Parameter Table

November 10, 2011

Tim Bergsma

1 Purpose

This script picks up after model.Rnw to process bootstrap results and make a parameter table. It assumes the current working directory is the script directory containing this file.

1.1 Package

Listing 1:

```
> library(metrumrg)
```

```
metrumrg 5.4
enter "?metrumrg" for help
```

2 inputs

'wikitab' gives us a quick synthesis of 'rlog' and the 'lookup' of wiki notation in 1005.ctl. We do some science on the result first, and then some aesthetics for printing in a LaTeXtable. Table 1.

Listing 2:

```
> tab <- wikitab(1005,'../nonmem')
> tab$estimate <- signif(as.numeric(tab$estimate),3)
> tab$tool <- NULL
> tab$run <- NULL
> tab$se <- NULL
> tab
```

```
   parameter                                 description
1     THETA1                      apparent oral clearance
2     THETA2                central volume of distribution
```

```
3      THETA3                       absorption rate constant
4      THETA4                   intercompartmental clearance
5      THETA5              peripheral volume of distribution
6      THETA6                       male effect on clearance
7      THETA7                     weight effect on clearance
8    OMEGA1.1      interindividual variability of clearance
9    OMEGA2.1   interindividual clearance-volume covariance
10   OMEGA2.2 interindividual variability of central volume
11   OMEGA3.1        interindividual clearance-Ka covariance
12   OMEGA3.2           interindividual volume-Ka covariance
13   OMEGA3.3              interindividual variability of Ka
14   SIGMA1.1                             proportional error
15   SIGMA2.2                                 additive error
                                                              model estimate
1  CL/F (L/h) ~ theta_1 *  theta_6 ^MALE * (WT/70)^theta_7  * e^eta_1   9.5100
2                          V_c /F (L) ~ theta_2 * (WT/70)^1 * e^eta_2  22.8000
3                                     K_a (h^-1 ) ~ theta_3 * e^eta_3   0.0714
4                                                Q/F (L/h) ~ theta_4   3.4700
5                                               V_p /F (L) ~ theta_5 113.0000
6                                                MALE_CL/F ~ theta_6   1.0200
7                                                  WT_CL/F ~ theta_7   1.1900
8                                               IIV_CL/F ~ Omega_1.1   0.2140
9                                               cov_CL,V ~ Omega_2.1   0.1210
10                                            IIV_V_c /F ~ Omega_2.2   0.0945
11                                            cov_CL,Ka  ~ Omega_3.1  -0.0116
12                                             cov_V,Ka  ~ Omega_3.2  -0.0372
13                                              IIV_K_a  ~ Omega_3.3   0.0466
14                                              err_prop ~ Sigma_1.1   0.0492
15                                               err_add ~ Sigma_2.2   0.2020
   prse
1  9.84
2  9.56
3  7.35
4  15.4
```

```
5    21
6  11.2
7  28.4
8  22.8
9  26.4
10 33.2
11  173
12 36.1
13 34.7
14 10.9
15 33.5
```

Now we can extract some information from the model statements.

Listing 3:

```
> tab$units <- justUnits(tab$model)
> tab$model <- noUnits(tab$model)
> tab$name <- with(tab, wiki2label(model))
> tab[c('model','units','name')]
```

```
                                                          model units
1  CL/F  ~ theta_1 *  theta_6 ^MALE * (WT/70)^theta_7  * e^eta_1   L/h
2                       V_c /F  ~ theta_2 * (WT/70)^1 * e^eta_2     L
3                                      K_a  ~ theta_3 * e^eta_3 h^-1
4                                                Q/F  ~ theta_4   L/h
5                                             V_p /F  ~ theta_5     L
6                                           MALE_CL/F ~ theta_6
7                                             WT_CL/F ~ theta_7
8                                           IIV_CL/F ~ Omega_1.1
9                                           cov_CL,V ~ Omega_2.1
10                                        IIV_V_c /F ~ Omega_2.2
11                                        cov_CL,Ka  ~ Omega_3.1
12                                         cov_V,Ka  ~ Omega_3.2
13                                          IIV_K_a  ~ Omega_3.3
```

```
14                                         err_prop ~ Sigma_1.1
15                                          err_add ~ Sigma_2.2
          name
1         CL/F
2        V_c/F
3          K_a
4          Q/F
5        V_p/F
6   MALE_CL/F
7     WT_CL/F
8    IIV_CL/F
9    cov_CL,V
10 IIV_V_c/F
11 cov_CL,Ka
12  cov_V,Ka
13    IIV_K_a
14   err_prop
15    err_add
```

3 variance

The estimates for the matrix diagonals are variances, and their square roots have special meaning. In model 1005, interindividual variability was modelled exponentially, in which case square root of variance gives an approximate CV; alternatively, and exact CV can be calculated. For proportional error terms like ERR1, square root gives an exact CV. For additive error terms like ERR2, square root gives standard deviation.

We can use functions of ‘parameter’ to sort out the various error components, as they are used in this model.

3.1 exponential

Listing 4:

```
> expo <- is.iiv(tab$parameter) & is.diagonal(tab$parameter)
> tab$parameter[expo]
```

```
[1] "OMEGA1.1" "OMEGA2.2" "OMEGA3.3"
```

Listing 5:

```
> tab$cv[expo] <- cvLognormal(tab$estimate[expo])
> tab[,c('parameter','name','estimate','cv')]
```

```
   parameter       name  estimate        cv
1     THETA1       CL/F    9.5100        NA
2     THETA2     V_c/F   22.8000        NA
3     THETA3        K_a    0.0714        NA
4     THETA4        Q/F    3.4700        NA
5     THETA5      V_p/F  113.0000        NA
6     THETA6 MALE_CL/F    1.0200        NA
7     THETA7    WT_CL/F    1.1900        NA
8   OMEGA1.1   IIV_CL/F    0.2140 0.4884902
9   OMEGA2.1   cov_CL,V    0.1210        NA
10  OMEGA2.2 IIV_V_c/F    0.0945 0.3148161
11  OMEGA3.1 cov_CL,Ka   -0.0116        NA
12  OMEGA3.2   cov_V,Ka   -0.0372        NA
13  OMEGA3.3    IIV_K_a    0.0466 0.2184098
14  SIGMA1.1   err_prop    0.0492        NA
15  SIGMA2.2    err_add    0.2020        NA
```

3.2 proportional

Listing 6:

```
> writeLines(read.nmctl('../nonmem/ctl/1005.ctl')$err)
```

```
 Y=F*(1+ERR(1)) + ERR(2)
 IPRE=F
;<doc>
```

Listing 7:

```
> prop <- is.random(tab$parameter) & tab$name %contains% 'prop'
> tab$parameter[prop]
```

```
[1] "SIGMA1.1"
```

Listing 8:

```
> tab$cv[prop] <- sqrt(tab$estimate[prop])
> tab[,c('parameter','name','estimate','cv')]
```

```
   parameter       name  estimate        cv
1     THETA1       CL/F    9.5100        NA
2     THETA2      V_c/F   22.8000        NA
3     THETA3        K_a    0.0714        NA
4     THETA4        Q/F    3.4700        NA
5     THETA5      V_p/F  113.0000        NA
6     THETA6  MALE_CL/F    1.0200        NA
7     THETA7    WT_CL/F    1.1900        NA
8   OMEGA1.1   IIV_CL/F    0.2140 0.4884902
9   OMEGA2.1   cov_CL,V    0.1210        NA
10  OMEGA2.2  IIV_V_c/F    0.0945 0.3148161
11  OMEGA3.1  cov_CL,Ka   -0.0116        NA
12  OMEGA3.2   cov_V,Ka   -0.0372        NA
13  OMEGA3.3    IIV_K_a    0.0466 0.2184098
14  SIGMA1.1   err_prop    0.0492 0.2218107
15  SIGMA2.2    err_add    0.2020        NA
```

3.3 additive

Listing 9:

```
> add <- is.residual(tab$parameter) & tab$name %contains% 'add'
> tab$parameter[add]
```

```
[1] "SIGMA2.2"
```

Listing 10:

```
> tab$sd[add] <- sqrt(tab$estimate[add])
> tab[,c('parameter','name','estimate','cv','sd')]
```

```
   parameter      name estimate        cv        sd
1     THETA1      CL/F   9.5100        NA        NA
2     THETA2     V_c/F  22.8000        NA        NA
3     THETA3       K_a   0.0714        NA        NA
4     THETA4       Q/F   3.4700        NA        NA
5     THETA5     V_p/F 113.0000        NA        NA
6     THETA6 MALE_CL/F   1.0200        NA        NA
7     THETA7   WT_CL/F   1.1900        NA        NA
8   OMEGA1.1  IIV_CL/F   0.2140 0.4884902        NA
9   OMEGA2.1  cov_CL,V   0.1210        NA        NA
10  OMEGA2.2 IIV_V_c/F   0.0945 0.3148161        NA
11  OMEGA3.1 cov_CL,Ka  -0.0116        NA        NA
12  OMEGA3.2  cov_V,Ka  -0.0372        NA        NA
13  OMEGA3.3   IIV_K_a   0.0466 0.2184098        NA
14  SIGMA1.1  err_prop   0.0492 0.2218107        NA
15  SIGMA2.2   err_add   0.2020        NA 0.4494441
```

4 covariance

The estimates of matrix off-diagonals are covariances, and are more useful if transformed to correlations. We could extract the matrices manually, or use package shortcuts.

Listing 11:

```
> cor <- omegacor(run=1005,project='../nonmem')
> cor
```

```
           [,1]       [,2]       [,3]
[1,]  1.0000000  0.8492811 -0.1163229
[2,]  0.8492811  1.0000000 -0.5607054
[3,] -0.1163229 -0.5607054  1.0000000
```

Listing 12:

```
> half(cor)
```

```
      1.1        2.1        2.2        3.1        3.2        3.3
1.0000000  0.8492811  1.0000000 -0.1163229 -0.5607054  1.0000000
```

Listing 13:

```
> offdiag(half(cor))
```

```
      2.1        3.1        3.2
0.8492811 -0.1163229 -0.5607054
```

Listing 14:

```
> off <- is.iiv(tab$parameter) & is.offdiagonal(tab$parameter)
> tab$parameter[off]
```

```
[1] "OMEGA2.1" "OMEGA3.1" "OMEGA3.2"
```

Listing 15:

```
> tab$cor[off] <- offdiag(half(cor))
> tab[,c('parameter','name','estimate','cv','sd','cor')]
```

```
   parameter       name estimate        cv        sd        cor
1     THETA1       CL/F   9.5100        NA        NA         NA
2     THETA2      V_c/F  22.8000        NA        NA         NA
3     THETA3        K_a   0.0714        NA        NA         NA
4     THETA4        Q/F   3.4700        NA        NA         NA
5     THETA5      V_p/F 113.0000        NA        NA         NA
6     THETA6 MALE_CL/F    1.0200        NA        NA         NA
7     THETA7    WT_CL/F   1.1900        NA        NA         NA
8   OMEGA1.1   IIV_CL/F   0.2140 0.4884902        NA         NA
9   OMEGA2.1   cov_CL,V   0.1210        NA        NA  0.8492811
10  OMEGA2.2 IIV_V_c/F    0.0945 0.3148161        NA         NA
11  OMEGA3.1 cov_CL,Ka   -0.0116        NA        NA -0.1163229
12  OMEGA3.2  cov_V,Ka   -0.0372        NA        NA -0.5607054
13  OMEGA3.3   IIV_K_a    0.0466 0.2184098        NA         NA
14  SIGMA1.1  err_prop    0.0492 0.2218107        NA         NA
15  SIGMA2.2   err_add    0.2020        NA 0.4494441         NA
```

5 confidence interval

We wish to include 95 percentiles in our table as confidence intervals.

Listing 16:

```
> boot <- read.csv('../nonmem/1005.boot/log.csv',as.is=TRUE)
> head(boot)
```

```
  X tool run parameter   moment           value
1 1  nm7   1       ofv  minimum 2183.5752739686
2 2  nm7   1    THETA1 estimate         8.00123
3 3  nm7   1    THETA1     prse            <NA>
4 4  nm7   1    THETA1       se            <NA>
5 5  nm7   1    THETA2 estimate         20.6599
```

```
6 6   nm7    1     THETA2      prse             <NA>
```

Listing 17:

```
> boot <- boot[boot$moment=='estimate',]
> boot <- data.frame(cast(boot,... ~ moment))
> head(boot)
```

```
   X tool run parameter  estimate
1  2  nm7   1    THETA1   8.00123
2  5  nm7   1    THETA2   20.6599
3  8  nm7   1    THETA3 0.0624993
4 11  nm7   1    THETA4   3.10323
5 14  nm7   1    THETA5   166.952
6 17  nm7   1    THETA6  0.941659
```

Listing 18:

```
> boot <- boot[,c('run','parameter','estimate')]
> sapply(boot,class)
```

```
        run   parameter    estimate
  "integer" "character"    "factor"
```

Listing 19:

```
> boot$estimate <- as.numeric(as.character(boot$estimate))
> unique(boot$parameter)
```

```
 [1] "THETA1"    "THETA2"    "THETA3"    "THETA4"    "THETA5"    "THETA6"
 [7] "THETA7"    "OMEGA1.1" "OMEGA2.1" "OMEGA2.2" "OMEGA3.1" "OMEGA3.2"
[13] "OMEGA3.3" "SIGMA1.1" "SIGMA2.1" "SIGMA2.2"
```

Listing 20:

```
> quan <- function(x,probs)as.character(signif(quantile(x,probs=probs,na.rm=TRUE),3))
> boot$lo <- with(boot, reapply(estimate,parameter,quan,probs=.05))
> boot$hi <- with(boot, reapply(estimate,parameter,quan,probs=.95))
> head(boot)

  run parameter    estimate     lo    hi
1   1    THETA1   8.0012300   7.24  10.9
2   1    THETA2  20.6599000   19.2    27
3   1    THETA3   0.0624993 0.0618 0.082
4   1    THETA4   3.1032300   2.76   4.9
5   1    THETA5 166.9520000   84.9   749
6   1    THETA6   0.9416590  0.864  1.25
```

Listing 21:

```
> boot <- unique(boot[,c('parameter','lo','hi')])
> boot

   parameter      lo      hi
1     THETA1    7.24    10.9
2     THETA2    19.2      27
3     THETA3  0.0618   0.082
4     THETA4    2.76     4.9
5     THETA5    84.9     749
6     THETA6   0.864    1.25
7     THETA7   0.613    1.82
8   OMEGA1.1   0.137    0.36
9   OMEGA2.1    0.07     0.2
10  OMEGA2.2  0.0506   0.159
11  OMEGA3.1 -0.0505  0.0253
12  OMEGA3.2 -0.0535 -0.0122
13  OMEGA3.3  0.0257  0.0735
14  SIGMA1.1   0.039  0.0585
```

```
15  SIGMA2.1      0      0
16  SIGMA2.2 0.0711  0.331
```

Listing 22:

```
> boot$ci <- with(boot, parens(glue(lo,',',hi)))
> boot
```

```
   parameter      lo      hi                ci
1     THETA1    7.24    10.9       (7.24,10.9)
2     THETA2    19.2      27         (19.2,27)
3     THETA3  0.0618   0.082    (0.0618,0.082)
4     THETA4    2.76     4.9        (2.76,4.9)
5     THETA5    84.9     749        (84.9,749)
6     THETA6   0.864    1.25      (0.864,1.25)
7     THETA7   0.613    1.82      (0.613,1.82)
8   OMEGA1.1   0.137    0.36      (0.137,0.36)
9   OMEGA2.1    0.07     0.2        (0.07,0.2)
10  OMEGA2.2  0.0506   0.159    (0.0506,0.159)
11  OMEGA3.1 -0.0505  0.0253  (-0.0505,0.0253)
12  OMEGA3.2 -0.0535 -0.0122 (-0.0535,-0.0122)
13  OMEGA3.3  0.0257  0.0735   (0.0257,0.0735)
14  SIGMA1.1   0.039  0.0585    (0.039,0.0585)
15  SIGMA2.1       0       0             (0,0)
16  SIGMA2.2  0.0711   0.331    (0.0711,0.331)
```

Listing 23:

```
> tab <- stableMerge(tab,boot[,c('parameter','ci')])
> tab
```

```
   parameter                          description
1     THETA1               apparent oral clearance
2     THETA2         central volume of distribution
3     THETA3              absorption rate constant
```

```
4     THETA4                 intercompartmental clearance
5     THETA5             peripheral volume of distribution
6     THETA6                      male effect on clearance
7     THETA7                    weight effect on clearance
8   OMEGA1.1      interindividual variability of clearance
9   OMEGA2.1   interindividual clearance-volume covariance
10  OMEGA2.2 interindividual variability of central volume
11  OMEGA3.1       interindividual clearance-Ka covariance
12  OMEGA3.2          interindividual volume-Ka covariance
13  OMEGA3.3             interindividual variability of Ka
14  SIGMA1.1                            proportional error
15  SIGMA2.2                                additive error
                                                      model estimate prse
1  CL/F  ~ theta_1 *  theta_6 ^MALE * (WT/70)^theta_7  * e^eta_1   9.5100 9.84
2                      V_c /F  ~ theta_2 * (WT/70)^1 * e^eta_2  22.8000 9.56
3                                   K_a  ~ theta_3 * e^eta_3   0.0714 7.35
4                                            Q/F  ~ theta_4   3.4700 15.4
5                                         V_p /F  ~ theta_5 113.0000   21
6                                       MALE_CL/F ~ theta_6   1.0200 11.2
7                                         WT_CL/F ~ theta_7   1.1900 28.4
8                                      IIV_CL/F ~ Omega_1.1   0.2140 22.8
9                                      cov_CL,V ~ Omega_2.1   0.1210 26.4
10                                   IIV_V_c /F ~ Omega_2.2   0.0945 33.2
11                                   cov_CL,Ka  ~ Omega_3.1  -0.0116  173
12                                    cov_V,Ka  ~ Omega_3.2  -0.0372 36.1
13                                     IIV_K_a  ~ Omega_3.3   0.0466 34.7
14                                     err_prop ~ Sigma_1.1   0.0492 10.9
15                                      err_add ~ Sigma_2.2   0.2020 33.5
   units      name       cv       sd        cor               ci
1    L/h      CL/F       NA       NA         NA      (7.24,10.9)
2      L     V_c/F       NA       NA         NA        (19.2,27)
3  h^-1        K_a       NA       NA         NA  (0.0618,0.082)
4    L/h       Q/F       NA       NA         NA       (2.76,4.9)
5      L     V_p/F       NA       NA         NA       (84.9,749)
```

```
6        MALE_CL/F        NA        NA          NA       (0.864,1.25)
7          WT_CL/F        NA        NA          NA       (0.613,1.82)
8         IIV_CL/F 0.4884902        NA          NA       (0.137,0.36)
9          cov_CL,V        NA        NA   0.8492811       (0.07,0.2)
10       IIV_V_c/F 0.3148161        NA          NA     (0.0506,0.159)
11        cov_CL,Ka        NA        NA -0.1163229   (-0.0505,0.0253)
12         cov_V,Ka        NA        NA -0.5607054  (-0.0535,-0.0122)
13          IIV_K_a 0.2184098        NA          NA    (0.0257,0.0735)
14         err_prop 0.2218107        NA          NA     (0.039,0.0585)
15          err_add        NA 0.4494441          NA     (0.0711,0.331)
```

6 aesthetics

Here we format the table for printing.

Listing 24:

```
> tab$name <- NULL
> tab$parameter <- NULL
> tab$model <- wiki2latex(tab$model)
> tab$estimate <- as.character(tab$estimate)
> tab$estimate <- paste(tab$estimate,'$', tab$units,'$')
> tab$units <- NULL
```

Note that no parameter defines more than one of CV, SD,and COR. We could collapse these into a single column, and add a descriptive flag.

Listing 25:

```
> m <- as.matrix(tab[,c('cv','sd','cor')])
> tab$variability <- suppressWarnings(apply(m,1,max,na.rm=TRUE))
> tab$variability[is.infinite(tab$variability)] <- NA
> i <- !is.na(m)
> i[!i] <- NA
```

```
> tab$statistic <- apply(i,1,function(x){
+   p <- colnames(i)[x]
+   ifelse(all(is.na(p)),NA,p[!is.na(p)])
+ })
> toPercent <- with(tab, !is.na(statistic) & statistic=='cv')
> tab$variability[toPercent] <- percent(tab$variability[toPercent])
> tab$variability <- as.character(signif(tab$variability,3))
> tab$statistic <- map(tab$statistic,from=c(NA,'cv','cor','sd'),to=c(NA,'\\%CV','CORR','SD'))
> tab$variability <- paste(tab$statistic,tab$variability,sep=' = ')
> tab$variability[is.na(tab$statistic)] <- NA
> tab$statistic <- NULL
> tab$cv <- NULL
> tab$sd <- NULL
> tab$cor <- NULL
```

7 simple parameter table

We can make a quick parameter table that does not use wikitab markup. Table 2.

Listing 26:

```
> tab <- rlog(1005,'../nonmem',tool='nm7')
> head(tab)
```

```
  tool  run parameter   moment            value
1  nm7 1005       ofv  minimum 2405.91625845151
2  nm7 1005    THETA1 estimate          9.50754
3  nm7 1005    THETA1     prse             9.84
4  nm7 1005    THETA1       se         0.935942
5  nm7 1005    THETA2 estimate          22.7907
6  nm7 1005    THETA2     prse             9.56
```

Table 1: Parameter Estimates from Population Pharmacokinetic Model Run 1005

description	model	estimate	prse	ci	variability
apparent oral clearance	$\mathrm{CL/F} \sim \theta_1 \cdot \theta_6^{\mathrm{MALE}} \cdot (\mathrm{WT}/70)^{\theta_7} \cdot \mathrm{e}^{\eta_1}$	9.51 L/h	9.84	(7.24,10.9)	
central volume of distribution	$\mathrm{V_c/F} \sim \theta_2 \cdot (\mathrm{WT}/70)^1 \cdot \mathrm{e}^{\eta_2}$	22.8 L	9.56	(19.2,27)	
absorption rate constant	$\mathrm{K_a} \sim \theta_3 \cdot \mathrm{e}^{\eta_3}$	0.0714 h^-1	7.35	(0.0618,0.082)	
intercompartmental clearance	$\mathrm{Q/F} \sim \theta_4$	3.47 L/h	15.4	(2.76,4.9)	
peripheral volume of distribution	$\mathrm{V_p/F} \sim \theta_5$	113 L	21	(84.9,749)	
male effect on clearance	$\mathrm{MALE_{CL/F}} \sim \theta_6$	1.02	11.2	(0.864,1.25)	
weight effect on clearance	$\mathrm{WT_{CL/F}} \sim \theta_7$	1.19	28.4	(0.613,1.82)	
interindividual variability of clearance	$\mathrm{IIV_{CL/F}} \sim \Omega_{1.1}$	0.214	22.8	(0.137,0.36)	%CV = 48.8
interindividual clearance-volume covariance	$\mathrm{cov_{CL,V}} \sim \Omega_{2.1}$	0.121	26.4	(0.07,0.2)	CORR = 0.849
interindividual variability of central volume	$\mathrm{IIV_{V_c/F}} \sim \Omega_{2.2}$	0.0945	33.2	(0.0506,0.159)	%CV = 31.5
interindividual clearance-Ka covariance	$\mathrm{cov_{CL,Ka}} \sim \Omega_{3.1}$	-0.0116	173	(-0.0505,0.0253)	CORR = -0.116
interindividual volume-Ka covariance	$\mathrm{cov_{V,Ka}} \sim \Omega_{3.2}$	-0.0372	36.1	(-0.0535,-0.0122)	CORR = -0.561
interindividual variability of Ka	$\mathrm{IIV_{K_a}} \sim \Omega_{3.3}$	0.0466	34.7	(0.0257,0.0735)	%CV = 21.8
proportional error	$\mathrm{err_{prop}} \sim \Sigma_{1.1}$	0.0492	10.9	(0.039,0.0585)	%CV = 22.2
additive error	$\mathrm{err_{add}} \sim \Sigma_{2.2}$	0.202	33.5	(0.0711,0.331)	SD = 0.449

Listing 27:

```
> tab$tool <- NULL
> tab$run <- NULL
> tab <- tab[tab$moment %in% c('estimate','prse'),]
> unique(tab$parameter)
```

```
 [1] "THETA1"   "THETA2"   "THETA3"   "THETA4"   "THETA5"   "THETA6"
 [7] "THETA7"   "OMEGA1.1" "OMEGA2.1" "OMEGA2.2" "OMEGA3.1" "OMEGA3.2"
[13] "OMEGA3.3" "SIGMA1.1" "SIGMA2.1" "SIGMA2.2"
```

Listing 28:

```
> tab$value <- signif(as.numeric(tab$value),3)
> tab$parameter <- factor(tab$parameter,levels=unique(tab$parameter))#to preserve row order during cast
> tab <- cast(tab,parameter ~ moment)
> tab
```

```
   parameter estimate   prse
1     THETA1   9.5100   9.84
2     THETA2  22.8000   9.56
3     THETA3   0.0714   7.35
4     THETA4   3.4700  15.40
5     THETA5 113.0000  21.00
6     THETA6   1.0200  11.20
7     THETA7   1.1900  28.40
8   OMEGA1.1   0.2140  22.80
9   OMEGA2.1   0.1210  26.40
10  OMEGA2.2   0.0945  33.20
11  OMEGA3.1  -0.0116 173.00
12  OMEGA3.2  -0.0372  36.10
13  OMEGA3.3   0.0466  34.70
14  SIGMA1.1   0.0492  10.90
15  SIGMA2.1   0.0000    Inf
16  SIGMA2.2   0.2020  33.50
```

Listing 29:

```
> tab$parameter <- parameter2wiki(tab$parameter)
> tab
```

```
    parameter estimate   prse
1     theta_1   9.5100   9.84
2     theta_2  22.8000   9.56
3     theta_3   0.0714   7.35
4     theta_4   3.4700  15.40
5     theta_5 113.0000  21.00
6     theta_6   1.0200  11.20
7     theta_7   1.1900  28.40
8   Omega_1.1   0.2140  22.80
9   Omega_2.1   0.1210  26.40
10  Omega_2.2   0.0945  33.20
11  Omega_3.1  -0.0116 173.00
12  Omega_3.2  -0.0372  36.10
13  Omega_3.3   0.0466  34.70
14  Sigma_1.1   0.0492  10.90
15  Sigma_2.1   0.0000    Inf
16  Sigma_2.2   0.2020  33.50
```

Listing 30:

```
> tab$parameter <- wiki2latex(tab$parameter)
> tab
```

```
                    parameter estimate   prse
1    $\\mathrm{\\theta_{1}}$   9.5100   9.84
2    $\\mathrm{\\theta_{2}}$  22.8000   9.56
3    $\\mathrm{\\theta_{3}}$   0.0714   7.35
4    $\\mathrm{\\theta_{4}}$   3.4700  15.40
5    $\\mathrm{\\theta_{5}}$ 113.0000  21.00
6    $\\mathrm{\\theta_{6}}$   1.0200  11.20
```

```
7     $\\mathrm{\\theta_{7}}$   1.1900  28.40
8   $\\mathrm{\\Omega_{1.1}}$   0.2140  22.80
9   $\\mathrm{\\Omega_{2.1}}$   0.1210  26.40
10  $\\mathrm{\\Omega_{2.2}}$   0.0945  33.20
11  $\\mathrm{\\Omega_{3.1}}$  -0.0116 173.00
12  $\\mathrm{\\Omega_{3.2}}$  -0.0372  36.10
13  $\\mathrm{\\Omega_{3.3}}$   0.0466  34.70
14  $\\mathrm{\\Sigma_{1.1}}$   0.0492  10.90
15  $\\mathrm{\\Sigma_{2.1}}$   0.0000    Inf
16  $\\mathrm{\\Sigma_{2.2}}$   0.2020  33.50
```

Table 2: Simple Parameter Table

parameter	estimate	prse
θ_1	9.5100	9.84
θ_2	22.8000	9.56
θ_3	0.0714	7.35
θ_4	3.4700	15.40
θ_5	113.0000	21.00
θ_6	1.0200	11.20
θ_7	1.1900	28.40
$\Omega_{1.1}$	0.2140	22.80
$\Omega_{2.1}$	0.1210	26.40
$\Omega_{2.2}$	0.0945	33.20
$\Omega_{3.1}$	−0.0116	173.00
$\Omega_{3.2}$	−0.0372	36.10
$\Omega_{3.3}$	0.0466	34.70
$\Sigma_{1.1}$	0.0492	10.90
$\Sigma_{2.1}$	0.0000	Inf
$\Sigma_{2.2}$	0.2020	33.50