Crossover Trial

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Simulate crossover trial

```r
n <- 3  # number of patients

sdB = 1  # between person SD

sdW = 1  # within person SD

beta = c(1, 1, 1, 1)  #intercept, main effect, order effect, interaction


Patient <- as.factor(rep(1:(2 * n), rep(2, 2 * n)))

Treatment <- c(rep(c("Treatment1", "Treatment2"), n), rep(c("Treatment2",
    "Treatment1"), n))

Order <- rep(c("First", "Second"), 2 * n)

Data <- data.frame(Patient, Treatment, Order)

FMat <- model.matrix(~Treatment * Order, data = Data)

RMat <- model.matrix(~0 + Patient, data = Data)

Response <- FMat %*% beta + RMat %*% rnorm(2 * n, 0, sdB) + rnorm(4 *
    n, 0, sdW)

Data$Response <- Response

FMat
```

	(Intercept)	TreatmentTreatment2	OrderSecond
1	1	0	0
2	1	1	1
3	1	0	0
4	1	1	1
5	1	0	0
6	1	1	1
7	1	1	0
8	1	0	1
9	1	1	0
10	1	0	1
11	1	1	0
12	1	0	1

	TreatmentTreatment2:OrderSecond
1	0
2	1
3	0
4	1
5	0
6	1
7	0
8	0
9	0

```
10                              0
11                              0
12                              0
attr(,"assign")
[1] 0 1 2 3
attr(,"contrasts")
attr(,"contrasts")$Treatment
[1] "contr.treatment"

attr(,"contrasts")$Order
[1] "contr.treatment"
```

RMat

```
   Patient1 Patient2 Patient3 Patient4 Patient5 Patient6
1         1        0        0        0        0        0
2         1        0        0        0        0        0
3         0        1        0        0        0        0
4         0        1        0        0        0        0
5         0        0        1        0        0        0
6         0        0        1        0        0        0
7         0        0        0        1        0        0
8         0        0        0        1        0        0
9         0        0        0        0        1        0
10        0        0        0        0        1        0
11        0        0        0        0        0        1
12        0        0        0        0        0        1
attr(,"assign")
[1] 1 1 1 1 1 1
attr(,"contrasts")
attr(,"contrasts")$Patient
[1] "contr.treatment"
```

Data

```
   Patient  Treatment  Order    Response
1        1 Treatment1  First  0.90044056
2        1 Treatment2 Second  2.17446312
3        2 Treatment1  First  0.08296966
4        2 Treatment2 Second  3.32416054
5        3 Treatment1  First  3.78279011
6        3 Treatment2 Second  5.91852214
7        4 Treatment2  First  2.47127984
8        4 Treatment1 Second  2.18119111
9        5 Treatment2  First  1.57344660
10       5 Treatment1 Second  3.91620087
11       6 Treatment2  First  4.21291547
12       6 Treatment1 Second  1.74844783
```

##

Model

```
(Fit <- lme4::lmer(Response ~ (1 | Patient) + Treatment * Order,
    data = Data))
```

```
Linear mixed model fit by REML ['lmerMod']
Formula: Response ~ (1 | Patient) + Treatment * Order
   Data: Data
REML criterion at convergence: 34.3185
Random effects:
 Groups    Name        Std.Dev.
 Patient  (Intercept) 0.9754
 Residual             1.3007
Number of obs: 12, groups:  Patient, 6
Fixed Effects:
                    (Intercept)
                        1.58873
            TreatmentTreatment2
                        1.16381
                    OrderSecond
                        1.02655
TreatmentTreatment2:OrderSecond
                        0.02662
```

```
confint(Fit)
```

```
                                      2.5 %    97.5 %
.sig01                            0.0000000 2.067994
.sigma                            0.6594705 1.983156
(Intercept)                      -0.0702044 3.247671
TreatmentTreatment2              -1.1822785 3.509906
OrderSecond                      -1.3195459 3.372639
TreatmentTreatment2:OrderSecond  -4.1201312 4.173371
```

Estimating Population Size

Estimating Population Size

Estimating Population Size

Computing Environment

```
sessionInfo()
```

```
R version 3.6.1 (2019-07-05)
Platform: x86_64-w64-mingw32/x64 (64-bit)
Running under: Windows 10 x64 (build 17134)

Matrix products: default

locale:
[1] LC_COLLATE=English_United Kingdom.1252
[2] LC_CTYPE=English_United Kingdom.1252
[3] LC_MONETARY=English_United Kingdom.1252
[4] LC_NUMERIC=C
[5] LC_TIME=English_United Kingdom.1252

attached base packages:
[1] stats     graphics  grDevices utils     datasets
[6] methods   base

other attached packages:
[1] knitr_1.23

loaded via a namespace (and not attached):
 [1] Rcpp_1.0.1      lattice_0.20-38 digest_0.6.20
 [4] MASS_7.3-51.4   grid_3.6.1      nlme_3.1-140
 [7] formatR_1.7     magrittr_1.5    evaluate_0.14
[10] stringi_1.4.3   minqa_1.2.4     nloptr_1.2.1
[13] Matrix_1.2-17   boot_1.3-22     rmarkdown_1.14
[16] splines_3.6.1   lme4_1.1-21     tools_3.6.1
[19] stringr_1.4.0   xfun_0.8        yaml_2.2.0
[22] compiler_3.6.1  htmltools_0.3.6
```

This took 1.39 seconds to execute.