R PROFILING AND OPTIMISATION

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Pending changes

Warning: this is under construction.

- Control information may be included as special stack in raw format.
- A list of profiles may become default. Only one profiling interval value per profile.
- Nodes may be implemented as *`factor`*.

Contents

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Key words and phrases. R programming, profiling, optimisation, R program language.
An R *vignette for package sprof.*
URL: `http://sintro.r-forge.r-project.org/` *Private Version*
.
URL: `http://sintro.r-forge.r-project.org/`.

Profiling facilities in R

R provides the basic instruments for profiling, both for time based samplers as for event based instrumentation. However this source of information seems to be rarely used.

Maybe the supporting tools are not adequate. The summaries provided by R reduce the information beyond necessity. Additional packages are available, but these are not sufficiently action oriented.

With package *sprof* we want to give a data representation that keeps the full profile information. Tools to answer common questions are provided. The data structure should make it easy to extend the tools as required.

The package is currently distributed at r-forge as part of the *sintro* material.

To install this package directly within R, type
`install.packages("sprof",repos="http://r-forge.r-project.org")`

To install the recent package from source directly within R, type
`install.packages("sprof",repos="http://r-forge.r-project.org",type="source")`

LaTeX Layout Tools and Utilities

Print parameters used here:

Input

```
options(width = 72)
options(digits = 6)
```

We want immediate warnings, if necessary. Set to level 2 to handle warnings as error.

Input

```
message("switching  options(warn=1) -- immediate warning on")
options(warn=1)
```

For larger tables and data frames, we use a kludge to avoid long outputs.

ToDo: add keep3 to keep header, some middle, tail

Input
```
xcutdata.frame <- function(df,  cut, margin){
#! keep3, to add: margin top - random center - margin bottom
        if (!is.data.frame(df)) return(df)
        nrow <- nrow(df)
        # cut a range if it is not empty.
        # Quiet noop else.
        # Does not cut single lines.
         cutrng <- function(cutfrom,cutto){
                 if (cutfrom<cutto){
                df[cutfrom,] <- NA
                if (!is.null(rownames(df))) rownames(df)[cutfrom] <- "< cut >"
                if (!is.null(df$name)) df$name[cutfrom] <- ""

                cutfrom <- cutfrom+1
                df[-(cutfrom:cutto),]
                }#if
        }
        if (!missing(cut))  {df <- cutrng(cut[1],cut[2]); return(df)}
        if (!missing(margin))  {
                if (length(margin)==1) margin <-  c(margin,margin)
        cut <- c(margin[1]+1,nrow-margin[2])
        df <-cutrng(cut[1],cut[2]);
        return(df)}
#        if (!missing(keep3))  { cut <- c(keep3[1]+1, keep3[1]+1,
#                nrow-keep3[3]-1,nrow-keep3[3]-1)
#        if (cut[3]-cut[4] > keep3[2]+2){delta<-(cut[3]-cut[2]) div 2
#        cut[3]<-0
#        browser()
#        } else df <- cutrng(cut[1],cut[4])
#        cutrng(cut[1],cut[4]) return(df)}
}
```

We use the R function *xtable()* for output and LaTeX *longtable*. A convenient wrapper to use this in out *Sweave* source is:

ToDo: remove text vdots from string/-name columns

Input
```
library(xtable)
prxt <- function (x, digits=3,         caption=NULL,
        label=NULL, ...)  {
        margin <- 10
        if (nrow(x)> 2*margin+3) x <-xcutdata.frame(x, margin=margin)
        print(
                xtable(x, digits=digits, caption=caption,
                                label=label, ...),
                floating=FALSE,
                tabular.environment="longtable",
                caption.placement="top",
                NA.string="\\vdots")
        }
```

This is to be used with `<<print=FALSE, results =tex, label=tab:prxx>>=`

1. Profiling

The basic information provided by all profilers in is a protocol of sampled stacks. For each recorded event, the protocol has one record, such as a line with a text string showing the sampled stack.

We use profiles to provide hints on the dynamic behaviour of programs. Most often, this is used to improve or even optimise programs. Sometimes, it is even used to understand some algorithm.

Profiles represent the program flow, which is considered to be laid out by the control structure of a program. The control structure is represented by the control graph, and this leads to the common approach to (re)construct the control graph, map the profile to this graph, and used graph based methods for further analysis. The prime example for this strategy is the GNU profiler *gprof* (see `http://sourceware.org/binutils/docs/gprof/`) which is used as master plan for many common profilers.

It is only half of the truth that the control graph can serve as a base for the profiled stacks. In R, we have some peculiarities.

lazy evaluation: Arguments to functions can passed as promises. These are only evaluated when needed, which may be at a later time, and may then lead to insertions in the stack. So we may have information resulting from the data flow, interspersed with the control flow.

memory management: Allocation of memory, and garbage collection, may interfere and leave their traces in the stack. While allocation is closely related to the visible control flow, garbage collection is a collective effect largely out of control of the code to execute.

primitives: Internal functions may escape the usual stack conventions and execute without leaving any identifiable trace on the stack.

control structures: In R, many control structures are implemented as function. Most notably, the *apply()* family appear as function calls and lead to cliques in the graph representation that do not correspond to relevant structures. Since these functions are well know, they can have a special treatment.

So while the stack follows an overall well known dynamics, in R there are exceptions from regularity. The general approach, by *summaryRprof()* and others, is to reduce the profile to node information, or two consider single transitions.

We take a different approach. We take the stacks, as recorded in the profiles as our basic information unit. From this, we ask: what are the actions we need to answer our questions? Representation in graphs may come later, if they can help.

If the stacks would come from the control flow only, we could make use of the sequential nature of stacks. But since we have to live with the R specific interferences, we stay with the raw stacks.

Input
```
options(error = recover)
library(sprof)
```

In this presentation, we will use a small list of examples Since *Rprof* is not implemented on all systems, and since the profiles tend to get very large, we use some prepared examples that are frozen in this vignette and not included in the distribution, but all the code to generate the examples is provided.

1.1. Simple regression example.

Input
```
n <- 10000
x <- runif(n)
err <- rnorm(n)
y <- 2+ 3 * x + err
reg0data <- data.frame(x=x, y=y, err=err)
rm(x,y,err)
```

We will use this example to illustrate the basics. Of course the immediate questions are the variance between varying samples, and the influence of the sample size n. We keep everything fixed, so the only issue for now is the computational performance under strict iid conditions.

Still we have parameters to choose. We can determine the profiling granularity by setting the timing interval, and we can use repeated measurements to increase precision below the timing interval.

The timing interval should depend on the clock speed. Using for example 1ms amounts to some 1000 steps on a current CPU, per kernel.

If we use repeated samples, the usual rules of statistics applies. So taking 100 runs and taking the mean reduces the standard deviation by a factor 1/10.

Input
```
profinterval <- 0.001
simruns <- 100
Rprof(filename="RprofsRegressionExpl.out", interval = profinterval)
for (i in 1:simruns) xxx<- summary(lm(y~x, data=reg0data))
Rprof(NULL)
```

We now have the profile data in a file *RprofsRegressionExpl.out*. For this vignette, we use a frozen version *RprofsRegressionExpl01.out*.

1.1.1. *R basic.* The basic R invites us to get a summary.

Input

```
sumRprofRegressionExpl <- summaryRprof("RprofsRegressionExpl01.out")
str(sumRprofRegressionExpl, vec.len=3)
```

```
Output
List of 4
 $ by.self        :'data.frame':        41 obs. of  4 variables:
  ..$ self.time : num [1:41] 0.087 0.057 0.051 0.043 0.042 0.04 0.032 0.026 ...
  ..$ self.pct  : num [1:41] 16.67 10.92 9.77 8.24 ...
  ..$ total.time: num [1:41] 0.113 0.099 0.069 0.043 0.474 0.045 0.033 0.114 ...
  ..$ total.pct : num [1:41] 21.65 18.97 13.22 8.24 ...
 $ by.total       :'data.frame':        62 obs. of  4 variables:
  ..$ total.time: num [1:62] 0.522 0.522 0.521 0.521 0.521 0.521 0.521 0.521 ...
  ..$ total.pct : num [1:62] 100 100 99.8 99.8 ...
  ..$ self.time : num [1:62] 0.006 0 0.001 0 0 0 0 0 ...
  ..$ self.pct  : num [1:62] 1.15 0 0.19 0 0 0 0 0 ...
 $ sample.interval: num 0.001
 $ sampling.time  : num 0.522
```

The summary reduces the information contained in the profile to marginal statistics per node. This is provided in two data frames giving the same information, only in different order.

The file contains several spurious recordings: nodes that have been recorded only few times. It is worth noting these, but then they better be discarded. We use a time limit of 4ms, which given our sampling interval of 1ms means we require more than four observations.

```
Input
prxt(sumRprofRegressionExpl$by.self,
        caption="summaryRprof result: by.self as final stack entry, all records",
        label="tab:prSRREbs")
```

Table 1: summaryRprof result: by.self as final stack entry, all records

	self.time	self.pct	total.time	total.pct
"lm.fit"	0.087	16.670	0.113	21.650
"[.data.frame"	0.057	10.920	0.099	18.970
"model.matrix.default"	0.051	9.770	0.069	13.220
"as.character"	0.043	8.240	0.043	8.240
"lm"	0.042	8.050	0.474	90.800
"summary.lm"	0.040	7.660	0.045	8.620
"structure"	0.032	6.130	0.033	6.320
"na.omit.data.frame"	0.026	4.980	0.114	21.840
"anyDuplicated.default"	0.022	4.210	0.022	4.210
"as.list.data.frame"	0.022	4.210	0.022	4.210
< cut >	⋮	⋮	⋮	⋮
"FUN"	0.001	0.190	0.007	1.340
"%in%"	0.001	0.190	0.004	0.770
"deparse"	0.001	0.190	0.002	0.380
"$"	0.001	0.190	0.001	0.190

"as.list.default"	0.001	0.190	0.001	0.190
"as.name"	0.001	0.190	0.001	0.190
"coef"	0.001	0.190	0.001	0.190
"file"	0.001	0.190	0.001	0.190
"NCOL"	0.001	0.190	0.001	0.190
"terms.formula"	0.001	0.190	0.001	0.190

Input
```
prxt(sumRprofRegressionExpl$by.total[sumRprofRegressionExpl$by.total$total.time>0.004,],
        caption="summaryRprof result: by.total, total time > 0.004s",
        label="tab:prSRREbt")
```

Table 2: summaryRprof result: by.total, total time > 0.004s

	total.time	total.pct	self.time	self.pct
"<Anonymous>"	0.522	100.000	0.006	1.150
"Sweave"	0.522	100.000	0.000	0.000
"eval"	0.521	99.810	0.001	0.190
"doTryCatch"	0.521	99.810	0.000	0.000
"evalFunc"	0.521	99.810	0.000	0.000
"try"	0.521	99.810	0.000	0.000
"tryCatch"	0.521	99.810	0.000	0.000
"tryCatchList"	0.521	99.810	0.000	0.000
"tryCatchOne"	0.521	99.810	0.000	0.000
"withVisible"	0.521	99.810	0.000	0.000
< cut >	⋮	⋮	⋮	⋮
"as.list"	0.023	4.410	0.000	0.000
"anyDuplicated.default"	0.022	4.210	0.022	4.210
"as.list.data.frame"	0.022	4.210	0.022	4.210
"sapply"	0.014	2.680	0.001	0.190
"match"	0.011	2.110	0.001	0.190
"[[.data.frame"	0.008	1.530	0.001	0.190
"[["	0.008	1.530	0.000	0.000
"rep.int"	0.007	1.340	0.007	1.340
"FUN"	0.007	1.340	0.001	0.190
"list"	0.005	0.960	0.005	0.960

1.1.2. *Package sprof.* In contrast to the common R packages, in our implementation we take a two step approach. First we read in the profile file to an internal representation. Analysis is done in later steps.

```
Input
sprof01lm <- readRprof("RprofsRegressionExpl01.out")
sprof01 <- sprof01lm
```

We keep this example and use the copy `sprof01` of it extensively for illustration.

```
Input
save(sprof01lm, file="sprof01lm.RData")
```

To run the vignette with a different profile, replace `sprof01` by your example. You still have `sprof01lm` for reference.

Package `sprof` provides a function `sampleRprof()` to take a sample and create a profile on the fly, as in

```
Input
sprof01temp <- sampleRprof(runif(10000), runs=100)
```

The basic data structure consists of four data frames. The ircodeinfo section collects global information from the input file, such as an identification strings and various global matrix. The `nodes` section initially gives the same information marginal information as `summaryRprof`. The `stacks` section puts the node information into their calling context as found in the input profile file. The `profiles` section gives the temporal context. It is implemented as a list, but conceptually it is a data frame. Implementing it as a list allows run length encoding of variables, which unfortunately is not allowed by R in data frames.

```
Input
str(sprof01, max.level=2, vec.len=3,nchar.max=40)
```

```
Output
List of 4
 $ info    :'data.frame':        1 obs. of  8 variables:
  ..$ id       : Factor w/ 1 level "\"RprofsRegressionExpl01.out\" 2013-06-"| __truncated__: 1
  ..$ date     : POSIXct[1:1], format: "2013-07-14 22:27:19"
  ..$ nrnodes  : int 62
  ..$ nrstacks : int 50
  ..$ nrrecords: int 522
  ..$ firstline: Factor w/ 1 level "sample.interval=1000": 1
  ..$ ctllines : Factor w/ 1 level "sample.interval=1000": 1
  ..$ ctllinenr: num 1
 $ nodes   :'data.frame':        62 obs. of  5 variables:
  ..$ name      : Factor w/ 62 levels "!","..getNamespace",..: 1 2 3 4 5 6 7 8 ...
  ..$ self.time : num [1:62] 2 0 2 0 0 57 0 1 ...
  ..$ self.pct  : num [1:62] 0.38 0 0.38 0 ...
  ..$ total.time: num [1:62] 2 1 4 26 99 99 8 8 ...
  ..$ total.pct : num [1:62] 0.03 0.01 0.05 0.34 1.29 1.29 0.1 0.1 ...
 $ stacks  :'data.frame':        50 obs. of  7 variables:
  ..$ nodes         :List of 50
  ..$ shortname     : Factor w/ 50 levels "S<A>eFttCtCLtCOdTCwVeesleem.m..n.n...[["| __truncated__,.
  ..$ refcount      : num [1:50] 1 5 26 55 13 43 51 87 ...
  ..$ stacklength   : int [1:50] 19 20 19 21 14 15 15 14 ...
  ..$ stackheadnodes: int [1:50] 52 52 52 52 52 52 52 52 ...
  ..$ stackleafnodes: int [1:50] 27 28 41 6 39 14 38 30 ...
  ..$ stackssrc     : Factor w/ 50 levels "! [.data.frame [ na.omit.data.frame na."| __truncated__,.
 $ profiles:List of 4
  ..$ data    : int [1:522] 1 2 2 3 4 4 5 5 ...
  ..$ mem     : NULL
  ..$ malloc  : NULL
  ..$ timesRLE:List of 2
  .. ..- attr(*, "class")= chr "rle"
 - attr(*, "class")= chr [1:2] "sprof" "list"
```

The nodes do not come in a specific order. Access via a permutation vector is preferred. This allows different views on the same data set. For example, table 3 on the following page uses a permutation by total time, and a selection (compare to table 2 on page 7). The only difference is that we work on a ms base internally, whereas R uses seconds as a base.

ToDo: introduce cpu clock cycle as a time base

Input
```
nodes <- sprof01$nodes[order(sprof01$nodes$total.time, decreasing=TRUE),]
prxt(nodes[nodes$total.time>4,],
caption="splot result: by.total, total time > 0.004s",
        label="tab:prspbt")
```

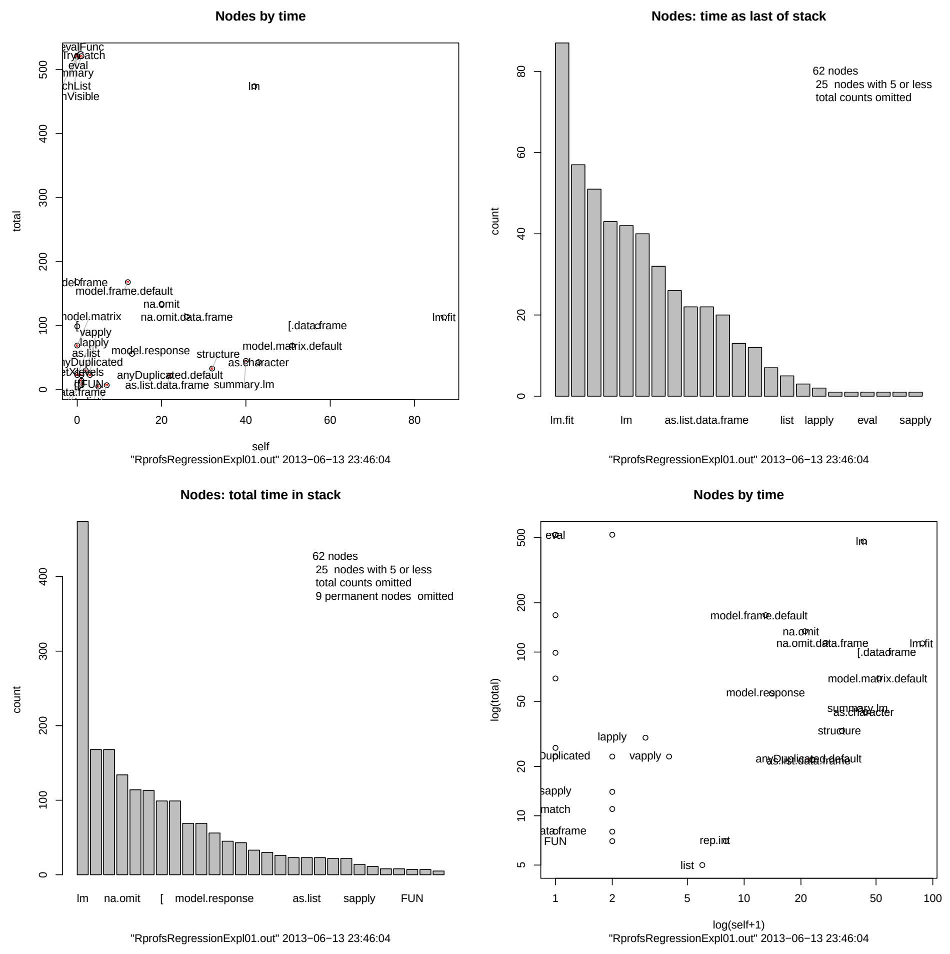
Table 3: splot result: by.total, total time > 0.004s

	name	self.time	self.pct	total.time	total.pct
10	<Anonymous>	6.000	1.150	522.000	6.790
52	Sweave	0.000	0.000	522.000	6.790
21	doTryCatch	0.000	0.000	521.000	6.780
22	eval	1.000	0.190	521.000	6.780
23	evalFunc	0.000	0.000	521.000	6.780
55	try	0.000	0.000	521.000	6.780
56	tryCatch	0.000	0.000	521.000	6.780
57	tryCatchList	0.000	0.000	521.000	6.780
58	tryCatchOne	0.000	0.000	521.000	6.780
62	withVisible	0.000	0.000	521.000	6.780
< cut >	\vdots	⋮	⋮	⋮	⋮
61	vapply	3.000	0.570	23.000	0.300
13	anyDuplicated.default	22.000	4.210	22.000	0.290
16	as.list.data.frame	22.000	4.210	22.000	0.290
47	sapply	1.000	0.190	14.000	0.180
31	match	1.000	0.190	11.000	0.140
7	[[	0.000	0.000	8.000	0.100
8	[[.data.frame	1.000	0.190	8.000	0.100
25	FUN	1.000	0.190	7.000	0.090
46	rep.int	7.000	1.340	7.000	0.090
28	list	5.000	0.960	5.000	0.070

ToDo: remove text vdots from string/-name columns

Common rearrangements as by total time and by self time are supplied by the display functions. Plot, for example, currently gives a choice of four displays for nodes.

Input
```
oldpar <- par(mfrow=c(2,2))
plot_nodes(sprof01)
par(oldpar)
```



We can add attributes to the plots. But we can also attributes to the nodes, and use these in the plots. The attribute `icol` is a special case. If present, it will be interpreted as an index to a colour table. For example, we can collect special well known functions in groups:

Input

```
x_apply <- c("apply", "lapply", "vapply", "sapply")
x_as <- c("as.list", "as.data.frame", "as.list.data.frame",
        "as.character", "as.list.default","as.name")
```

(Extend as you need it) and then us as for example:

Input
```
nodeclass <- rep("x_nn", sprof01$info$nrnodes)
nodeclass[sprof01$nodes$name %in% x_apply] <- "x_apply"
nodeclass[sprof01$nodes$name %in% x_as] <- "x_as"
```

or use assignments on the fly

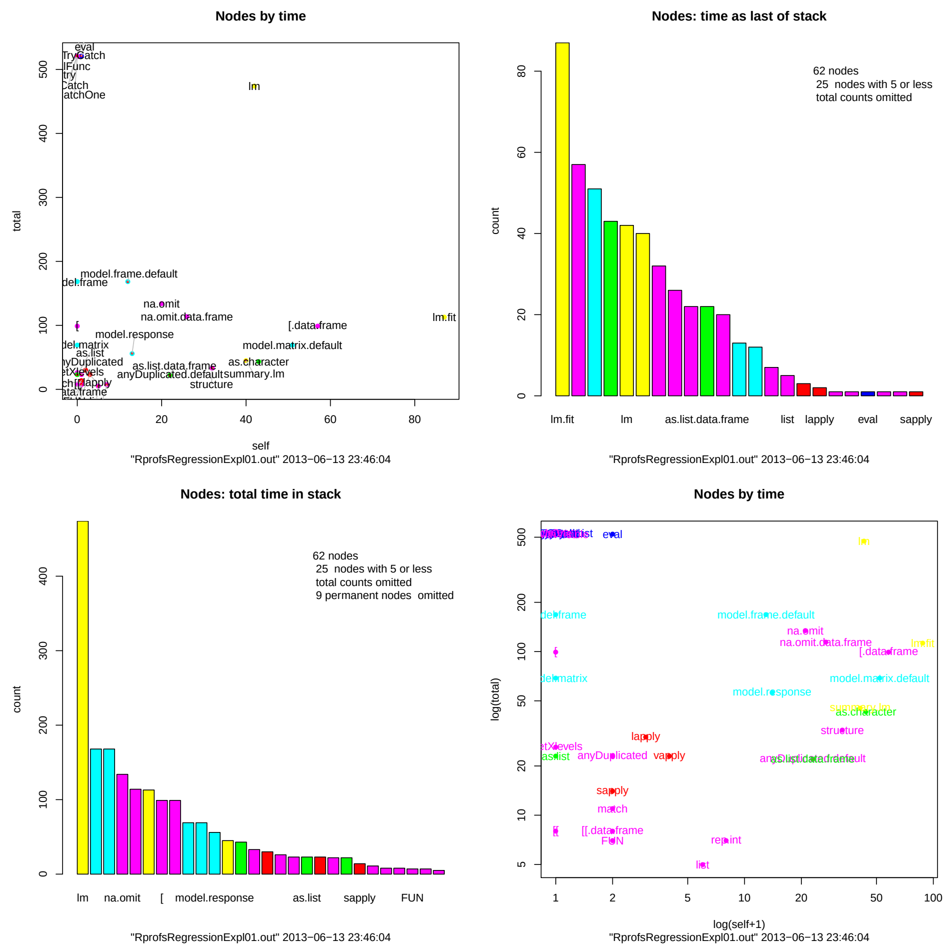
Input
```
nodeclass[sprof01$nodes$name %in%
        c("eval",  "evalFunc",
                "try", "tryCatch", "tryCatchList", "trCatchOne",
                "doTryCatch")
                ] <- "x_eval"
nodeclass[sprof01$nodes$name %in%
        c("model.frame", "model.matrix.default","model.frame.default",
         " model.response", "model.matrix", "model.response")
                ] <- "x_model"
nodeclass[sprof01$nodes$name %in%
        c("lm", "lm.fit", "summary.lm")
                ] <- "x_lm"
```

Input
```
sprof01$nodes$icol <-as.factor(nodeclass)
```

adds a sticky color attribute. To interpret, you should choose your preferred color palette, for example

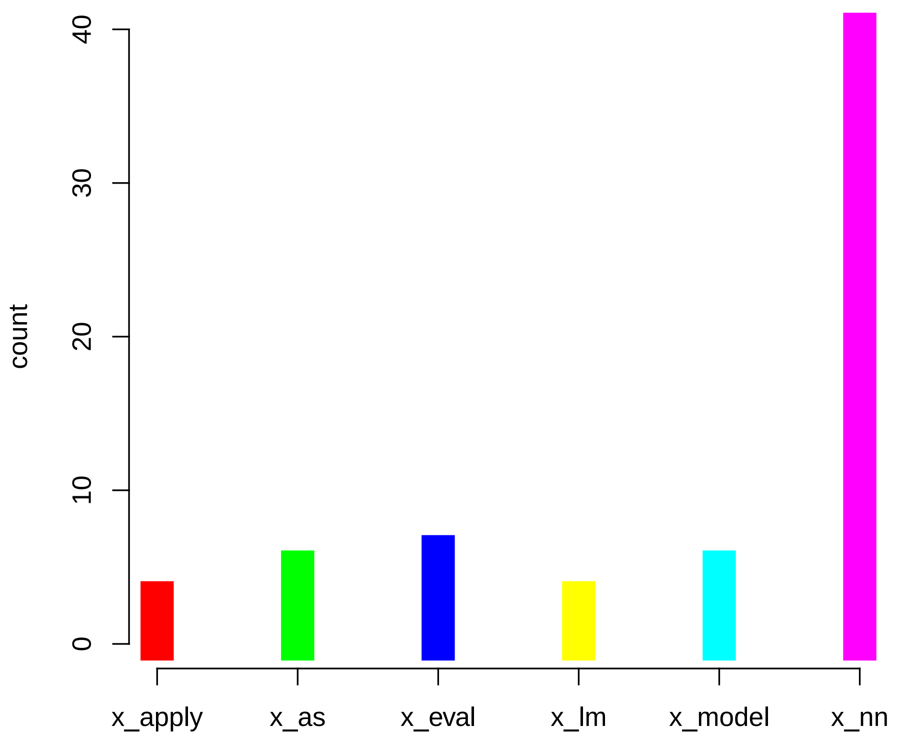
Input
```
col=c("red", "green", "blue", "yellow", "cyan", "magenta")
```

Input
```
oldpar <- par(mfrow=c(2,2))
plot_nodes(sprof01, col=c("red", "green", "blue", "yellow", "cyan", "magenta"))
par(oldpar)
```



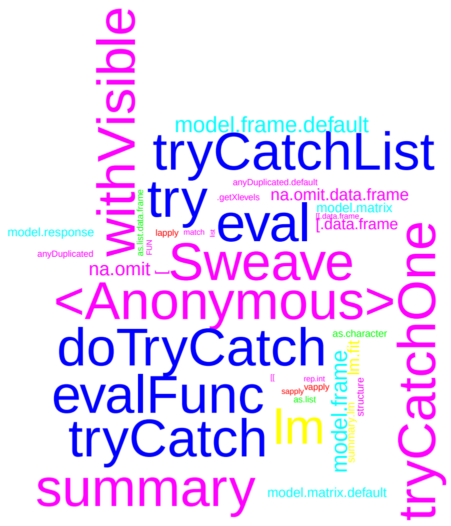
You can break down the frequency by the classes you have define. But beware of Simpson's paradox. The information you think you see may be strongly affected by your choices - what you see are reflections of conditional distributions. These may very different from the global picture.

Input
```
plot(table(sprof01$nodes$icol),
        type="h", lwd=20,col=col, lend="square", ylab="count")
```



If package ***wordcloud*** is installed, a different view is possible.

Input
```
nodescloud <- function(sprof,min.freq=3, col){
        wordcloud(sprof$nodes$name, freq = sprof$nodes$total.time,
                min.freq=min.freq,
                random.order=FALSE,
                rot.per=0.3,
                colors = col[sprof01$nodes$icol],
                ordered.colors=TRUE)
        }
nodescloud(sprof01, min.freq=5,
                col=c("red", "green", "blue", "yellow", "cyan", "magenta"))
```



2. A better grip on profile information

The basic information provided by all profilers in R is a protocol of sampled stacks. The conventional approach is to break the information down to nodes and edges. The stacks provide more information than this. One way to access it is to use linking to pass information.

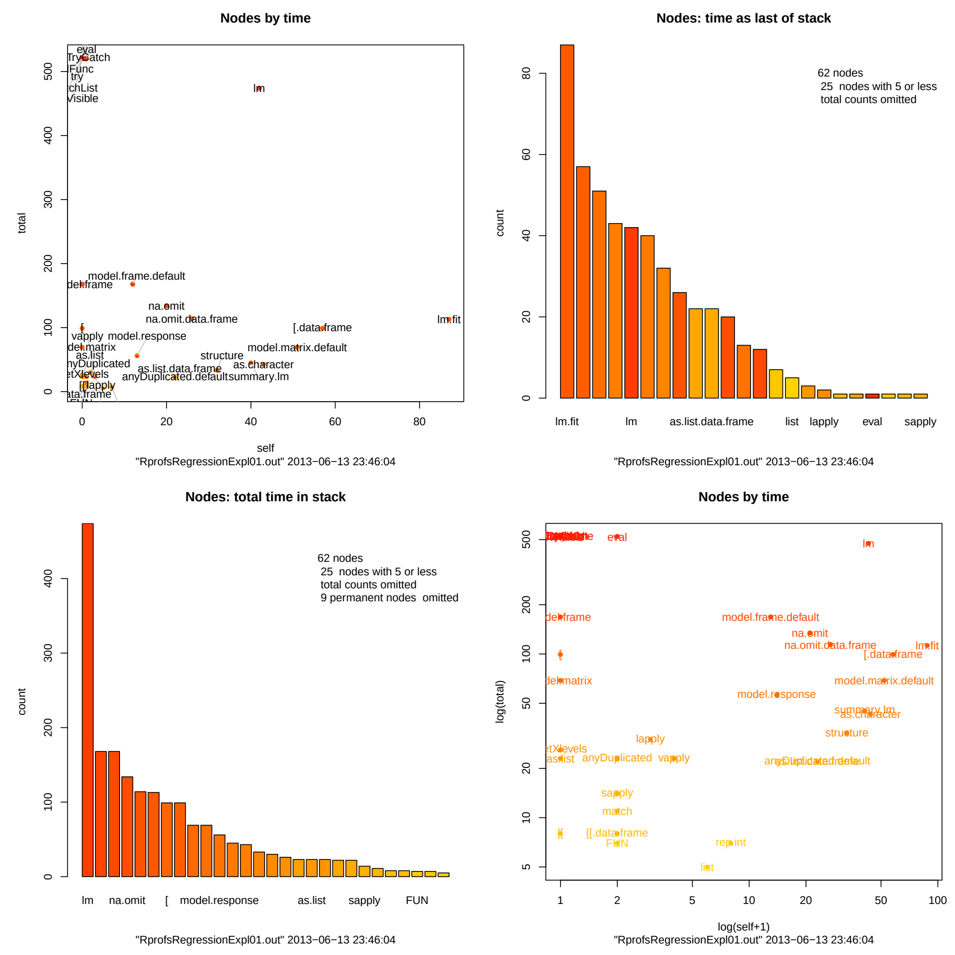
To illustrate this, we encode the frequency of the nodes as colour. As a palette, we choose a heat map here.

Input
```
freqrank <- rank(-sprof01$nodes$total.time, ties.method="random")
col <- heat.colors(length(freqrank))
```

Here is the node view using these choices:

Input
```
sprof01$nodes$icol <- freqrank
oldpar <- par(mfrow=c(2,2))
```

```
plot_nodes(sprof01, col=col)
par(oldpar)
```



We can go beyond node level.

This is what we get for free from the node information on our three levels: node, stack, and profile.

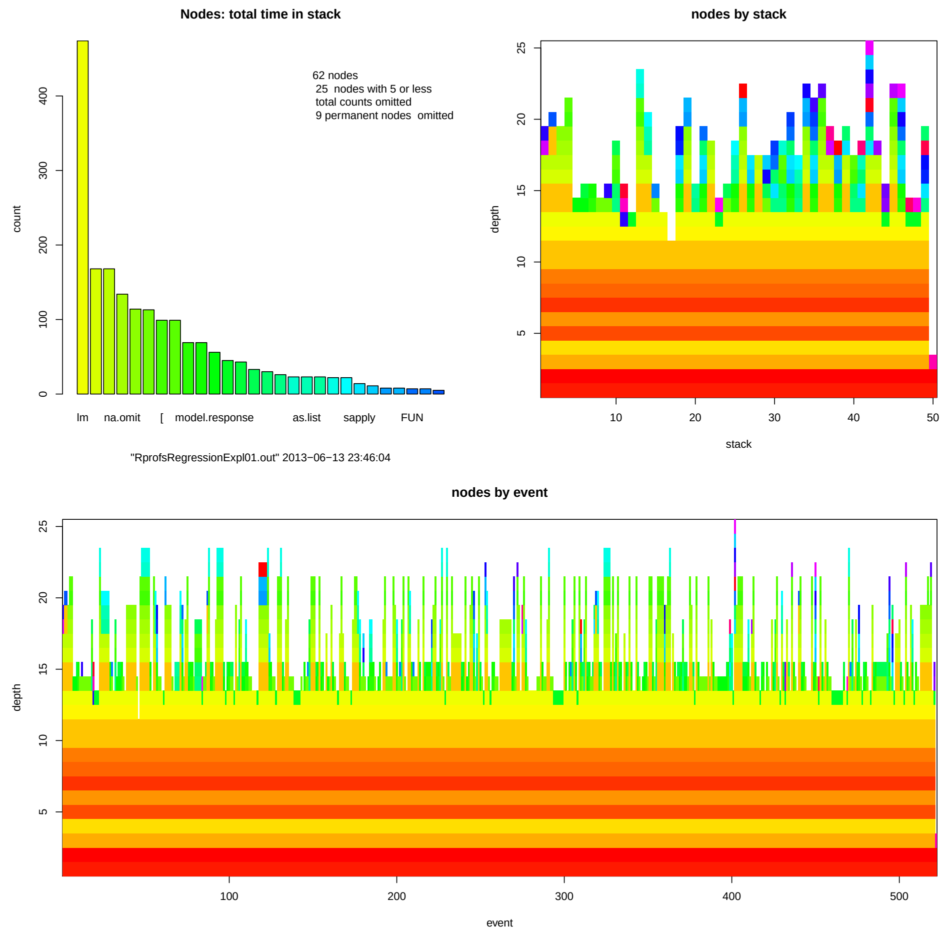
ToDo: check and stabilize colour linking

```
Input
shownodes <- function(sprof=sprof01, col) {
#oldpar <- par(mfrow=c(1,3))
oldpar<- par(no.readonly = TRUE)
layout(matrix(c(1,2,3,3), 2, 2, byrow = TRUE))

#plot_nodes # 3
xnodes <- sprof$nodes
src <- sprof$info$src
mincount <- 5
nrnodes <- dim(xnodes)[1]
```

```
 totaltime <- sum(xnodes$self.time)
if(missing(col)) col <- rainbow(nrnodes)

ordertotal<- order(xnodes$total.time,decreasing=TRUE);
if (is.null(xnodes$icol)) {warning("nodes$icol is undefined. Generated on the fly.")
icol <-ordertotal
xnodes$icol <- icol
sprof$xnodes$icol <- icol
}
xnodes <- xnodes[xnodes$total.time < totaltime,]
#browser()
if (mincount>0) xnodes <- xnodes[xnodes$total.time>=mincount,]
trimmed <- nrnodes-dim(xnodes)[1]

totaltime <- sum(xnodes$self.time)
fulltime <- dim(xnodes)[1]
xnodes <- xnodes[xnodes$total.time < totaltime,]
fulltime <- fulltime - dim(xnodes)[1]
ordertotal<- order(xnodes$total.time,decreasing=TRUE);

# nodes
plot_nodes(sprof, which=3, ask=FALSE, col=col)

stacks_nodes <- list.as.matrix(sprof$stacks$nodes)
sn <- stacks_nodes
sn <- sprof$nodes$icol[sn]
dim(sn)<-dim(stacks_nodes)
image(x=1:ncol(stacks_nodes),y=1:nrow(stacks_nodes),
t(sn), col=col,
xlab="stack", ylab="depth", main="nodes by stack")

#image(x=1:ncol(stacks_nodes),y=1:nrow(stacks_nodes),
#t(stacks_nodes), col=col,
#xlab="stack", ylab="depth", main="nodes by stack")

profile_nodes <- profiles_matrix(sprof)
pn <- profile_nodes
pn <- sprof$nodes$icol[pn]
dim(pn)<-dim(profile_nodes)

image(x=1:ncol(profile_nodes),y=1:nrow(profile_nodes),
t(pn),col=col,
xlab="event", ylab="depth", main="nodes by event")
par(oldpar)
}
```

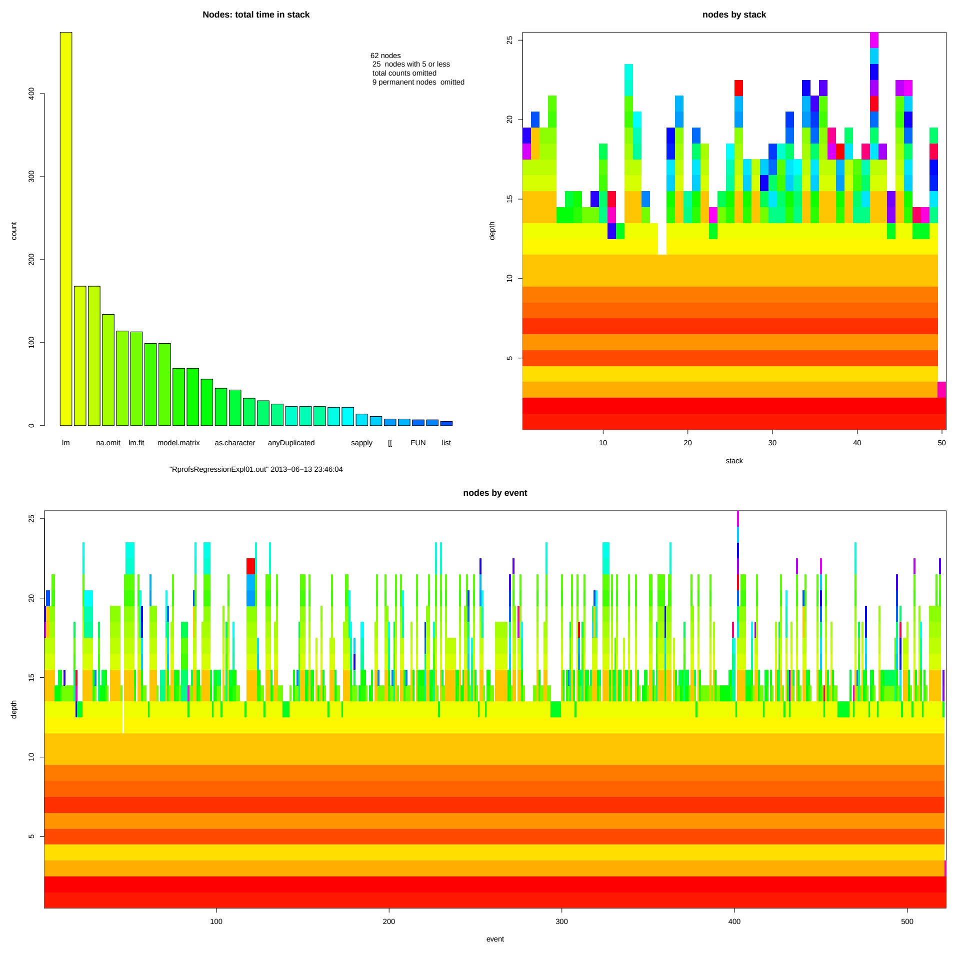
Input

```
#12
shownodes(sprof01)
```



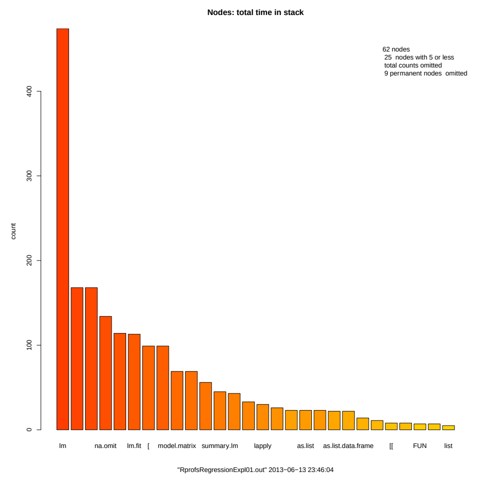
Input

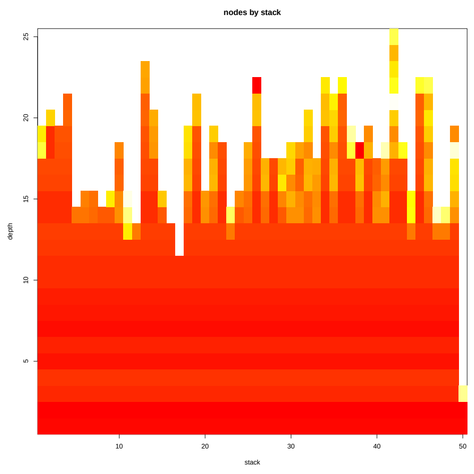
```
#18
shownodes(sprof01, col=rainbow(62))
```

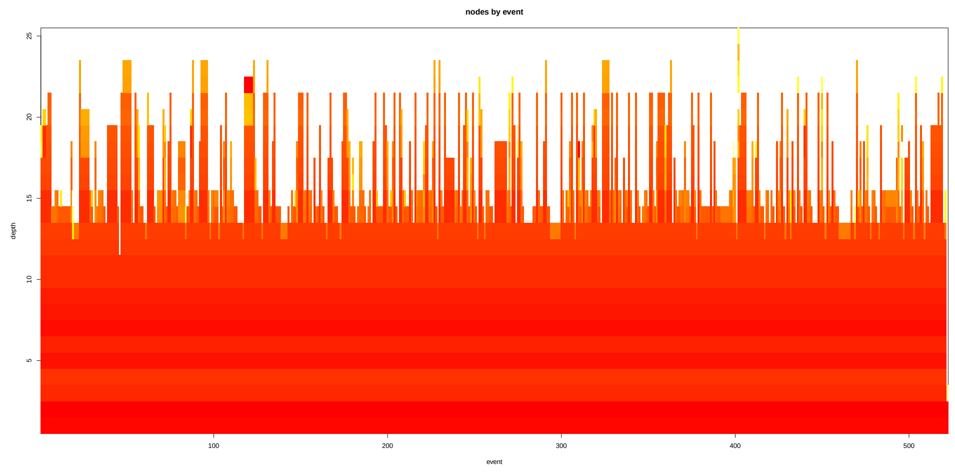


Input

```
#20
shownodes(sprof01, col=heat.colors(62))
```







The obvious message is that if seen by stack level, there are different structures. Profiling usually takes place in a framework. So at the base of the stacks, we find entries that are (almost) persistent. Then usually we have some few steps where the algorithm splits, and then we have the finer details. These can be identified using information on the stack level, but of course they are not visible on the node or edge level.

Not so often, but a frequent phenomenon is to have some “burn in” or “fade out”. To identify this, we need to look at the profile level.

At a closer look, we may find stack patterns (maybe marked by specific nodes) that indicate administrative intervention and rather should be handled as separators between distinct profiles rather than as part of the general dynamics.

Stable framework effect can be detected automatically. “burn in” or “fade out’ may need a closer look, and special stacks need and individual inspection on low frequency stacks.

Before starting additional inspection, the data better be trimmed. At this point, it is a decision whether to adapt the timing information, or keep the original information.

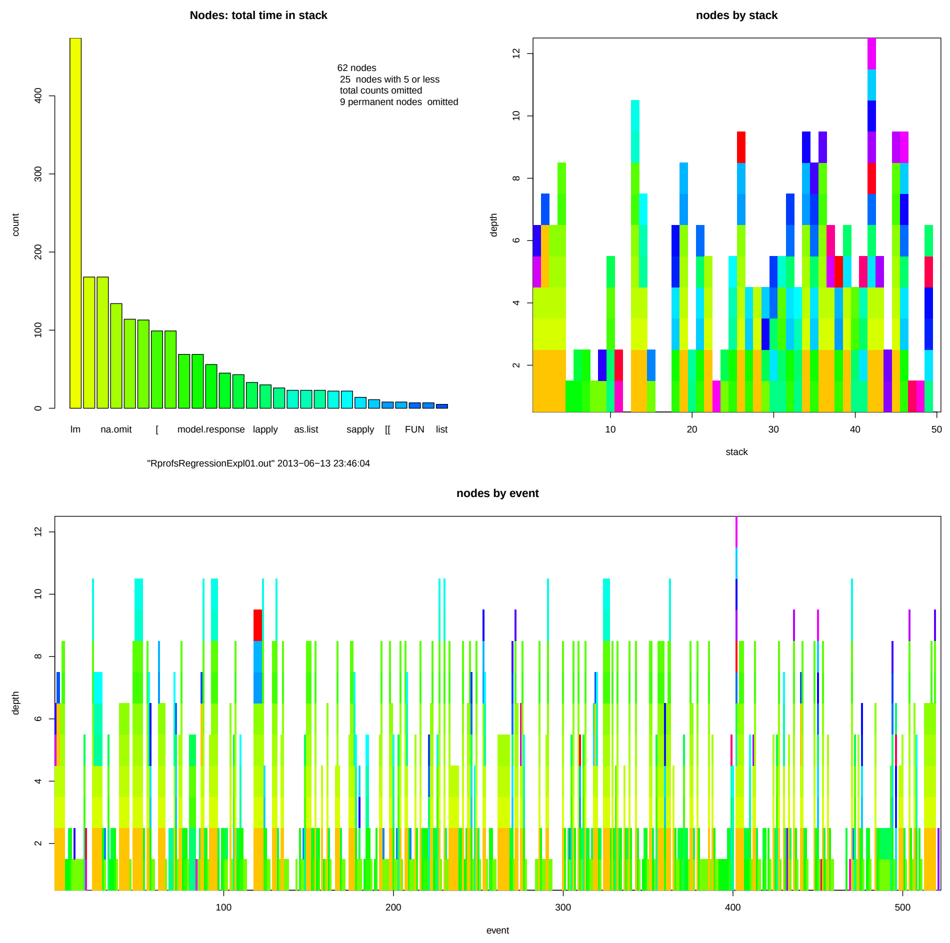
Since this decision does affect the structural information, it is not critical. But analysis is easier if unused nodes are eliminated.

Input

```
sprof02 <- sprof01
basetrim <- 13
sprof02$stacks$nodes <- sapply(sprof02$stacks$nodes,
        function (x){if (length(x)> basetrim) x[-(1:basetrim)] })
```

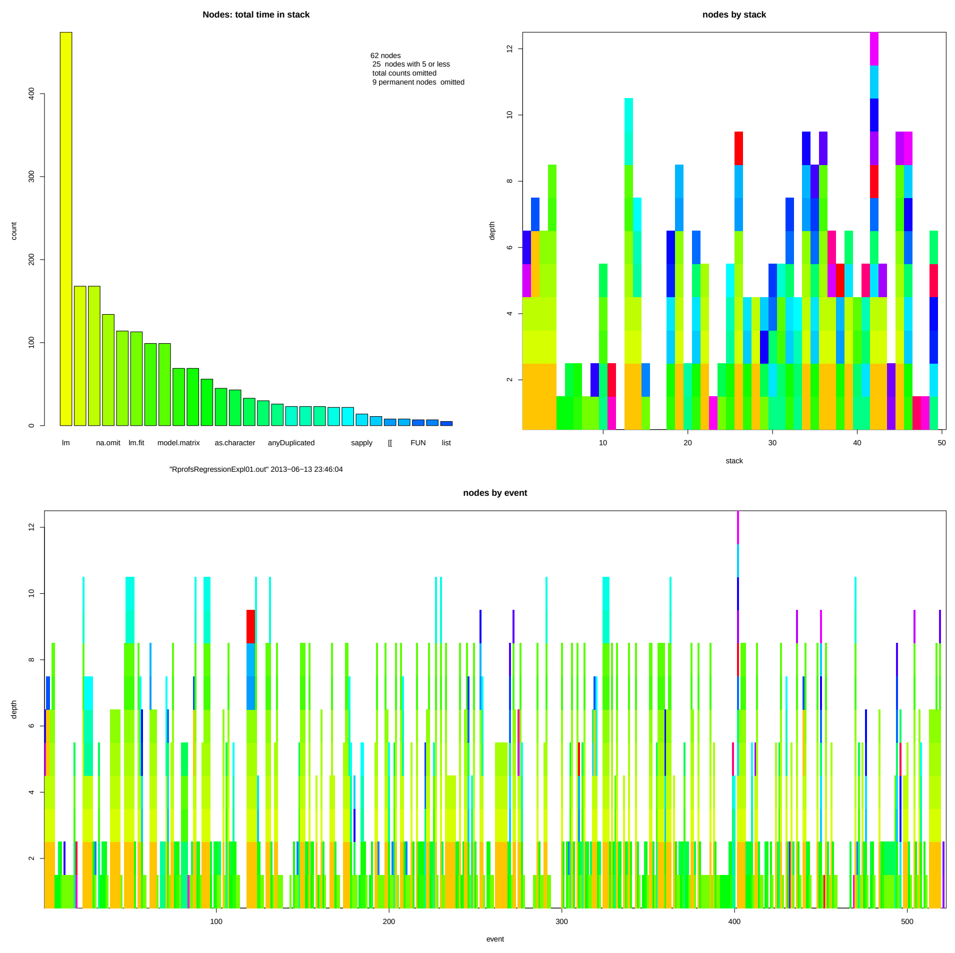
Input

```
#14
shownodes(sprof02)
```



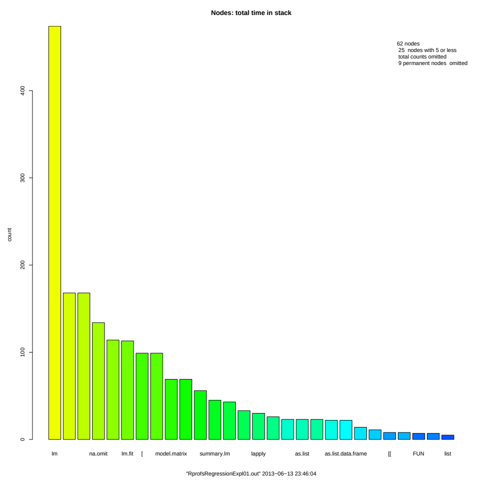
Input

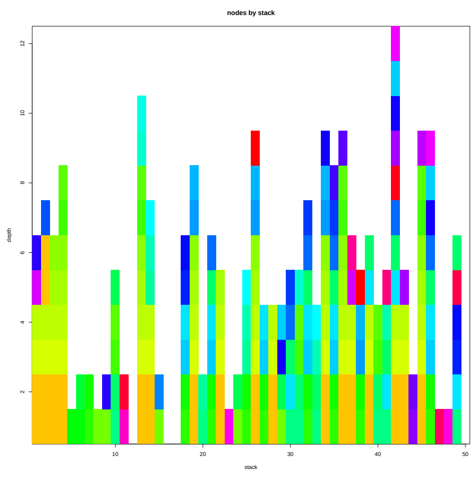
```
#18
shownodes(sprof02)
```

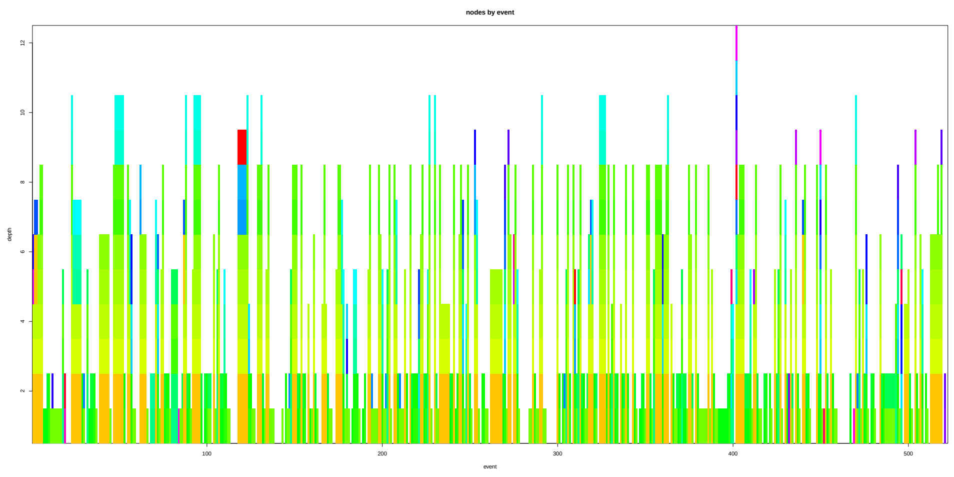


Input

```
#24
shownodes(sprof02)
```







For a visual inspection, runs of the same node and level in the profile are easily perceived. For an analytical inspection, we have to reconstruct the runs from the data. In stacks, runs are organized hierarchically. On the root level, runs are just ordinary runs. On the next levels, runs have to be defined given (within) the previous runs. So we need a recursive version of `rle`, applied to the profile information. This gives a detailed information about the presence time of each node, by stack level.

Input
```
profile_nodes <- profiles_matrix(sprof02)
profile_nodes_rle<- rrle(profile_nodes)
```

On a given stack level, the run lenght is the best information on the time used per call, and the run count of a node is the best information on the numer of calls. So this is a prime starting point for in-dpeth analysis.

ToDo: keep as factor. This is a cube with margins node, stack level, run length.

Input
```
profile_nodes_rlet <- lapply(profile_nodes_rle,
        function(x) table(x,dnn=c("run length","node")) )
```

```
invisible(lapply(profile_nodes_rlet,
function(x) print.table(x,zero.print = ".") ))
```

Output

```
          node
run length  2  4 11 19 22 30 32 37 39 43
         1  1 17  1  1 40 46  2 55 35  1
         2  .  1  .  . 17 18  .  4  3  .
         3  .  1  .  .  6  3  .  2  3  .
         4  .  1  .  .  4  1  .  .  .  .
         5  .  .  .  .  2  1  .  .  .  .
         6  .  .  .  .  6  1  .  .  1  .
         7  .  .  .  .  2  1  .  .  .  .
          node
run length 14 18 22 26 27 33 38 46 47 49 61
         1 34  1 40 16  1  2 55  7  3 10  .
         2  3  . 17  .  .  .  4  .  .  1  .
         3  1  .  6  .  .  .  2  .  .  .  1
         4  .  .  4  1  .  .  .  .  .  .  .
         5  .  .  2  .  .  .  .  .  .  .  .
         6  .  .  6  .  .  .  .  .  .  1  .
         7  .  .  2  .  .  .  .  .  .  .  .
          node
run length  5  7  9 15 26 31 35 48 61
         1 14  1  1  2  2  9 40  1  6
         2  .  .  .  .  .  . 17  .  1
         3  .  .  .  .  .  .  6  .  .
         4  1  .  .  .  .  .  4  .  .
         5  .  .  .  .  .  .  2  .  .
         6  .  .  .  .  .  .  6  .  .
         7  .  .  .  .  .  .  2  .  .
          node
run length  6  8 15 16 25 31 36 47 59
         1 14  1  7  2  1  1 40  9  1
         2  .  .  1  .  .  . 17  .  .
         3  .  .  .  .  .  .  6  .  .
         4  1  .  .  .  .  .  4  .  .
         5  .  .  .  .  .  .  2  .  .
         6  .  .  .  .  .  .  6  .  .
         7  .  .  .  .  .  .  2  .  .
          node
run length  3 10 12 16 17 20 22 26 40 47 48 49 53 60 61
         1  1  1  1  6  1  1  3  5 46  2  3 11  2  1  7
         2  .  .  .  1  .  .  1  . 10  .  .  .  .  .  .
         3  .  .  .  .  .  .  .  .  5  .  .  .  .  .  .
         4  .  .  .  .  .  .  .  .  4  .  .  1  .  .  .
         5  .  .  .  .  .  .  .  .  1  .  .  .  .  .  1
         6  .  .  .  .  .  .  .  .  3  .  .  .  .  .  .
         7  .  .  .  .  .  .  .  .  2  .  .  .  .  .  .
          node
run length 15 22 25 26 27 41 54 59
         1  7  3  5  3  1 43  1  3
         2  .  1  .  .  .  7  .  .
         3  .  .  .  .  .  4  .  .
         4  .  .  .  .  .  5  .  .
         5  1  .  .  .  .  .  .  .
         6  .  .  .  .  .  3  .  .
         7  .  .  .  .  .  1  .  .
          node
run length  3  5  7  9 16 25 28
         1  3 46  2  1  7  1  3
         2  .  4  .  .  .  .  1
         3  .  3  .  .  .  .  .
         4  .  3  .  .  .  .  .
         5  .  .  1  .  1  .  .
         6  .  1  .  .  .  .  .
          node
run length  6  8 31 44 45
         1 46  2  1  1  2
         2  4  .  .  .  .
         3  3  .  .  .  .
         4  3  .  .  .  .
         5  .  1  .  .  .
         6  1  .  .  .  .
          node
run length 1 9 10 12 20 34 42
         1 2 1  .  9  1  1  2
         4 . .  .  2  .  .  .
         5 . .  1  1  .  .  .
          node
run length 9 13
         1 1  9
         4 .  2
         5 .  1
          node
run length 31
         1  1
          node
run length 34
         1  1
```

These are some attempts to recover the factor structures.

Input
```
xfi <- levels(sprof02$nodes$name)
profile_nodes_rlefac <- lapply(profile_nodes_rle, function(xl) {xl$values <- factor(xl$values, leve
profile_nodes_rletfac <- lapply(profile_nodes_rle,
        function(x) table(x,dnn=c("run length","node")) ) #factors lost again
colnames(profile_nodes_rletfac[[1]]) <- sprof02$nodes$name[ as.integer(colnames(profile_nodes_rletf
profile_nodes_rletfac1 <- lapply(profile_nodes_rletfac,
        function(xl) {colnames(xl) <- sprof02$nodes$name[ as.integer(colnames(xl))];
        xl} )
invisible(lapply(profile_nodes_rletfac1,
function(x) print.table(t(x),zero.print = ".") ))
```

Output

```
      run length
node    1  2  3  4  5  6  7
  <NA>  1  .  .  .  .  .  .
  <NA> 17  1  1  1  .  .  .
  <NA>  1  .  .  .  .  .  .
  <NA>  1  .  .  .  .  .  .
  <NA> 40 17  6  4  2  6  2
  <NA> 46 18  3  1  1  1  1
  <NA>  2  .  .  .  .  .  .
  <NA> 55  4  2  .  .  .  .
  <NA> 35  3  3  .  .  1  .
  <NA>  1  .  .  .  .  .  .
                    run length
node                   1  2  3  4  5  6  7
  as.character        34  3  1  .  .  .  .
  as.name              1  .  .  .  .  .  .
  eval                40 17  6  4  2  6  2
  lapply              16  .  .  1  .  .  .
  lazyLoadDBfetch      1  .  .  .  .  .  .
  mean.default         2  .  .  .  .  .  .
  model.matrix.default 55  4  2  .  .  .  .
  rep.int              7  .  .  .  .  .  .
  sapply               3  .  .  .  .  .  .
  structure           10  1  .  .  .  1  .
  vapply               .  .  1  .  .  .  .
              run length
node             1  2  3  4  5  6  7
  [             14  .  .  1  .  .  .
  [[             1  .  .  .  .  .  .
  %in%           1  .  .  .  .  .  .
  as.list        2  .  .  .  .  .  .
  lapply         2  .  .  .  .  .  .
  match          9  .  .  .  .  .  .
  model.frame   40 17  6  4  2  6  2
  simplify2array  1  .  .  .  .  .  .
  vapply         6  1  .  .  .  .  .
                   run length
node                  1  2  3  4  5  6  7
  [.data.frame       14  .  .  1  .  .  .
  [[.data.frame       1  .  .  .  .  .  .
  as.list             7  1  .  .  .  .  .
  as.list.data.frame  2  .  .  .  .  .  .
  FUN                 1  .  .  .  .  .  .
  match               1  .  .  .  .  .  .
  model.frame.default 40 17  6  4  2  6  2
  sapply              9  .  .  .  .  .  .
  unique              1  .  .  .  .  .  .
                   run length
node                 1  2  3  4  5  6  7
  .deparseOpts       1  .  .  .  .  .  .
  <Anonymous>        1  .  .  .  .  .  .
  anyDuplicated      1  .  .  .  .  .  .
  as.list.data.frame  6  1  .  .  .  .  .
  as.list.default     1  .  .  .  .  .  .
  deparse             1  .  .  .  .  .  .
  eval                3  1  .  .  .  .  .
  lapply              5  .  .  .  .  .  .
  na.omit            46 10  5  4  1  3  2
  sapply              2  .  .  .  .  .  .
  simplify2array      3  .  .  .  .  .  .
  structure          11  .  .  1  .  .  .
  terms               2  .  .  .  .  .  .
  unlist              1  .  .  .  .  .  .
  vapply              7  .  .  .  1  .  .
                    run length
node                  1  2  3  4  5  6  7
  as.list             7  .  .  .  1  .  .
  eval                3  1  .  .  .  .  .
  FUN                 5  .  .  .  .  .  .
  lapply              3  .  .  .  .  .  .
  lazyLoadDBfetch     1  .  .  .  .  .  .
  na.omit.data.frame 43  7  4  5  .  3  1
  terms.formula       1  .  .  .  .  .  .
  unique              3  .  .  .  .  .  .
                    run length
node                  1  2  3  4  5  6
  .deparseOpts        3  .  .  .  .  .
  [                  46  4  3  3  .  1
  [[                  2  .  .  .  1  .
  %in%                1  .  .  .  .  .
  as.list.data.frame  7  .  .  .  1  .
  FUN                 1  .  .  .  .  .
  list                3  1  .  .  .  .
               run length
node             1  2  3  4  5  6
  [.data.frame  46  4  3  3  .  1
  [[.data.frame  2  .  .  .  1  .
  match          1  .  .  .  .  .
  paste          1  .  .  .  .  .
  pmatch         2  .  .  .  .  .
               run length
node            1 4 5
  !             2 . .
  %in%          1 . .
  <Anonymous>   . . 1
  anyDuplicated 9 2 1
  deparse       1 . .
  mode          1 . .
  names         2 . .
                       run length
node                    1 4 5
  %in%                  1 . .
  anyDuplicated.default 9 2 1
       run length
node    1
  match 1
```

```
      run length
node   1
  mode 1
```

Input

ToDo: add current level
ToDo: generate a coplot representation
ToDo: add time per call information: add marginals statistics run time by node

2.1. **The details.** For each recorded event, the protocol records one line with a text string showing the sampled stack (in reverse order: most recent first). The stack lines may be preceded by header lines with event specific information. The protocol may be interspersed with control information, such as information about the timing interval used.

We know that the structural information, static information as well as dynamic information, can be represented with the help of a graph. For a static analysis, the graph representation may be the first choice. For a dynamic analysis, the stack information is our first information. A stack is a connected path in the program graph. If we start with nodes and edges, we loose information which is readily available in record of stacks.

As we know that we are working with stacks, we know that they have their peculiarities. Stacks tend to grow and shrink. Subsequent events will have extensions and shrinkages of stacks (if the recording is on a fine scale), or stack sharing common stumps (if the recording is on a coarser scale).

There have always been interrupts, and these show up in profiles. In R, this is related problem (GC)

The graph is a second instance that is (re)constructed from the stack recording.

Here is the way we represent the profile information:

The profile log file is sanitised:

- Control lines are extracted and recorded in a separate list.
- Head parts, if present, ere extracted and recorded in a matrix that is kept line-aligned with the remainder
- Line content is standardised, for example by removing stray quotation marks etc.

After this, the sanitised lines are encoded as a vector of stacks, and references to this.

If necessary, these steps are done by chunks to reduce memory load.

From the vector of stacks, a vector of nodes (or rather node names) is derived.

The stacks are now encoded by references to the nodes table. For convenience, we keep the (sanitised) textual representation of the stacks.

So far, texts are in reverse order. For each stack, we record the trailing leaf, and then we reverse order. The top of stack is now on first position.

Several statistics can be accumulated easily as a side effect.

Conceptually, the data structure consist of three tables (the implementation may differ, and is subject to change).

The profiles table is the representation of the input file. Control lines are are collected in a special table. With the control lines removed, the rest is a table, one row per input line. The body of the line, the stack, is encoded as a reference to a stacks table (obligatory) and header information (optional).

The stacks table contains the collected stacks, each stack encoded as a list of references to the node table. This is obligatory. This list is kept in reverse order (root at position 1). A source line representing the stack information may be kept (optional).

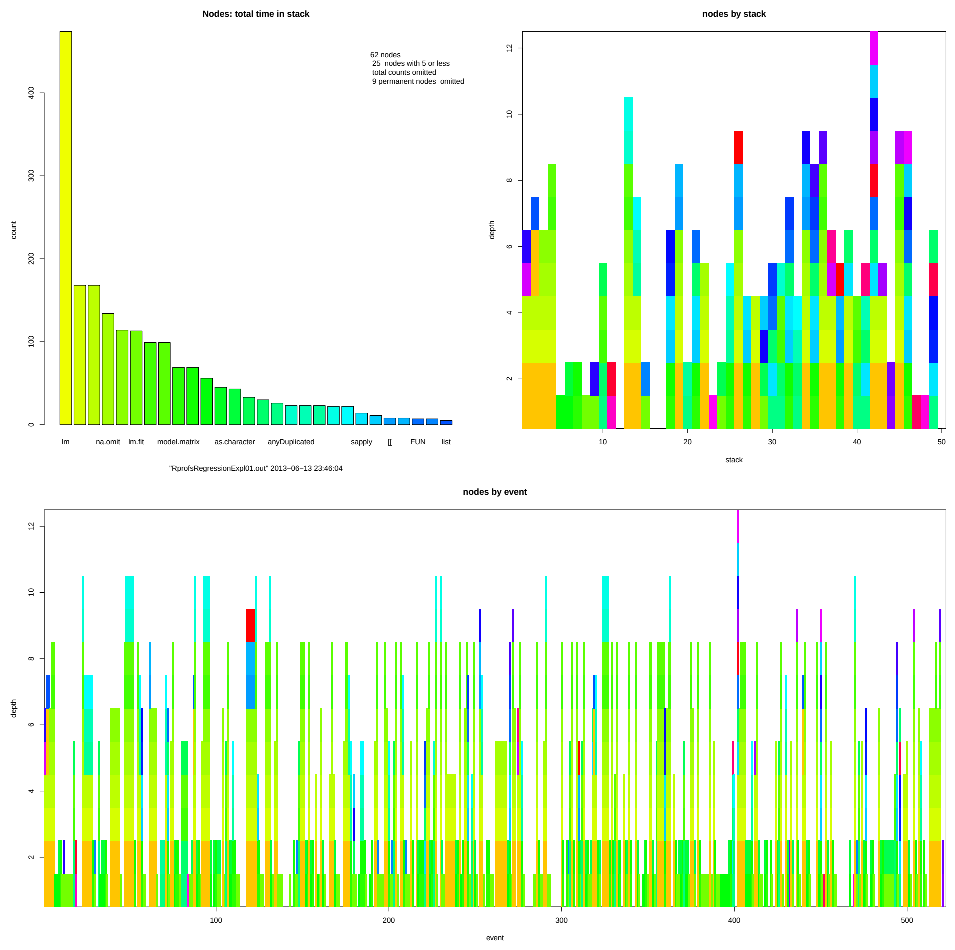
ToDo: 18*18

The nodes table keeps the names at the nodes.

2.2. **The free lunch.** This is what you get for free when using package *sprof*:

Input

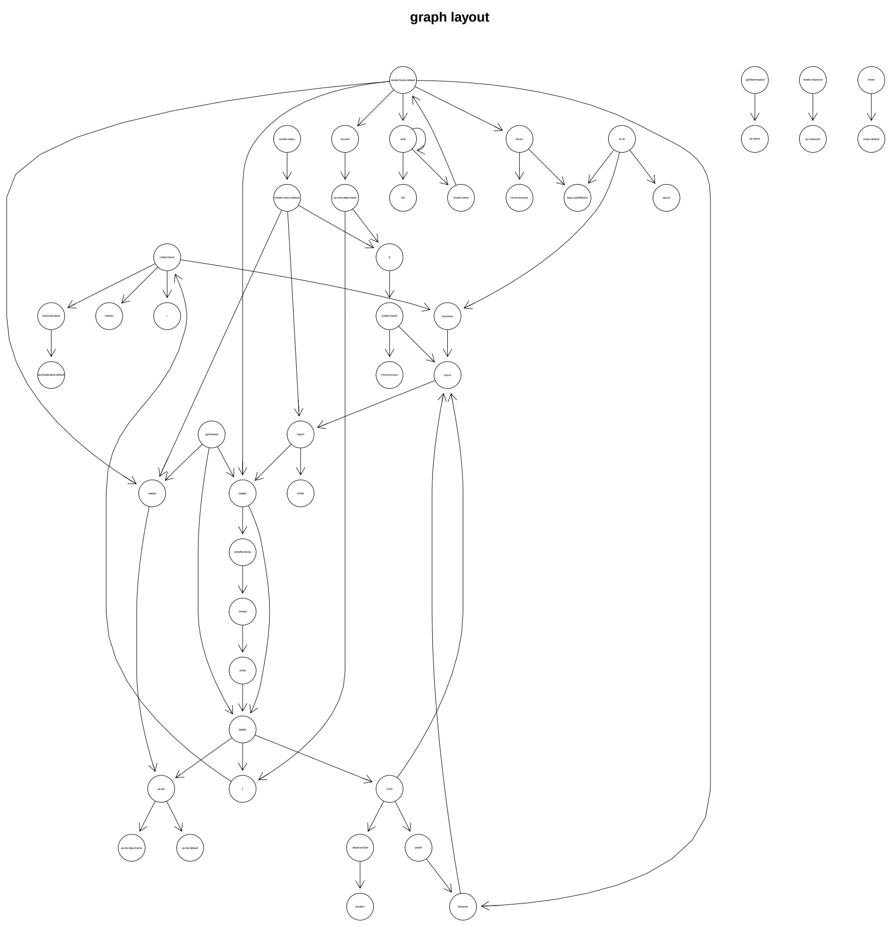
```
#18
shownodes(sprof02)
```



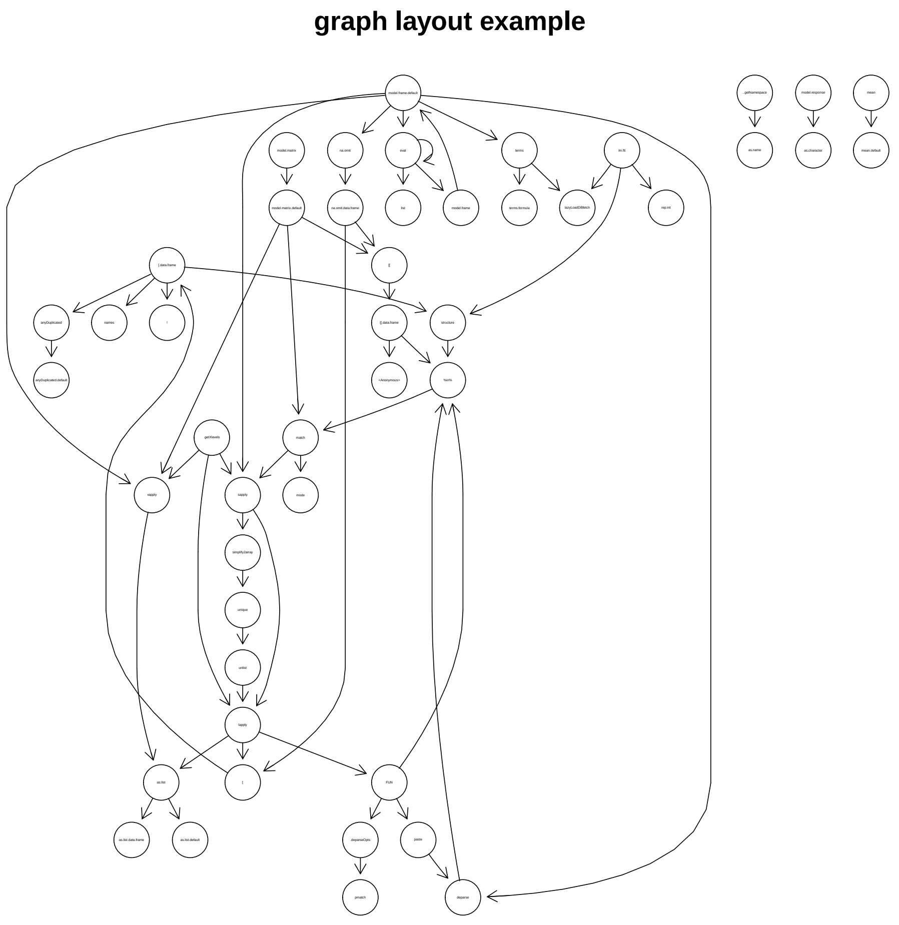
If your want to wrap up the information and look at it from a graph point of view, here is just one example. More are in section 8 on page 75. But before changing to the graph perspective, we recommend to see the next sections, not to skip them. The preview, at his point, taking package ***graph*** as an example:

Input

```
#24
library(graph)
sprof02adjNEL <- as(adjacency(sprof02),"graphNEL")
plot(sprof02adjNEL,  main="graph layout example", cex.main=2)
```



Input
```
plot(sprof02adjNEL,  main="graph layout example", cex.main=2)
rm(sprof02adjNEL);
# detach("package:graph")
#! sorry. still needed by Rgraphviz -- clean up
```



2.3. **Cheap thrills.**

3. xxx

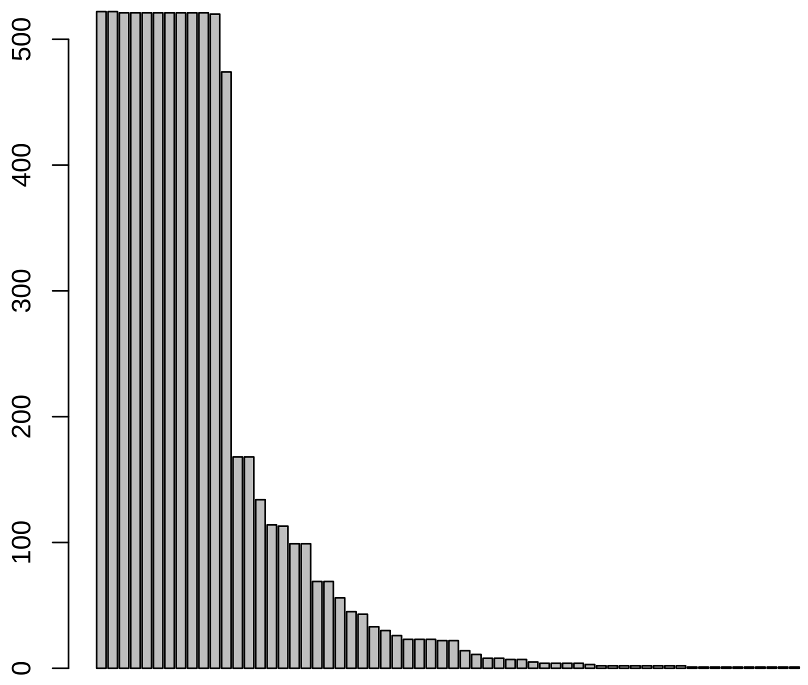
Input
```
# xtable cannot handle posix
str(sprof01$info,
        caption="splot node info",
        label="tab:prSREinfo0")
```

Output
```
'data.frame':	1 obs. of  8 variables:
 $ id       : Factor w/ 1 level "\"RprofsRegressionExpl01.out\" 2013-06-13 23:46:04": 1
 $ date     : POSIXct, format: "2013-07-14 22:27:19"
 $ nrnodes  : int 62
 $ nrstacks : int 50
 $ nrrecords: int 522
 $ firstline: Factor w/ 1 level "sample.interval=1000": 1
 $ ctllines : Factor w/ 1 level "sample.interval=1000": 1
 $ ctllinenr: num 1
```

As a convention, we do not re-arrange items for ad-hoc choices, but use a permutation vector instead.

Input

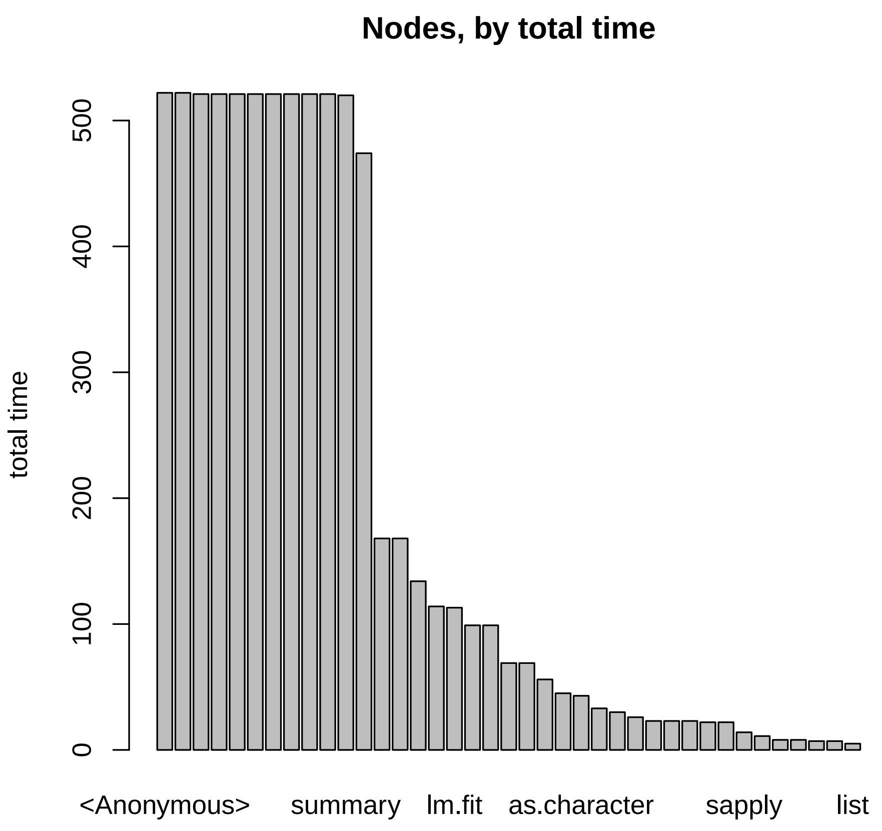
```
rownames(sprof01$nodes) <- sprof01$nodes$names
nodesperm <- order(sprof01$nodes$total.time,decreasing=TRUE)
barplot(sprof01$nodes$total.time[nodesperm])
```



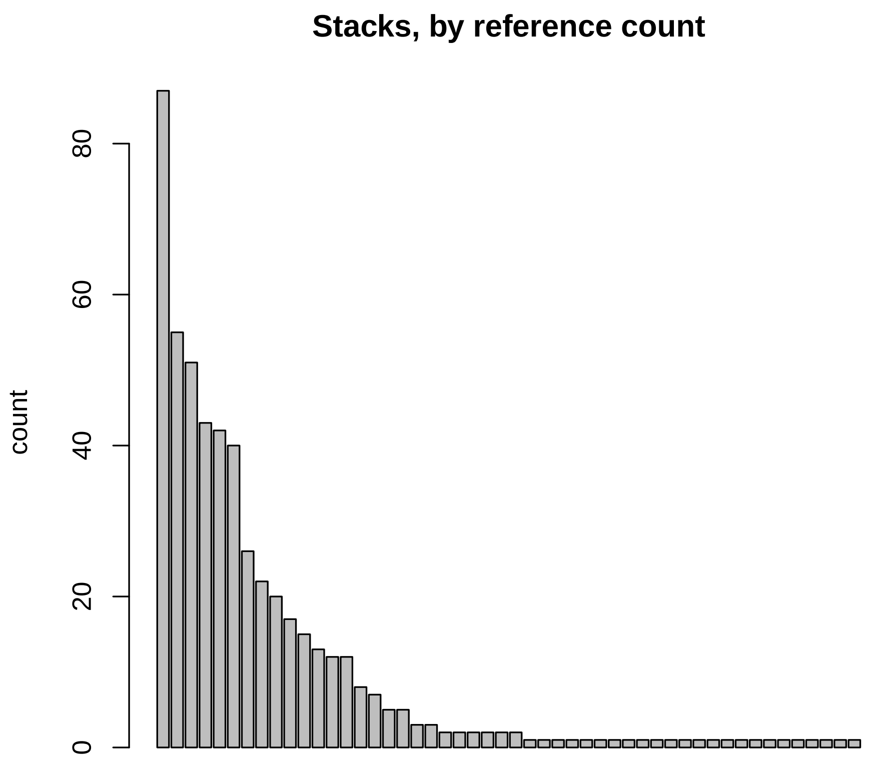
Selections are recorded as selection vectors, with reference to the original order. This needs some caution to align them with the order choices.

Input

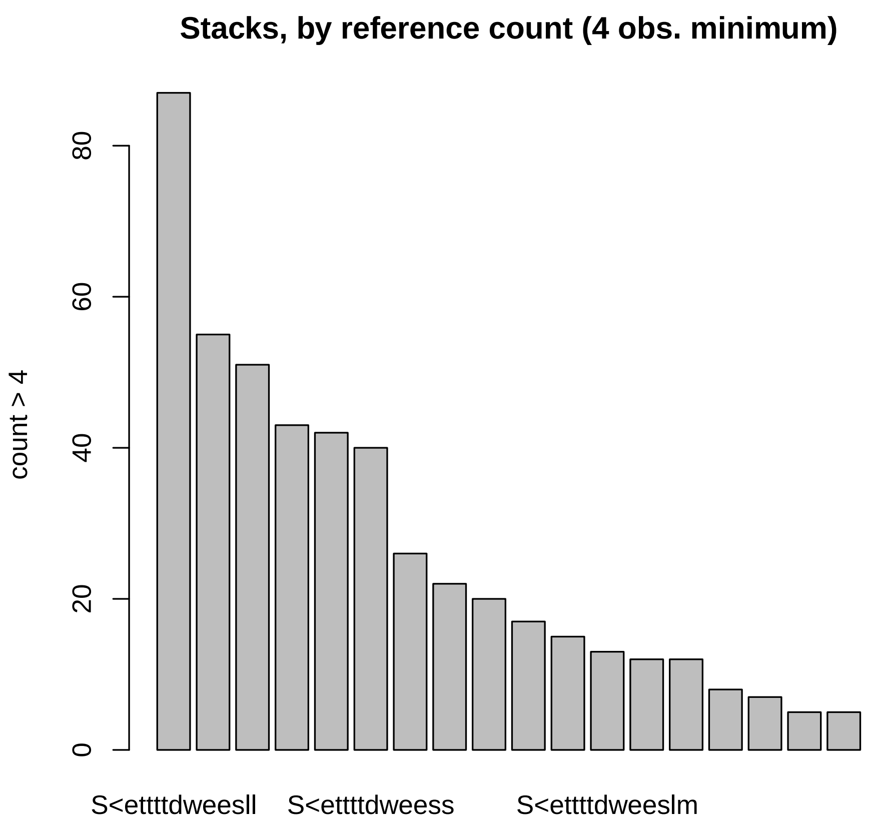
```
nodesnrobsok <- sprof01$nodes$total.time > 4
sp <- sprof01$nodes$total.time[nodesperm][nodesnrobsok[nodesperm]]
names(sp) <- sprof01$nodes$name[nodesperm][nodesnrobsok[nodesperm]]
barplot(sp,
 main="Nodes, by total time", ylab="total time")
```



Input
```
#rownames(sprof01$nodes) <- sprof01$nodes$names
stacksperm <- order(sprof01$stacks$refcount,decreasing=TRUE)
barplot(sprof01$stacks$refcount[stacksperm],main="Stacks, by reference count", ylab="count")
```

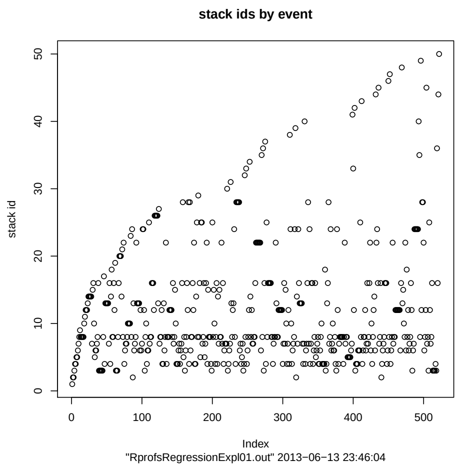


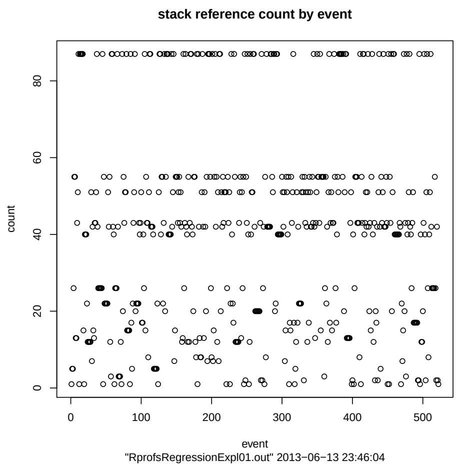
Input
```
stacksnrobsok <- sprof01$stacks$refcount > 4
sp4 <- sprof01$stacks$refcount[stacksperm][stacksnrobsok[stacksperm]]
names(sp4) <- sprof01$stacks$shortname[stacksperm][stacksnrobsok[stacksperm]]
barplot(sp4,
 main="Stacks, by reference count (4 obs. minimum)", ylab="count > 4")
```

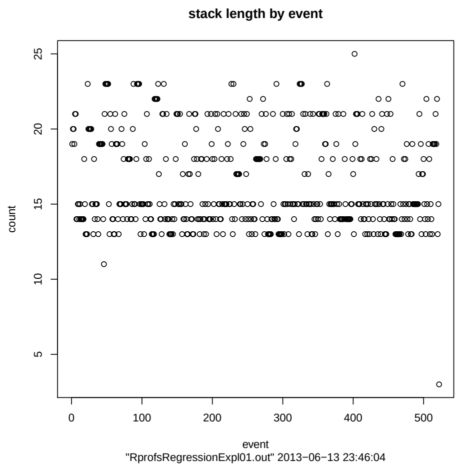


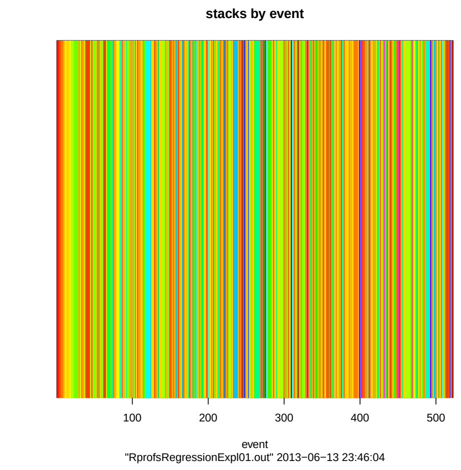
On the first look, information on the profile level is not informative. Profile records are just recordings of some step, taken at regular intervals. We get a minimal information, if we encode the stacks in colour.

Input
```
oldpar<-par(mfrow=c(2,2))
plot_profiles(sprof01)
par(oldpar)
```





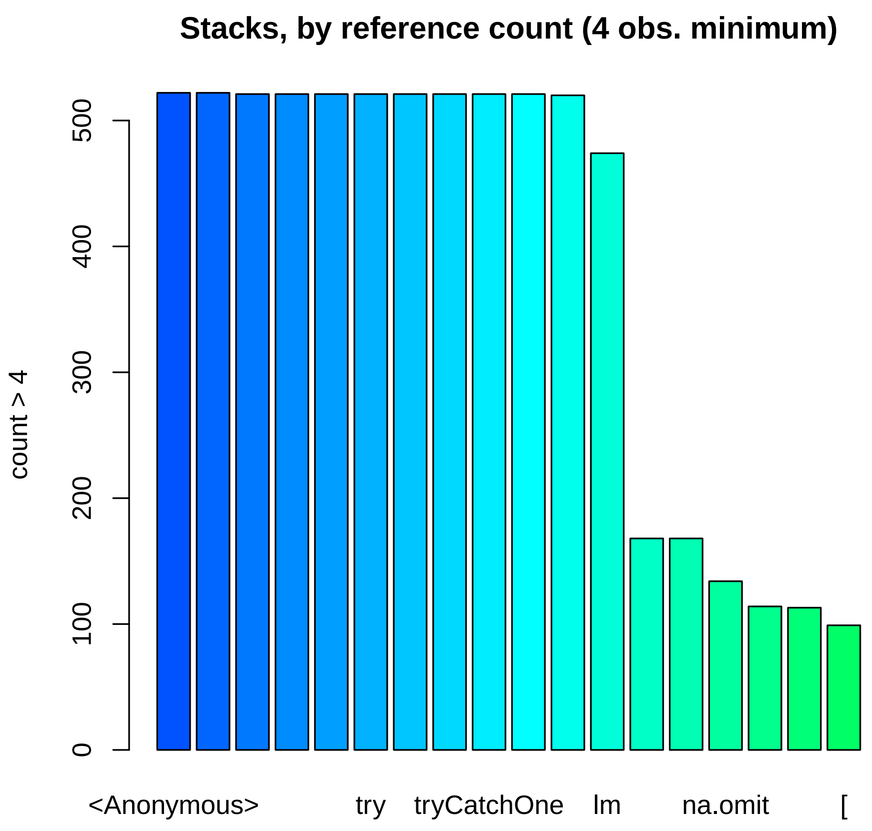




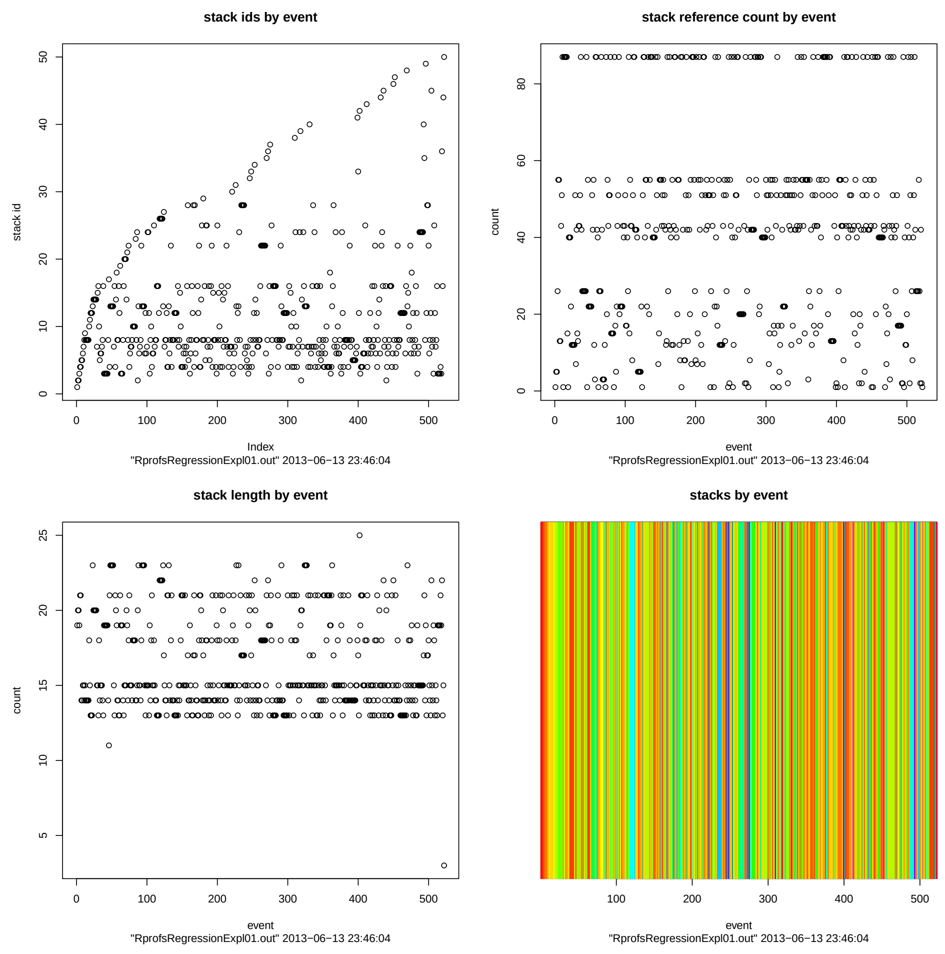
We now do a step down analysis. Aggregating the information from the profiling events, we have the frequency of stack references. On the stack level, we encode the frequency in color, and linking propagates this to the profile level.

Input

```
stackfreqscore <- rank(sprof01$stacks$refcount,ties.method="random")
stackfreqscore4<- stackfreqscore[stacksperm][stacksnrobsok[stacksperm]]
barplot(sp[stacksnrobsok[stacksperm]], main="Stacks, by reference count (4 obs. minimum)", ylab="co
col=rainbow(80)[stackfreqscore4])
```



Input
```
oldpar<- par(mfrow=c(2,2))
plot_profiles(sprof01)
par(oldpar)
```


stack ids by event
stack id
Index
"RprofsRegressionExpl01.out" 2013−06−13 23:46:04
stack reference count by event
count
event
"RprofsRegressionExpl01.out" 2013−06−13 23:46:04
stack length by event
count
event
"RprofsRegressionExpl01.out" 2013−06−13 23:46:04
stacks by event
event
"RprofsRegressionExpl01.out" 2013−06−13 23:46:04

Input
```
prxt(sprof01$nodes,
        caption="nodes",
        label="tab:prSREnodes")
```

Table 4: nodes

	name	self.time	self.pct	total.time	total.pct	icol
1	!	2.000	0.380	2.000	0.030	46
2	..getNamespace	0.000	0.000	1.000	0.010	55
3	.deparseOpts	2.000	0.380	4.000	0.050	40
4	.getXlevels	0.000	0.000	26.000	0.340	27
5	[	0.000	0.000	99.000	1.290	19
6	[.data.frame	57.000	10.920	99.000	1.290	18
7	[[	0.000	0.000	8.000	0.100	36
8	[[.data.frame	1.000	0.190	8.000	0.100	35
9	%in%	1.000	0.190	4.000	0.050	43
10	<Anonymous>	6.000	1.150	522.000	6.790	1
< cut >	\vdots	⋮	⋮	⋮	⋮	⋮
53	terms	0.000	0.000	2.000	0.030	51
54	terms.formula	1.000	0.190	1.000	0.010	57
55	try	0.000	0.000	521.000	6.780	10
56	tryCatch	0.000	0.000	521.000	6.780	4
57	tryCatchList	0.000	0.000	521.000	6.780	7
58	tryCatchOne	0.000	0.000	521.000	6.780	3
59	unique	3.000	0.570	4.000	0.050	42
60	unlist	0.000	0.000	1.000	0.010	60
61	vapply	3.000	0.570	23.000	0.300	28
62	withVisible	0.000	0.000	521.000	6.780	6

Input

```
str(sprof01$stacks, max.level=1)
```

Output

```
'data.frame':       50 obs. of  7 variables:
 $ nodes         :List of 50
 $ shortname     : Factor w/ 50 levels "S<A>eFttCtCLtCOdTCwVeesleem.m..n.n...[[.",..: 27 17 19 1 35
 $ refcount      : num  1 5 26 55 13 43 51 87 1 15 ...
 $ stacklength   : int  19 20 19 21 14 15 15 14 15 18 ...
 $ stackheadnodes: int  52 52 52 52 52 52 52 52 52 52 ...
 $ stackleafnodes: int  27 28 41 6 39 14 38 30 27 49 ...
 $ stackssrc     : Factor w/ 50 levels "! [.data.frame [ na.omit.data.frame na.omit model.frame.defa
```

Input

Input

```
str(sprof01$profiles, max.level=1)
```

Output

```
List of 4
 $ data    : int [1:522] 1 2 2 3 4 4 5 5 6 7 ...
 $ mem     : NULL
 $ malloc  : NULL
 $ timesRLE:List of 2
  ..- attr(*, "class")= chr "rle"
```

Input

A summary is provided on request.

Input

```
sumsprof01 <- summary.sprof(sprof01)
```

Output

```
                      shortname root leaf self.time   self.pct
!                             !    - LEAF         2  0.383142
..getNamespace             ..gN    -    -         0  0.000000
.deparseOpts               .dpO    - LEAF         2  0.383142
.getXlevels                .gtX    -    -         0  0.000000
[                             [    -    -         0  0.000000
[.data.frame               [.d.    - LEAF        57 10.919540
[[                           [[    -    -         0  0.000000
[[.data.frame              [[..    - LEAF         1  0.191571
%in%                       %in%    - LEAF         1  0.191571
<Anonymous>                <An>    - LEAF         6  1.149425
$                             $    - LEAF         1  0.191571
anyDuplicated              anyD    - LEAF         1  0.191571
anyDuplicated.default      anD.    - LEAF        22  4.214559
as.character               as.c    - LEAF        43  8.237548
as.list                    as.l    -    -         0  0.000000
as.list.data.frame         a...    - LEAF        22  4.214559
as.list.default            as..    - LEAF         1  0.191571
as.name                    as.n    - LEAF        1  0.191571
coef                       coef    - LEAF        1  0.191571
deparse                    dprs    - LEAF        1  0.191571
doTryCatch                 dTrC    -    -        0  0.000000
eval                       eval    - LEAF        1  0.191571
evalFunc                   evlF    -    -        0  0.000000
file                       file    - LEAF        1  0.191571
FUN                         FUN    - LEAF        1  0.191571
lapply                     lppl    - LEAF        2  0.383142
lazyLoadDBfetch            lLDB    - LEAF        2  0.383142
list                       list    - LEAF        5  0.957854
lm                           lm    - LEAF       42  8.045977
lm.fit                     lm.f    - LEAF       87 16.666667
match                      mtch    - LEAF        1  0.191571
mean                       mean    -    -        0  0.000000
mean.default               mn.d    - LEAF        2  0.383142
mode                       mode    - LEAF        2  0.383142
model.frame               mdl.f    -    -        0  0.000000
model.frame.default      mdl.f.    - LEAF       12  2.298851
model.matrix              mdl.m    -    -        0  0.000000
model.matrix.default     mdl.m.    - LEAF       51  9.770115
model.response            mdl.r    - LEAF       13  2.490421
na.omit                    n.mt    - LEAF       20  3.831418
na.omit.data.frame         n...    - LEAF       26  4.980843
names                      nams    - LEAF        2  0.383142
NCOL                       NCOL    - LEAF        1  0.191571
paste                      past    -    -        0  0.000000
pmatch                     pmtc    - LEAF        2  0.383142
rep.int                    rp.n    - LEAF        7  1.340996
sapply                     sppl    - LEAF        1  0.191571
simplify2array             smp2    -    -        0  0.000000
structure                  strc    - LEAF       32  6.130268
summary                    smmr    -    -        0  0.000000
summary.lm                 smm.    - LEAF       40  7.662835
Sweave                     Swev ROOT    -        0  0.000000
terms                      trms    -    -        0  0.000000
terms.formula              trm.    - LEAF        1  0.191571
try                         try    -    -        0  0.000000
tryCatch                   tryC    -    -        0  0.000000
tryCatchList               trCL    -    -        0  0.000000
tryCatchOne                trCO    -    -        0  0.000000
unique                     uniq    - LEAF        3  0.574713
unlist                     unls    -    -        0  0.000000
vapply                     vppl    - LEAF        3  0.574713
withVisible                wthV    -    -        0  0.000000
                      total.time total.pct
!                              0         0
..getNamespace                 0         0
.deparseOpts                   0         0
.getXlevels                    0         0
[                              0         0
[.data.frame                   0         0
[[                             0         0
```

```
[[.data.frame                  0         0
%in%                           0         0
<Anonymous>                    0         0
$                              0         0
anyDuplicated                  0         0
anyDuplicated.default          0         0
as.character                   0         0
as.list                        0         0
as.list.data.frame             0         0
as.list.default                0         0
as.name                        0         0
coef                           0         0
deparse                        0         0
doTryCatch                     0         0
eval                           0         0
evalFunc                       0         0
file                           0         0
FUN                            0         0
lapply                         0         0
lazyLoadDBfetch                0         0
list                           0         0
lm                             0         0
lm.fit                         0         0
match                          0         0
mean                           0         0
mean.default                   0         0
mode                           0         0
model.frame                    0         0
model.frame.default            0         0
model.matrix                   0         0
model.matrix.default           0         0
model.response                 0         0
na.omit                        0         0
na.omit.data.frame             0         0
names                          0         0
NCOL                           0         0
paste                          0         0
pmatch                         0         0
rep.int                        0         0
sapply                         0         0
simplify2array                 0         0
structure                      0         0
summary                        0         0
summary.lm                     0         0
Sweave                         0         0
terms                          0         0
terms.formula                  0         0
try                            0         0
tryCatch                       0         0
tryCatchList                   0         0
tryCatchOne                    0         0
unique                         0         0
unlist                         0         0
```

```
vapply                          0         0
withVisible                     0         0
$nrstacks
[1] 50

$stacklength
[1]  3 25

$nrnodesperlevel
 [1]  1  1  2  1  1  1  1  1  1  1  1  1  3 10 11  9  9 15  8  7  5  7
[23]  2  1  1

$id
[1] "Profile Summary Sun Jul 14 22:27:22 2013"

$len
[1] 522

$uniquestacks
[1] 50

$nr_runs
[1] 396
```

Input

```
str(sumsprof01, max.level=2)
```

Output

```
List of 4
 $ id          : chr "Profile Summary Sun Jul 14 22:27:22 2013"
 $ len         : int 522
 $ uniquestacks: int 50
 $ nr_runs     : int 396
```

The classical approach hides the work that has been done. Actually it breaks down the data to record items. This figure is not reported anywhere. In our case, it can be reconstructed. The profile data have 8456 words in 524 lines.

In our approach, we break down the information. Two lines of control information are split off. We have 522 lines of profile with 50 unique stacks, referencing 62 nodes. Instead of reducing it to a summary, we keep the full information. Information is always kept on its original level.

On the profiles level, we know the sample interval length, and the id of the stack recorded. On the stack level, for each stack we have a reference count, with the sample interval lengths used as weights. This reference count is added up for each node in the stack to give the node timings.

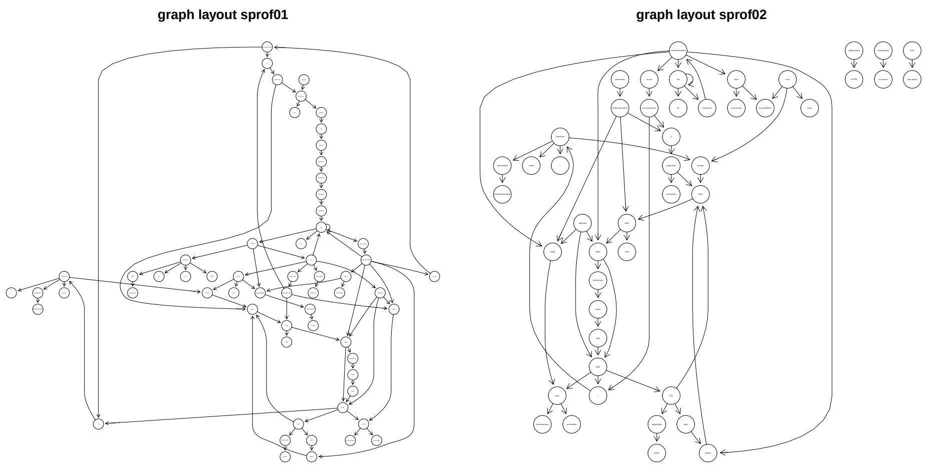
Cheap statistics are collected as the come by. For example, from the stacks table it is cheap to identify root and leaf nodes, and this mark is propagated to the nodes table.

4. Surgery

Looking at nodes gives you a point-wise horizon. Looking at edges gives you a one step horizon. The stacks give a wider horizon, typically a step size of 10 or more. The stacks we get from R have peculiarities, and we can handle with this broader perspective. These are not relevant if we look point-wise, but may become dominating if we try to get a global picture. We take a look ahead (details to come in section 8 on page 75 and nave a preview how our example is represented as a graph. Left is the original graph as recovered from the edge information, right the graph after we have cut off the scaffold effects.

4.1. **graph Package.**

Input
```
oldpar <- par(mfrow=c(1,2))
library(graph)
plot(as(adjacency(sprof01),"graphNEL"),  main="graph layout sprof01", cex.main=2)
plot(as(adjacency(sprof02),"graphNEL"),  main="graph layout sprof02", cex.main=2)
par(oldpar)
```



R is function based, and control structures in general are implemented as functions. In a graph representation, they appear as nodes, concentrating and seeding to unrelated paths. We can detect these on the stack level and replace them by surrogates, introducing new nodes. **ToDo:** implement

Input
```
newchopnode <- function(nodenames, chop) {
tmpname <- paste("<",as.character(nodenames[chop]),">")
# chec for existing.
# add if necessary
tmpname
}
chopstack <- function(x , chop, replacement)
{
# is chop in x`
# y: cut x.
# merge x <- head + replacement + tiail
return(x)
}
```

4.2. **Apply & Co.** Control structures may be represented in R as function, and these may lead to concentration points. Using information from the stacks, we can avoid these by introducing substitute nodes on the stack level. For example,

`"[" "lapply" ".getXlevels" -> "<.getXlevels_[>"`

`"as.list" "vapply" "model.frame.default" -> "<model_as.list>"`

ToDo: fix null name

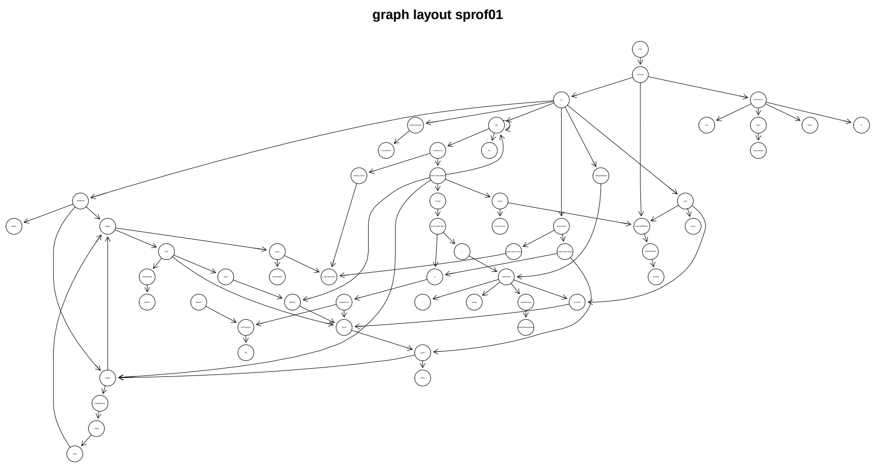
```
"as.list" "vapply" "model.matrix.default" -> "<model_matrix_as.list>"
```

Input

```
sprof03 <- readRprof("RprofsRegressionExpl03.out")
#sprof03$nodes$name[1] <-  sprof03$nodes$name[2]
#sprof03$nodes$name[1]<-"<noop>"??
```

Input

```
library(graph)
a03<-adjacency(sprof03)
rnames <- rownames(a03)
rnames[1]<-"noop";rownames(a03) <- rnames; colnames(a03) <- rnames;
plot(as(a03,"graphNEL"),  main="graph layout sprof01", cex.main=2)
```

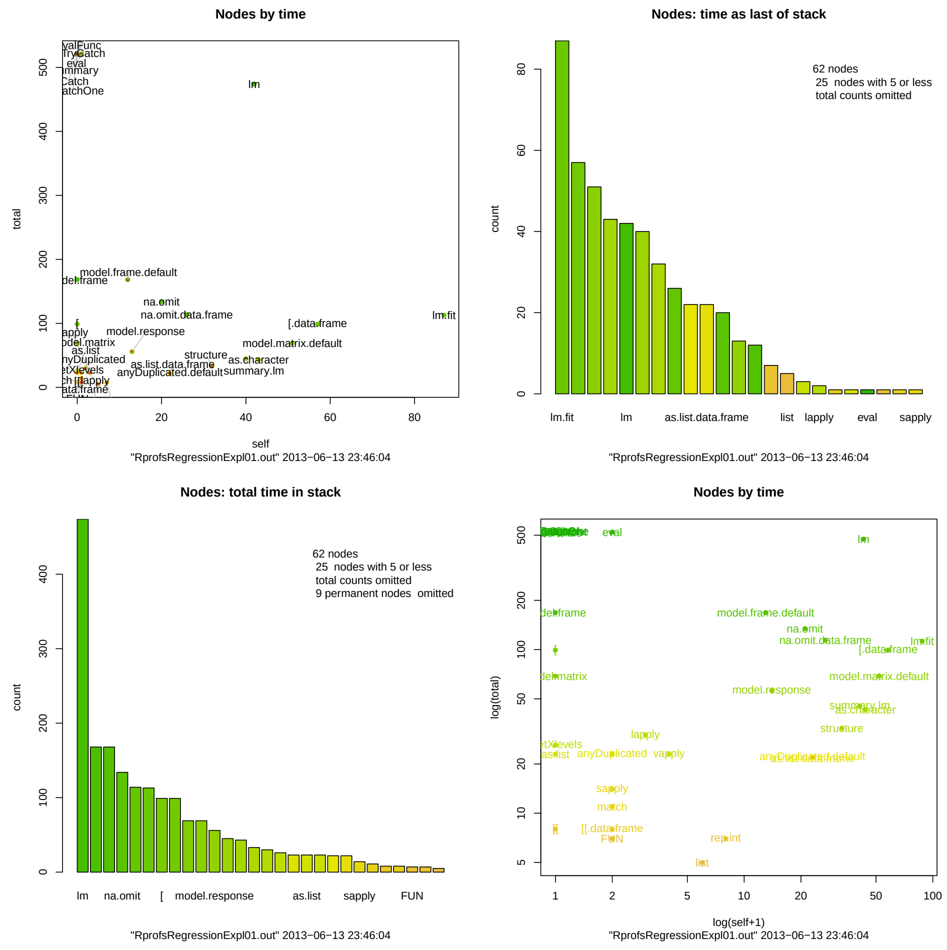


5. YYY

5.0.1. *Plot.* Looking at lists of numbers is not too informative. We get a first impression by plotting the data.

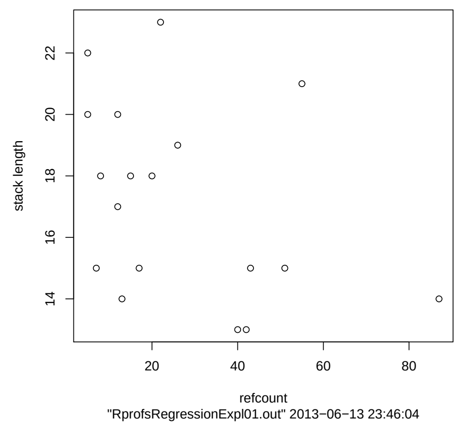
Input

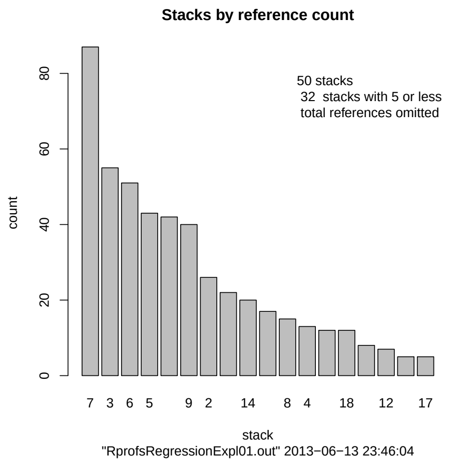
```
#plot_nodes(sprof01, col=nodescol[nodescore])
oldpar <- par(mfrow=c(2,2))
plot_nodes(sprof01)
par(oldpar)
```



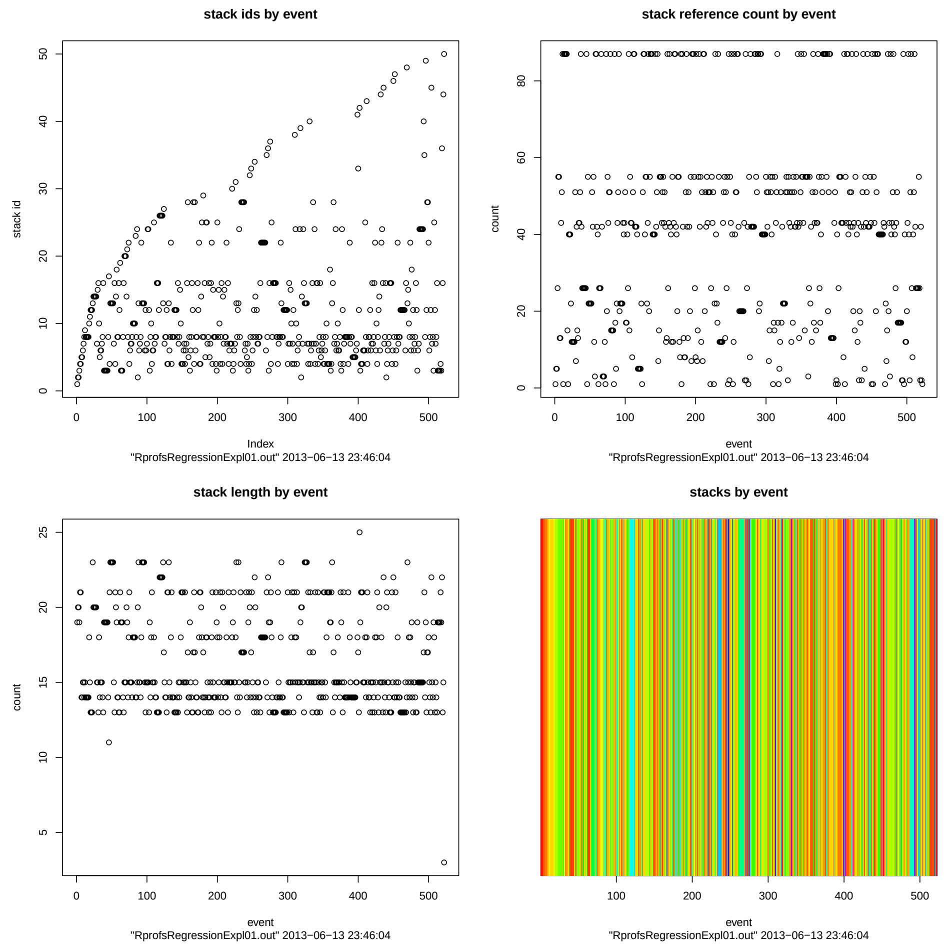
Input

```
oldpar <- par(mfrow=c(1,2))
plot_stacks(sprof01)
par(oldpar)
```





Input
```
oldpar <-par(mfrow=c(2,2))
plot_profiles(sprof01)
par(oldpar)
```



The `plot()` method for `sprof` objects concatenates these three functions.

5.1. analysis.

Input

```
profile_nodes_rrle <- rrle(profile_nodes)
str(profile_nodes_rrle)
```

Output

```
List of 12
 $ :List of 2
  ..$ lengths: int [1:361] 6 3 1 7 1 1 1 1 1 6 ...
  ..$ values : int [1:361] 22 39 37 30 4 2 NA NA NA 22 ...
  ..- attr(*, "class")= chr "rle"
 $ :List of 2
  ..$ lengths: int [1:407] 6 1 1 1 1 1 1 1 1 1 ...
  ..$ values : int [1:407] 22 NA NA 14 38 NA 27 NA NA NA ...
  ..- attr(*, "class")= chr "rle"
 $ :List of 2
  ..$ lengths: int [1:427] 6 1 1 1 1 1 1 1 1 1 ...
  ..$ values : int [1:427] 35 NA NA NA NA NA NA NA NA NA ...
  ..- attr(*, "class")= chr "rle"
 $ :List of 2
  ..$ lengths: int [1:427] 6 1 1 1 1 1 1 1 1 1 ...
  ..$ values : int [1:427] 36 NA NA NA NA NA NA NA NA NA ...
  ..- attr(*, "class")= chr "rle"
 $ :List of 2
  ..$ lengths: int [1:450] 1 2 3 1 1 1 1 1 1 1 ...
  ..$ values : int [1:450] 53 22 40 NA NA NA NA NA NA NA ...
  ..- attr(*, "class")= chr "rle"
 $ :List of 2
  ..$ lengths: int [1:466] 1 2 3 1 1 1 1 1 1 1 ...
  ..$ values : int [1:466] 27 22 41 NA NA NA NA NA NA NA ...
  ..- attr(*, "class")= chr "rle"
 $ :List of 2
  ..$ lengths: int [1:489] 1 2 1 2 1 1 1 1 1 1 ...
  ..$ values : int [1:489] NA 28 NA 5 NA NA NA NA NA NA ...
  ..- attr(*, "class")= chr "rle"
 $ :List of 2
  ..$ lengths: int [1:494] 1 1 1 1 2 1 1 1 1 1 ...
  ..$ values : int [1:494] NA NA NA NA 6 NA NA NA NA NA ...
  ..- attr(*, "class")= chr "rle"
 $ :List of 2
  ..$ lengths: int [1:508] 1 1 1 1 1 1 1 1 1 1 ...
  ..$ values : int [1:508] NA NA NA NA NA NA NA NA NA NA ...
  ..- attr(*, "class")= chr "rle"
 $ :List of 2
  ..$ lengths: int [1:512] 1 1 1 1 1 1 1 1 1 1 ...
  ..$ values : int [1:512] NA NA NA NA NA NA NA NA NA NA ...
  ..- attr(*, "class")= chr "rle"
 $ :List of 2
  ..$ lengths: int [1:522] 1 1 1 1 1 1 1 1 1 1 ...
  ..$ values : int [1:522] NA NA NA NA NA NA NA NA NA NA ...
  ..- attr(*, "class")= chr "rle"
 $ :List of 2
  ..$ lengths: int [1:522] 1 1 1 1 1 1 1 1 1 1 ...
  ..$ values : int [1:522] NA NA NA NA NA NA NA NA NA NA ...
  ..- attr(*, "class")= chr "rle"
```

5.2. **trimming.**

Input

```
trimstacks <- function(sprof, level){
lapply(sprof$stacks$nodes, function(x) {x[-(1:level)]})
}
```

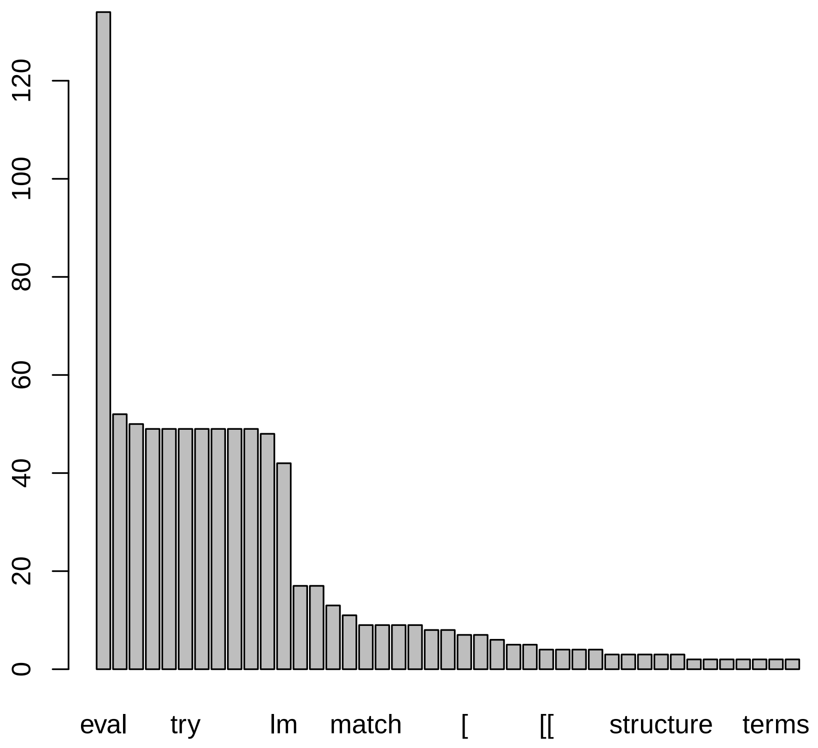
Input

```
sprof01Tr <- trimstacks(sprof01, 11)
#profile_nodesTr <- profiles_matrix(sprof01Tr)
#image(x=1:ncol(profile_nodesTr),y=1:nrow(profile_nodesTr), t(profile_nodesTr),xlab="event", ylab="
```

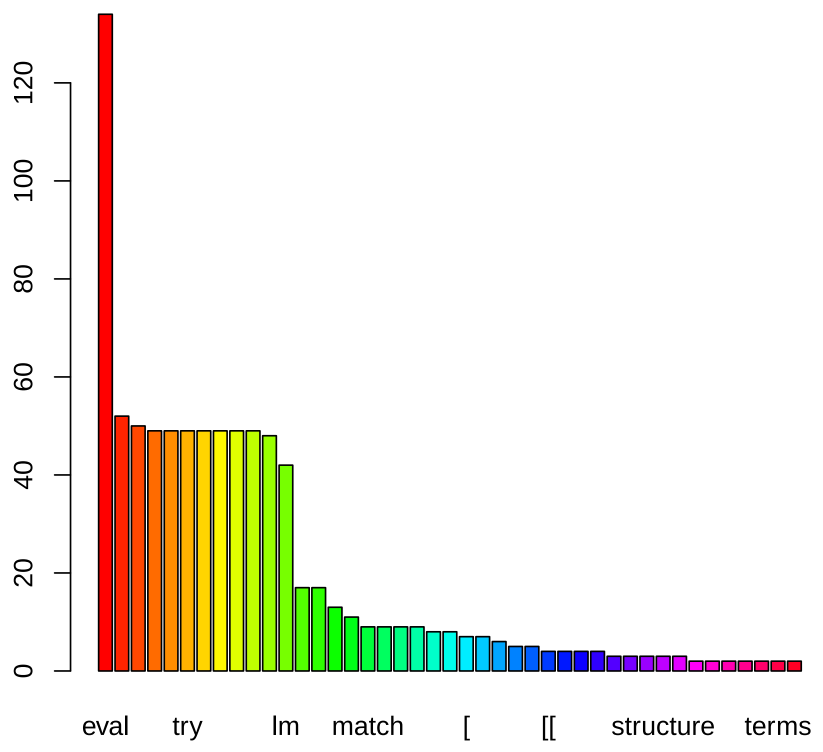
Input
```
nodefreq <- rep(0,length(sprof01$nodes$name))
for (i in (1:length(sprof01$stacks$nodes))){
        nodefreq <- nodefreq +
                table( factor(sprof01$stacks$nodes[[i]],
                        levels <- 1:length(sprof01$nodes$name),
                        ordered=FALSE))
        }
names(nodefreq) <- sprof01$nodes$name
```

Top frequent nodes.

Input
```
ndf <- nodefreq[nodefreq>1]
ondf <- order(ndf,decreasing=TRUE)
barplot(ndf[ondf])
```

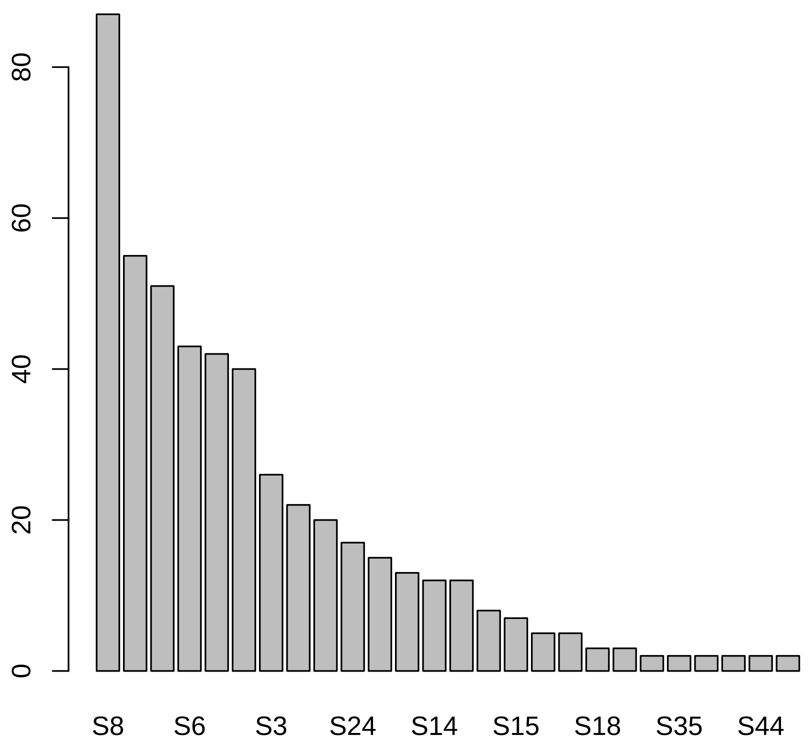


Input
```
barplot(ndf[ondf], col=rainbow(length(ondf)))
```



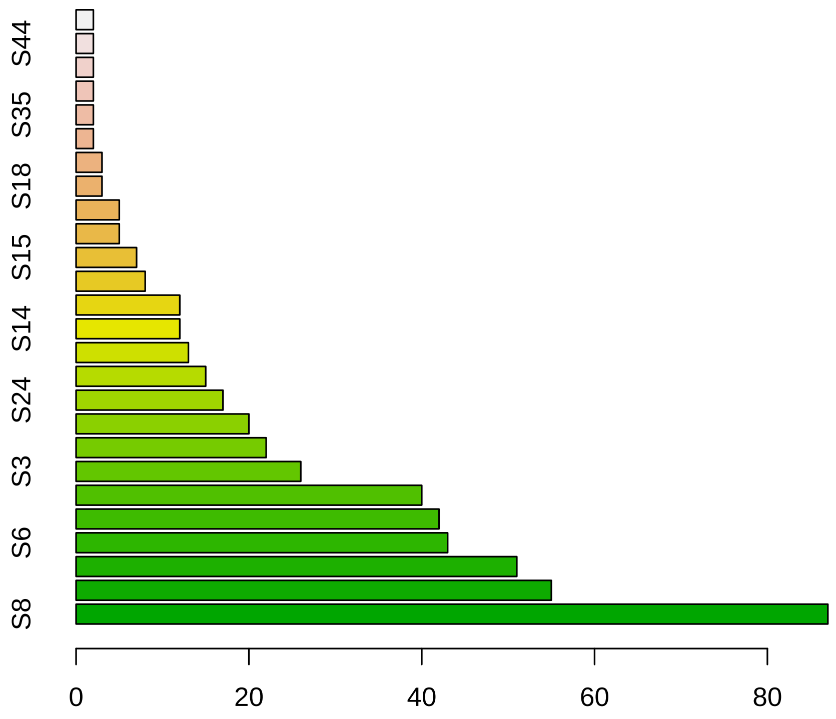
Top frequent stacks.

Input
```
x <- sprof01
xsrc <- as.matrix(x$stacks$refcount)
rownames(xsrc) <- rownames(xsrc, do.NULL=FALSE, prefix="S")
#stf <- x$stacks$refcount[x$stacks$refcount>1]
#names(stf) <-  x$stacks$shortname[x$stacks$refcount>1]
stf <- xsrc[xsrc>1]
names(stf) <- rownames(xsrc)[xsrc>1]
ostf <- order(stf,decreasing=TRUE)
barplot(stf[ostf])
```

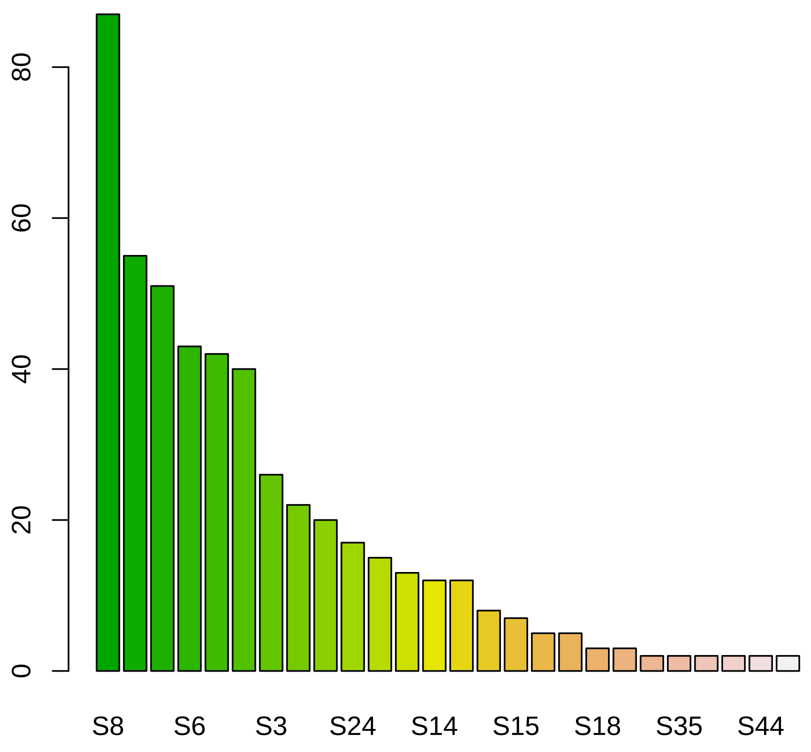


Input

```
barplot(stf[ostf], col=terrain.colors(length(ostf)), horiz=TRUE)
```



Input
```
barplot(stf[ostf], col=terrain.colors(length(ostf)))
```



There is no statistics on profiles. Profiling are our elementary data. However we can link to our derived data to get a more informative display. For example, going one step back we can encode stacks and use these color codes in the display of a profile.

Or going two steps back, we can encode nodes in color, giving colored stacks, and use these in the display of profile data.

6. Standard output

For a reference, here are complete outputs of the standard function.

Input
```
sprof <- sprof01
```

6.1. Print.

Input
```
print_nodes(sprof)
```

```
Output
                      shortname root leaf self.time  self.pct
!                             !    - LEAF         2  0.383142
..getNamespace              ..gN   -    -         0  0.000000
.deparseOpts                .dpO   - LEAF         2  0.383142
.getXlevels                 .gtX   -    -         0  0.000000
[                              [   -    -         0  0.000000
[.data.frame                [.d.   - LEAF        57 10.919540
[[                            [[   -    -         0  0.000000
[[.data.frame               [[..   - LEAF         1  0.191571
%in%                        %in%   - LEAF         1  0.191571
<Anonymous>                 <An>   - LEAF         6  1.149425
$                              $   - LEAF         1  0.191571
anyDuplicated               anyD   - LEAF         1  0.191571
anyDuplicated.default       anD.   - LEAF        22  4.214559
as.character                as.c   - LEAF        43  8.237548
as.list                     as.l   -    -         0  0.000000
as.list.data.frame          a...   - LEAF        22  4.214559
as.list.default             as..   - LEAF         1  0.191571
as.name                     as.n   - LEAF         1  0.191571
coef                        coef   - LEAF         1  0.191571
deparse                     dprs   - LEAF         1  0.191571
doTryCatch                  dTrC   -    -         0  0.000000
eval                        eval   - LEAF         1  0.191571
evalFunc                    evlF   -    -         0  0.000000
file                        file   - LEAF         1  0.191571
FUN                          FUN   - LEAF         1  0.191571
lapply                      lppl   - LEAF         2  0.383142
lazyLoadDBfetch             lLDB   - LEAF         2  0.383142
list                        list   - LEAF         5  0.957854
lm                            lm   - LEAF        42  8.045977
lm.fit                      lm.f   - LEAF        87 16.666667
match                       mtch   - LEAF         1  0.191571
mean                        mean   -    -         0  0.000000
mean.default                mn.d   - LEAF         2  0.383142
mode                        mode   - LEAF         2  0.383142
model.frame                mdl.f   -    -         0  0.000000
model.frame.default       mdl.f.   - LEAF        12  2.298851
model.matrix               mdl.m   -    -         0  0.000000
model.matrix.default      mdl.m.   - LEAF        51  9.770115
model.response             mdl.r   - LEAF        13  2.490421
na.omit                     n.mt   - LEAF        20  3.831418
na.omit.data.frame          n...   - LEAF        26  4.980843
names                       nams   - LEAF         2  0.383142
NCOL                        NCOL   - LEAF         1  0.191571
paste                       past   -    -         0  0.000000
pmatch                      pmtc   - LEAF         2  0.383142
rep.int                     rp.n   - LEAF         7  1.340996
sapply                      sppl   - LEAF         1  0.191571
simplify2array              smp2   -    -         0  0.000000
structure                   strc   - LEAF        32  6.130268
summary                     smmr   -    -         0  0.000000
summary.lm                  smm.   - LEAF        40  7.662835
```

```
Sweave                    Swev ROOT    -         0  0.000000
terms                     trms    -    -         0  0.000000
terms.formula             trm.    - LEAF         1  0.191571
try                        try    -    -         0  0.000000
tryCatch                  tryC    -    -         0  0.000000
tryCatchList              trCL    -    -         0  0.000000
tryCatchOne               trCO    -    -         0  0.000000
unique                    uniq    - LEAF         3  0.574713
unlist                    unls    -    -         0  0.000000
vapply                    vppl    - LEAF         3  0.574713
withVisible               wthV    -    -         0  0.000000
                     total.time total.pct
!                             0         0
..getNamespace                0         0
.deparseOpts                  0         0
.getXlevels                   0         0
[                             0         0
[.data.frame                  0         0
[[                            0         0
[[.data.frame                 0         0
%in%                          0         0
<Anonymous>                   0         0
$                             0         0
anyDuplicated                 0         0
anyDuplicated.default         0         0
as.character                  0         0
as.list                       0         0
as.list.data.frame            0         0
as.list.default               0         0
as.name                       0         0
coef                          0         0
deparse                       0         0
doTryCatch                    0         0
eval                          0         0
evalFunc                      0         0
file                          0         0
FUN                           0         0
lapply                        0         0
lazyLoadDBfetch               0         0
list                          0         0
lm                            0         0
lm.fit                        0         0
match                         0         0
mean                          0         0
mean.default                  0         0
mode                          0         0
model.frame                   0         0
model.frame.default           0         0
model.matrix                  0         0
model.matrix.default          0         0
model.response                0         0
na.omit                       0         0
na.omit.data.frame            0         0
```

```
names                          0         0
NCOL                           0         0
paste                          0         0
pmatch                         0         0
rep.int                        0         0
sapply                         0         0
simplify2array                 0         0
structure                      0         0
summary                        0         0
summary.lm                     0         0
Sweave                         0         0
terms                          0         0
terms.formula                  0         0
try                            0         0
tryCatch                       0         0
tryCatchList                   0         0
tryCatchOne                    0         0
unique                         0         0
unlist                         0         0
vapply                         0         0
withVisible                    0         0
```

Input

```
print_stacks(sprof)
```

Output

```
   len refcount root leafs
1   19        1   52    27
2   20        5   52    28
3   19       26   52    41
4   21       55   52     6
5   14       13   52    39
6   15       43   52    14
7   15       51   52    38
8   14       87   52    30
9   15        1   52    27
10  18       15   52    49
11  15        1   52    18
12  13       40   52    51
13  23       22   52    13
14  20       12   52    16
15  15        7   52    46
16  13       42   52    29
17  11        1   52    22
18  19        3   52    59
19  21        1   52     8
20  15        3   52    61
21  19        1   52    25
22  18       20   52    40
23  14        1   52    11
24  15       17   52    49
25  18        8   52    16
26  22        5   52    10
```

```
27  17        1   52    47
28  17       12   52    36
29  17        1   52    31
30  18        1   52     3
31  18        1   52    12
32  20        1   52     3
33  17        2   52    16
34  22        1   52     9
35  21        2   52    45
36  22        2   52     1
37  19        1   52    54
38  18        1   52    10
39  19        1   52    26
40  17        2   52     6
41  18        1   52    17
42  25        1   52    34
43  18        1   52    20
44  15        2   52    33
45  22        2   52    42
46  22        1   52    34
47  14        1   52    43
48  14        1   52    19
49  19        1   52    26
50   3        1   52    24
```

Input
```
print_profiles(sprof)
```

Output
```
$id
[1] "Profile Summary Sun Jul 14 22:27:24 2013"

$len
[1] 522

$uniquestacks
[1] 50

$nr_runs
[1] 396
```

The `print()` method for `sprof` objects concatenates these three functions.

6.2. **Summary.**

Input
```
summary_nodes(sprof)
```

Output
```
                       shortname root leaf self.time  self.pct
!                              !    - LEAF         2  0.383142
..getNamespace               ..gN    -    -         0  0.000000
.deparseOpts                 .dpO    - LEAF         2  0.383142
```

```
.getXlevels                .gtX    -    -         0  0.000000
[                             [    -    -         0  0.000000
[.data.frame               [.d.    - LEAF        57 10.919540
[[                           [[    -    -         0  0.000000
[[.data.frame              [[..    - LEAF         1  0.191571
%in%                       %in%    - LEAF         1  0.191571
<Anonymous>                <An>    - LEAF         6  1.149425
$                             $    - LEAF         1  0.191571
anyDuplicated              anyD    - LEAF         1  0.191571
anyDuplicated.default      anD.    - LEAF        22  4.214559
as.character               as.c    - LEAF        43  8.237548
as.list                    as.l    -    -         0  0.000000
as.list.data.frame         a...    - LEAF        22  4.214559
as.list.default            as..    - LEAF         1  0.191571
as.name                    as.n    - LEAF         1  0.191571
coef                       coef    - LEAF         1  0.191571
deparse                    dprs    - LEAF         1  0.191571
doTryCatch                 dTrC    -    -         0  0.000000
eval                       eval    - LEAF         1  0.191571
evalFunc                   evlF    -    -         0  0.000000
file                       file    - LEAF         1  0.191571
FUN                         FUN    - LEAF         1  0.191571
lapply                     lppl    - LEAF         2  0.383142
lazyLoadDBfetch            lLDB    - LEAF         2  0.383142
list                       list    - LEAF         5  0.957854
lm                           lm    - LEAF        42  8.045977
lm.fit                     lm.f    - LEAF        87 16.666667
match                      mtch    - LEAF         1  0.191571
mean                       mean    -    -         0  0.000000
mean.default               mn.d    - LEAF         2  0.383142
mode                       mode    - LEAF         2  0.383142
model.frame               mdl.f    -    -         0  0.000000
model.frame.default      mdl.f.    - LEAF        12  2.298851
model.matrix              mdl.m    -    -         0  0.000000
model.matrix.default     mdl.m.    - LEAF        51  9.770115
model.response            mdl.r    - LEAF        13  2.490421
na.omit                    n.mt    - LEAF        20  3.831418
na.omit.data.frame         n...    - LEAF        26  4.980843
names                      nams    - LEAF         2  0.383142
NCOL                       NCOL    - LEAF         1  0.191571
paste                      past    -    -         0  0.000000
pmatch                     pmtc    - LEAF         2  0.383142
rep.int                    rp.n    - LEAF         7  1.340996
sapply                     sppl    - LEAF         1  0.191571
simplify2array             smp2    -    -         0  0.000000
structure                  strc    - LEAF        32  6.130268
summary                    smmr    -    -         0  0.000000
summary.lm                 smm.    - LEAF        40  7.662835
Sweave                     Swev ROOT    -         0  0.000000
terms                      trms    -    -         0  0.000000
terms.formula              trm.    - LEAF         1  0.191571
try                         try    -    -         0  0.000000
tryCatch                   tryC    -    -         0  0.000000
```

```
tryCatchList              trCL    -    -         0  0.000000
tryCatchOne               trCO    -    -         0  0.000000
unique                    uniq    - LEAF         3  0.574713
unlist                    unls    -    -         0  0.000000
vapply                    vppl    - LEAF         3  0.574713
withVisible               wthV    -    -         0  0.000000
                     total.time total.pct
!                             0         0
..getNamespace                0         0
.deparseOpts                  0         0
.getXlevels                   0         0
[                             0         0
[.data.frame                  0         0
[[                            0         0
[[.data.frame                 0         0
%in%                          0         0
<Anonymous>                   0         0
$                             0         0
anyDuplicated                 0         0
anyDuplicated.default         0         0
as.character                  0         0
as.list                       0         0
as.list.data.frame            0         0
as.list.default               0         0
as.name                       0         0
coef                          0         0
deparse                       0         0
doTryCatch                    0         0
eval                          0         0
evalFunc                      0         0
file                          0         0
FUN                           0         0
lapply                        0         0
lazyLoadDBfetch               0         0
list                          0         0
lm                            0         0
lm.fit                        0         0
match                         0         0
mean                          0         0
mean.default                  0         0
mode                          0         0
model.frame                   0         0
model.frame.default           0         0
model.matrix                  0         0
model.matrix.default          0         0
model.response                0         0
na.omit                       0         0
na.omit.data.frame            0         0
names                         0         0
NCOL                          0         0
paste                         0         0
pmatch                        0         0
rep.int                       0         0
```

```
sapply                         0         0
simplify2array                 0         0
structure                      0         0
summary                        0         0
summary.lm                     0         0
Sweave                         0         0
terms                          0         0
terms.formula                  0         0
try                            0         0
tryCatch                       0         0
tryCatchList                   0         0
tryCatchOne                    0         0
unique                         0         0
unlist                         0         0
vapply                         0         0
withVisible                    0         0
```

Input

```
summary_stacks(sprof)
```

Output

```
$nrstacks
[1] 50

$stacklength
[1]  3 25

$nrnodesperlevel
 [1]  1  1  2  1  1  1  1  1  1  1  1  1  3 10 11  9  9 15  8  7  5  7
[23]  2  1  1
```

Input

```
summary_profiles(sprof)
```

Output

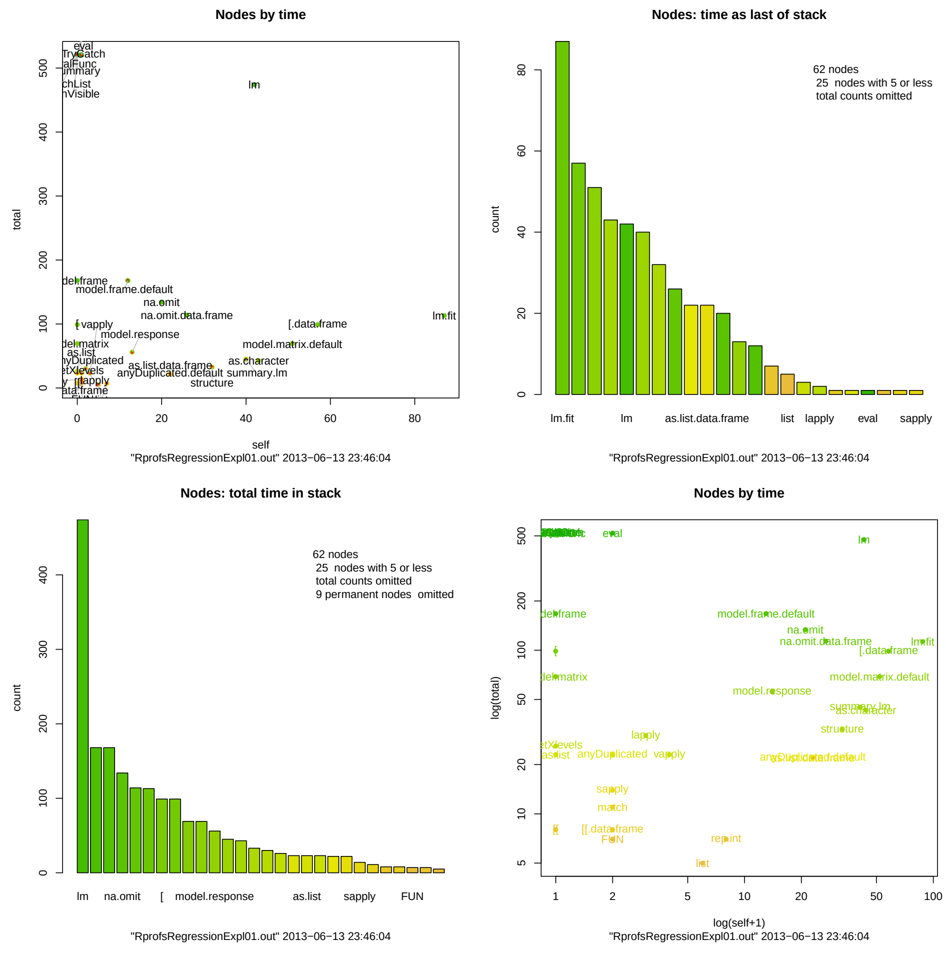
```
$id
[1] "Profile Summary Sun Jul 14 22:27:24 2013"

$len
[1] 522

$uniquestacks
[1] 50

$nr_runs
[1] 396
```

The *summary()* method for *sprof* objects concatenates these three functions.

6.3. **Plot.**

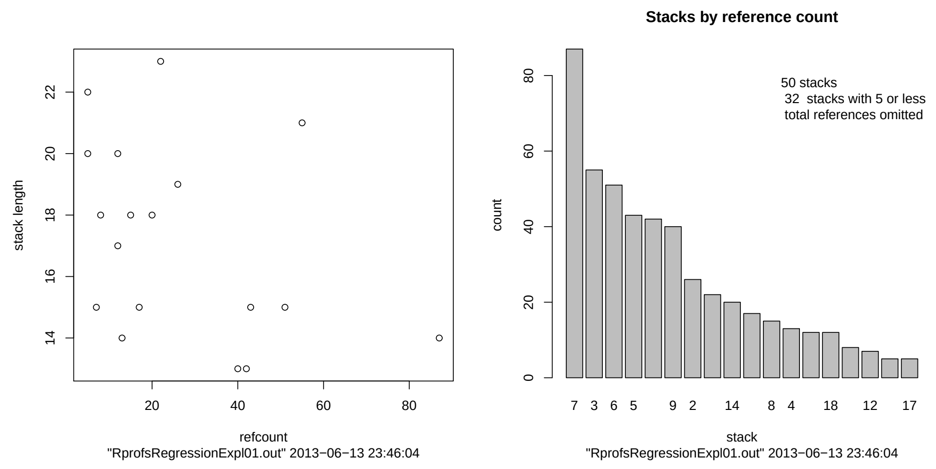
Input

```
oldpar<- par(mfrow=c(2,2))
plot_nodes(sprof)
par(oldpar)
```

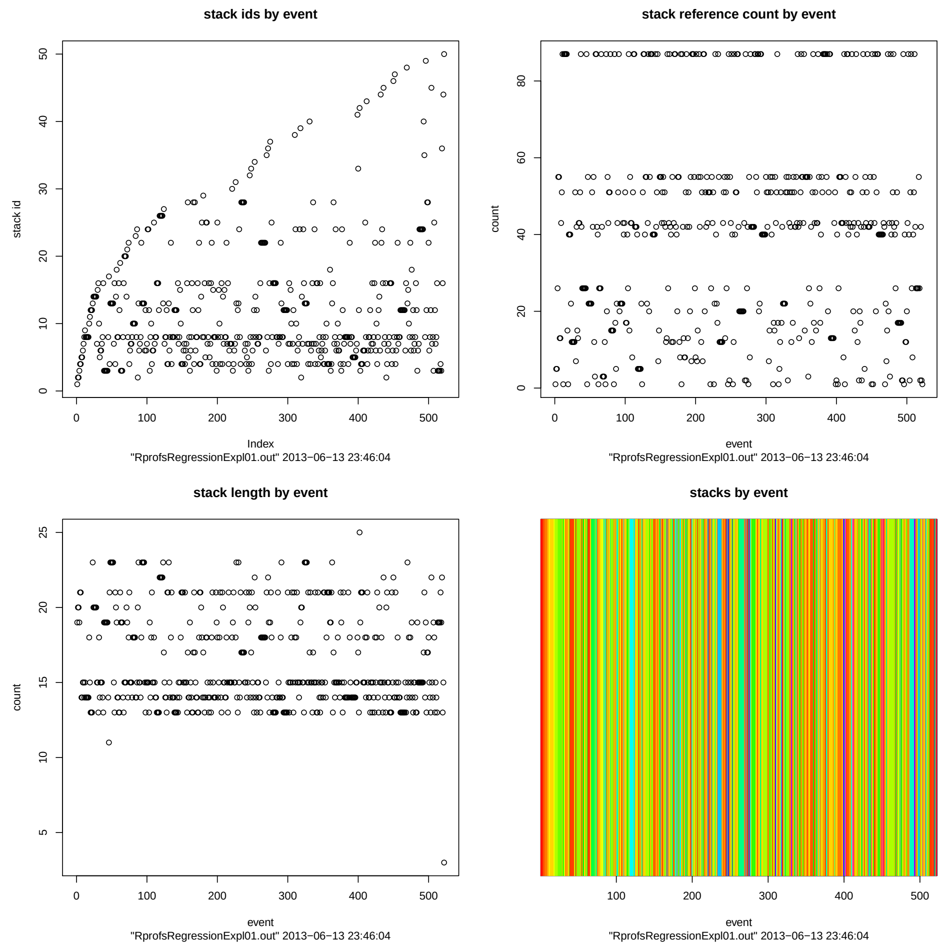


Input

```
oldpar<- par(mfrow=c(1,2))
plot_stacks(sprof)
par(oldpar)
```



Input
```
oldpar<- par(mfrow=c(2,2))
plot_profiles(sprof)
par(oldpar)
```



The *plot()* method for *sprof* objects concatenates these three functions.

7. Graph

In this section, we use the recent version of our example, *sprof02* for demonstration. You can re-run it, using your *sprof* data by modifying this instruction:

Input
```
sprof <- sprof02
```

To interface *sprof* to a graph handling package, *until()* can extract the adjacency matrix from the profile.

There are various packages for finding a graph layout, and the choice is open to your preferences. The R packages for most of these are just wrapper

Input
```
sprofadj <- adjacency(sprof)
```

This is a format any graph package can handle (maybe).

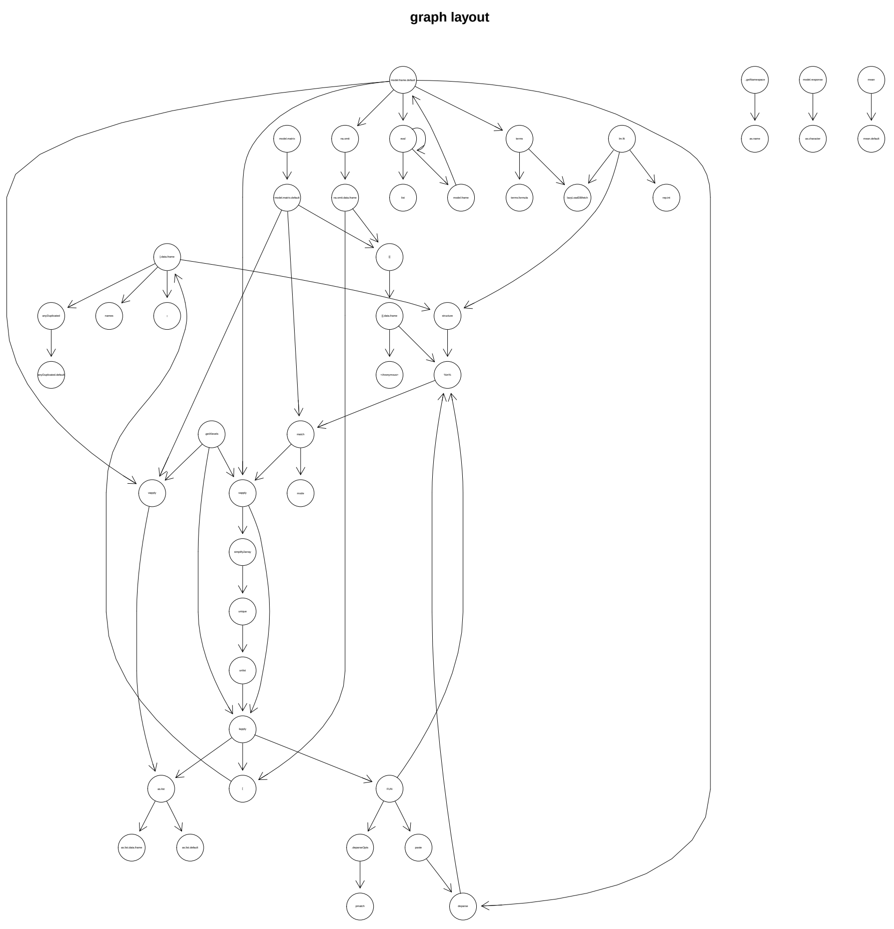
7.1. graph Package.

Input

```
library(graph)
sprofadjNEL <- as(sprofadj,"graphNEL")
```

Input

```
plot(sprofadjNEL,  main="graph layout", cex.main=2)
#detach("package:graph")
```



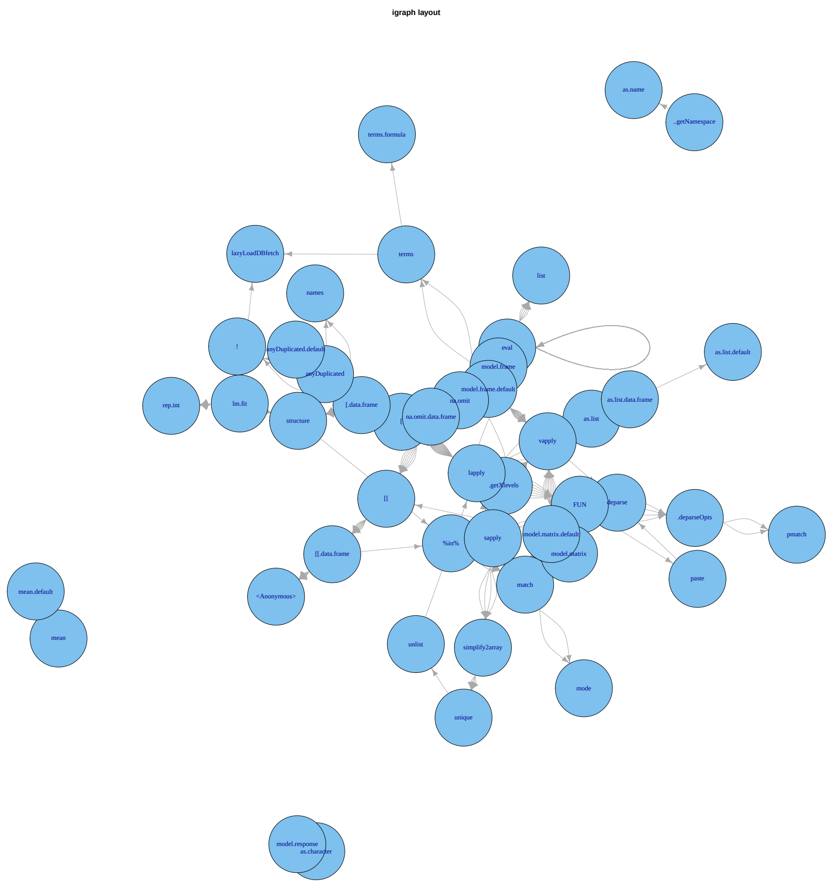
7.1.1. *igraph Package.*

Input

```
library(igraph)
sprofig <- graph.adjacency(sprofadj)
```

Input

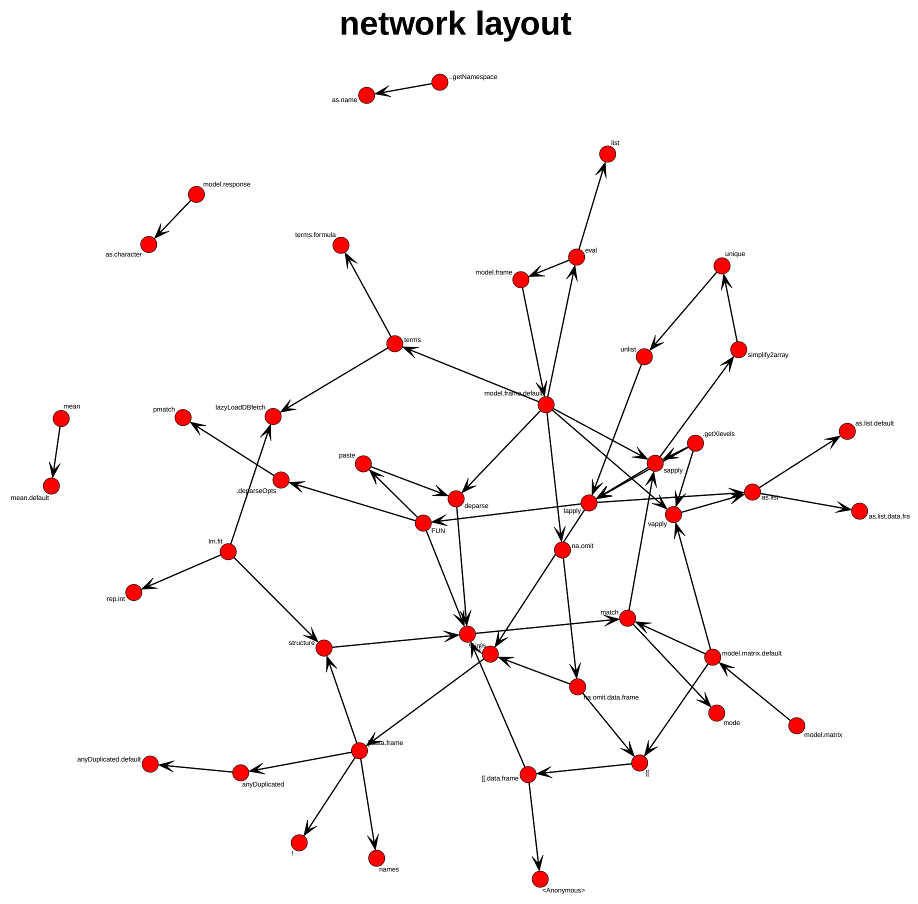
```
#plot(sprofig, main="igraph layout", cex.main=5)
plot(sprofig, main="igraph layout")
detach("package:igraph")
```



7.1.2. *network Package.*

Input

```
library(network)
nwsprofadj <- as.network(sprofadj) # names is not imported
network.vertex.names(nwsprofadj) <- rownames(sprofadj) # not honoured by plot
plot(nwsprofadj, label=rownames(sprofadj), main="network layout", cex.main=5)
```

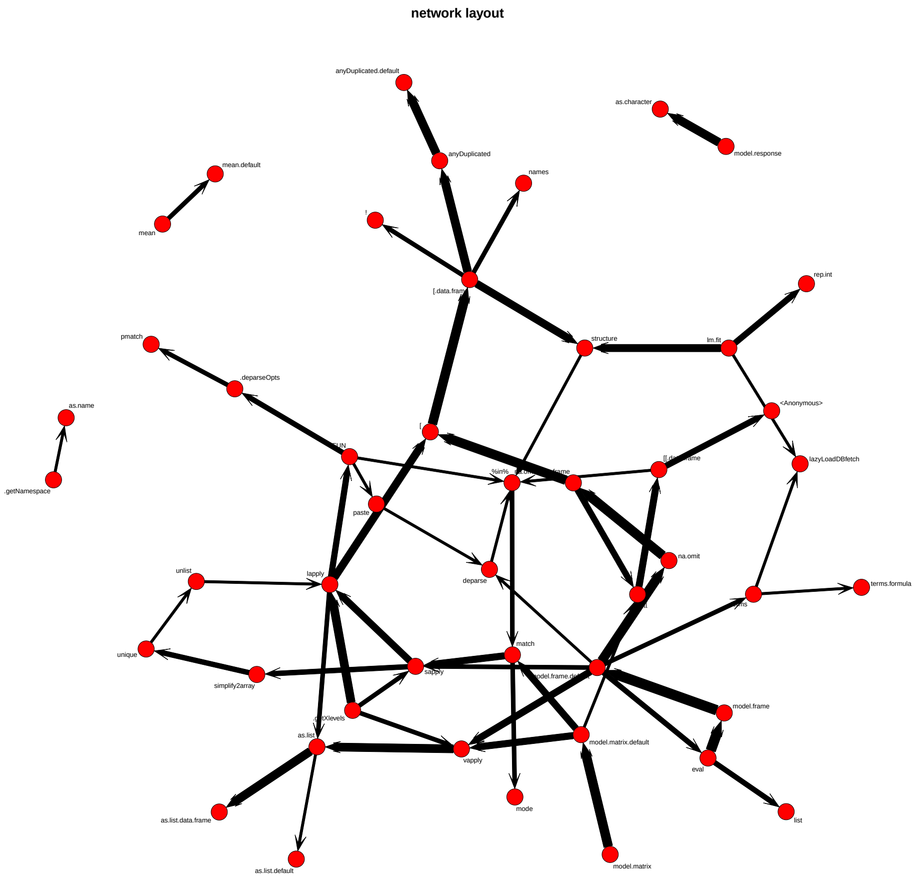


Experiments to include weight.

ToDo: maximum edge.lwd?

Input

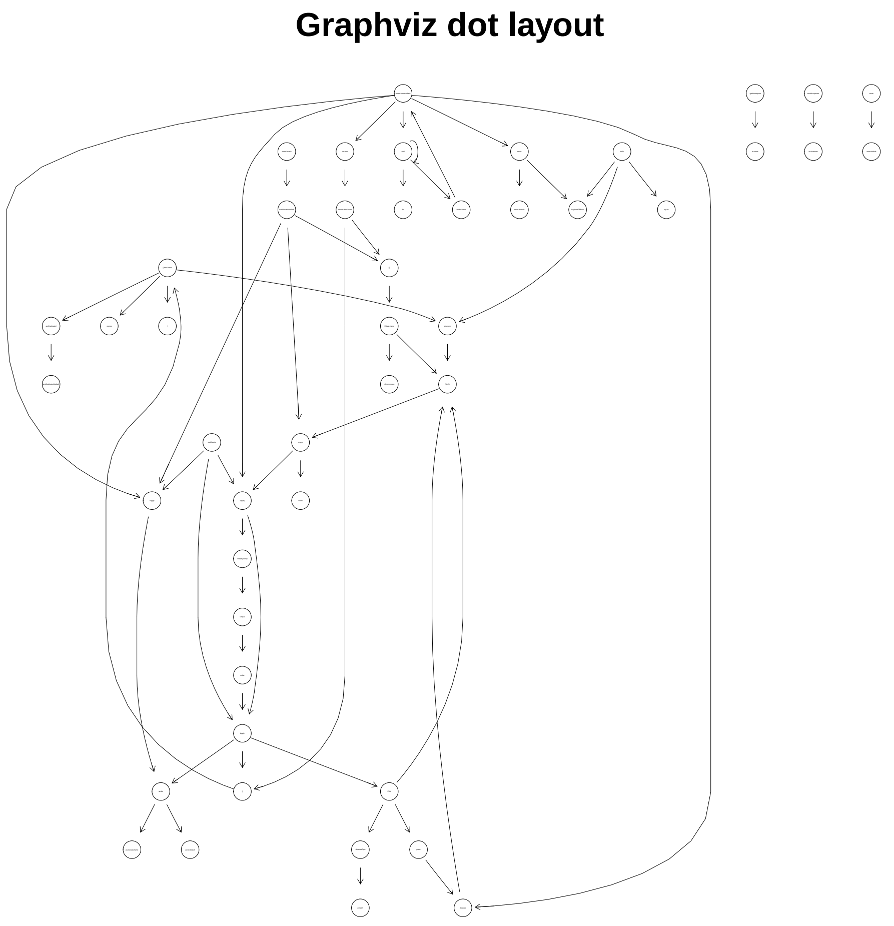
```
edge.lwd<-sprofadj
edge.lwd[edge.lwd>0]<- rank(edge.lwd[edge.lwd>0], ties.method="max")
#edge.lwd <- trunc(sprofadj/max(sprofadj)*10)+1
edge.lwd <- round(edge.lwd/max(edge.lwd)*12)
plot(nwsprofadj, label=rownames(sprofadj), main="network layout", cex.main=2, edge.lwd=edge.lwd)
detach("package:network")
```



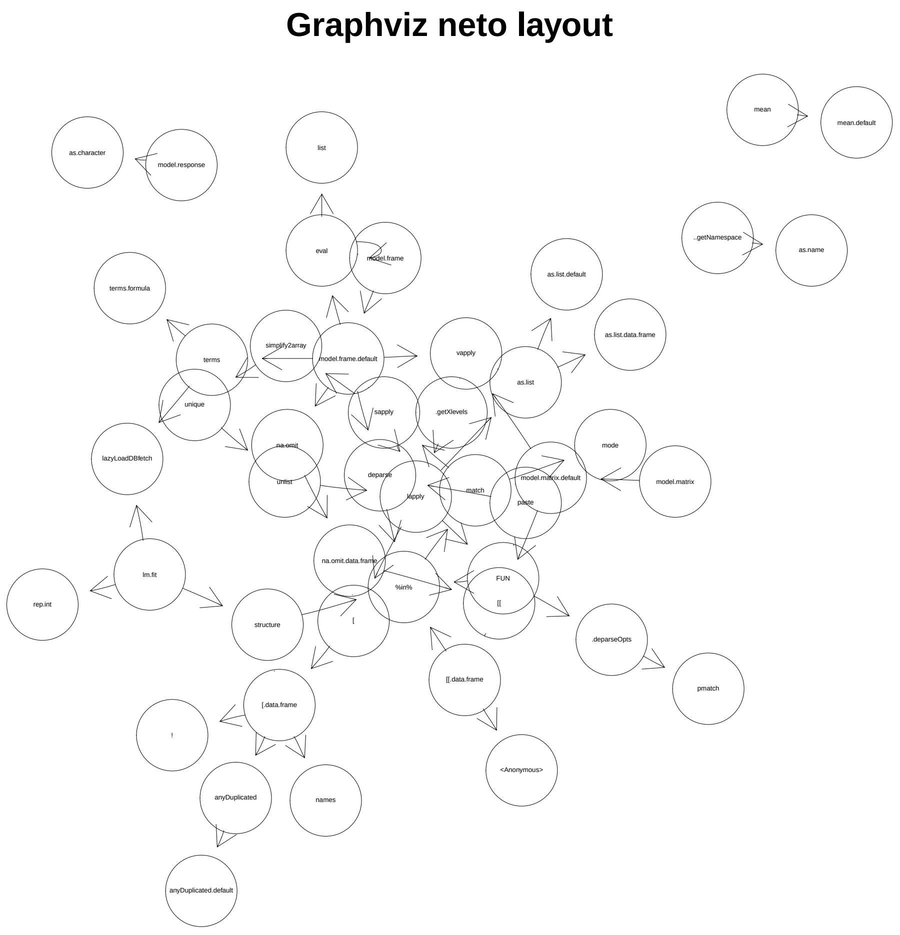
7.1.3. *Rgraphviz Package.*

Input
```
library(Rgraphviz)
sprofadjRag <- agopen(sprofadjNEL, name="Rprof Example")
```

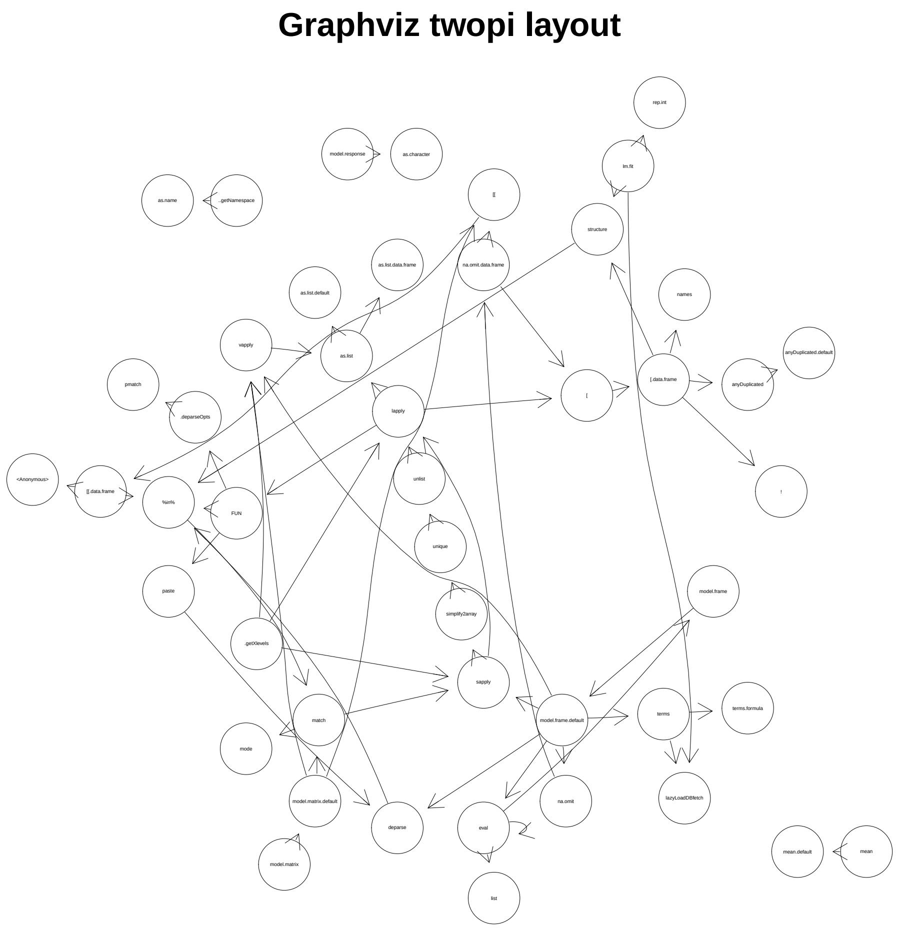
Input
```
plot(sprofadjRag, main="Graphviz dot layout", cex.main=5)
```



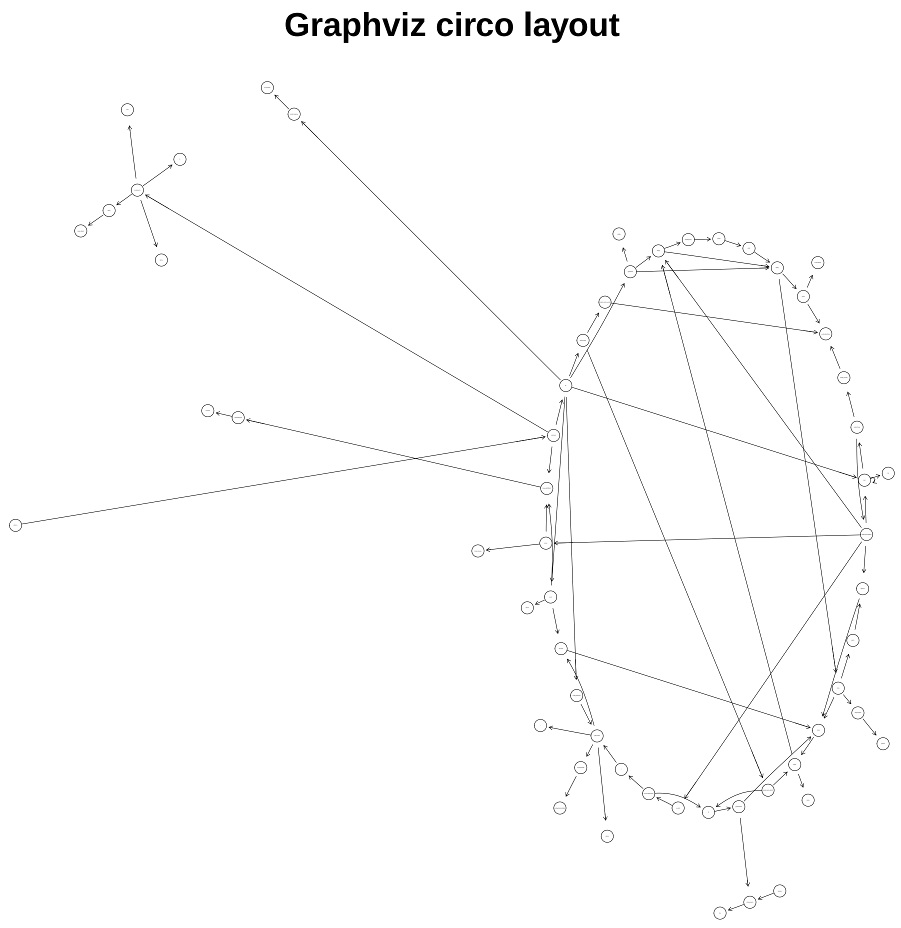
Input
```
plot(sprofadjRag,"neato", main="Graphviz neto layout", cex.main=5)
```



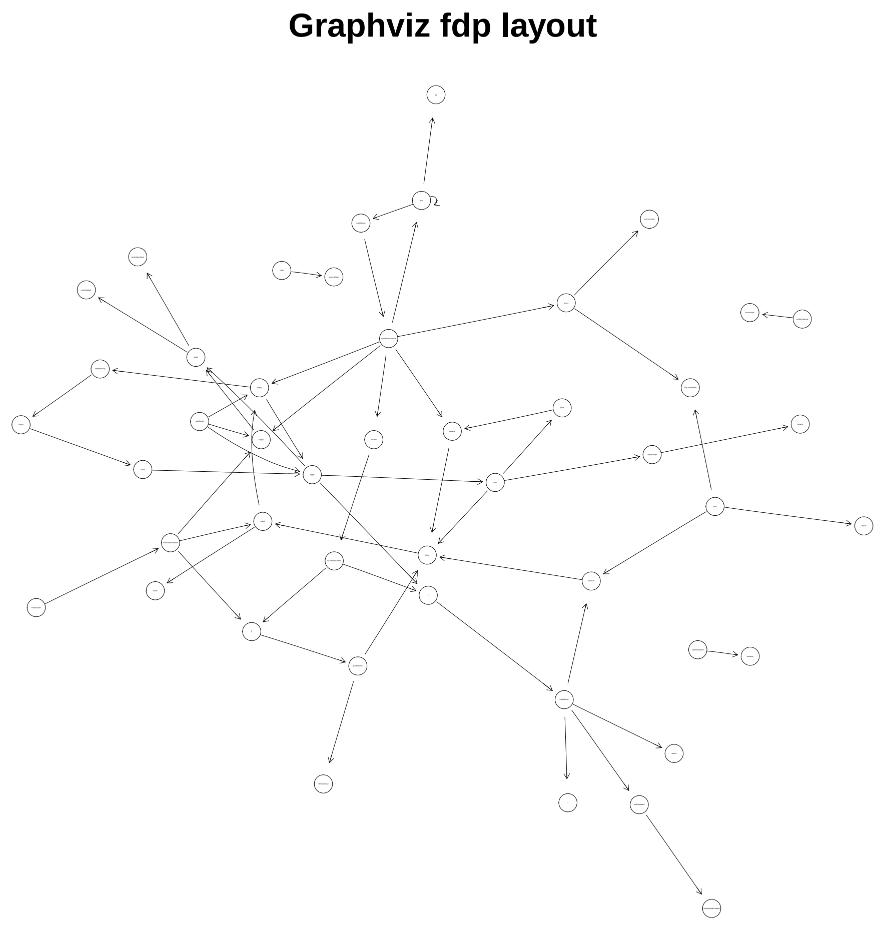
Input
```
plot(sprofadjRag,"twopi", main="Graphviz twopi layout", cex.main=5)
```



Input
```
plot(sprofadjRag,"circo", main="Graphviz circo layout", cex.main=5)
```



Input
```
plot(sprofadjRag,"fdp", main="Graphviz fdp layout", cex.main=5)
```



8. Graph II

In this section, we use the reduced version of our example, *sprof03* for demonstration. Except for the change of the data set, this is just a copy of the previous chapter, collecting the various layouts for easy reference.

You can re-run it, using your *sprof* data by modifying this instruction:

Input
```
sprof <- sprof03
```

To interface *sprof* to a graph handling package, *until()* can extract the adjacency matrix from the profile.

Input

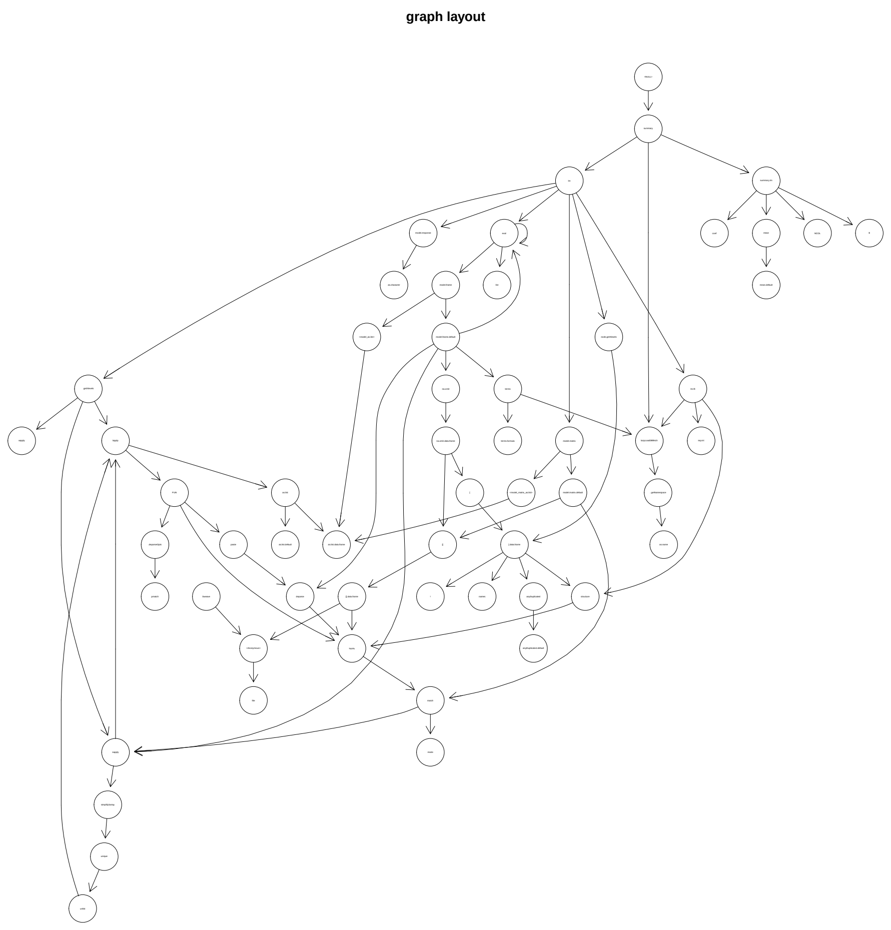
```
sprofadj <- adjacency(sprof)
adjname <- colnames(sprofadj)
adjname[adjname==""] <- "<NULL>"
 colnames(sprofadj) <- adjname
 rownames(sprofadj) <- adjname
```

This is a format any graph package can handle (maybe).

8.1. graph Package.

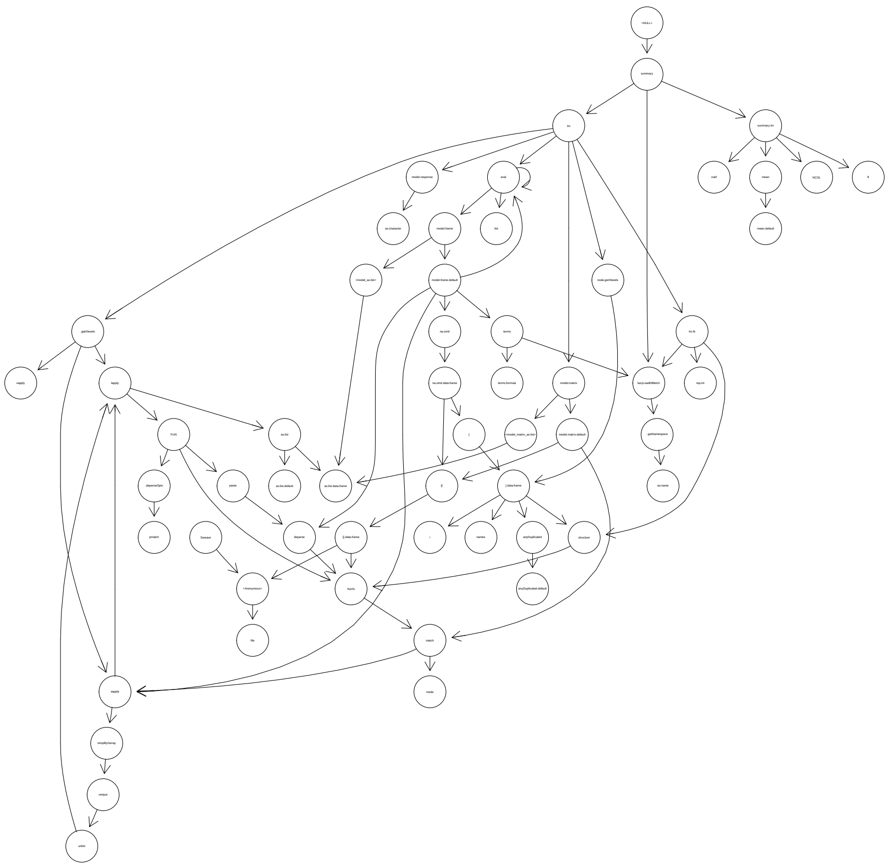
Input
```
library(graph)
sprofadjNEL <- as(sprofadj,"graphNEL")
```

Input
```
#24
plot(sprofadjNEL,  main="graph layout", cex.main=2)
#detach("package:graph")
```



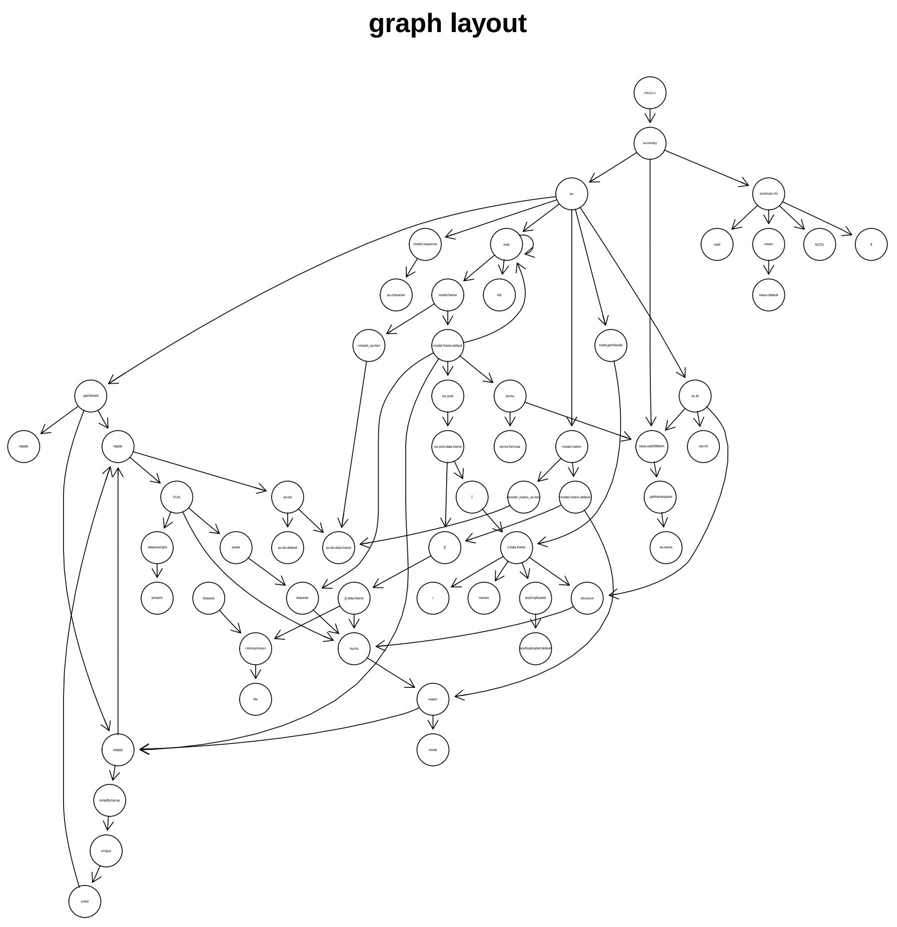
Input
```
#18
plot(sprofadjNEL,  main="graph layout", cex.main=2)
#detach("package:graph")
```

graph layout



Input

```
#12
plot(sprofadjNEL,  main="graph layout", cex.main=2)
#detach("package:graph")
```


graph layout
<NULL>
summary
lm
summary.lm
coef
mean
NCOL
$
mean.default
model.response
eval
as.character
model.frame
list
<model_as.list>
model.frame.default
node.getXlevels
.getXlevels
na.omit
terms
lm.fit
vapply
lapply
na.omit.data.frame
terms.formula
model.matrix
lazyLoadDBfetch
rep.int
FUN
as.list
[
<model_matrix_as.list>
model.matrix.default
..getNamespace
.deparseOpts
paste
as.list.default
as.list.data.frame
[[
[.data.frame
as.name
pmatch
Sweave
deparse
[[.data.frame
!
names
anyDuplicated
structure
<Anonymous>
%in%
anyDuplicated.default
file
match
sapply
mode
simplify2array
unique
unlist

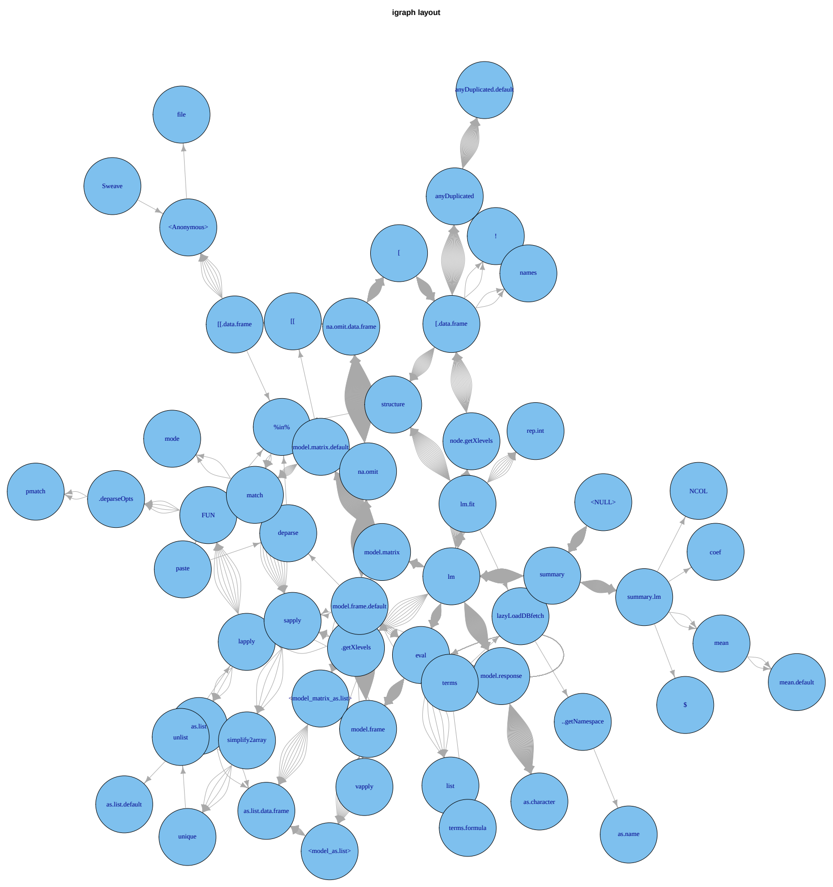
8.1.1. *igraph Package.*

Input

```
library(igraph)
sprofig <- graph.adjacency(sprofadj)
```

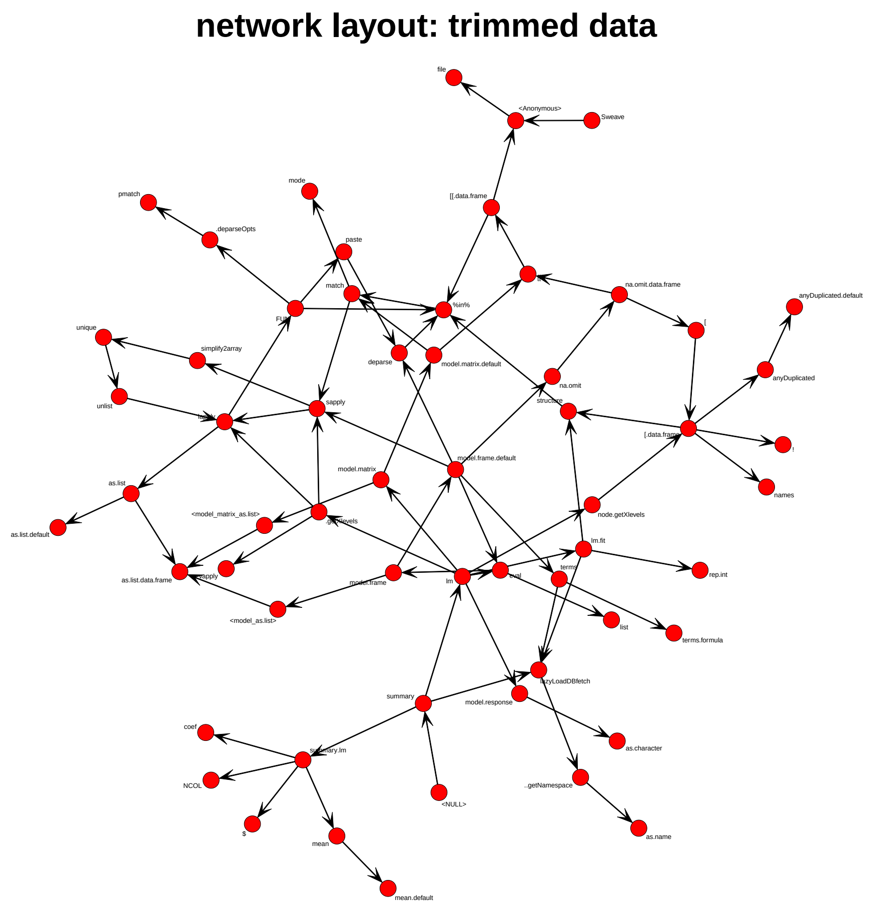
Input

```
#plot(sprofig, main="igraph layout", cex.main=5)
plot(sprofig, main="igraph layout")
detach("package:igraph")
```



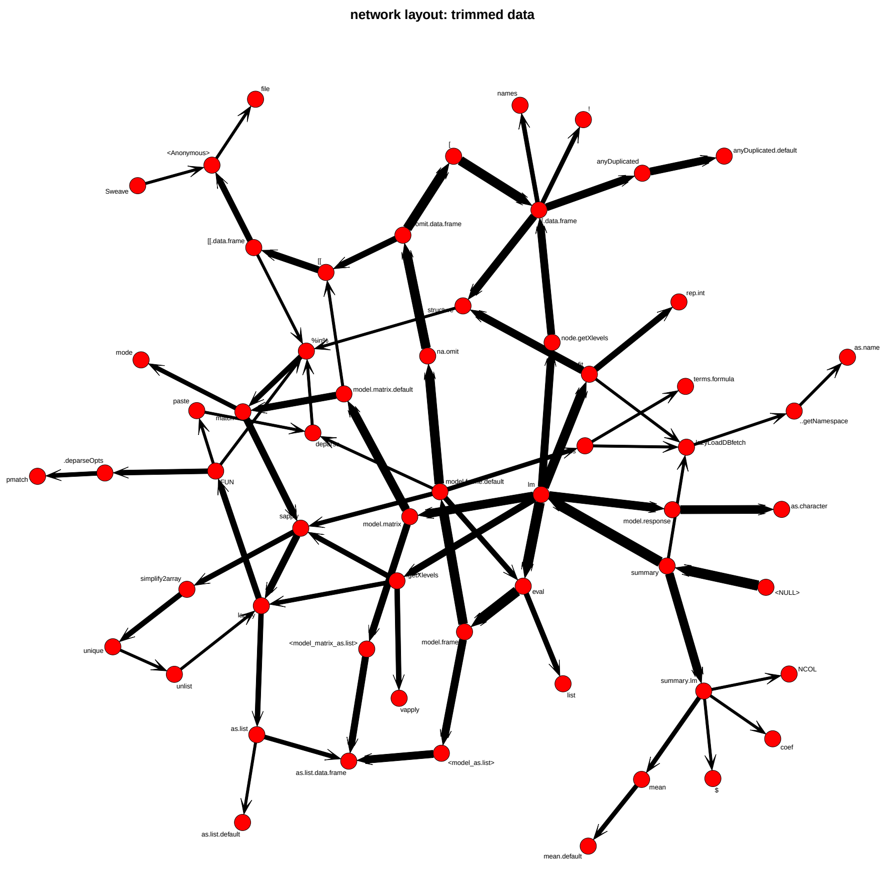
8.1.2. *network Package.*

Input
```
library(network)
nwsprofadj <- as.network(sprofadj) # names is not imported
network.vertex.names(nwsprofadj) <- rownames(sprofadj) # not honoured by plot
plot(nwsprofadj, label=rownames(sprofadj), main="network layout: trimmed data", cex.main=5)
```

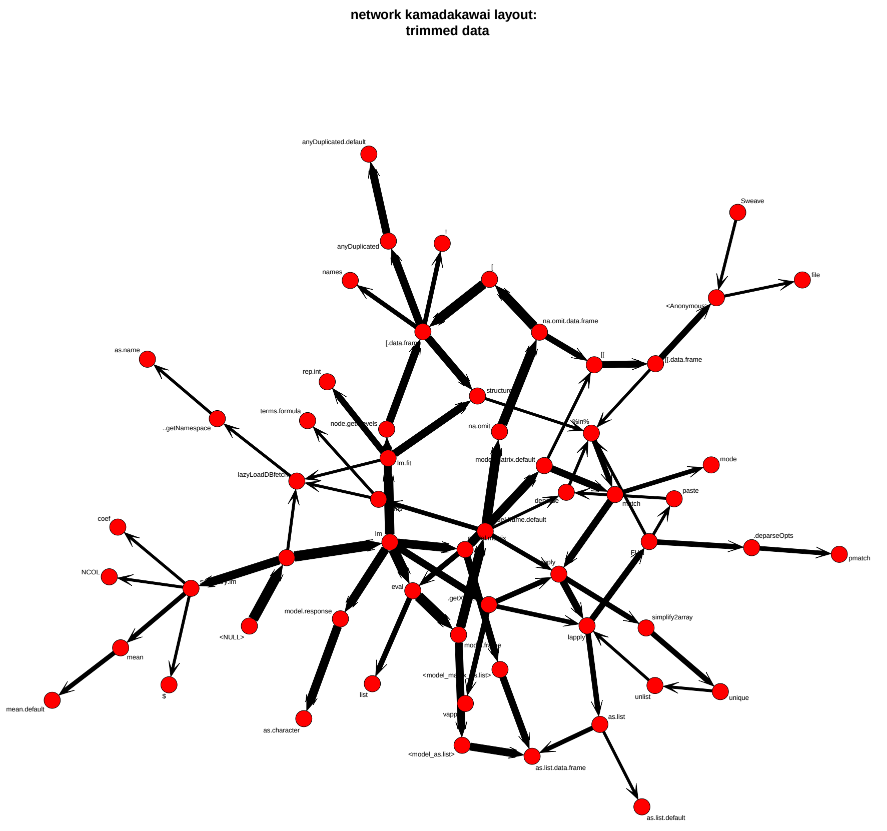


Input

```
edge.lwd<-sprofadj
edge.lwd[edge.lwd>0]<- rank(edge.lwd[edge.lwd>0], ties.method="max")
#edge.lwd <- trunc(sprofadj/max(sprofadj)*10)+1
edge.lwd <- round(edge.lwd/max(edge.lwd)*12)
plot(nwsprofadj, label=rownames(sprofadj), main="network layout: trimmed data", cex.main=2, edge.lw
```

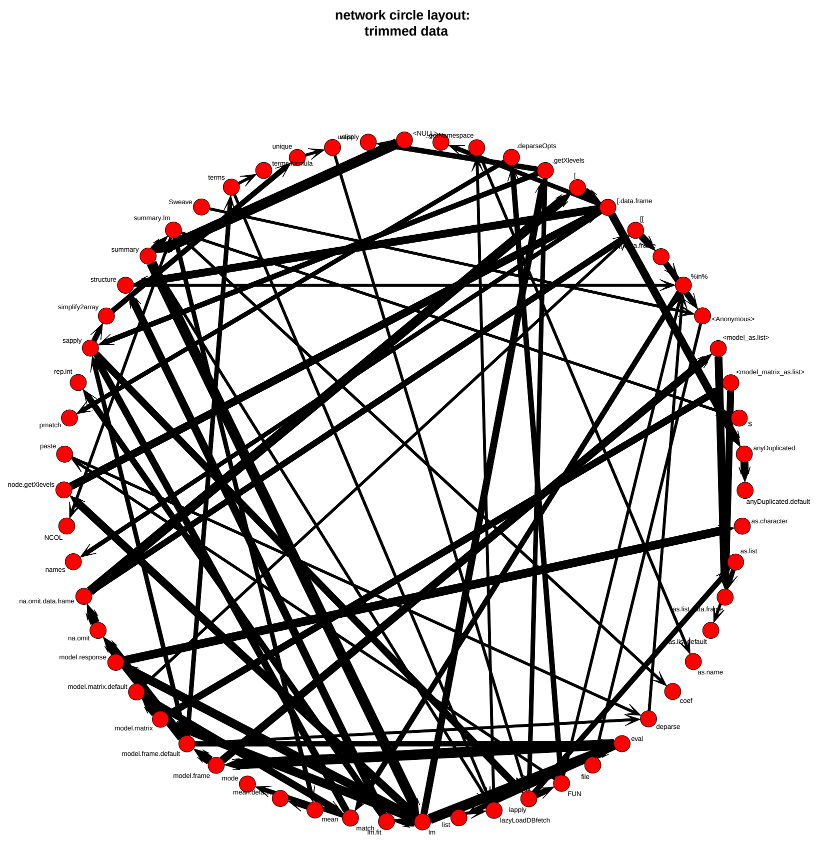


Input
```
plot(nwsprofadj, label=rownames(sprofadj),
main="network kamadakawai layout: \n trimmed data",
mode="kamadakawai",
cex.main=2, edge.lwd=edge.lwd)
```



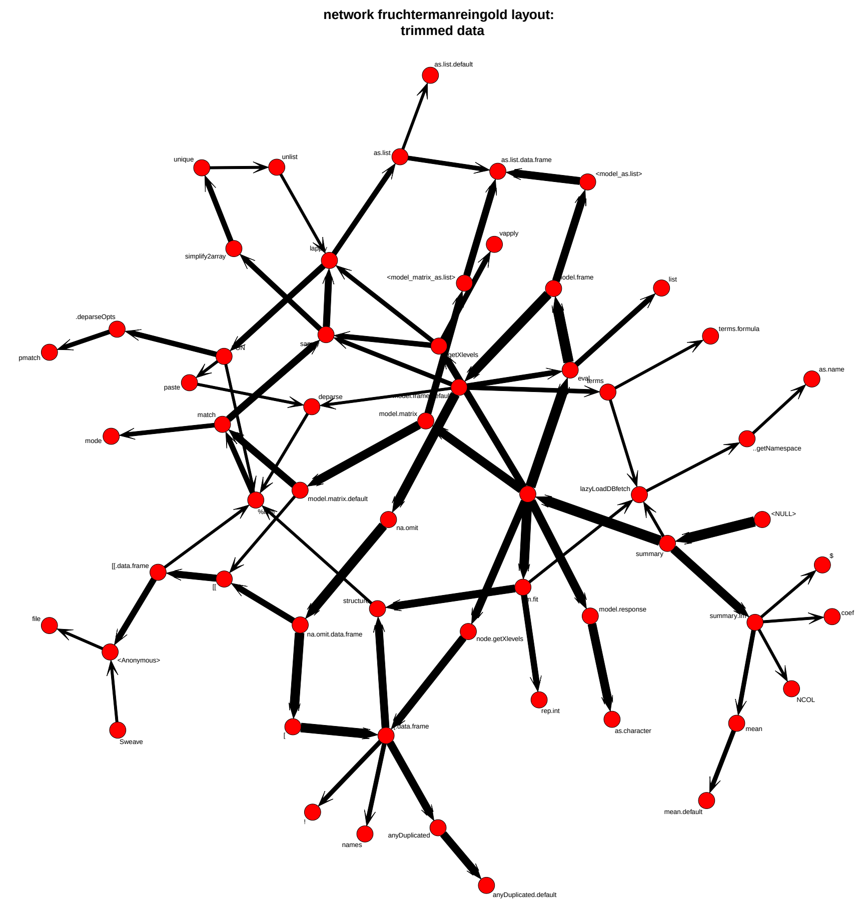
Input

```
plot(nwsprofadj, label=rownames(sprofadj),
main="network circle layout: \n trimmed data",
mode="circle",
cex.main=2, edge.lwd=edge.lwd)
```



Input

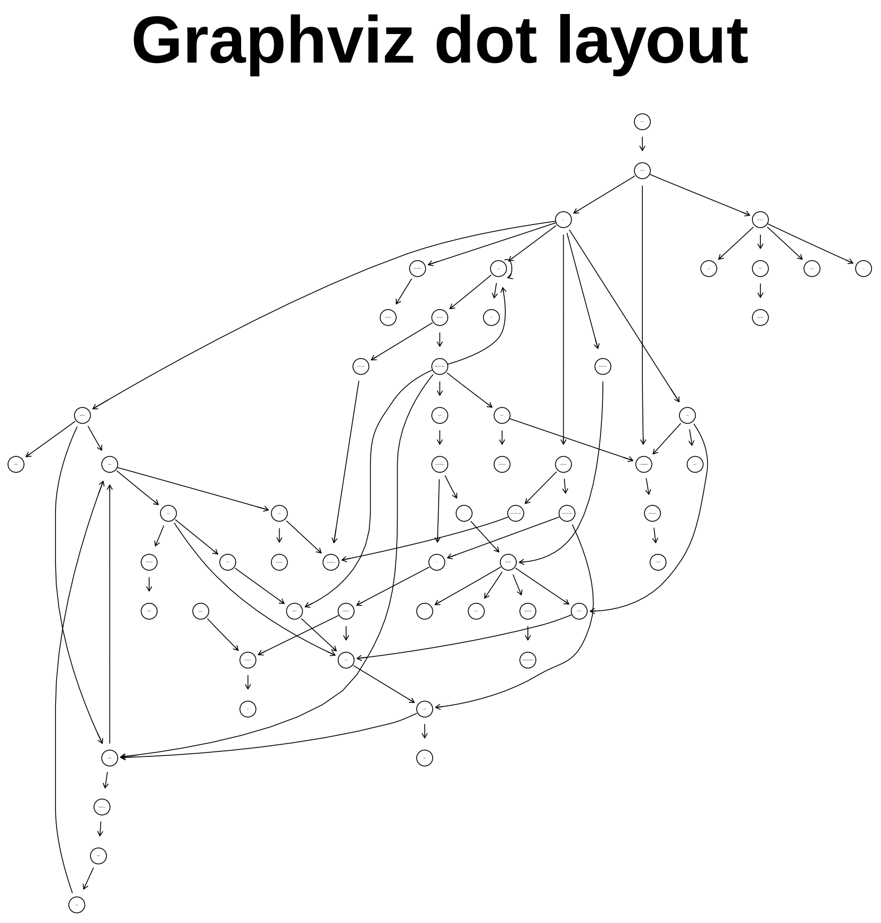
```
plot(nwsprofadj, label=rownames(sprofadj),
main="network fruchtermanreingold layout: \n trimmed data",
mode="fruchtermanreingold",
cex.main=2, edge.lwd=edge.lwd)
detach("package:network")
```


network fruchtermanreingold layout:
trimmed data
as.list.default
as.list
as.list.data.frame
<model_as.list>
unique
unlist
vapply
simplify2array
lapply
<model_matrix_as.list>
model.frame
list
.deparseOpts
pmatch
FUN
sapply
getXlevels
terms.formula
paste
deparse
model.frame.default
eval
terms
as.name
match
mode
model.matrix
..getNamespace
model.matrix.default
%in%
lazyLoadDBfetch
<NULL>
na.omit
summary
$
[[.data.frame
[[
structure
lm.fit
model.response
summary.lm
coef
file
na.omit.data.frame
node.getXlevels
<Anonymous>
NCOL
rep.int
as.character
Sweave
[
[.data.frame
mean
mean.default
!
names
anyDuplicated
anyDuplicated.default

8.1.3. *Rgraphviz Package.*

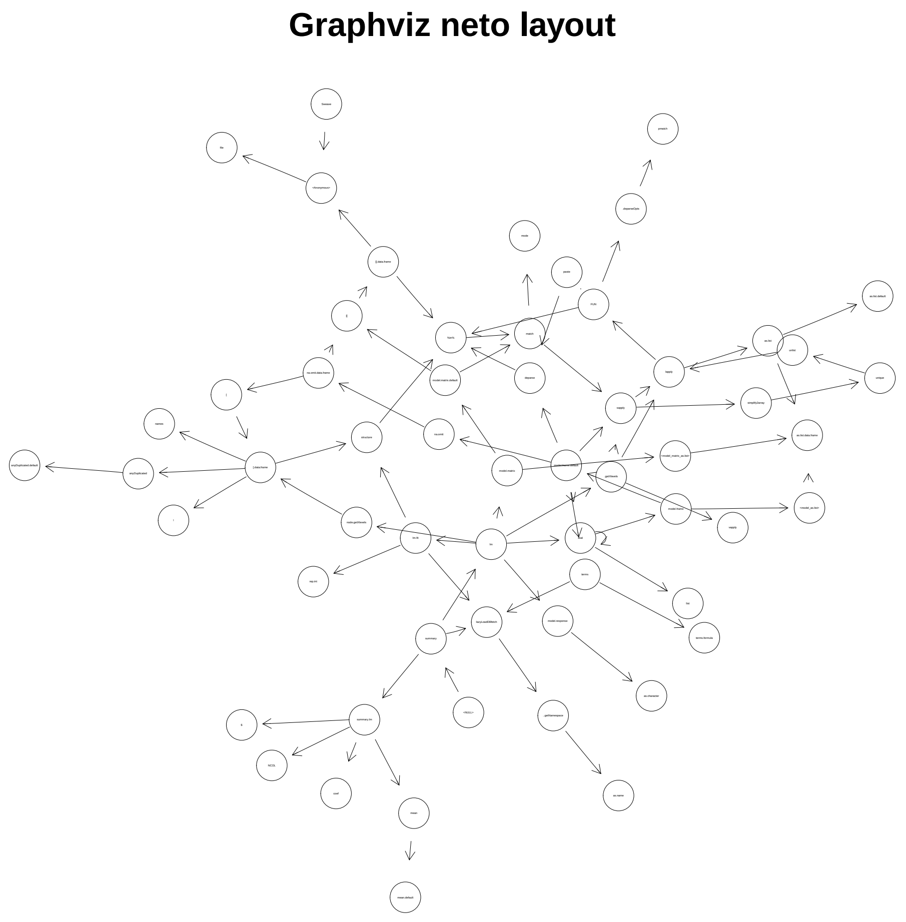
Input
```
library(Rgraphviz)
sprofadjRag <- agopen(sprofadjNEL, name="Rprof Example")
```

Input
```
#12
plot(sprofadjRag, main="Graphviz dot layout", cex.main=5)
```

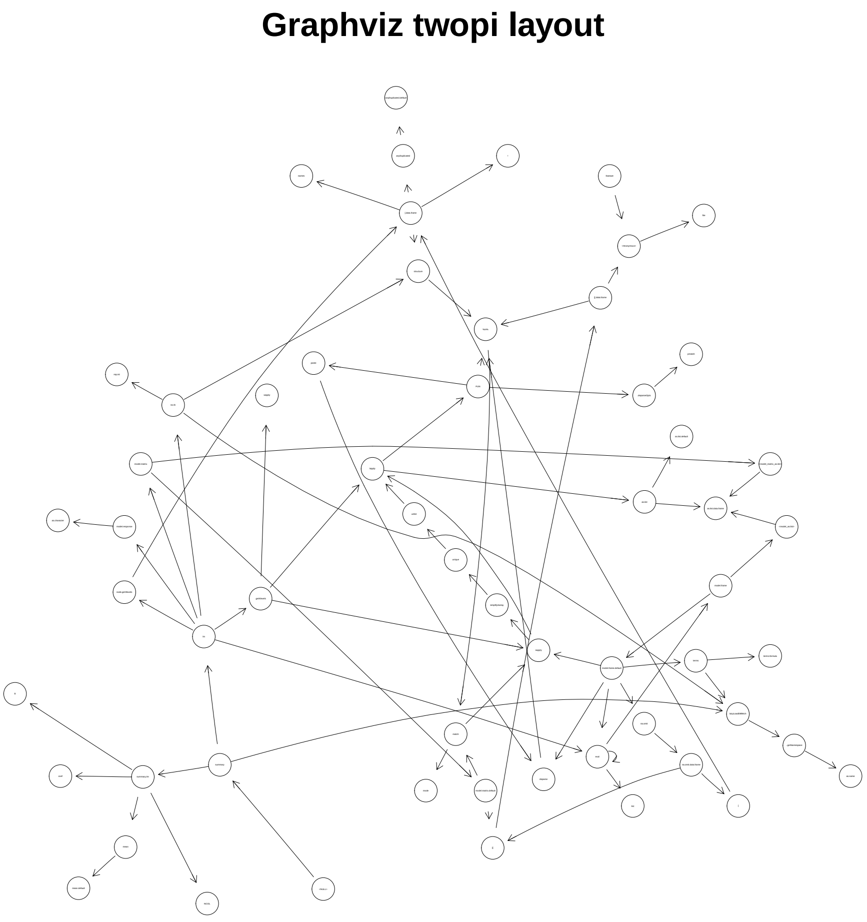


Input

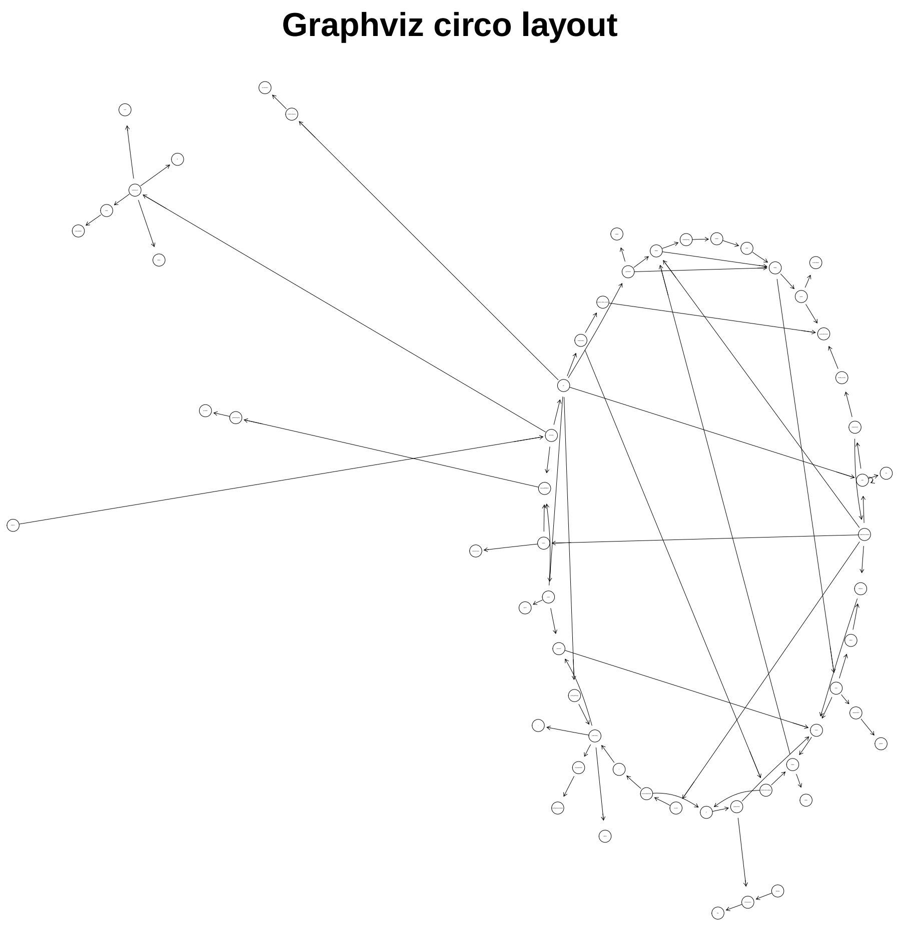
```
plot(sprofadjRag,"neato", main="Graphviz neto layout", cex.main=5)
```



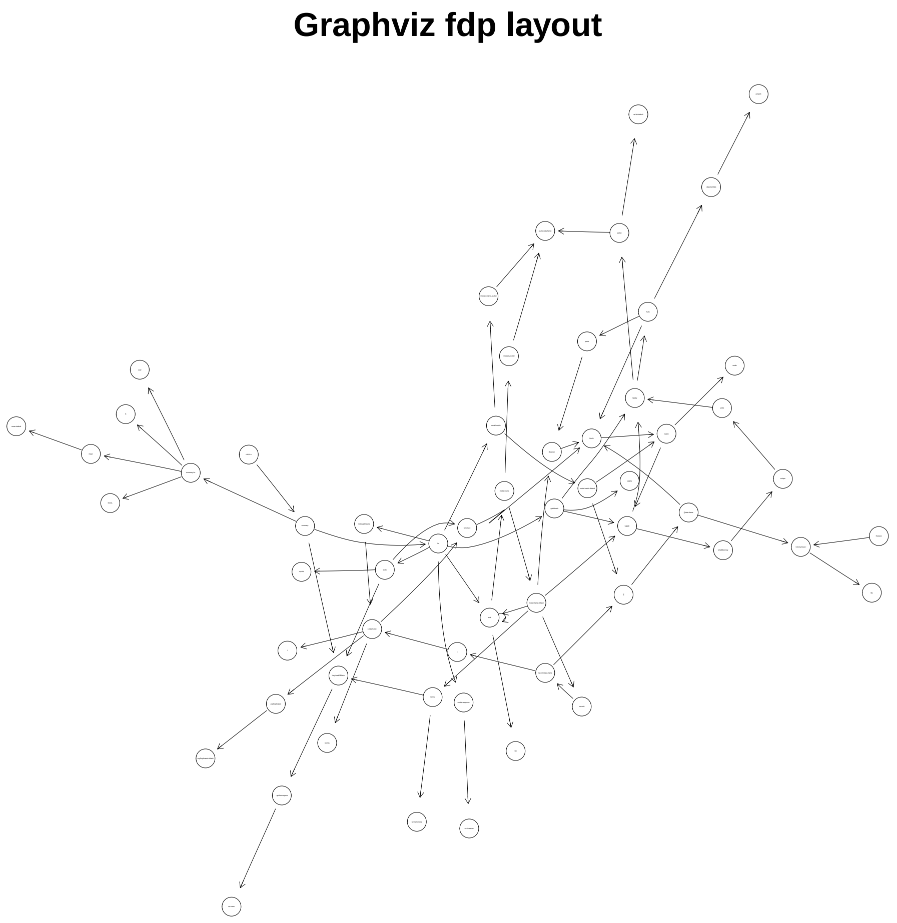
Input
```
plot(sprofadjRag,"twopi", main="Graphviz twopi layout", cex.main=5)
```



Input
```
plot(sprofadjRag,"circo", main="Graphviz circo layout", cex.main=5)
```



Input
```
plot(sprofadjRag,"fdp", main="Graphviz fdp layout", cex.main=5)
```



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R session info:

- R version 3.0.1 (2013-05-16), `x86_64-apple-darwin10.8.0`
- Locale:
  `en_GB.UTF-8/en_GB.UTF-8/en_GB.UTF-8/C/en_GB.UTF-8/en_GB.UTF-8`
- Base packages: base, datasets, graphics, grDevices, grid, methods, stats, utils
- Other packages: graph 1.38.2, RColorBrewer 1.0-5, Rcpp 0.10.3, Rgraphviz 2.4.0, sna 2.3-1, sprof 0.0-5, wordcloud 2.4, xtable 1.7-1
- Loaded via a namespace (and not attached): BiocGenerics 0.6.0, igraph 0.6.5-2, network 1.7.2, parallel 3.0.1, slam 0.1-28, stats4 3.0.1, tools 3.0.1

LaTeX information:

textwidth: 4.9823in linewidth:4.9823in
textheight: 8.0824in

Svn repository information:

`$HeadURL:` svnssh://gsawitzki@svn.r-forge.r-project.org/svnroot/sintro/pkg/sprof/vignettes/sprofiling.Rnw +

`$Source: /u/math/j40/cvsroot/lectures/src/insider/profile/Rnw/profile.Rnw,v $`

`$Id: sprofiling.Rnw 169 2013-07-14 12:51:59Z gsawitzki $`

`$Revision: 169 $`

`$Date: 2013-07-14 14:51:59` 0200$(Sun, 14 Jul 2013)+$

`$name: $`

`$Author: gsawitzki $`

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