When to use random effects? Ben Bolker says:

Philosophically: We are not interested in the estimates of the random effects. In frequentist settings, we don't even call these "estimates", but rather "predictions", as in BLUP (best linear unbiased predictor). We want random effect levels to be drawn from a larger population, to be "exchangeable" (i.e. we could relabel/swap around the levels without any change in meaning) and their estimates are a random variable.

Pragmatically: We have lots of levels, with not much information about each individual level, and possibly unbalanced amounts of information. We don't want to use up the degrees of freedom associated with fitting one parameter for each level; automatically adjust between "completely pooled" (no effect) and "completely separate" (fixed effect). We have enough levels that it is practical to estimate a variance (i.e. at least 5-6, preferably more than that).

To Bayesians, the difference between fixed and random is much simpler and more pragmatic: do we add a hyperparameter to the model to characterize the estimates (= random effect = we estimate a variance), or estimate them separately (= fixed effect = we use an infinite variance)?

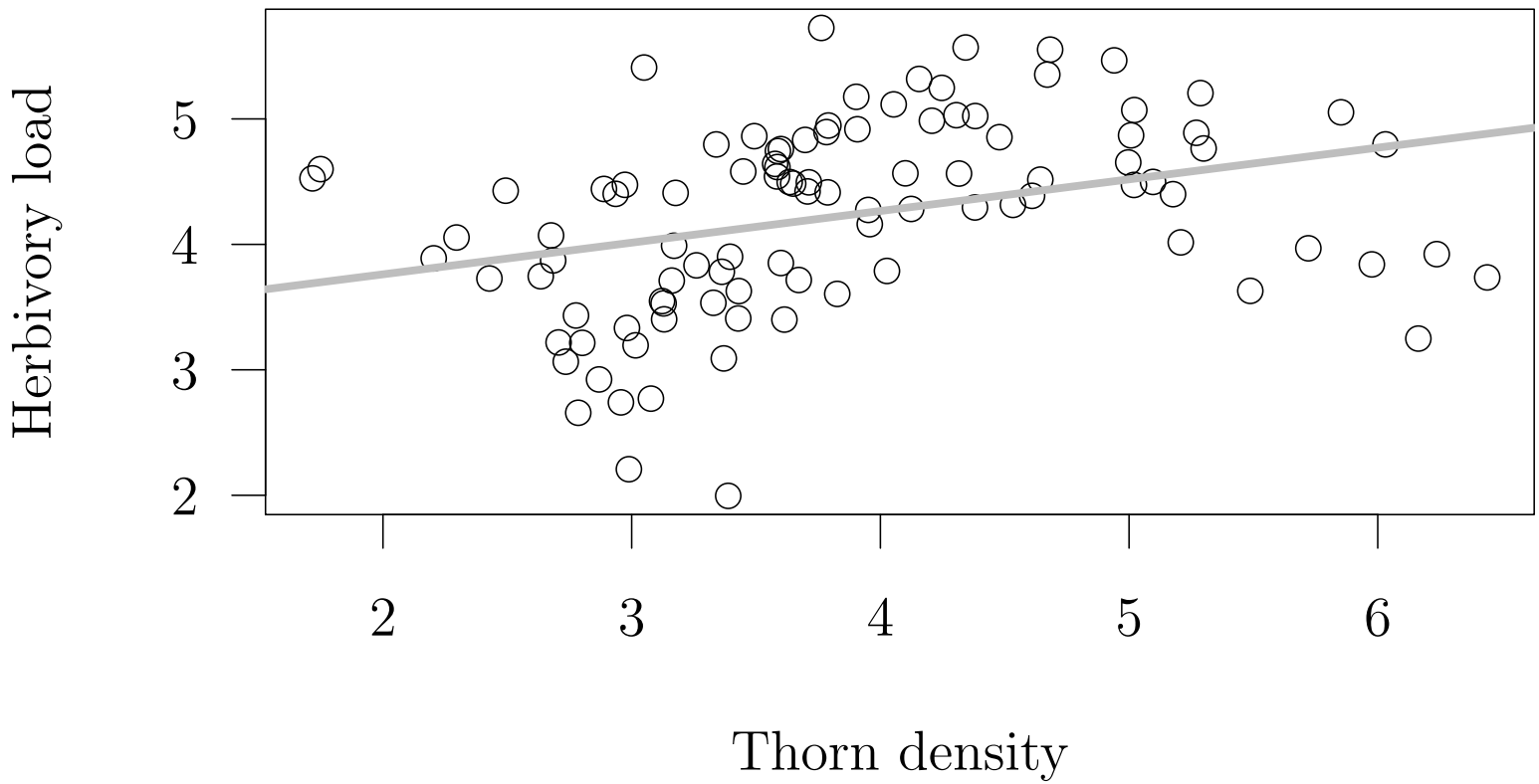
Linear mixed models 2

Uncertainty in random effects / random interactions

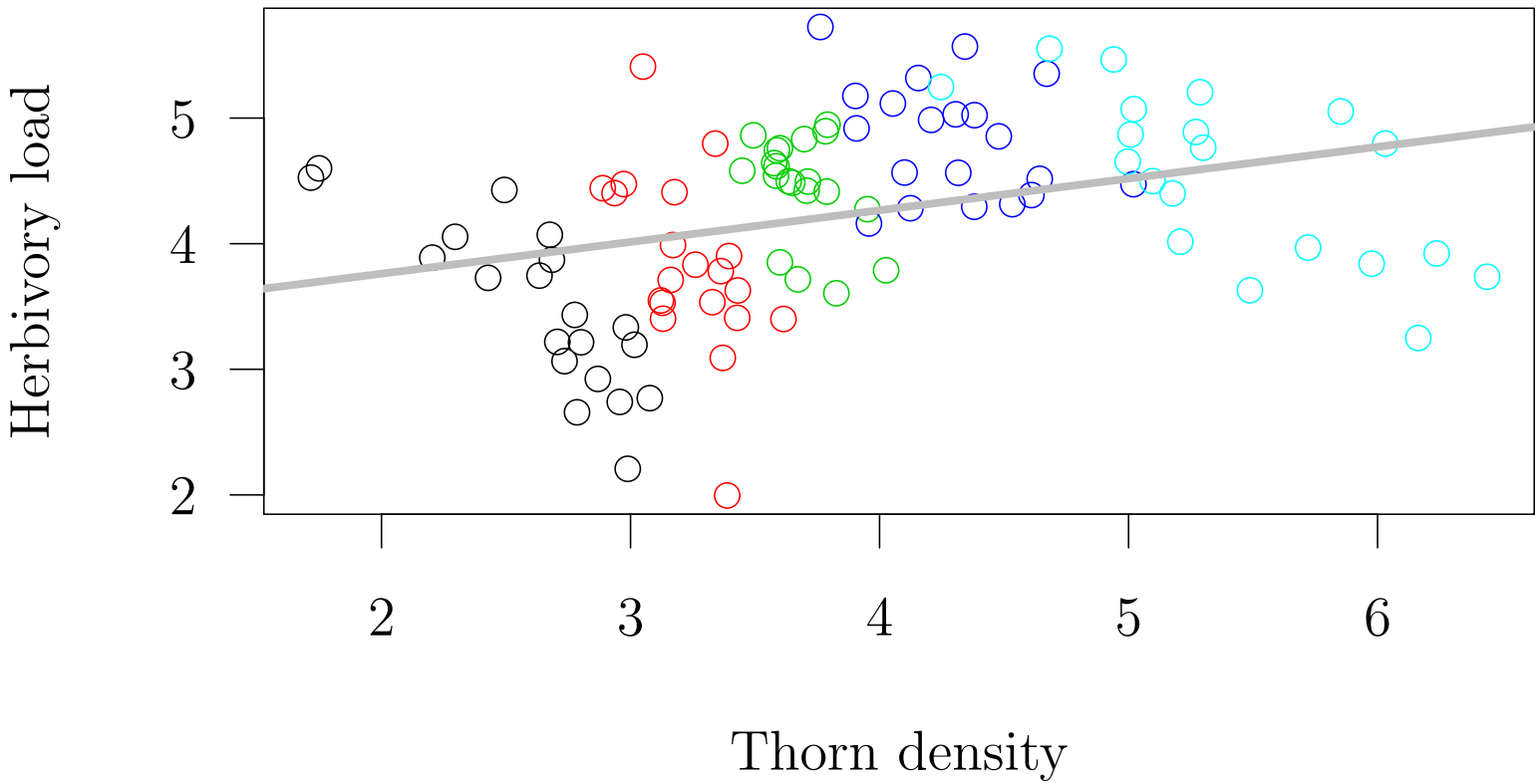
Timothée Bonnet

February 21, 2019

Mixed models reminder



Mixed models reminder



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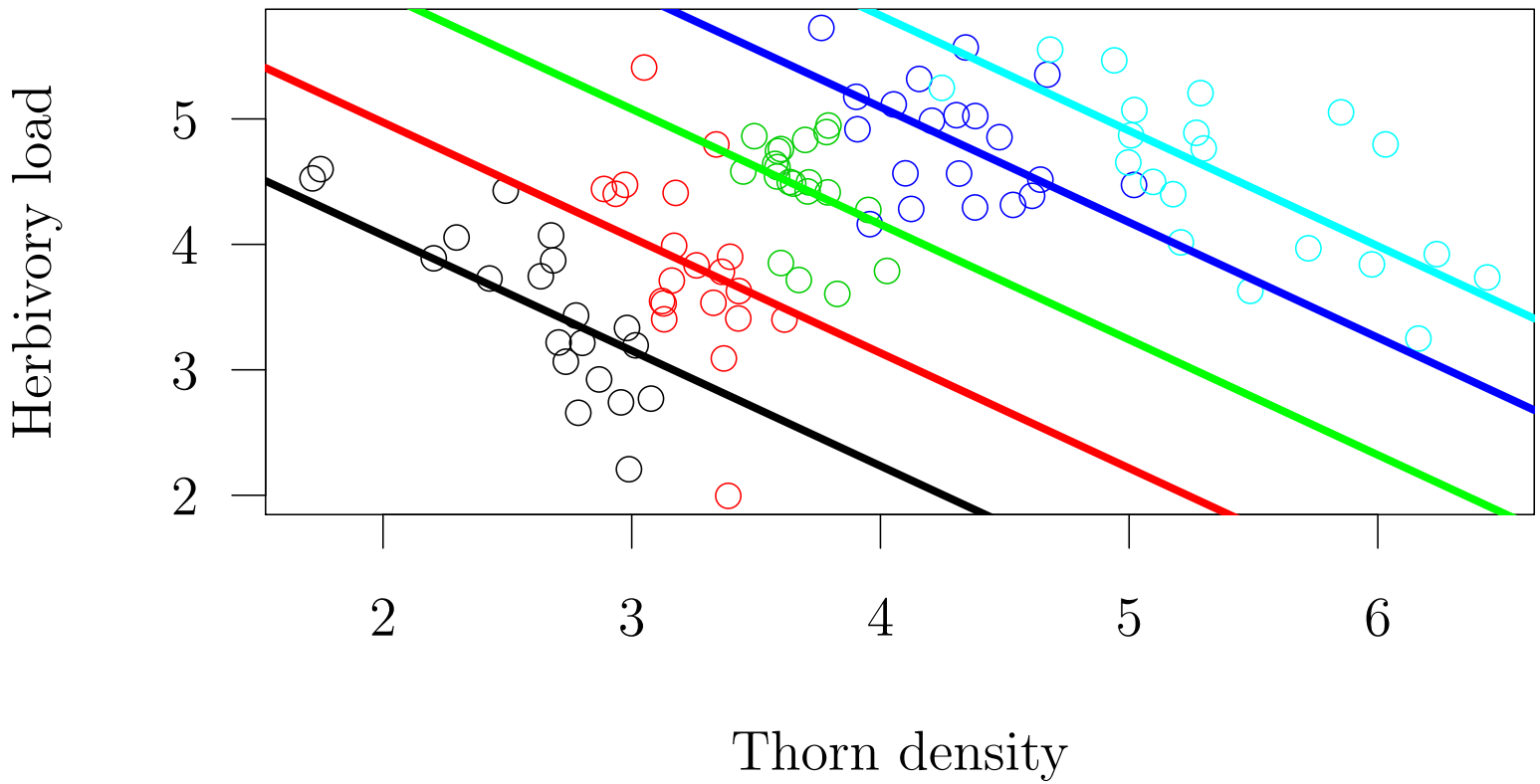
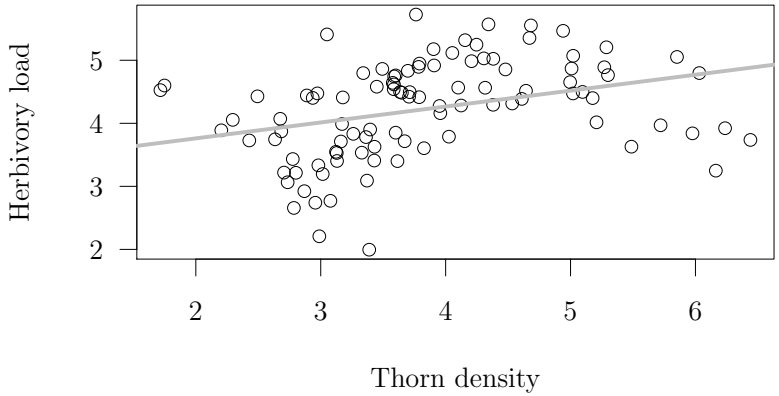
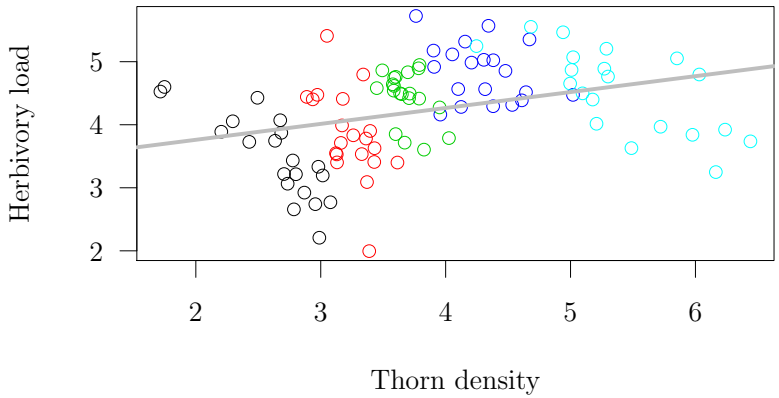


Mixed models reminder

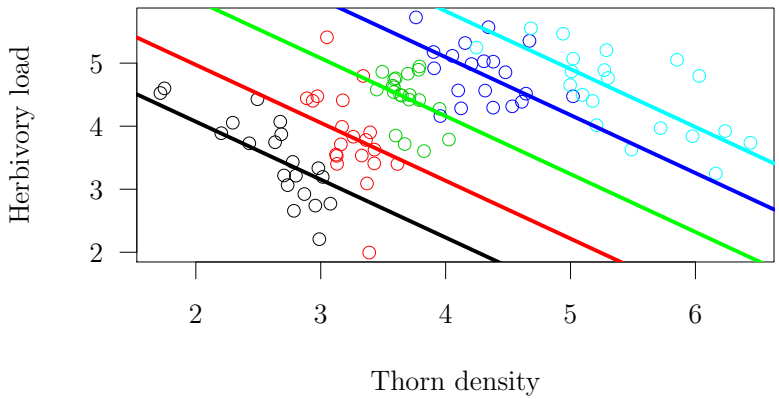
1. First model assumes residuals are independent



2. But they are not. Data come from five different places



3. Adding random effect "place" gets correct slope. Residuals are now really independent



Mixed models reminder

Add a random effect to a basic lm:

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lm(response ~ predictor, data=thorns)
library(lme4)
lmer(response ~ predictor + (1|block), data=thorns)
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Demo in R: Excercise 1

Mixed models reminder

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```

Questions you may have:

- Is the random effect "significant"?
- Should I include as many random effects as possible?

Mixed models today

1. Quantify uncertainty in random effects
   - p-values and tests (*R-coding!*)
   - confidence intervals
   - BLUPs = random effect levels
2. Beyond random intercepts
   - Random interactions

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Test?

- **Yes if effect of interest**
- Optional if "nuisance" parameter part of experimental design

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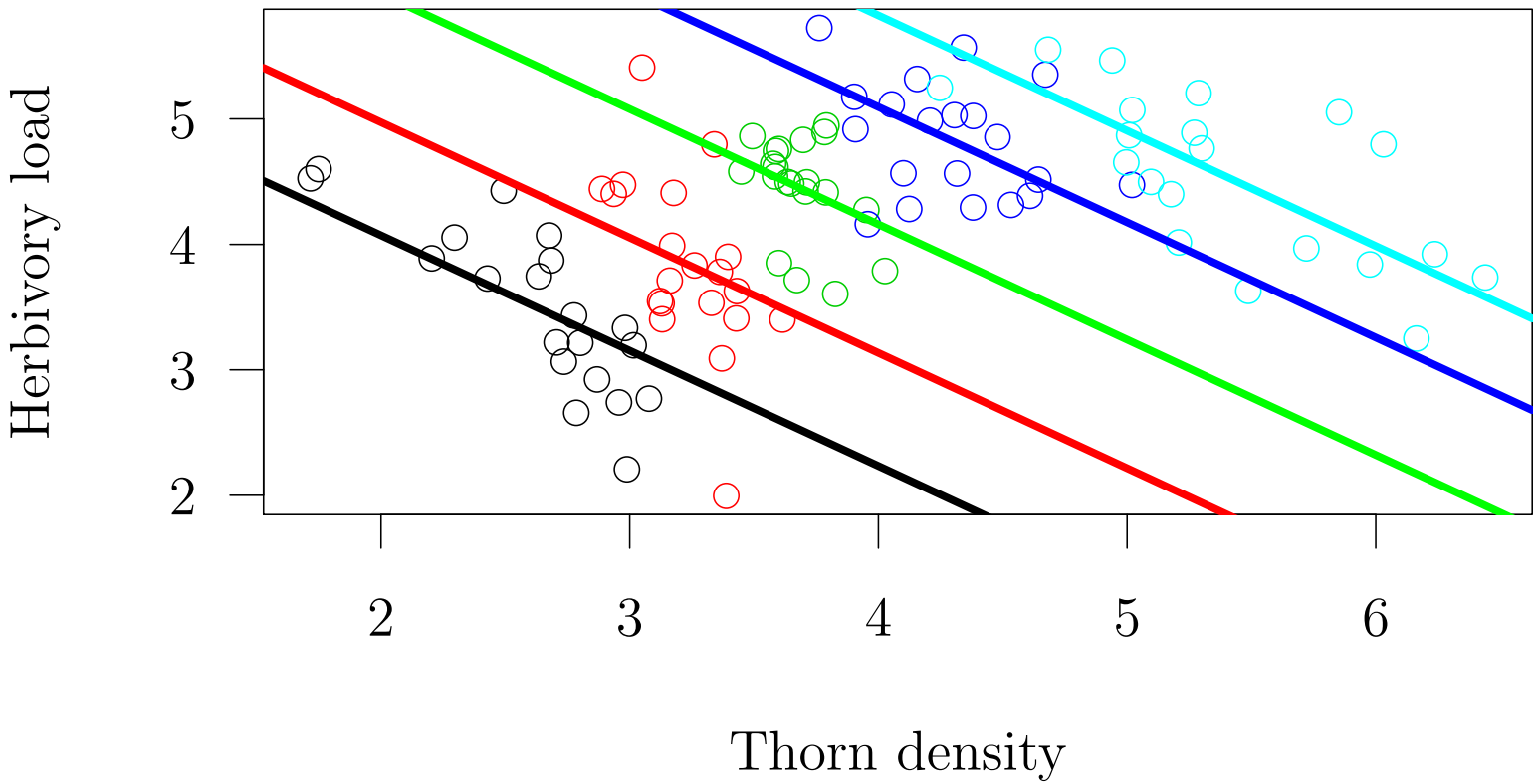
Remove non-significant?

- No if clearly part of experimental design
- But doesn't matter if estimated variance is zero
- Maybe remove if model too complex (i.e., difficult to interpret or convergence issues) but acknowledge assumptions!

Not only intercept vary!



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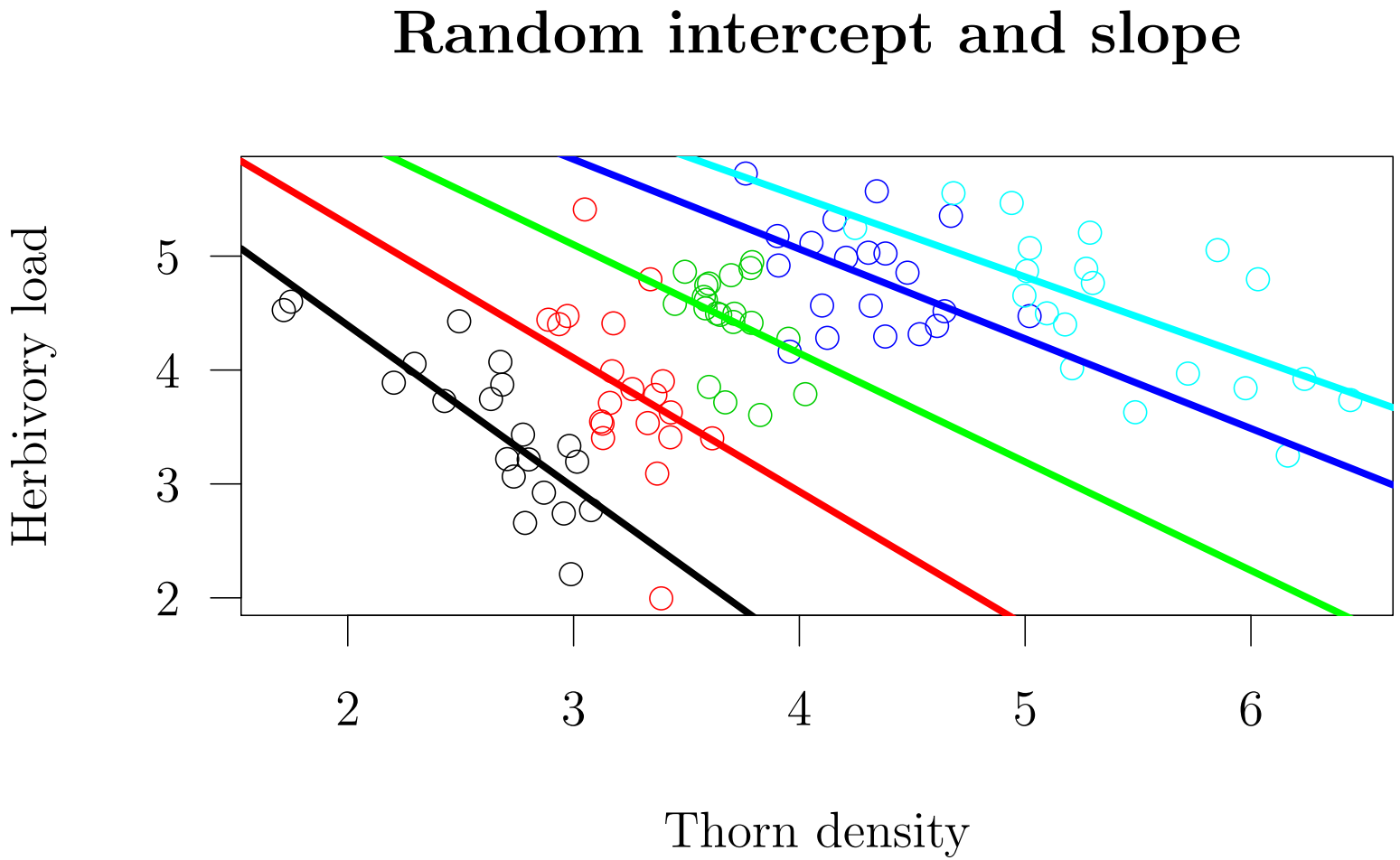

Beyond random intercepts

Right-hand side = what groups observations

Nested, crossed et al. on the right hand side of the `|`: `(1|something)`
How are data related to each other, what groups them
Does not tell what parameter vary accoring to group

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The 1 stands for **intercept**
But many things can go to the left hand side.

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But many things can go to the left hand side.

Random interactions, random regressions, random slopes...

e.g., $y \sim 1 + x + (1 + x|something)$

Everything you need to know about mixed models

- `http://bbolker.github.io/mixedmodels-misc/glmmFAQ.html`
- Subscribe to mailing-list:
  `https://stat.ethz.ch/mailman/listinfo/r-sig-mixed-models`