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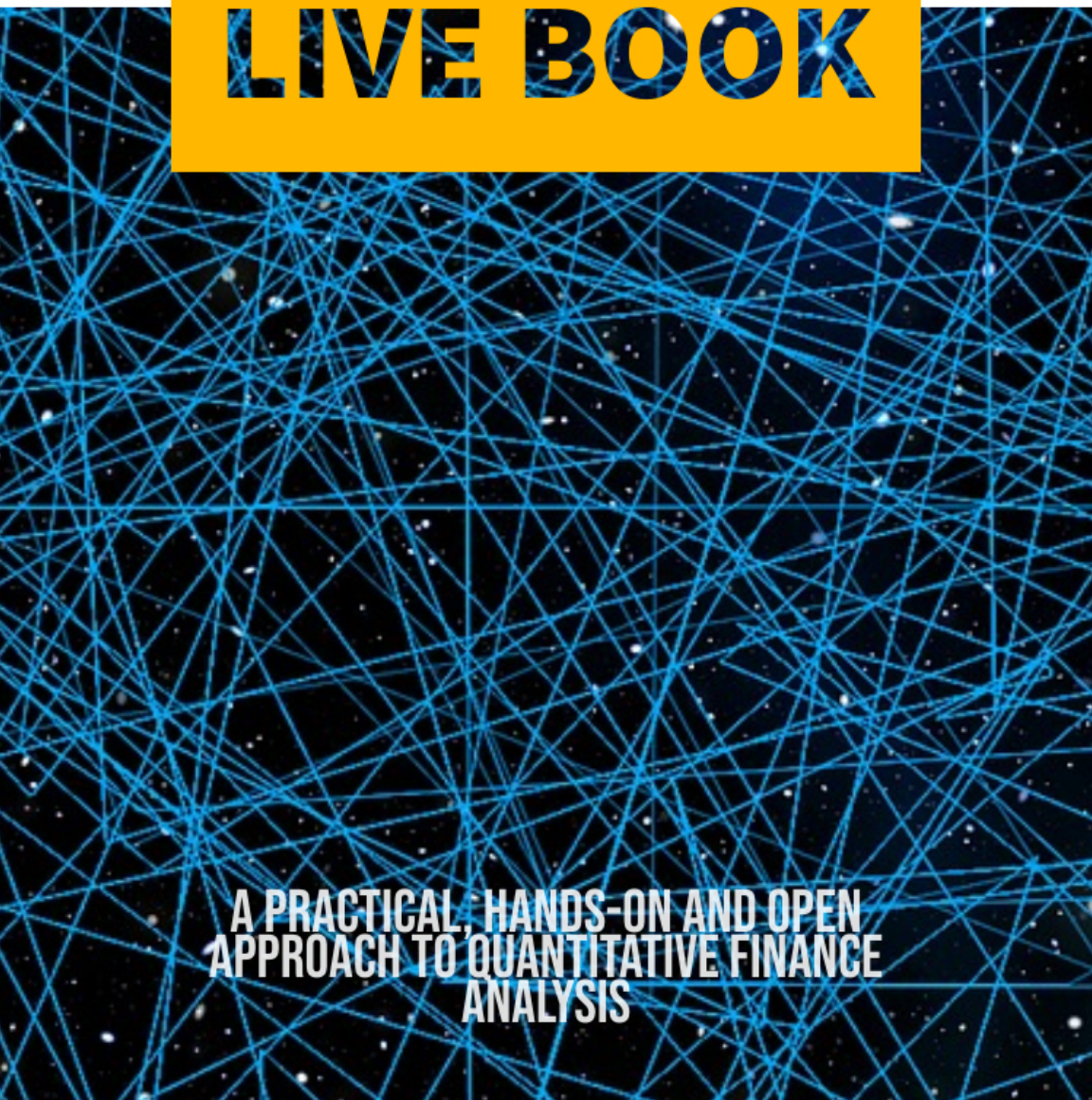
OPEN QUANT LIVE BOOK



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. 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].

[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/
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Part I

The Basics

Chapter 1

I/O

In this Chapter, we will introduce basic input and output functions in R. You will learn how to read text and excel files as well as how to read large files. We will also show how to obtain free financial and economic data from sources such as Quandl, IEX and Alpha Vantage.

1.1 Reading and Writing

1.1.1 Text Files

The most basic and commonly used option to import data from text files in R is the use of the function `read.table` from the **R Base**. We can use this function to read files with extensions such as `.txt` and `.csv`.

```
dat.table <- read.table(file = "<name of your file>.txt")
dat.csv <- read.csv(file = "<name of your file>.csv")
```

The package **readr** provides functions for reading text data into R that are much faster that the functions from the **R Base**. The `read_table`

function from the package **readr** provides a near-replacement for the `read.table` function.

```
library(readr)
dat.table <- readr::read_table2(file = "<name of your file>.txt")
dat.csv <- readr::read_csv(file = "<name of your file>.csv")
```

Another option to save data is to write it in `rds` format. Data stored in `rds` format has the advantage to keep the original data struture and type of the object saved. Also, `.rds` files are compressed and consume less space then saving the data in `.csv`, for instance. For example, a data.frame object `dat.frame` can be saved in `rds` format and then loaded back follows:

```
write_rds(dat.frame, path = "<name of your file>.rds")
dat.frame <- read_rds(path = "<name of your file>.rds")
```

1.1.2 Excel Files

The package `readxl` has an easy to use interface to functions to load excel documents in R. The functions `read_xls` and `read_xlsx` can be used to read excel files.

```
library(readxl)
readxl::read_xls(path = "<name of your file>.xls")
readxl::read_xlsx(path = "<name of your file>.xlsx")
```

The function `read_excel()` automatically detects the extension of the file.

```
readxl::read_excel("<name and extension of your file>", sheet = "<sh
```

In the `read_excel` function, the `sheet` argument can receive either the target sheet name or index, where sheet indexing starts at 1.

The `readxl` has been oberving increased use compared to other comparable packages such as **gdata** and the **xlsx** due to its relative ease of use and performance. Also, the `readxl` do not have depency with external code libraries while the packages **gdata** and **xlsx** depend on `ActiveState PERL` and the `Java JDK`, respectively.

1.1.3 Large Files

1.2 Data Sources

1.2.1 Alpha Vantage

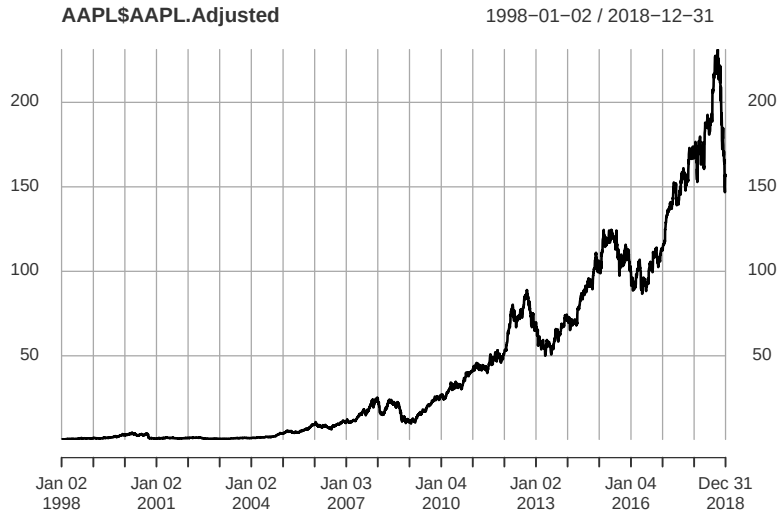
Alpha Vantage offers free access to pricing data including:

- 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:

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

```
plot(AAPL$AAPL.Adjusted)
```



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.

1.2.2 IEX

1.2.3 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

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

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

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

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