Getting Started with Lattice
immediate
July 29, 2010

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1 Introduction
The lattice package implements the Trellis graphics system and provides high-level functions for visualization of multivariate data. This lab covers some of the basics of the lattice package.

Although the lattice package is included in $R$, you must explicitly load the package to make use of the functions it provides:

> library("lattice")
Lattice provides several plotting functions, some of the commonly used ones are listed below.

<table>
<thead>
<tr>
<th>Lattice functions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>xyplot()</td>
<td>Scatter plot</td>
</tr>
<tr>
<td>dotplot()</td>
<td>Cleveland dot plot</td>
</tr>
<tr>
<td>bwplot()</td>
<td>Box and whisker plot</td>
</tr>
<tr>
<td>histogram()</td>
<td>Histogram</td>
</tr>
<tr>
<td>densityplot()</td>
<td>Kernel density plot</td>
</tr>
<tr>
<td>qq()</td>
<td>Two sample quantile plot</td>
</tr>
</tbody>
</table>

Table 1: Commonly used high-level lattice functions

## 2 Basic ideas

A typical call to the lattice function `xyplot` is shown below.

```r
> xyplot(y ~ x | c, data, groups = g)
```

The arguments to a lattice function can be summarized in terms of

1. lattice function: A lattice plotting function such as `xyplot`, `Rfunctiondotplot` etc.

2. formula: The first argument to a lattice method is a formula. The formula for our example is `y ~ x | c`. If the lattice method takes only a single vector as input, the formula can be expressed as `~ x | c`.
   - primary variables: Variables `y` (Y axis of the plot) and `x` (X axis of the plot) that defines the lattice display separated by the `~` character.
   - conditioning variable: Variable `c` in the example separated from the primary variables by the character `|`. The conditioning variable divides the plot into separate panels.

3. grouping variable: The variable `g` in the example. The grouping variable segregates data into subgroups within each panel.

4. data: A `data.frame` with column names corresponding to the variables `y`, `x`, `c` and `g`.

Lattice functions do not, in fact, generate a visual display. They return an object of class `trellis` which will generate the desired display when printed using the `print` function.
3 Scatter plot (xyplot)

We will use the Indometh data that contains plasma concentrations of the drug indomethacin for six subjects over a period of eight hours to illustrate a few aspects of lattice. First, we will use `xyplot` to produce a scatterplot of concentration of the drug over time. (Figure 1)

```r
> data(Indometh)
> df <- Indometh
> head(df)

<table>
<thead>
<tr>
<th>Subject</th>
<th>time</th>
<th>conc</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.25</td>
<td>1.50</td>
</tr>
<tr>
<td>2</td>
<td>0.50</td>
<td>0.94</td>
</tr>
<tr>
<td>3</td>
<td>0.75</td>
<td>0.78</td>
</tr>
<tr>
<td>4</td>
<td>1.00</td>
<td>0.48</td>
</tr>
<tr>
<td>5</td>
<td>1.25</td>
<td>0.37</td>
</tr>
<tr>
<td>6</td>
<td>2.00</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Exercise 1
Reproduce the concentration vs time plot from Figure 1 by following the steps described below.

1. Create a scatter plot using `xyplot`. Use the formula `conc ~ time` with `df` as the data argument.
2. Change the X–axis label to 'Time (hours)' by adding an `xlab` argument to the `xyplot` call.
3. Similarly, change the Y–axis label to 'Concentration (mcg/ml)' using `ylab`.
4. Finally, change the title of the plot by adding a `main` argument.

Solution:
```r
> myplot <- xyplot(conc ~ time, data = df,
+                  xlab = "Time (hours)",
+                  ylab = "Concentration (mcg/ml)",
+                  main = "Pharmacokinetics of Indomethicin")
```

A scatter plot with the concentration profile for each patient appearing in a separate panel can be seen in Figure 2. This plot was produced by making use of `Subject` as the conditioning variable.

Exercise 2
1. Create a scatter plot by adding the conditioning variable `Subject` to the formula from Exercise 1.
2. Modify the conditioning variable in the formula to `factor(Subject, levels = 1:6)` and observe the difference in the order of plots.

Solution:

```r
> myplot <- xyplot(conc ~ time | factor(Subject, levels = 1:6),
+                  data = df, main = "Pharmacokinetics of Indomethicin",
+                  ylab = "Concentration (mcg/ml)",
+                  xlab = "Time (hours)"
)
```

A scatter plot produced by superimposing the concentration profiles from all the subjects to a single panel can be seen in Figure 3. The figure makes use of lines instead of points and also has a legend to help distinguish the concentration profiles of different subjects.

Exercise 3

1. Create a single scatter plot of the superimposed concentrations by making use of formula `conc ~ time` and the additional argument `groups = Subject` to the `xyplot` function.

2. Add an additional argument `type='l'` to the function and observe what effect it has on the plot.

3. Add an additional argument `auto.key = list(space = "right")` to the `xyplot` to add a legend to the right of the plot.

Solution:

```r
> myplot <- xyplot(conc ~ time, data = df, groups = Subject, type='l',
+                  auto.key = list(space = "right"),
+                  main = "Pharmacokinetics of Indomethicin",
+                  ylab = "Concentration (mcg/ml)",
+                  xlab = "Time (hours)"
)
```

4 Box and whisker plots (bwplot)

We are interested in finding out differences in the plasma concentration of Indomethicin amongst the six subjects. A box and whisker plot of the concentration of Indomethicin produced using the `bwplot` method can be observed in Figure 4.

Exercise 4

1. Create a boxplot using the formula `~ conc` and the lattice function `bwplot`.

2. Update the formula to `~ conc | Subject` in order to add a conditioning variable to the boxplot.
Pharmacokinetics of Indomethicin

Figure 1: Concentration of Indomethicin over time produced using `xyplot`

3. Add an additional argument `layout=c(6,1)` to the `bwplot` and observe its effect on the plot.

Solution:

```r
> myplot <- bwplot(~ conc | Subject, data = df, layout = c(6,1),
+                  main = "Concentration of Indomethicin",
+                  xlab = "Concentration (mcg/ml)"
+                  )
```

5 Further Reading

- The `lattice` package includes many detailed help pages. You can get an overview using the R command `help(package="lattice")`.
- A good source of several lattice plots along with the code that produced them is [http://lmdvr.r-forge.r-project.org](http://lmdvr.r-forge.r-project.org).
Figure 2: Concentration of Indomethicin over time using Subject as the conditioning variable xyplot

Figure 3: Concentration vs Time of Indomethicin for 6 subjects using the Grouping variable Subject.
Figure 4: Concentration vs Time of Indomethicin for 6 subjects using the Grouping variable Subject.

6 Session information

- R version 2.11.1 Patched (2010-07-25 r52612), i386-apple-darwin9.8.0
- Locale: C/C/C/C/C/en_US.UTF-8
- Base packages: base, datasets, grDevices, graphics, methods, stats, tools, utils
- Other packages: lattice 0.18-8
- Loaded via a namespace (and not attached): grid 2.11.1