

# Using asreml and asremlPlus for the Ladybird example from Welham et al. (2014)

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## Introduction

This vignette shows how to use `asremlPlus` (Brien, 2024a), and `dae` (Brien, 2024b), for exploring and presenting predictions from a linear mixed model analysis, the predictions having been produced using `asreml` (Butler et al., 2023). Here, `asremlPlus`, `dae` and `asreml` are packages for the R Statistical Computing environment (R Core Team, 2024).

The context is a three-factor factorial experiment on ladybirds (Welham et al., 2014, Example 8.2) that aims to answer the question “Will ladybirds transfer fungus to aphids on plants?” The experiment consists of 2 runs of 36 containers, each with a plant and aphids. There are three factors that results in 12 treatments: Host plant (beans, trefoil), infected Cadavers (5, 10, 20), Ladybird (-, +). Ther are randomized to the containers within a run so that each is replicated 3 times within a run. The response to be analysed is the logit of the proportion of live aphids that were infected.

## Initialize

```
library(knitr)
opts_chunk$set("tidy" = FALSE, comment = NA)
suppressMessages(library(asreml))
```

```
## Offline License checked out Mon Jan 15 10:49:51 2024
```

```
packageVersion("asreml")
```

```
## [1] '4.2.0.276'
```

```
suppressMessages(library(asremlPlus))
packageVersion("asremlPlus")
```

```
## [1] '4.4.25'
```

```
suppressMessages(library("dae"))
packageVersion("dae")
```

```
## [1] '3.2.21'
```

```
options(width = 95, show.signif.stars = FALSE)
```

## Get data available in asremlPlus

```
data("Ladybird.dat")
```

## Do an ANOVA of logits

```
Ladybird.aov <- aov(logitP ~ Host*Cadavers*Ladybird + Error(Run/Plant),
                    data=Ladybird.dat)
summary(Ladybird.aov)
```

```
Error: Run
      Df Sum Sq Mean Sq F value Pr(>F)
Residuals  1 0.06766 0.06766

Error: Run:Plant
      Df Sum Sq Mean Sq F value    Pr(>F)
Host      1 13.599   13.599   59.172 1.82e-10
Cadavers  2 17.027    8.514   37.044 3.78e-11
Ladybird  1 11.091   11.091   48.257 3.33e-09
Host:Cadavers  2  0.308    0.154    0.670  0.5158
Host:Ladybird  1  0.228    0.228    0.992  0.3234
Cadavers:Ladybird  2  1.735    0.867    3.774  0.0287
Host:Cadavers:Ladybird  2  0.200    0.100    0.435  0.6493
Residuals    59 13.560    0.230
```

The anova table gives the F-tests for the three-factor effects and interactions. Note the **Residuals Mean Sq** value for Run:Plant of 0.230. Also, it is clear that the Run component is negative, given that the **Residuals Mean Sq** value for Run is less than that for Run:Plant; it is  $(0.06766 - 0.230) / 36$ . From the table it is seen that the only significant interaction is Cadavers:Ladybird and that the Host main effect is significant.

## Use asreml to analyse the logits

### Mixed model analysis of logits

```
m <- asreml(logitP ~ Host*Cadavers*Ladybird,
            random = ~ Run,
            residual = ~ Run:Plant,
            data = Ladybird.dat)
summary(m)$varcomp
```

|             | component    | std.error  | z.ratio  | bound | %ch |
|-------------|--------------|------------|----------|-------|-----|
| Run         | 2.298309e-08 | NA         | NA       | B     | NA  |
| Run:Plant!R | 2.271216e-01 | 0.04156985 | 5.463612 | P     | 0   |

As expected the Run component is bound (B) at approximately zero. This results in a change in the estimate of the residual variance to 0.227. To allow for a negative estimate we will unconstrain the Run component. As Littell et al. (2006, p.150) say

if you do not set the negative variance component estimate to zero, but allow it to remain negative, you get better control over Type I error and, for cases of negative wholeplot error variance estimates, greater power. Therefore, this is the recommended procedure.

## Unconstrain Reps to make the analysis equivalent to ANOVA

```
m <- setvarianceterms(m$call, terms = "Run", bounds = "U")
summary(m)$varcomp
```

|             | component    | std.error   | z.ratio   | bound | %ch |
|-------------|--------------|-------------|-----------|-------|-----|
| Run         | -0.004504789 | 0.002896281 | -1.555370 | U     | 0.1 |
| Run:Plant!R | 0.229834648  | 0.042316936 | 5.431269  | P     | 0.0 |

Now the Run component is negative and the Run:Plant variance estimate is now equal to that for the Residuals Mean Sq for Run:Plant from the anova table.

## Set up an asrtests object

```
current.asrt <- as.asrtests(m)
print(current.asrt, which = "pseudoanova")
```

```
#### Pseudo-anova table for fixed terms
```

Wald tests for fixed effects.

Response: logitP

|                        | Df | denDF | F.inc   | Pr     |
|------------------------|----|-------|---------|--------|
| (Intercept)            | 1  | 1     | 1550.00 | 0.0162 |
| Host                   | 1  | 59    | 59.17   | 0.0000 |
| Cadavers               | 2  | 59    | 37.04   | 0.0000 |
| Ladybird               | 1  | 59    | 48.26   | 0.0000 |
| Host:Cadavers          | 2  | 59    | 0.67    | 0.5158 |
| Host:Ladybird          | 1  | 59    | 0.99    | 0.3234 |
| Cadavers:Ladybird      | 2  | 59    | 3.77    | 0.0287 |
| Host:Cadavers:Ladybird | 2  | 59    | 0.44    | 0.6493 |

The asrtests object contains a wald.tab component which can be printed by specifying that the pseudoanova is printed. The *F*-values for the fixed terms in this table are the same as those in the anova table.

## Obtain the marginality matrix for the fixed terms

The `pstructure` function from the `dae` package (Brien, 2024b) produce the marginality matrix for a formula as a side effect and we take advantage of that to obtain the matrix required here.

```
Ladybird.pstr <- pstructure(formula = ~ Host*Cadavers*Ladybird,
                           data = Ladybird.dat)
HCL.marg <- marginality(Ladybird.pstr)
print(HCL.marg)
```

|                        | Host | Cadavers | Host:Cadavers | Ladybird | Host:Ladybird | Cadavers:Ladybird |
|------------------------|------|----------|---------------|----------|---------------|-------------------|
| Host                   | 1    | 0        | 1             | 0        | 1             | 0                 |
| Cadavers               | 0    | 1        | 1             | 0        | 0             | 1                 |
| Host:Cadavers          | 0    | 0        | 1             | 0        | 0             | 0                 |
| Ladybird               | 0    | 0        | 0             | 1        | 1             | 1                 |
| Host:Ladybird          | 0    | 0        | 0             | 0        | 1             | 0                 |
| Cadavers:Ladybird      | 0    | 0        | 0             | 0        | 0             | 1                 |
| Host:Cadavers:Ladybird | 0    | 0        | 0             | 0        | 0             | 0                 |

|                        | Host:Cadavers:Ladybird |
|------------------------|------------------------|
| Host                   | 1                      |
| Cadavers               | 1                      |
| Host:Cadavers          | 1                      |
| Ladybird               | 1                      |
| Host:Ladybird          | 1                      |
| Cadavers:Ladybird      | 1                      |
| Host:Cadavers:Ladybird | 1                      |

This marginality matrix is interpreted by taking a row term and noting that it is marginal to any column term with a one in this row.

## Choose marginality-compliant model

```
chosen <- chooseModel(current.asrt, terms.marginality = HCL.marg)
current.asrt <- chosen$asrtests.obj
print(current.asrt, which = "test", omit.columns = c("AIC", "BIC"))
```

#### Sequence of model investigations

|   | terms                  | DF | denDF | p      | action         |
|---|------------------------|----|-------|--------|----------------|
| 1 | Host:Cadavers:Ladybird | 2  | 59    | 0.6493 | Nonsignificant |
| 2 | Cadavers:Ladybird      | 2  | 59    | 0.0287 | Significant    |
| 3 | Host:Ladybird          | 1  | 59    | 0.3234 | Nonsignificant |
| 4 | Host:Cadavers          | 2  | 59    | 0.5158 | Nonsignificant |
| 5 | Host                   | 1  | 59    | 0.0000 | Significant    |

```
(chosen$sig.terms)
```

```
[[1]]
```

```
[1] "Cadavers:Ladybird"
```

```
[[2]]
```

```
[1] "Host"
```

The `chooseModel` function produces a list with components `sig.terms`, a list with the terms in the marginality-compliant model, and `asrtests.obj`, the `asrtests` object resulting from the model selection. In particular, the `asrtests` object contains a `test.summary` that details the tests performed in choosing the model; the AIC and BIC columns are omitted from `test.summary` because their inclusion has not been requested. Note that `chooseModel` does not test the main effects for Cadavers or Ladybird, because these are marginal to the significant two-factor interaction Cadavers:Ladybird.

### Form formula for selected model

```
chosen.mod <- paste(unlist(chosen$sig.terms), collapse = " + ")
(chosen.mod <- as.formula(paste("~", chosen.mod)))
```

```
~Cadavers:Ladybird + Host
```

### Obtain predictions under the chosen model and form an alldiffs object

```
diffs <- predictPlus(current.asrt$asreml.obj,
  classify = "Host:Ladybird:Cadavers",
  linear.transformation = ~Cadavers:Ladybird + Host,
  wald.tab = current.asrt$wald.tab,
  error.intervals = "halfLeast",
  LSDtype = "factor.combination", LSDby = "Host",
  tables = "predictions")
```

```
Joining with 'by = join_by(fac.comb)'
```

```
Joining with 'by = join_by(Host)'
```

```
#### Predictions for logitP transform(s) from Host:Ladybird:Cadavers
```

Notes:

The original predictions, obtained as described below, have been linearly transformed to form estimated marginal means.

- The predictions are obtained by averaging across the hypertable calculated from model terms constructed solely from factors in the averaging and classify sets.
- Use 'average' to move ignored factors into the averaging set.
- The ignored set: Run

|   | Host | Ladybird | Cadavers | predicted.value | standard.error | upper.halfLeastSignificant.limit |
|---|------|----------|----------|-----------------|----------------|----------------------------------|
| 1 | bean | -        | 5        | -1.6038338      | 0.1417454      | -1.4080222                       |
| 2 | bean | -        | 10       | -1.1454308      | 0.1417454      | -0.9496192                       |

|    |         |   |    |            |           |            |
|----|---------|---|----|------------|-----------|------------|
| 3  | bean    | - | 20 | -0.7448097 | 0.1417454 | -0.5489981 |
| 4  | bean    | + | 5  | -1.0195475 | 0.1417454 | -0.8237359 |
| 5  | bean    | + | 10 | -0.5983440 | 0.1417454 | -0.4025323 |
| 6  | bean    | + | 20 | 0.4786704  | 0.1417454 | 0.6744820  |
| 7  | trefoil | - | 5  | -2.4730339 | 0.1417454 | -2.2772223 |
| 8  | trefoil | - | 10 | -2.0146309 | 0.1417454 | -1.8188193 |
| 9  | trefoil | - | 20 | -1.6140098 | 0.1417454 | -1.4181982 |
| 10 | trefoil | + | 5  | -1.8887476 | 0.1417454 | -1.6929360 |
| 11 | trefoil | + | 10 | -1.4675441 | 0.1417454 | -1.2717325 |
| 12 | trefoil | + | 20 | -0.3905297 | 0.1417454 | -0.1947181 |

|    | lower.halfLeastSignificant.limit | est.status |
|----|----------------------------------|------------|
| 1  | -1.7996454                       | Estimable  |
| 2  | -1.3412425                       | Estimable  |
| 3  | -0.9406214                       | Estimable  |
| 4  | -1.2153592                       | Estimable  |
| 5  | -0.7941556                       | Estimable  |
| 6  | 0.2828588                        | Estimable  |
| 7  | -2.6688455                       | Estimable  |
| 8  | -2.2104426                       | Estimable  |
| 9  | -1.8098215                       | Estimable  |
| 10 | -2.0845593                       | Estimable  |
| 11 | -1.6633557                       | Estimable  |
| 12 | -0.5863414                       | Estimable  |

LSD values

minimum LSD = 0.3916233 0.3916233

mean LSD = 0.3916233 0.3916233

maximum LSD = 0.3916233 0.3916233

(sed range / mean sed = 9.92e-16 9.92e-16 )

Setting the `terms` argument to `Host:Ladybird:Cadavers` requests predictions for all combinations of the three factors and the `linear.transformation` argument is used to obtain estimated marginal means (emm) that conform to the chosen model. The `wald.tab` is supplied so that it can be used to get the degrees of freedom for the *t*-value to be used in calculating the LSD; the degrees of freedom of the source for the `terms` argument will be used. The `error.intervals` argument has been set to "halfLeast", the `LSDtype` argument to "factor.combination" and the `LSDby` argument to "Host" so that the average LSD will be calculated for each Host. This necessary because, under the chosen model, the LSDs differ between Hosts. It results in `lower.halfLeastSignificant.limit` and `upper.halfLeastSignificant.limit` being added to the `predictions` component of the `alldiffs` object.

Or, caculate predictions to check first and then transform to conform to chosen model

```
diffs.full <- predictPlus(current.asrt$asreml.obj,
  classify = "Host:Ladybird:Cadavers",
  wald.tab = current.asrt$wald.tab,
  tables = "none", Vmatrix = TRUE)
```

```
diffs <- linTransform(diffs.full, linear.transformation = ~Cadavers:Ladybird + Host,
                      wald.tab = current.asrt$wald.tab,
                      error.intervals = "halfLeast",
                      LSDtype = "factor.combination", LSDby = "Host",
                      tables = "predictions")
```

Joining with 'by = join\_by(fac.comb)'  
 Joining with 'by = join\_by(Host)'

#### Predictions for logitP transform(s) from Host:Ladybird:Cadavers

Notes:

- The original predictions, obtained as described below, have been linearly transformed to form estimated marginal means.
- The predictions are obtained by averaging across the hypertable calculated from model terms constructed solely from factors in the averaging and classify sets.
  - Use 'average' to move ignored factors into the averaging set.
  - The ignored set: Run

|    | Host    | Ladybird | Cadavers | predicted.value                  | standard.error | upper.halfLeastSignificant.limit |
|----|---------|----------|----------|----------------------------------|----------------|----------------------------------|
| 1  | bean    | -        | 5        | -1.6038338                       | 0.1417454      | -1.4080222                       |
| 2  | bean    | -        | 10       | -1.1454308                       | 0.1417454      | -0.9496192                       |
| 3  | bean    | -        | 20       | -0.7448097                       | 0.1417454      | -0.5489981                       |
| 4  | bean    | +        | 5        | -1.0195475                       | 0.1417454      | -0.8237359                       |
| 5  | bean    | +        | 10       | -0.5983440                       | 0.1417454      | -0.4025323                       |
| 6  | bean    | +        | 20       | 0.4786704                        | 0.1417454      | 0.6744820                        |
| 7  | trefoil | -        | 5        | -2.4730339                       | 0.1417454      | -2.2772223                       |
| 8  | trefoil | -        | 10       | -2.0146309                       | 0.1417454      | -1.8188193                       |
| 9  | trefoil | -        | 20       | -1.6140098                       | 0.1417454      | -1.4181982                       |
| 10 | trefoil | +        | 5        | -1.8887476                       | 0.1417454      | -1.6929360                       |
| 11 | trefoil | +        | 10       | -1.4675441                       | 0.1417454      | -1.2717325                       |
| 12 | trefoil | +        | 20       | -0.3905297                       | 0.1417454      | -0.1947181                       |
|    |         |          |          | lower.halfLeastSignificant.limit | est.status     |                                  |
| 1  |         |          |          | -1.7996454                       | Estimable      |                                  |
| 2  |         |          |          | -1.3412425                       | Estimable      |                                  |
| 3  |         |          |          | -0.9406214                       | Estimable      |                                  |
| 4  |         |          |          | -1.2153592                       | Estimable      |                                  |
| 5  |         |          |          | -0.7941556                       | Estimable      |                                  |
| 6  |         |          |          | 0.2828588                        | Estimable      |                                  |
| 7  |         |          |          | -2.6688455                       | Estimable      |                                  |
| 8  |         |          |          | -2.2104426                       | Estimable      |                                  |
| 9  |         |          |          | -1.8098215                       | Estimable      |                                  |
| 10 |         |          |          | -2.0845593                       | Estimable      |                                  |
| 11 |         |          |          | -1.6633557                       | Estimable      |                                  |
| 12 |         |          |          | -0.5863414                       | Estimable      |                                  |

LSD values

minimum LSD = 0.3916233 0.3916233

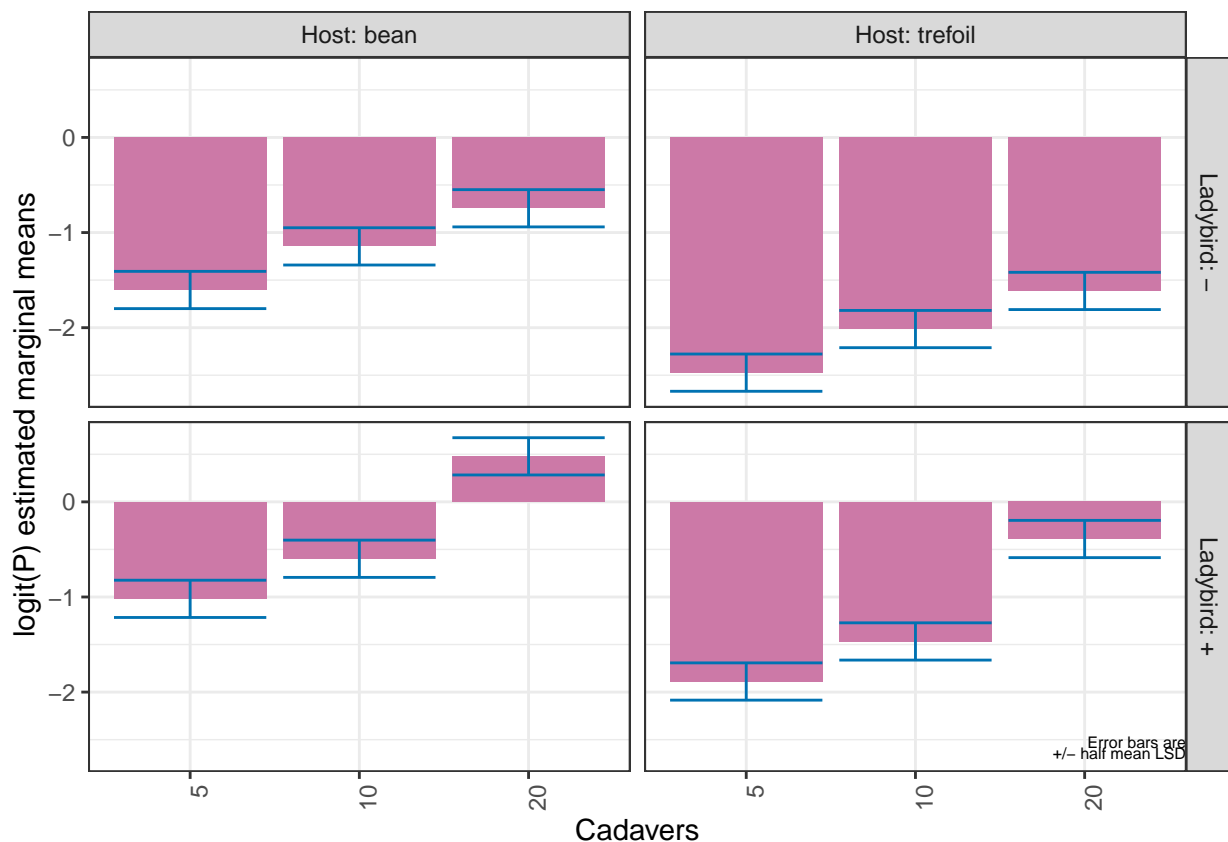
mean LSD = 0.3916233 0.3916233

maximum LSD = 0.3916233 0.3916233

(sed range / mean sed = 9.92e-16 9.92e-16 )

### Plot the predictions

```
plotPredictions(diffs$predictions, y = "predicted.value",
  y.title = "logit(P) estimated marginal means",
  classify = "Host:Ladybird:Cadavers",
  error.intervals = "halfLeast",
  ggplotFuncs = list(facet_grid(Ladybird ~ Host,
    labeller = label_both)))
```



The function `plotPredictions` uses `ggplot` to produce the plot and the `ggplotFuncs` argument allows the addition of `ggplot` functions to modify the plot. In this case, the `facet_grid` function is respescted to include `prepender` functions that modify the labels of the facets to include the factor names. Note the the error bars in the plots are of  $\pm 0.5LSD$  so that pairs of prediction with nonoverlapping bars are significantly different (Snee, 1981).



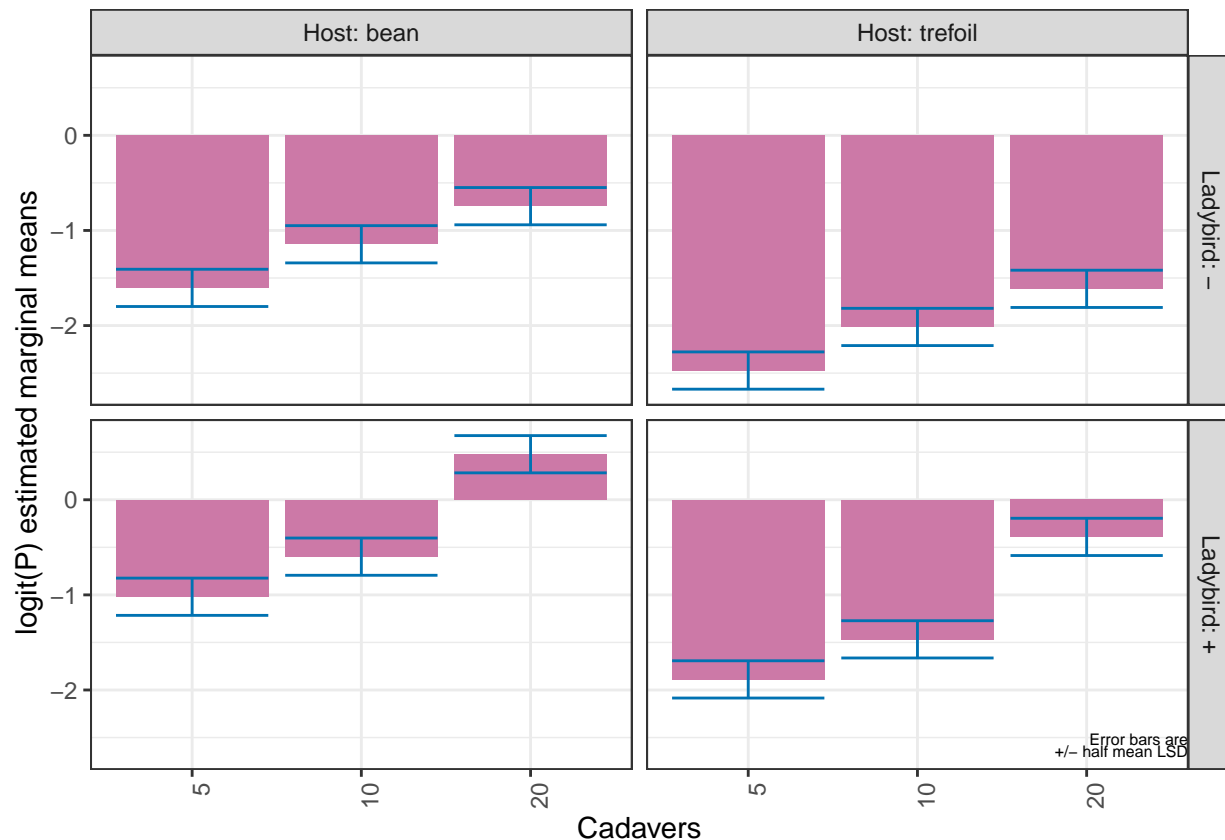
## Get and plot the predictions with a single function call

The `predictPresent` function combines the functionality of `predictPlus` and `plotPredictions`, as demonstrated now. Also, the use of `plotPvalues` to plot the pairwise  $p$ -values is displayed. The `predictPresent` function has the capability of producing `alldiffs` objects for multiple terms and these are stored in a list each of which is named for the term whose `alldiffs` object it stores. Thus, the term has to be specified in referencing components of `diffs`.

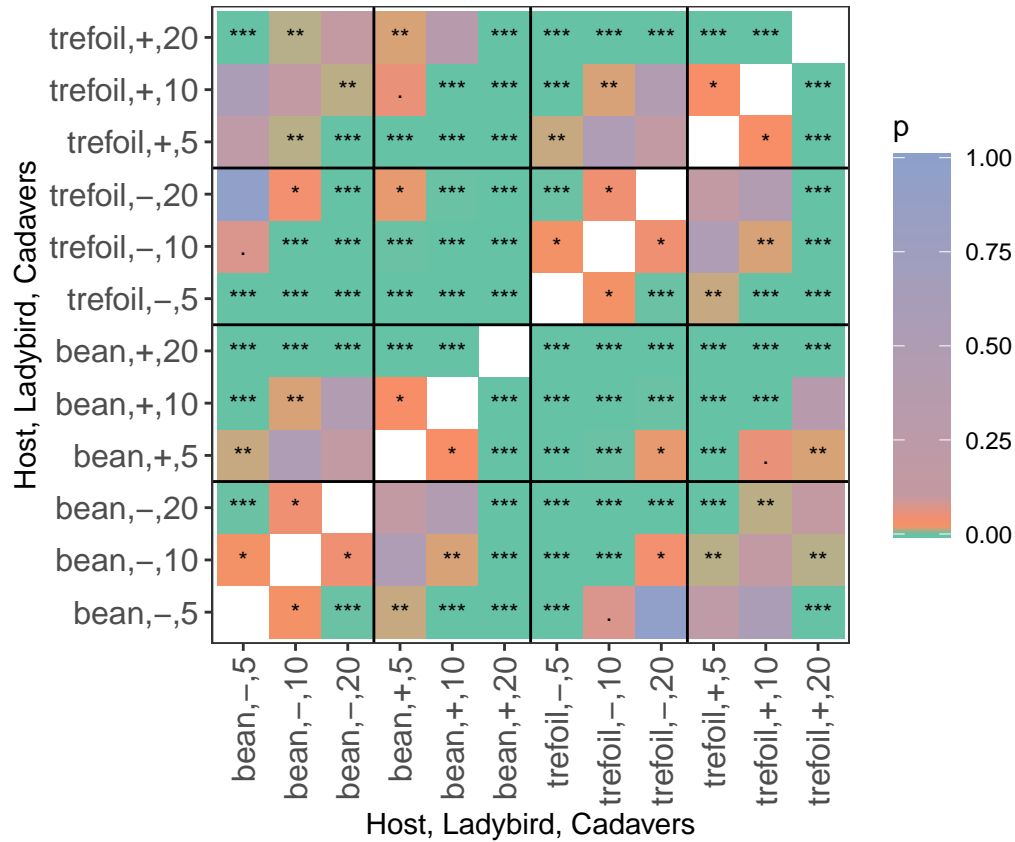
```
titl <- "logit(P) estimated marginal means"
names(titl) <- "logitP"
difs <- predictPresent(current.asrt$asreml.obj,
  terms = "Host:Ladybird:Cadavers",
  linear.transformation = ~Cadavers:Ladybird + Host,
  titles = titl,
  wald.tab = current.asrt$wald.tab,
  error.intervals = "halfLeast",
  LSDtype = "factor.combination", LSDby = "Host",
  tables = "none",
  ggplotFuncs = list(facet_grid(Ladybird ~ Host,
    labeller = label_both)))
```

Joining with 'by = join\_by(fac.comb)'

Joining with 'by = join\_by(Host)'



```
plotPvalues(diffs$Host.Ladybird.Cadavers, factors.per.grid = 1, show.sig = TRUE)
```



```
options(width = 90)
```

```
diffs$Host.Ladybird.Cadavers$differences
```

|              | bean,-,5    | bean,-,10    | bean,-,20    | bean,+,5    | bean,+,10    | bean,+,20    |
|--------------|-------------|--------------|--------------|-------------|--------------|--------------|
| bean,-,5     | 0.00000000  | -0.4584030   | -0.8590241   | -0.5842863  | -1.0054898   | -2.0825042   |
| bean,-,10    | 0.45840297  | 0.0000000    | -0.4006211   | -0.1258833  | -0.5470869   | -1.6241012   |
| bean,-,20    | 0.85902408  | 0.4006211    | 0.0000000    | 0.2747378   | -0.1464657   | -1.2234801   |
| bean,+,5     | 0.58428627  | 0.1258833    | -0.2747378   | 0.0000000   | -0.4212036   | -1.4982179   |
| bean,+,10    | 1.00548982  | 0.5470869    | 0.1464657    | 0.4212036   | 0.0000000    | -1.0770144   |
| bean,+,20    | 2.08250420  | 1.6241012    | 1.2234801    | 1.4982179   | 1.0770144    | 0.0000000    |
| trefoil,-,5  | -0.86920012 | -1.3276031   | -1.7282242   | -1.4534864  | -1.8746899   | -2.9517043   |
| trefoil,-,10 | -0.41079715 | -0.8692001   | -1.2698212   | -0.9950834  | -1.4162870   | -2.4933014   |
| trefoil,-,20 | -0.01017604 | -0.4685790   | -0.8692001   | -0.5944623  | -1.0156659   | -2.0926802   |
| trefoil,+,5  | -0.28491385 | -0.7433168   | -1.1439379   | -0.8692001  | -1.2904037   | -2.3674180   |
| trefoil,+,10 | 0.13628970  | -0.3221133   | -0.7227344   | -0.4479966  | -0.8692001   | -1.9462145   |
| trefoil,+,20 | 1.21330408  | 0.7549011    | 0.3542800    | 0.6290178   | 0.2078143    | -0.8692001   |
|              | trefoil,-,5 | trefoil,-,10 | trefoil,-,20 | trefoil,+,5 | trefoil,+,10 | trefoil,+,20 |
| bean,-,5     | 0.8692001   | 0.4107972    | 0.01017604   | 0.2849139   | -0.1362897   | -1.2133041   |
| bean,-,10    | 1.3276031   | 0.8692001    | 0.46857901   | 0.7433168   | 0.3221133    | -0.7549011   |
| bean,-,20    | 1.7282242   | 1.2698212    | 0.86920012   | 1.1439379   | 0.7227344    | -0.3542800   |
| bean,+,5     | 1.4534864   | 0.9950834    | 0.59446231   | 0.8692001   | 0.4479966    | -0.6290178   |
| bean,+,10    | 1.8746899   | 1.4162870    | 1.01566586   | 1.2904037   | 0.8692001    | -0.2078143   |
| bean,+,20    | 2.9517043   | 2.4933014    | 2.09268024   | 2.3674180   | 1.9462145    | 0.8692001    |

|              |           |            |             |            |            |            |
|--------------|-----------|------------|-------------|------------|------------|------------|
| trefoil,-,5  | 0.0000000 | -0.4584030 | -0.85902408 | -0.5842863 | -1.0054898 | -2.0825042 |
| trefoil,-,10 | 0.4584030 | 0.0000000  | -0.40062111 | -0.1258833 | -0.5470869 | -1.6241012 |
| trefoil,-,20 | 0.8590241 | 0.4006211  | 0.00000000  | 0.2747378  | -0.1464657 | -1.2234801 |
| trefoil,+,5  | 0.5842863 | 0.1258833  | -0.27473781 | 0.0000000  | -0.4212036 | -1.4982179 |
| trefoil,+,10 | 1.0054898 | 0.5470869  | 0.14646574  | 0.4212036  | 0.0000000  | -1.0770144 |
| trefoil,+,20 | 2.0825042 | 1.6241012  | 1.22348012  | 1.4982179  | 1.0770144  | 0.0000000  |

```
options(width = 90)
print(diffs$Host.Ladybird.Cadavers$sed)
```

|              | bean,-,5     | bean,-,10    | bean,-,20   | bean,+,5     | bean,+,10    | bean,+,20 | trefoil,-,5 |
|--------------|--------------|--------------|-------------|--------------|--------------|-----------|-------------|
| bean,-,5     | NA           | 0.1957142    | 0.1957142   | 0.1957142    | 0.1957142    | 0.1957142 | 0.1129957   |
| bean,-,10    | 0.1957142    | NA           | 0.1957142   | 0.1957142    | 0.1957142    | 0.1957142 | 0.2259913   |
| bean,-,20    | 0.1957142    | 0.1957142    | NA          | 0.1957142    | 0.1957142    | 0.1957142 | 0.2259913   |
| bean,+,5     | 0.1957142    | 0.1957142    | 0.1957142   | NA           | 0.1957142    | 0.1957142 | 0.2259913   |
| bean,+,10    | 0.1957142    | 0.1957142    | 0.1957142   | 0.1957142    | NA           | 0.1957142 | 0.2259913   |
| bean,+,20    | 0.1957142    | 0.1957142    | 0.1957142   | 0.1957142    | 0.1957142    | NA        | 0.2259913   |
| trefoil,-,5  | 0.1129957    | 0.2259913    | 0.2259913   | 0.2259913    | 0.2259913    | 0.2259913 | NA          |
| trefoil,-,10 | 0.2259913    | 0.1129957    | 0.2259913   | 0.2259913    | 0.2259913    | 0.2259913 | 0.1957142   |
| trefoil,-,20 | 0.2259913    | 0.2259913    | 0.1129957   | 0.2259913    | 0.2259913    | 0.2259913 | 0.1957142   |
| trefoil,+,5  | 0.2259913    | 0.2259913    | 0.2259913   | 0.1129957    | 0.2259913    | 0.2259913 | 0.1957142   |
| trefoil,+,10 | 0.2259913    | 0.2259913    | 0.2259913   | 0.2259913    | 0.1129957    | 0.2259913 | 0.1957142   |
| trefoil,+,20 | 0.2259913    | 0.2259913    | 0.2259913   | 0.2259913    | 0.2259913    | 0.1129957 | 0.1957142   |
|              | trefoil,-,10 | trefoil,-,20 | trefoil,+,5 | trefoil,+,10 | trefoil,+,20 |           |             |
| bean,-,5     | 0.2259913    | 0.2259913    | 0.2259913   | 0.2259913    | 0.2259913    |           |             |
| bean,-,10    | 0.1129957    | 0.2259913    | 0.2259913   | 0.2259913    | 0.2259913    |           |             |
| bean,-,20    | 0.2259913    | 0.1129957    | 0.2259913   | 0.2259913    | 0.2259913    |           |             |
| bean,+,5     | 0.2259913    | 0.2259913    | 0.1129957   | 0.2259913    | 0.2259913    |           |             |
| bean,+,10    | 0.2259913    | 0.2259913    | 0.2259913   | 0.1129957    | 0.2259913    |           |             |
| bean,+,20    | 0.2259913    | 0.2259913    | 0.2259913   | 0.2259913    | 0.1129957    |           |             |
| trefoil,-,5  | 0.1957142    | 0.1957142    | 0.1957142   | 0.1957142    | 0.1957142    |           |             |
| trefoil,-,10 | NA           | 0.1957142    | 0.1957142   | 0.1957142    | 0.1957142    |           |             |
| trefoil,-,20 | 0.1957142    | NA           | 0.1957142   | 0.1957142    | 0.1957142    |           |             |
| trefoil,+,5  | 0.1957142    | 0.1957142    | NA          | 0.1957142    | 0.1957142    |           |             |
| trefoil,+,10 | 0.1957142    | 0.1957142    | 0.1957142   | NA           | 0.1957142    |           |             |
| trefoil,+,20 | 0.1957142    | 0.1957142    | 0.1957142   | 0.1957142    | NA           |           |             |

## Perform the analysis with just selected model fitted

The model with nonsignificant fixed terms dropped is obtained in order to compare it with the fit when they are retained and the estimated marginal means for the chosen model are obtained.

```
ns.terms <- current.asrt$test.summary$terms[current.asrt$test.summary$action == "Nonsignificant"]
red.asrt <- changeTerms(current.asrt, dropFixed = paste(ns.terms, collapse = "+"))
summary(red.asrt$asreml.obj)$varcomp
```

|             | component    | std.error   | z.ratio   | bound | %ch |
|-------------|--------------|-------------|-----------|-------|-----|
| Run         | -0.004327122 | 0.002802876 | -1.543815 | U     | 0.8 |
| Run:Plant!R | 0.223431497  | 0.039503516 | 5.655990  | P     | 0.0 |

```
print(red.asrt, which = "pseudoanova")
```

```
#### Pseudo-anova table for fixed terms
```

Wald tests for fixed effects.

Response: logitP

|                   | Df | denDF | F.inc   | Pr     |
|-------------------|----|-------|---------|--------|
| (Intercept)       | 1  | 1     | 1550.00 | 0.0162 |
| Host              | 1  | 64    | 60.88   | 0.0000 |
| Cadavers          | 2  | 64    | 38.12   | 0.0000 |
| Ladybird          | 1  | 64    | 49.65   | 0.0000 |
| Cadavers:Ladybird | 2  | 64    | 3.88    | 0.0256 |

```
diffs.red <- predictPlus(red.asrt$asreml.obj,
                          classify = "Host:Ladybird:Cadavers",
                          wald.tab = current.asrt$wald.tab,
                          error.intervals = "halfLeast",
                          LSDtype = "factor.combination", LSDby = "Host",
                          tables = "predictions")
```

Joining with 'by = join\_by(fac.comb)'

Joining with 'by = join\_by(Host)'

```
#### Predictions for logitP from Host:Ladybird:Cadavers
```

Notes:

- The predictions are obtained by averaging across the hypertable calculated from model terms constructed solely from factors in the averaging and classify sets.
- Use 'average' to move ignored factors into the averaging set.
- The ignored set: Run

|    | Host    | Ladybird | Cadavers | predicted.value | standard.error |
|----|---------|----------|----------|-----------------|----------------|
| 1  | bean    | -        | 5        | -1.6038338      | 0.1398332      |
| 2  | bean    | -        | 10       | -1.1454308      | 0.1398332      |
| 3  | bean    | -        | 20       | -0.7448097      | 0.1398332      |
| 4  | bean    | +        | 5        | -1.0195475      | 0.1398332      |
| 5  | bean    | +        | 10       | -0.5983440      | 0.1398332      |
| 6  | bean    | +        | 20       | 0.4786704       | 0.1398332      |
| 7  | trefoil | -        | 5        | -2.4730339      | 0.1398332      |
| 8  | trefoil | -        | 10       | -2.0146309      | 0.1398332      |
| 9  | trefoil | -        | 20       | -1.6140098      | 0.1398332      |
| 10 | trefoil | +        | 5        | -1.8887476      | 0.1398332      |
| 11 | trefoil | +        | 10       | -1.4675441      | 0.1398332      |
| 12 | trefoil | +        | 20       | -0.3905297      | 0.1398332      |

|    | upper.halfLeastSignificant.limit | lower.halfLeastSignificant.limit | est.status |
|----|----------------------------------|----------------------------------|------------|
| 1  | -1.4107942                       | -1.7968734                       | Estimable  |
| 2  | -0.9523913                       | -1.3384704                       | Estimable  |
| 3  | -0.5517702                       | -0.9378493                       | Estimable  |
| 4  | -0.8265080                       | -1.2125871                       | Estimable  |
| 5  | -0.4053044                       | -0.7913835                       | Estimable  |
| 6  | 0.6717100                        | 0.2856308                        | Estimable  |
| 7  | -2.2799944                       | -2.6660735                       | Estimable  |
| 8  | -1.8215914                       | -2.2076705                       | Estimable  |
| 9  | -1.4209703                       | -1.8070494                       | Estimable  |
| 10 | -1.6957081                       | -2.0817872                       | Estimable  |
| 11 | -1.2745045                       | -1.6605837                       | Estimable  |
| 12 | -0.1974902                       | -0.5835693                       | Estimable  |

LSD values

minimum LSD = 0.3860791 0.3860791

mean LSD = 0.3860791 0.3860791

maximum LSD = 0.3860791 0.3860791

(sed range / mean sed = 1.44e-16 1.44e-16 )

```
options(width = 90)
print(diffs.red$sed)
```

|              | bean,-,5     | bean,-,10    | bean,-,20   | bean,+,5     | bean,+,10    | bean,+,20 | trefoil,-,5 |
|--------------|--------------|--------------|-------------|--------------|--------------|-----------|-------------|
| bean,-,5     | NA           | 0.1929435    | 0.1929435   | 0.1929435    | 0.1929435    | 0.1929435 | 0.1113960   |
| bean,-,10    | 0.1929435    | NA           | 0.1929435   | 0.1929435    | 0.1929435    | 0.1929435 | 0.2227920   |
| bean,-,20    | 0.1929435    | 0.1929435    | NA          | 0.1929435    | 0.1929435    | 0.1929435 | 0.2227920   |
| bean,+,5     | 0.1929435    | 0.1929435    | 0.1929435   | NA           | 0.1929435    | 0.1929435 | 0.2227920   |
| bean,+,10    | 0.1929435    | 0.1929435    | 0.1929435   | 0.1929435    | NA           | 0.1929435 | 0.2227920   |
| bean,+,20    | 0.1929435    | 0.1929435    | 0.1929435   | 0.1929435    | 0.1929435    | NA        | 0.2227920   |
| trefoil,-,5  | 0.1113960    | 0.2227920    | 0.2227920   | 0.2227920    | 0.2227920    | 0.2227920 | NA          |
| trefoil,-,10 | 0.2227920    | 0.1113960    | 0.2227920   | 0.2227920    | 0.2227920    | 0.2227920 | 0.1929435   |
| trefoil,-,20 | 0.2227920    | 0.2227920    | 0.1113960   | 0.2227920    | 0.2227920    | 0.2227920 | 0.1929435   |
| trefoil,+,5  | 0.2227920    | 0.2227920    | 0.2227920   | 0.1113960    | 0.2227920    | 0.2227920 | 0.1929435   |
| trefoil,+,10 | 0.2227920    | 0.2227920    | 0.2227920   | 0.2227920    | 0.1113960    | 0.2227920 | 0.1929435   |
| trefoil,+,20 | 0.2227920    | 0.2227920    | 0.2227920   | 0.2227920    | 0.2227920    | 0.1113960 | 0.1929435   |
|              | trefoil,-,10 | trefoil,-,20 | trefoil,+,5 | trefoil,+,10 | trefoil,+,20 |           |             |
| bean,-,5     | 0.2227920    | 0.2227920    | 0.2227920   | 0.2227920    | 0.2227920    |           |             |
| bean,-,10    | 0.1113960    | 0.2227920    | 0.2227920   | 0.2227920    | 0.2227920    |           |             |
| bean,-,20    | 0.2227920    | 0.1113960    | 0.2227920   | 0.2227920    | 0.2227920    |           |             |
| bean,+,5     | 0.2227920    | 0.2227920    | 0.1113960   | 0.2227920    | 0.2227920    |           |             |
| bean,+,10    | 0.2227920    | 0.2227920    | 0.2227920   | 0.1113960    | 0.2227920    |           |             |
| bean,+,20    | 0.2227920    | 0.2227920    | 0.2227920   | 0.2227920    | 0.1113960    |           |             |
| trefoil,-,5  | 0.1929435    | 0.1929435    | 0.1929435   | 0.1929435    | 0.1929435    |           |             |
| trefoil,-,10 | NA           | 0.1929435    | 0.1929435   | 0.1929435    | 0.1929435    |           |             |
| trefoil,-,20 | 0.1929435    | NA           | 0.1929435   | 0.1929435    | 0.1929435    |           |             |
| trefoil,+,5  | 0.1929435    | 0.1929435    | NA          | 0.1929435    | 0.1929435    |           |             |
| trefoil,+,10 | 0.1929435    | 0.1929435    | 0.1929435   | NA           | 0.1929435    |           |             |
| trefoil,+,20 | 0.1929435    | 0.1929435    | 0.1929435   | 0.1929435    | NA           |           |             |

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