A quick introduction to FLR

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The Fisheries Library in R (FLR) is a collection of tools for quantitative fisheries science, developed in the R language, that facilitates the construction of bio-economic simulation models of fisheries systems.

FLR builds on the powerful R environment and syntax to create a domain-specific language for the quantitative analysis of the expected risks and effects of fisheries management decision. The classes and methods in FLR consider uncertainty an integral part of our knowledge of fisheries system. [. . .]

Required packages

To follow this tutorial you should have installed the following packages:

- FLR: FLCore

You can do so as follows,

```r
install.packages(c("FLCore"), repos="http://flr-project.org/R")
```

Starting with FLR

The main *classes* (i.e. data structures) and methods (i.e. procedures) in the FLR system are found in the `FLCore` package. Let's load it first

```r
library(FLCore)
```

The `FLQuant` class

The basic element on which the FLR classes are based is the `FLQuant` class. We can look at the structure of the class in its help page

```r
help(FLQuant)
```

It is a six-dimensional array, in which the first dimension is free to have any name, *quant* by default, commonly `age`, while the other five have set names:

- `year`: year of the data point.
- `unit`: any subdivision of the data not based on space or time, for example gender (`male` and `female`).
- `season`: any time step shorter than year (e.g. month, quarter, week).
- `area`: spatial subdivision of data
- `iter`: multiple iterations of the same process (e.g. bootstrap, Bayesian, Monte Carlo, . . .)

We can now call the `FLQuant()` constructor method to see an example with some random numbers

```r
FLQuant(rlnorm(20), dim=c(4,5), quant="age", units="kg")
```

```
## An object of class "FLQuant"
## , , unit = unique, season = all, area = unique
##
##     year
## age 1       2       3       4       5
##   1 0.60352 0.97440 0.99065 1.68515 1.36443
```

```
##   2 1.93833 2.09946 3.13919 0.84972 0.53418
##   3 0.24826 1.51710 5.28007 0.61229 0.59522
##   4 3.14748 6.16351 1.06234 0.93561 1.43151
##
## units:  kg
```

and this produces an `FLQuant` object with some numbers for ages 1 to 4, and years 1 to 5. The name of the first dimension has been specified to be "age", while the units of measurement, "kg", have been stored as an attribute to the array.

An important part of the information associated with any dataset is kept in an `FLQuant` as the `dimnames` of the array. For example, we can specify in the constructor call the names of any of the dimensions, by using the `dimnames` argument

```
FLQuant(rlnorm(20), units="kg",
  dimnames=list(age=0:3, year=2010:2014))
```

```
## An object of class "FLQuant"
## , , unit = unique, season = all, area = unique
##
##     year
## age 2010     2011     2012     2013     2014
##   0 5.05653  0.15654  0.69089  1.00484  0.59178
##   1 0.69980  4.84358  2.49983  2.98628 18.75915
##   2 1.19544  3.67105  0.28047  3.45236  0.35310
##   3 0.81529  0.88436  0.41125  2.65102  0.43105
##
## units:  kg
```

There are a number of methods and ways to create `FLQuant` objects from different R objects (`vector`, `matrix`, `array` or `data.frame`) once loaded into R, please see `?FLQuant` and `?as.FLQuant` for a complete list of available methods.

Objects of this class have the same properties as any `array` in R, with some important differences. For example, subsetting on an `FLQuant` does not drop by default unused dimensions

```
flq <- FLQuant(rlnorm(20), units="kg",
  dimnames=list(age=0:3, year=2010:2014))
```

```
flq[1,]
```

```
## An object of class "FLQuant"
## , , unit = unique, season = all, area = unique
##
##      year
## age 2010    2011    2012    2013    2014
##    0 0.83273 0.93033 0.57937 0.53811 0.66576
##
## units:  kg
```

```
dim(flq[1,])
```

```
## [1] 1 5 1 1 1 1
```

so they remain valid `FLQuant` objects. Similarly, arithmetic operations on objects of the class, against each other or against numeric vectors, always return an `FLQuant` object.

```
flq * 2
```

```
## An object of class "FLQuant"
## , , unit = unique, season = all, area = unique
##
##     year
## age 2010    2011    2012    2013    2014
##   0 1.66546 1.86067 1.15873 1.07622 1.33152
##   1 1.74553 1.58617 1.13461 2.58775 2.61444
##   2 0.95651 1.61724 0.91591 1.52422 0.46513
##   3 4.02794 4.84576 1.19348 0.76540 1.54251
##
## units:  kg
```

```
flq + (flq * 2)
```

```
## An object of class "FLQuant"
## , , unit = unique, season = all, area = unique
##
##     year
## age 2010   2011   2012   2013   2014
##   0 2.4982 2.7910 1.7381 1.6143 1.9973
##   1 2.6183 2.3793 1.7019 3.8816 3.9217
##   2 1.4348 2.4259 1.3739 2.2863 0.6977
##   3 6.0419 7.2686 1.7902 1.1481 2.3138
##
## units:  kg
```

- summary, plot

```
plot(FLQuant(rnorm(200), dim=c(2,20)))
```
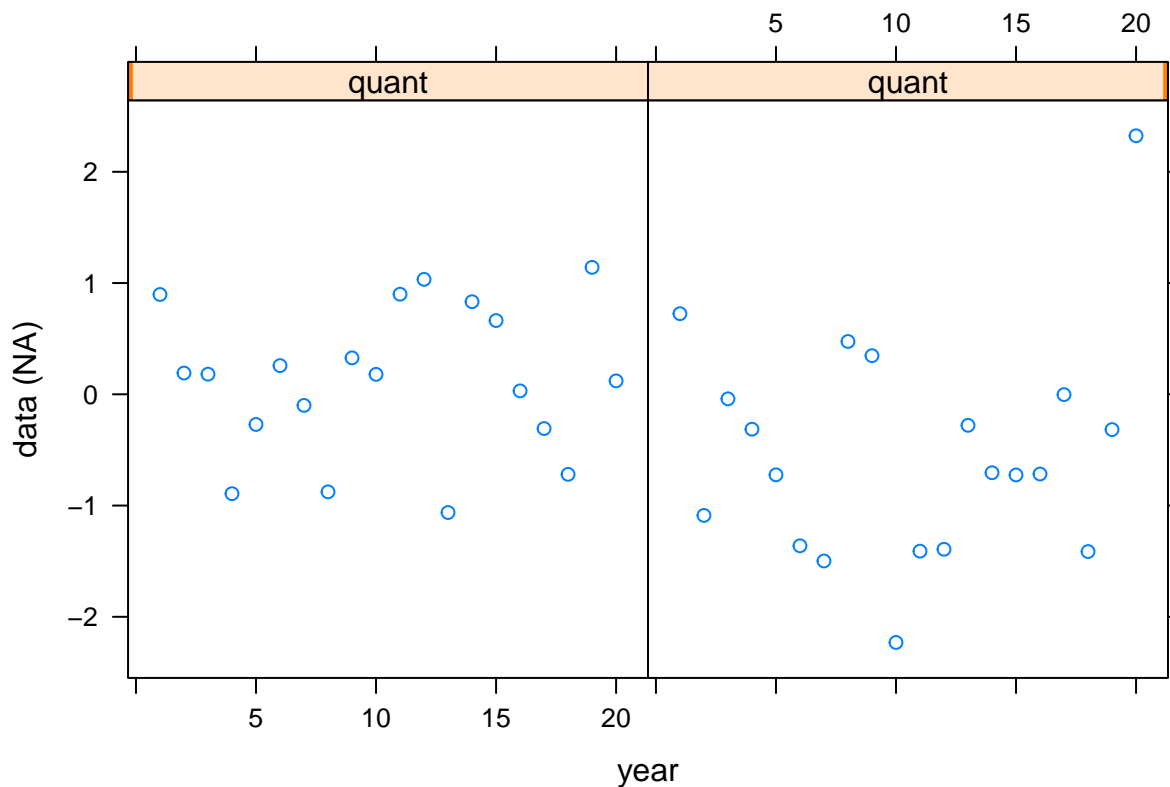

- FLStock
```

**FLPar**

**FLSR**

# References

L. T. Kell, I. Mosqueira, P. Grosjean, J-M. Fromentin, D. Garcia, R. Hillary, E. Jardim, S. Mardle, M. A. Pastoors, J. J. Poos, F. Scott, R. D. Scott; FLR: an open-source framework for the evaluation and development of management strategies. *ICES J Mar Sci* 2007; 64 (4): 640-646. doi: 10.1093/icesjms/fsm012

# More information

- You can submit bug reports, questions or suggestions on this tutorial at https://github.com/flr/doc/issues.
- Or send a pull request to https://github.com/flr/doc/
- For more information on the FLR Project for Quantitative Fisheries Science in R, visit the FLR webpage, http://flr-project.org.

## Software Versions

- R version 3.3.2 (2016-10-31)
- FLCore: 2.6.0.20170130
- **Compiled**: Tue Feb 14 21:31:40 2017

## License

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