

Plotting FLR objects with ggplotFL and ggplot2

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Using ggplot2 with FLR objects

The ggplot2 package provides a powerful alternative paradigm for creating simple and complex plots in R using the ideas of Wilkinson's *Grammar of Graphics*²

To facilitate the use of ggplot2 methods in FLR, the ggplotFL package has been created. The main resources on offer in this package are overloaded versions of the ggplot() method that take directly certain FLR classes, a new set of basic plots for some FLR classes, based on ggplot2 instead of lattice, and some examples and documentation on how best make use of ggplot2's powerful paradigm and implementation to obtain high quality plots for even fairly complex data structures.

The overloaded 'ggplot' method

The standard ggplot functions expects a data.frame for its first argument, data. If ggplot is called on an FLR object, a conversion to data.frame takes place before the result, plus any other arguments provided, are passed to the original ggplot(). Conversion makes use of as.data.frame³ methods defined in FLCore, with the cohort argument set to TRUE.

FLQuant

Passing an FLQuant object to ggplot, we can specify the names of the dimensions as variables in the plot, where data refers to the column storing the actual numeric values. For example, to plot data (the catch slot from ple4 in this case) against year, we could use

```
ggplot(data = catch(ple4), aes(year, data)) + geom_point() +  
  geom_line() + ylab("Catch (t)") + xlab("")
```

FLQuants

Similarly, we can pass on to ggplot an object of class FLQuants, and the conversion to data.frame will make use of the corresponding method⁴. A new column gives the name of each FLQuant in the list, called qname. We can then use it to, for example, define a call to facet_wrap() to obtain a separate subplot per element.

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² Wilkinson, L. 1999. *The Grammar of Graphics*, Springer. ISBN 0-387-98774-6.

³ method?as.data.frame('FLQuant')

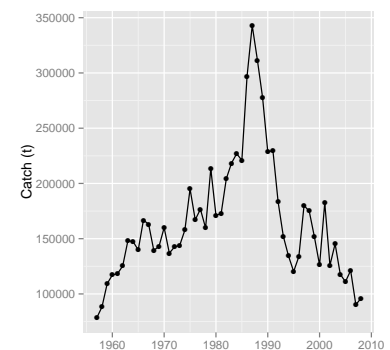


Figure 1: Combined line and point plot of a time series from an FLQuant object.

⁴ method?as.data.frame('FLQuants')

```
ggplot(data = FLQuants(Yield = catch(ple4), SSB = ssb(ple4),
  F = fbar(ple4)), aes(year, data)) + geom_line() +
  facet_wrap(~qname, scales = "free", nrow = 3) +
  labs(x = "", y = "")
```

This procedure is particularly useful when plotting information from objects with multiple `FLQuant` slots, as a subset can be selected for plotting, and transformations or computations can be carried out in the call to the `FLQuants()` creator.

FLStock

```
ggplot(data = ple4, aes(year, data)) + geom_line(aes(group = age,
  colour = factor(age))) + facet_wrap(~slot, scales = "free",
  nrow = 3) + labs(x = "", y = "") + theme(legend.position = "nc")
```

New plot() methods for FLR classes

The `ggplotFL` package also provides new versions of the `plot` method for a number of *FLR* classes. Each *S4* class defined in any *FLR* package should have a `plot()` method defined that provides a visual summary of the contents of the object.

FLStock

Using ggplot2 by converting to data.frame

The methods shown above simply depend on conversion of *FLR* objects into `data.frame`, which can then be passed to `ggplot()`. Calling `ggplot` on an *FLR* object takes care of this conversion behind the scenes, but to obtain certain plots, it is best to directly convert the *FLR* objects into a `data.frame`.

Some examples

Example: plot quantiles of a simulation

To have full control over a plot of the median (or mean) and the confidence or probability intervals of a simulated or randomized time series, i.e. an `FLQuant` object with `iters`, we need to arrange the different values computed from the object in separate columns of a `data.frame`.

If we start with some random `FLQuant` object, such as

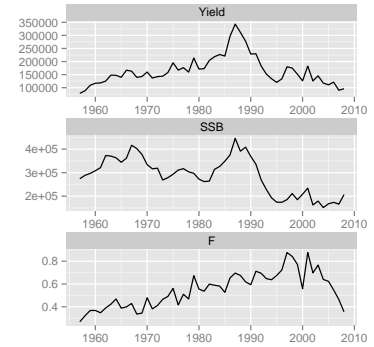


Figure 2: Facet wrap line plot of some time series from an `FLQuants` object.



Figure 3: Overall `ggplot` of an `FLStock` object, faceted by slot.

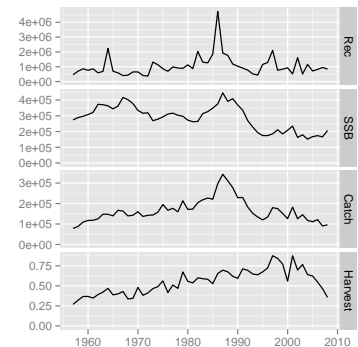


Figure 4: `ggplot2` version of the standard `plot()` for `FLStock`, as applied to `ple4`

```
fla <- rlnorm(100, FLQuant(exp(cumsum(rnorm(25, 0,
  0.1)))), 0.1)
ggplot(fla, aes(factor(year), data)) + geom_boxplot() +
  xlab("")
```

we can first compute the necessary statistics on the object itself, as these operations are very efficient on an array. `quantile()` on an `FLQuant` will return the specified quantiles along the `iter` dimension. Let's extract the 10th, 25th, 50th, 75th and 90th quantiles.

```
flq <- quantile(fla, c(0.1, 0.25, 0.5, 0.75, 0.9))
```

The object can now be coerced to a `data.frame`

```
fdf <- as.data.frame(flq)
```

and inspected to see how the 100 iters have been now turned into the five requested quantiles in the `iter` column

```
##   quant year  unit season  area iter  data
## 1  all    1 unique  all unique 10% 2.307
## 2  all    2 unique  all unique 10% 2.462
## 3  all    3 unique  all unique 10% 2.159
```

The long format `data.frame` can be reshaped into a wide format one so that we can instruct `ggplot` to use the quantiles, now in separate columns, to provide limits for the shaded areas in `geom_ribbon`. To do this we can use `cast`, as follows

```
fdw <- cast(fdf, quant + year + unit + season + area ~
  iter, value = "data")
```

This creates a wide `data.frame` in which the `iter` column is spread into five columns named as the levels of its conversion into factor

```
levels(fdw[, "iter"])
```

```
## [1] "10%" "25%" "50%" "75%" "90%"
```

We can now use those five quantile columns when plotting shaded areas using `geom_ribbon`. Please note that the column names returned by `quantile()` need to be quoted using backticks.

```
p <- ggplot(data = fdw, aes(x = year, y = '50%')) +
  geom_line() + geom_ribbon(aes(x = year, ymin = '10%',
    ymax = '90%'), fill = "red", alpha = 0.15) + geom_ribbon(aes(x =
    year, ymin = '25%', ymax = '75%'), fill = "red", alpha = 0.25) +
  ylab("data")
print(p)
```

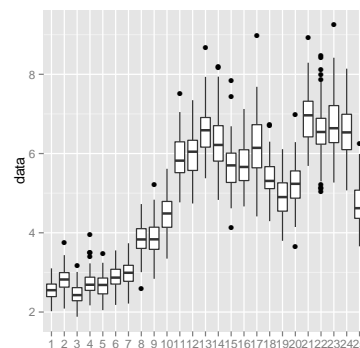


Figure 5:

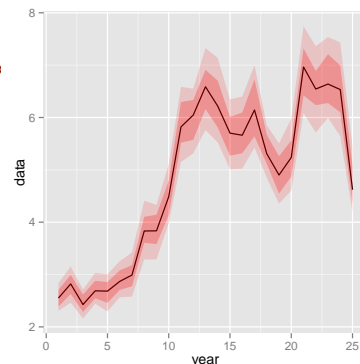


Figure 6:

Example: Using FLQuants

Coercion using `as.data.frame`, combined with the use of `cast` and `melt` (from the `reshape` package), provides the *FLR* user with most tools required to create a large range of `ggplots` out of any *FLR* object.

Example: Simulation trajectories plot

```
fds <- cast(as.data.frame(iter(fla, c(1, 4, 23, 56))),
           quant + year + unit + season + area ~ iter, value = "data")

p + geom_line(data = fds, aes(year, c('1')), colour = "red",
             size = 1)

fds <- as.data.frame(iter(fla, c(1, 4, 23, 56)))

p + geom_line(data = fds, aes(year, data, colour = iter),
             size = 1) + theme(legend.position = "none")
```

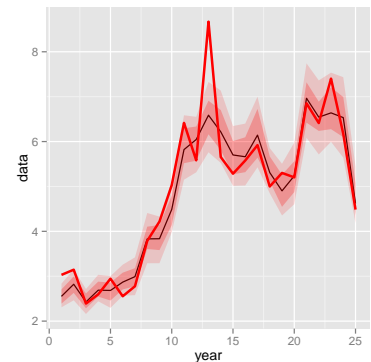


Figure 7:

Example: Bubble plots

```
ggplot(catch.n(ple4), aes(year, as.factor(age), size = data)) +
  geom_point(shape = 21) + scale_size(range = c(1,
  20)) + ylab("age") + theme(legend.position = "none")
```

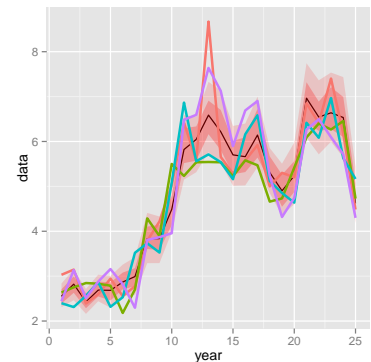


Figure 8:

Example: Residual plots

```
dat <- as.data.frame(catch.n(ple4))
dat$resid <- dat$data - mean(dat$data)

ggplot(dat, aes(year, as.factor(age), size = resid)) +
  geom_point(shape = 21, aes(colour = factor(sign(resid)),
    fill = factor(sign(resid)))) + scale_size(range = c(1,
  20)) + scale_colour_manual(values = c("black",
  "white")) + scale_fill_manual(values = c("lightgray",
  "black")) + theme(legend.position = "none") + ylab("age")
```

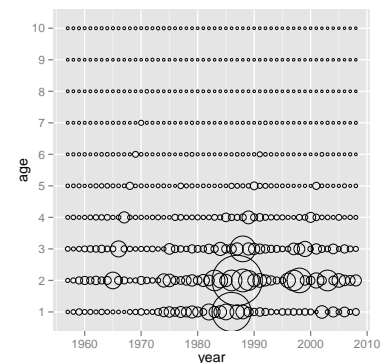
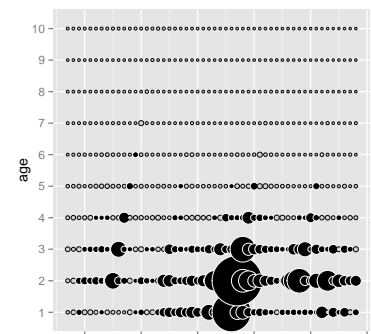


Figure 9:

Example: Cohort

```
ggplot(catch.n(ple4), aes(cohort, data)) + geom_line(aes(group = age,
  colour = factor(age))) + scale_colour_hue()
```



More information

- The latest version of ggplotFL can always be installed using the devtools package, by calling

```
library(devtools)
install_github("ggplotFL", "flr")
```

- Any bug, question or suggestion on ggplotFL can be notified to the developers at the ggplotFL issue page ⁵, or on the *FLR* mailing list.
- For more information on the FLR Project for Quantitative Fisheries Science in R, visit the FLR webpage ⁶.
- To learn more about ggplot2, visit the ggplot2 website ⁷, or read the ggplot2 book.⁸

⁵ <https://github.com/flr/ggplotFL/issues>

⁶ <http://flr-project.org>

⁷ <http://ggplot2.org/>

⁸ Wickham, H. 2009. *ggplot2: Elegant Graphics for Data Analysis*. Springer, Use R! Series. ISBN 978-0-387-98140-6

Package versions

- R: R version 3.0.1 (2013-05-16)
- ggplot2: 0.9.3.1
- ggplotFL: 2.15.20130823
- FLCore: 2.5.20130820