```
## Loading required package:  doBy
```

Groupwise computations and other utilities in the doBy package

Søren Højsgaard

doBy version 4.6.17 as of 2023-07-11

Contents

1 Introduction **2**

2 Data used for illustration **3**

3 Groupwise computations **3**
3.1 The summaryBy and summary_by functions 3
3.2 The orderBy function and order_by functions 4
3.3 The splitBy and split_by functions 4
3.4 The subsetBy and subset_by functions 6
3.5 The transformBy and transform_by functions 6
3.6 The lapplyBy and lapply_by function 7

4 Miscellaneous utilities **7**
4.1 The firstobs() / lastobs() functions 7
4.2 The which.maxn() and which.minn() functions 7
4.3 Subsequences - subSeq() 8
4.4 Recoding values of a vector - recodeVar() 8
4.5 Renaming columns of a dataframe or matrix – renameCol() 8
4.6 Time since an event - timeSinceEvent() 9
4.7 Example: Using subSeq() and timeSinceEvent() 11

5 Acknowledgements **15**

1 Introduction

The **doBy** package contains a variety of utility functions. This working document describes some of these functions. The package originally grew out of a need to calculate groupwise summary statistics (much in the spirit of PROC SUMMARY of the SAS system), but today the package contains many different utilities.

2 Data used for illustration

The description of the `doBy` package is based on the `mtcars` dataset.

```
> head(mtcars)

##                    mpg cyl disp  hp drat    wt  qsec vs am gear carb
## Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0  1    4    4
## Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0  1    4    4
## Datsun 710        22.8   4  108  93 3.85 2.320 18.61  1  1    4    1
## Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44  1  0    3    1
## Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0    3    2
## Valiant           18.1   6  225 105 2.76 3.460 20.22  1  0    3    1

> tail(mtcars)

##                 mpg cyl  disp  hp drat    wt qsec vs am gear carb
## Porsche 914-2  26.0   4 120.3  91 4.43 2.140 16.7  0  1    5    2
## Lotus Europa   30.4   4  95.1 113 3.77 1.513 16.9  1  1    5    2
## Ford Pantera L 15.8   8 351.0 264 4.22 3.170 14.5  0  1    5    4
## Ferrari Dino   19.7   6 145.0 175 3.62 2.770 15.5  0  1    5    6
## Maserati Bora  15.0   8 301.0 335 3.54 3.570 14.6  0  1    5    8
## Volvo 142E     21.4   4 121.0 109 4.11 2.780 18.6  1  1    4    2
```

A description of the variable names can be found here: `https://rstudio-pubs-static.s3.amazonaws.com/61800_faea93548c6b49cc91cd0c5ef5059894.html`; see also `https://www.jstor.org/stable/2529336?seq=12`.

3 Groupwise computations

3.1 The `summaryBy` and `summary_by` functions

The `summaryBy` function is used for calculating quantities like "the mean and variance of numerical variables x and y for each combination of two factors A and B". Notice: A functionality similar to `summaryBy` is provided by `aggregate()` from base R.

```
> myfun1 <- function(x){
      c(m=mean(x), s=sd(x))
  }
> summaryBy(cbind(mpg, cyl, lh=log(hp)) ~ vs,
            data=mtcars, FUN=myfun1)

##   vs mpg.m mpg.s cyl.m  cyl.s  lh.m   lh.s
## 1  0 16.62 3.861 7.444 1.1490 5.196 0.3299
## 2  1 24.56 5.379 4.571 0.9376 4.478 0.2894
```

A simpler call is

```
> summaryBy(mpg ~ vs, data=mtcars, FUN=mean)

##   vs mpg.mean
## 1  0    16.62
## 2  1    24.56
```

Instead of formula we may specify a list containing the left hand side and the right hand side

of a formula[1] but that is possible only for variables already in the dataframe:

```
> summaryBy(list(c("mpg", "cyl"), "vs"),
            data=mtcars, FUN=myfun1)

##   vs mpg.m mpg.s cyl.m  cyl.s
## 1  0 16.62 3.861 7.444 1.1490
## 2  1 24.56 5.379 4.571 0.9376
```

Inspired by the **dplyr** package, there is a `summary_by` function which does the samme as `summaryBy` but with the data argument being the first so that one may write

```
> mtcars %>% summary_by(cbind(mpg, cyl, lh=log(hp)) ~ vs,
                        FUN=myfun1)

##   vs mpg.m mpg.s cyl.m  cyl.s  lh.m   lh.s
## 1  0 16.62 3.861 7.444 1.1490 5.196 0.3299
## 2  1 24.56 5.379 4.571 0.9376 4.478 0.2894
```

3.2 The `orderBy` function and `order_by` functions

Ordering (or sorting) a data frame is possible with the `orderBy` function. For example, we order the rows according to `gear` and `carb` (within `gear`):

```
> x1 <- orderBy(~ gear + carb, data=mtcars)
> head(x1, 4)

##                    mpg cyl  disp  hp drat    wt  qsec vs am gear carb
## Hornet 4 Drive    21.4   6 258.0 110 3.08 3.215 19.44  1  0    3    1
## Valiant           18.1   6 225.0 105 2.76 3.460 20.22  1  0    3    1
## Toyota Corona     21.5   4 120.1  97 3.70 2.465 20.01  1  0    3    1
## Hornet Sportabout 18.7   8 360.0 175 3.15 3.440 17.02  0  0    3    2

> tail(x1, 4)

##                 mpg cyl  disp  hp drat    wt qsec vs am gear carb
## Lotus Europa   30.4   4  95.1 113 3.77 1.513 16.9  1  1    5    2
## Ford Pantera L 15.8   8 351.0 264 4.22 3.170 14.5  0  1    5    4
## Ferrari Dino   19.7   6 145.0 175 3.62 2.770 15.5  0  1    5    6
## Maserati Bora  15.0   8 301.0 335 3.54 3.570 14.6  0  1    5    8
```

If we want the ordering to be by decreasing values of one of the variables, we can do

```
> x2 <- orderBy(~ -gear + carb, data=mtcars)
```

Alternative forms are:

```
> x3 <- orderBy(c("gear", "carb"), data=mtcars)
> x4 <- orderBy(c("-gear", "carb"), data=mtcars)
> x5 <- mtcars %>% order_by(c("gear", "carb"))
> x6 <- mtcars %>% order_by(~ -gear + carb)
```

3.3 The `splitBy` and `split_by` functions

Suppose we want to split the `airquality` data into a list of dataframes, e.g. one dataframe for each month. This can be achieved by:

[1] This is a feature of `summaryBy` and it does not work with `aggregate`.

```
> x <- splitBy(~ Month, data=airquality)
> x <- splitBy(~ vs, data=mtcars)
> lapply(x, head, 4)

## $'0'
##                    mpg cyl disp  hp drat    wt  qsec vs am gear carb
## Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0  1    4    4
## Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0  1    4    4
## Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0    3    2
## Duster 360        14.3   8  360 245 3.21 3.570 15.84  0  0    3    4
##
## $'1'
##                 mpg cyl  disp  hp drat    wt  qsec vs am gear carb
## Datsun 710     22.8   4 108.0  93 3.85 2.320 18.61  1  1    4    1
## Hornet 4 Drive 21.4   6 258.0 110 3.08 3.215 19.44  1  0    3    1
## Valiant        18.1   6 225.0 105 2.76 3.460 20.22  1  0    3    1
## Merc 240D      24.4   4 146.7  62 3.69 3.190 20.00  1  0    4    2

> attributes(x)

## $names
## [1] "0" "1"
##
## $groupid
##   vs
## 1  0
## 2  1
##
## $idxvec
## $idxvec$'0'
##  [1]  1  2  5  7 12 13 14 15 16 17 22 23 24 25 27 29 30 31
##
## $idxvec$'1'
##  [1]  3  4  6  8  9 10 11 18 19 20 21 26 28 32
##
##
## $grps
##  [1] "0" "0" "1" "1" "0" "1" "0" "1" "1" "1" "1" "0" "0" "0" "0" "0" "0" "1" "1" "1" "1"
## [22] "0" "0" "0" "0" "1" "0" "1" "0" "0" "0" "1"
##
## $class
## [1] "splitByData" "list"
```

Alternative forms are:

```
> splitBy("vs", data=mtcars)

##   listentry vs
## 1         0  0
## 2         1  1

> mtcars %>% split_by(~ vs)

##   listentry vs
## 1         0  0
## 2         1  1
```

3.4 The subsetBy and subset_by functions

Suppose we want to select those rows within each month for which the the wind speed is larger than the mean wind speed (within the month). This is achieved by:

```
> x <- subsetBy(~am, subset=mpg > mean(mpg), data=mtcars)
> head(x)

##                   mpg cyl  disp  hp drat    wt  qsec vs am gear carb
## 1.Fiat 128       32.4   4  78.7  66 4.08 2.200 19.47  1  1    4    1
## 1.Honda Civic    30.4   4  75.7  52 4.93 1.615 18.52  1  1    4    2
## 1.Toyota Corolla 33.9   4  71.1  65 4.22 1.835 19.90  1  1    4    1
## 1.Fiat X1-9      27.3   4  79.0  66 4.08 1.935 18.90  1  1    4    1
## 1.Porsche 914-2  26.0   4 120.3  91 4.43 2.140 16.70  0  1    5    2
## 1.Lotus Europa   30.4   4  95.1 113 3.77 1.513 16.90  1  1    5    2
```

Note that the statement `Wind > mean(Wind)` is evaluated within each month.

Alternative forms are

```
> x <- subsetBy("am", subset=mpg > mean(mpg), data=mtcars)
> x <- mtcars  %>% subset_by("vs", subset=mpg > mean(mpg))
> x <- mtcars  %>% subset_by(~vs, subset=mpg > mean(mpg))
```

3.5 The transformBy and transform_by functions

The `transformBy` function is analogous to the `transform` function except that it works within groups. For example:

```
> head(x)

##                      mpg cyl  disp  hp drat    wt  qsec vs am gear carb
## 0.Mazda RX4         21.0   6 160.0 110 3.90 2.620 16.46  0  1    4    4
## 0.Mazda RX4 Wag     21.0   6 160.0 110 3.90 2.875 17.02  0  1    4    4
## 0.Hornet Sportabout 18.7   8 360.0 175 3.15 3.440 17.02  0  0    3    2
## 0.Merc 450SL        17.3   8 275.8 180 3.07 3.730 17.60  0  0    3    3
## 0.Pontiac Firebird  19.2   8 400.0 175 3.08 3.845 17.05  0  0    3    2
## 0.Porsche 914-2     26.0   4 120.3  91 4.43 2.140 16.70  0  1    5    2

> x <- transformBy(~vs, data=mtcars,
                   min.mpg=min(mpg), max.mpg=max(mpg))
> head(x)

##    mpg cyl  disp  hp drat    wt  qsec vs am gear carb min.mpg max.mpg
## 1 21.0   6 160.0 110 3.90 2.620 16.46  0  1    4    4    10.4      26
## 2 21.0   6 160.0 110 3.90 2.875 17.02  0  1    4    4    10.4      26
## 3 18.7   8 360.0 175 3.15 3.440 17.02  0  0    3    2    10.4      26
## 4 14.3   8 360.0 245 3.21 3.570 15.84  0  0    3    4    10.4      26
## 5 16.4   8 275.8 180 3.07 4.070 17.40  0  0    3    3    10.4      26
## 6 17.3   8 275.8 180 3.07 3.730 17.60  0  0    3    3    10.4      26
```

Alternative forms:

```
> x <- transformBy("vs", data=mtcars,
                   min.mpg=min(mpg), max.mpg=max(mpg))
> x <- mtcars %>% transform_by("vs",
                               min.mpg=min(mpg), max.mpg=max(mpg))
```

3.6 The `lapplyBy` and `lapply_by` function

This `lapplyBy` function is a wrapper for first splitting data into a list according to the formula (using splitBy) and then applying a function to each element of the list (using lapply).

```
> lapplyBy(~vs, data=mtcars,
           FUN=function(d) lm(mpg~cyl, data=d)  %>% summary  %>% coef)

## $'0'
##             Estimate Std. Error t value  Pr(>|t|)
## (Intercept)   36.927     3.6908  10.005 2.728e-08
## cyl           -2.728     0.4903  -5.564 4.273e-05
##
## $'1'
##             Estimate Std. Error t value  Pr(>|t|)
## (Intercept)   41.940      5.778   7.258 1.004e-05
## cyl           -3.803      1.240  -3.066 9.782e-03
```

4 Miscellaneous utilities

4.1 The `firstobs()` / `lastobs()` functions

To obtain the indices of the first/last occurences of an item in a vector do:

```
> x <- c(1, 1, 1, 2, 2, 2, 1, 1, 1, 3)
> firstobs(x)

## [1]  1  4 10

> lastobs(x)

## [1]  6  9 10
```

The same can be done on variables in a data frame, e.g.

```
> firstobs(~vs, data=mtcars)

## [1] 1 3

> lastobs(~vs, data=mtcars)

## [1] 31 32
```

4.2 The `which.maxn()` and `which.minn()` functions

The location of the n largest / smallest entries in a numeric vector can be obtained with

```
> x <- c(1:4, 0:5, 11, NA, NA)
> which.maxn(x, 3)

## [1] 11 10  4

> which.minn(x, 5)

## [1] 5 1 6 2 7
```

4.3 Subsequences - `subSeq()`

Find (sub) sequences in a vector:

```
> x <- c(1, 1, 2, 2, 2, 1, 1, 3, 3, 3, 3, 1, 1, 1)
> subSeq(x)

##   first last slength midpoint value
## 1     1    2       2        2     1
## 2     3    5       3        4     2
## 3     6    7       2        7     1
## 4     8   11       4       10     3
## 5    12   14       3       13     1

> subSeq(x, item=1)

##   first last slength midpoint value
## 1     1    2       2        2     1
## 2     6    7       2        7     1
## 3    12   14       3       13     1

> subSeq(letters[x])

##   first last slength midpoint value
## 1     1    2       2        2     a
## 2     3    5       3        4     b
## 3     6    7       2        7     a
## 4     8   11       4       10     c
## 5    12   14       3       13     a

> subSeq(letters[x], item="a")

##   first last slength midpoint value
## 1     1    2       2        2     a
## 2     6    7       2        7     a
## 3    12   14       3       13     a
```

4.4 Recoding values of a vector - `recodeVar()`

```
> x <- c("dec", "jan", "feb", "mar", "apr", "may")
> src1 <- list(c("dec", "jan", "feb"), c("mar", "apr", "may"))
> tgt1 <- list("winter", "spring")
> recodeVar(x, src=src1, tgt=tgt1)

## [1] "winter" "winter" "winter" "spring" "spring" "spring"
```

4.5 Renaming columns of a dataframe or matrix – `renameCol()`

```
> head(renameCol(mtcars, c("vs", "mpg"), c("vs_", "mpg_")))

##                   mpg_ cyl disp  hp drat    wt  qsec vs_ am gear carb
## Mazda RX4         21.0   6  160 110 3.90 2.620 16.46   0  1    4    4
## Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02   0  1    4    4
## Datsun 710        22.8   4  108  93 3.85 2.320 18.61   1  1    4    1
## Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44   1  0    3    1
## Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02   0  0    3    2
## Valiant           18.1   6  225 105 2.76 3.460 20.22   1  0    3    1
```

4.6 Time since an event - `timeSinceEvent()`

Consider the vector

```
> yvar <- c(0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0)
```

Imagine that "1" indicates an event of some kind which takes place at a certain time point. By default time points are assumed equidistant but for illustration we define time time variable

```
> tvar <- seq_along(yvar) + c(0.1, 0.2)
```

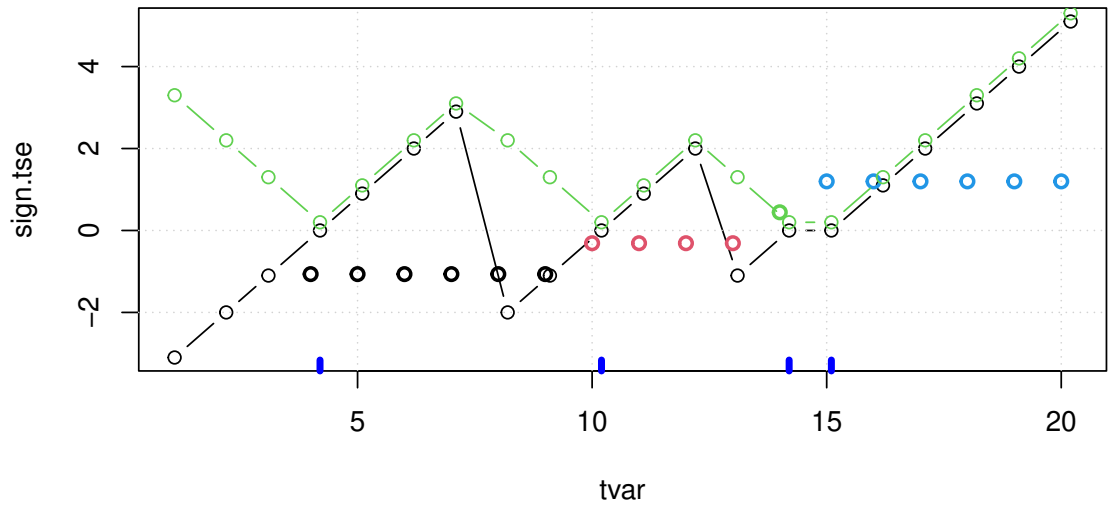
Now we find time since event as

```
> tse <- timeSinceEvent(yvar, tvar)
> tse

##    yvar tvar abs.tse sign.tse ewin run tae  tbe
## 1     0  1.1     3.1     -3.1    1  NA  NA -3.1
## 2     0  2.2     2.0     -2.0    1  NA  NA -2.0
## 3     0  3.1     1.1     -1.1    1  NA  NA -1.1
## 4     1  4.2     0.0      0.0    1   1 0.0  0.0
## 5     0  5.1     0.9      0.9    1   1 0.9 -5.1
## 6     0  6.2     2.0      2.0    1   1 2.0 -4.0
## 7     0  7.1     2.9      2.9    1   1 2.9 -3.1
## 8     0  8.2     2.0     -2.0    2   1 4.0 -2.0
## 9     0  9.1     1.1     -1.1    2   1 4.9 -1.1
## 10    1 10.2     0.0      0.0    2   2 0.0  0.0
## 11    0 11.1     0.9      0.9    2   2 0.9 -3.1
## 12    0 12.2     2.0      2.0    2   2 2.0 -2.0
## 13    0 13.1     1.1     -1.1    3   2 2.9 -1.1
## 14    1 14.2     0.0      0.0    3   3 0.0  0.0
## 15    1 15.1     0.0      0.0    4   4 0.0  0.0
## 16    0 16.2     1.1      1.1    4   4 1.1   NA
## 17    0 17.1     2.0      2.0    4   4 2.0   NA
## 18    0 18.2     3.1      3.1    4   4 3.1   NA
## 19    0 19.1     4.0      4.0    4   4 4.0   NA
## 20    0 20.2     5.1      5.1    4   4 5.1   NA
```

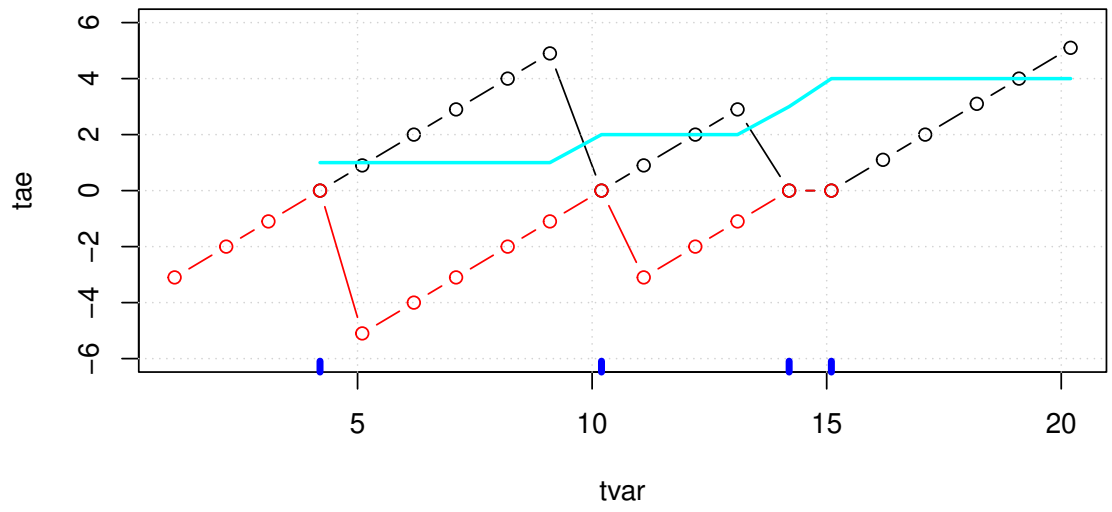
The output reads as follows:

- `abs.tse`: Absolute time since (nearest) event.
- `sign.tse`: Signed time since (nearest) event.
- `ewin`: Event window: Gives a symmetric window around each event.
- `run`: The value of `run` is set to 1 when the first event occurs and is increased by 1 at each subsequent event.
- `tae`: Time after event.
- `tbe`: Time before event.

```
> plot(sign.tse ~ tvar, data=tse, type="b")
> grid()
> rug(tse$tvar[tse$yvar == 1], col="blue",lwd=4)
> points(scale(tse$run), col=tse$run, lwd=2)
> lines(abs.tse + .2 ~ tvar, data=tse, type="b",col=3)
```

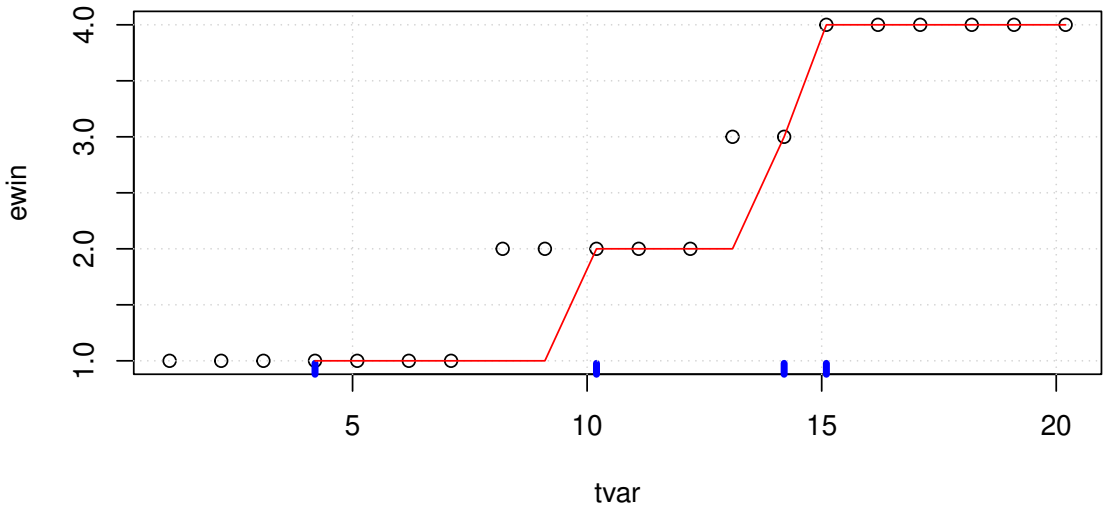



```
> plot(tae ~ tvar, data=tse, ylim=c(-6,6), type="b")
> grid()
> lines(tbe ~ tvar, data=tse, type="b", col="red")
> rug(tse$tvar[tse$yvar==1], col="blue", lwd=4)
> lines(run ~ tvar, data=tse, col="cyan", lwd=2)
```




```
> plot(ewin ~ tvar, data=tse, ylim=c(1, 4))
> rug(tse$tvar[tse$yvar==1], col="blue", lwd=4)
```

```
> grid()
> lines(run ~ tvar, data=tse, col="red")
```



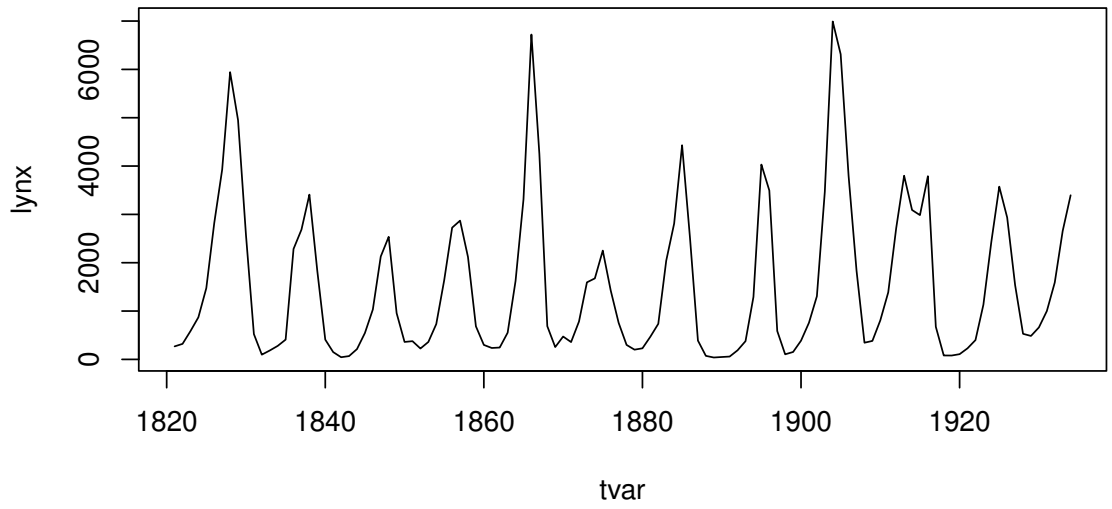
We may now find times for which time since an event is at most 1 as

```
> tse$tvar[tse$abs <= 1]

## [1]  4.2  5.1 10.2 11.1 14.2 15.1
```

4.7 Example: Using `subSeq()` and `timeSinceEvent()`

Consider the `lynx` data:

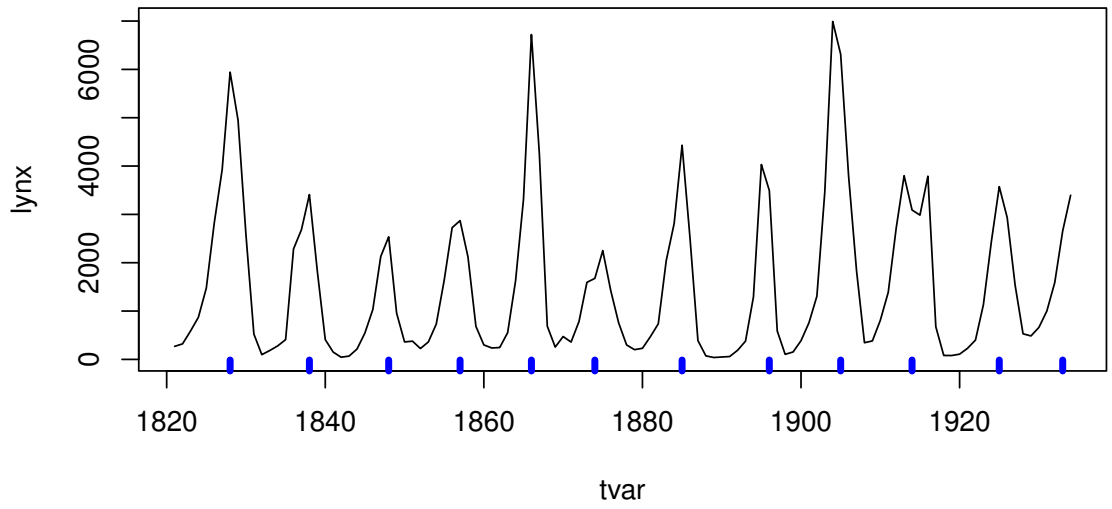
```
> lynx <- as.numeric(lynx)
> tvar <- 1821:1934
> plot(tvar, lynx, type="l")
```



Suppose we want to estimate the cycle lengths. One way of doing this is as follows:

```
> yyy <- lynx > mean(lynx)
> head(yyy)

## [1] FALSE FALSE FALSE FALSE FALSE  TRUE

> sss <- subSeq(yyy, TRUE)
> sss

##    first last slength midpoint value
## 1      6   10       5        8  TRUE
## 2     16   19       4       18  TRUE
## 3     27   28       2       28  TRUE
## 4     35   38       4       37  TRUE
## 5     44   47       4       46  TRUE
## 6     53   55       3       54  TRUE
## 7     63   66       4       65  TRUE
## 8     75   76       2       76  TRUE
## 9     83   87       5       85  TRUE
## 10    92   96       5       94  TRUE
## 11   104  106       3      105  TRUE
## 12   112  114       3      113  TRUE
```

```
> plot(tvar, lynx, type="l")
> rug(tvar[sss$midpoint], col="blue", lwd=4)
```



Create the "event vector"

```
> yvar <- rep(0, length(lynx))
> yvar[sss$midpoint] <- 1
> str(yvar)

##  num [1:114] 0 0 0 0 0 0 0 1 0 0 ...
```

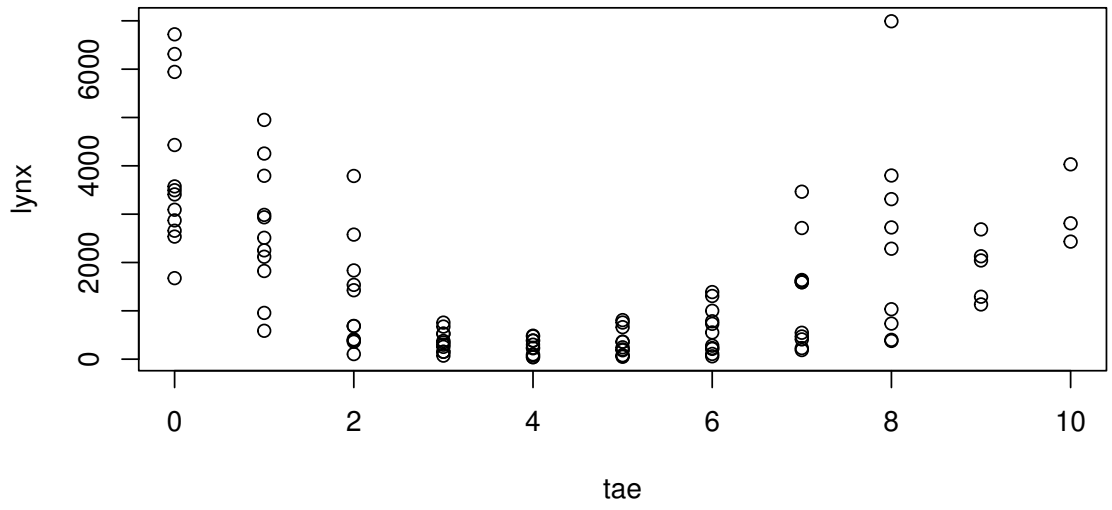
```
> tse <- timeSinceEvent(yvar,tvar)
> head(tse, 20)

##    yvar tvar abs.tse sign.tse ewin run tae tbe
## 1     0 1821       7       -7    1  NA  NA  -7
## 2     0 1822       6       -6    1  NA  NA  -6
## 3     0 1823       5       -5    1  NA  NA  -5
## 4     0 1824       4       -4    1  NA  NA  -4
## 5     0 1825       3       -3    1  NA  NA  -3
## 6     0 1826       2       -2    1  NA  NA  -2
## 7     0 1827       1       -1    1  NA  NA  -1
## 8     1 1828       0        0    1   1   0   0
## 9     0 1829       1        1    1   1   1  -9
## 10    0 1830       2        2    1   1   2  -8
## 11    0 1831       3        3    1   1   3  -7
## 12    0 1832       4        4    1   1   4  -6
## 13    0 1833       5        5    1   1   5  -5
## 14    0 1834       4       -4    2   1   6  -4
## 15    0 1835       3       -3    2   1   7  -3
## 16    0 1836       2       -2    2   1   8  -2
## 17    0 1837       1       -1    2   1   9  -1
## 18    1 1838       0        0    2   2   0   0
## 19    0 1839       1        1    2   2   1  -9
## 20    0 1840       2        2    2   2   2  -8
```

We get two different (not that different) estimates of period lengths:

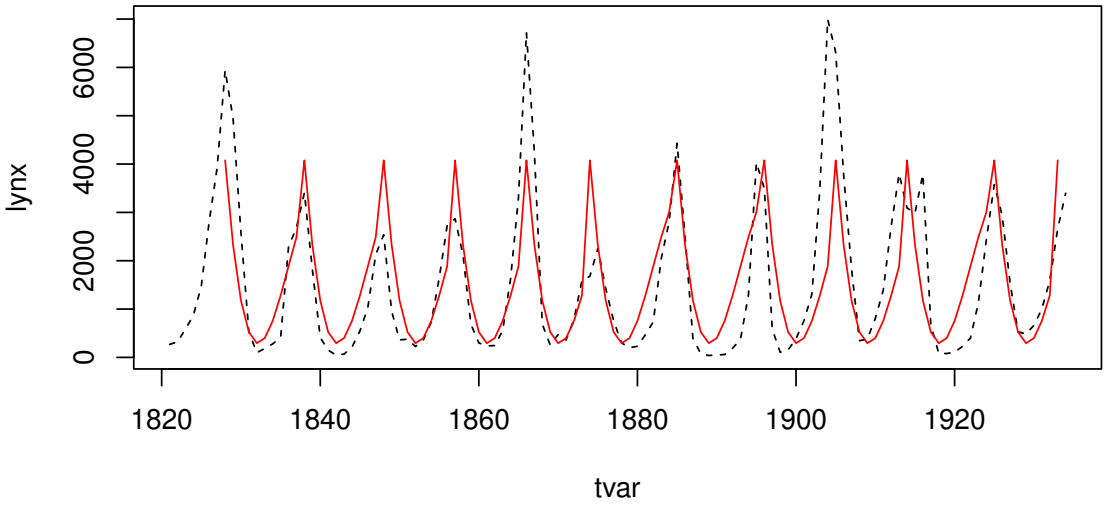
```
> len1 <- tapply(tse$ewin, tse$ewin, length)
> len2 <- tapply(tse$run, tse$run, length)
> c(median(len1), median(len2), mean(len1), mean(len2))

## [1] 9.500 9.000 9.500 8.917
```

We can overlay the cycles as:

```
> tse$lynx <- lynx
> tse2 <- na.omit(tse)
> plot(lynx ~ tae, data=tse2)
```




```
> plot(tvar, lynx, type="l", lty=2)
> mm <- lm(lynx ~ tae + I(tae^2) + I(tae^3), data=tse2)
> lines(fitted(mm) ~ tvar, data=tse2, col="red")
```



5 Acknowledgements

Credit is due to Dennis Chabot, Gabor Grothendieck, Paul Murrell and Jim Robison-Cox for reporting various bugs and making various suggestions to the functionality in the **doBy** package.