

Using the `trouBBlme4SolveR` package

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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
-3.1190  0.0000  0.0000  0.3486  1.2942

Random effects:
Groups Name      Variance Std.Dev.
Unit   (Intercept) 4.640e-01 0.681178
Day    (Intercept) 8.082e-05 0.008990
SUR.ID (Intercept) 5.209e-05 0.007217
Number of obs: 220, groups: Unit, 220; Day, 5; SUR.ID, 3

Fixed effects:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -11.391900  7.144458 -1.595 0.110822
c.tm.depth   -1.020750  1.389373 -0.735 0.462532
c.receiver.depth 6.811302  8.976359  0.759 0.447970
c.temp       -5.487191  2.793898 -1.964 0.049531 *
c.wind        -6.271209  3.713372 -1.689 0.091254 .
tmPT-04      -2.147390  0.566823 -3.788 0.000152 ***
c.distance   -0.004280  0.003005 -1.425 0.154270
AreaFinger   11.585004  7.258297  1.596 0.110465
replicate2    2.695495  1.259289  2.140 0.032315 *
tmPT-04:AreaFinger 0.456378  0.689633  0.662 0.508119
tmPT-04:c.distance -0.005865  0.003672 -1.597 0.110193
AreaFinger:c.distance 0.013074  0.004455  2.935 0.003336 **
AreaFinger:c.tm.depth -3.049233  4.993059 -0.611 0.541402
AreaFinger:c.receiver.depth -34.883003 16.989263 -2.053 0.040049 *
AreaFinger:c.temp      2.195607  1.868833  1.175 0.240053
AreaFinger:c.wind      8.353265  4.160630  2.008 0.044676 *
---
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| = 0.0992467 (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  1.2867

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    4.8596 -1.666 0.095708 .
c.tm.depth                            -0.5121    0.6748 -0.759 0.447914
c.receiver.depth                      2.1910    2.8133  0.779 0.436105
c.temp                                -13.7827   6.6734 -2.065 0.038894 *
c.wind                                 -21.8300   12.2425 -1.783 0.074564 .
tmPT-04                               -2.1344    0.5614 -3.802 0.000144 ***
c.distance                            -0.5175    0.3868 -1.338 0.180890

```

```

AreaFinger           10.8986   5.8332   1.868  0.061710 .
replicate2          2.8322   1.2662   2.237  0.025296 *
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   2.4325  -0.546  0.585325
AreaFinger:c.receiver.depth -11.3658   5.4366  -2.091  0.036565 *
AreaFinger:c.temp      5.6156   4.4728   1.256  0.209294
AreaFinger:c.wind       28.9305  13.7303   2.107  0.035113 *
---
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(trouBBlme4SolveR)
> 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    4.8656  -1.664 0.096121 .
c.tm.depth  -0.5121    0.6748  -0.759 0.447914
c.receiver.depth 2.1910    2.8137   0.779 0.436158
c.temp      -13.7827   6.6818  -2.063 0.039138 *

```

```

c.wind           -21.8300   12.2586  -1.781  0.074948 .
tmPT-04         -2.1344    0.5614  -3.802  0.000144 ***
c.distance      -0.5175    0.3869  -1.338  0.181008
AreaFinger     10.8986    5.8400  1.866  0.062011 .
replicate2     2.8322    1.2674  2.235  0.025435 *
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  0.003411 **
c.tm.depth:AreaFinger -1.3272   2.4332  -0.545  0.585436
c.receiver.depth:AreaFinger -11.3658  5.4371  -2.090  0.036579 *
c.temp:AreaFinger    5.6156    4.4778  1.254  0.209802
c.wind:AreaFinger    28.9305   13.7474  2.104  0.035340 *
---
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 <- dwmw(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      0.0000  
Residual           18.74      4.3290  
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 <- dwmw(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 = "trouBBlme4SolveR")
> 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 <- dwmw(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 = "trouBBlme4SolveR")
> 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      997

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) -0.376322  0.149529 -2.517   0.0118 *
AGE         0.025962  0.002183 11.891  <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 is nearly unidentifiable: very large eigenvalue
- Rescale variables?

> fit_new <- dwmw(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 = "trouBBlme4SolveR")
> 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   0.37944   7.358 1.87e-13 ***
week                           0.01590   0.02130   0.747 0.455357
treatment+3                     0.73604   0.52873   1.392 0.163900
treatmentambient                0.14951   0.48660   0.307 0.758656
fzonepioneer                     2.32594   0.47435   4.903 9.42e-07 ***
week:treatment+3                -0.06710   0.02823  -2.377 0.017455 *
week:treatmentambient           -0.02521   0.02668  -0.945 0.344577
week:fzonepioneer                 -0.08658   0.02233  -3.876 0.000106 ***
treatment+3:fzonepioneer        -0.88456   0.66440  -1.331 0.183066
treatmentambient:fzonepioneer   -0.41838   0.63189  -0.662 0.507903
week:treatment+3:fzonepioneer   0.12520   0.02967   4.220 2.45e-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 fznpnr wk:t+3 wk:trt wk:fzn trt+3:
week          -0.399
treatment+3  -0.718  0.286
tretmntmbnt -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:trtmnt+3: -0.286  0.718  0.351  0.223  0.250 -0.951 -0.573 -0.753 -0.308
wk:trtmntmb: -0.299  0.749  0.214  0.356  0.261 -0.565 -0.938 -0.785 -0.186
                  trtmn: wk:+3:
week
treatment+3
tretmntmbnt
fzonepioneer
wk:trtmnt+3
wk:trtmntmb
week:fznpnr
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| = 0.00276098 (tol = 0.002, component 1)

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

Iteration: 1
Try solving:
Model failed to converge with max|grad| = 0.00276098 (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  9.5256

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)                         2.79177  0.37942  7.358  1.87e-13 ***
week                                0.01591  0.02130  0.747  0.455035
treatment+3                          0.73609  0.52871  1.392  0.163848
treatmentambient                     0.14961  0.48658  0.307  0.758488
fzonepioneer                         2.32590  0.47433  4.904  9.41e-07 ***
week:treatment+3                   -0.06711  0.02823 -2.378  0.017424 *
week:treatmentambient              -0.02522  0.02668 -0.946  0.344387
week:fzonepioneer                   -0.08659  0.02233 -3.877  0.000106 ***
treatment+3:fzonepioneer           -0.88444  0.66436 -1.331  0.183097
treatmentambient:fzonepioneer      -0.41846  0.63186 -0.662  0.507801
week:treatment+3:fzonepioneer      0.12522  0.02967  4.220  2.44e-05 ***
week:treatmentambient:fzonepioneer 0.06164  0.02844  2.167  0.030199 *
---
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
trtmntmbnt -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:trtmnt+3: -0.286  0.718  0.351  0.223  0.250 -0.951 -0.573 -0.753 -0.308
wk:trtmntmb: -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)
+
+   fit_new <- dwmw(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       5.364e-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        0.0134156 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 `fstructure` 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 4.4.1 (2024-06-14)
Platform: x86_64-pc-linux-gnu
Running under: Debian GNU/Linux 12 (bookworm)

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-r0.3.21.so; LAPACK version

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

time zone: Europe/Madrid
tzcode source: system (glibc)

attached base packages:
[1] stats      graphics   grDevices utils      datasets   methods    base
```

```
other attached packages:
[1] trouBBlme4SolveR_0.1.2 lme4_1.1-35.5           Matrix_1.7-0

loaded via a namespace (and not attached):
[1] vctrs_0.6.5      nlme_3.1-165      cli_3.6.3       rlang_1.1.4
[5] generics_0.1.3   minqa_1.2.8      glue_1.7.0      colorspace_2.1-1
[9] scales_1.3.0     fansi_1.0.6      grid_4.4.1      munsell_0.5.1
[13] tibble_3.2.1    MASS_7.3-61      lifecycle_1.0.4 compiler_4.4.1
[17] dplyr_1.1.4     Rcpp_1.0.13      pkgconfig_2.0.3 lattice_0.22-6
[21] nloptr_2.1.1    R6_2.5.1       tidyselect_1.2.1 utf8_1.2.4
[25] pillar_1.9.0    splines_4.4.1   magrittr_2.0.3   tools_4.4.1
[29] gtable_0.3.5    boot_1.3-30     ggplot2_3.5.1
```