Making irregular data regular

IMPORTING AND MANAGING FINANCIAL DATA IN R

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Instructor

Regular date-time sequences

- Time observations are same distance apart
- Create regular date-time sequences using `seq()` methods:
  - `seq.Date()`
  - `seq.POSIXt()` (`POSIXct` and `POSIXlt`)

```
from_date <- as.Date("2017-01-01")
to_date <- as.Date("2017-01-03")
date_seq <- seq(from = from_date, to = to_date, by = "day")
```

- `start()` first index value
- `end()` last index value

```
regular_xts <- xts(seq_along(date_seq), order.by = date_seq)
start(regular_xts)
```

```
"2017-01-01"
```

```
end(regular_xts)
```

```
"2017-01-03"
```

```
seq(from = start(regular_xts), to = end(regular_xts), by = "day")
```

```
"2017-01-01" "2017-01-02" "2017-01-03"
```

Zero-width xts objects

- `xts` object with an index, no data

```
zero_width_xts <- xts(, order.by = date_seq)
zero_width_xts
```

```
Data:
numeric(0)
Index:
 Date[1:3], format: "2017-01-01" "2017-01-02" "2017-01-03"
```

```
str(zero_width_xts)
```

```
An 'xts' object of zero-width
```

Creating regular from irregular data

- Add observation at each date-time in regular sequence
- `NA` in the result

Merge irregular xts with regular zero-width xts

```
irregular
```

```
           Price
2017-01-02 20.01
2017-01-04 20.02
2017-01-10 20.05
```

```
date_seq <- seq(from = start(irregular),
                to = end(irregular),
                by = "day")
```

```
regular_xts <- xts(, date_seq)
```

Merge irregular xts with regular zero-width xts

```
merge(irregular, regular_xts)
```

```
           Price
2017-01-02 20.01
2017-01-03    NA
2017-01-04 20.02
2017-01-05    NA
2017-01-06    NA
2017-01-07    NA
2017-01-08    NA
2017-01-09    NA
2017-01-10 20.05
```

Filling missing values

```
merged_xts <- merge(irregular, regular_xts)
na.locf(merged_xts)
```

```
           Price
2017-01-02 20.01
2017-01-03 20.01
2017-01-04 20.02
2017-01-05 20.02
2017-01-06 20.02
2017-01-07 20.02
2017-01-08 20.02
2017-01-09 20.02
2017-01-10 20.05
```

Filling missing values

```
merge(irregular, regular_xts, fill = na.locf)
```

```
           Price
2017-01-02 20.01
2017-01-03 20.01
2017-01-04 20.02
2017-01-05 20.02
2017-01-06 20.02
2017-01-07 20.02
2017-01-08 20.02
2017-01-09 20.02
2017-01-10 20.05
```

Let's practice!

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Aggregating to lower frequency

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Low frequency data

- Timestamps have too much resolution
- Represent the first quarter of 2017
  - `"2017-01-01"` (first)
  - `"2017-03-31"` (last)
  - `"2017-02-01"` (middle)

Example

- Compare the daily 10-year Treasury constant maturity rate with USA Gross Domestic Product (quarterly)
- FRED symbols:
  - `DGS10`
  - `GDP`

Merge aggregated data with low-frequency data

```r
# Aggregate to quarterly
QGS10 <- apply.quarterly(DGS10, median, na.rm = TRUE)
# Merge quarterly aggregate with quarterly GDP
QGS10_GDP <- merge(QGS10, GDP)
QGS10_GDP
```

```
           DGS10     GDP
2015-01-01    NA 17783.6
2015-03-31  1.97      NA
2015-04-01    NA 17998.3
2015-06-30  2.19      NA
2015-07-01    NA 18141.9
2015-09-30  2.20      NA
2015-10-01    NA 18222.8
2015-12-31  2.23      NA
```

Low frequency date-time classes

- `yearmon()` for monthly data
- `yearqtr()` for quarterly data

```
as.Date("2017-01-01")
```

```
"2017-01-01"
```

```
as.yearmon("2017-01-01")
```

```
"Jan 2017"
```

```
as.yearqtr("2017-01-01")
```

```
"2017 Q1"
```

Convert index to lowest frequency

```
# Convert both indexes to yearqtr
index(QGS10) <- as.yearqtr(index(QGS10))
index(GDP) <- as.yearqtr(index(GDP))
```

```
# Merging 'just works'
merge(QGS10, GDP)
```

```
        DGS10     GDP
2015 Q1  1.97 17783.6
2015 Q2  2.19 17998.3
2015 Q3  2.20 18141.9
2015 Q4  2.23 18222.8
```

Align with beginning-of-period timestamp

```
# Last observation carried backward
QGS10_GDP_locb <- na.locf(QGS10_GDP, fromLast = TRUE)
```

```
# Subset by beginning-of-period index
QGS10_GDP_first_period <- QGS10_GDP_locb[index(GDP)]
QGS10_GDP_first_period
```

```
          DGS10     GDP
2015-01-01  1.97 17783.6
2015-04-01  2.19 17998.3
2015-07-01  2.20 18141.9
2015-10-01  2.23 18222.8
```

Let's practice!

IMPORTING AND MANAGING FINANCIAL DATA IN R

Aggregating and combining intraday data

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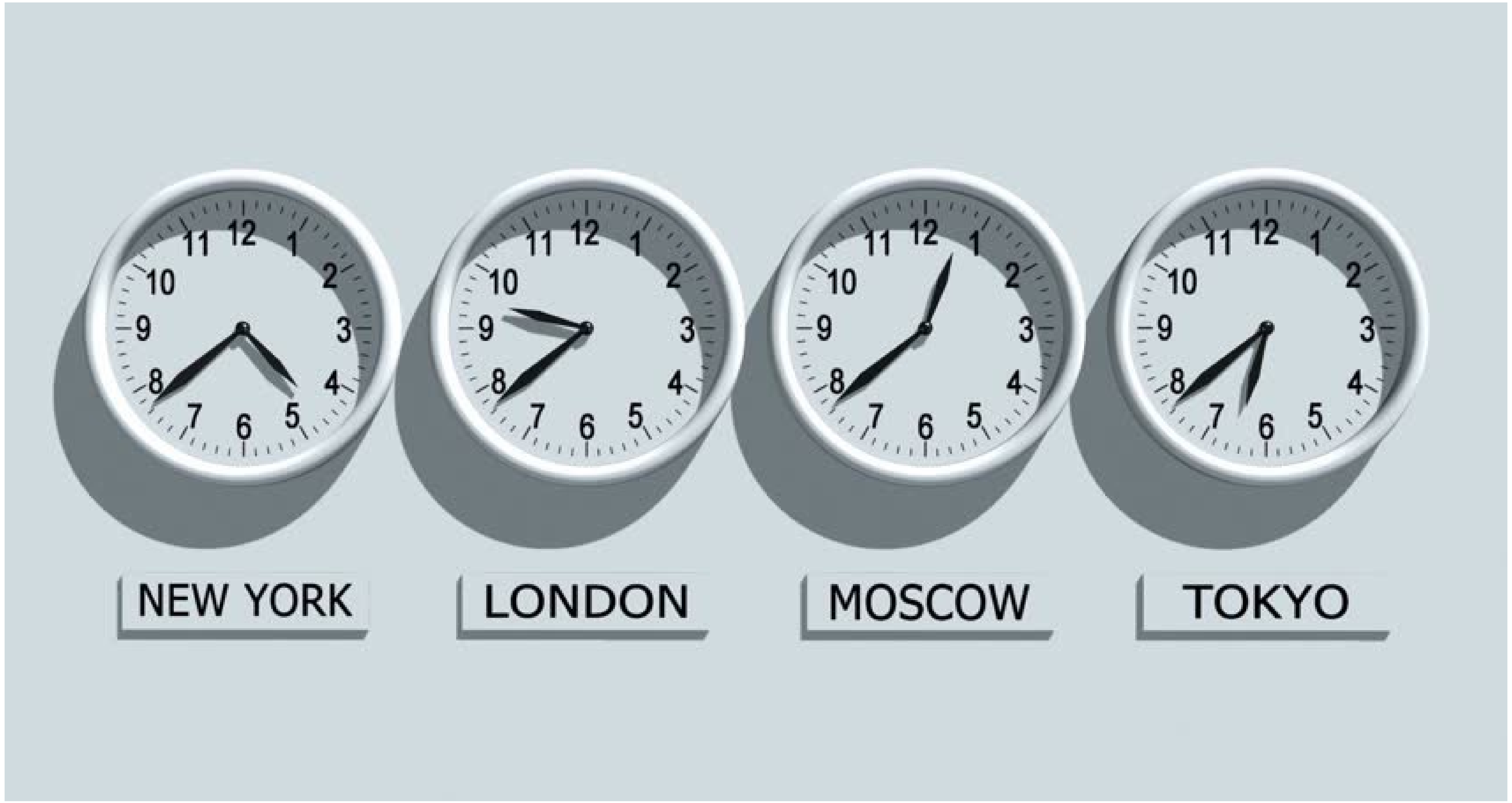
Timezones!



[1] Source: https://www.shutterstock.com/video/search/time-zone-clocks

Timezones!

- Internally, `xts` index is seconds since midnight `1970-01-01` in UTC
- `merge()` uses internal index
- `merge()` result will have timezone of the first object

Timezones!

```
datetime <- as.POSIXct("2017-01-18 10:00:00", tz = "UTC")
london <- xts(1, datetime, tzone = "Europe/London")
tokyo <- xts(1, datetime, tzone = "Asia/Tokyo")
```

```
merge(london, tokyo)
```

```
                    london tokyo
2017-01-18 10:00:00      1     1
```

```
merge(tokyo, london)
```

```
                    tokyo london
2017-01-18 19:00:00     1      1
```

Creating regular intraday data

```
head(dc_trades)
```

```
                    Price
2016-01-16 08:00:58 20.85
2016-01-16 08:01:56 20.85
2016-01-16 08:03:35 20.85
2016-01-16 08:07:44 20.84
2016-01-16 08:45:58 20.85
2016-01-16 08:46:49 20.85
```

Creating regular intraday data

```r
datetimes <- seq(from = as.POSIXct("2016-01-16 08:00"),
                 to = as.POSIXct("2016-01-17 18:00"),
                 by = "1 min")
```

```r
regular_xts <- xts(, order.by = datetimes)
```

```r
merged_xts <- merge(dc_trades, regular_xts)
head(merged_xts)
```

```
                    Price
2016-01-16 08:00:00    NA
2016-01-16 08:00:58 20.85
2016-01-16 08:01:00    NA
2016-01-16 08:01:56 20.85
2016-01-16 08:02:00    NA
2016-01-16 08:03:00    NA
```

Subset to trading hours

```
# All observations should be NA
all(is.na(merged_xts["2016-01-16 19:00/2016-01-17 07:00"]))
```

```
TRUE
```

```
# xts time-of-day subsetting
merged_trade_day <- merged_xts["T08:00/T18:00"]
```

```
# Now there are no observations
nrow(merged_trade_day["2016-01-16 19:00/2016-01-17 07:00"])
```

```
0
```

Fill missing values by trading day

- `split()` - `lapply()` - `rbind()` paradigm from this DataCamp course about manipulating time series

```
# split() data into list of non-overlapping chunks
trade_day_list <- split(merged_trade_day, "days")
```

```
# lapply() a function to each chunk (list element)
filled_trade_day_list <- lapply(trade_day_list, na.locf)
```

```
# Combine list of chunks using do.call() and rbind()
filled_trade_day <- do.call(rbind, filled_trade_day_list)
```

Aggregate irregular intraday data

- Aggregate dense intraday data with `to.period()`
  - `period` : new periodicity (e.g. seconds, hours, days, etc)
  - `k` : number of periods per new observation

Aggregate irregular intraday data (1)

```
head(dc_price)
```

```
                    DC.Price
2016-01-16 00:00:07 20.84224
2016-01-16 00:00:08 20.84225
2016-01-16 00:00:08 20.84225
2016-01-16 00:00:11 20.84225
2016-01-16 00:00:25 20.84224
2016-01-16 00:00:44 20.84224
```

```
xts_5min <- to.period(dc_price, period = "minutes", k = 5)
head(xts_5min, n = 4)
```

```
                    dc_price.Open  dc_price.High  dc_price.Low  dc_price.Close
2016-01-16 00:03:49      20.84224       20.84227      20.84140        20.84160
2016-01-16 00:09:50      20.84160       20.84160      20.84156        20.84156
2016-01-16 00:14:57      20.84156       20.84156      20.84154        20.84154
2016-01-16 00:19:23      20.84154       20.84154      20.83206        20.83211
```

```
xts_aligned <- align.time(xts_5min, n = 60 * 5)
head(xts_aligned, n = 4)
```

```
                    dc_price.Open  dc_price.High  dc_price.Low  dc_price.Close
2016-01-16 00:05:00      20.84224       20.84227      20.84140        20.84160
2016-01-16 00:05:00      20.84160       20.84160      20.84156        20.84156
2016-01-16 00:15:00      20.84156       20.84156      20.84154        20.84154
2016-01-16 00:20:00      20.84154       20.84154      20.83206        20.83211
```

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