Julia for R Lovers 2

July 15, 2021

1 Julia for R-Lovers

1.1 Demo: Sleepstudy LMM

[1]:
```
using RCall;
using MixedModels;
using StatsBase, CSV, DataFrames;

R"""
library(tidyverse)
library(lme4) #package for doing linear mixed effects models in R
"""
```

```
 Warning: RCall.jl: Warning: replacing previous import ‘vctrs::data_frame’ by
‘tibble::data_frame’ when loading ‘dplyr’
   Attaching packages                     tidyverse 1.3.0

  ggplot2 3.3.5      purrr   0.3.4
  tibble  3.1.2      dplyr   1.0.0
  tidyr   1.1.2      stringr 1.4.0
  readr   1.3.1      forcats 0.5.0
   Conflicts                         tidyverse_conflicts()

  dplyr::filter() masks stats::filter()
  dplyr::lag()    masks stats::lag()
 @ RCall /Users/kylamcconnell/.julia/packages/RCall/Qzssx/src/io.jl:160
 Warning: RCall.jl: Loading required package: Matrix

 Attaching package: ‘Matrix’

 The following objects are masked from ‘package:tidyr’:

     expand, pack, unpack

 @ RCall /Users/kylamcconnell/.julia/packages/RCall/Qzssx/src/io.jl:160
```

[1]:
```
RObject{StrSxp}
 [1] "lme4"      "Matrix"    "forcats"   "stringr"   "dplyr"     "purrr"
```

```
 [7] "readr"     "tidyr"     "tibble"    "ggplot2"   "tidyverse" "stats"
[13] "graphics"  "grDevices" "utils"     "datasets"  "methods"   "base"
```

1.1.1 Sleep study data

- Dataset included in lme4 in R and MixedModels in Julia
- 18 participants restricted to 3 hours of sleep every night for 9 nights
- DV: average reaction time speed
- http://lme4.r-forge.r-project.org/slides/2011-01-11-Madison/2Longitudinal.pdf

1.1.2 LMMs

- linear mixed effects models, add to linear regression the ability to account for random variance in repeated-measures designs (i.e., same participants or same items)
- technique well-used in psychology, cognitive science, linguistics, etc.
- lme4 models often fail to converge in R (i.e. don't find a solution), requiring simplified model specification
- takes a long time even when it does converge

1.2 1) Load data in Julia

[2]:
```
sleep = DataFrame(MixedModels.dataset(:sleepstudy));

names(sleep)
```

[2]:
```
3-element Array{String,1}:
 "subj"
 "days"
 "reaction"
```

[3]:
```
first(sleep, 10)
```

[3]:

	subj	days	reaction
	String	Int8	Float64
1	S308	0	249.56
2	S308	1	258.705
3	S308	2	250.801
4	S308	3	321.44
5	S308	4	356.852
6	S308	5	414.69
7	S308	6	382.204
8	S308	7	290.149
9	S308	8	430.585
10	S308	9	466.353

[4]:
```
summarystats(sleep.reaction)
```

[4]:
```
Summary Stats:
Length:         180
Missing Count:  0
Mean:           298.507892
Minimum:        194.332200
1st Quartile:   255.375825
Median:         288.650800
3rd Quartile:   336.752075
Maximum:        466.353500
```

1.3 2) Wrangling in R

[5]:
```
@rput sleep;
```

[6]:
```
R"""
sleep %>%
  group_by(days) %>%
  summarize(mean(reaction))
"""
```

```
 Warning: RCall.jl: `summarise()` ungrouping output (override with `.groups`
argument)
 @ RCall /Users/kylamcconnell/.julia/packages/RCall/Qzssx/src/io.jl:160
```

[6]:
```
RObject{VecSxp}
# A tibble: 10 x 2
    days `mean(reaction)`
   <int>            <dbl>
 1     0             257.
 2     1             264.
 3     2             265.
 4     3             283.
 5     4             289.
 6     5             309.
 7     6             312.
 8     7             319.
 9     8             337.
10     9             351.
```

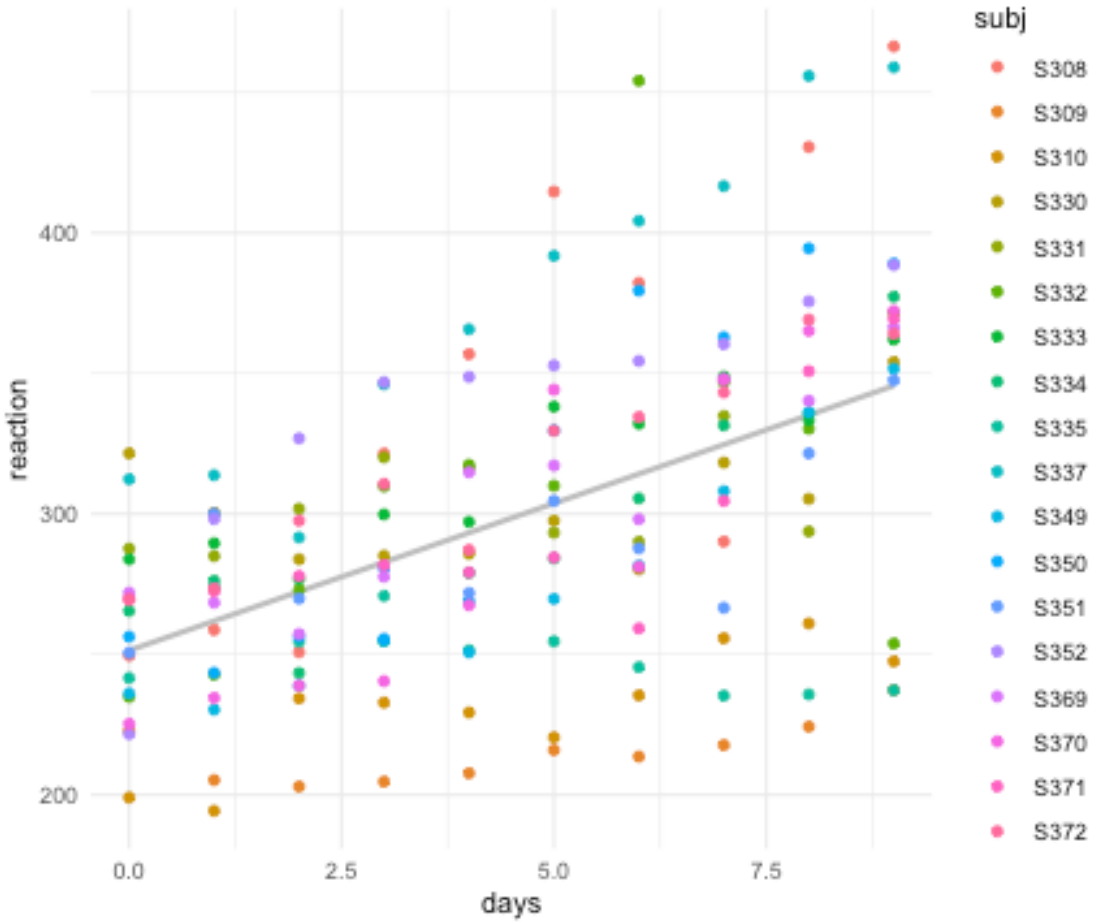
[7]:
```
R"""
sleep %>%
  group_by(subj) %>%
  summarize(mean(reaction))
```

```
"""
```

```
 Warning: RCall.jl: `summarise()` ungrouping output (override with `.groups`
argument)
 @ RCall /Users/kylamcconnell/.julia/packages/RCall/Qzssx/src/io.jl:160
```

[7]:
```
RObject{VecSxp}
# A tibble: 18 x 2
   subj  `mean(reaction)`
   <chr>            <dbl>
 1 S308              342.
 2 S309              215.
 3 S310              231.
 4 S330              303.
 5 S331              309.
 6 S332              307.
 7 S333              316.
 8 S334              295.
 9 S335              250.
10 S337              376.
11 S349              276.
12 S350              314.
13 S351              290.
14 S352              337.
15 S369              306.
16 S370              292.
17 S371              295.
18 S372              318.
```

[8]:
```
R"""
ggplot(sleep, aes(x= days, y = reaction)) +
  geom_smooth(method = "lm", color = "grey", se = F) +
  geom_point(aes(color = subj), position = "dodge") +
  theme_minimal()
"""
```



[8]: RObject{VecSxp}

```
Warning: RCall.jl: `geom_smooth()` using formula 'y ~ x'
Warning: Width not defined. Set with `position_dodge(width = ?)`
@ RCall /Users/kylamcconnell/.julia/packages/RCall/Qzssx/src/io.jl:160
```

[9]:
```
R"""
ggplot(sleep, aes(x= days, y = reaction)) +
  geom_smooth(method = "lm", color = "grey", se = F) +
  geom_point(aes(color = as.factor(days)), position = "dodge", show.legend =␣
 ↪FALSE) +
  facet_wrap(~subj) +
  theme_minimal()
"""
```

[9]: RObject{VecSxp}

```
Warning: RCall.jl: `geom_smooth()` using formula 'y ~ x'
Warning: Width not defined. Set with `position_dodge(width = ?)`
@ RCall /Users/kylamcconnell/.julia/packages/RCall/Qzssx/src/io.jl:160
```

1.4 3) Model in Julia

[10]:
```
@rget sleep #don't have to do this in this example, but would have to if you␣
↪make changes to the df in R
```

[10]:

	subj	days	reaction
	String	Int64	Float64
1	S308	0	249.56
2	S308	1	258.705
3	S308	2	250.801
4	S308	3	321.44
5	S308	4	356.852
6	S308	5	414.69
7	S308	6	382.204
8	S308	7	290.149
9	S308	8	430.585
10	S308	9	466.353
11	S309	0	222.734
12	S309	1	205.266
13	S309	2	202.978
14	S309	3	204.707
15	S309	4	207.716
16	S309	5	215.962
17	S309	6	213.63
18	S309	7	217.727
19	S309	8	224.296
20	S309	9	237.314
21	S310	0	199.054
22	S310	1	194.332
23	S310	2	234.32
24	S310	3	232.842
25	S310	4	229.307
26	S310	5	220.458
27	S310	6	235.421
28	S310	7	255.751
29	S310	8	261.012
30	S310	9	247.515
...	...	...	...

LMM formula (similar to R) Regression syntax - DV ~ predictors Random effect term: - accounts for difference by subj - random intercepts (y-axis location) - random slope - (1 + predictor | subj)

- In this case MixedModel syntax is similar to R:
  - lmer(reaction ~ days + (1 + days | subj))

[11]:
```
formula_sleep = @formula (reaction ~ days + (1 + days | subj));
```

[12]:
```
sleep_model = fit(MixedModel, formula_sleep, sleep);
```

[13]:
```
show(sleep_model)
```

```
Linear mixed model fit by maximum likelihood
 reaction ~ 1 + days + (1 + days | subj)
```

```
   logLik   -2 logLik     AIC       AICc        BIC
  -875.9697  1751.9393  1763.9393  1764.4249  1783.0971

Variance components:
            Column    Variance Std.Dev.   Corr.
subj     (Intercept)  565.51069 23.78047
         days          32.68212  5.71683 +0.08
Residual              654.94145 25.59182
 Number of obs: 180; levels of grouping factors: 18

  Fixed-effects parameters:

               Coef.  Std. Error      z  Pr(>|z|)

(Intercept)  251.405      6.63226  37.91    <1e-99
days          10.4673     1.50224   6.97    <1e-11
```

1.4.1 Example

```
formula_maximal = @formula (DV ~ f_1 * f_2 * f_3 * f_4 + c_1 + c_2 + c_3 + c_4 +
c_5 + (1 + f_1 + c_1 + c_2 + c_3 + c_4 | id) + (1 + c_1 + f_2 * f_3 | item_1) +
(1 + c_1 + f_2 * f_3 | item_2));
```

1.4.2 Coding categorical predictors

```
cntrsts = merge( Dict(:cond => EffectsCoding(base=``cond_A''), :education =>
HelmertCoding(levels=[``High school'', ``Undergraduate'', ``Grad school'']), :id
=> Grouping(), :item => Grouping()) );

sleep_model = fit(MixedModel, formula_sleep, sleep, contrasts = cntrsts);
```

1.5 Visualize model output in R

[14]:
```
using JellyMe4 #companion to lme4 / MixedModels and RCall

sleep_model_R = (sleep_model, sleep)

@rput sleep_model_R
```

[14]:
```
(Linear mixed model fit by maximum likelihood
 reaction ~ 1 + days + (1 + days | subj)
   logLik   -2 logLik     AIC       AICc        BIC
  -875.9697  1751.9393  1763.9393  1764.4249  1783.0971

Variance components:
            Column    Variance Std.Dev.   Corr.
subj     (Intercept)  565.51069 23.78047
         days          32.68212  5.71683 +0.08
```

```
Residual              654.94145 25.59182
 Number of obs: 180; levels of grouping factors: 18

  Fixed-effects parameters:

               Coef.  Std. Error      z  Pr(>|z|)

(Intercept)  251.405      6.63226  37.91    <1e-99
days          10.4673     1.50224   6.97    <1e-11
                          , 180×3 DataFrame
  Row   subj     days    reaction
        String   Int64   Float64

  1     S308     0       249.56
  2     S308     1       258.705
  3     S308     2       250.801
  4     S308     3       321.44
  5     S308     4       356.852
  6     S308     5       414.69
  7     S308     6       382.204
  8     S308     7       290.149
  9     S308     8       430.585
  10    S308     9       466.353

  170   S371     9       369.469
  171   S372     0       269.412
  172   S372     1       273.474
  173   S372     2       297.597
  174   S372     3       310.632
  175   S372     4       287.173
  176   S372     5       329.608
  177   S372     6       334.482
  178   S372     7       343.22
  179   S372     8       369.142
  180   S372     9       364.124   )
```

[15]:
```
@rput sleep_model_R
```

[15]:
```
(Linear mixed model fit by maximum likelihood
 reaction ~ 1 + days + (1 + days | subj)
   logLik   -2 logLik     AIC       AICc        BIC
 -875.9697  1751.9393  1763.9393  1764.4249  1783.0971

Variance components:
            Column    Variance Std.Dev.   Corr.
subj     (Intercept)  565.51069 23.78047
         days          32.68212  5.71683 +0.08
```

```
Residual              654.94145 25.59182
 Number of obs: 180; levels of grouping factors: 18

  Fixed-effects parameters:

               Coef.  Std. Error      z  Pr(>|z|)

(Intercept)  251.405      6.63226  37.91    <1e-99
days          10.4673     1.50224   6.97    <1e-11
                          , 180×3 DataFrame
  Row   subj     days    reaction
        String   Int64   Float64

  1     S308     0       249.56
  2     S308     1       258.705
  3     S308     2       250.801
  4     S308     3       321.44
  5     S308     4       356.852
  6     S308     5       414.69
  7     S308     6       382.204
  8     S308     7       290.149
  9     S308     8       430.585
  10    S308     9       466.353

  170   S371     9       369.469
  171   S372     0       269.412
  172   S372     1       273.474
  173   S372     2       297.597
  174   S372     3       310.632
  175   S372     4       287.173
  176   S372     5       329.608
  177   S372     6       334.482
  178   S372     7       343.22
  179   S372     8       369.142
  180   S372     9       364.124   )
```

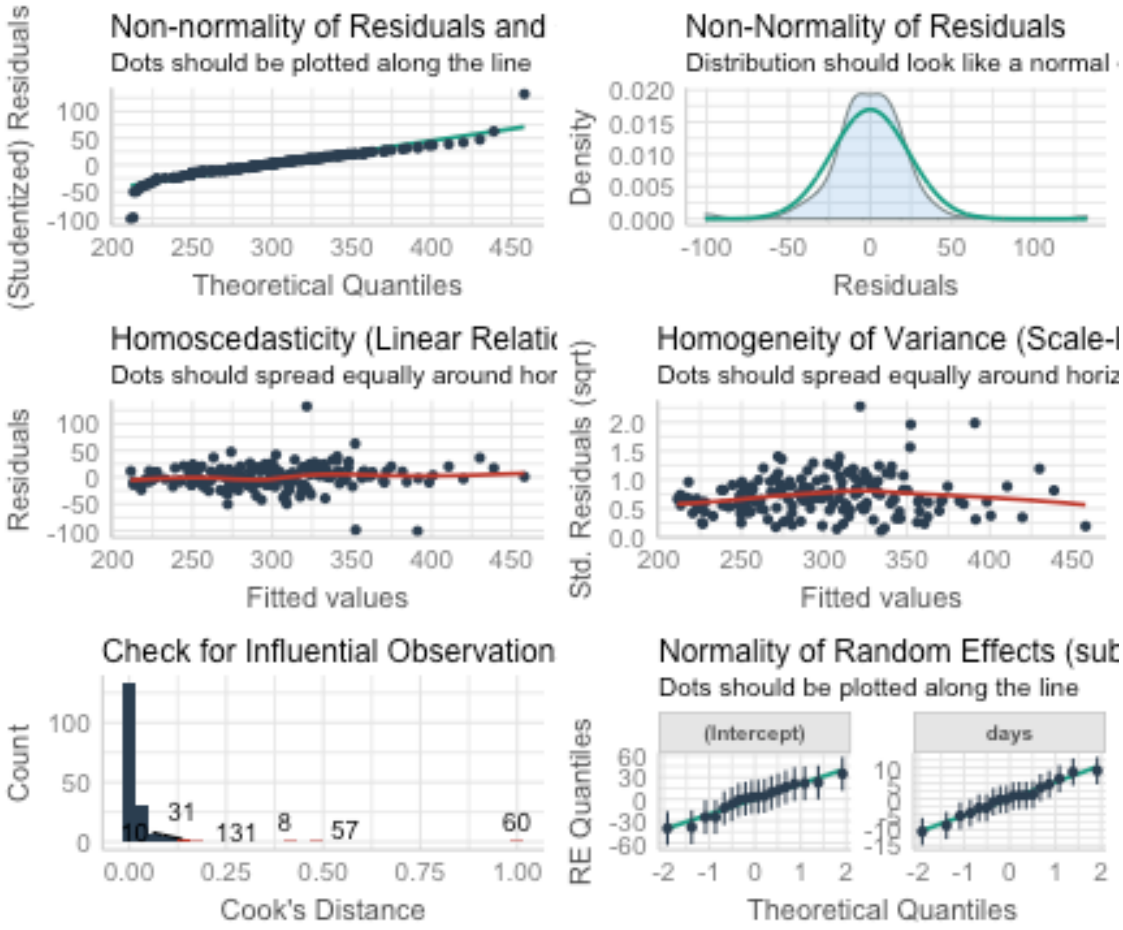
[16]:
```
R"sleep_model_R"
```

[16]:
```
RObject{S4Sxp}
Linear mixed model fit by maximum likelihood  ['lmerMod']
Formula: reaction ~ 1 + days + (1 + days | subj)
   Data: jellyme4_data
      AIC       BIC    logLik  deviance  df.resid
1763.9393 1783.0971 -875.9697 1751.9393       174
Random effects:
 Groups   Name        Std.Dev. Corr
 subj     (Intercept) 23.780
```

```
          days          5.717    0.08
 Residual              25.592
Number of obs: 180, groups:  subj, 18
Fixed Effects:
(Intercept)         days
     251.41        10.47
```

[17]:
```
R"""
library(performance)
check_model(sleep_model_R)
"""
```

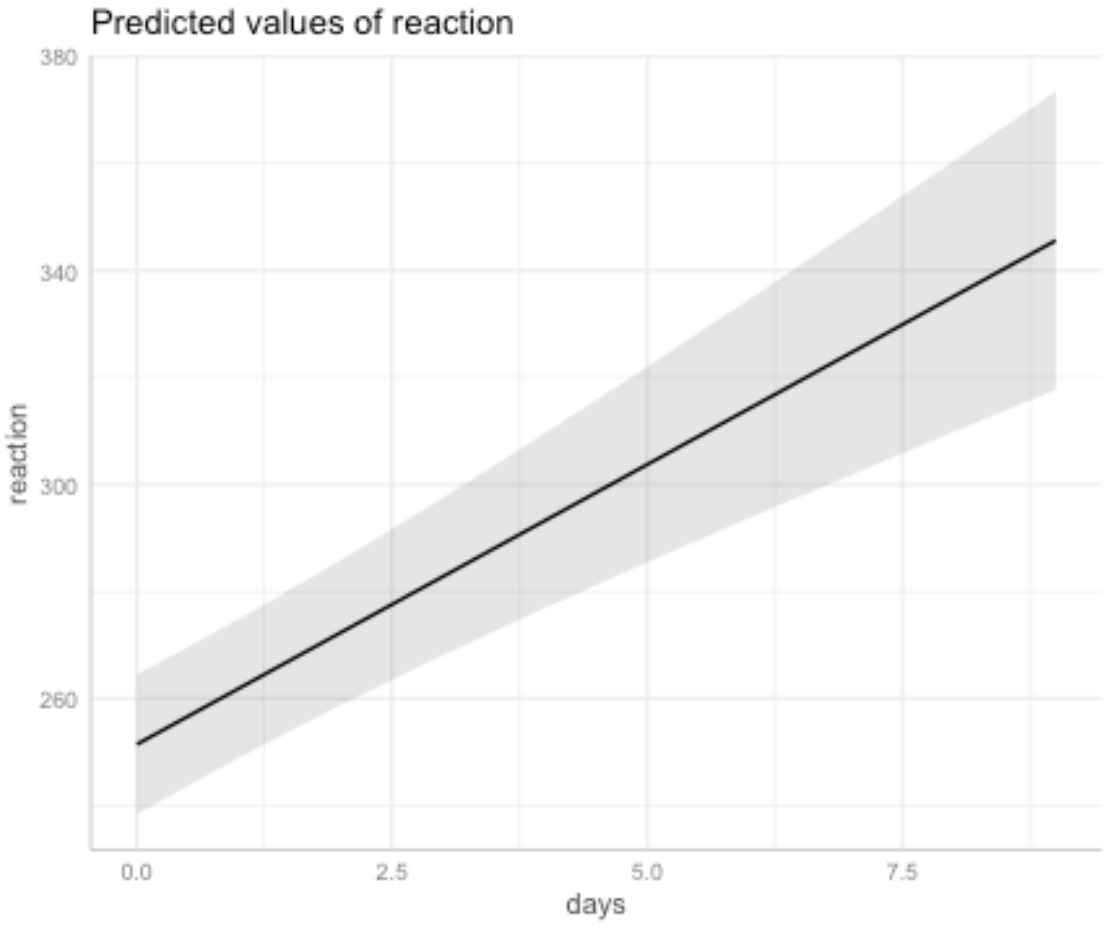
```
Not enough model terms in the conditional part of the model to check for
multicollinearity.
```



[17]: RObject{VecSxp}

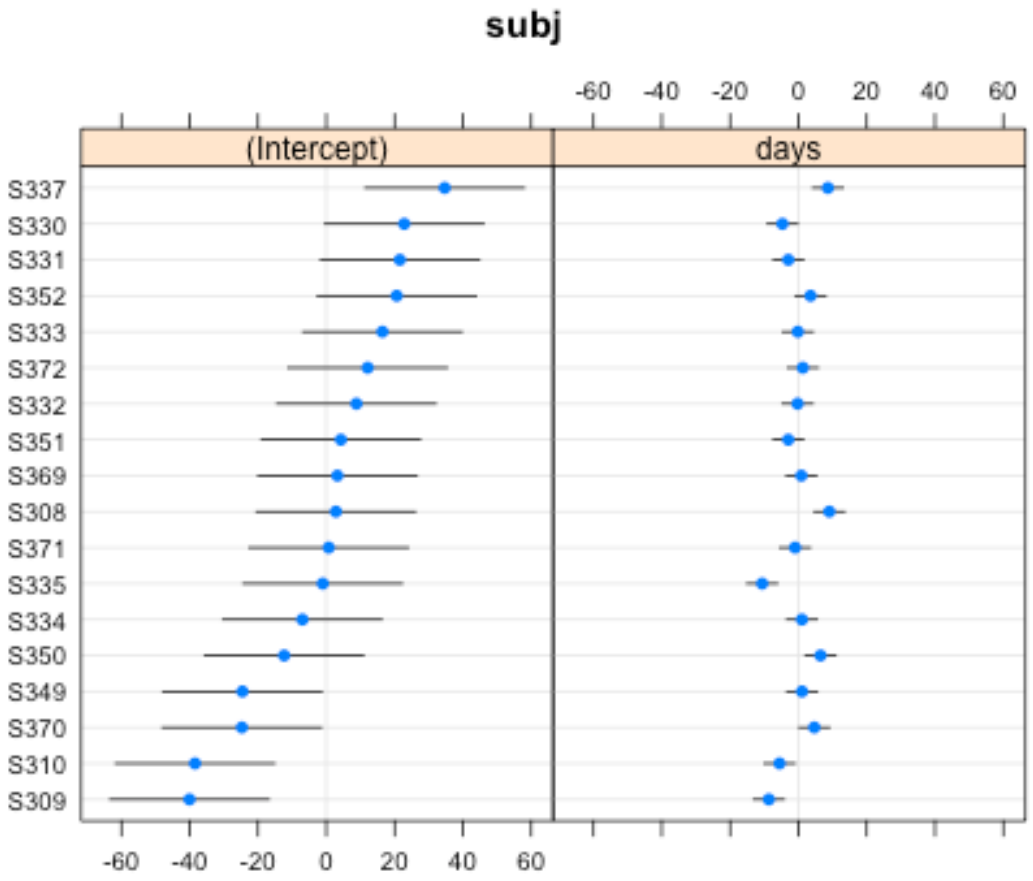
```
  Warning: RCall.jl: Warning: `guides(<scale> = FALSE)` is deprecated. Please
use `guides(<scale> = "none")` instead.
  `geom_smooth()` using formula 'y ~ x'
  `geom_smooth()` using formula 'y ~ x'
  `geom_smooth()` using formula 'y ~ x'
  `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
  Warning: Removed 174 rows containing missing values (geom_text_repel).
  `geom_smooth()` using formula 'y ~ x'
  @ RCall /Users/kylamcconnell/.julia/packages/RCall/Qzssx/src/io.jl:160
```

[18]:
```
R"""
library(ggeffects)
plot(ggpredict(sleep_model_R, terms = "days"))
"""
```



[18]: RObject{VecSxp}

[19]:
```
R"""
library(lattice)
dotplot(ranef(sleep_model_R))
"""
```



[19]:
```
RObject{VecSxp}
$subj
```

1.6 Summary

- With the R commands from RCall (R"``, @rput, @rget) you can use R for visualization and wrangling but let Julia do the''heavy lifting" of modeling
- My example uses LMMs (my use case) but you could substitute that step with any modeling methodology

Things to look out for: - missing values may be treated differently - easy solution: remove NAs in R in advance - changes in packages, especially

``younger'' ones - may have to be creative with package management - may be less on Stack Overflow