Beyond R's basic graphics system: lattice and ggplot2

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Outline

Some preliminary work

The lattice package

The ggplot2 package

Acknowledgment, license and downloads

- This work was supported by a fellowship within the Postdoc-Programme of the German Academic Exchange Service (DAAD)(Grant D/10/43517).

- My presentation was created using Emacs' *org-mode* and *Babel: active code in Org-mode*.

- Slides, dataset and R code can be downloaded from my github page: https://github.com/berndweiss/lattice$_g$*gplot2*$_i$*ntro* (see "Downloads" button on the right-hand side).

Topic

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Loading packages and creating the data

```
1  library(lattice)
2  library(ggplot2)
3
4  ## Regression model: y = 1.2 + 0.3*x1 + 0.4*x2 + 0.9*x1*x2 + e
5  set.seed(1)
6  x1 <- round(runif(1000, min = 1, max = 10), digits = 0)
7  x2 <- round(runif(1000, min = 1, max = 4), digits = 0)
8
9  y = 1.2 + 0.3*x1 + 0.4*x2 + 0.9*x1*x2 + rnorm(1000, 0, 1)
10 df <- data.frame(y = y, x1 = x1, x2 = x2,
11                  x2f = factor(x2, labels = c("a", "b", "c", "d")))
12
13 lm(y ~ x1 + x2 + x1*x2, data = df)
```

```
Call:
lm(formula = y ~ x1 + x2 + x1 * x2, data = df)

Coefficients:
(Intercept)           x1           x2        x1:x2
     1.3046       0.2554       0.3738       0.9140
```

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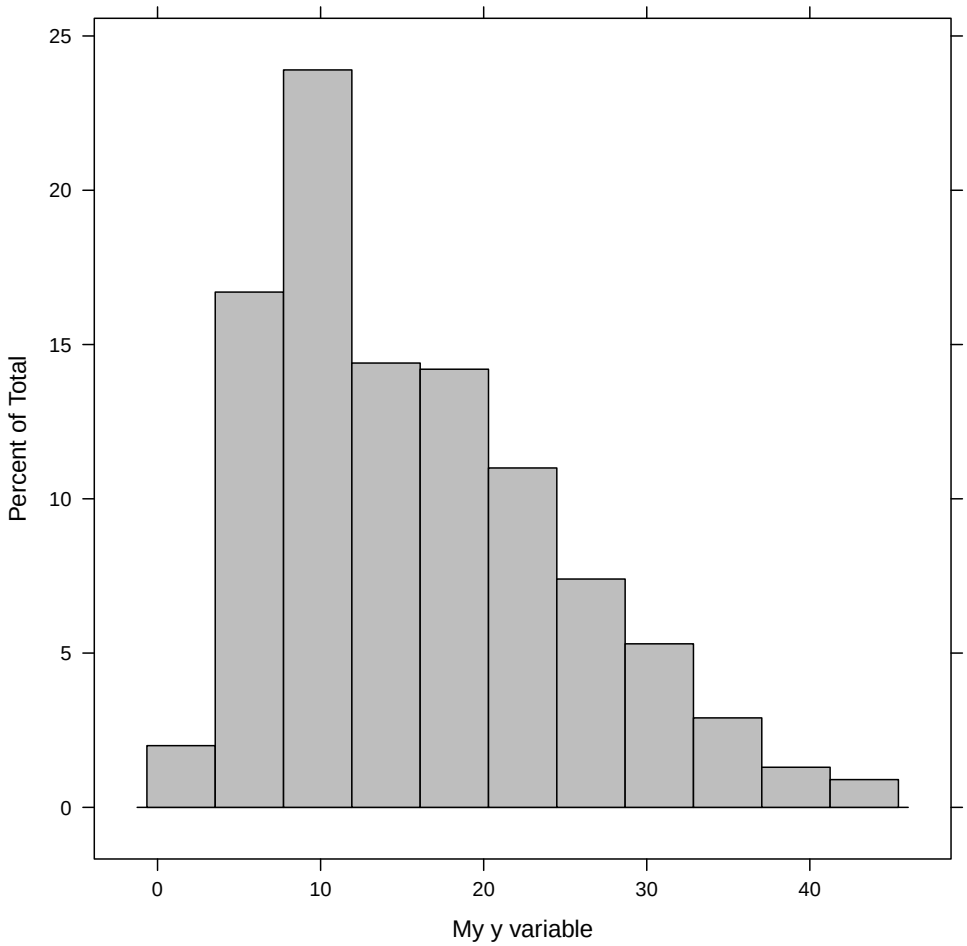
A basic overview about the lattice package

- Needs to be loaded via `library(lattice)`
- Most lattice function use the formula interface (e.g., `y ~ x`).
- One strength on `lattice` is the ability to create multipanel plots (trellis graphs). Use the "conditional on" symbol `|` to create a multipanel plot (e.g., `y ~ x | g`).
- Sometimes, original data need to be prepared (e.g., for barcharts)
- Web resources:
  - Website for "Lattice: Multivariate Data Visualization with R - Figures and Code" by Deepayan Sarkar
  - Using Lattice Graphics in R
  - An Introduction to R by Deepayan Sarkar

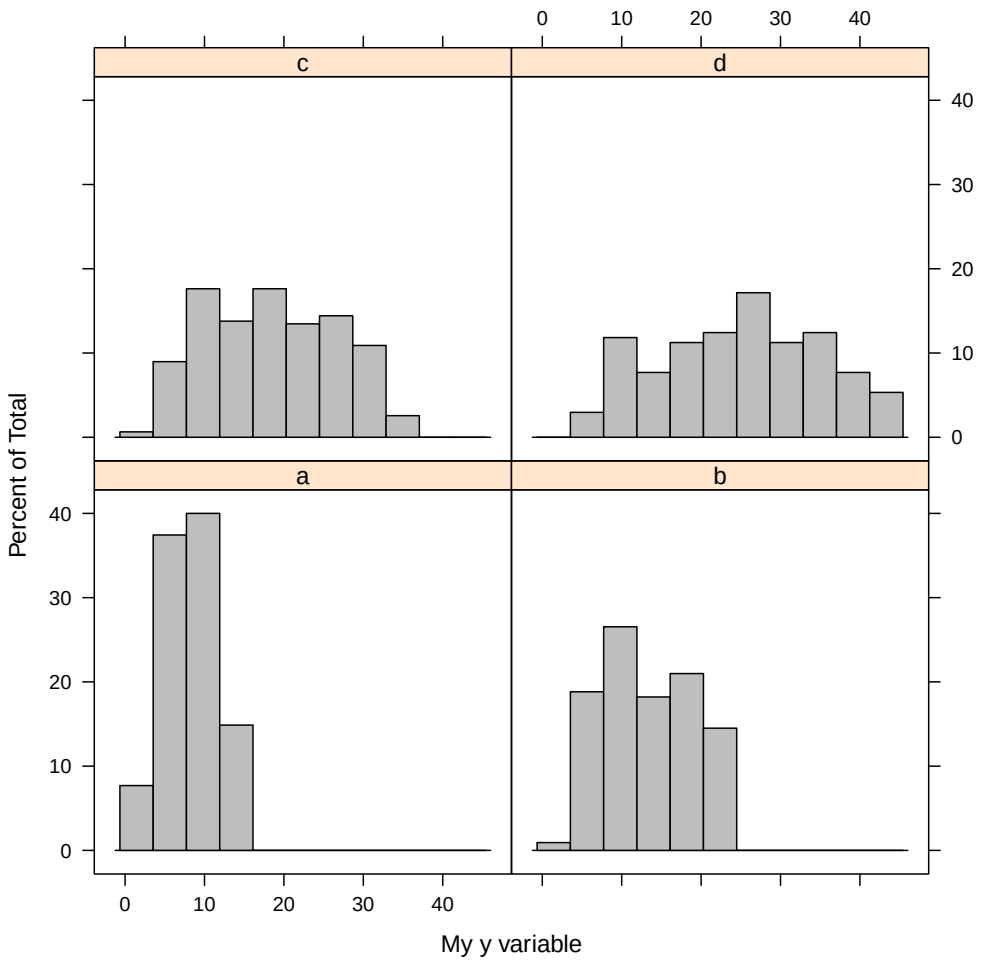
Histogram

```
1 histogram(~ y, data = df, xlab = "My y variable",
2           col = "gray")
```



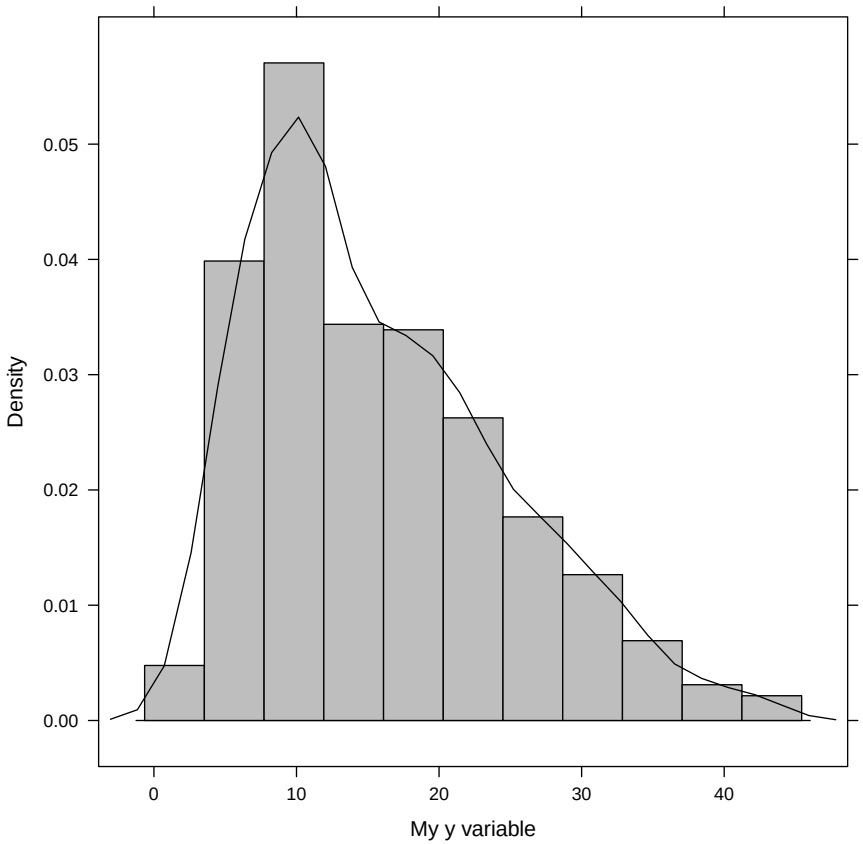
Histogram conditional on x2f

```
1 histogram(~ y | x2f, data = df,
2           xlab = "My y variable", col = "gray")
```



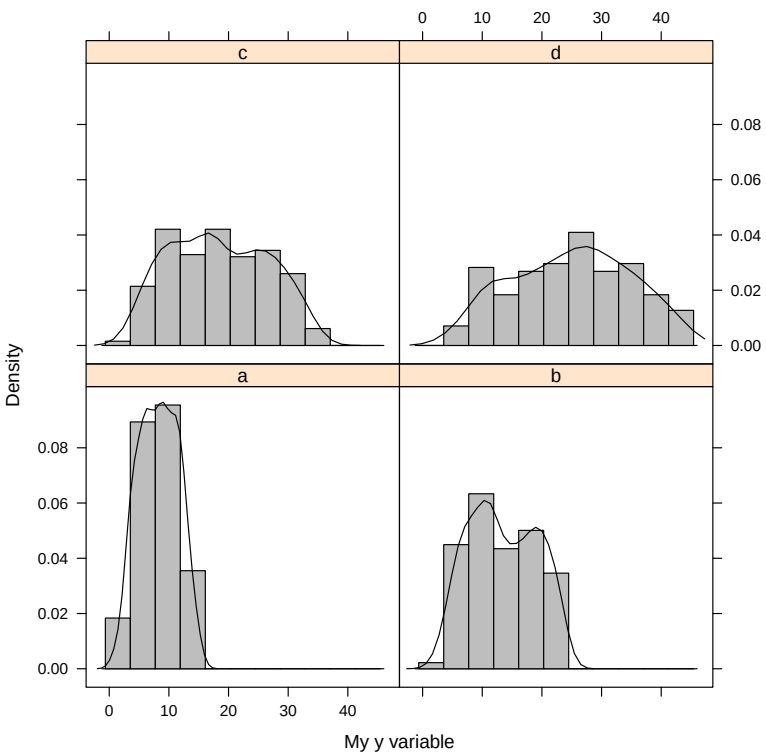
Histogram with superimposed density plot

```
histogram(~ y, data = df, xlab = "My y variable",
          col = "gray", type = "density",
          panel = function(...){
              panel.histogram(...);
              panel.densityplot(..., col.line = "black")
          }
)
```



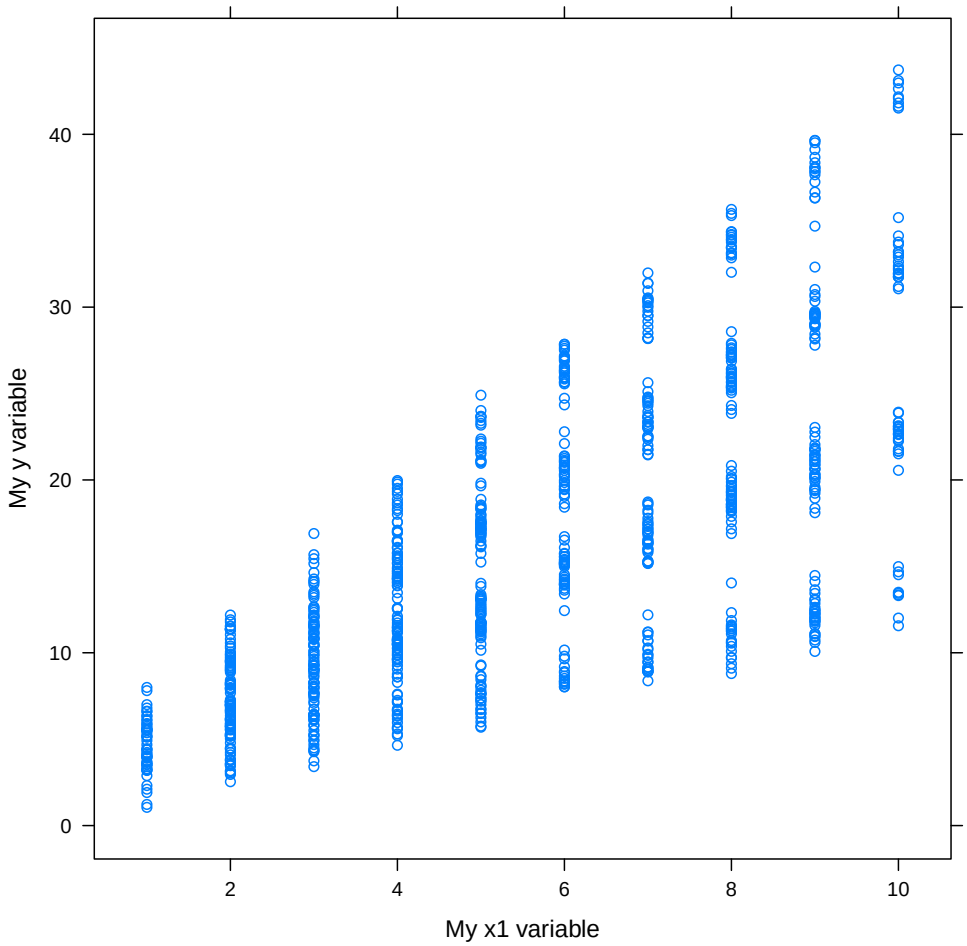
Histogram with superimposed density plot and conditional on x2f

```
histogram(~ y | x2f, data = df, xlab = "My y variable",
          col = "gray", type = "density",
          panel = function(...){
              panel.histogram(...);
              panel.densityplot(...,
                                col.line = "black")
          }
)
```



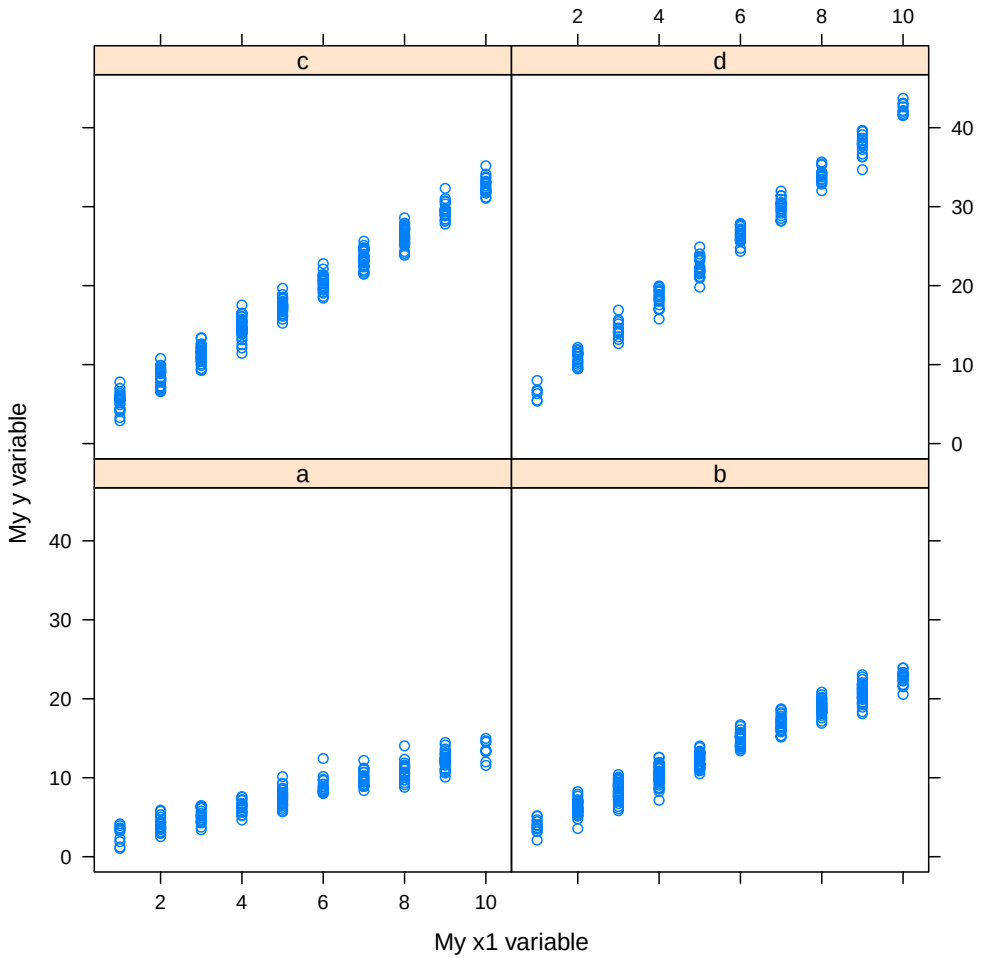
Scatter plot

```
1  xyplot(y ~ x1, data = df,
2         xlab = "My x1 variable", ylab = "My y variable")
```



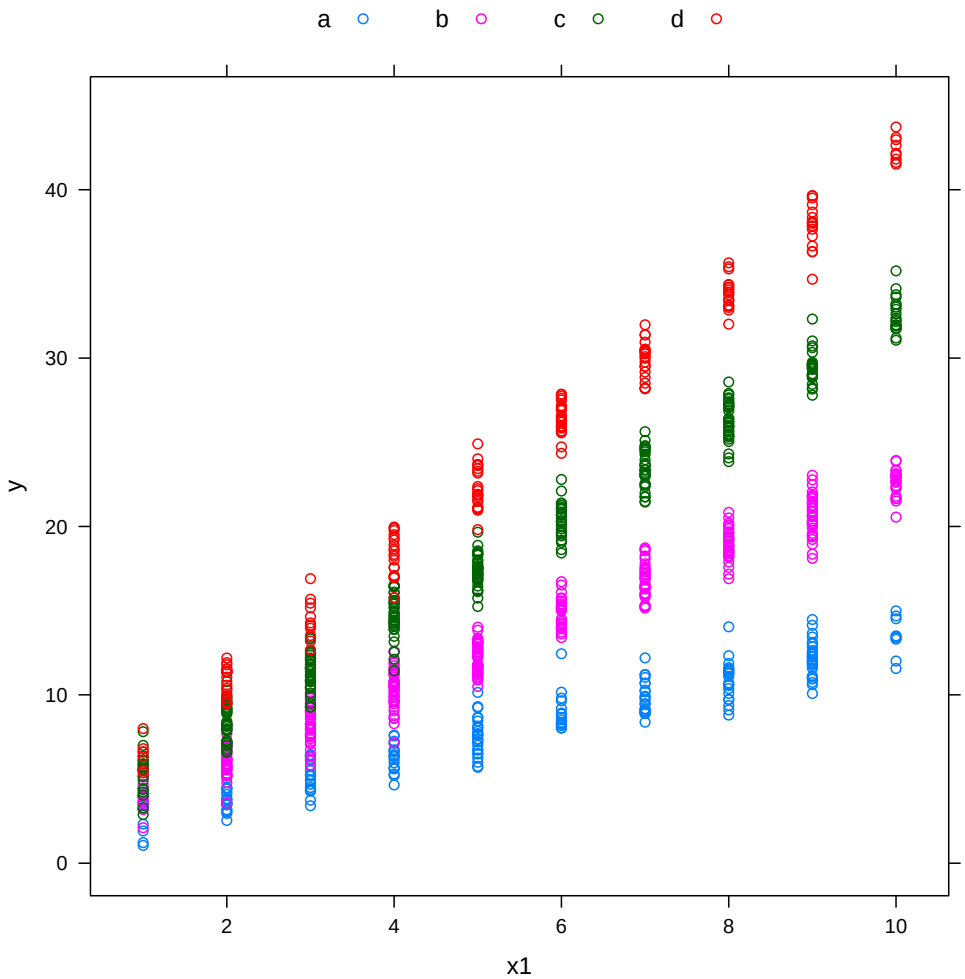
Multipanel scatter plot by x2f

```
1  xyplot(y ~ x1 | x2f, data = df,
2         xlab = "My x1 variable", ylab = "My y variable")
```



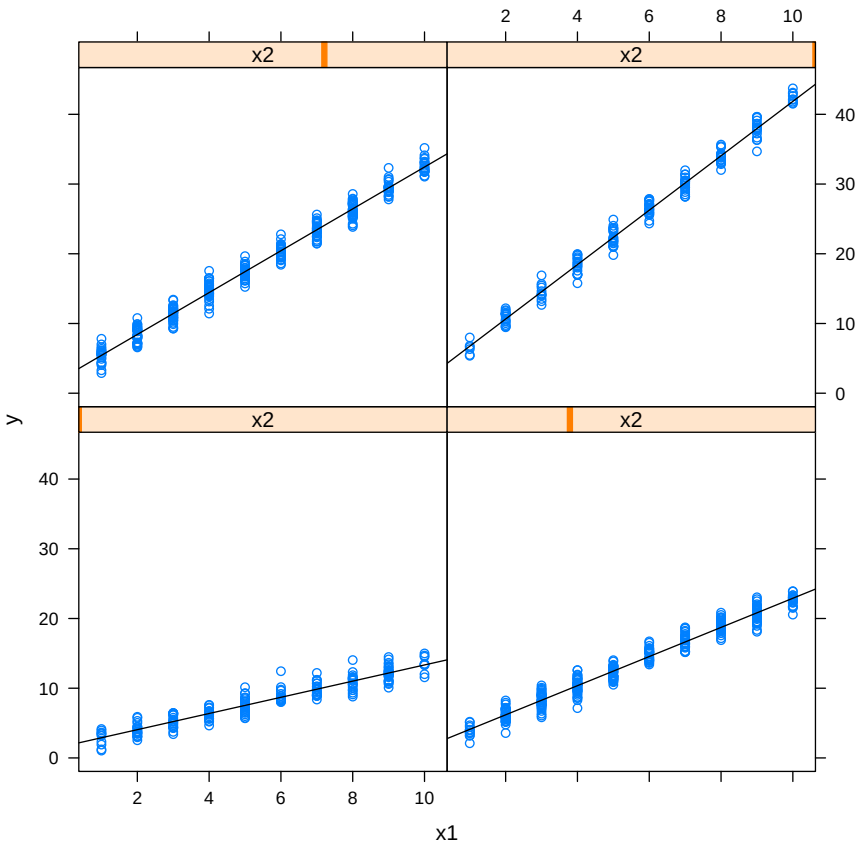
Scatter plot by grouping variable x2

```
1  xyplot(y ~ x1, groups = x2f, data = df,
2         key = simpleKey(text = levels(df$x2f), columns = 4))
```



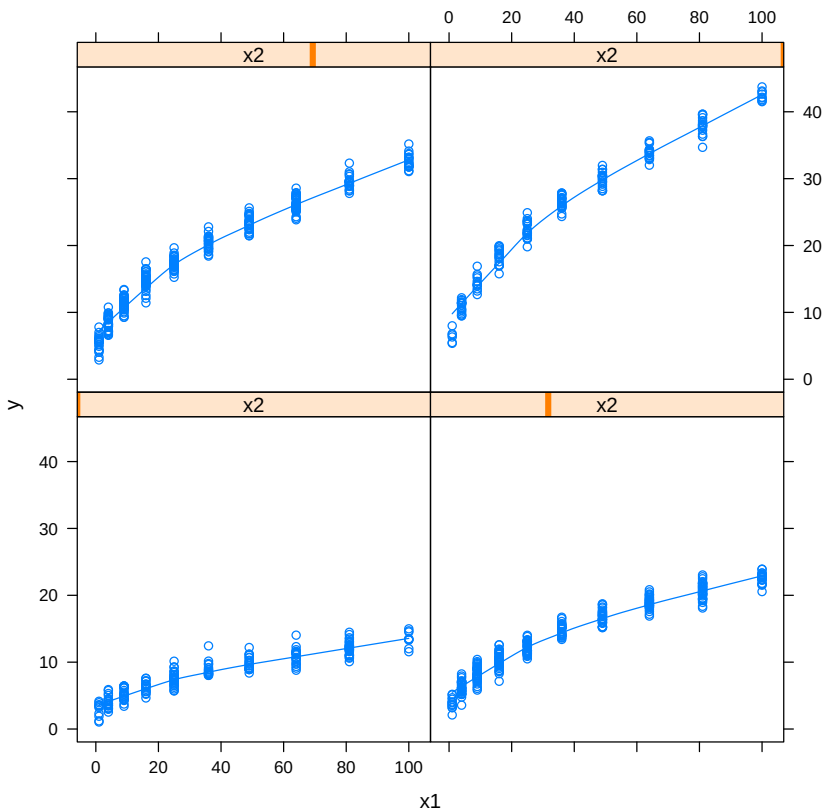
Scatter plot and linear regression line by grouping variable x2

```
1  xyplot(y ~ x1 | x2, data = df,
2         panel = function(y, x1, ...){
3             panel.xyplot(x1, y);
4             panel.lmline(x1, y)
5         })
```



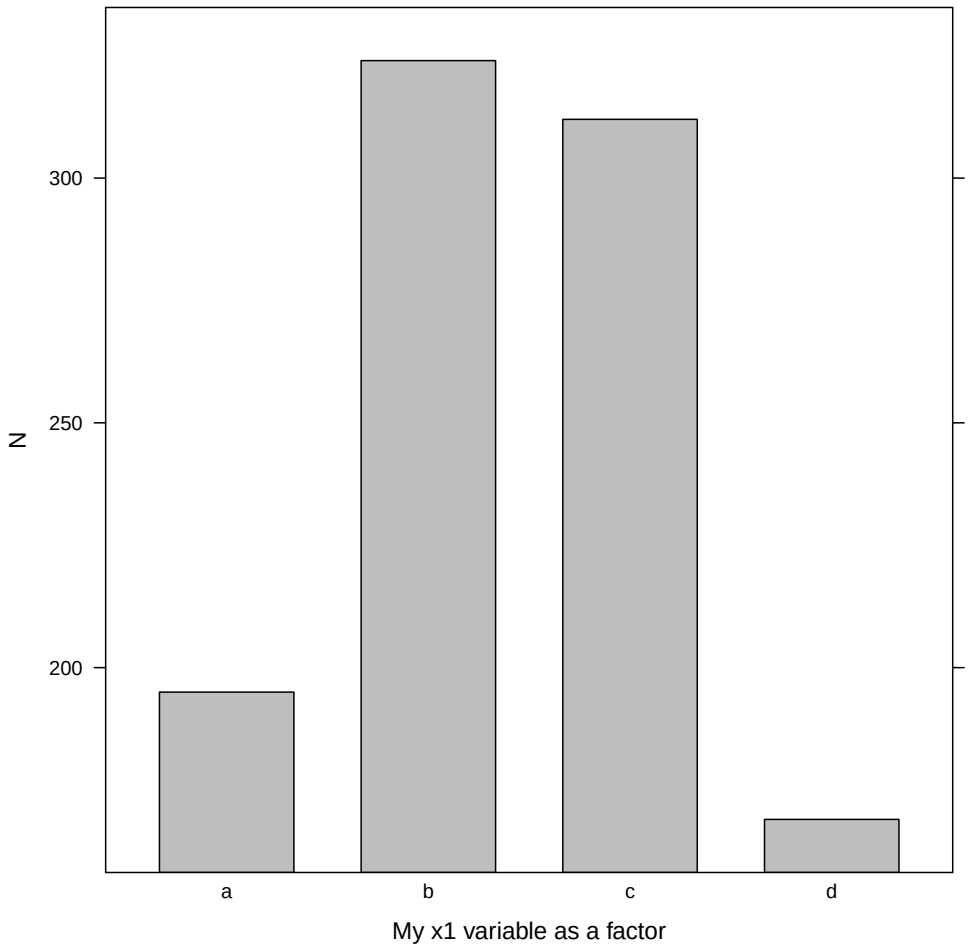
Scatter plot and LOESS line by grouping variable x2

```
1 xyplot(y ~ x1 | x2,
2        data = data.frame(df[, -2], x1 = df$x1^2),
3        panel = function(y, x1, ...){
4            panel.xyplot(x1, y);
5            panel.loess(x1, y)
6        })
```



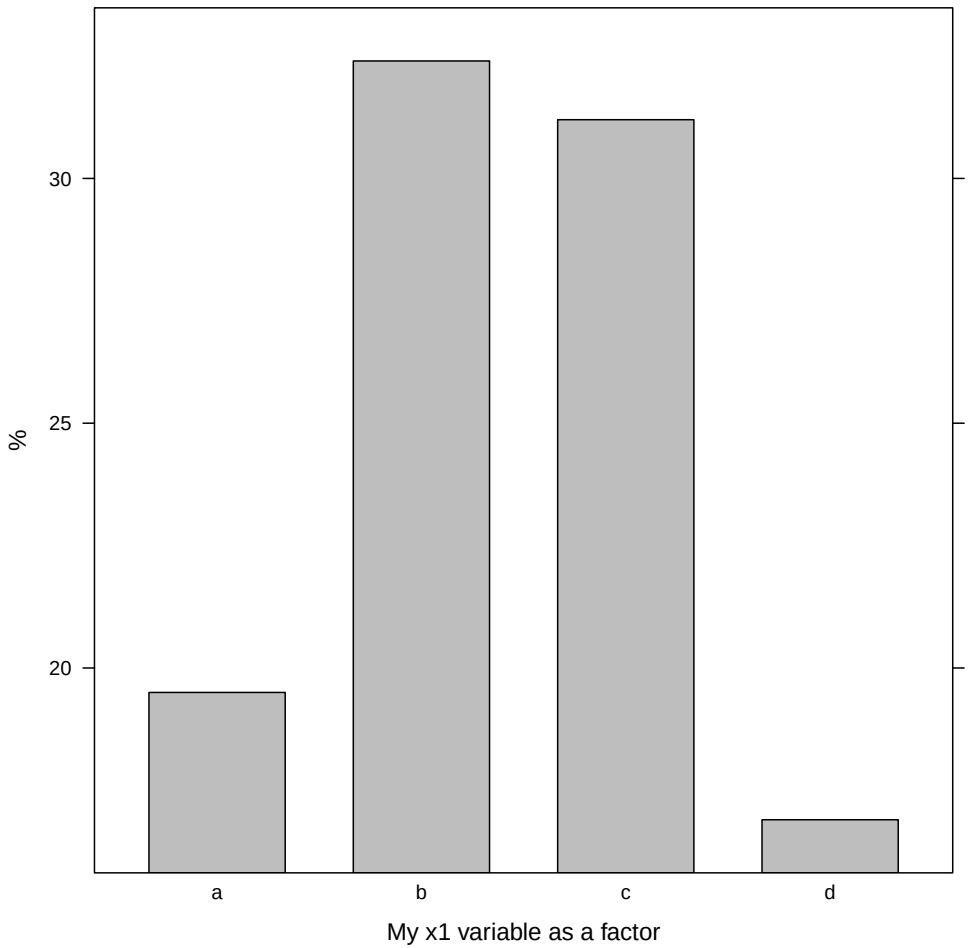
Bar chart (absolute frequencies)

```
1 barchart(Freq ~ Var1, data = data.frame(table(df$x2f)),
2          xlab = "My x1 variable as a factor", ylab = "N",
3          col = "gray")
```



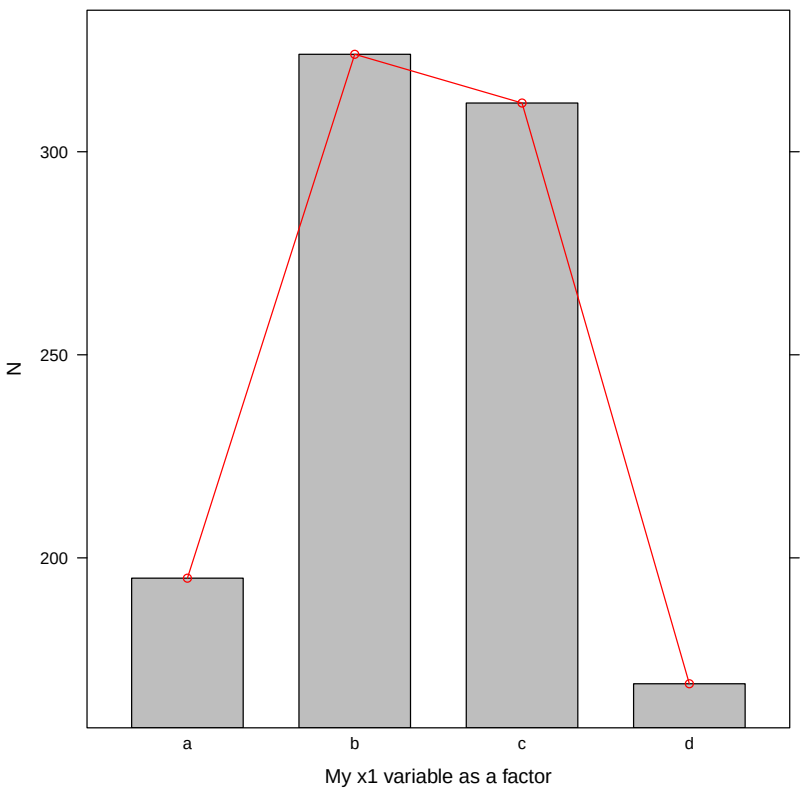
Bar chart (percentages)

```
barchart(Freq ~ Var1,
         data = data.frame(100 * prop.table(table(df$x2f))),
         xlab = "My x1 variable as a factor", ylab = "%",
         col = "gray")
```



Bar chart with superimposed line plot

```
barchart(Freq ~ Var1, data = data.frame(table(df$x2f)),
         xlab = "My x1 variable as a factor", ylab = "N",
         col = "gray",
         panel = function(...){
             panel.barchart(...);
             panel.xyplot(..., type = "b", col.symbol = "red",
                          col.line = "red");
         })
```



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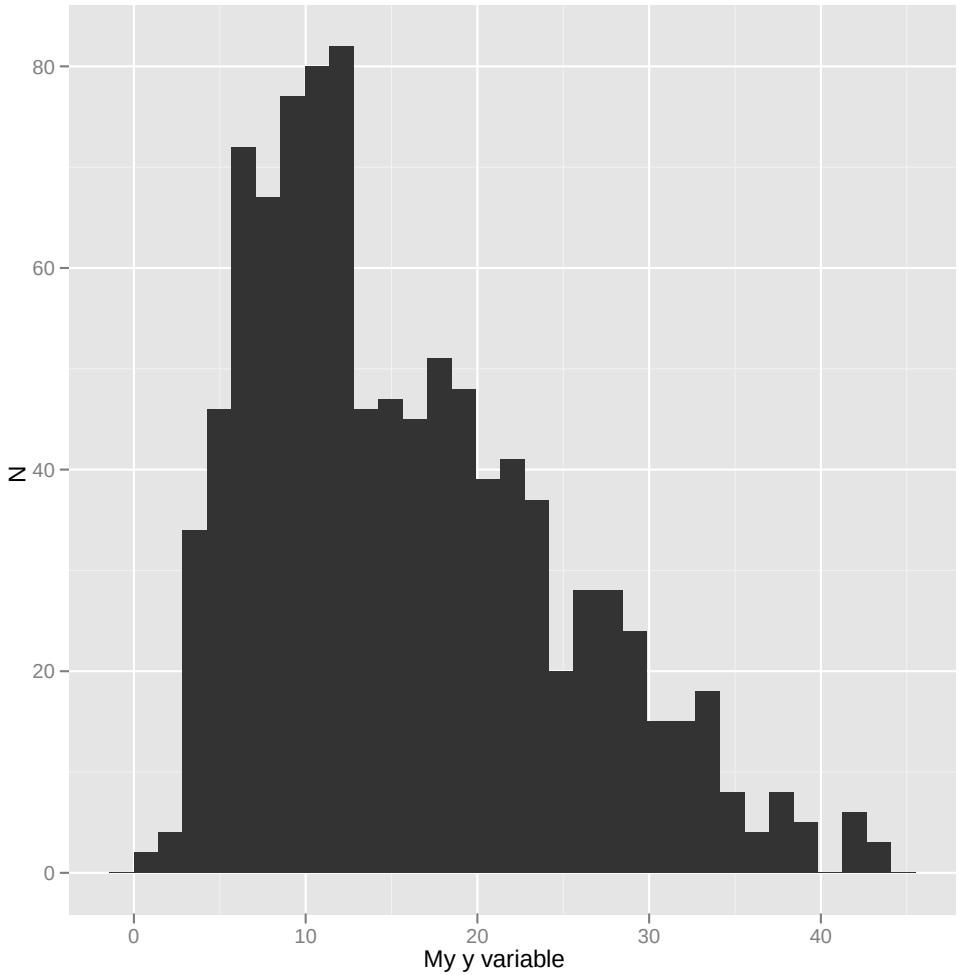
A basic overview about the ggplot2 package

- Needs to be loaded via `library(ggplot2)`
- Is based on The Grammar of Graphics by Leland Wilkinson
- Sometimes difficult to "tweak" plots which do not follow the GoG (and Hadley Wickham's implementation of the GoG)
- Often, original data need to be modified (e.g., aggregated for barcharts)
- Web resources:
  - Hadley Wickham's website for ggplot2 (this website is simply awesome; he also has written a ggplot2 related book)
  - Wiki for ggplot2: Elegant graphics for data analysis (ultimate resource when it comes to fine tuning)
  - The blog Learning R offers a lot of examples of how ggplot2 works
  - Visualizing Data with R and ggplot2 (video w/ slides) (website: www.drewconway.com/zia/?p=1637)

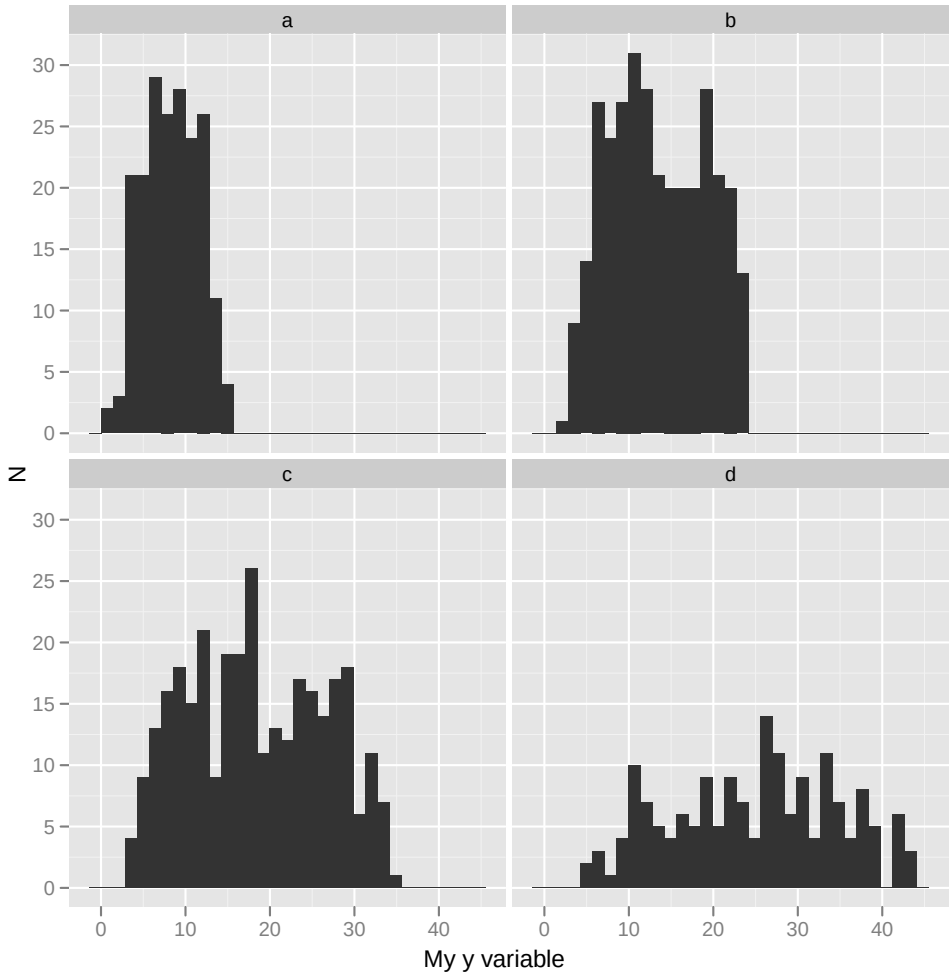
Histogram

```
ggplot(aes(x = y), data = df) + geom_histogram() +
    xlab("My y variable") + ylab("N")
```



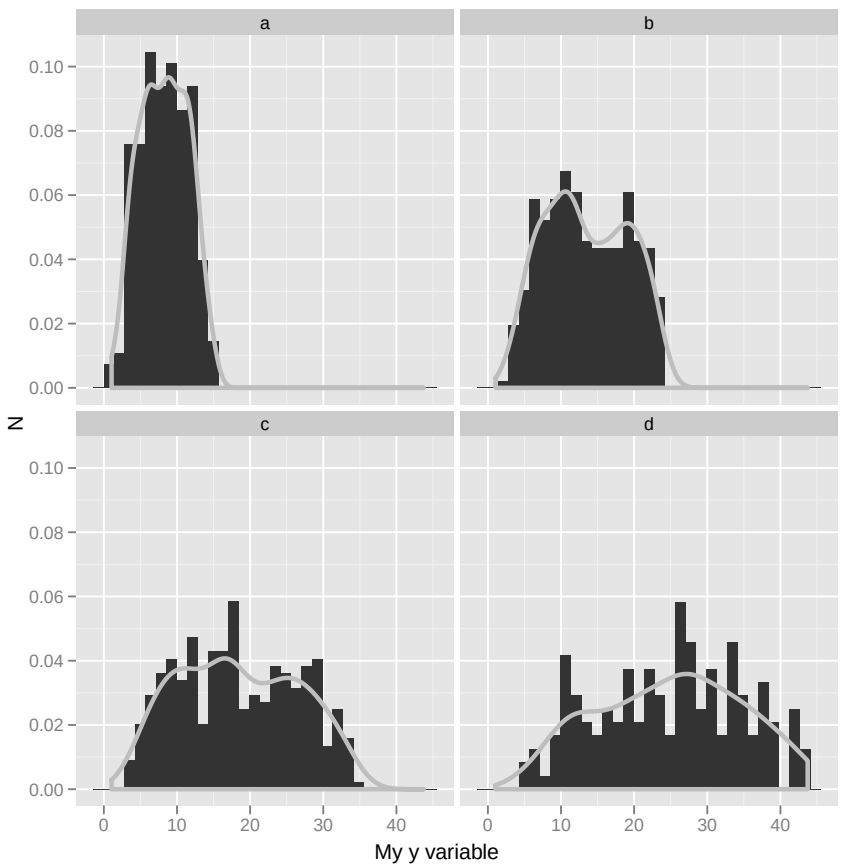
Histogram conditional on x2f

```
1  ggplot(aes(x = y), data = df) + geom_histogram() +
2      xlab("My y variable") + ylab("N") + facet_wrap(~x2f)
```



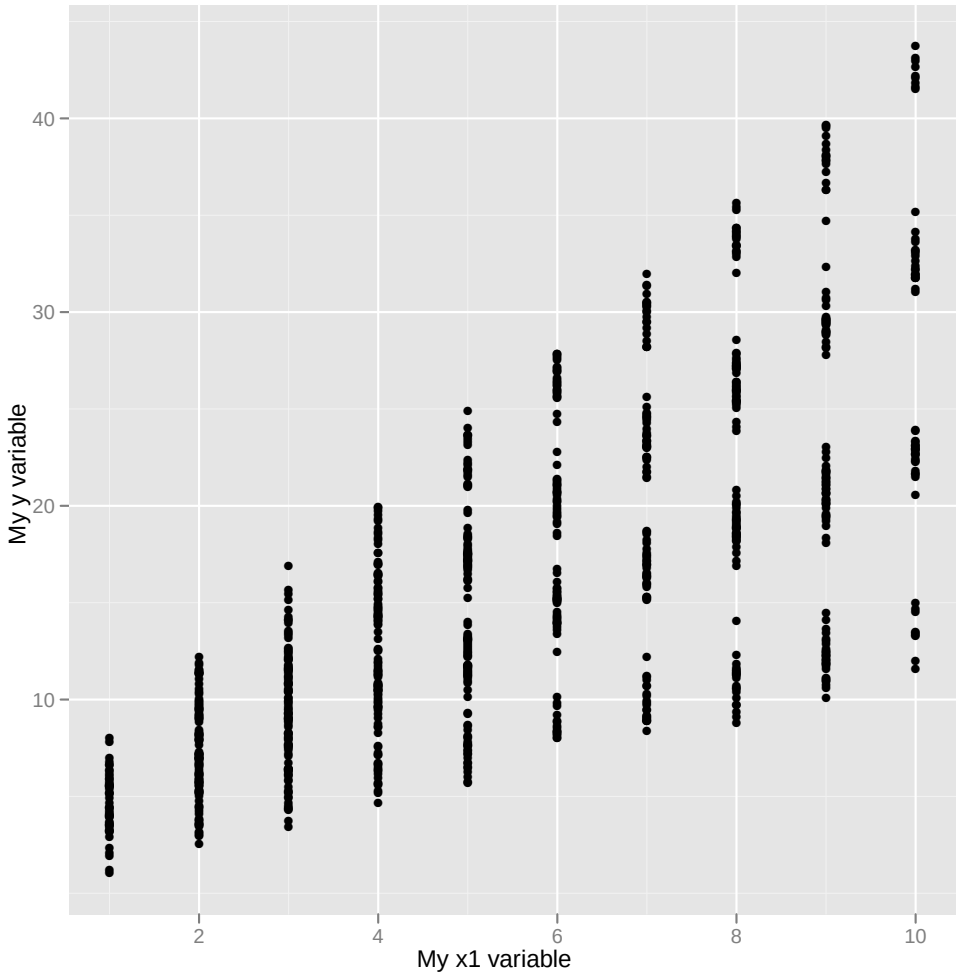
Histogram with superimposed density plot and conditional on x2f

```
ggplot(aes(x = y), data = df) +
    geom_histogram(aes(y = ..density..)) +
    geom_density(colour = "grey", size = 1.2) +
    xlab("My y variable") + ylab("N") +
    facet_wrap(~x2f)
```



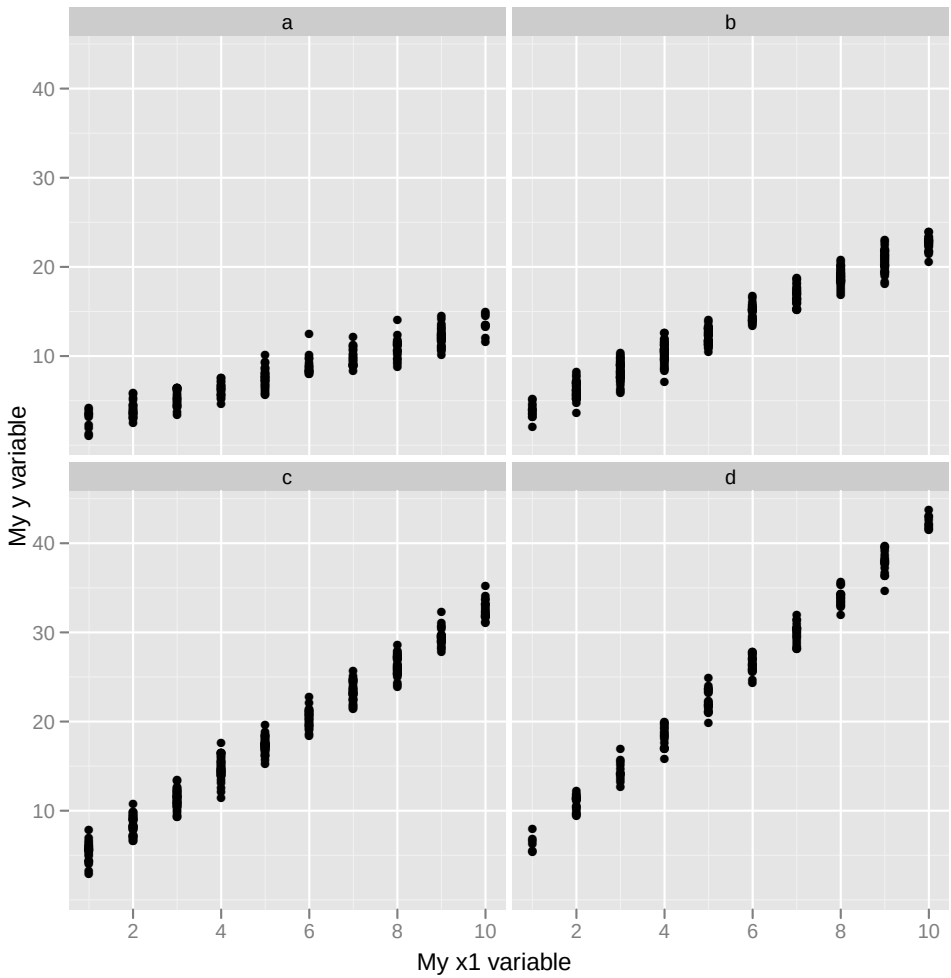
Scatter plot

```
ggplot(aes(x = x1, y = y), data = df) + geom_point() +
    xlab("My x1 variable") + ylab("My y variable")
```



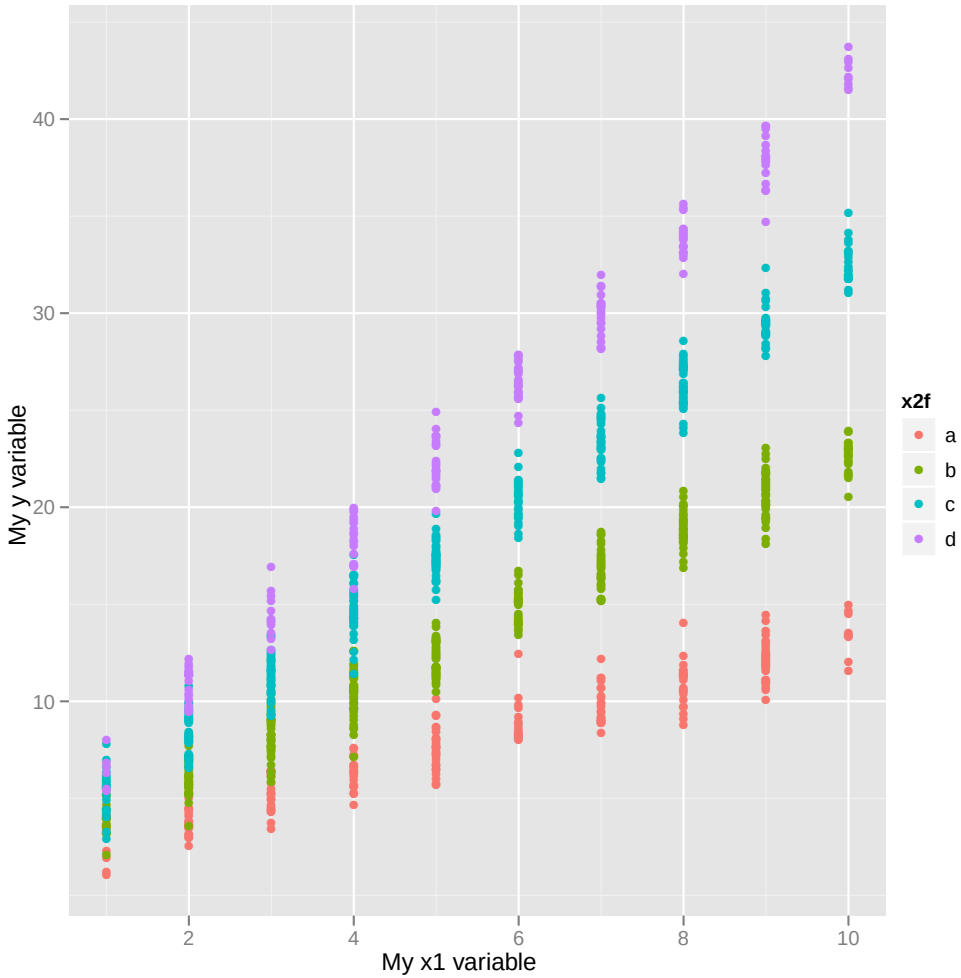
Multipanel scatter plot by x2f

```
ggplot(aes(x = x1, y = y), data = df) + geom_point() +
    xlab("My x1 variable") + ylab("My y variable") +
    facet_wrap(~ x2f)
```



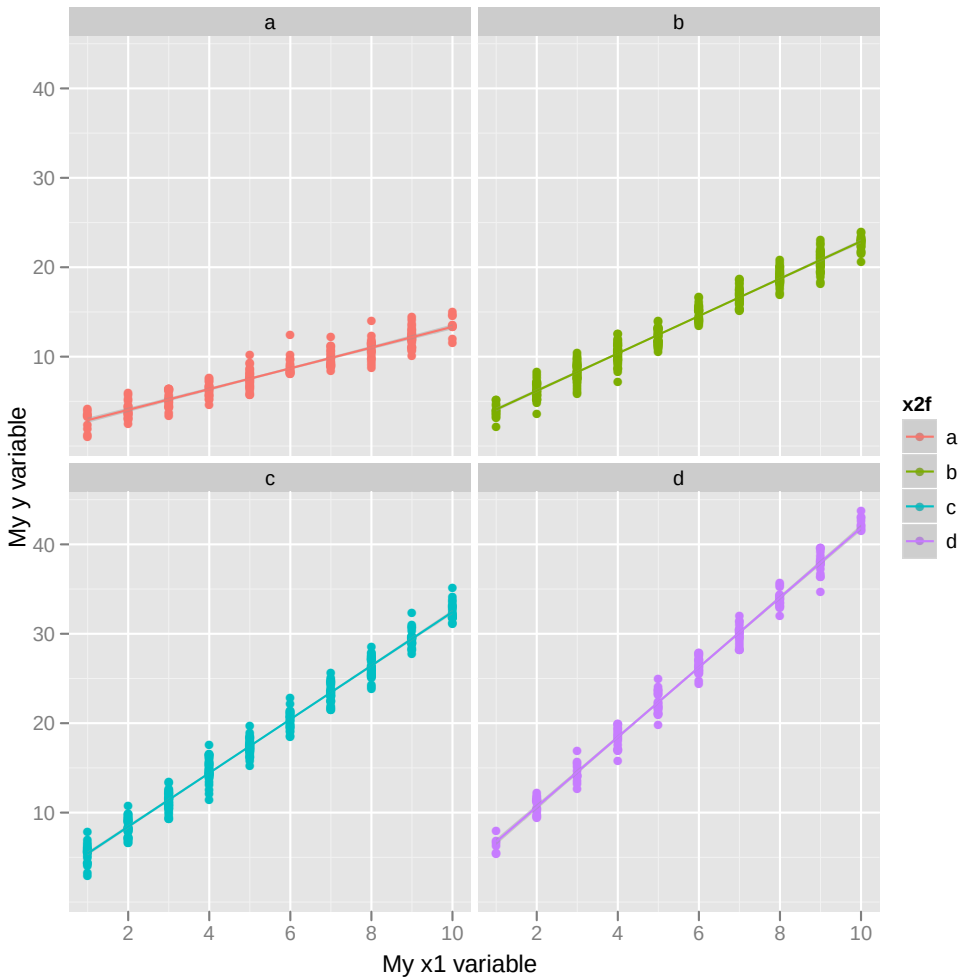
Scatter plot by grouping variable x2

```
1  ggplot(aes(x = x1, y = y, colour = x2f), data = df) +
2      geom_point() + xlab("My x1 variable") +
3      ylab("My y variable")
```



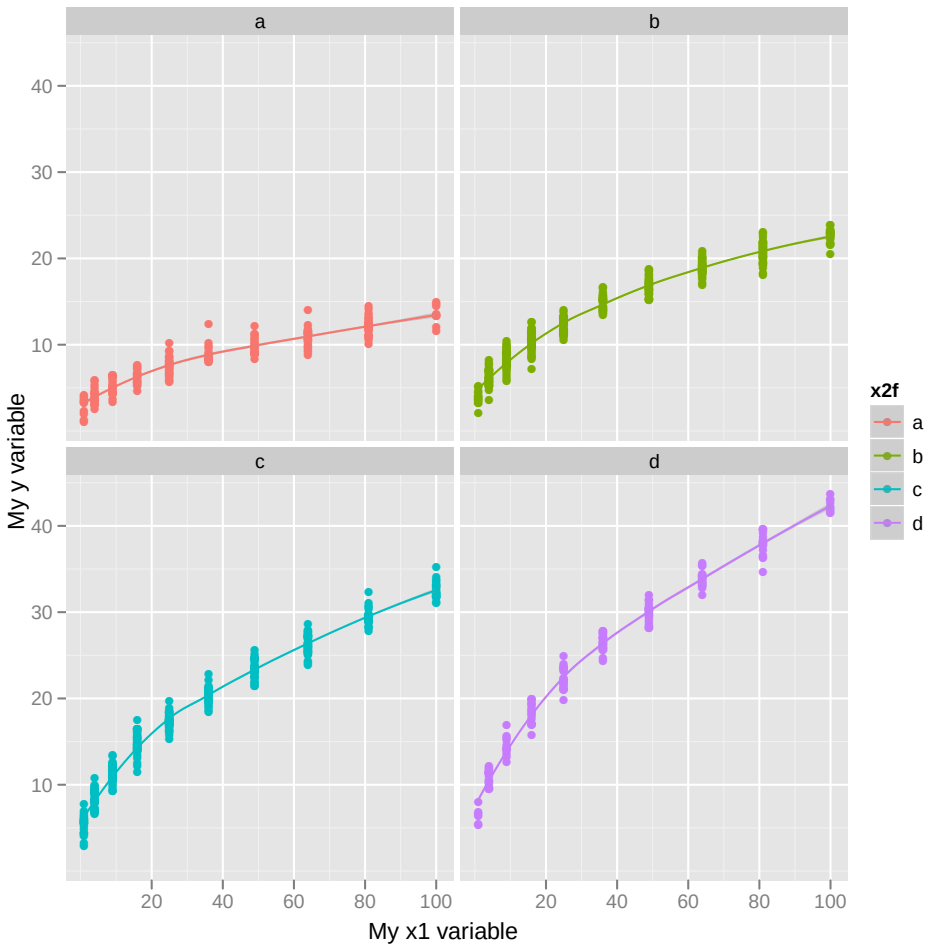
Scatter plot and linear regression line by x2

```
1  ggplot(aes(x = x1, y = y, colour = x2f), data = df) +
2      geom_point() + xlab("My x1 variable") +
3      ylab("My y variable") + facet_wrap(~x2f) +
4      geom_smooth(method = "lm")
```



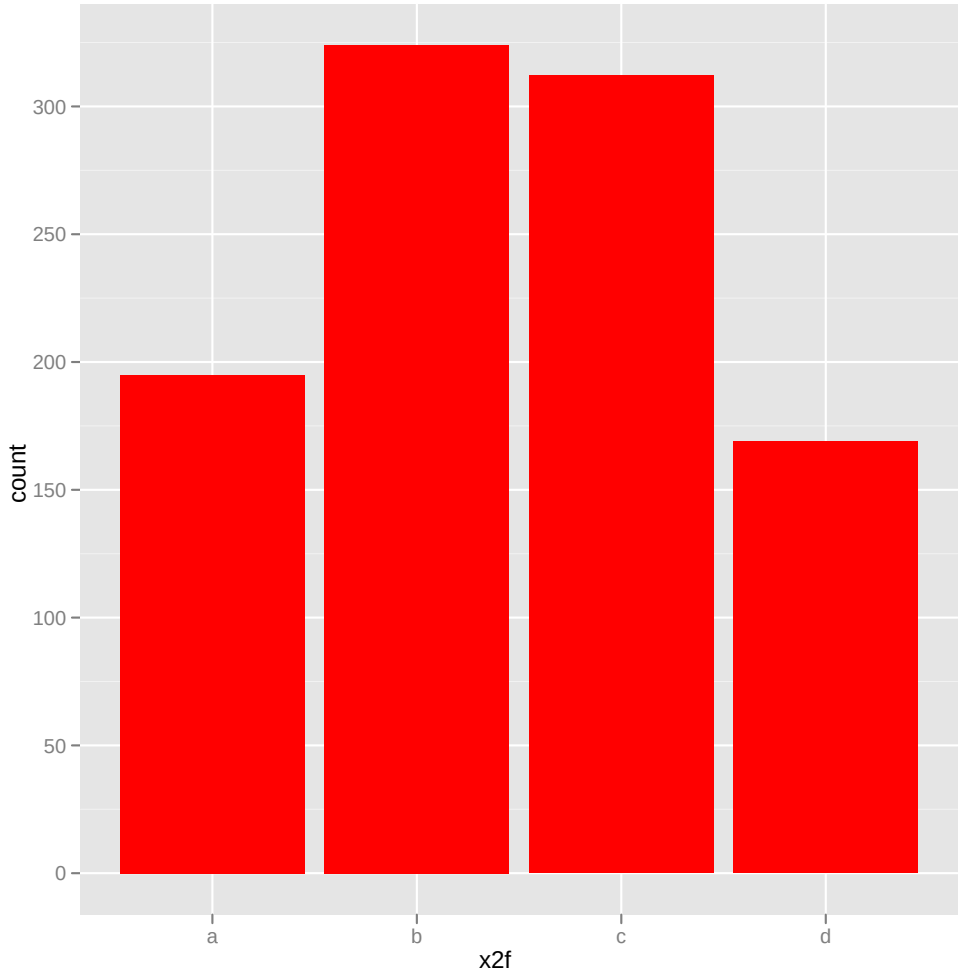
Scatter plot and LOESS line by x2

```
ggplot(aes(x = x1, y = y, colour = x2f),
       data = data.frame(df[, -2], x1 = df$x1^2)) +
    geom_point() + xlab("My x1 variable") +
    ylab("My y variable") + facet_wrap(~x2f) +
    geom_smooth(method = "loess")
```



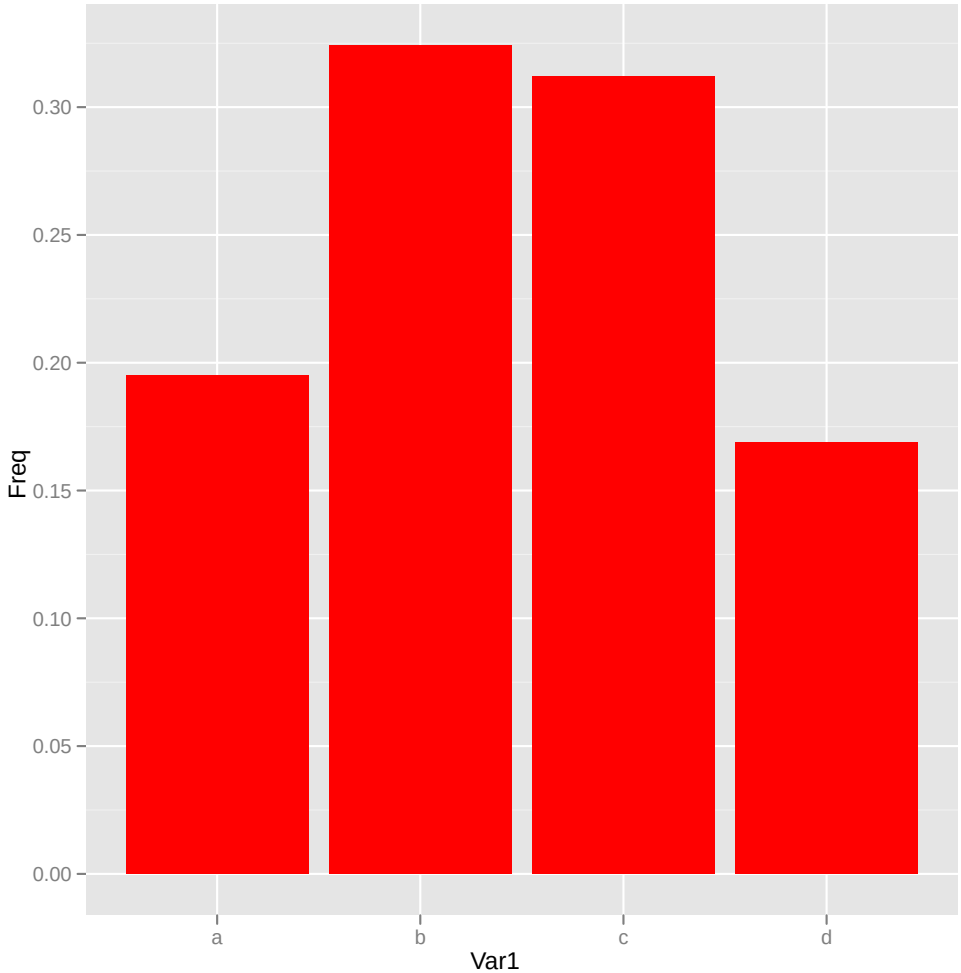
Bar chart (absolute frequencies)

```
1  ggplot(aes(x = x2f), data = df) + geom_bar(fill = "red")
```



Bar chart (percentages)

```
1  tmp <- data.frame(prop.table(table(df$x2f)))
2  ggplot(aes(x = Var1, y = Freq), data = tmp) +
3      geom_bar(fill = "red")
```



Box plot, jittered scatterplot, LOESS line (slightly useless. . .)

```
ggplot(aes(x = x2f, y = y), data = df) +
    geom_jitter() + geom_boxplot(alpha = 0.8) +
    stat_smooth(aes(x = as.numeric(x2f, y = y)),
                data = df, method = "loess",
                level = 0.90) +
    geom_hline(yintercept = mean(df$y),
               col = "green", size = 1.2)
```