Visualization

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Source: `vignettes/tutorial/visualization.Rmd` (https://github.com/mlr-org/mlr/blob/master/vignettes/tutorial/visualization.Rmd)

Generation and plotting functions

`mlr`'s visualization capabilities rely on *generation functions* which generate data for plots, and *plotting functions* which plot this output using either `ggplot2::ggplot2()` `(ggplot2.tidyverse.org/reference/ggplot2-package.html)` or `ggvis::ggvis()` (the latter being currently experimental).

This separation allows users to easily make custom visualizations by taking advantage of the generation functions. The only data transformation that is handled inside plotting functions is reshaping. The reshaped data is also accessible by calling the plotting functions and then extracting the data from the `ggplot2::ggplot()` `(ggplot2.tidyverse.org/reference/ggplot.html)` object.

The functions are named accordingly.

- Names of generation functions start with `generate` and are followed by a title-case description of their `FunctionPurpose`, followed by `Data`, i.e., `generateFunctionPurposeData`. These functions output objects of class `FunctionPurposeData`.
- Plotting functions are prefixed by `plot` followed by their purpose, i.e., `plotFunctionPurpose`.
- `ggvis::ggvis()` plotting functions have an additional suffix `GGVIS`, i.e., `plotFunctionPurposeGGVIS`.

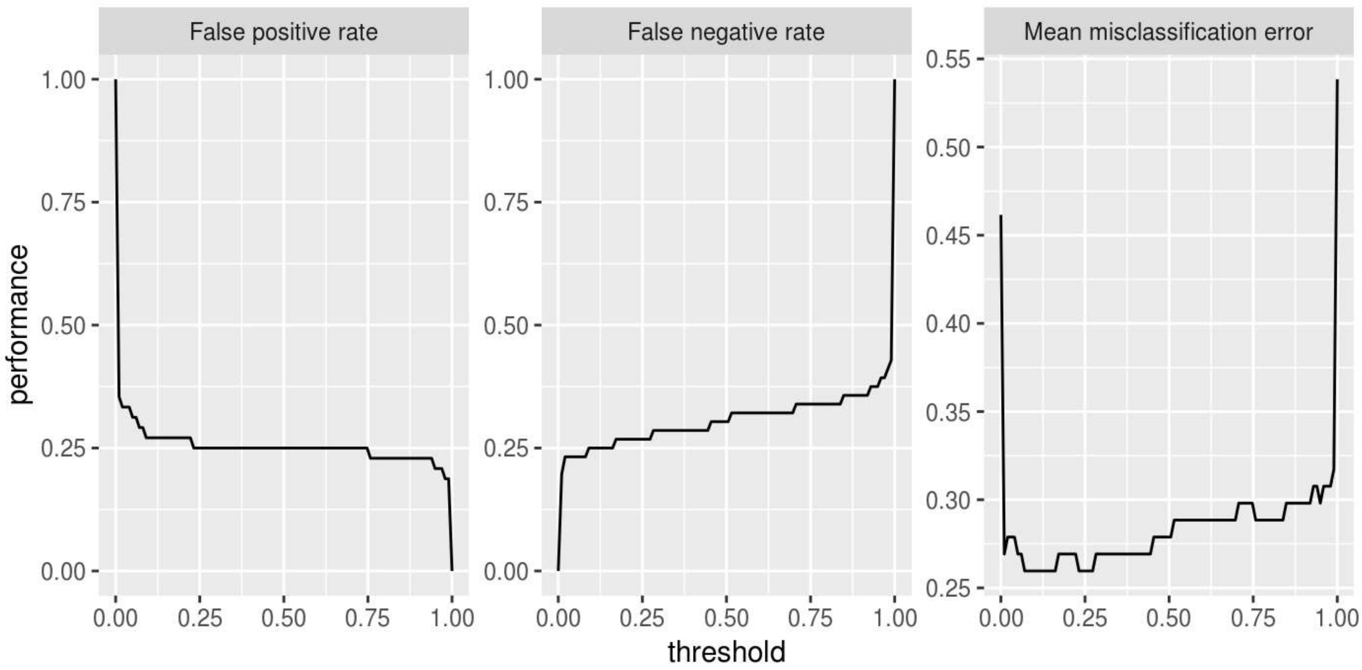
Some examples

In the example below we create a plot of classifier performance as function of the decision threshold for the binary classification problem `sonar.task`. The generation function `generateThreshVsPerfData()` `(../../reference/generateThreshVsPerfData.html)` creates an object of class `ThreshVsPerfData` which contains the data for the plot in slot `$data`.

```
lrn = makeLearner (../../reference/makeLearner.html)("classif.lda", predict.type
n = getTaskSize (../../reference/getTaskSize.html)(sonar.task)
mod = train (../../reference/train.html)(lrn, task = sonar.task, subset = seq(1,
pred = predict(mod, task = sonar.task, subset = seq(2, n, by = 2))
d = generateThreshVsPerfData (../../reference/generateThreshVsPerfData.html)(pre

class(d)
## [1] "ThreshVsPerfData"

head(d$data)
##         fpr       fnr      mmce  threshold
## 1 1.0000000 0.0000000 0.4615385 0.00000000
## 2 0.3541667 0.1964286 0.2692308 0.01010101
## 3 0.3333333 0.2321429 0.2788462 0.02020202
## 4 0.3333333 0.2321429 0.2788462 0.03030303
## 5 0.3333333 0.2321429 0.2788462 0.04040404
## 6 0.3125000 0.2321429 0.2692308 0.05050505
```

For plotting we can use the built-in `mlr` function `plotThreshVsPerf()` `(../../reference/plotThreshVsPerf.html)`.

```
plotThreshVsPerf (../../reference/plotThreshVsPerf.html)(d)
```



Note that by default the `Measure` `name`s are used to annotate the panels.

```
fpr$name
## [1] "False positive rate"

fpr$id
## [1] "fpr"
```

This does not only apply to `plotThreshVsPerf()` `(../../reference/plotThreshVsPerf.html)`, but to other plot functions that show performance measures as well, for example `plotLearningCurve()` `(../../reference/plotLearningCurve.html)`. You can use the `id`s instead of the names by setting `pretty.names = FALSE`.

Customizing plots

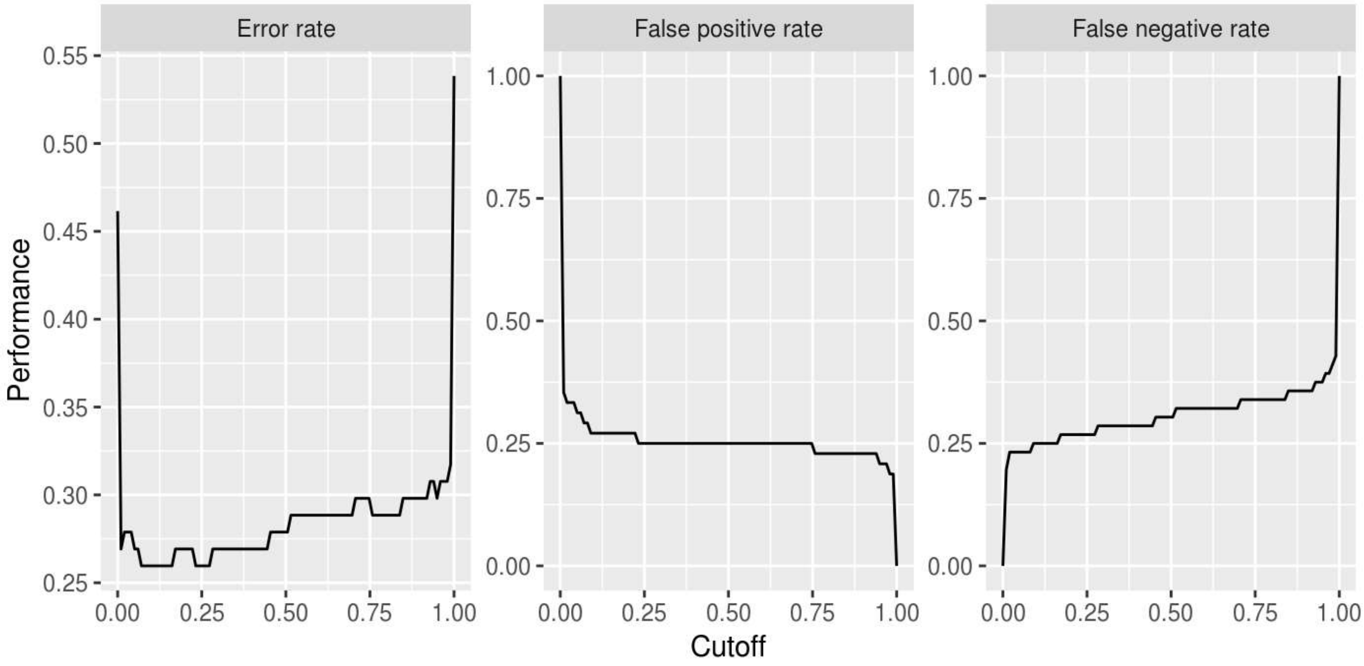
As mentioned above it is easily possible to customize the built-in plots or making your own visualizations from scratch based on the generated data.

What will probably come up most often is changing labels and annotations. Generally, this can be done by manipulating the `ggplot2::ggplot()` `(ggplot2.tidyverse.org/reference/ggplot.html)` object, in this example the object returned by `plotThreshVsPerf()` `(../../reference/plotThreshVsPerf.html)`, using the usual `ggplot2::ggplot2()` `(ggplot2.tidyverse.org/reference/ggplot2-package.html)` functions like `ggplot2::labs()` `(ggplot2.tidyverse.org/reference/labs.html)` or `ggplot2::labeller()` `(ggplot2.tidyverse.org/reference/labeller.html)`. Moreover, you can change the underlying data, either `d$data` (resulting from `generateThreshVsPerfData()` `(../../reference/generateThreshVsPerfData.html)` or the possibly reshaped data contained in the `ggplot2::ggplot()` `(ggplot2.tidyverse.org/reference/ggplot.html)` object (resulting from `plotThreshVsPerf()` `(../../reference/plotThreshVsPerf.html)`, most often by renaming columns or factor levels.

Below are two examples of how to alter the axis and panel labels of the above plot.

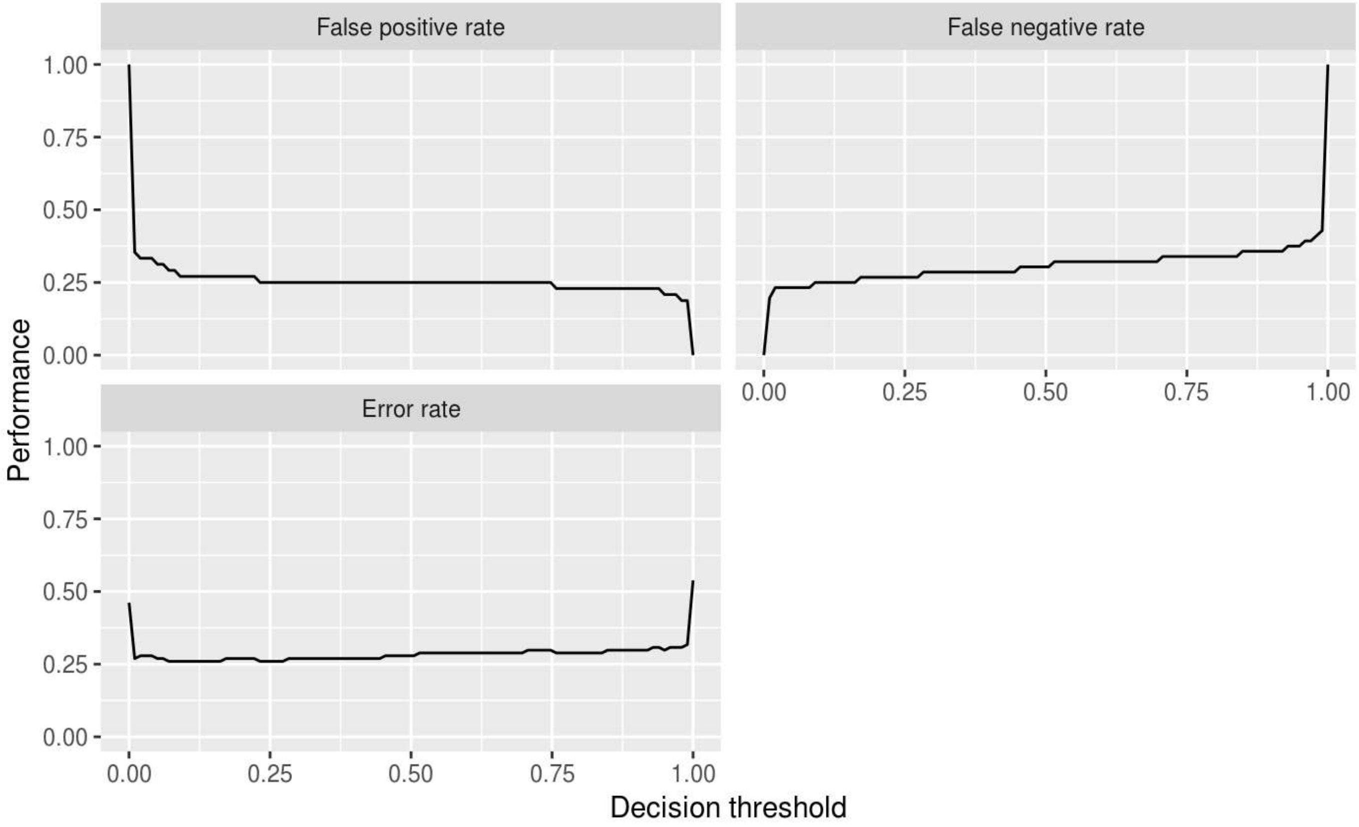
Imagine you want to change the order of the panels and also are not satisfied with the panel names, for example you find that “Mean misclassification error” is too long and you prefer “Error rate” instead. Moreover, you want the error rate to be displayed first.

```
plt = plotThreshVsPerf (../../reference/plotThreshVsPerf.html)(d, pretty.names =

# Reshaped version of the underlying data d
head(plt$data)
##    threshold measure performance
## 1 0.00000000     fpr   1.0000000
## 2 0.01010101     fpr   0.3541667
## 3 0.02020202     fpr   0.3333333
## 4 0.03030303     fpr   0.3333333
## 5 0.04040404     fpr   0.3333333
## 6 0.05050505     fpr   0.3125000

levels(plt$data$measure)
## [1] "fpr"  "fnr"  "mmce"

# Rename and reorder factor levels
plt$data$measure = factor(plt$data$measure, levels = c("mmce", "fpr", "fnr"),
  labels = c("Error rate", "False positive rate", "False negative rate"))
plt = plt + xlab("Cutoff") + ylab("Performance")
plt
```



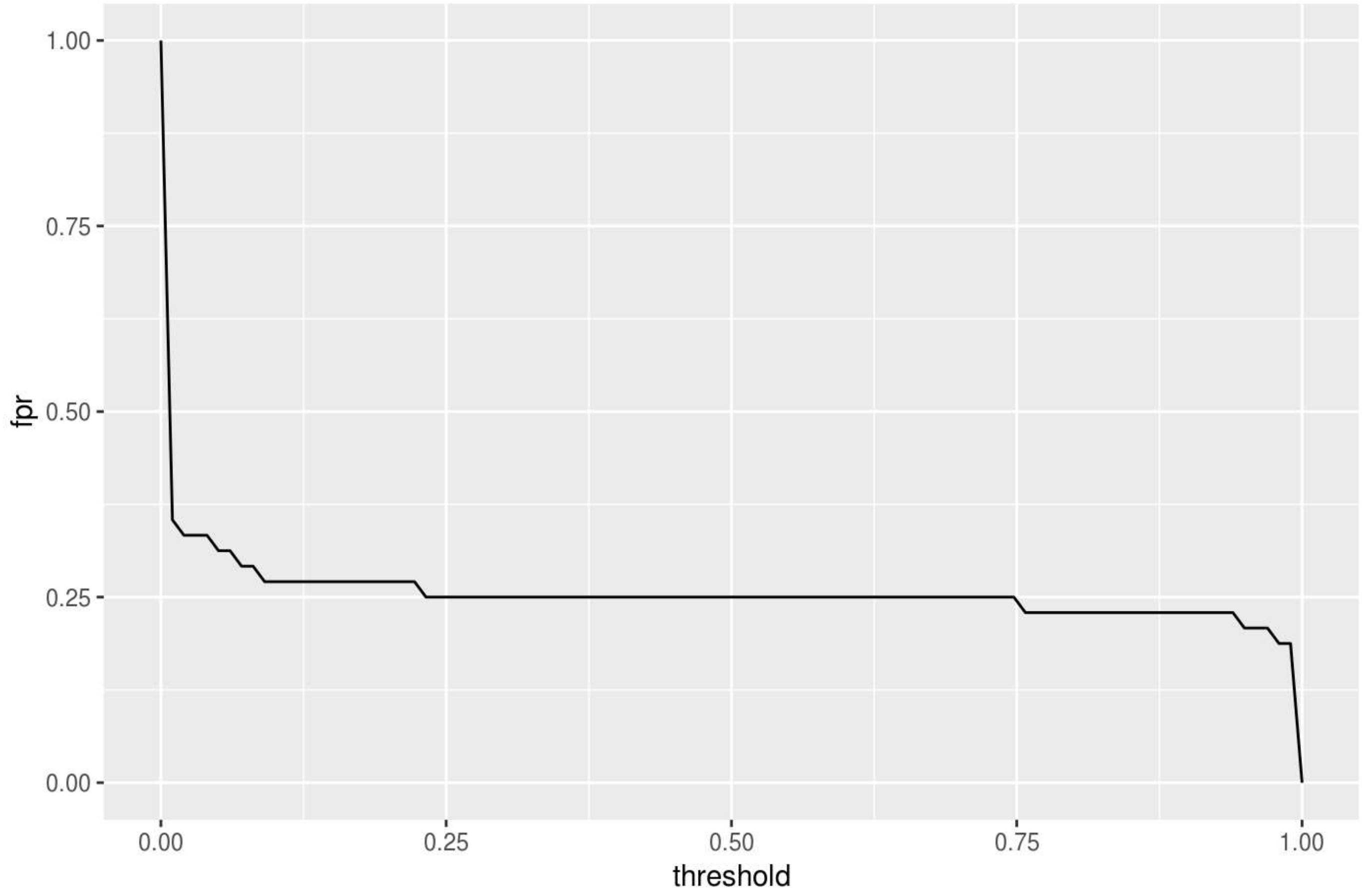
Using the `ggplot2::labeller()` (`ggplot2.tidyverse.org/reference/labeller.html`) function requires calling `ggplot2::facet_wrap()` (`ggplot2.tidyverse.org/reference/facet_wrap.html`) (or `ggplot2::facet_grid()` (`ggplot2.tidyverse.org/reference/facet_grid.html`)), which can be useful if you want to change how the panels are positioned (number of rows and columns) or influence the axis limits.

```
plt = plotThreshVsPerf (../../reference/plotThreshVsPerf.html)(d, pretty.names =

measure_names = c(
  fpr = "False positive rate",
  fnr = "False negative rate",
  mmce = "Error rate"
)
# Manipulate the measure names via the labeller function and
# arrange the panels in two columns and choose common axis limits for all panels
plt = plt + facet_wrap( ~ measure, labeller = labeller(measure = measure_names),
plt = plt + xlab("Decision threshold") + ylab("Performance")
plt
```



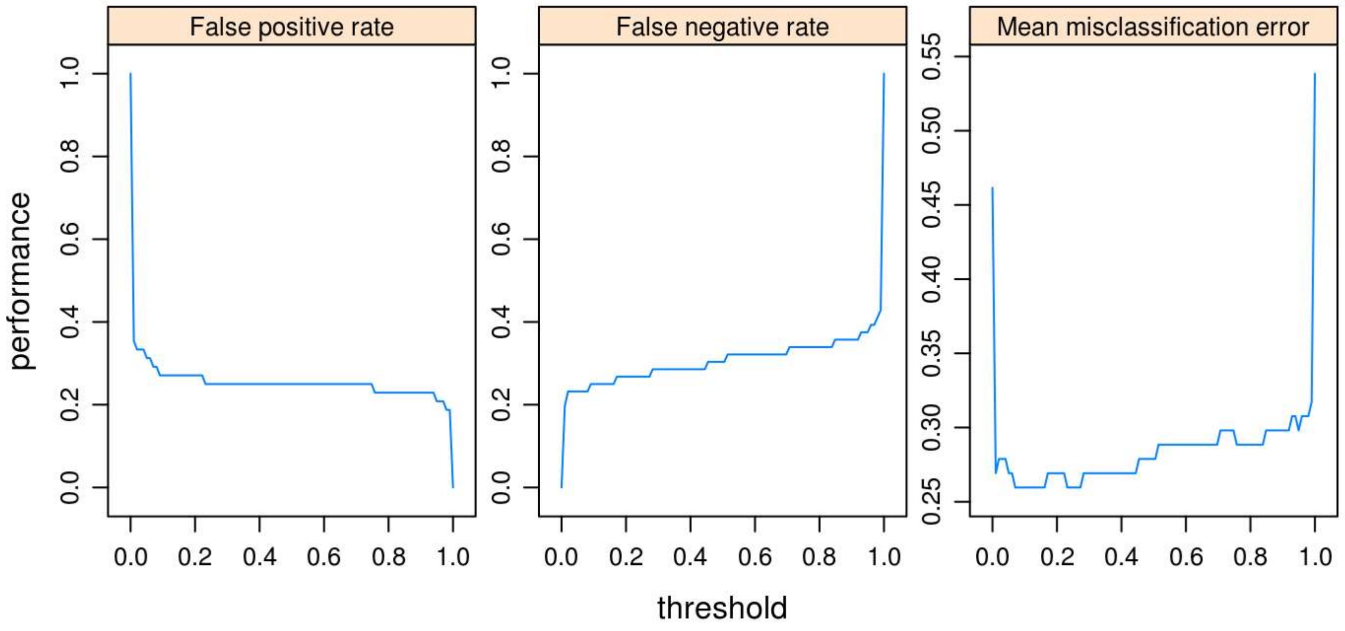
Instead of using the built-in function `plotThreshVsPerf()` `(../../reference/plotThreshVsPerf.html)` we could also manually create the plot based on the output of `generateThreshVsPerfData()` `(../../reference/generateThreshVsPerfData.html)`: In this case to plot only one measure.

```
ggplot(d$data, aes(threshold, fpr)) + geom_line()
```



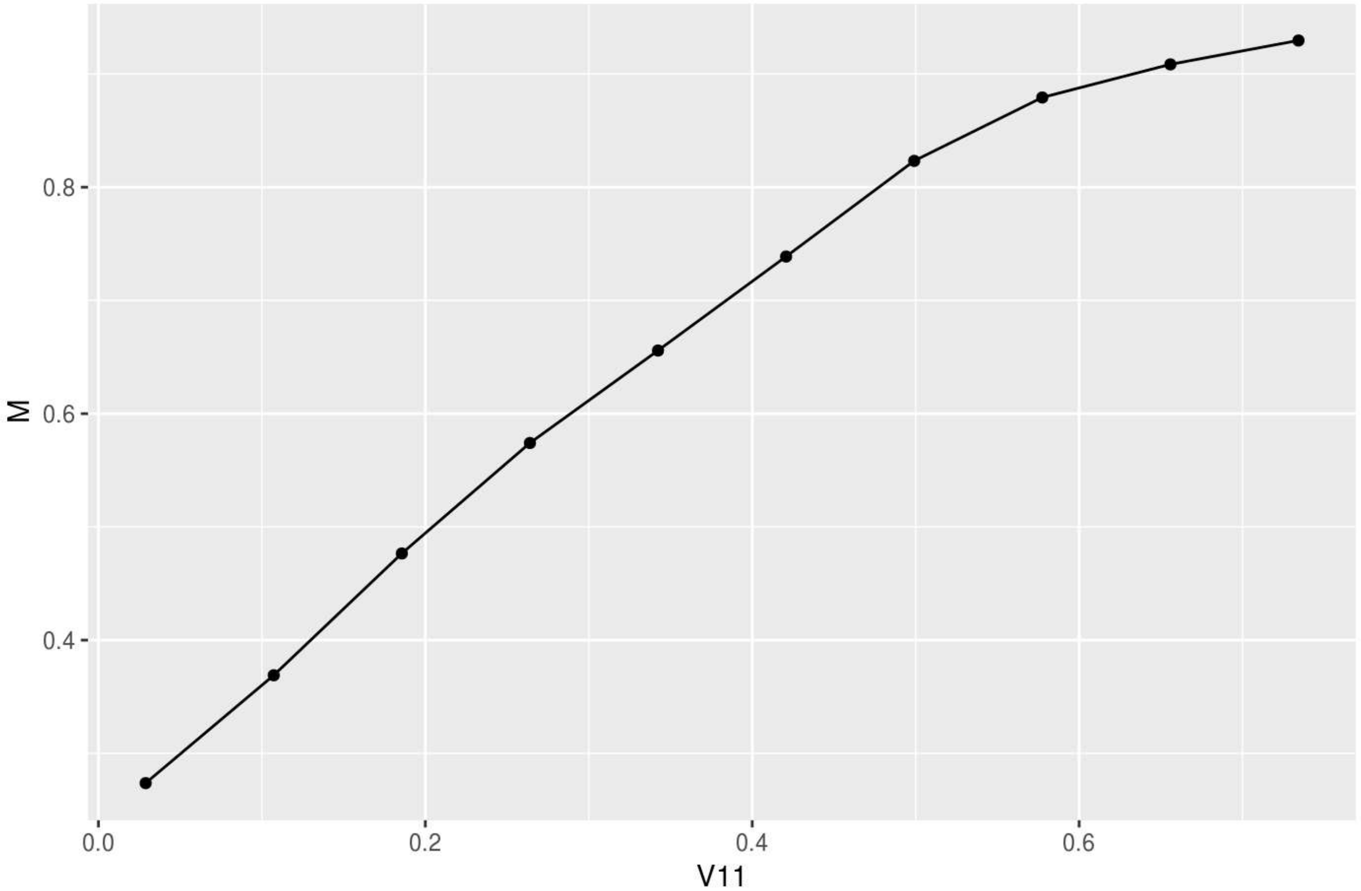
The decoupling of generation and plotting functions is especially practical if you prefer traditional `graphics::graphics()` `(http://www.rdocumentation.org/packages/graphics/topics/graphics-package)` or `lattice::lattice()` `(http://www.rdocumentation.org/packages/lattice/topics/Lattice)`. Here is a `lattice::lattice()` `(http://www.rdocumentation.org/packages/lattice/topics/Lattice)` plot which gives a result similar to that of `plotThreshVsPerf()` `(../../reference/plotThreshVsPerf.html)`.

```
lattice::xyplot (http://www.rdocumentation.org/packages/lattice/topics/xyplot)(fp
  outer = TRUE, scales = list(relation = "free"),
  strip = strip.custom(factor.levels = sapply(d$measures, function(x) x$name),
    par.strip.text = list(cex = 0.8)))
```

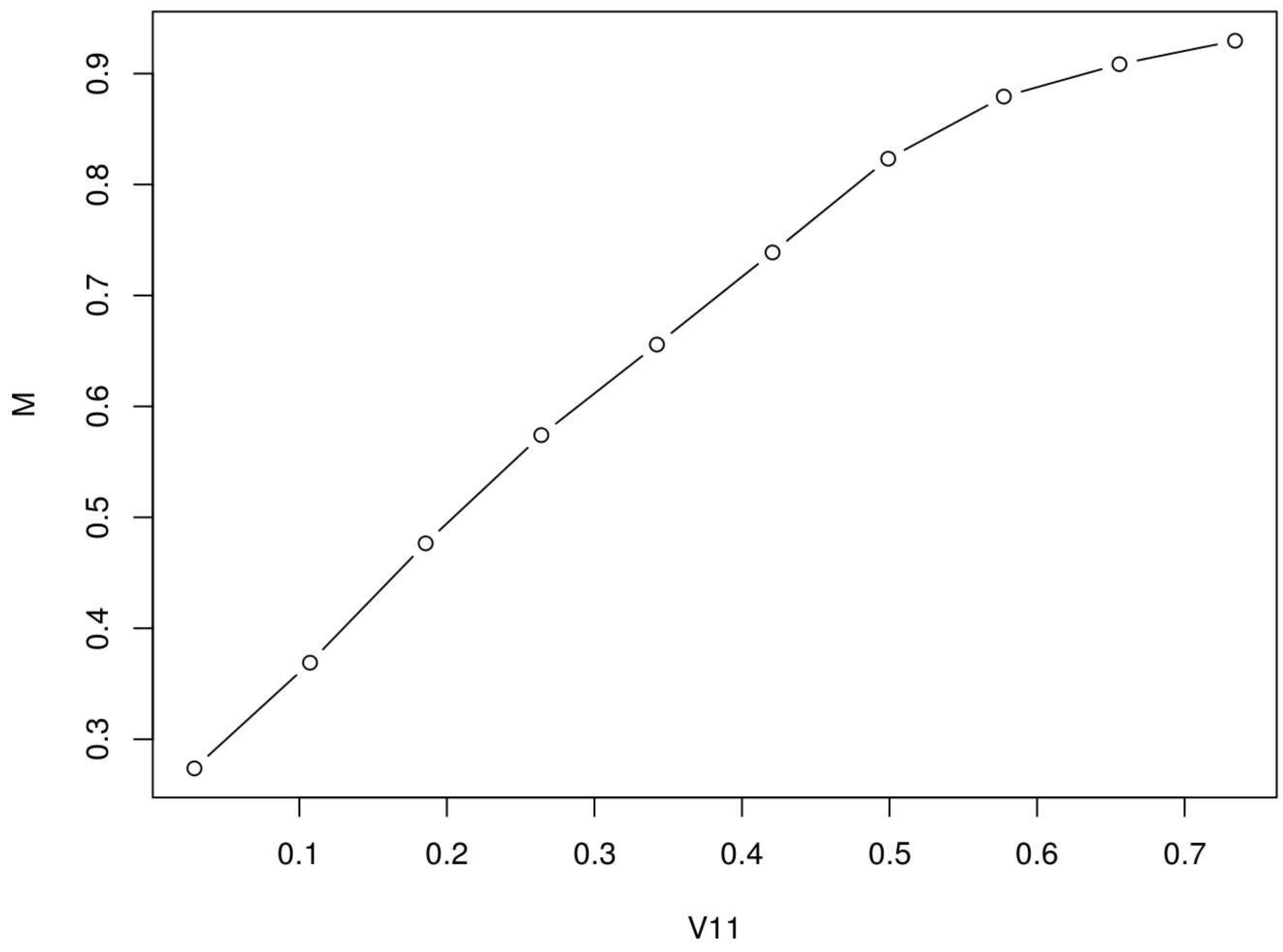


Let's conclude with a brief look on a second example. Here we use `plotPartialDependence()` `(../../reference/plotPartialDependence.html)` but extract the data from the `ggplot2::ggplot()` `(ggplot2.tidyverse.org/reference/ggplot.html)` object `plt` and use it to create a traditional `graphics::plot()` `(http://www.rdocumentation.org/packages/graphics/topics/plot)`, additional to the `ggplot2::ggplot()` `(ggplot2.tidyverse.org/reference/ggplot.html)` plot.

```
sonar = getTaskData (../../reference/getTaskData.html)(sonar.task)
pd = generatePartialDependenceData (../../reference/generatePartialDependenceData
## Loading required package: mmpf
plt = plotPartialDependence (../../reference/plotPartialDependence.html)(pd)
head(plt$data)
##           M Feature     Value
## 1 0.2737158     V11 0.0289000
## 2 0.3689970     V11 0.1072667
## 3 0.4765742     V11 0.1856333
## 4 0.5741233     V11 0.2640000
## 5 0.6557857     V11 0.3423667
## 6 0.7387962     V11 0.4207333

plt
```



```
plot(M ~ Value, data = plt$data, type = "b", xlab = plt$data$Feature[1])
```



Available generation and plotting functions

Below the currently available generation and plotting functions are listed and tutorial pages that provide in depth descriptions of the listed functions are referenced.

Note that some plots, e.g., `plotTuneMultiCritResult()` `(../../reference/plotTuneMultiCritResult.html)` are not mentioned here since they lack a generation function. Both `plotThreshVsPerf()` `(../../reference/plotThreshVsPerf.html)` and `plotROCCurves()` `(../../reference/plotROCCurves.html)` operate on the result of `generateThreshVsPerfData()` `(../../reference/generateThreshVsPerfData.html)`. Functions `plotPartialDependence()` `(../../reference/plotPartialDependence.html)` and `plotPartialDependenceGGVIS()` can be applied to the results of both `generatePartialDependenceData()` `(../../reference/generatePartialDependenceData.html)` and `generateFunctionalANOVAData()`.

The `ggvis::ggvis()` functions are experimental and are subject to change, though they should work. Most generate interactive `shiny::shiny()` `(http://www.rdocumentation.org/packages/shiny/topics/shiny-package)` applications, that automatically start and run locally.

generation function	ggplot2 plotting function	ggv
generateThreshVsPerfData() (../../reference/generateThreshVsPerfData.html)	plotThresVsPerf()	pl
	plotROCCurves() (../../reference/plotROCCurves.html)	–
generateCritDifferencesData() (../../reference/generateCritDifferencesData.html)	plotCritDifferences() (../../reference/plotCritDifferences.html)	–
generateHyperParsEffectData() (../../reference/generateHyperParsEffectData.html)	plotHyperParsEffect() (../../reference/plotHyperParsEffect.html)	
generateFilterValuesData() (../../reference/generateFilterValuesData.html)	plotFilterValues() (../../reference/plotFilterValues.html)	pl
generateLearningCurveData() (../../reference/generateLearningCurveData.html)	plotLearningCurve() (../../reference/plotLearningCurve.html)	pl
generatePartialDependenceData() (../../reference/generatePartialDependenceData.html)	plotPartialDependence() (../../reference/plotPartialDependence.html)	pl
generateFunctionalANOVAData()		
generateCalibrationData() (../../reference/generateCalibrationData.html)	plotCalibration() (../../reference/plotCalibration.html)	–