Modifying **grid** grobs

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There is a distinction between grobs which are just stored in user-level R objects and grobs which represent drawn output (i.e., grobs on the **grid** display list). There is a naming convention that `grid.*()` functions are (mainly) used for their side-effect of producing output or modifying existing output (they create/affect grobs on the display list). Functions of the form `*Grob()` are used for their return value; the grob that they create/modify. For example, the following creates a grob and then modifies it, but performs absolutely no drawing; this is purely manipulating a description of a graphical object.

```
> gl <- linesGrob()
> gl <- editGrob(gl, gp = gpar(col = "green"))
```

The next example produces output. A grob is returned, but that grob is just a description of the output that was drawn and has no direct link to the output. It is possible to access the grob representing the output by using the grob's `name`. In order to access a grob which represents drawn output (i.e., a grob on the display list), you must specify a `gPath`. The `gPath` should be created using the `gPath()` function for writing scripts, but in interactive use, it is possible to specify the `gPath` directly as a string. The code below shows both approaches.

```
> grid.newpage()
> grid.lines(name = "lines")
> grid.edit(gPath("lines"), gp = gpar(col = "pink"))
> grid.edit("lines", gp = gpar(col = "red"))
```

Complex graphical objects are provided by the `gTree` class. A `gTree` is a grob which may have other grobs as children. The `xaxis` and `yaxis` grobs provided by **grid** are examples of `gTree`s; the children of an axis include a lines grob for the tick-marks and a text grob for the tick-mark labels. The function `childNames()` can be used to list the names of the children of a `gTree`. When dealing with these hierarchical objects, more complex `gPath`s can be used to access children of a `gTree`. In the following example, an x-axis is drawn, then the xaxis itself is edited to modify the locations of the tick-marks, then the xaxis's text child is edited to modify the location of the labels on the tick-marks.

```
> grid.newpage()
> pushViewport(viewport(w = .5, h = .5))
> grid.rect(gp = gpar(col = "grey"))
> grid.xaxis(name = "myxaxis")
> grid.edit("myxaxis", at = 1:4/5)
```

```
> grid.edit(gPath("myxaxis", "labels"), y = unit(-1, "lines"))
>
```

This next example extends the idea a step further to edit the child of a child of a `gTree`. It also shows the use of the `gTree` function to construct a simple `gTree` (this is just creating an instance of the `gTree` class – it is also possible to extend the `gTree` class in order to provide specialised behaviour for drawing and other things; more on this later). Finally, the example demonstrates how `gPath`s of depth greater than 1 can be specified directly as a string.

```
> grid.newpage()
> pushViewport(viewport(w = .5, h = .5))
> myplot <-
+     gTree(name = "myplot",
+           children = gList(rectGrob(name = "box", gp = gpar(col = "grey")),
+                            xaxisGrob(name = "xaxis")))
> grid.draw(myplot)
> grid.edit("myplot::xaxis", at = 1:10/11)
> grid.edit("myplot::xaxis::labels", label = round(1:10/11, 2))
> grid.edit("myplot::xaxis::labels", y = unit(-1, "lines"))
```

`"grobwidth"` units require a `grob` to give the width of. There are two ways to specify the `grob`. The following example shows the most obvious method of simply supplying a `grob`. Notice that if you modify `gt` it will have no effect on the width of the drawn rectangle.

```
> grid.newpage()
> gt <- grid.text("Hi there")
> grid.rect(width = unit(1, "grobwidth", gt))
```

In order to allow a `"grobwidth"` unit to track changes in the `grob`, it is possible to specify a `gPath` rather than a `grob` as the data for a `"grobwidth"` unit. The following example modifies the previous example to use a `gPath`. Now, the width of the rectangle changes when the width of the underlying `grob` changes.

```
> grid.newpage()
> gt <- grid.text("Hi there", name = "sometext")
> grid.rect(width = unit(1, "grobwidth", "sometext"))
> grid.edit("sometext", label = "Something different")
```

One issue in the evaluation of `"grobwidth"` units involves establishing the correct "context" for a `grob` when determining its width (if a `grob` has a viewport in its `vp` slot then that viewport gets pushed before the `grob` is drawn; that viewport should also be pushed when determining the width of the `grob`). To achieve this there are `preDrawDetails()`, `drawDetails()`, and `postDrawDetails()` generic functions. (suggestions for better names welcome!). The idea is that pushing and popping of viewports should occur in the `pre` and `post` generics, and any actual drawing happens in the main `drawDetails()` generic. This allows the code that calculates a `grob` width to call the `preDrawDetails()` in order to establish the context in which the `grob` would be drawn before calculating its width. The following example shows a test case; a `grob` is created (extending to a new class to allow specific methods to be written), and methods are provided which establish a particular context for drawing the `grob`. These methods are used both in the drawing of the `grob` and in the calculation of the `grob`'s width (when drawing a bounding rectangle).

```
> grid.newpage()
> mygrob <- grob(name = "mygrob", cl = "mygrob")
> preDrawDetails.mygrob <- function(x)
+     pushViewport(viewport(gp = gpar(fontsize = 20)))
> drawDetails.mygrob <- function(x, recording = TRUE)
+     grid.draw(textGrob("hi there"), recording = FALSE)
> postDrawDetails.mygrob <- function(x) popViewport()
> widthDetails.mygrob <- function(x) unit(1, "strwidth", "hi there")
> grid.draw(mygrob)
> grid.rect(width = unit(1, "grobwidth", mygrob))
```

This next example shows a slightly different test case where the standard `preDrawDetails()` and `postDrawDetails()` methods are used, but the `grob` does have a `vp` slot so these methods do something. Another interesting feature of this example is the slightly more complex `gTree` that is created. The `gTree` has a `childrenvp` specified. When the `gTree` is drawn, this viewport is pushed and then "up"ed before the children of the `gTree` are drawn. This means that the children of the `gTree` can specify a `vpPath` to the viewport they should be in. This allows the parent `gTree` to create a suite of viewports and then children of the `gTree` select which one they want – this can be more efficient than having each child push and pop the viewports it needs, especially if several children are drawn within the same viewport. Another, more realistic example of this is given later.

```
> grid.newpage()
> mygtree <- gTree(name = "mygrob",
+                  childrenvp = viewport(name = "labelvp",
+                                        gp = gpar(fontsize = 20)),
+                  children = gList(textGrob("hi there", name = "label",
+                    vp = "labelvp")),
+                  cl = "mygtree")
> widthDetails.mygtree <- function(x)
+     unit(1, "grobwidth", getGrob(x, "label"))
> grid.draw(mygtree)
> grid.rect(width = unit(1, "grobwidth", mygtree))
```

Constructing a description of a `frame` `grob` must be done via `packGrob()` and `placeGrob()`. The following example shows the construction of a simple frame consisting of two equal-size columns.

```
> grid.newpage()
> fg <- frameGrob(layout = grid.layout(1, 2))
> fg <- placeGrob(fg, textGrob("Hi there"), col = 1)
> fg <- placeGrob(fg, rectGrob(), col = 2)
> grid.draw(fg)
```

This next example constructs a slightly fancier frame using packing.

```
> grid.newpage()
> pushViewport(viewport(layout = grid.layout(2, 2)))
> drawIt <- function(row, col) {
+     pushViewport(viewport(layout.pos.col = col, layout.pos.row = row))
```

```
+     grid.rect(gp = gpar(col = "grey"))
+     grid.draw(fg)
+     upViewport()
+ }
> fg <- frameGrob()
> fg <- packGrob(fg, textGrob("Hi there"))
> fg <- placeGrob(fg, rectGrob())
> drawIt(1, 1)
> fg <- packGrob(fg, textGrob("Hello again"), side = "right")
> drawIt(1, 2)
> fg <- packGrob(fg, rectGrob(), side = "right", width = unit(1, "null"))
> drawIt(2, 2)
```

In order to allow frames to update when the objects packed within them are modified, there is a `dynamic` argument to `packGrob()` (and `grid.pack()`). The following extends the previous example to show how this might be used. Another feature of this example is the demonstration of "non-strict" searching that occurs in the `grid.edit()` call; the `grob` called `"midtext"` is not at the top-level, but is still found. Something like `grid.get("midtext", strict = TRUE)` would fail.

```
> grid.newpage()
> fg <- frameGrob()
> fg <- packGrob(fg, textGrob("Hi there"))
> fg <- placeGrob(fg, rectGrob())
> fg <- packGrob(fg, textGrob("Hello again", name = "midtext"),
+                side = "right", dynamic = TRUE)
> fg <- packGrob(fg, rectGrob(), side = "right", width = unit(1, "null"))
> grid.draw(fg)
> grid.edit("midtext", label = "something much longer")
```

There have been a few examples already which have involved creating a `gTree`. This next example explicitly demonstrates this technique. A `gTree` is created with two important components. The `childrenvp` is a `vpTree` consisting of a `"plotRegion"` viewport to provide margins around a plot and a `"dataRegion"` viewport to provide x- and y-scales. The `"dataRegion"` gets pushed within the `"plotRegion"` and both are pushed and then "up"ed before the children are drawn. The `children` of the `gTree` are an `xaxis` and a `yaxis` both drawn within the `"dataRegion"`, and a `rect` drawn around the border of the `"plotRegion"`. A further feature of this example is the use of the `addGrob()` and `removeGrob()` functions to modify the `gTree`. The first modification involves adding a new child to the `gTree` which is a set of points drawn within the `"dataRegion"`. The second modification involves adding another set of points with a different symbol (NOTE that this second set of points is given a name so that it is easy to identify this set amongst the children of the `gTree`). The final modification is to remove the second set of points from the `gTree`.

```
> grid.newpage()
> pushViewport(viewport(layout = grid.layout(2, 2)))
> drawIt <- function(row, col) {
+     pushViewport(viewport(layout.pos.col = col, layout.pos.row = row))
+     grid.rect(gp = gpar(col = "grey"))
+     grid.draw(gplot)
+     upViewport()
```

```
+ }
> gplot <- gTree(x = NULL, y = NULL,
+                childrenvp = vpTree(
+                  plotViewport(c(5, 4, 4, 2), name = "plotRegion"),
+                  vpList(viewport(name = "dataRegion"))),
+                children = gList(
+                  xaxisGrob(vp = "plotRegion::dataRegion"),
+                  yaxisGrob(vp = "plotRegion::dataRegion"),
+                  rectGrob(vp = "plotRegion")))
> drawIt(1, 1)
> gplot <- addGrob(gplot, pointsGrob(vp = "plotRegion::dataRegion"))
> drawIt(1, 2)
> gplot <- addGrob(gplot, pointsGrob(name = "data1", pch = 2,
+                                    vp = "plotRegion::dataRegion"))
> drawIt(2, 1)
> gplot <- removeGrob(gplot, "data1")
> drawIt(2, 2)
```

This next example provides a simple demonstration of saving and loading **grid** grobs. It is also a nice demonstration that grobs copy like normal R objects.

```
> gplot <- gTree(x = NULL, y = NULL,
+                childrenvp = vpTree(
+                  plotViewport(c(5, 4, 4, 2), name = "plotRegion"),
+                    vpList(viewport(name = "dataRegion"))),
+                children = gList(
+                  xaxisGrob(vp = "plotRegion::dataRegion"),
+                  yaxisGrob(vp = "plotRegion::dataRegion"),
+                  rectGrob(vp = "plotRegion")))
> save(gplot, file = "gplot1")
> gplot <- addGrob(gplot, pointsGrob(vp = "plotRegion::dataRegion"))
> save(gplot, file = "gplot2")
> grid.newpage()
> pushViewport(viewport(layout = grid.layout(1, 2)))
> pushViewport(viewport(layout.pos.col = 1))
> load("gplot1")
> grid.draw(gplot)
> popViewport()
> pushViewport(viewport(layout.pos.col = 2))
> load("gplot2")
> grid.draw(gplot)
> popViewport()
```

This next example just demonstrates that it is possible to use a `gPath` to access the children of a `gTree` when editing. This is the `editGrob()` equivalent of an earlier example that used `grid.edit()`. One useful application of this API is the ability to modify the appearance of quite precise elements of a large, complex graphical object by editing the `gp` slot of a child (of a child ...) of a `gTree`.

```
> myplot <- gTree(name = "myplot",
+                 children = gList(
```

```
+                   rectGrob(name = "box", gp = gpar(col = "grey")),
+                   xaxisGrob(name = "xaxis")))
> myplot <- editGrob(myplot, gPath = "xaxis", at = 1:10/11)
> myplot <- editGrob(myplot, gPath = "xaxis::labels", label = round(1:10/11, 2))
> myplot <- editGrob(myplot, gPath = "xaxis::labels", y = unit(-1, "lines"))
> grid.newpage()
> pushViewport(viewport(w = .5, h = .5))
> grid.draw(myplot)
>
```

The following example demonstrates the use of the `getGrob()` and `grid.get()` (along with `gPath`s) to access `grob`s.

```
> myplot <- gTree(name = "myplot",
+                 children = gList(
+                   rectGrob(name = "box", gp = gpar(col = "grey")),
+                   xaxisGrob(name = "xaxis")))
> getGrob(myplot, "xaxis")
> myplot <- editGrob(myplot, gPath="xaxis", at=1:10/11)
> getGrob(myplot, "xaxis::labels")
> grid.newpage()
> pushViewport(viewport(w=.5, h=.5))
> grid.draw(myplot)
> grid.get("myplot")
> grid.get("myplot::xaxis")
> grid.get("myplot::xaxis::labels")
```

There is also an API for (re)setting children of a `gTree` or any drawn `grob`. This is not intended for general user use, but provides a simple way for developers to perform modifications to the structure of a `gTree` by doing something like ...

```
grob <- getGrob(<spec>)
<modify grob>
setGrob(<spec>, grob)
```

This approach is used in the implementation of packing and placing grobs. The following example shows some simple usage of the `setGrob()` and `grid.set()` functions to replace children of a `gTree` with different `grob`s. NOTE that currently such replacement can only occur if the name of the new `grob` is the same as the name of the old `grob`.

```
> myplot <- gTree(name = "myplot",
+                 children = gList(rectGrob(name = "box", gp = gpar(col = "grey")),
+                   xaxisGrob(name = "xaxis")))
> myplot <- setGrob(myplot, "xaxis", rectGrob(name = "xaxis"))
> grid.newpage()
> pushViewport(viewport(w = .5, h = .5))
> grid.draw(myplot)
> grid.set("myplot::xaxis", xaxisGrob(name = "xaxis", at = 1:3/4))
> grid.set("myplot::xaxis::labels",
+          textGrob(name = "labels", x = unit(1:3/4, "native"),
```

```
+                   y = unit(-1, "lines"), label = letters[1:3]))
> myplot <- setGrob(grid.get("myplot"), "xaxis::labels",
+                   circleGrob(name = "labels"))
> grid.newpage()
> pushViewport(viewport(w = .5, h = .5))
> grid.draw(myplot)
```

This next example just shows more complex use of the add/remove facilities for modifying grobs. Again, `addGrob()` and `removeGrob()` are for constructing descriptions of graphical objects and `grid.add()` and `grid.remove()` are for modifying drawn output. Of particular note are the last two lines involving `grid.remove()`. The first point is that there are multiple grobs on the display list with the same name. The example only affects the first one it finds; this could easily be extended to affect the display list "globally" (for children of gTrees, there cannot be multiple children with the same name so the issue does not arise). The last line is interesting because it actually erases the `grob` named `"plot1"` from the display list altogether (well, the first instance on the display list of a `grob` called `"plot1"` anyway).

```
> drawIt <- function(row, col) {
+   pushViewport(viewport(layout.pos.col = col, layout.pos.row = row))
+   grid.rect(gp = gpar(col = "grey"))
+   grid.draw(gplot)
+   upViewport()
+ }
> gplot <- gTree(name = "plot1",
+                childrenvp = vpTree(
+                  plotViewport(c(5, 4, 4, 2), name = "plotRegion"),
+                  vpList(viewport(name = "dataRegion"))),
+                children = gList(
+                  xaxisGrob(name = "xaxis", vp = "plotRegion::dataRegion"),
+                  yaxisGrob(name = "yaxis", vp = "plotRegion::dataRegion"),
+                  rectGrob(name = "box", vp = "plotRegion")))
> grid.newpage()
> pushViewport(viewport(layout = grid.layout(2, 2)))
> drawIt(1, 1)
> grid.add("plot1", pointsGrob(0.5, 0.5, name = "data1",
+                              vp = "plotRegion::dataRegion"))
> grid.add("plot1::xaxis",
+          textGrob("X Axis", y = unit(-2, "lines"), name = "xlab"))
> grid.edit("plot1::xaxis::xlab", y = unit(-3, "lines"))
> gplot <- grid.get("plot1")
> gplot <- addGrob(gplot, gPath = "yaxis",
+                  textGrob("Y Axis", x = unit(-3, "lines"), rot = 90,
+                           name = "ylab"))
> drawIt(1, 2)
> gplot <- removeGrob(gplot, "xaxis::xlab")
> drawIt(2, 1)
> grid.remove("plot1::data1")
> grid.remove("plot1")
```

The next example is just a `grid.place()` and `grid.pack()` equivalent of an earlier example involving `placeGrob()` and `packGrob()`. The interesting feature is that each action is

reflected in the output as it occurs.

```
> grid.newpage()
> grid.frame(name = "myframe", layout = grid.layout(1, 2))
> grid.place("myframe", textGrob("Hi there"), col = 1)
> grid.place("myframe", rectGrob(), col = 2)
> grid.newpage()
> grid.frame(name = "frame2")
> grid.pack("frame2", textGrob("Hi there"))
> grid.place("frame2", rectGrob())
> grid.pack("frame2", textGrob("Hello again"), side = "right")
> grid.pack("frame2", rectGrob(), side = "right", width = unit(1, "null"))
```