

Parameter Table

October 23, 2013

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)
```

2 inputs

'wikitab' gives us a quick synthesis of 'rlog' and the 'lookup' of wiki notation in 1005.ctf. We do some science on the result first, and then some aesthetics for printing in a \LaTeX table. 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  9.72
2  9.56
3  7.34
4  15.4
5  20.9
6   11
7  28.3
8  22.8
9  26.4
10 33.2
11 173
12 36.1
13 34.8
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	0.8494277	-0.1162464
[2,]	0.8494277	1.0000000	-0.5605290
[3,]	-0.1162464	-0.5605290	1.0000000

Listing 12:

```
> half(cor)
```

```

      1.1      2.1      2.2      3.1      3.2      3.3
1.0000000  0.8494277  1.0000000 -0.1162464 -0.5605290  1.0000000

```

Listing 13:

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

```

      2.1      3.1      3.2
0.8494277 -0.1162464 -0.5605290

```

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	0.8494277
10	OMEGA2.2	IIV_V_c/F	0.0945	0.3148161	NA	NA
11	OMEGA3.1	cov_CL,Ka	-0.0116	NA	NA	-0.1162464
12	OMEGA3.2	cov_V,Ka	-0.0372	NA	NA	-0.5605290
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/1005bootlog.csv',as.is=TRUE)
> head(boot)
```

```

X tool run parameter      moment      value
1 1  nm7    1      ofv  minimum 2459.17577376723
2 2  nm7    1      THETA1 estimate      9.90624
3 3  nm7    1      THETA1      prse      <NA>
4 4  nm7    1      THETA1      se      <NA>
5 5  nm7    1      THETA2 estimate     21.8851
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  9.90624
2 5  nm7    1      THETA2  21.8851
3 8  nm7    1      THETA3  0.0708172
4 11 nm7    1      THETA4  3.36908
5 14 nm7    1      THETA5  94.6441
6 17 nm7    1      THETA6  0.972459

```

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  9.9062400  7.31  11.1
2 1      THETA2 21.8851000  19.2  27.9
3 1      THETA3  0.0708172  0.0625 0.0838
4 1      THETA4  3.3690800  2.78  4.91
5 1      THETA5 94.6441000  85.6  559
6 1      THETA6  0.9724590  0.847  1.24

```


Listing 21:

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

	parameter	lo	hi
1	THETA1	7.31	11.1
2	THETA2	19.2	27.9
3	THETA3	0.0625	0.0838
4	THETA4	2.78	4.91
5	THETA5	85.6	559
6	THETA6	0.847	1.24
7	THETA7	0.61	1.91
8	OMEGA1.1	0.128	0.321
9	OMEGA2.1	0.0606	0.183
10	OMEGA2.2	0.0471	0.158
11	OMEGA3.1	-0.0448	0.0261
12	OMEGA3.2	-0.0577	-0.00491
13	OMEGA3.3	0.0236	0.0811
14	SIGMA1.1	0.0399	0.0587
15	SIGMA2.1	0	0
16	SIGMA2.2	0.0836	0.329

Listing 22:

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

	parameter	lo	hi	ci
1	THETA1	7.31	11.1	(7.31,11.1)
2	THETA2	19.2	27.9	(19.2,27.9)
3	THETA3	0.0625	0.0838	(0.0625,0.0838)
4	THETA4	2.78	4.91	(2.78,4.91)
5	THETA5	85.6	559	(85.6,559)
6	THETA6	0.847	1.24	(0.847,1.24)
7	THETA7	0.61	1.91	(0.61,1.91)
8	OMEGA1.1	0.128	0.321	(0.128,0.321)
9	OMEGA2.1	0.0606	0.183	(0.0606,0.183)
10	OMEGA2.2	0.0471	0.158	(0.0471,0.158)
11	OMEGA3.1	-0.0448	0.0261	(-0.0448,0.0261)
12	OMEGA3.2	-0.0577	-0.00491	(-0.0577,-0.00491)
13	OMEGA3.3	0.0236	0.0811	(0.0236,0.0811)
14	SIGMA1.1	0.0399	0.0587	(0.0399,0.0587)
15	SIGMA2.1	0	0	(0,0)
16	SIGMA2.2	0.0836	0.329	(0.0836,0.329)

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	9.72
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	7.34
4		Q/F ~ theta_4		3.4700	15.4
5		V_p /F ~ theta_5		113.0000	20.9
6		MALE_CL/F ~ theta_6		1.0200	11
7		WT_CL/F ~ theta_7		1.1900	28.3
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	34.8
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	(7.31,11.1)
2	L	V_c/F	NA	NA	(19.2,27.9)
3	h^-1	K_a	NA	NA	(0.0625,0.0838)
4	L/h	Q/F	NA	NA	(2.78,4.91)
5	L	V_p/F	NA	NA	(85.6,559)
6		MALE_CL/F	NA	NA	(0.847,1.24)
7		WT_CL/F	NA	NA	(0.61,1.91)
8		IIV_CL/F	0.4884902	NA	(0.128,0.321)
9		cov_CL,V	NA	0.8494277	(0.0606,0.183)
10		IIV_V_c/F	0.3148161	NA	(0.0471,0.158)
11		cov_CL,Ka	NA	-0.1162464	(-0.0448,0.0261)
12		cov_V,Ka	NA	-0.5605290	(-0.0577,-0.00491)
13		IIV_K_a	0.2184098	NA	(0.0236,0.0811)
14		err_prop	0.2218107	NA	(0.0399,0.0587)
15		err_add	NA 0.4494441	NA	(0.0836,0.329)

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$variability)] <- NA
> i <- is.defined(m)
> i[!i] <- NA
> tab$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', file=NULL)
> head(tab)
```

Table 1: Parameter Estimates from Population Pharmacokinetic Model Run 1005

description	model	estimate	prse	ci
apparent oral clearance	$CL/F \sim \theta_1 \cdot \theta_6^{MALE} \cdot (WT/70)^{\theta_7} \cdot e^{\eta_1}$	9.51 L/h	9.72	(7.31,11.1)
central volume of distribution	$V_c/F \sim \theta_2 \cdot (WT/70)^{\theta_1} \cdot e^{\eta_2}$	22.8 L	9.56	(19.2,27.9)
absorption rate constant	$K_a \sim \theta_3 \cdot e^{\eta_3}$	0.0714 h ⁻¹	7.34	(0.0625,0.0838)
intercompartmental clearance	$Q/F \sim \theta_4$	3.47 L/h	15.4	(2.78,4.91)
peripheral volume of distribution	$V_p/F \sim \theta_5$	113 L	20.9	(85.6,559)
male effect on clearance	$MALE_{CL/F} \sim \theta_6$	1.02	11	(0.847,1.24)
weight effect on clearance	$WT_{CL/F} \sim \theta_7$	1.19	28.3	(0.61,1.91)
interindividual variability of clearance	$IIV_{CL/F} \sim \Omega_{1.1}$	0.214	22.8	(0.128,0.321)
interindividual clearance-volume covariance	$cov_{CL,V} \sim \Omega_{2.1}$	0.121	26.4	(0.0606,0.183)
interindividual variability of central volume	$IIV_{V_c/F} \sim \Omega_{2.2}$	0.0945	33.2	(0.0471,0.158)
interindividual clearance-Ka covariance	$cov_{CL,Ka} \sim \Omega_{3.1}$	-0.0116	173	(-0.0448,0.026)
interindividual volume-Ka covariance	$cov_{V,Ka} \sim \Omega_{3.2}$	-0.0372	36.1	(-0.0577,-0.004)
interindividual variability of Ka	$IIV_{K_a} \sim \Omega_{3.3}$	0.0466	34.8	(0.0236,0.0811)
proportional error	$err_{prop} \sim \Sigma_{1.1}$	0.0492	10.9	(0.0399,0.0587)
additive error	$err_{add} \sim \Sigma_{2.2}$	0.202	33.5	(0.0836,0.329)

```

tool  run parameter  moment      value
1  nm7 1005      ofv  minimum 2405.91626347113
2  nm7 1005      THETA1 estimate    9.5079
3  nm7 1005      THETA1 prse         9.72
4  nm7 1005      THETA1 se          0.923845
5  nm7 1005      THETA2 estimate    22.7899
6  nm7 1005      THETA2 prse         9.56

```

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    9.72
2      THETA2     22.8000    9.56
3      THETA3      0.0714    7.34
4      THETA4      3.4700   15.40
5      THETA5    113.0000   20.90
6      THETA6      1.0200   11.00
7      THETA7      1.1900   28.30
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   34.80
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    9.72
2      theta_2     22.8000    9.56
3      theta_3      0.0714    7.34
4      theta_4      3.4700   15.40
5      theta_5    113.0000   20.90
6      theta_6      1.0200   11.00
7      theta_7      1.1900   28.30
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   34.80
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     $\theta_1$       9.5100    9.72
2     $\theta_2$      22.8000    9.56
3     $\theta_3$       0.0714    7.34
4     $\theta_4$       3.4700   15.40

```

```

5    $\mathrm{\theta_5}$ 113.0000 20.90
6    $\mathrm{\theta_6}$ 1.0200 11.00
7    $\mathrm{\theta_7}$ 1.1900 28.30
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 34.80
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	9.72
θ_2	22.8000	9.56
θ_3	0.0714	7.34
θ_4	3.4700	15.40
θ_5	113.0000	20.90
θ_6	1.0200	11.00
θ_7	1.1900	28.30
$\Omega_{1.1}$	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	34.80
$\Sigma_{1.1}$	0.0492	10.90
$\Sigma_{2.1}$	0.0000	Inf
$\Sigma_{2.2}$	0.2020	33.50