g., minutos, onde há presença de efeitos de microstructura. Por outro lado, a função de autocorrelação do valor absoluto de retornos financeiros decai lentamente com o tempo.

A correlação contemporânea é maior do que a correlação cruzada.

Chapter 3

Correlation & Causation

Part II

Algo Trading

Chapter 4

Limit Order

Part III

Portfolio Optimization

Part IV

Machine Learning

Part V

Econophysics

Chapter 5

Entropy

Chapter 6

Transfer Entropy

Chapter 7

Financial Networks