Introduction to Geostatistics

3. Descriptive graphs, and statistics

Edzer J. Pebesma

edzer.pebesma@uni-muenster.de
Institute for Geoinformatics (**ifgi**)
University of Münster

summer semester 2007/8,
April 19, 2009

ifgi

Why graphics are important

- a picture is worth more than a thousand words
- the other brain half
- dense information content, but the reader determines how much is read
- graphics need annotation (speach, written text), about

Why graphics are important

- a picture is worth more than a thousand words
- the other brain half
- dense information content, but the reader determines how much is read
- graphics need annotation (speach, written text), about

Why graphics are important

- a picture is worth more than a thousand words
- the other brain half
- dense information content, but the reader determines how much is read
- graphics need annotation (speach, written text), about
  - what it is about
  - ...

Why graphics are important

- a picture is worth more than a thousand words
- the other brain half
- dense information content, but the reader determines how much is read
- graphics need annotation (speach, written text), about
  - what it is about
  - what the the essential message is

Why graphics are important

- a picture is worth more than a thousand words
- the other brain half
- dense information content, but the reader determines how much is read
- graphics need annotation (speach, written text), about
  - what it is about
  - what the the essential message is

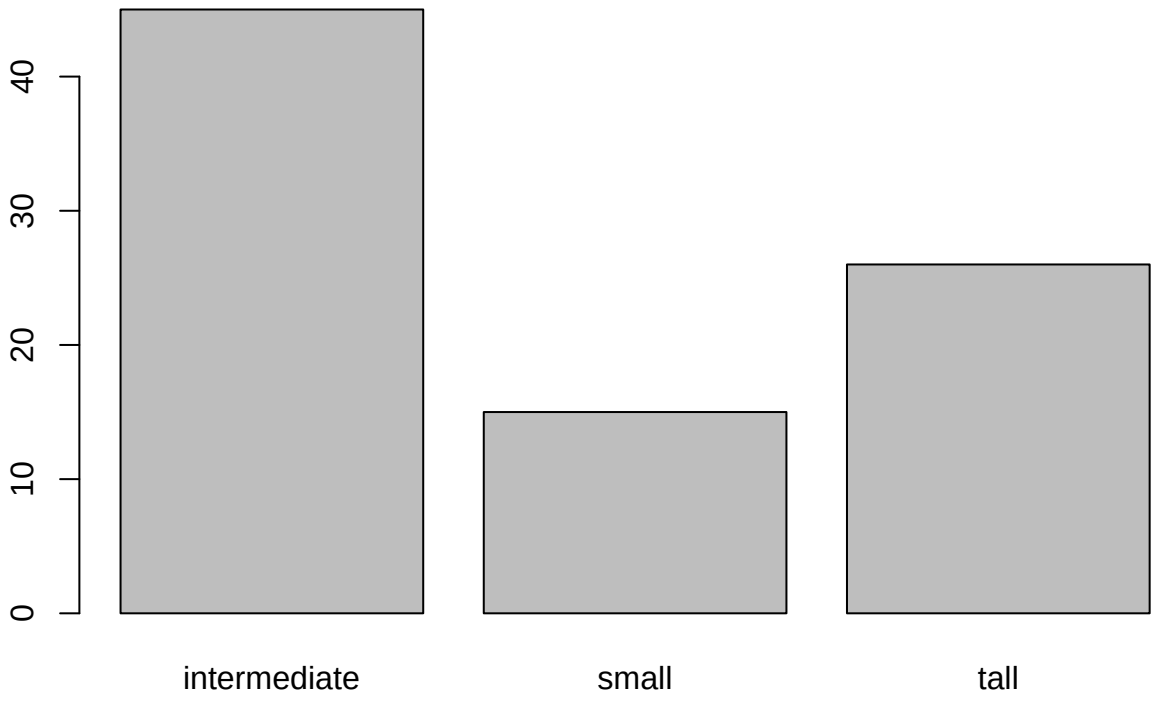
Why graphics are important

- a picture is worth more than a thousand words
- the other brain half
- dense information content, but the reader determines how much is read
- graphics need annotation (speach, written text), about
  - what it is about
  - what the the essential message is

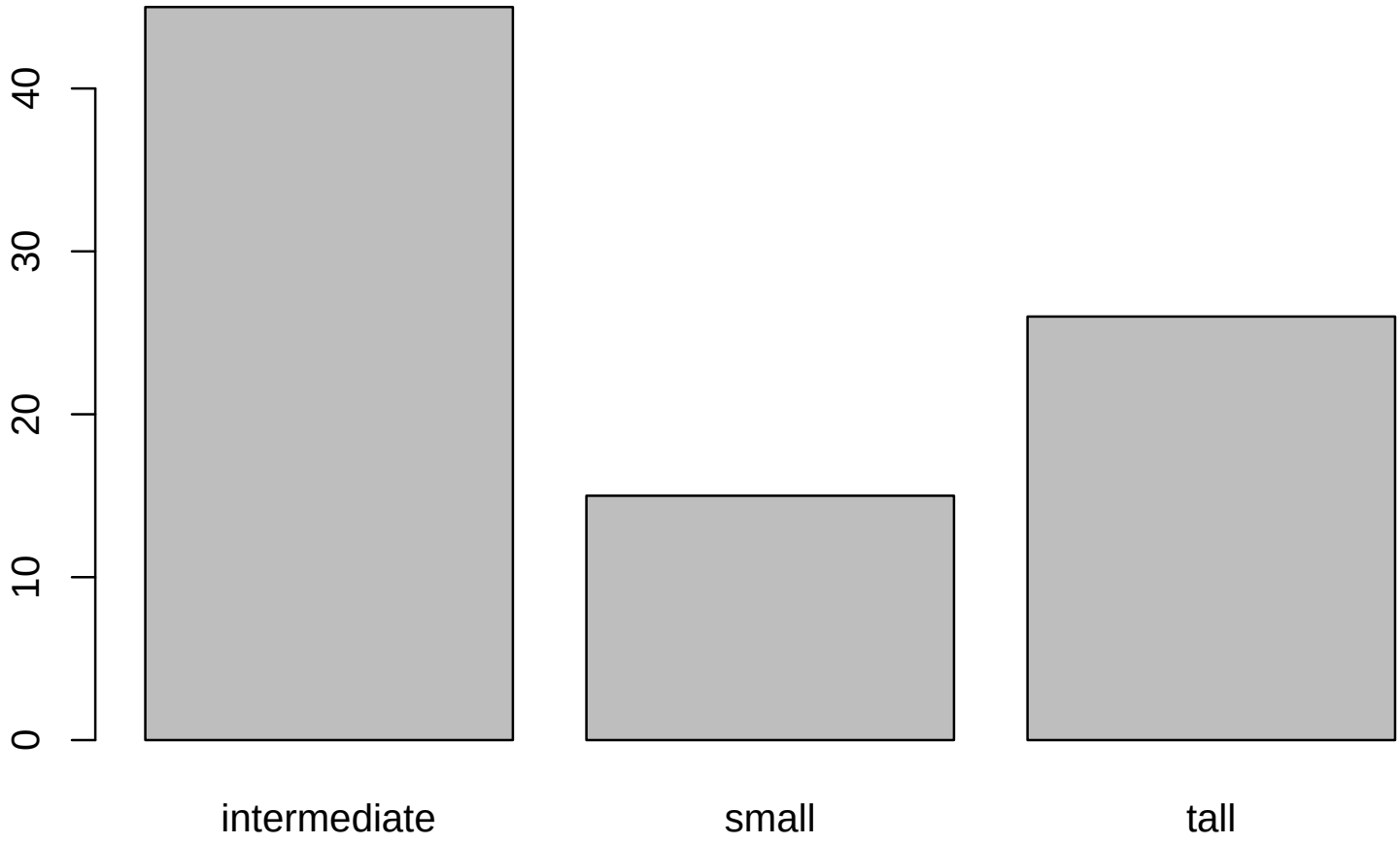
Univariate graphs: bar chart

Discrete (nominal, ordinal) data:

```
> load("students.RData")
> attach(students)
> plot(I.am.)
```



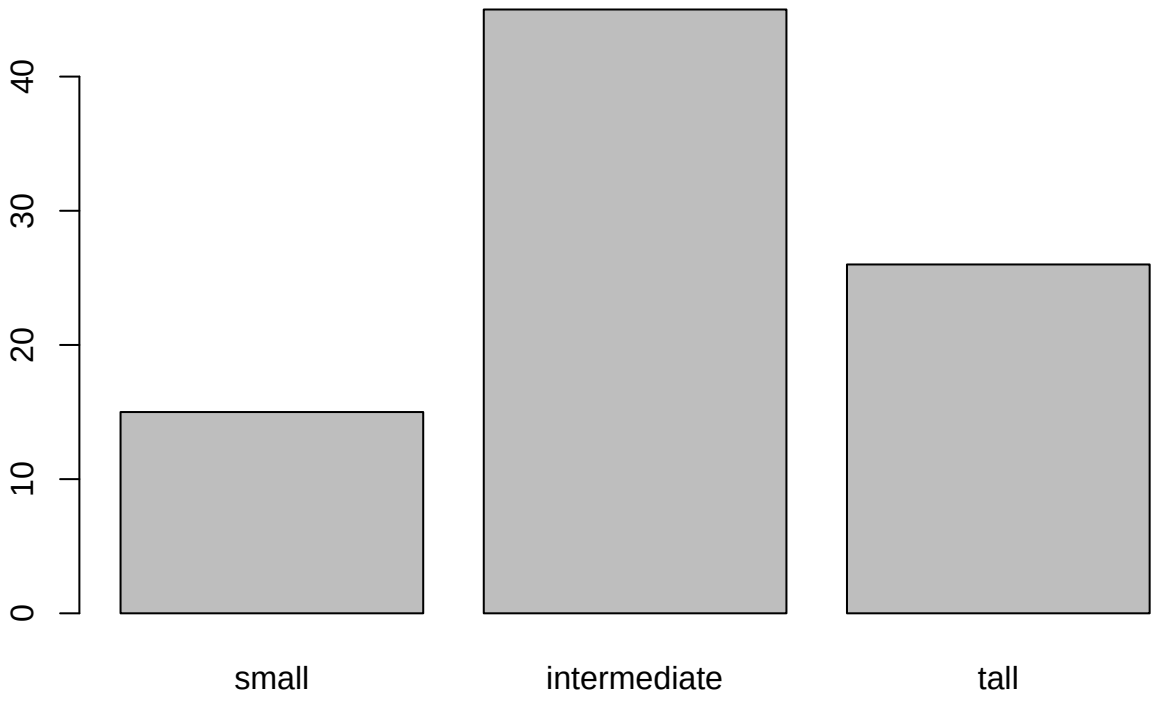
ifgi



ifgi

Univariate graphs: bar chart 2

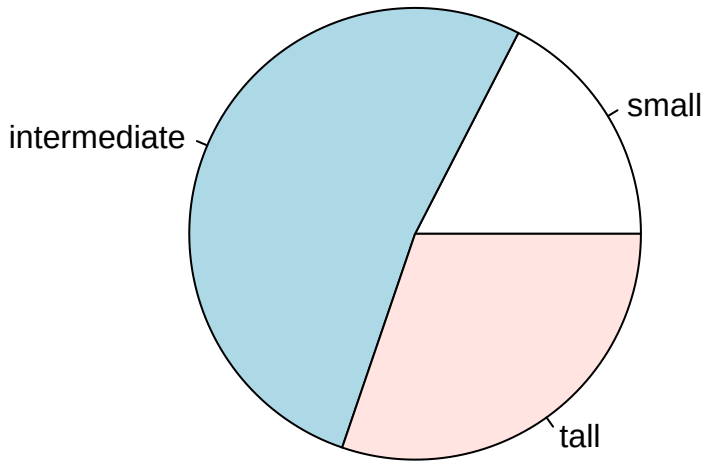
```
> I.am.2 = as.character(I.am.)
> I.am.2 = factor(I.am.2, levels = c("small", "intermediate",
+     "tall"))
> plot(I.am.2)
```



ifgi

Univariate graphs: pie chart

```
> pie(table(I.am.2))
```



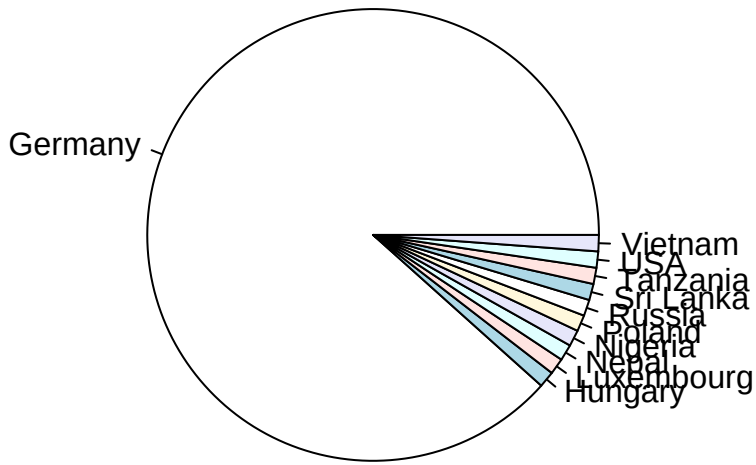
Note that `intermediate` is more than `small` + `tall`

ifgi

Univariate graphs: pie chart

Pie charts do not always work well.

```
> pie(table(Country.of.birth))
```

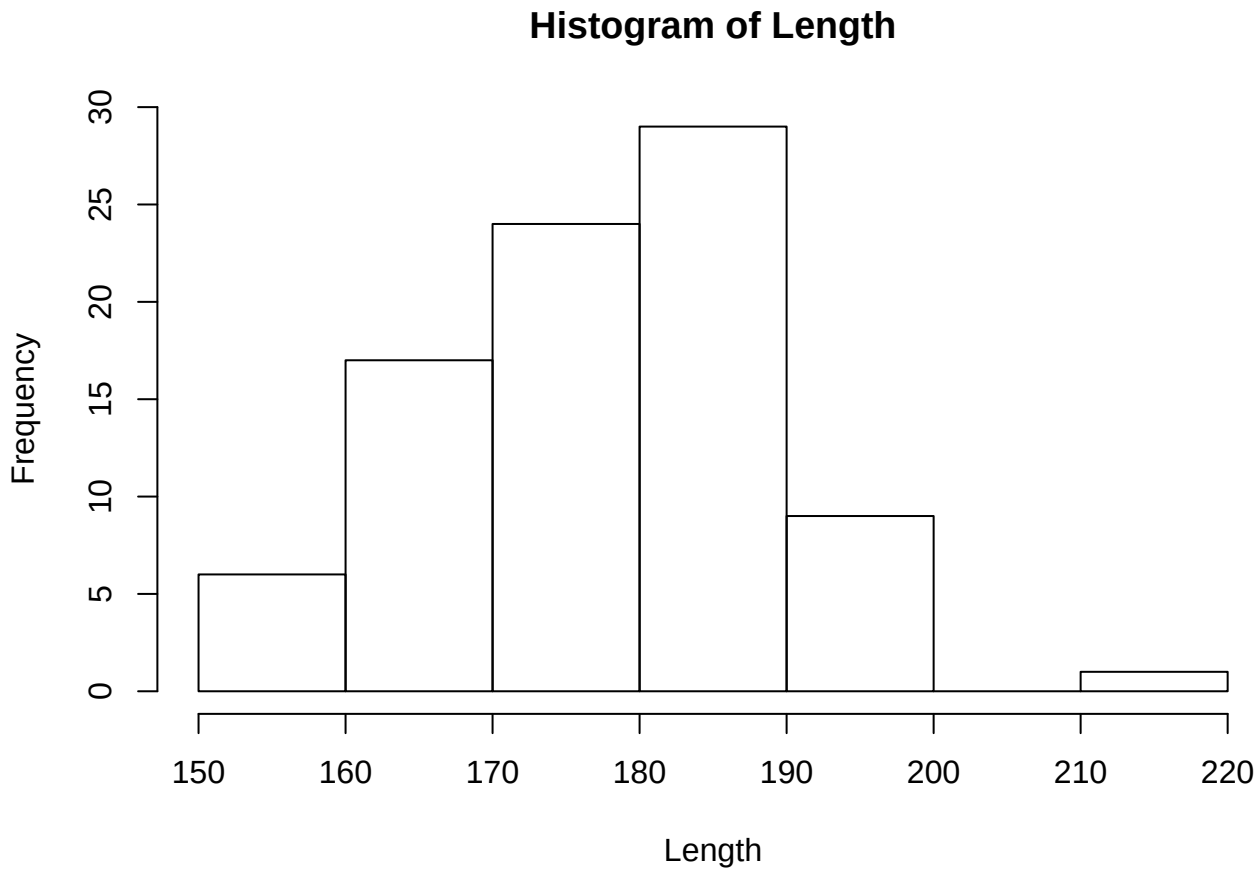


ifgi

Univariate graphs: histogram

Histograms show the *distribution* of continuous data:

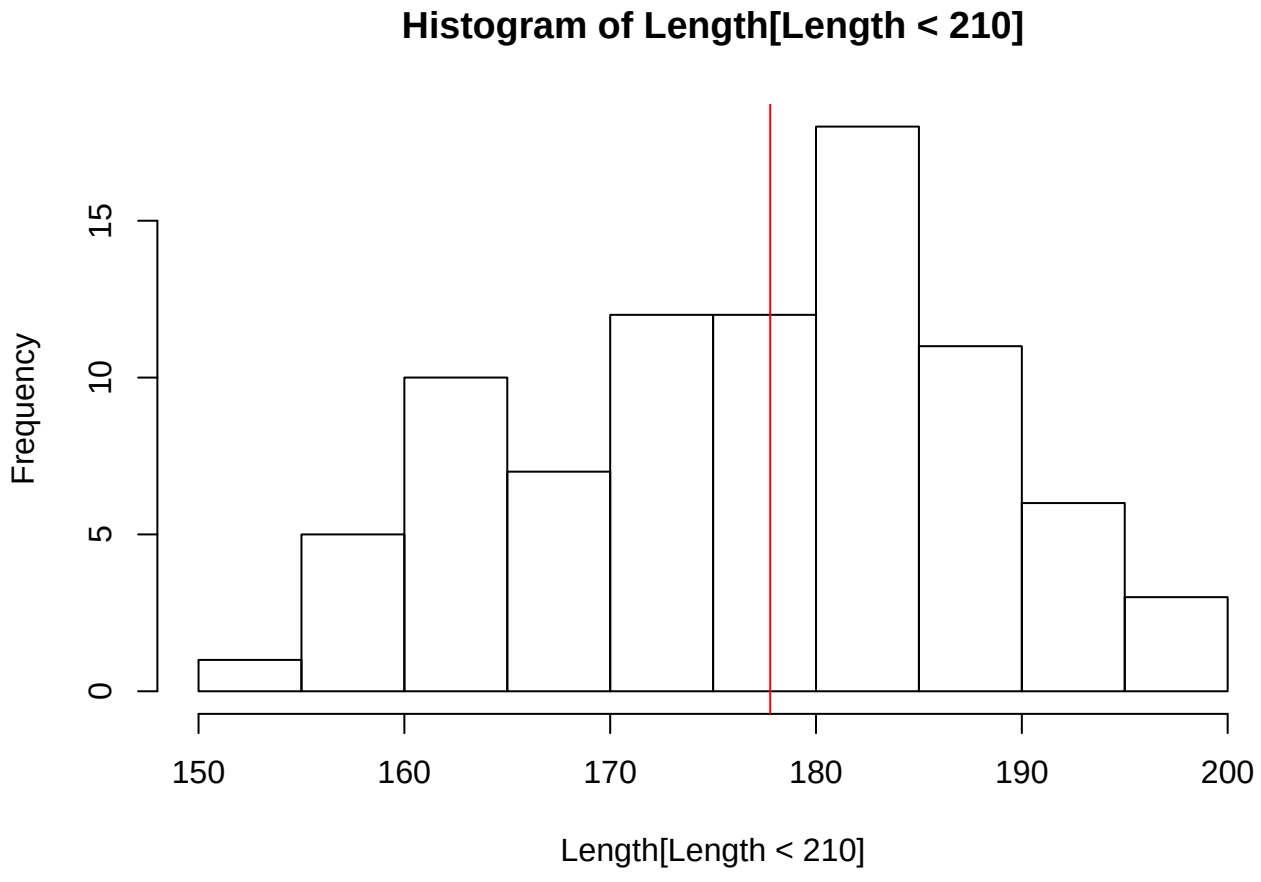
```
> hist(Length)
```



ifgi

Univariate graphs: annotated histogram

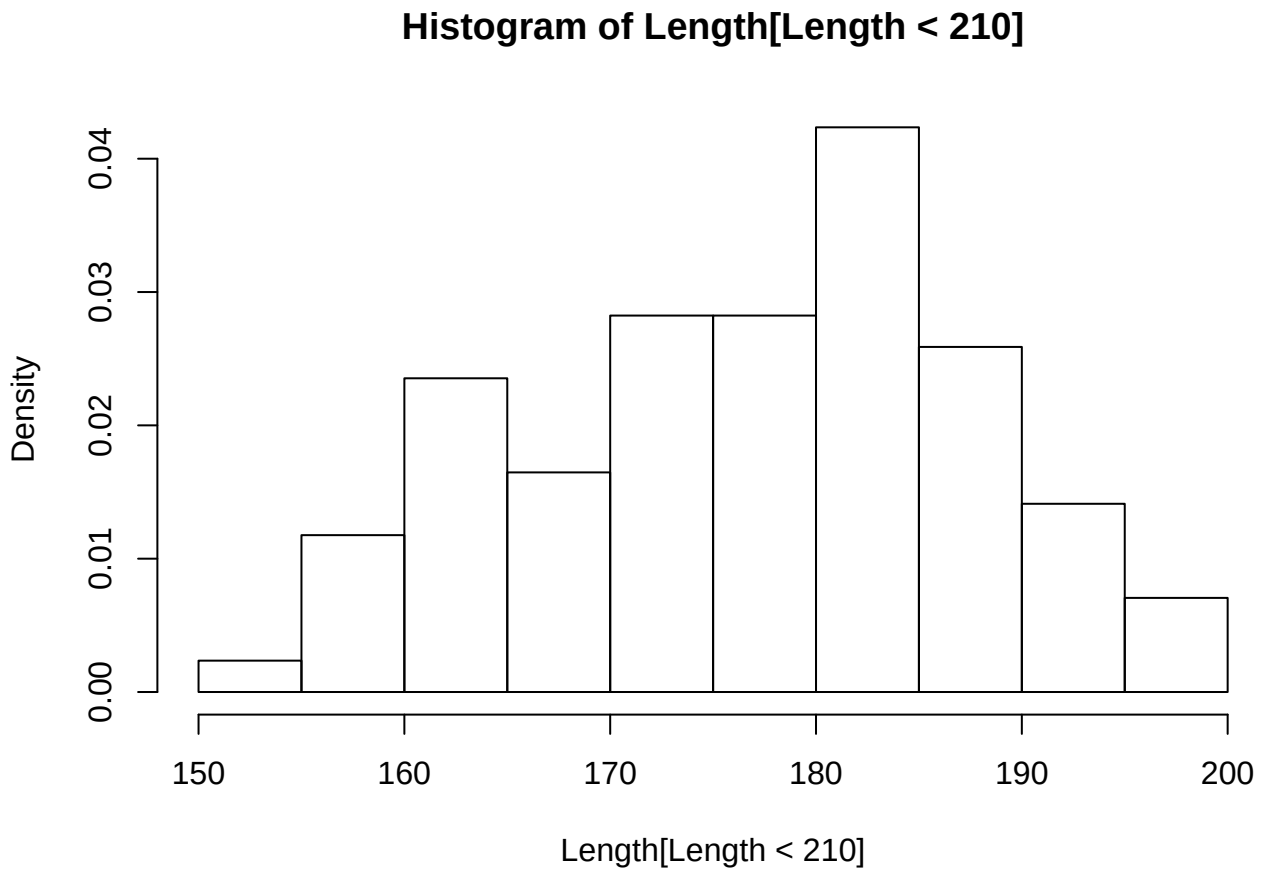
```
> hist(Length[Length < 210])
> abline(v = mean(Length[Length < 210]), col = "red")
```



ifgi

Histogram with fractions

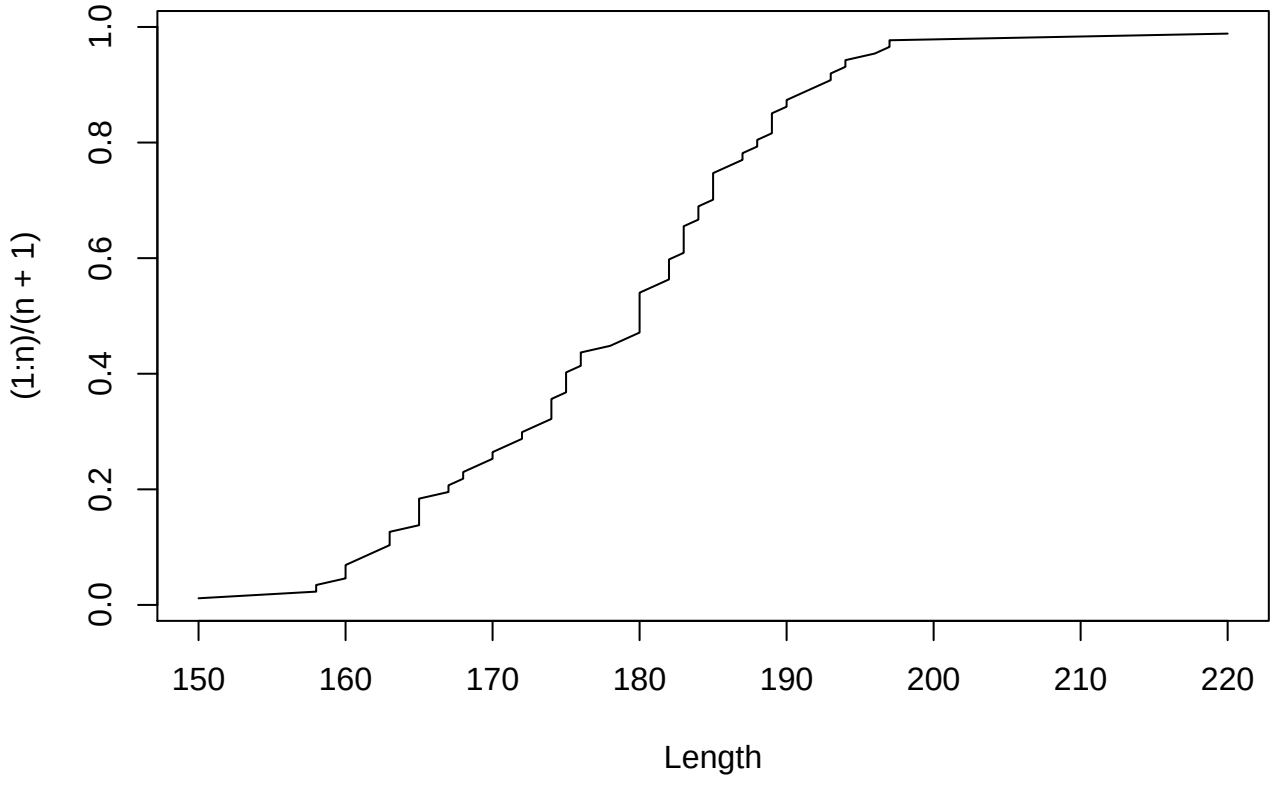
```
> hist(Length[Length < 210], freq = FALSE)
```



ifgi

Cumulative frequency curve

```
> n = length(Length)
> qqplot(Length, (1:n)/(n + 1), type = "l")
```

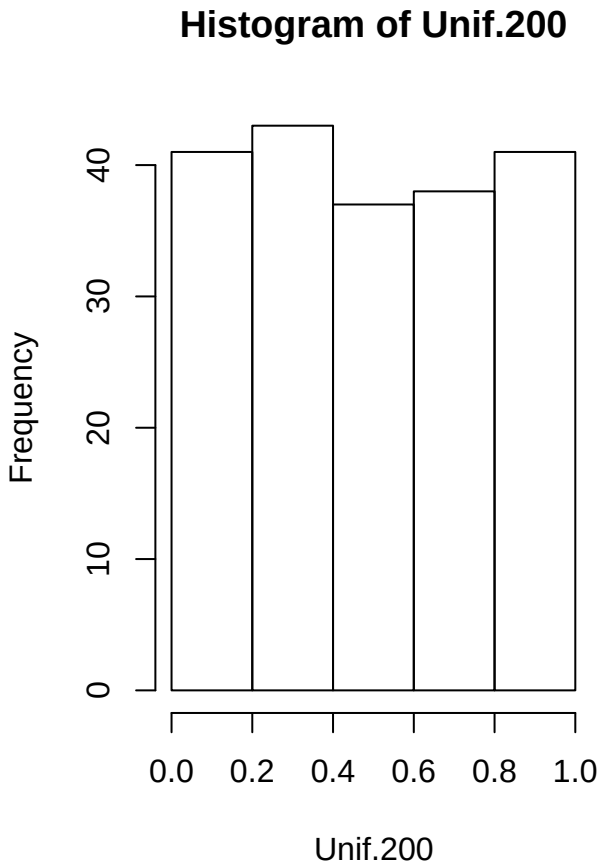


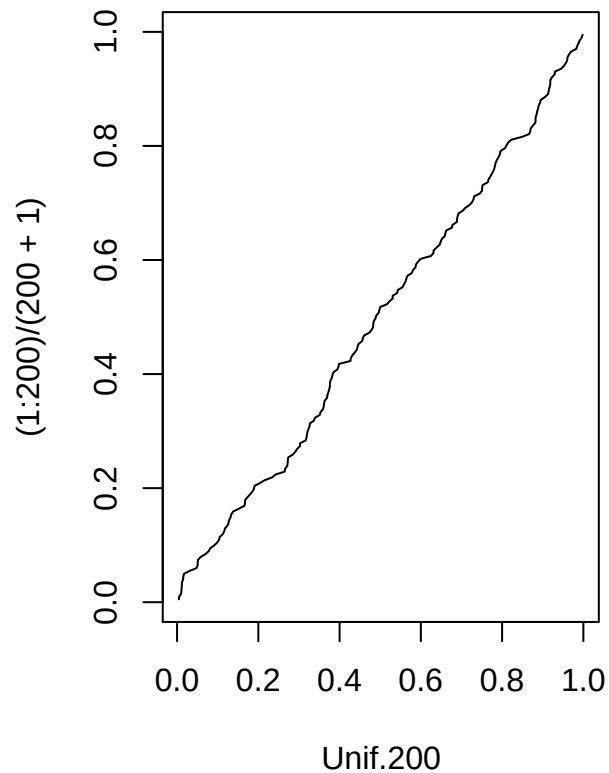
ifgi

Cumulative frequency curve

When does this curve plot a straight line?

```
> Unif.200 = runif(200)
> n = length(Unif.200)
> par(mfrow = c(1, 2))
> hist(Unif.200, 5)
> qqplot(Unif.200, (1:200)/(200 + 1), type = "l")
```



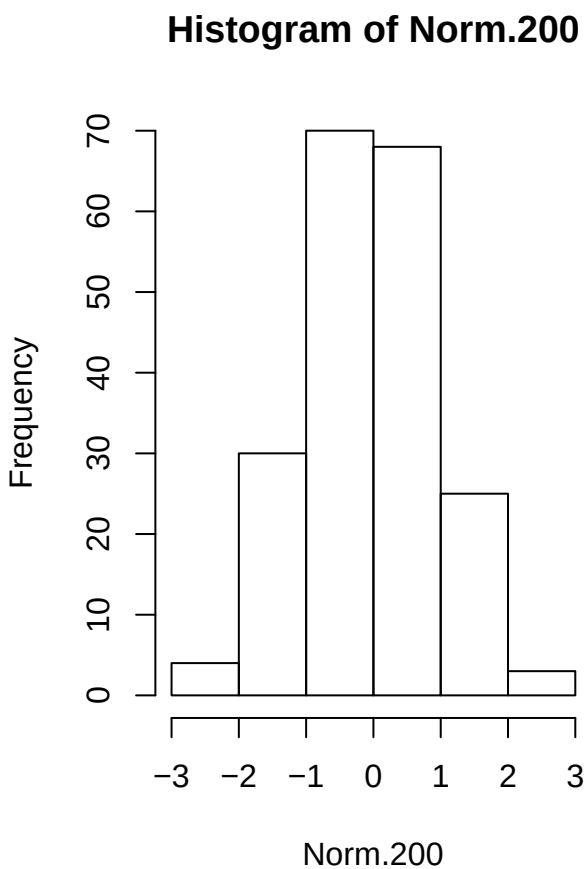


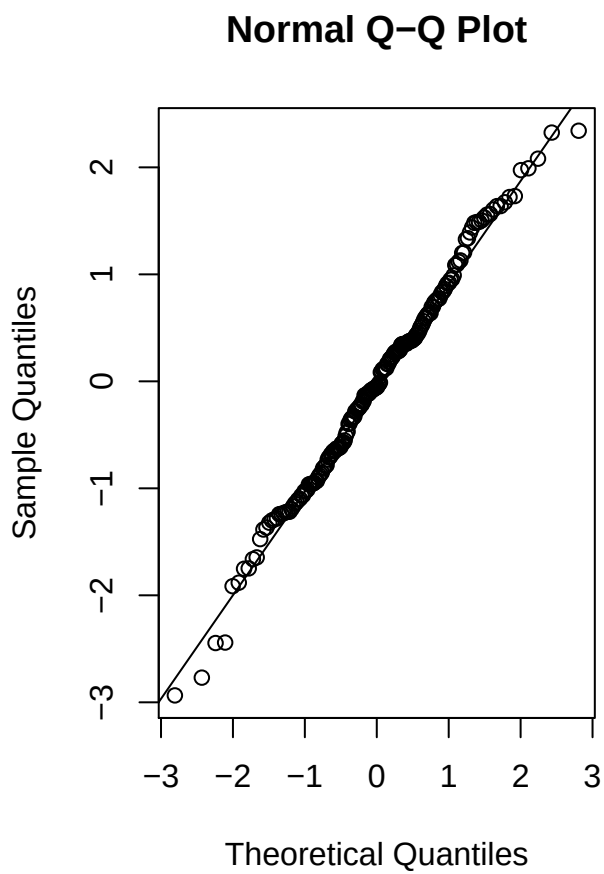
ifgi

Normal probability plots: 1

When does the normal curve plot a straight line?

```
> Norm.200 = rnorm(200)
> par(mfrow = c(1, 2))
> hist(Norm.200, 5)
> qqnorm(Norm.200)
> qqline(Norm.200)
```



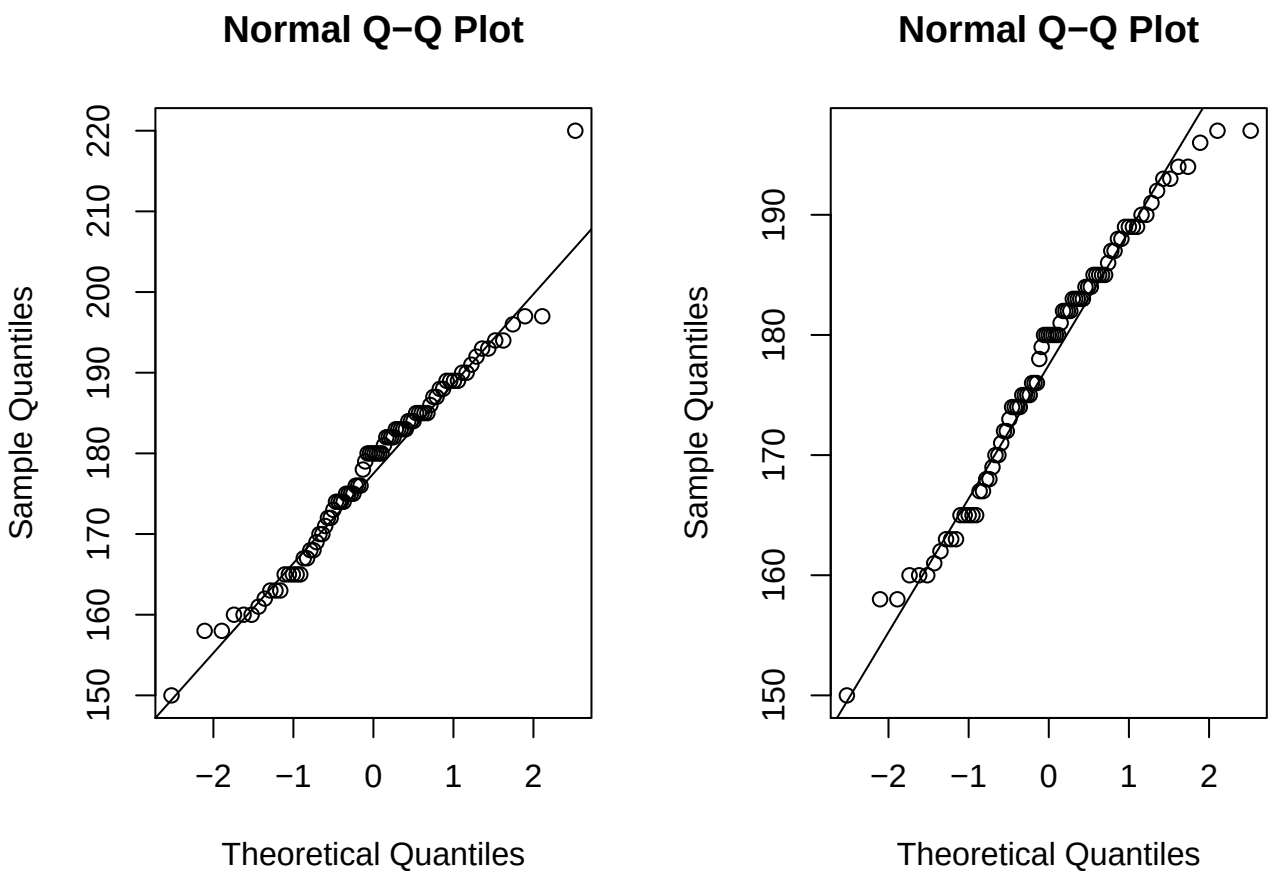


ifgi

Normal probability plots: 2

Does Length follow a normal distribution?

```
> par(mfrow = c(1, 2))
> qqnorm(Length)
> qqline(Length)
> qqnorm(Length[Length < 210])
> qqline(Length[Length < 210])
```



ifgi

Intermezzo: S formula's

```
> Weight ~ Length

Weight ~ Length

> class(Weight ~ Length)

[1] "formula"
```

Formula's are a language construct that specify *dependency*: `y ~ x` means `y` depends on `x`. The following are e.g. equivalent:

```
> plot(x, y)
> plot(y ~ x)
```

Note that `plot` is a *generic*. The actual plot instance called depends on the class of its first argument.

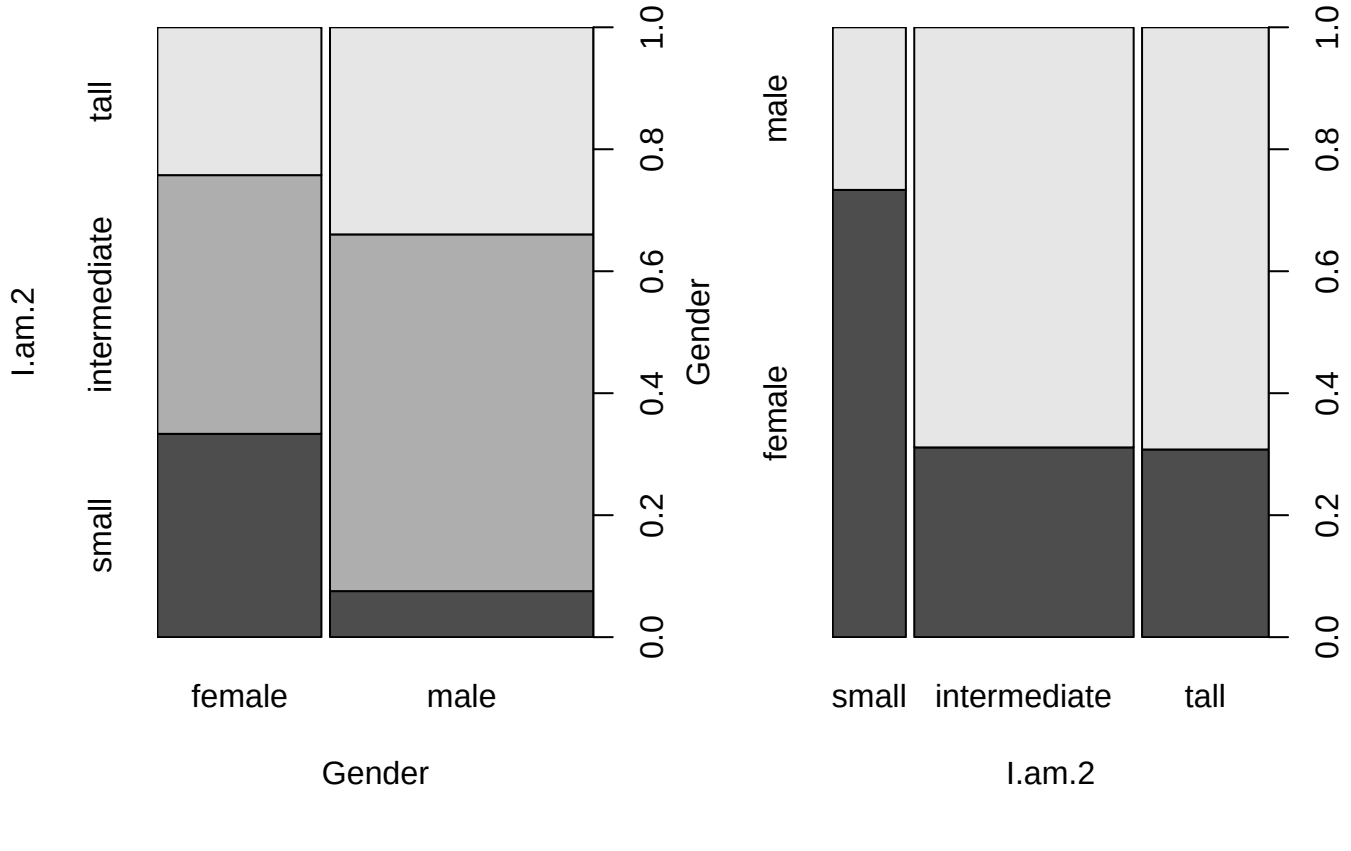
```
> methods(plot)

 [1] plot.acf*            plot.data.frame*     plot.Date*
 [4] plot.decomposed.ts*  plot.default         plot.dendrogram*
 [7] plot.density         plot.ecdf            plot.factor*
[10] plot.formula*        plot.hclust*         plot.histogram*
[13] plot.HoltWinters*    plot.isoreg*         plot.lm
[16] plot.medpolish*      plot.mlm             plot.POSIXct*
[19] plot.POSIXlt*        plot.ppr*            plot.prcomp*
[22] plot.princomp*       plot.profile.nls*    plot.spec
[25] plot.spec.coherency  plot.spec.phase      plot.stepfun
```

ifgi

Bivariate graphs: 2 factors

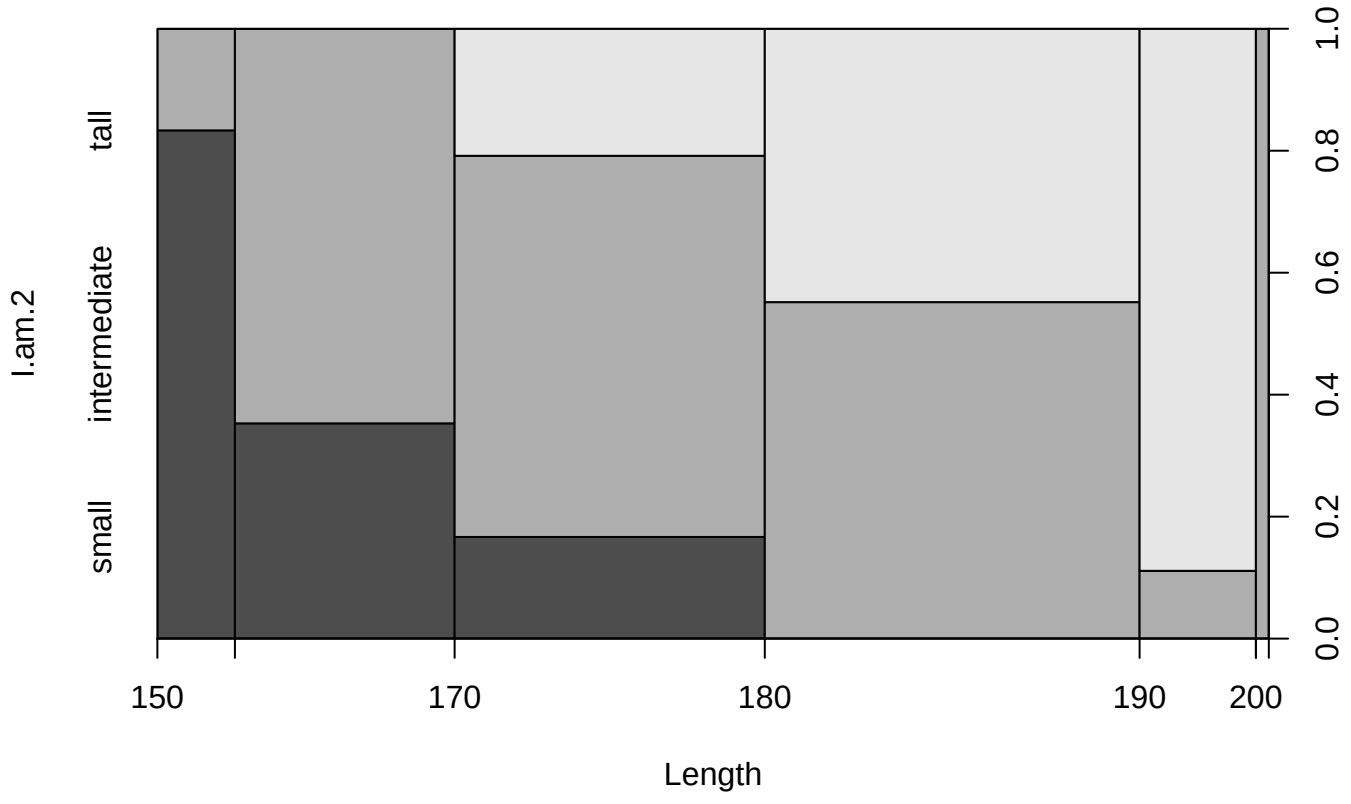
```
> par(mfrow = c(1, 2))
> plot(I.am.2 ~ Gender)
> plot(Gender ~ I.am.2)
```



ifgi

Bivariate graphs: *x* numerical, *y* factor

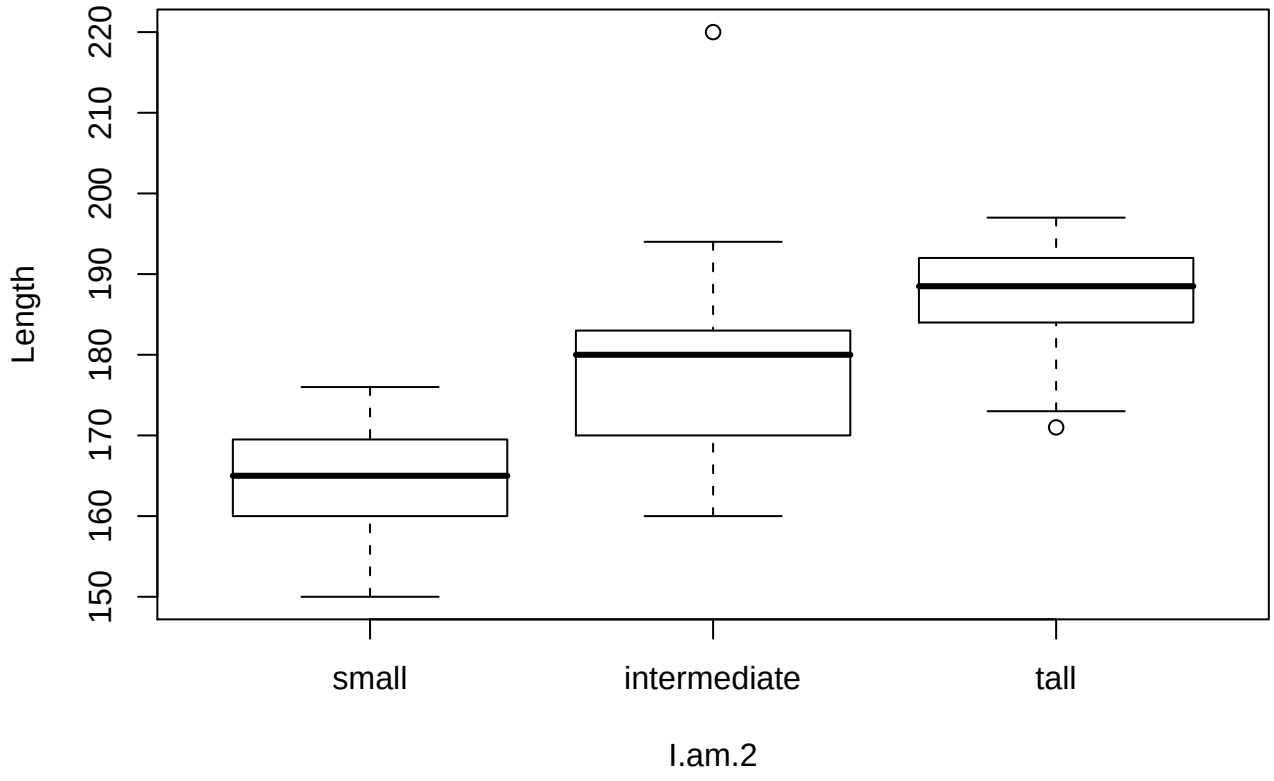
```
> plot(I.am.2 ~ Length)
```



ifgi

Bivariate graphs: *x* factor, *y* numerical

```
> plot(Length ~ I.am.2)
```

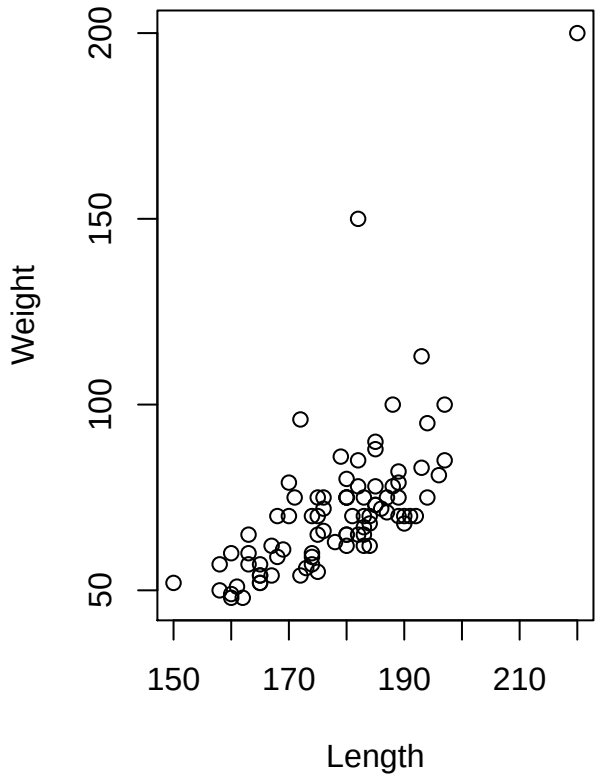


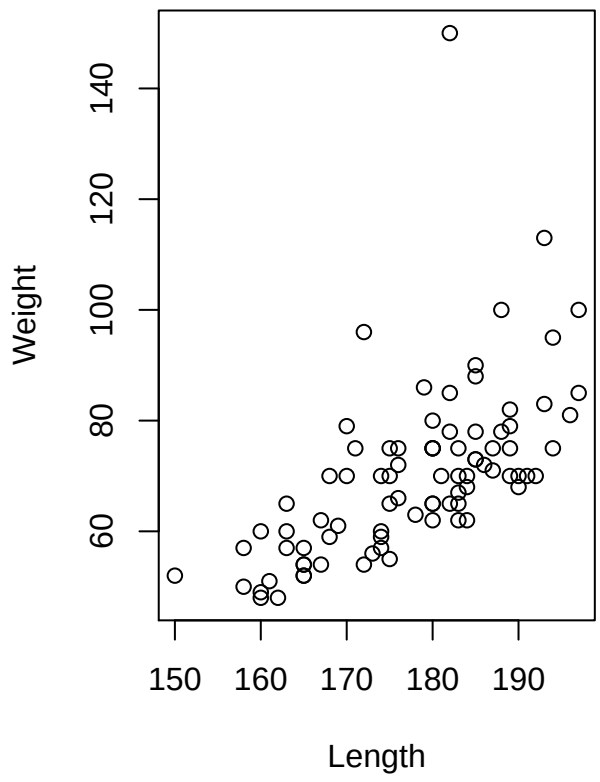
See also `range` in `?boxplot`

Bivariate graphs: scatter plot

Two numerical variables:

```
> par(mfrow = c(1, 2))
> plot(Weight ~ Length)
> plot(Weight ~ Length, students[Length < 200, ])
```



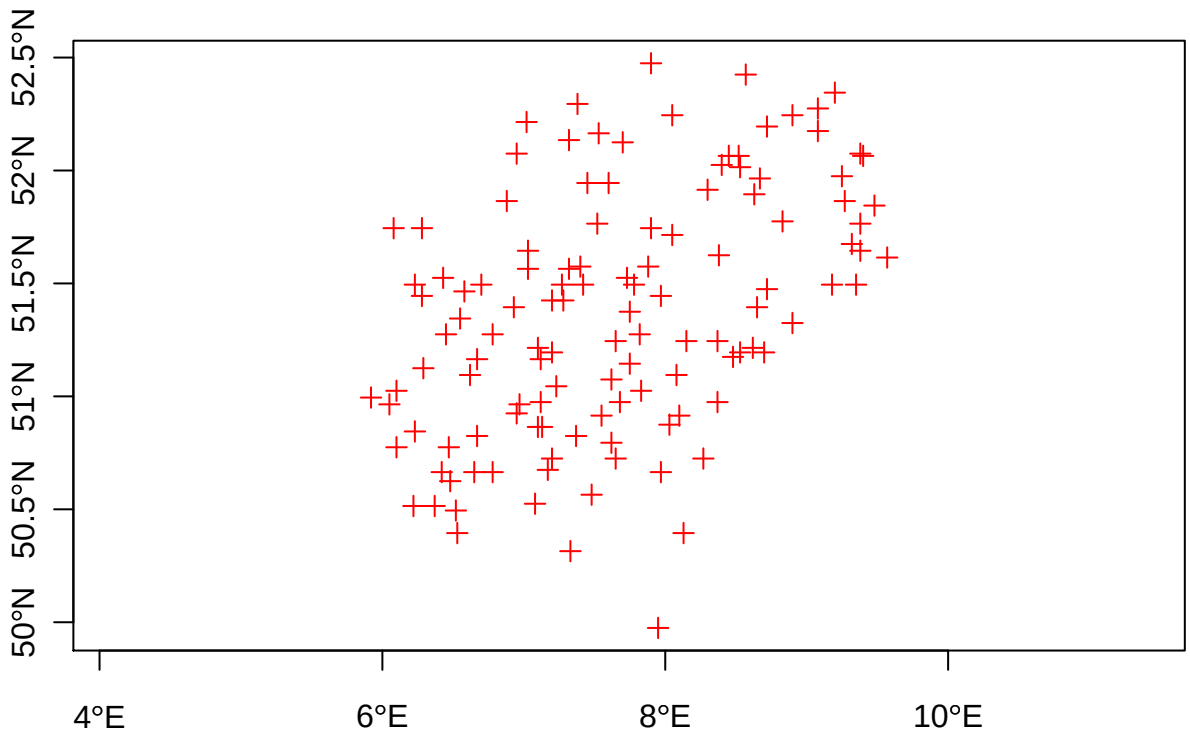


ifgi

Bivariate graphs: geographical map

Two numerical variables: x- and y-coordinate. Features: points, lines, polygons, grids.
Axes have special properties, e.g. aspect ratio

```
> library(sp)
> load("katha/.RData")
> plot(wetter.ll, axes = TRUE, col = "red")
```

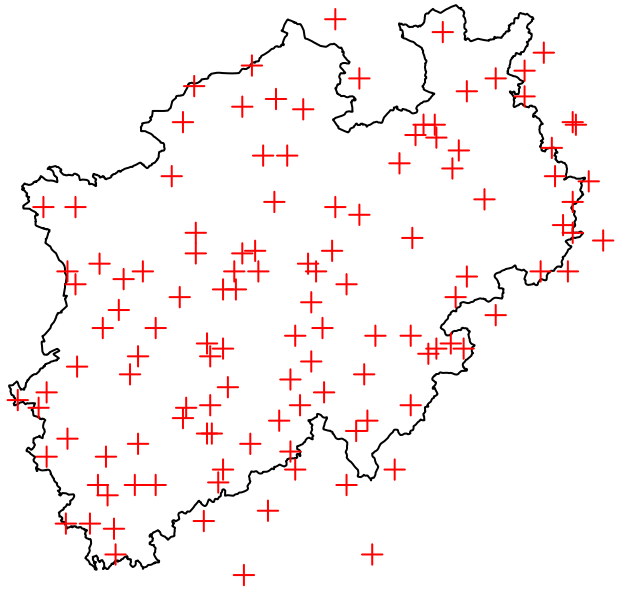


ifgi

Bivariate graphs: geographical map

On maps, axes are often replaced by useful reference features

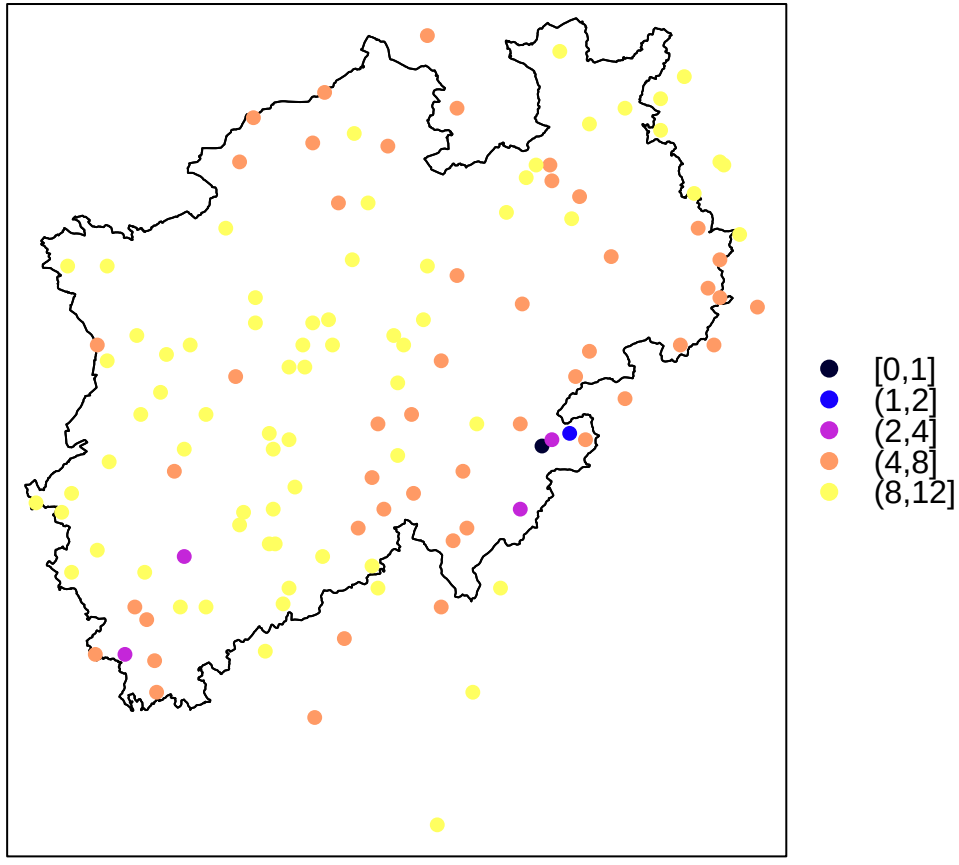
```
> library(sp)
> plot(NRW)
> plot(wetter.ll, add = TRUE, col = "red")
```



ifgi

Trivariate graphs: maps with features

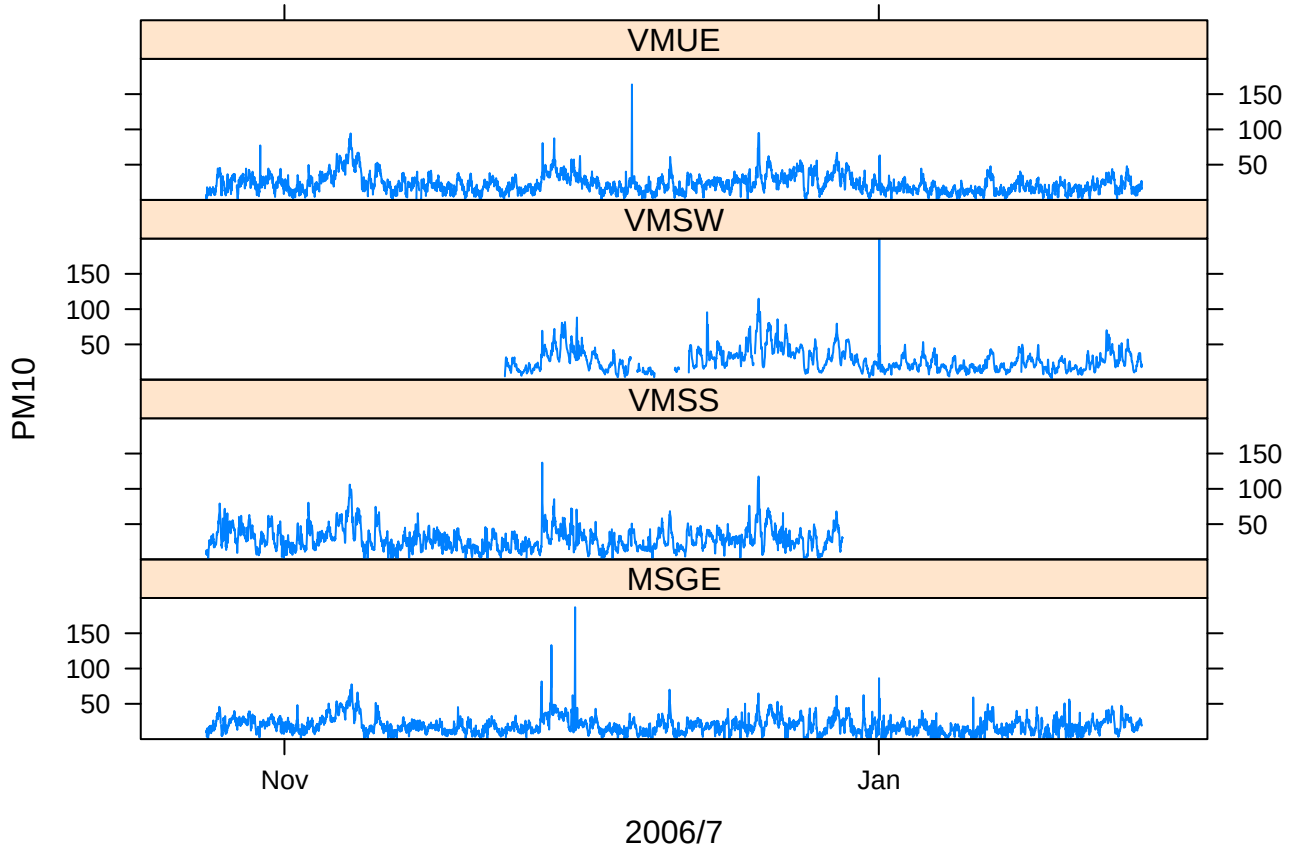
```
> library(sp)
> spplot(wetter.ll, "MESSWERT")
```



ifgi

Time series graphs: PM10

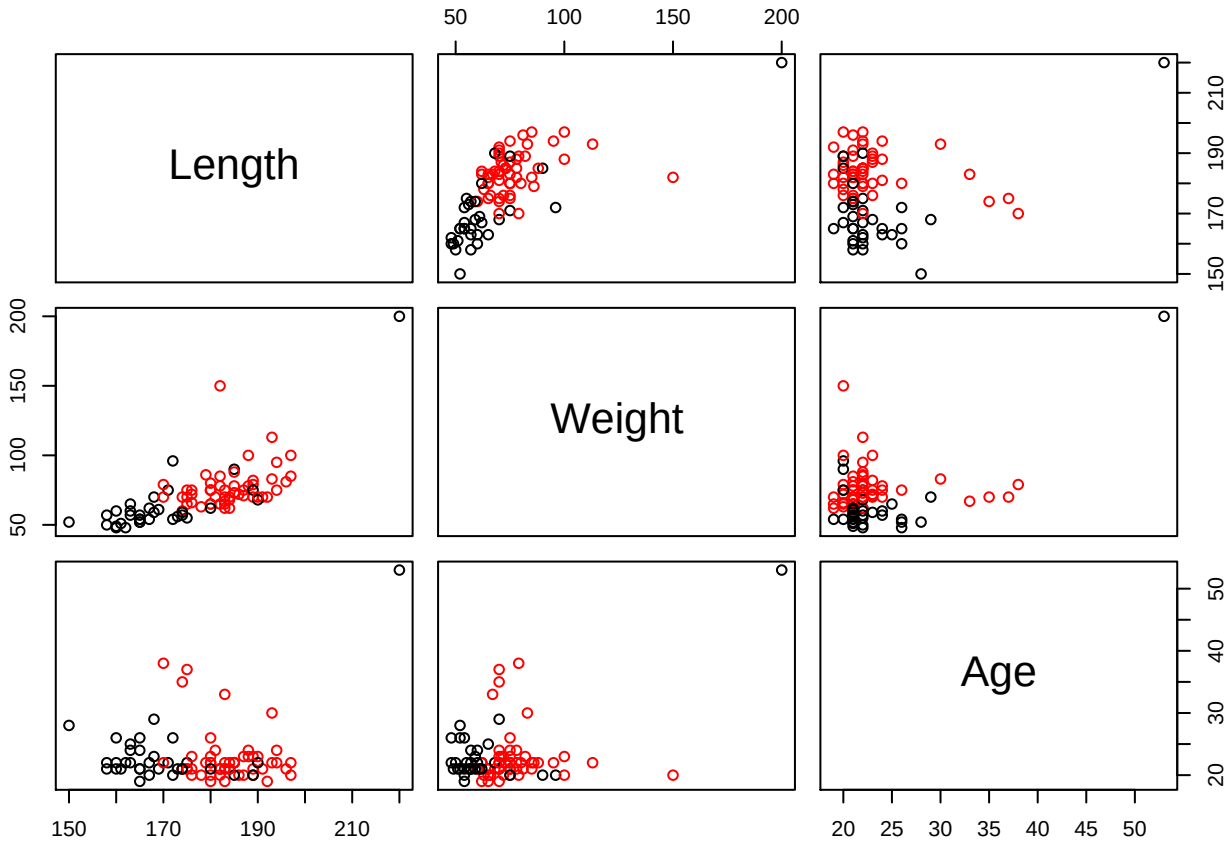
```
> library(lattice)
> load("pm10.RData")
> xyplot(values ~ time | Station, pm10tso, type = "l",
+     layout = c(1, 4), xlab = "2006/7", ylab = "PM10",
+     ylim = c(0, 200))
```



ifgi

Scatter plot matrix: students

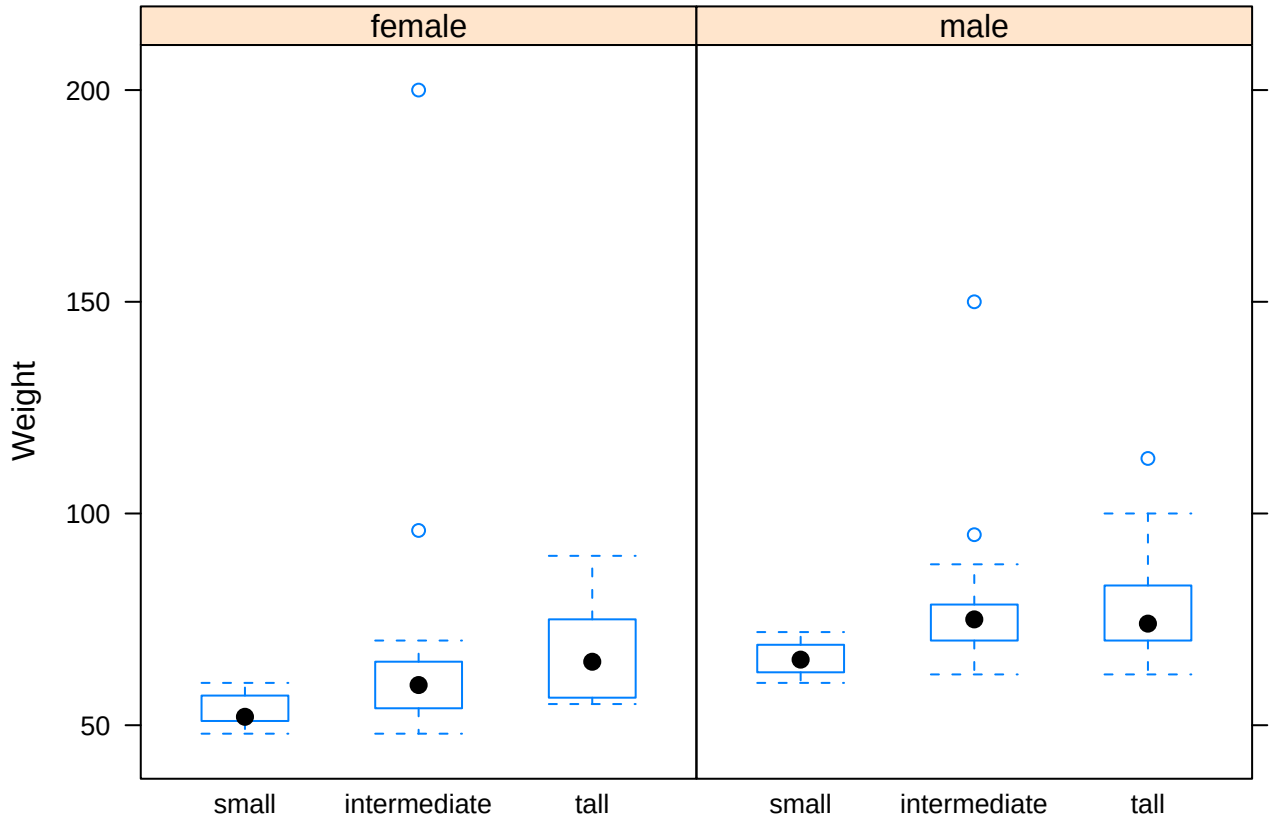
```
> plot(students[c("Length", "Weight", "Age")], col = as.numeric(student
```



ifgi

Trivariate graphs: 2. students

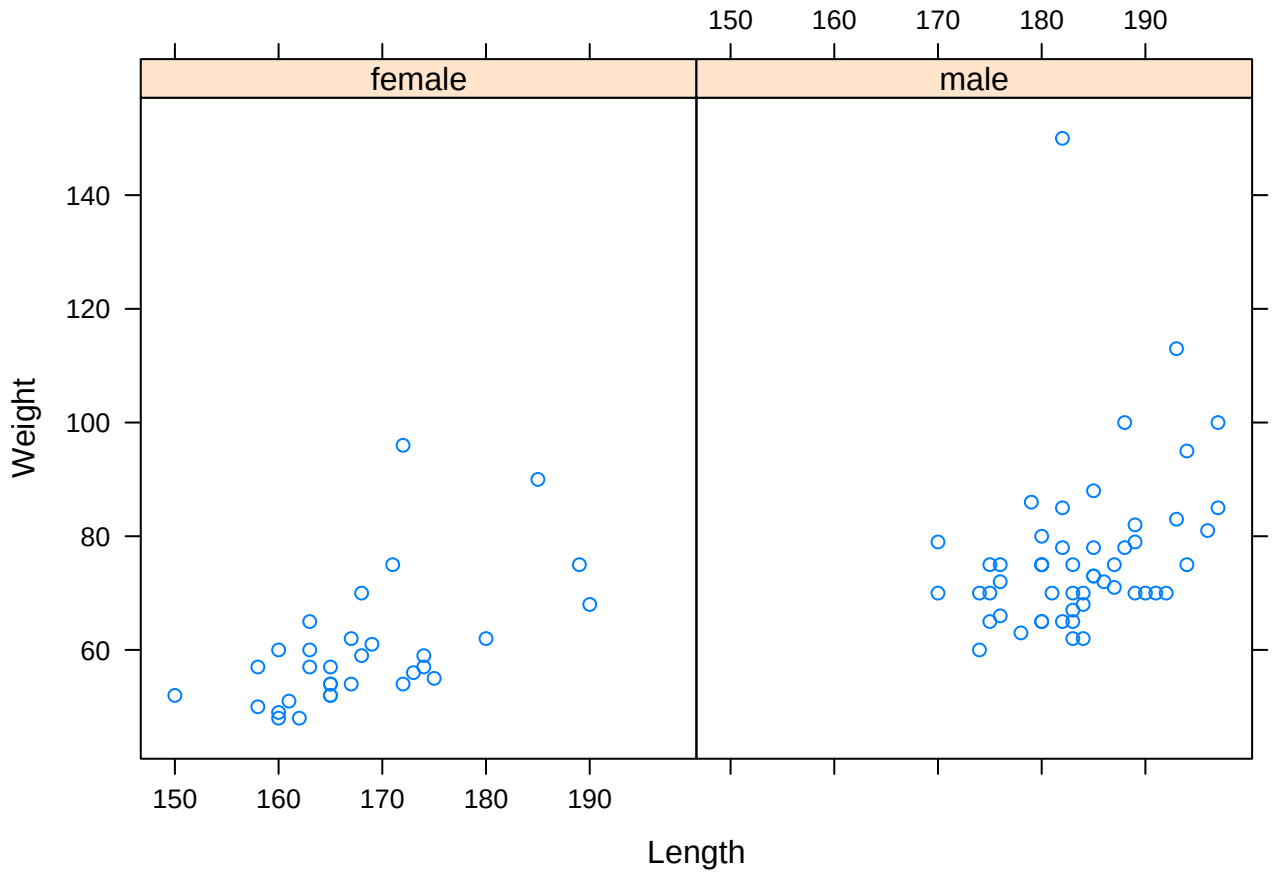
```
> library(lattice)
> bwplot(Weight ~ I.am.2 | Gender, students)
```



ifgi

Trivariate graphs 3: students

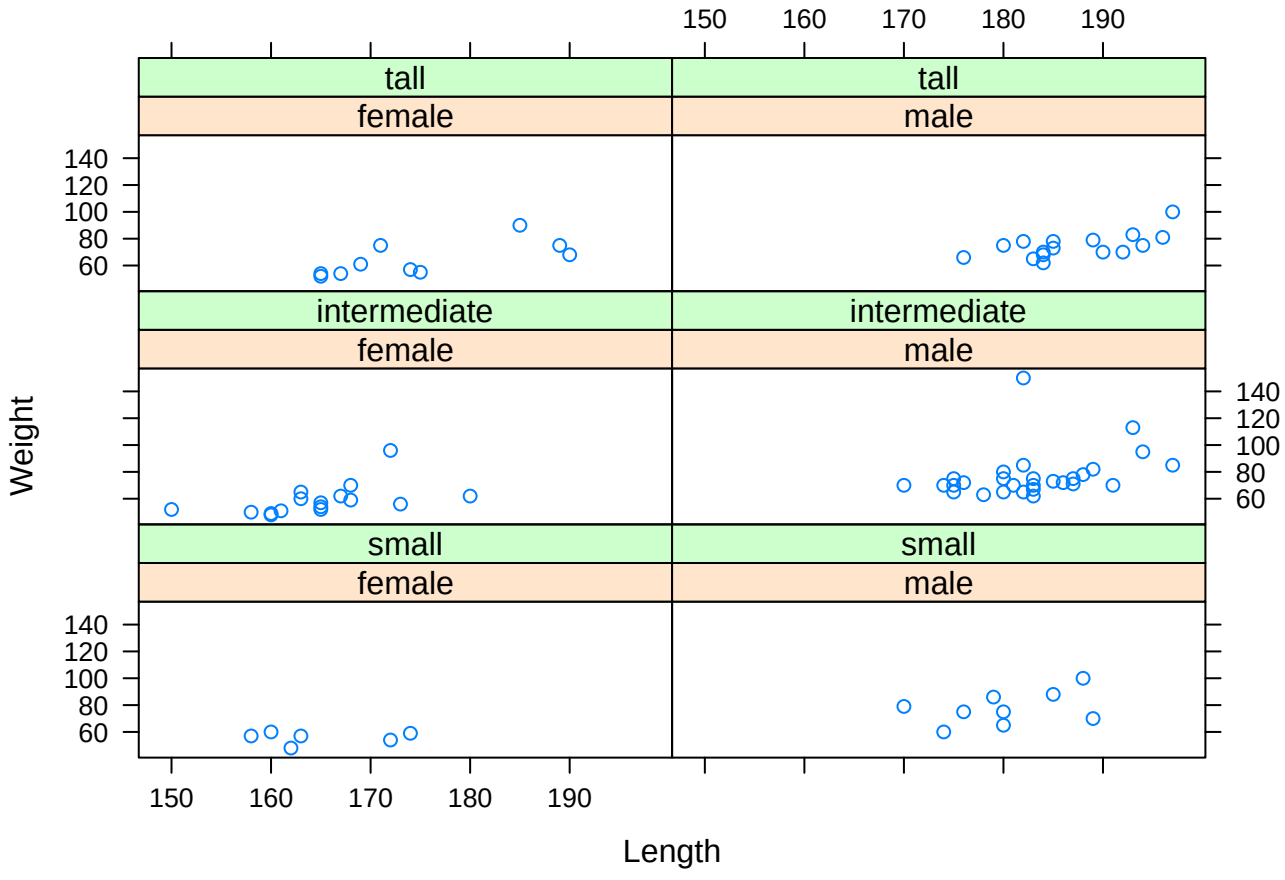
```
> library(lattice)
> check = Length < 220
> xyplot(Weight ~ Length | Gender, students[check, ])
```



ifgi

Multivariate graphs 2: students

```
> library(lattice)
> xyplot(Weight ~ Length | Gender + I.am.2, students[check,
+     ])
```



ifgi

Lattice `xyplot` examples

Why graphics are important

- a picture is worth more than a thousand words
- the other brain half
- dense information content, but the reader determines how much is read
- graphics need annotation (speach, written text), about

Why graphics are important

- a picture is worth more than a thousand words
- the other brain half
- dense information content, but the reader determines how much is read
- graphics need annotation (speach, written text), about

Why graphics are important

- a picture is worth more than a thousand words
- the other brain half
- dense information content, but the reader determines how much is read
- graphics need annotation (speach, written text), about
  - what it is about
  - ...

Why graphics are important

- a picture is worth more than a thousand words
- the other brain half
- dense information content, but the reader determines how much is read
- graphics need annotation (speach, written text), about
  - what it is about
  - what the the essential message is

Why graphics are important

- a picture is worth more than a thousand words
- the other brain half
- dense information content, but the reader determines how much is read
- graphics need annotation (speach, written text), about
  - what it is about
  - what the the essential message is

Why graphics are important

- a picture is worth more than a thousand words
- the other brain half
- dense information content, but the reader determines how much is read
- graphics need annotation (speach, written text), about
  - what it is about
  - what the the essential message is