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 lme4 convergence warnings: troubleshooting, 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 -2*log(L)  df.resid
    252.2     316.7    -107.1     214.2       201

Scaled residuals:
    Min      1Q  Median      3Q     Max
-3.1190  0.0000  0.0000  0.3485  1.2942

Random effects:
 Groups Name        Variance  Std.Dev.
 Unit   (Intercept) 4.640e-01 0.681158
 Day    (Intercept) 8.079e-05 0.008988
 SUR.ID (Intercept) 5.207e-05 0.007216
Number of obs: 220, groups:  Unit, 220; Day, 5; SUR.ID, 3

Fixed effects:
                             Estimate Std. Error z value Pr(>|z|)
(Intercept)                -11.391910   7.140424  -1.595 0.110620
c.tm.depth                  -1.020726   1.389347  -0.735 0.462534
c.receiver.depth             6.811247   8.974782   0.759 0.447893
c.temp                      -5.487190   2.792434  -1.965 0.049412 *
c.wind                      -6.271208   3.711173  -1.690 0.091063 .
tmPT-04                     -2.147392   0.566821  -3.788 0.000152 ***
c.distance                  -0.004281   0.003004  -1.425 0.154198
AreaFinger                  11.585026   7.254146   1.597 0.110261
replicate2                   2.695469   1.258814   2.141 0.032252 *
tmPT-04:AreaFinger           0.456363   0.689631   0.662 0.508132
tmPT-04:c.distance          -0.005865   0.003672  -1.597 0.110200
AreaFinger:c.distance        0.013074   0.004455   2.935 0.003335 **
AreaFinger:c.tm.depth       -3.049218   4.992410  -0.611 0.541351
AreaFinger:c.receiver.depth -34.883153  16.989022  -2.053 0.040046 *
AreaFinger:c.temp            2.195607   1.867820   1.175 0.239798
AreaFinger:c.wind            8.353287   4.158556   2.009 0.044569 *
---
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| = 0.0964374 (tol = 0.002, component 1)
```

```
  See ?lme4::convergence and ?lme4::troubleshooting.
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 -2*log(L)  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     4.9263  -1.643 0.100291
c.tm.depth                  -0.5121     0.6751  -0.758 0.448159
c.receiver.depth             2.1910     2.8066   0.781 0.435003
```

```
c.temp                       -13.7826     6.7585  -2.039 0.041421 *
c.wind                       -21.8299    12.3629  -1.766 0.077436 .
tmPT-04                       -2.1344     0.5590  -3.818 0.000135 ***
c.distance                    -0.5175     0.3889  -1.331 0.183282
AreaFinger                    10.8986     5.9362   1.836 0.066365 .
replicate2                     2.8322     1.2893   2.197 0.028049 *
tmPT-04:AreaFinger             0.4551     0.7068   0.644 0.519702
tmPT-04:c.distance            -0.7847     0.4824  -1.627 0.103781
AreaFinger:c.distance          1.6900     0.5902   2.863 0.004191 **
AreaFinger:c.tm.depth         -1.3272     2.4955  -0.532 0.594835
AreaFinger:c.receiver.depth -11.3658     5.6968  -1.995 0.046030 *
AreaFinger:c.temp              5.6156     4.5457   1.235 0.216702
AreaFinger:c.wind             28.9304    13.9252   2.078 0.037750 *
---
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 -2*log(L)  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  1.2867

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)                   -8.0961     4.8551  -1.668 0.095403 .
c.tm.depth                    -0.5121     0.6748  -0.759 0.447912
c.receiver.depth               2.1910     2.8130   0.779 0.436056
c.temp                       -13.7827     6.6673  -2.067 0.038714 *
c.wind                       -21.8299    12.2311  -1.785 0.074296 .
tmPT-04                       -2.1344     0.5614  -3.802 0.000143 ***
c.distance                    -0.5175     0.3867  -1.338 0.180785
AreaFinger                    10.8986     5.8283   1.870 0.061491 .
replicate2                     2.8322     1.2652   2.239 0.025183 *
tmPT-04:AreaFinger             0.4551     0.6922   0.657 0.510894
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     2.4318  -0.546 0.585224
c.receiver.depth:AreaFinger -11.3658     5.4349  -2.091 0.036504 *
c.temp:AreaFinger              5.6156     4.4696   1.256 0.208976
c.wind:AreaFinger             28.9305    13.7165   2.109 0.034929 *
---
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 = "trouBBlme4SolveR")
> 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 <- 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 -2*log(L)  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 -2*log(L)  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
```

With the current version of **lme4** (1.1-38), `glmer` applied to the larger dataset, converges without warnings.

- 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 = poisson)
> 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 -2*log(L)  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 0.455356
treatment+3                          0.73604    0.52873   1.392 0.163897
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 0.344577
week:fzonepioneer                   -0.08658    0.02233  -3.876 0.000106 ***
treatment+3:fzonepioneer            -0.88456    0.66439  -1.331 0.183065
treatmentambient:fzonepioneer       -0.41838    0.63188  -0.662 0.507898
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
fzonepioner -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
tretmntmbnt
fzonepioner
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| = 0.00276091 (tol = 0.002, component 1)
  See ?lme4::convergence and ?lme4::troubleshooting.
```

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

```
Iteration: 1
 Try solving:
 Model failed to converge with max|grad| = 0.00276091 (tol = 0.002, component 1)
  See ?lme4::convergence and ?lme4::troubleshooting.
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 -2*log(L)  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 0.163853
treatmentambient                     0.14961    0.48658   0.307 0.758489
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    0.66437  -1.331 0.183104
treatmentambient:fzonepioneer       -0.41846    0.63186  -0.662 0.507802
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
tretmntmbnt -0.780  0.311  0.560
fzonepioner -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
tretmntmbnt
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 = diamonds_subset)
+         # 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 = diamonds_subset)
+
+         fit_new <- dwmw(fit_1, scale = TRUE, verbose = TRUE)
+ }

Iteration: 1
 Try solving:
 Some predictor variables are on very different scales: consider rescaling.
You may also use (g)lmerControl(autoscale = TRUE) to improve numerical stability.
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.
You may also use (g)lmerControl(autoscale = TRUE) to improve numerical stability.

> 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)   -1.9175112  0.0247826 -77.373
depth          0.0134156  0.0002614  51.320
table          0.0021038  0.0001853  11.352
I(price/1000)  0.0094664  0.0049594   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 4.5.2 (2025-10-31)
Platform: x86_64-pc-linux-gnu
Running under: Debian GNU/Linux 13 (trixie)

Matrix products: default
BLAS:   /usr/lib/x86_64-linux-gnu/blas/libblas.so.3.12.1
LAPACK: /usr/lib/x86_64-linux-gnu/lapack/liblapack.so.3.12.1;  LAPACK version 3.12.0

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_0.1.4 lme4_1.1-38            Matrix_1.7-4

loaded via a namespace (and not attached):
 [1] vctrs_0.6.5        nlme_3.1-168       cli_3.6.5
 [4] rlang_1.1.6        reformulas_0.4.2   generics_0.1.4
 [7] S7_0.2.1           minqa_1.2.8        glue_1.8.0
[10] scales_1.4.0       grid_4.5.2         tibble_3.3.0
[13] MASS_7.3-65        lifecycle_1.0.4    compiler_4.5.2
[16] dplyr_1.1.4        RColorBrewer_1.1-3 pkgconfig_2.0.3
[19] Rcpp_1.1.0         farver_2.1.2       lattice_0.22-7
[22] nloptr_2.2.1       R6_2.6.1           tidyselect_1.2.1
[25] pillar_1.11.1      Rdpack_2.6.4       splines_4.5.2
[28] magrittr_2.0.4     rbibutils_2.4      tools_4.5.2
[31] gtable_0.3.6       boot_1.3-32        ggplot2_4.0.1
```