

## Simulating with Parameter Uncertainty

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## 1 Purpose

This script shows how to conduct a simulation that considers uncertainty in the parameter estimates. See also [http://www.page-meeting.org/page/page2006/P2006III\\_11.pdf](http://www.page-meeting.org/page/page2006/P2006III_11.pdf).

## 2 Data

Here we load metrumrg and read in the data to be used for simulations.

Listing 1:

```
> library(metrumrg)
> data <- read.csv("../data/derived/phase1.csv")
> head(data)
```

	C	ID	TIME	SEQ	EVID	AMT	DV	SUBJ	HOUR	HEIGHT	WEIGHT	SEX	AGE	DOSE	FED	SMK
1	C	1	0.00	0	0	.	0	1	0.00	174	74.2	0	29.1	1000	1	0
2	.	1	0.00	1	1	1000	.	1	0.00	174	74.2	0	29.1	1000	1	0
3	.	1	0.25	0	0	.	0.363	1	0.25	174	74.2	0	29.1	1000	1	0
4	.	1	0.50	0	0	.	0.914	1	0.50	174	74.2	0	29.1	1000	1	0
5	.	1	1.00	0	0	.	1.12	1	1.00	174	74.2	0	29.1	1000	1	0
6	.	1	2.00	0	0	.	2.28	1	2.00	174	74.2	0	29.1	1000	1	0

  

	DS	CRCN	TAFD	TAD	LDOS	MDV	predose	zerodv
1	0	83.5	0.00	.	.	0	1	0
2	0	83.5	0.00	0	1000	1	0	0
3	0	83.5	0.25	0.25	1000	0	0	0
4	0	83.5	0.50	0.5	1000	0	0	0
5	0	83.5	1.00	1	1000	0	0	0
6	0	83.5	2.00	2	1000	0	0	0

We use NONMEM output from a simple two compartment model to generate parameters. We use 1005.lst and 1005.cov output from NM7 to populate a call to metrumrg::simpar().

Listing 2:

```
> cov <- read.table("../nonmem/1005/1005.cov", skip=1, header=T)
> head(cov)
```

	NAME	THETA1	THETA2	THETA3	THETA4	THETA5
1	THETA1	0.85349000	0.78471700	1.02964e-03	0.06201550	-1.2885700
2	THETA2	0.78471700	4.74387000	6.65868e-03	0.89539600	5.5877600
3	THETA3	0.00102964	0.00665868	2.75169e-05	0.00221641	-0.0298637
4	THETA4	0.06201550	0.89539600	2.21641e-03	0.28656000	0.2410890
5	THETA5	-1.28857000	5.58776000	-2.98637e-02	0.24108900	559.0090000
6	THETA6	-0.03952260	-0.02453050	-1.02177e-04	-0.01047580	0.7350690

  

	THETA6	THETA7	SIGMA.1.1.	SIGMA.2.1.	SIGMA.2.2.	OMEGA.1.1.
1	-0.039522600	-0.176224000	-4.89162e-04	0	2.04096e-02	6.28811e-03
2	-0.024530500	0.068529700	-3.11007e-03	0	1.89401e-02	5.84996e-03
3	-0.000102177	-0.000132916	-1.02493e-05	0	5.86438e-05	3.24081e-06

```

4 -0.010475800  0.015606300 -6.27671e-04      0  2.50369e-03  4.31368e-03
5  0.735069000 -0.684622000  4.52242e-02      0 -4.20659e-01  2.73881e-01
6  0.012748500  0.000415439  1.17741e-04      0 -1.03450e-03  1.63668e-03
      OMEGA.2.1.  OMEGA.2.2.  OMEGA.3.1.  OMEGA.3.2.  OMEGA.3.3.
1 -1.59957e-04 -4.31064e-03 -5.37918e-03 -2.56445e-03 -3.38999e-03
2 -2.19085e-02 -2.43988e-02 -1.95676e-02 -1.11920e-02  4.75058e-03
3 -6.49265e-05 -7.78059e-05 -6.74428e-05 -2.74920e-05  2.82116e-05
4 -6.19519e-03 -7.76509e-03 -4.54515e-03 -2.24113e-03  3.06880e-03
5  1.59962e-01  2.51679e-02 -7.08665e-03  7.40212e-02 -3.34805e-02
6  2.98890e-04  5.89470e-04 -5.36299e-04 -5.60638e-05 -3.30708e-04

```

We are interested in theta covariance, so we remove extra columns and rows.

Listing 3:

```
> cov<- cov[1:7,c(2:8)]
```

### 3 Parameters

Now we generate 10 sets of population parameters based on the 1005.lst results.

Listing 4:

```

> set.seed(10)
> PKparms <- simpar(
+   nsim=10,
+   theta=c(8.58,21.6, 0.0684, 3.78, 107, 0.999, 1.67),
+   covar=cov,
+   omega=list(0.196, 0.129, 0.107),
+   odf=c(40,40,40),
+   sigma=list(0.0671),
+   sdf=c(200)
+ )
> PKparms

```

	TH.1	TH.2	TH.3	TH.4	TH.5	TH.6	TH.7	OM1.1	OM2.2	OM3.3
1	9.458	24.04	0.06312	3.509	106.50	1.0150	1.593	0.1847	0.15400	0.13630
2	10.720	22.98	0.06798	3.817	111.30	0.8489	1.301	0.2862	0.12000	0.16400
3	9.024	21.24	0.06630	3.969	139.40	1.0770	1.507	0.1647	0.12770	0.11300
4	10.670	23.61	0.07183	3.909	121.20	1.1500	1.013	0.1886	0.11460	0.08460
5	10.010	23.01	0.07001	3.573	100.00	0.9469	1.767	0.1526	0.08448	0.13140
6	8.952	21.73	0.06876	3.343	97.78	1.0610	1.809	0.2462	0.17640	0.08805
7	8.655	19.73	0.06614	3.380	135.60	0.9608	1.343	0.2221	0.14440	0.09957
8	9.214	21.24	0.06098	3.084	115.60	1.0420	1.753	0.2287	0.13820	0.06118
9	8.998	23.97	0.06985	4.114	145.40	0.9439	1.778	0.1765	0.12310	0.08504
10	8.938	22.73	0.06436	3.704	113.10	1.0610	1.582	0.2116	0.11940	0.09954
SG1.1										
1	0.06894									
2	0.06099									

```
3 0.06041
4 0.07700
5 0.06269
6 0.07274
7 0.06160
8 0.06692
9 0.06092
10 0.06269
```

## 4 Control Streams

We read in a control stream and clean out extra xml markup.

Listing 5:

```
> ctl <- as.nmctl(readLines("../nonmem/ctl/1005.ctl"))
> ctl[] <- lapply(ctl,function(rec)sub("<.*","",rec))
```

Now we iterate across the rows of PKparms, writing out a separate ctl for each.

Listing 6:

```
> dir.create('../nonmem/sim')
> set <- lapply(
+   rownames(PKparms),
+   function(row,params,ctl){
+     params <- as.character(PKparms[row,])
+     ctl$prob <- sub(1005,row,ctl$prob)
+     ctl$theta <- params[1:7]
+     ctl$omega <- params[8:10]
+     ctl$sigma <- params[11]
+     names(ctl)[names(ctl)=='estimation'] <- 'simulation'
+     ctl$simulation <- paste(
+       '(',
+       as.numeric(row) + 7995,
+       'NEW) (',
+       as.numeric(row) + 8996,
+       'UNIFORM) ONLYSIMULATION'
+     )
+     ctl$cov <- NULL
+     ctl$table <- NULL
+     ctl$stable <- NULL
+     ctl$stable <- 'ID TIME DV WT SEX LDOS NOPRINT NOAPPEND FILE=sim.tab
+     write.nmctl(ctl,file=file.path('../nonmem/sim',paste(sep='.',row,'
+     ctl'))))
+     return(ctl)
+   },
+   params=PKparms,
```

```
+      ctl=ctl  
+ )
```

## 5 Simulation

Finally, we run NONMEM simulations using NONR.

Listing 7:

```
> NONR72 (  
+   run=1:10,  
+   command="/opt/NONMEM/nm72/nmqual/autolog.pl",  
+   project="../nonmem/sim",  
+   diag=FALSE,  
+   checkrunno=FALSE,  
+   grid=TRUE  
+ )
```