

Using the `trouBBlme4Solver` package

Iago Giné-Vázquez

August 8, 2022

In this vignette we show an introduction to the package `trouBBlme4Solver` and some examples of how to use the `dwmw` function (whose name was motivated because of *Dealing With Model Warnings*).

In 2014, Ben Bolker wrote the publication <https://rpubs.com/bbolker/lme4trouble1>, with some hints to solve convergence warnings produced by the functions `lmer` and `glmer`. Along the past years, he also have answered several related questions on the `lme4` repository in Github and in the SO forums. He also treated these issues in the GLMM FAQ, mainly in the section Troubleshooting. This package was inspired by these documents and by the `lme4` documentation pages `troubleshooting` and `convergence`. This is the reason to make a homage to Ben Bolker in the package name, being a “Solver for (4) `lme4` troubles”, making the “troub-lme4-SolveR” a “BB [Ben Bolker]-troub-lme4-SolveR”, i.e., `trouBBlme4Solver`.

Let’s start by the same example explained by Ben Bolker in his 2014’s publication. Scaling and updating the optimizer to avoid model failed to converge is automatic by means of `dwmw`. Beyond that, while the final model in the publication is yet singular, the output model by `dwmw` is not.

```
> library(lme4)
> data("fly_parameters", package = "trouBBlme4Solver")
> df <- fly_parameters
> df$SUR.ID <- factor(df$SUR.ID)
> df$replicate <- factor(df$replicate)
> Rdet <- cbind(df$ValidDetections, df$FalseDetections)
> Unit <- factor(1:length(df$ValidDetections))
> m1 <- glmer(Rdet ~ tm:Area + tm:c.distance +
+           c.distance:Area + c.tm.depth:Area +
+           c.receiver.depth:Area + c.temp:Area +
+           c.wind:Area +
+           c.tm.depth + c.receiver.depth +
+           c.temp + c.wind + tm + c.distance + Area +
+           replicate +
+           (1|SUR.ID) + (1|Day) + (1|Unit) ,
+   data = df, family = binomial(link="logit"))
> summary(m1)
```

Generalized linear mixed model fit by maximum likelihood (Laplace Approximation) [glmerMod]
 Family: binomial (logit)
 Formula: Rdet ~ tm:Area + tm:c.distance + c.distance:Area + c.tm.depth:Area + c.receiver.depth:Area + c.temp:Area + c.wind:Area + c.tm.depth + c.receiver.depth + c.temp + c.wind + tm + c.distance + Area + replicate + (1 | SUR.ID) + (1 | Day) + (1 | Unit)
 Data: df

AIC	BIC	logLik	deviance	df.resid
252.2	316.7	-107.1	214.2	201

Scaled residuals:

Min	1Q	Median	3Q	Max
-3.1211	0.0000	0.0000	0.3433	1.2976

Random effects:

Groups	Name	Variance	Std.Dev.
Unit	(Intercept)	4.624e-01	0.679983
Day	(Intercept)	1.181e-04	0.010867
SUR.ID	(Intercept)	5.241e-05	0.007239

Number of obs: 220, groups: Unit, 220; Day, 5; SUR.ID, 3

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-11.379308	7.149613	-1.592	0.111475
c.tm.depth	-1.036422	1.389863	-0.746	0.455848
c.receiver.depth	6.855221	8.986477	0.763	0.445560
c.temp	-5.482533	2.796059	-1.961	0.049901 *
c.wind	-6.263240	3.715552	-1.686	0.091857 .
tmPT-04	-2.148023	0.567118	-3.788	0.000152 ***
c.distance	-0.004259	0.003003	-1.418	0.156132
AreaFinger	11.617257	7.252924	1.602	0.109214
replicate2	2.705058	1.260891	2.145	0.031925 *
tmPT-04:AreaFinger	0.449961	0.689452	0.653	0.513991
tmPT-04:c.distance	-0.005923	0.003675	-1.612	0.107046
AreaFinger:c.distance	0.013033	0.004453	2.927	0.003425 **
AreaFinger:c.tm.depth	-2.887978	4.990921	-0.579	0.562828
AreaFinger:c.receiver.depth	-34.952817	16.835765	-2.076	0.037884 *
AreaFinger:c.temp	2.185838	1.865843	1.172	0.241397
AreaFinger:c.wind	8.334450	4.162632	2.002	0.045262 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

optimizer (Nelder_Mead) convergence code: 0 (OK)

Model failed to converge with max|grad| = 0.252244 (tol = 0.002, component 1)

Model is nearly unidentifiable: very large eigenvalue

```

- Rescale variables?
Model is nearly unidentifiable: large eigenvalue ratio
- Rescale variables?

> numcols <- grep("^c\\.\"",names(df))
> dfs <- df
> dfs[,numcols] <- scale(dfs[,numcols])
> m1_sc <- update(m1,data=dfs)
> ss <- getME(m1_sc,c("theta","fixef"))
> m3 <- update(m1_sc,start=ss,control=glmerControl(optimizer="bobyqa",
+                                               optCtrl=list(maxfun=2e5)))
> summary(m3)

```

```

Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) [glmerMod]
Family: binomial ( logit )
Formula: Rdet ~ tm:Area + tm:c.distance + c.distance:Area + c.tm.depth:Area +
c.receiver.depth:Area + c.temp:Area + c.wind:Area + c.tm.depth +
c.receiver.depth + c.temp + c.wind + tm + c.distance + Area +
replicate + (1 | SUR.ID) + (1 | Day) + (1 | Unit)
Data: dfs
Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))

```

AIC	BIC	logLik	deviance	df.resid
252.2	316.7	-107.1	214.2	201

```

Scaled residuals:
  Min       1Q   Median       3Q      Max
-3.1643  0.0000  0.0000  0.3449  1.2866

```

```

Random effects:
Groups Name          Variance Std.Dev.
Unit  (Intercept)  0.4721  0.6871
Day   (Intercept)  0.0000  0.0000
SUR.ID (Intercept) 0.0000  0.0000
Number of obs: 220, groups:  Unit, 220; Day, 5; SUR.ID, 3

```

```

Fixed effects:
              Estimate Std. Error z value Pr(>|z|)
(Intercept)   -8.0961    4.8627  -1.665 0.095924 .
c.tm.depth    -0.5121    0.6748  -0.759 0.447914
c.receiver.depth  2.1910    2.8135   0.779 0.436136
c.temp       -13.7827    6.6778  -2.064 0.039021 *
c.wind       -21.8299   12.2512  -1.782 0.074772 .
tmPT-04      -2.1344    0.5614  -3.802 0.000144 ***
c.distance    -0.5175    0.3868  -1.338 0.180950

```

```

AreaFinger          10.8986      5.8368    1.867 0.061870 .
replicate2          2.8322      1.2668    2.236 0.025368 *
tmPT-04:AreaFinger  0.4551      0.6922    0.657 0.510896
tmPT-04:c.distance -0.7847      0.4770   -1.645 0.099920 .
AreaFinger:c.distance 1.6900      0.5772    2.928 0.003411 **
AreaFinger:c.tm.depth -1.3272      2.4328   -0.546 0.585381
AreaFinger:c.receiver.depth -11.3658      5.4363   -2.091 0.036554 *
AreaFinger:c.temp    5.6156      4.4754    1.255 0.209564
AreaFinger:c.wind    28.9305     13.7390    2.106 0.035229 *

```

```

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
optimizer (bobyqa) convergence code: 0 (OK)
boundary (singular) fit: see help('isSingular')

```

```

> library(trouBB1me4Solver)
> m1_new <- dwmw(m1, scale = TRUE, max_message_iter = 3)
> summary(m1_new)

```

```

Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) [glmerMod]
Family: binomial ( logit )
Formula: Rdet ~ c.tm.depth + c.receiver.depth + c.temp + c.wind + tm +
c.distance + Area + replicate + (1 | Unit) + tm:Area + tm:c.distance +
Area:c.distance + Area:c.tm.depth + Area:c.receiver.depth +
Area:c.temp + Area:c.wind
Data: df-rescaled
Control: glmerControl(optimizer = next_optimizer, optCtrl = next_optCtrl)

```

AIC	BIC	logLik	deviance	df.resid
248.2	305.9	-107.1	214.2	203

```

Scaled residuals:
  Min       1Q   Median       3Q      Max
-3.1643  0.0000  0.0000  0.3449  1.2866

```

```

Random effects:
 Groups Name      Variance Std.Dev.
 Unit  (Intercept) 0.4721  0.6871
Number of obs: 220, groups: Unit, 220

```

```

Fixed effects:
              Estimate Std. Error z value Pr(>|z|)
(Intercept)   -8.0962    4.8577  -1.667 0.095579 .
c.tm.depth    -0.5121    0.6748  -0.759 0.447910
c.receiver.depth  2.1910    2.8132   0.779 0.436076
c.temp       -13.7828    6.6709  -2.066 0.038820 *

```

```

c.wind                -21.8301    12.2387   -1.784  0.074474 .
tmPT-04               -2.1344     0.5614   -3.802  0.000143 ***
c.distance            -0.5175     0.3867   -1.338  0.180836
AreaFinger            10.8987     5.8311    1.869  0.061613 .
replicate2            2.8322     1.2656    2.238  0.025237 *
tmPT-04:AreaFinger    0.4551     0.6922    0.657  0.510895
tmPT-04:c.distance    -0.7847     0.4770   -1.645  0.099920 .
c.distance:AreaFinger  1.6900     0.5772    2.928  0.003410 **
c.tm.depth:AreaFinger -1.3272     2.4321   -0.546  0.585269
c.receiver.depth:AreaFinger -11.3658    5.4345   -2.091  0.036490 *
c.temp:AreaFinger     5.6156     4.4718    1.256  0.209193
c.wind:AreaFinger     28.9307    13.7248    2.108  0.035039 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

Next is an example in the `lme4` documentation, which is singular. Our function desingularizes it.

```

> if(requireNamespace("nlme")){
+   data(Orthodont,package="nlme")
+   Orthodont$nsex <- as.numeric(Orthodont$Sex=="Male")
+   Orthodont$nsexage <- with(Orthodont, nsex*age)
+   fmo <- lmer(distance ~ age + (age|Subject) + (0 + nsex|Subject) +
+             (0 + nsexage|Subject), data = Orthodont)
+   # without warnings
+   fmo_new <- dwwm(fmo)
+ }

```

```
> summary(fmo)
```

```

Linear mixed model fit by REML ['lmerMod']
Formula: distance ~ age + (age | Subject) + (0 + nsex | Subject) + (0 +
  nsexage | Subject)
Data: Orthodont

```

```
REML criterion at convergence: 442.6
```

```
Scaled residuals:
```

```

      Min       1Q   Median       3Q      Max
-3.2232 -0.4938  0.0073  0.4722  3.9160

```

```
Random effects:
```

```

Groups   Name             Variance Std.Dev.  Corr
Subject  (Intercept)  5.414e+00  2.3268096
          age       5.126e-02  0.2264158 -0.61
Subject.1 nsex       2.430e-08  0.0001559
Subject.2 nsexage    0.000e+00  0.0000000

```

```
Residual          1.716e+00 1.3100560
Number of obs: 108, groups: Subject, 27
```

Fixed effects:

	Estimate	Std. Error	t value
(Intercept)	16.76111	0.77523	21.621
age	0.66019	0.07125	9.265

Correlation of Fixed Effects:

```
(Intr)
age -0.848
optimizer (nloptwrap) convergence code: 0 (OK)
boundary (singular) fit: see help('isSingular')
```

```
> summary(fmo_new)
```

```
Linear mixed model fit by REML ['lmerMod']
Formula: distance ~ age + (age | Subject) + (0 + nsex | Subject)
Data: Orthodont
```

REML criterion at convergence: 442.6

Scaled residuals:

Min	1Q	Median	3Q	Max
-3.2231	-0.4938	0.0073	0.4722	3.9160

Random effects:

Groups	Name	Variance	Std.Dev.	Corr
Subject	(Intercept)	5.415e+00	2.3269989	
	age	5.128e-02	0.2264469	-0.61
Subject.1	nsex	3.427e-07	0.0005854	
Residual		1.716e+00	1.3100290	

Number of obs: 108, groups: Subject, 27

Fixed effects:

	Estimate	Std. Error	t value
(Intercept)	16.76111	0.77524	21.621
age	0.66019	0.07126	9.265

Correlation of Fixed Effects:

```
(Intr)
age -0.848
```

Other examples

- SO question lme4 error: boundary (singular) fit: see ?isSingular

```

> data("plants", package = "troubB1me4Solver")
> fit <- lmer(Weight ~ 1 + (1|Rep:PLANT), data = plants)
> summary(fit)

Linear mixed model fit by REML ['lmerMod']
Formula: Weight ~ 1 + (1 | Rep:PLANT)
Data: plants

REML criterion at convergence: 2521.2

Scaled residuals:
    Min      1Q  Median      3Q      Max
-4.8883 -0.2685  0.1935  0.6554  1.8104

Random effects:
Groups      Name      Variance Std.Dev.
Rep:PLANT (Intercept)  0.00    0.000
Residual                18.74    4.329
Number of obs: 437, groups: Rep:PLANT, 8

Fixed effects:
              Estimate Std. Error t value
(Intercept)  25.1625    0.2071   121.5
optimizer (nloptwrap) convergence code: 0 (OK)
boundary (singular) fit: see help('isSingular')

> fit_new <- dwwm(fit)
> summary(fit_new)

Call:
lm(formula = Weight ~ 1, data = plants)

Residuals:
    Min      1Q  Median      3Q      Max
-21.1625 -1.1625  0.8375  2.8375  7.8375

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  25.1625    0.2071   121.5 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 4.329 on 436 degrees of freedom
(99 observations deleted due to missingness)

```

In this case, as the package does not analyze the random effect of each of the factors in an interaction among them (Rep and PLANT), it does not try to

update the formula including them separately ((1|Rep) or (1|PLANT)), which is the final answer in the SO question, but it removes random effect specified and outputs a simple linear model.

- **lme4** issue convergence issues with continuous variables in model at Github.

In this example, scaling the continuous predictor makes the large-eigenvalue warning go away.

```
> data("issue618", package = "trouBB1me4Solver")
> fit <- glmer(outcome_dead ~ AGE + (1|ZIP), family = binomial, data = issue618)
> summary(fit)
```

```
Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) [glmerMod]
Family: binomial ( logit )
Formula: outcome_dead ~ AGE + (1 | ZIP)
Data: issue618
```

AIC	BIC	logLik	deviance	df.resid
953.9	968.6	-474.0	947.9	997

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.9350	0.3408	0.4074	0.4664	0.9831

Random effects:

Groups Name	Variance	Std.Dev.
ZIP (Intercept)	0.3403	0.5834

Number of obs: 1000, groups: ZIP, 614

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-0.400877	0.482552	-0.831	0.406
AGE	0.028986	0.007147	4.056	4.99e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

```
(Intr)
AGE -0.961
optimizer (Nelder_Mead) convergence code: 0 (OK)
Model is nearly unidentifiable: very large eigenvalue
- Rescale variables?
```

```
> fit_new <- dwww(fit, scale = TRUE)
> summary(fit_new)
```



```

Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) [glmerMod]
Family: binomial ( logit )
Formula: outcome_dead ~ AGE + (1 | ZIP)
Data: issue618-rescaled

```

AIC	BIC	logLik	deviance	df.resid
953.9	968.6	-474.0	947.9	997

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.9350	0.3408	0.4074	0.4664	0.9831

Random effects:

Groups Name	Variance	Std.Dev.
ZIP (Intercept)	0.3403	0.5834

Number of obs: 1000, groups: ZIP, 614

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	1.60681	0.13641	11.779	< 2e-16 ***
AGE	0.34489	0.08503	4.056	4.99e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

(Intr)
AGE 0.228

The same with the larger dataset:

```

> data("issue618large", package = "trouBB1me4Solver")
> fit <- glmer(outcome_dead ~ AGE + (1|ZIP), family = binomial, data = issue618large)
> summary(fit)

```

```

Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) [glmerMod]
Family: binomial ( logit )
Formula: outcome_dead ~ AGE + (1 | ZIP)
Data: issue618large

```

AIC	BIC	logLik	deviance	df.resid
9815.3	9836.9	-4904.6	9809.3	9997

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.7766	0.3902	0.4546	0.5168	0.9550

Random effects:

Groups Name	Variance	Std.Dev.
ZIP (Intercept)	0.02448	0.1565

Number of obs: 10000, groups: ZIP, 1235

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-0.376328	0.149517	-2.517	0.0118 *
AGE	0.025962	0.002183	11.892	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

(Intr)

AGE -0.984

optimizer (Nelder_Mead) convergence code: 0 (OK)

Model failed to converge with max|grad| = 0.00416831 (tol = 0.002, component 1)

Model is nearly unidentifiable: very large eigenvalue

- Rescale variables?

```
> fit_new <- dnmw(fit, scale = TRUE)
```

```
> summary(fit_new)
```

Generalized linear mixed model fit by maximum likelihood (Laplace Approximation) [glmerMod]

Family: binomial (logit)

Formula: outcome_dead ~ AGE + (1 | ZIP)

Data: issue618large-rescaled

AIC	BIC	logLik	deviance	df.resid
9815.3	9836.9	-4904.6	9809.3	9997

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.7766	0.3902	0.4546	0.5168	0.9551

Random effects:

Groups Name	Variance	Std.Dev.
ZIP (Intercept)	0.02448	0.1565

Number of obs: 10000, groups: ZIP, 1235

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	1.43141	0.02731	52.41	<2e-16 ***
AGE	0.29822	0.02508	11.89	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
(Intr)
AGE 0.181

- Cross Validated question lme4: glmer() warning messages with count data mixed-effects model and how to proceed with model fit

The convergence issue posted is solved by means of updating the model start parameters:

```
> data("treatments", package = "trouBB1me4Solver")  
> glmm.1 <- glmer(total_no ~ week * treatment * fzone + (1|plot), data = treatments, family  
> summary(glmm.1)
```

Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) [glmerMod]
Family: poisson (log)
Formula: total_no ~ week * treatment * fzone + (1 | plot)
Data: treatments

AIC	BIC	logLik	deviance	df.resid
1558.4	1596.8	-766.2	1532.4	129

Scaled residuals:

Min	1Q	Median	3Q	Max
-5.3750	-1.3546	-0.0084	1.1502	9.5257

Random effects:

Groups Name	Variance	Std.Dev.
plot (Intercept)	0.236	0.4858

Number of obs: 142, groups: plot, 16

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	2.79184	0.37943	7.358	1.87e-13 ***
week	0.01590	0.02130	0.747	0.455355
treatment+3	0.73604	0.52872	1.392	0.163892
treatmentambient	0.14951	0.48659	0.307	0.758653
fzonepioneer	2.32594	0.47435	4.903	9.42e-07 ***
week:treatment+3	-0.06710	0.02823	-2.377	0.017454 *
week:treatmentambient	-0.02521	0.02668	-0.945	0.344576
week:fzonepioneer	-0.08658	0.02233	-3.876	0.000106 ***
treatment+3:fzonepioneer	-0.88456	0.66438	-1.331	0.183057
treatmentambient:fzonepioneer	-0.41838	0.63188	-0.662	0.507898

```

week:treatment+3:fzonepioneer      0.12520    0.02967    4.220 2.44e-05 ***
week:treatmentambient:fzonepioneer  0.06163    0.02844    2.167 0.030231 *

```

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

```

(Intr) week  trtm+3  trtmnt  fznpr  wk:t+3  wk:trt  wk:fzn  trt+3:
week          -0.399
treatment+3  -0.718  0.286
tretmntbnt   -0.780  0.311  0.560
fzonepioneer -0.800  0.319  0.574  0.624
wk:trtmnt+3  0.301 -0.755 -0.369 -0.235 -0.241
wk:trtmntmb  0.319 -0.799 -0.229 -0.380 -0.255  0.603
week:fznprnr  0.380 -0.954 -0.273 -0.297 -0.332  0.720  0.762
trtmnt+3:fz  0.571 -0.228 -0.796 -0.445 -0.714  0.294  0.182  0.237
trtmntmbnt:  0.600 -0.240 -0.431 -0.770 -0.751  0.181  0.292  0.249  0.536
wk:trtmn+3:  -0.286  0.718  0.351  0.223  0.250 -0.951 -0.573 -0.753 -0.308
wk:trtmntm:  -0.299  0.749  0.214  0.356  0.261 -0.565 -0.938 -0.785 -0.186
trtmn: wk:+3:

```

```

week
treatment+3
tretmntbnt
fzonepioneer
wk:trtmnt+3
wk:trtmntmb
week:fznprnr
trtmnt+3:fz
trtmntmbnt:
wk:trtmn+3: -0.188
wk:trtmntm: -0.310  0.591
optimizer (Nelder_Mead) convergence code: 0 (OK)
Model failed to converge with max|grad| = 0.00276087 (tol = 0.002, component 1)

```

```
> glmm.11 <- dnmw(glmm.1, verbose = TRUE)
```

Iteration: 1

Try solving:

```

Model failed to converge with max|grad| = 0.00276087 (tol = 0.002, component 1)
UPDATING MODEL START PARAMETERS

```

```
> summary(glmm.11)
```

```

Generalized linear mixed model fit by maximum likelihood (Laplace
Approximation) [glmerMod]
Family: poisson ( log )
Formula: total_no ~ week * treatment * fzone + (1 | plot)
Data: treatments

```

AIC	BIC	logLik	deviance	df.resid
1558.4	1596.8	-766.2	1532.4	129

Scaled residuals:

Min	1Q	Median	3Q	Max
-5.3750	-1.3547	-0.0084	1.1502	9.5257

Random effects:

Groups Name	Variance	Std.Dev.
plot (Intercept)	0.236	0.4858

Number of obs: 142, groups: plot, 16

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	2.79179	0.37942	7.358	1.87e-13 ***
week	0.01591	0.02130	0.747	0.455097
treatment+3	0.73608	0.52871	1.392	0.163854
treatmentambient	0.14957	0.48658	0.307	0.758543
fzonepioneer	2.32590	0.47434	4.903	9.41e-07 ***
week:treatment+3	-0.06711	0.02823	-2.378	0.017425 *
week:treatmentambient	-0.02522	0.02668	-0.945	0.344408
week:fzonepioneer	-0.08659	0.02233	-3.877	0.000106 ***
treatment+3:fzonepioneer	-0.88445	0.66437	-1.331	0.183100
treatmentambient:fzonepioneer	-0.41846	0.63187	-0.662	0.507807
week:treatment+3:fzonepioneer	0.12522	0.02967	4.220	2.44e-05 ***
week:treatmentambient:fzonepioneer	0.06164	0.02844	2.167	0.030204 *

 Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

	(Intr)	week	trtm+3	trtmnt	fznpnr	wk:t+3	wk:trt	wk:fzn	trt+3:	
week		-0.399								
treatment+3		-0.718	0.286							
treatmentambient		-0.780	0.311	0.560						
fzonepioneer		-0.800	0.319	0.574	0.624					
wk:trtmnt+3		0.301	-0.755	-0.369	-0.235	-0.241				
wk:trtmntmb		0.319	-0.799	-0.229	-0.380	-0.255	0.603			
week:fznpnr		0.380	-0.954	-0.273	-0.297	-0.332	0.720	0.762		
trtmnt+3:fz		0.571	-0.228	-0.796	-0.445	-0.714	0.294	0.182	0.237	
trtmntmbnt:		0.600	-0.240	-0.431	-0.770	-0.751	0.181	0.292	0.249	0.536
wk:trtmn+3:		-0.286	0.718	0.351	0.223	0.250	-0.951	-0.573	-0.753	-0.308
wk:trtmntm:		-0.299	0.749	0.214	0.356	0.261	-0.565	-0.938	-0.785	-0.186
			trtmn:	wk:+3:						
week										
treatment+3										

```

trtmntmbnt
fzonepioner
wk:trtmnt+3
wk:trtmntmb
week:fznpnr
trtmnt+3:fz
trtmntmbnt:
wk:trtmn+3: -0.188
wk:trtmntm: -0.310  0.591

```

- A bag of tips and tricks for dealing with scale issues

In this publication, the author suggests removing the convergence failing through dividing the variable price by 1000. Another option is scaling (standardizing) all the continuous predictors.

```

> if(requireNamespace("ggplot2")){
+   data("diamonds", package = "ggplot2")
+
+   # Grab the priciest diamonds
+   diamonds_subset <- diamonds[(nrow(diamonds)-10000):nrow(diamonds),]
+   # Fit the model
+   fit_1 <- lmer(carat ~ depth + table + price + x + y + z + (1 + price | cut), data
+   # Let's try dividing price by 1000
+   fit_2 <- lmer(carat ~ depth + table + I(price/1000) + x + y + z + (1 + I(price/1000) | cut), data)
+
+   fit_new <- dnmw(fit_1, scale = TRUE, verbose = TRUE)
+ }

```

Iteration: 1

Try solving:

Model failed to converge: degenerate Hessian with 1 negative eigenvalues
unable to evaluate scaled gradient
Some predictor variables are on very different scales: consider rescaling
SCALING PARAMETERS

```
> summary(fit_1)
```

Linear mixed model fit by REML ['lmerMod']

Formula: carat ~ depth + table + price + x + y + z + (1 + price | cut)

Data: diamonds_subset

REML criterion at convergence: -40082.4

Scaled residuals:

Min	1Q	Median	3Q	Max
-10.760	-0.445	-0.106	0.374	49.847

Random effects:

Groups	Name	Variance	Std.Dev.	Corr
cut	(Intercept)	1.213e-03	3.482e-02	
	price	5.365e-10	2.316e-05	-0.96
Residual		1.049e-03	3.239e-02	

Number of obs: 10001, groups: cut, 5

Fixed effects:

	Estimate	Std. Error	t value
(Intercept)	-1.917e+00	2.838e-02	-67.550
depth	1.340e-02	2.618e-04	51.195
table	2.094e-03	1.856e-04	11.280
price	9.890e-06	1.045e-05	0.946
x	2.873e-01	1.853e-03	155.031
y	2.416e-03	1.202e-03	2.011
z	-5.778e-04	1.116e-03	-0.517

Correlation of Fixed Effects:

	(Intr)	depth	table	price	x	y
depth	-0.736					
table	-0.587	0.376				
price	-0.501	-0.014	-0.005			
x	-0.206	0.144	-0.033	-0.059		
y	-0.038	0.041	0.017	-0.003	-0.593	
z	0.115	-0.224	0.022	-0.002	-0.308	-0.073

fit warnings:

Some predictor variables are on very different scales: consider rescaling
optimizer (nloptwrap) convergence code: 0 (OK)
unable to evaluate scaled gradient
Model failed to converge: degenerate Hessian with 1 negative eigenvalues

> summary(fit_2)

Linear mixed model fit by REML ['lmerMod']

Formula:

carat ~ depth + table + I(price/1000) + x + y + z + (1 + I(price/1000) |
cut)

Data: diamonds_subset

REML criterion at convergence: -40099.9

Scaled residuals:

Min	1Q	Median	3Q	Max
-10.736	-0.445	-0.106	0.374	49.827

```

Random effects:
Groups   Name             Variance Std.Dev. Corr
cut      (Intercept)      0.0002811 0.01677
          I(price/1000) 0.0001138 0.01067 -0.91
Residual                    0.0010498 0.03240
Number of obs: 10001, groups:  cut, 5

```

```

Fixed effects:
              Estimate Std. Error t value
(Intercept)  -1.9175113  0.0247826 -77.373
depth         0.0134157  0.0002614  51.320
table         0.0021038  0.0001853  11.352
I(price/1000) 0.0094664  0.0049595   1.909
x             0.2872836  0.0018522 155.105
y             0.0024191  0.0012019   2.013
z            -0.0005757  0.0011167  -0.516

```

```

Correlation of Fixed Effects:
              (Intr) depth  table  I(/100 x      y
depth         -0.840
table         -0.669  0.374
I(prc/1000)  -0.216 -0.031 -0.012
x             -0.232  0.142 -0.035 -0.126
y             -0.044  0.041  0.017 -0.005 -0.593
z             0.131 -0.224  0.022 -0.004 -0.308 -0.073

```

```
> summary(fit_new)
```

```

Linear mixed model fit by REML ['lmerMod']
Formula: carat ~ depth + table + price + x + y + z + (1 + price | cut)
Data: diamonds_subset-rescaled

```

```
REML criterion at convergence: -40096.8
```

```

Scaled residuals:
   Min       1Q   Median       3Q      Max
-10.736  -0.445  -0.106   0.374  49.827

```

```

Random effects:
Groups   Name             Variance Std.Dev. Corr
cut      (Intercept)      7.665e-05 0.008755
          price          3.763e-05 0.006134 0.61
Residual                    1.050e-03 0.032400
Number of obs: 10001, groups:  cut, 5

```

```
Fixed effects:
```


	Estimate	Std. Error	t value
(Intercept)	0.6015549	0.0039516	152.232
depth	0.0198214	0.0003862	51.320
table	0.0048810	0.0004300	11.352
price	0.0054427	0.0028514	1.909
x	0.1372493	0.0008849	155.105
y	0.0013028	0.0006473	2.013
z	-0.0002389	0.0004634	-0.516

Correlation of Fixed Effects:

	(Intr)	depth	table	price	x	y
depth	-0.038					
table	-0.046	0.374				
price	0.576	-0.031	-0.012			
x	-0.017	0.142	-0.035	-0.126		
y	0.002	0.041	0.017	-0.005	-0.593	
z	-0.001	-0.224	0.022	-0.004	-0.308	-0.073

- SO question how to use `update()` for random part in `lmer()`?

Function `fstruction` updates the formula of singular models according to a similar proceeding to which is explained in that SO question.

0.1 Session info

```
> sessionInfo()
```

```
R version 4.2.1 (2022-06-23)
Platform: x86_64-pc-linux-gnu (64-bit)
Running under: Debian GNU/Linux 11 (bullseye)

Matrix products: default
BLAS: /usr/lib/x86_64-linux-gnu/openblas-pthread/libblas.so.3
LAPACK: /usr/lib/x86_64-linux-gnu/openblas-pthread/libopenblas-p-r0.3.13.so
```

locale:

```
[1] LC_CTYPE=en_GB.UTF-8      LC_NUMERIC=C
[3] LC_TIME=en_GB.UTF-8      LC_COLLATE=C
[5] LC_MONETARY=en_GB.UTF-8  LC_MESSAGES=en_GB.UTF-8
[7] LC_PAPER=en_GB.UTF-8     LC_NAME=C
[9] LC_ADDRESS=C             LC_TELEPHONE=C
[11] LC_MEASUREMENT=en_GB.UTF-8 LC_IDENTIFICATION=C
```

attached base packages:

```
[1] stats      graphics  grDevices  utils      datasets  methods    base
```

other attached packages:

```
[1] trouBBlme4Solver_0.1.1 lme4_1.1-30          Matrix_1.4-1
```

```
loaded via a namespace (and not attached):
```

```
[1] Rcpp_1.0.9      magrittr_2.0.3  splines_4.2.1  MASS_7.3-57
[5] tidyselect_1.1.2 munsell_0.5.0  colorspace_2.0-3 lattice_0.20-45
[9] R6_2.5.1        rlang_1.0.4    minqa_1.2.4    fansi_1.0.3
[13] dplyr_1.0.9     tools_4.2.1    grid_4.2.1     gtable_0.3.0
[17] nlme_3.1-158    utf8_1.2.2     DBI_1.1.3      cli_3.3.0
[21] assertthat_0.2.1 tibble_3.1.8   lifecycle_1.0.1 purrr_0.3.4
[25] nloptr_2.0.3    ggplot2_3.3.6  vctrs_0.4.1    glue_1.6.2
[29] compiler_4.2.1 pillar_1.8.0   generics_0.1.3 scales_1.2.0
[33] boot_1.3-28     pkgconfig_2.0.3
```