xts FAQ
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What is xts? ................................................................. 2
Why should I use xts rather than zoo or another time-series package? .......... 2
How do I install xts? ...................................................... 2
I have multiple .csv time-series files that I need to load in a single xts object. What is the most efficient way to import the files? ............................................... 2
Why is xts implemented as a matrix rather than a data frame? ........................ 2
How can I simplify the syntax when referring to xts object column names? ....... 2
How can I replace the zeros in an xts object with the last non-zero value in the series? ........................ 3
How do I create an xts index with millisecond precision? ............................... 3
I have a millisecond-resolution index, but the milliseconds aren’t displayed. What went wrong? ............................................................... 3
I set digits.sec=3, but R doesn’t show the values correctly. ............................. 4
I am using apply to run a custom function on my xts object. Why does the returned matrix have different dimensions than the original one? .............. 4
I have an xts object with varying numbers of observations per day (e.g., one day might contain 10 observations, while another day contains 20 observations). How can I apply a function to all observations for each day? ..................... 4
How can I process daily data for a specific time subset? ................................. 5
How can I analyze my irregular data in regular blocks, adding observations for each regular block if one doesn’t exist in the original time-series object? .... 5
Why do I get a zoo object when I call transform on my xts object? ................................. 6
Why can’t I use the & operator in xts objects when querying dates? ................. 6
How do I subset an xts object to only include weekdays (excluding Saturday and Sundays)? ............................................................ 6
I need to quickly convert a data.frame that contains the time-stamps in one of the columns. Using as.xts(Data) returns an error. How do I build my xts object? ................................. 7
I have two time-series with different frequency. I want to combine the data into a single xts object, but the times are not exactly aligned. I want to have one row in the result for each ten minute period, with the time index showing the beginning of the time period. ........................................... 7
Why do I get a warning when running the code below? .................................. 7

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What is xts?

xts is an R package offering a number of functionalities to work on time-indexed data. xts extends zoo, another popular package for time-series analysis.

Why should I use xts rather than zoo or another time-series package?

The main benefit of xts is its seamless compatibility with other packages using different time-series classes (timeSeries, zoo, ...). In addition, xts allows the user to add custom attributes to any object. See the main xts vignette for more information.

How do I install xts?

xts depends on zoo and suggests some other packages. You should be able to install xts and all the other required components by simply calling install.packages('pkg') from the R prompt.

I have multiple .csv time-series files that I need to load in a single xts object. What is the most efficient way to import the files?

If the files have the same format, load them with read.zoo and then call rbind to join the series together; finally, call as.xts on the result. Using a combination of lapply and do.call can accomplish this with very little code:

```r
> filenames <- c("a.csv", "b.csv", "c.csv")
> sample.xts <- as.xts(do.call("rbind", lapply(filenames, read.zoo)))
```

Why is xts implemented as a matrix rather than a data frame?

xts uses a matrix rather than data.frame because:

1. xts is a subclass of zoo, and that’s how zoo objects are structured; and
2. matrix objects have much better performance than data.frames.

How can I simplify the syntax when referring to xts object column names?

with allows you to use the column names while avoiding the full square brackets syntax. For example:

```r
> lm(sample.xts[, "Res"] ~ sample.xts[, "ThisVar"] + sample.xts[, "ThatVar"])
```
can be converted to

```r
> with(sample.xts, lm(Res ~ ThisVar + ThatVar))
```

How can I replace the zeros in an `xts` object with the last non-zero value in the series?

Convert the zeros to NA and then use `na.locf`:

```r
> sample.xts <- xts(c(1:3, 0, 0, 0), as.POSIXct("1970-01-01")+0:5)
> sample.xts[sample.xts==0] <- NA
> cbind(orig=sample.xts, locf=na.locf(sample.xts))
```

<table>
<thead>
<tr>
<th>orig</th>
<th>locf</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970-01-01 00:00:00</td>
<td>1</td>
</tr>
<tr>
<td>1970-01-01 00:00:01</td>
<td>2</td>
</tr>
<tr>
<td>1970-01-01 00:00:02</td>
<td>3</td>
</tr>
<tr>
<td>1970-01-01 00:00:03</td>
<td>NA</td>
</tr>
<tr>
<td>1970-01-01 00:00:04</td>
<td>NA</td>
</tr>
<tr>
<td>1970-01-01 00:00:05</td>
<td>NA</td>
</tr>
</tbody>
</table>

How do I create an `xts` index with millisecond precision?

Milliseconds in `xts` indexes are stored as decimal values. This example builds an index spaced by 100 milliseconds, starting at the current system time:

```r
> data(sample_matrix)
> sample.xts <- xts(1:10, seq(as.POSIXct("1970-01-01"), by=0.1, length=10))
```

I have a millisecond-resolution index, but the milliseconds aren’t displayed. What went wrong?

Set the `digits.secs` option to some sub-second precision. Continuing from the previous example, if you are interested in milliseconds:

```r
> options(digits.secs=3)
> head(sample.xts)
```

```
[,1]
1970-01-01 00:00:00.0 | 1
1970-01-01 00:00:00.1 | 2
1970-01-01 00:00:00.2 | 3
1970-01-01 00:00:00.3 | 4
1970-01-01 00:00:00.4 | 5
1970-01-01 00:00:00.5 | 6
```
I set digits.sec=3, but R doesn’t show the values correctly.

Sub-second values are stored with approximately microsecond precision. Setting the precision to only 3 decimal hides the full index value in microseconds and might be tricky to interpret depending how the machine rounds the millisecond (3rd) digit. Set the digits.secs option to a value higher than 3 or convert the date-time to numeric and use print’s digits argument, or sprintf to display the full value. For example:

```r
> dt <- as.POSIXct("2012-03-20 09:02:50.001")
> print(as.numeric(dt), digits=20)
[1] 1332234170.0009999275
> sprintf("%20.10f", dt)
[1] "1332234170.0009999275"
```

I am using apply to run a custom function on my xts object. Why does the returned matrix have different dimensions than the original one?

When working on rows, apply returns a transposed version of the original matrix. Simply call t on the returned matrix to restore the original dimensions:

```r
> sample.xts.2 <- xts(t(apply(sample.xts, 1, myfun)), index(sample.xts))
```

I have an xts object with varying numbers of observations per day (e.g., one day might contain 10 observations, while another day contains 20 observations). How can I apply a function to all observations for each day?

You can use apply.daily, or period.apply more generally:

```r
> sample.xts <- xts(1:50, seq(as.POSIXct("1970-01-01"),
+ as.POSIXct("1970-01-03")-1, length=50))
> apply.daily(sample.xts, colMeans)

[,1]
1970-01-01 23:30:36.244 13
1970-01-02 23:59:59.000 38

> period.apply(sample.xts, endpoints(sample.xts, "days"), colMeans)

[,1]
1970-01-01 23:30:36.244 13
1970-01-02 23:59:59.000 38

> period.apply(sample.xts, endpoints(sample.xts, "hours", 6), colMeans)
```
How can I process daily data for a specific time subset?

First use time-of-day subsetting to extract the time range you want to work on (note the leading "T" and leading zeros are required for each time in the range: "T06:00"), then use apply.daily to apply your function to the subset:

```r
> apply.daily(sample.xts['T06:00/T17:00'], colMeans)
```

How can I analyze my irregular data in regular blocks, adding observations for each regular block if one doesn’t exist in the original time-series object?

Use align.time to round-up the indexes to the periods you are interested in, then call period.apply to apply your function. Finally, merge the result with an empty xts object that contains all the regular index values you want:

```r
> # align index into regular (e.g. 3-hour) blocks
> aligned.xts <- align.time(sample.xts, n=60*60*3)
> # apply your function to each block
> count <- period.apply(aligned.xts, endpoints(aligned.xts, "hours", 3), length)
> # create an empty xts object with the desired regular index
> empty.xts <- xts(, seq(start(aligned.xts), end(aligned.xts), by="3 hours"))
> # merge the counts with the empty object
> head(out1 <- merge(empty.xts, count))

   count
2009-09-22 09:00:00 1
2009-09-22 12:00:00 NA
2009-09-22 15:00:00 NA
2009-09-22 18:00:00 NA
2009-09-22 21:00:00 NA
2009-09-23 00:00:00 NA
```

```r
> # or fill with zeros
> head(out2 <- merge(empty.xts, count, fill=0))
```

```r
   count
2009-09-22 09:00:00 1
2009-09-22 12:00:00 1
2009-09-22 15:00:00 1
2009-09-22 18:00:00 1
2009-09-22 21:00:00 1
2009-09-23 00:00:00 1
```
Why do I get a zoo object when I call `transform` on my xts object?

There’s no xts method for `transform`, so the zoo method is dispatched. The zoo method explicitly creates a new zoo object. To convert the transformed object back to an xts object wrap the `transform` call in `as.xts`:

```r
> sample.xts <- as.xts(transform(sample.xts, ABC=1))
```

You might also have to reset the index timezone:

```r
> tzonename(sample.xts) <- Sys.getenv("TZ")
```

Why can’t I use the `&` operator in xts objects when querying dates?

"2011-09-21" is not a logical vector and cannot be coerced to a logical vector. See `?&` for details.

xts’ ISO-8601 style subsetting is nice, but there’s nothing we can do to change the behavior of `.Primitive("&")`. You can do something like this though:

```r
> sample.xts[sample.xts$Symbol == "AAPL" & index(sample.xts) == as.POSIXct("2011-09-21"),]
```

or:

```r
> sample.xts[sample.xts$Symbol == "AAPL"]['2011-09-21']
```

How do I subset an xts object to only include weekdays (excluding Saturday and Sundays)?

Use `.indexwday` to only include Mon-Fri days:

```r
> data(sample_matrix)
> sample.xts <- as.xts(sample_matrix)
> wday.xts <- sample.xts[.indexwday(sample.xts) %in% 1:5]
> head(wday.xts)
```

<table>
<thead>
<tr>
<th>Open</th>
<th>High</th>
<th>Low</th>
<th>Close</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.03978</td>
<td>50.11778</td>
<td>49.95041</td>
<td>50.11778</td>
</tr>
<tr>
<td>50.23050</td>
<td>50.42188</td>
<td>50.23050</td>
<td>50.39767</td>
</tr>
</tbody>
</table>
I need to quickly convert a data.frame that contains the time-stamps in one of the columns. Using `as.xts(Data)` returns an error. How do I build my xts object?

The `as.xts` function assumes the date-time index is contained in the rownames of the object to be converted. If this is not the case, you need to use the `xts` constructor, which requires two arguments: a vector or a matrix carrying data and a vector of type `Date`, `POSIXct`, `chron`, ..., supplying the time index information. If you are certain the time-stamps are in a specific column, you can use:

```r
> Data <- data.frame(timestamp=as.Date("1970-01-01"), obs=21)
> sample.xts <- xts(Data[, -1], order.by=Data[, 1])
```

If you aren't certain, you need to explicitly reference the column name that contains the time-stamps:

```r
> Data <- data.frame(obs=21, timestamp=as.Date("1970-01-01"))
> sample.xts <- xts(Data[, !grepl("timestamp", colnames(Data))],
+   order.by=Data$timestamp)
```

I have two time-series with different frequency. I want to combine the data into a single xts object, but the times are not exactly aligned. I want to have one row in the result for each ten minute period, with the time index showing the beginning of the time period.

`align.time` creates evenly spaced time-series from a set of indexes, `merge` ensure two time-series are combined in a single xts object with all original columns and indexes preserved. The new object has one entry for each timestamp from both series and missing values are replaced with `NA`.

```r
> x1 <- align.time(xts(Data1$obs, Data1$timestamp), n=600)
> x2 <- align.time(xts(Data2$obs, Data2$timestamp), n=600)
> merge(x1, x2)
```

Why do I get a warning when running the code below?

```r
> data(sample_matrix)
> sample.xts <- as.xts(sample_matrix)
> sample.xts["2007-01"]$Close <- sample.xts["2007-01"]$Close + 1
```
This code creates two calls to the subset-replacement function `xts:::<-.xts`. The first call replaces the value of `Close` in a temporary copy of the first row of the object on the left-hand-side of the assignment, which works fine. The second call tries to replace the first *element* of the object on the left-hand-side of the assignment with the modified temporary copy of the first row. This is the problem.

For the command to work, there needs to be a comma in the first subset call on the left-hand-side:

```r
> sample.xts[\"2007-01\",]$Close <- sample.xts[\"2007-01\"]$Close + 1
```

This isn’t encouraged, because the code isn’t clear. Simply remember to subset by column first, then row, if you insist on making two calls to the subset-replacement function. A cleaner and faster solution is below. It’s only one function call and it avoids the `$` function (which is marginally slower on `xts` objects).

```r
> sample.xts[\"2007-01\",\"Close\"] <- sample.xts[\"2007-01\",\"Close\"] + 1
```