StatR 502 Lecture 5: Simulation, Box-Cox, Stepwise Model Selection, and the Anatomy of a Package

Gregor Thomas

February 4, 2016

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- We'll talk Final Projects tonight. Project Proposals are due Sunday February 15

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Simulation (briefly)

A naive approach to simulation...

A regression model has point-estimates for coefficients, but also standard errors. To simulate data from the model based only on the point-estimates would ignore the important information we know about their variances.

- This ignores the uncertainty in the model fitting, which is encoded in the standard errors for the coefficients.

A little better

A better procedure would be to draw a simulated coefficient from a normal distribution with mean = point estimate and sd = standard error...

Much better

This is easily accessible with `vcov(your_model)`, but the `sim()` function from `arm` makes it even easier.

Note that this is more or less the approach Nate Silver and the 538-blog in the popular election forecasting. Poll results, with margins of error, were compiled for each state, then simulations run to see the probability of outcomes in the aggregate.

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A better procedure would be to draw a simulated coefficient from a normal distribution with mean = point estimate and sd = standard error...

- But this still ignores the **covariance** of coefficient estimates.

Much better

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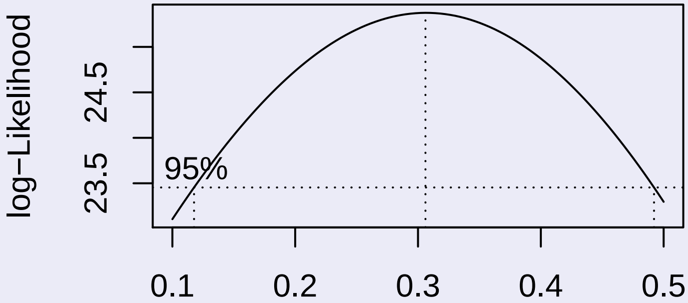
Box-Cox Transformations

Essentially, we're testing transforms of the form (y^lambda - 1) / lambda for lambda != 0 log(y) for lambda == 0 But the - 1 and / lambda parts are linear, so they don't change the model fit.

Box Cox

```
boxcox(Volume ~ Height + Girth, data = trees,
       lambda = seq(0.1, 0.5, length = 50))
```



```r
mod.log = lm(Volume ~ log(Height) + log(Girth), data = trees)
mod.log.log = lm(log(Volume) ~ log(Height) + log(Girth), data = trees)
mod = lm((Volume) ~ (Height) + (Girth), data = trees)
mod.crt = lm((Volume)^(1/3) ~ (Height) + (Girth), data = trees)
```

```
library(arm)
display(mod.log.log)

## lm(formula = log(Volume) ~ log(Height) + log(Girth), data = trees)
##             coef.est coef.se
## (Intercept) -6.63     0.80
## log(Height)  1.12     0.20
## log(Girth)   1.98     0.08
## ---
## n = 31, k = 3
## residual sd = 0.08, R-Squared = 0.98

display(mod.crt)

## lm(formula = (Volume)^(1/3) ~ (Height) + (Girth), data = trees)
##             coef.est coef.se
## (Intercept) -0.09     0.18
## Height       0.01     0.00
## Girth        0.15     0.01
## ---
## n = 31, k = 3
## residual sd = 0.08, R-Squared = 0.98
```

```r
par(mfrow = c(2, 2))
plot(mod.log, which = 1)
mtext("mod.log", adj = 1)
plot(mod.log.log, which = 1)
mtext("mod.log.log", adj = 1)
plot(mod, which = 1)
mtext("mod", adj = 1)
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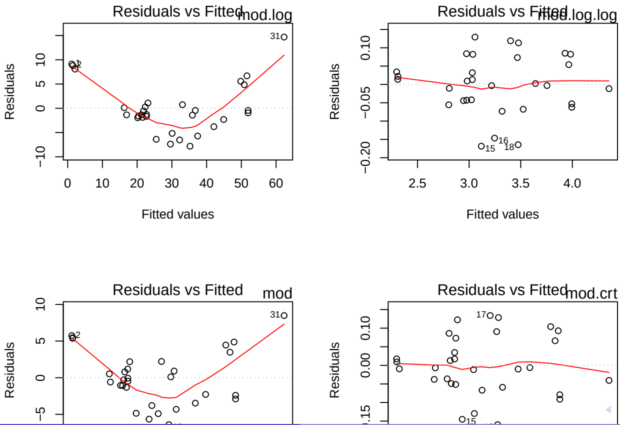

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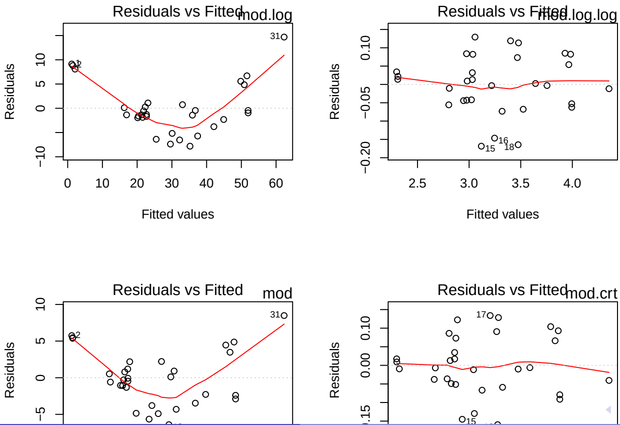

Automated Model Selection

Model Selection

Many people want to take the analyst out of analysis as much as possible. This is a good goal, but one we're still a good ways from achieving.
Model selection is **the** major problem in modern statistics.
Most of the problem is due to the lack of a perfect metric for model performance. If you're willing to focus solely on predictive accuracy, for example, then you can do pretty well with machine learning algorithms (things like random forests, which you'll see next quarter). Unfortunately, to get an *interpretable* model, especially a **causal** model, rather than black box that makes pretty good predictions, there is no silver bullet, and there are problems with selection and bias if you dredge your data too thoroughly.
All that said, let's look at a couple methods for automatically searching the "model space".

Step-wise Model Selection

Stepwise model selection (forward selection) starts with a simple model, and adds in predictors one at a time, choosing the best to add based on AIC (or BIC or similar).
Backward selection starts with a complex model and removes terms one at a time.
These are implemented in `MASS::stepAIC`. Setting `direction="both"` will consider adding or removing terms at each step.
(quick demo)

More thorough searches

You could try all combinations of variables, or all combinations with certain restrictions. The `leaps` package (not just a "step", haha) offers one implementation, another is in `bestglm`, but beware

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Box-Cox

Final Projects

- Build a (small) R package, that helps you to

Your data set will be included in the package, and your analysis will be written up as package vignette.

Anatomy of an R Package

R packages aren't all that special, just a collection of files. Nothing has to be compiled, the typical way of distributing package is just to compress the files together in a `.tar.gz` "tarball".

Library vs Package

A *library* is a folder on your computer where you store packages. A *package* is a folder that has a specific structure so R knows how to make its functions and documentation available to you when you load it.
You can see libraries on your search path with `.libPaths()` (also used for adding a new library location).

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Anatomy of an R Package

R packages aren't all that special, just a collection of files. Nothing has to be compiled, the typical way of distributing package is just to compress the files together in a `.tar.gz` "tarball".

Library vs Package

A *library* is a folder on your computer where you store packages. A *package* is a folder that has a specific structure so R knows how to make its functions and documentation available to you when you load it.
You can see libraries on your search path with `.libPaths()` (also used for adding a new library location).

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## [1] "C:/rlib"
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Choosing Nonlinear Transformations

Box-Cox

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