Complete this during the 2nd slide show!

Hierarchical linear regression in brms

We will again use the PDM data set, but with some different variables. You can load it using the following code in R:

```
library(curl)
```

```
# See https://github.com/mdnunez/encodingN200 for more information about the data
pdmdat <- curl("https://tinyurl.com/PDMdataESCOP2022")
pdm <- read.csv(pdmdat)
```

```
colnames(pdm) <- c('N200_latencies', 'N200_amplitudes',
    'RT', 'accuracy', 'condition', 'EEG_session',
    'experiment', 'session', 'subject')

pdm <- pdm[pdm$experiment == 1, ]

pdm$N200_latencies <- pdm$N200_latencies/1000

pdm$RT <- pdm$RT/1000

head(pdm)
```

1. (10min) What is the brms code to estimate a linear regression with *RT* as the dependent variable, *N200_latencies* and *N200_amplitudes* as the independent variables, and *an interaction term*?

The `summary()` should provide something like the output on the next page.

```
##  Family: gaussian
##   Links: mu = identity; sigma = identity
## Formula: RT ~ N200_latencies * N200_amplitudes
##    Data: pdm (Number of observations: 5532)
##   Draws: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup draws = 4000
##
## Population-Level Effects:
##                               Estimate Est.Error l-95% CI u-95% CI Rhat
## Intercept                         0.62      0.03     0.56     0.69 1.00
## N200_latencies                    0.83      0.15     0.53     1.14 1.00
## N200_amplitudes                  -0.01      0.02    -0.04     0.02 1.00
## N200_latencies:N200_amplitudes    0.01      0.08    -0.15     0.17 1.00
##                               Bulk_ESS Tail_ESS
## Intercept                         1324     1532
## N200_latencies                    1374     1564
## N200_amplitudes                   1186     1587
## N200_latencies:N200_amplitudes    1203     1603
##
## Family Specific Parameters:
##       Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sigma     0.24      0.00     0.23     0.24 1.00     2569     2104
##
## Draws were sampled using sampling(NUTS). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

2. (5min) What effects are significant in this model?

```
bayes_anova <- brm(RT ~ factor(condition)*factor(accuracy), data=pdm)
summary(bayes_anova)
```

```
summary(bayes_anova)
```

```
##  Family: gaussian
##   Links: mu = identity; sigma = identity
## Formula: RT ~ factor(condition) * factor(accuracy)
##    Data: pdm (Number of observations: 5532)
##   Draws: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup draws = 4000
##
## Population-Level Effects:
##                                  Estimate Est.Error l-95% CI u-95% CI Rhat
## Intercept                            0.84      0.01     0.83     0.86 1.00
## factorcondition1                    -0.05      0.01    -0.07    -0.02 1.00
## factorcondition2                    -0.02      0.01    -0.04     0.01 1.00
## factoraccuracy1                     -0.03      0.01    -0.06    -0.01 1.00
## factorcondition1:factoraccuracy1    -0.03      0.02    -0.06     0.00 1.01
## factorcondition2:factoraccuracy1    -0.06      0.02    -0.09    -0.02 1.00
##                                  Bulk_ESS Tail_ESS
## Intercept                            1831     2621
## factorcondition1                     1804     2485
## factorcondition2                     2082     2580
## factoraccuracy1                      1500     2275
## factorcondition1:factoraccuracy1     1431     2305
## factorcondition2:factoraccuracy1     1801     2071
##
## Family Specific Parameters:
##       Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sigma     0.24      0.00     0.23     0.24 1.00     3539     2794
##
## Draws were sampled using sampling(NUTS). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

3. (10min) What is the brms code to estimate a linear regression with *RT* as the dependent variable, *N200_latencies* and *N200_amplitudes* as the independent variables, an *interaction term*, and a random intercept for each *subject*?

The `summary()` should output something like this:

```
## Warning: There were 1 divergent transitions after warmup. Increasing adapt_delta
## above 0.8 may help. See http://mc-stan.org/misc/warnings.html#divergent-
## transitions-after-warmup
```

```
##  Family: gaussian
##   Links: mu = identity; sigma = identity
## Formula: RT ~ (1 | subject) + N200_latencies * N200_amplitudes
##    Data: pdm (Number of observations: 5532)
##   Draws: 4 chains, each with iter = 2000; warmup = 1000; thin = 1;
##          total post-warmup draws = 4000
##
## Group-Level Effects:
## ~subject (Number of levels: 12)
##               Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sd(Intercept)     0.13      0.03     0.09     0.21 1.01      774     1318
##
## Population-Level Effects:
##                                Estimate Est.Error l-95% CI u-95% CI Rhat
## Intercept                          0.61      0.05     0.52     0.71 1.01
## N200_latencies                     0.86      0.14     0.59     1.13 1.00
## N200_amplitudes                    0.00      0.02    -0.03     0.03 1.00
## N200_latencies:N200_amplitudes    -0.02      0.07    -0.16     0.12 1.00
##                                Bulk_ESS Tail_ESS
## Intercept                           550     1359
## N200_latencies                     1544     1699
## N200_amplitudes                    1423     1693
## N200_latencies:N200_amplitudes     1396     1548
##
## Family Specific Parameters:
##       Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS Tail_ESS
## sigma     0.21      0.00     0.21     0.22 1.00     2406     2304
##
## Draws were sampled using sampling(NUTS). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```