COMPUTATIONAL FINANCE & RISK MANAGEMENT

UNIVERSITY *of* WASHINGTON

Department of Applied Mathematics

ttr Package: indicator examples

CFRM 522 (012b)

Introduction to Trading Systems

Lecture References/Package Downloads

- Bollinger Bands
  - https://en.wikipedia.org/wiki/Bollinger_Bands
- Exponential Moving Average
  - https://en.wikipedia.org/wiki/Moving_average#Exponential_moving_average
- MACD:
  - https://www.tradingview.com/wiki/MACD_(Moving_Average_Convergence/Divergence)
- Clenow Ch 4:
  - Standard moving average crossover strategy
  - Standard breakout strategy
  - You will use these soon

Bollinger Bands (Wikipedia)

- Bollinger Bands (TM, 2011) and its related indicator ***%b*** can be used to measure the "highness" or "lowness" of the price relative to previous trades.
- Bollinger Bands are a type of volatility indicator
- Bollinger Bands consist of:
  - an N-period moving average (MA)
  - an upper band at K times an N-period standard deviation above the moving average (MA + Kσ)
  - a lower band at K times an N-period standard deviation below the moving average (MA − Kσ)

- Writing *upperBB* for the upper Bollinger Band, *lowerBB* for the lower Bollinger Band, and *last* for the last (price) value:

$$\%b = (last - lowerBB) / (upperBB - lowerBB)$$

Bollinger Bands (Wikipedia)

- The default choice for the average is a simple moving average (SMA), but other types of averages can be employed as needed. An exponential moving average (EMA) is a common second choice.

- Usually the same period is used for both the middle band and the calculation of standard deviation.

- Typical values for N and K are 20 and 2 (these are the defaults in the TTR package for R).

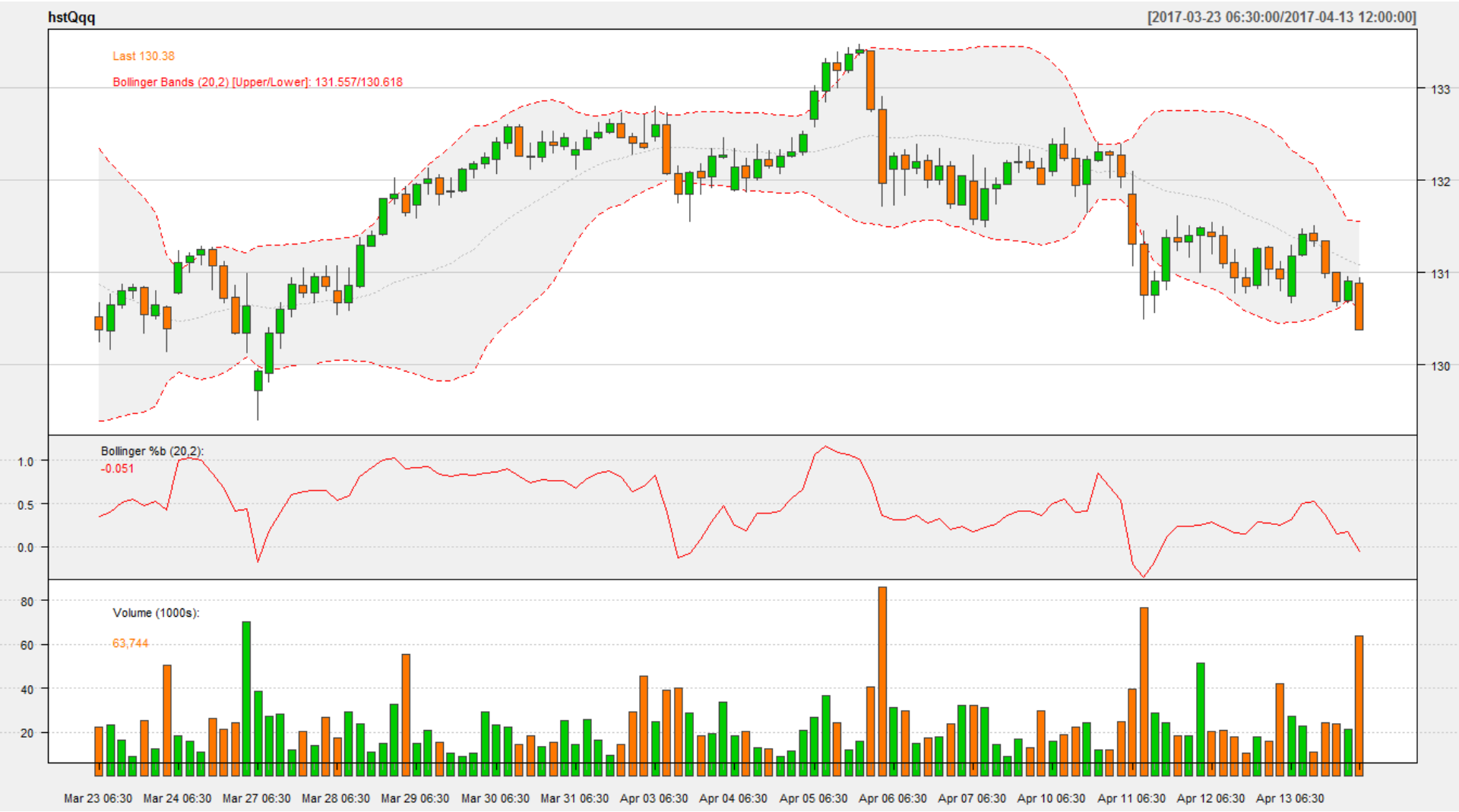
Bollinger Bands: Example (QQQ)

```
library(TTR)
library(IBrokers)
library(xts)

tws <- twsConnect(port=7497)  # 7497 is fixed by IB

qqq <- twsEquity("QQQ")

# This will take several minutes:
hstQqq <- reqHistoricalData(tws, qqq, barSize = "1 hour", duration = "1 M")

# Generate Bollinger Band values based on closing prices in this time series:
qqqBbCl <- BBands(HLC=Cl(hstQqq), n=20, sd=2, maType='SMA')
head(qqqBbCl,3)
                     dn mavg up pctB
2017-03-20 06:30:00 NA   NA NA   NA
2017-03-20 07:00:00 NA   NA NA   NA
2017-03-20 08:00:00 NA   NA NA   NA

tail(qqqBbCl,3)
                         dn     mavg       up       pctB
2017-04-13 10:00:00 130.5747 131.1880 131.8013  0.0940251
2017-04-13 11:00:00 130.6481 131.1315 131.6149  0.2709012
2017-04-13 12:00:00 130.5091 131.0850 131.6609 -0.1121231
```

Bollinger Bands: Example (QQQ)

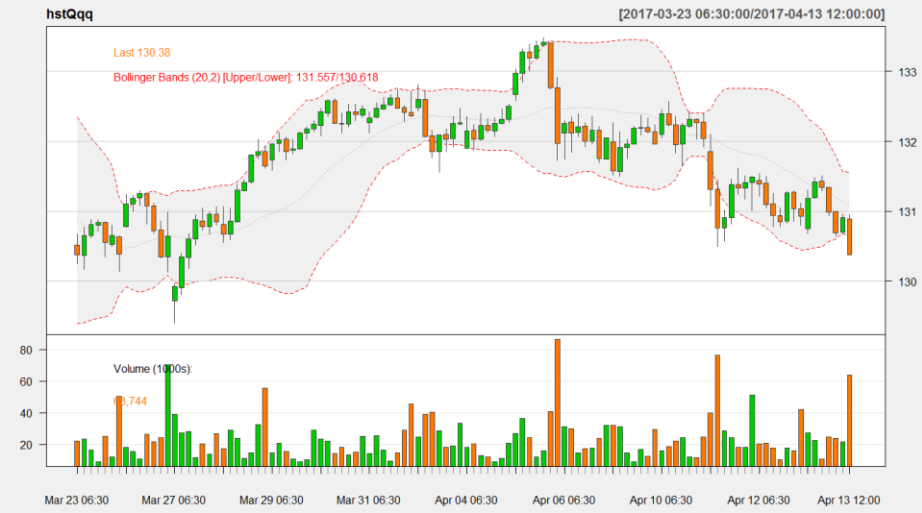
```
# n=20, sd=2, maType='SMA' are the defaults, so omit here to demonstrate.
# Also, use HLC(.) in place of Cl(.).

qqqBbHlc <- BBands(HLC=HLC(hstQqq))
tail(qqqBbHlc,3)

                          dn     mavg       up        pctB
2017-04-13 10:00:00 130.6032 131.1970 131.7908  0.14604538
2017-04-13 11:00:00 130.6955 131.1335 131.5715  0.17254411
2017-04-13 12:00:00 130.6177 131.0872 131.5566 -0.05084948

# Plot the results. NOTE: Use the original time series here from TWS, and
# NOT the result from BBands(.):
chartSeries(hstQqq,
            TA='addBBands(n=20, sd=2, maType="SMA");addBBands(draw="p");addVo()',
            theme='white', subset='2017-03-23::')
```

Bollinger Bands: Example (QQQ)

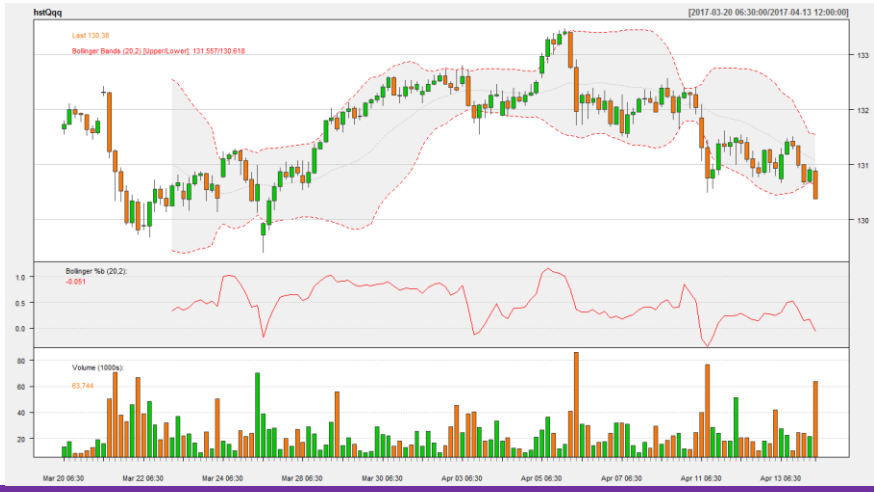


Bollinger Bands: Example (QQQ)

```
chartSeries(hstQqq,
            TA='addBBands();addVo()',
            theme='white', subset='2017-03-23::')
```

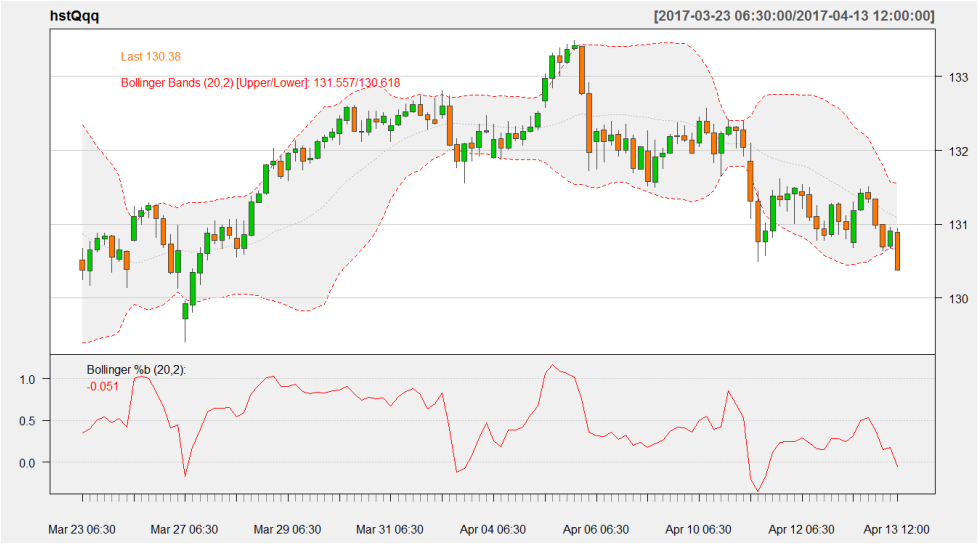



```
chartSeries(hstQqq,
            TA='addBBands();addBBands(draw="p");addVo()',
            theme='white')
```



Bollinger Bands: Example (QQQ)

```
chartSeries(hstQqq,
            TA='addBBands();addBBands(draw="p")',
            theme='white', subset='2017-03-23::')
```




```
chartSeries(hstQqq,
            TA='addBBands();addBBands(draw="p");addVo()',
            subset='2017-03-23::')
```

Exponential Moving Average (EMA)

- Prologue to the Moving Average Convergence-Divergence (MACD) indicator
- The EMA for a series Y may be calculated recursively (Wikipedia):

$$S_1 = Y_1$$

$$\text{for } t > 1, \quad S_t = \alpha \cdot Y_t + (1 - \alpha) \cdot S_{t-1}$$

- Where:
  - The coefficient α represents the degree of weighting decrease, a constant smoothing factor between 0 and 1. A higher α discounts older observations faster.
  - Y_t is the value (price) at a time period t.
  - S_t is the value of the EMA at any time period t.
- The default for α for the TTR function EMA(.) is $2 / (n + 1)$ for some choice of n. Note that, unlike the SMA case, the recursion will be applied beyond n elements in the series.

Moving Average Convergence Divergence (MACD) Indicator

- Traders use the MACD for determining trend direction, momentum and potential reversals.
- It is used to confirm trades based on other strategies, but it also provides its own trade signals.
- The indicator is determined by three EMA's: A faster EMA, and slower EMA, and an EMA on the difference in these two series.
- Typically applied to the closing prices.
- The default parameters are:
  - 12-day EMA for the faster series
  - 26-day EMA for the slower series
  - 9-day EMA on the difference between the two series (the signal)
- MACD line is the difference between the slower and faster series
- The histogram in the chart is the difference between the MACD line and the signal line

Moving Average Convergence Divergence (MACD) Indicator

```
getSymbols("XLU")
hstXlu <- XLU['2016::']

# Default parameters explicitly set; however, maType does
# not default to 'EMA'
macd <- MACD( Cl(hstXlu), nFast = 12, nSlow = 26, nSig = 9, maType="EMA" )

tail(macd, 3)

                macd    signal
2017-04-11 0.3833142 0.5175532
2017-04-12 0.4128345 0.4966094
2017-04-13 0.4048722 0.4782620

# quantmod plot:
# Defaults for addMACD(.) are shown explicitly here:
chartSeries(hstXlu, TA = 'addMACD(fast = 12, slow = 26, signal = 9, type = "EMA")',
            subset = "2016-03-31::", theme = 'white')
```

Moving Average Convergence Divergence (MACD) Indicator

Further Directions

- Relative Strength Index (RSI):
  - Similar to above in process
  - See CFRM522_012(G)_quantmod_and_TTR.pdf (Guy Yollin's slides) for more information

- Also read Ch 4 in Clenow; you will use the two given strategies in a related assignment (this is where it starts to get fun)

[END]