smires – Calculating Hydrological Metrics for Univariate Time Series

Tobias Gauster

Institute of Applied Statistics and Computing
BOKU, Vienna

useR!2017 BRUSSELS

Motivation

Happy families are all alike; ...
– Leo Tolstoi, Anna Karenina

Hydrological/ecological metrics are all alike.

SMIRES Science and Management of Intermittent Rivers and Ephemeral Streams

Working Group 1: *Prevalence, distribution and trends of IRES*

The R package `smires`

- Provides a framework for computing hydro-/ecological metrics.
- Contains sample datasets of every participating European country.

- Is aimed at unexperienced useRs.
- Has only a few requirements on input data.
- Can work with binary data (flow, no-flow).

`https://github.com/mundl/smires`

Functions

Preprocessing

`is.intermittent()`	checks for intermittency
`validate()`	validates input time series

Computing Metrics

`metric()`	continuous time series
`smires()`	binary time series, e.g. for intermittent rivers

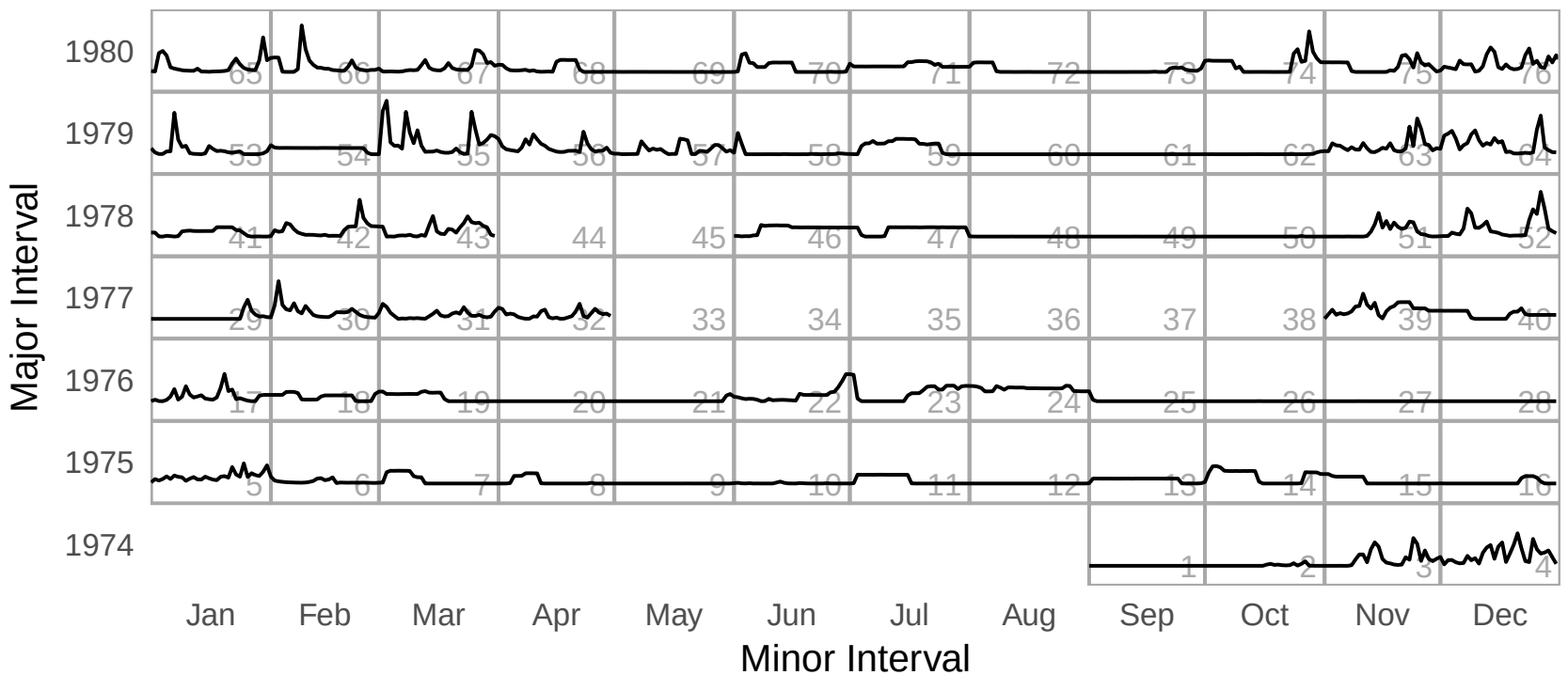
Low level functions

`group_by_interval()`	assigns indices and groups
`find_events()`	derives a binary time series

Metrics for continuous time series

E.g. mean maximum discharge

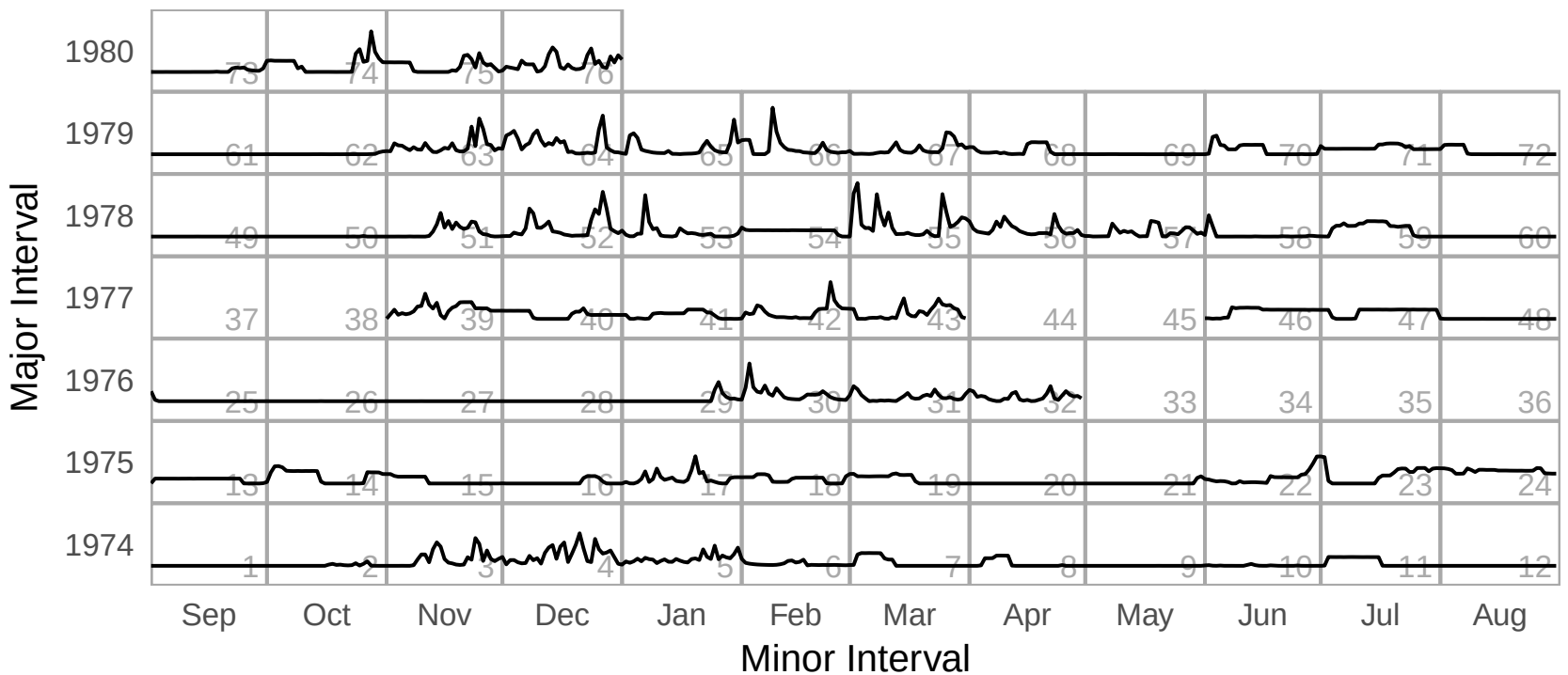
```
> metric(balder,
+        fun_major = max, fun_total = mean,
+        plot = T)
 [1] 5.438429
```



Metrics for continuous time series

E.g. mean maximum discharge, hydrological year starting in September

```
> metric(balder, major = 244,
+        fun_major = max, fun_total = mean,
+        plot = T)
 [1] 5.696429
```



Metrics for continuous time series

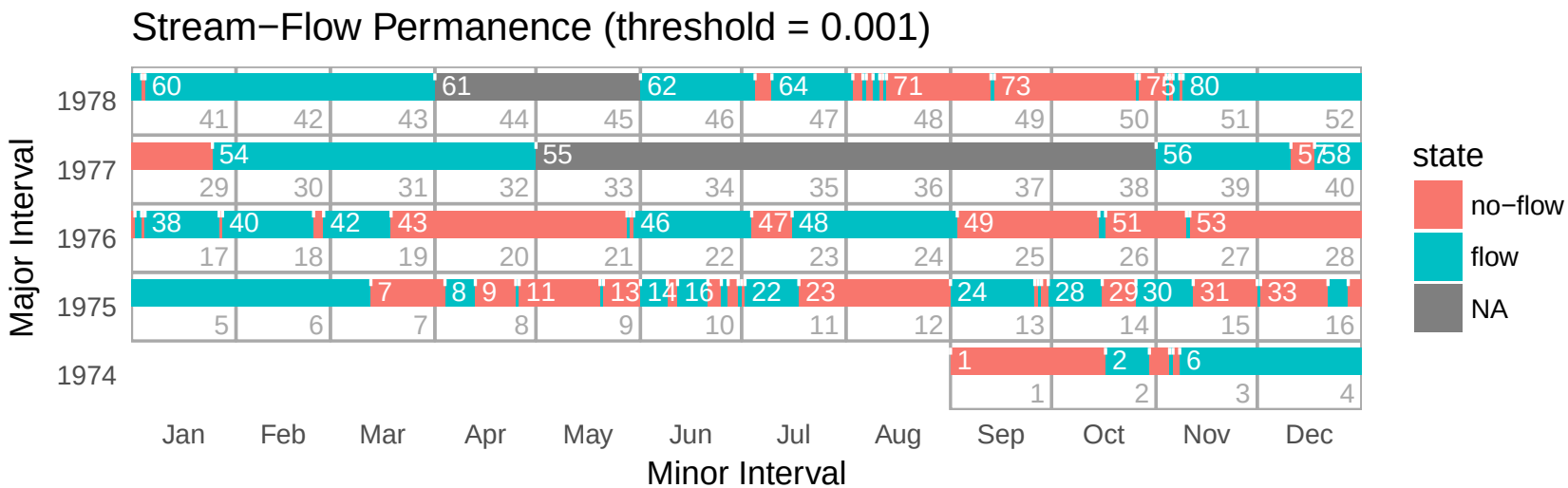
E.g. maximum discharge, hydrological year starting in September

```
> metric(balder, major = 244, fun_major = max)

# A tibble: 7 x 2
  major variable
  <ord>    <dbl>
1  1974    4.720
2  1975    3.955
3  1976    5.471
4  1977    5.334
5  1978    7.757
6  1979    6.753
7  1980    5.885
```

Metrics for binary time series

Threshold is 1 l/s

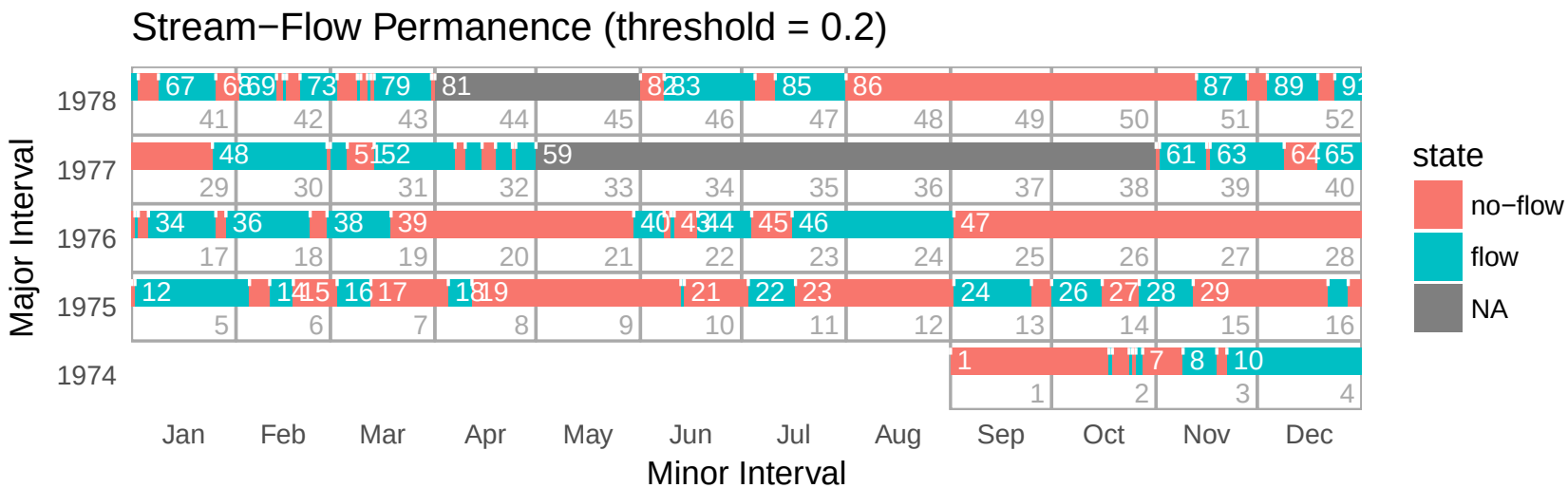
```
> smires(balder, plot = T)

# A tibble: 78 x 9
   event   state      start         end group duration major minor
   <ord>  <fctr>     <date>     <date> <dbl>   <time> <ord> <ord>
1      1 no-flow 1974-09-01 1974-10-17     1  46 days  1974   Sep
2      2    flow 1974-10-17 1974-10-30     2  13 days  1974   Oct
3      3 no-flow 1974-10-30 1974-11-05     2   6 days  1974   Oct
```



Metrics for binary time series

Threshold is 20 l/s

```
> smires(balder, threshold = 0.2, plot = T)

# A tibble: 89 x 9
   event   state      start         end group duration major minor
   <ord>  <fctr>     <date>      <date> <dbl>   <time> <ord> <ord>
1      1 no-flow 1974-09-01 1974-10-18     1  47 days  1974   Sep
2      2    flow 1974-10-18 1974-10-19     2   1 days  1974   Oct
3      3 no-flow 1974-10-19 1974-10-24     2   5 days  1974   Oct
```



Metrics for binary time series

Mean maximum duration of events

```
> smires(balder,
+        fun_major = max,
+        drop_na = "major")

# A tibble: 10 x 3
   major   state variable
   <ord>  <fctr>   <time>
 1  1974 no-flow  46 days
 2  1974    flow 125 days
 3  1975 no-flow  45 days
 4  1975    flow  25 days
 5  1976 no-flow  76 days
 6  1976    flow  49 days
 7  1979 no-flow  20 days
 8  1979    flow 214 days
 9  1980 no-flow  12 days
10  1980    flow  46 days
```

```
> smires(balder,
+        fun_major = max,
+        fun_total = mean,
+        drop_na = "major")

# A tibble: 2 x 2
    state  variable
   <fctr>    <time>
1 no-flow 39.8 days
2    flow 91.8 days
```

Metrics for binary time series

Low level functions

```
# Appending the group and interval indices
> group_by_interval(balder)

# A tibble: 2,314 x 6
        time discharge major minor group  hday
      <date>     <dbl> <ord> <ord> <dbl> <dbl>
1 1974-09-01         0  1974   Sep     1   244
2 1974-09-02         0  1974   Sep     1   245
3 1974-09-03         0  1974   Sep     1   246

# Detecting events
find_events(grouped, rule = "start")

# A tibble: 132 x 8
  event   state      start        end group duration major minor
  <ord>  <fctr>     <date>     <date> <dbl>   <time> <ord> <ord>
1     1 no-flow 1974-09-01 1974-10-17     1  46 days  1974   Sep
2     2    flow 1974-10-17 1974-10-30     2  13 days  1974   Oct
3     3 no-flow 1974-10-30 1974-11-05     2   6 days  1974   Oct
```

Varying the minor interval: Seasonal analysis

```
> seasons <- c(spring = 60, summer = 152,
               autumn = 244, winter = 335)

> smires(balder, minor = seasons, fun_minor = max)

# A tibble: 8 x 3
   minor   state variable
   <ord>  <fctr>   <time>
1 spring no-flow  70 days
2 spring    flow  96 days
3 summer no-flow  45 days
4 summer    flow  49 days
5 autumn no-flow  76 days
6 autumn    flow 214 days
7 winter no-flow  20 days
8 winter    flow  96 days
```

Summary

- The package **smires** provides a framework to compute metrics of univariate time series.
- Either continuous or binary time series.
- Free choice of the aggregation period (calendar years, hydrological years, months, seasons, ...).
- Free choice of the aggregation function.
- github: `https://github.com/mundl/smires`

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SMIRES Science and Management of Intermittent Rivers and Ephemeral Streams

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