HW8

Garrett Carr

3/22/2022

```
y <- t(matrix(bond$pressure,3,7))
tmt <- t(matrix(bond$metn,3,7))
ming <- t(matrix(bond$ingot,3,7))
p <- 3
q <- 7
bond_mult_dat <- list(p=p,q=q,y=y,tmt=tmt,ming=ming)

# Only run this once
mod1 <- cmdstan_model('multibond - Copy.stan')
```

```
fit <- mod1$sample(bond_mult_dat, chains = 4, parallel_chains = 4, adapt_delta = 0.85)
```

```
## Running MCMC with 4 parallel chains...

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## Chain 2 Exception: multibond__x32Copy_model_namespace::log_prob: vv is not symmetric. vv[1,2] = inf,

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## Chain 1 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 2 Iteration: 1600 / 2000 [ 80%]  (Sampling)
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## Chain 2 finished in 1.3 seconds.
## Chain 1 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 4 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1 finished in 1.4 seconds.
## Chain 4 finished in 1.4 seconds.
## Chain 3 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 3 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3 Iteration: 1700 / 2000 [ 85%]  (Sampling)
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## Chain 3 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3 finished in 1.7 seconds.
##
## All 4 chains finished successfully.
## Mean chain execution time: 1.5 seconds.
## Total execution time: 2.2 seconds.

##
## Warning: 2 of 4000 (0.0%) transitions ended with a divergence.
## This may indicate insufficient exploration of the posterior distribution.
## Possible remedies include:
##   * Increasing adapt_delta closer to 1 (default is 0.8)
##   * Reparameterizing the model (e.g. using a non-centered parameterization)
##   * Using informative or weakly informative prior distributions
```

```
fit
```

```
##  variable   mean median   sd  mad     q5    q95 rhat ess_bulk ess_tail
##  lp__     -48.01 -47.56 3.93 3.69 -55.17 -42.59 1.00      624      986
##  alpha[1]  71.14  71.14 2.13 1.94  67.65  74.60 1.00     2060     2113
##  alpha[2]  75.97  76.02 2.16 2.00  72.43  79.38 1.00     2213     2245
##  alpha[3]  70.21  70.25 2.14 1.99  66.64  73.58 1.00     2092     2320
##  u[1]      -0.67  -0.55 2.46 1.91  -4.74   3.04 1.00     3466     2034
##  u[2]      -1.78  -1.59 2.44 2.10  -5.91   1.75 1.00     2507     2367
```

```
##  u[3]       1.85   1.68 2.50 2.12  -1.74   6.06 1.00     2701     2007
##  u[4]       0.05   0.05 2.46 2.01  -3.88   4.05 1.00     3952     2023
##  u[5]       0.37   0.31 2.40 1.99  -3.42   4.44 1.00     4026     2606
##  u[6]      -1.42  -1.32 2.38 2.04  -5.36   2.17 1.00     2865     2051
##
##  # showing 10 of 31 rows (change via 'max_rows' argument or 'cmdstanr_max_rows' option)
```

```
# Only run once

N <- 21
p <- 3
q <- 7
ingot <- bond$ingot
metn <- bond$metn
pressure <- bond$pressure
bond_dat <- list(N=N,p=p,q=q,ingot=ingot,metn=metn,pressure=pressure)

mod2 <- cmdstan_model('mixedmod.stan')
```

```
fit2 <- mod2$sample(bond_dat, chains = 4, parallel_chains = 4, adapt_delta = 0.95)
```

```
## Running MCMC with 4 parallel chains...
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## Chain 3 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 3 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 3 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 3 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3 Iteration: 1700 / 2000 [ 85%]  (Sampling)
## Chain 3 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 3 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4 Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4 Iteration:  700 / 2000 [ 35%]  (Warmup)
## Chain 4 Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4 Iteration:  900 / 2000 [ 45%]  (Warmup)
## Chain 4 Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4 Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4 Iteration: 1100 / 2000 [ 55%]  (Sampling)
## Chain 4 Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4 Iteration: 1300 / 2000 [ 65%]  (Sampling)
## Chain 4 Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4 Iteration: 1500 / 2000 [ 75%]  (Sampling)
## Chain 4 Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4 Iteration: 1700 / 2000 [ 85%]  (Sampling)
```

```
## Chain 4 Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 4 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1 finished in 0.6 seconds.
## Chain 2 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2 finished in 0.6 seconds.
## Chain 3 finished in 0.6 seconds.
## Chain 4 finished in 0.5 seconds.
##
## All 4 chains finished successfully.
## Mean chain execution time: 0.6 seconds.
## Total execution time: 1.0 seconds.
```

```
fit2$summary()
```

```
## # A tibble: 37 x 10
##    variable    mean  median    sd   mad      q5     q95  rhat ess_bulk ess_tail
##    <chr>      <dbl>   <dbl> <dbl> <dbl>   <dbl>   <dbl> <dbl>    <dbl>    <dbl>
##  1 lp__     -46.8   -46.3    3.23  3.01 -52.6   -42.3    1.00     981.    1347.
##  2 alpha[1]  70.3    70.2    2.22  1.96  66.7    73.8    1.00     971.     777.
##  3 alpha[2]  76.0    75.9    2.27  2.02  72.4    79.6    1.00     908.     706.
##  4 alpha[3]  71.1    71.1    2.26  2.09  67.6    74.8    1.00     973.     821.
##  5 u[1]      -1.50   -1.32   2.45  2.16  -5.64    2.12   1.00    1191.     904.
##  6 u[2]      -3.49   -3.30   2.66  2.48  -8.07    0.350  1.00     953.     795.
##  7 u[3]       3.66    3.54   2.59  2.51  -0.206   8.04   1.00     968.    1555.
##  8 u[4]       0.118   0.128  2.35  2.05  -3.69    3.91   1.00    1063.     777.
##  9 u[5]       0.699   0.664  2.41  2.11  -3.19    4.73   1.00    1253.    1226.
## 10 u[6]      -2.86   -2.69   2.58  2.42  -7.34    0.899  1.00    1021.    1043.
## # ... with 27 more rows
```

It seems like model2 fits better, while model 1 runs into some divergence errors.

I think that it's possible that the mixed model just fits the data better!

One of the issues might be with the vv matrix. I'm not really sure how to do better.

```
fit
```

```
##  variable   mean median   sd  mad     q5    q95 rhat ess_bulk ess_tail
##  lp__     -48.01 -47.56 3.93 3.69 -55.17 -42.59 1.00      624      986
##  alpha[1]  71.14  71.14 2.13 1.94  67.65  74.60 1.00     2060     2113
##  alpha[2]  75.97  76.02 2.16 2.00  72.43  79.38 1.00     2213     2245
##  alpha[3]  70.21  70.25 2.14 1.99  66.64  73.58 1.00     2092     2320
##  u[1]      -0.67  -0.55 2.46 1.91  -4.74   3.04 1.00     3466     2034
##  u[2]      -1.78  -1.59 2.44 2.10  -5.91   1.75 1.00     2507     2367
##  u[3]       1.85   1.68 2.50 2.12  -1.74   6.06 1.00     2701     2007
##  u[4]       0.05   0.05 2.46 2.01  -3.88   4.05 1.00     3952     2023
##  u[5]       0.37   0.31 2.40 1.99  -3.42   4.44 1.00     4026     2606
##  u[6]      -1.42  -1.32 2.38 2.04  -5.36   2.17 1.00     2865     2051
##
##  # showing 10 of 31 rows (change via 'max_rows' argument or 'cmdstanr_max_rows' option)
```

```
fit2
```

```
##  variable   mean median   sd  mad     q5    q95 rhat ess_bulk ess_tail
##  lp__     -46.76 -46.32 3.23 3.01 -52.65 -42.27 1.00      981     1347
##  alpha[1]  70.28  70.21 2.22 1.96  66.73  73.80 1.00      970      777
##  alpha[2]  75.96  75.93 2.27 2.02  72.44  79.58 1.00      908      705
##  alpha[3]  71.13  71.09 2.26 2.09  67.60  74.76 1.00      973      820
##  u[1]      -1.50  -1.32 2.45 2.16  -5.64   2.12 1.00     1191      903
##  u[2]      -3.49  -3.30 2.66 2.48  -8.07   0.35 1.00      952      795
##  u[3]       3.66   3.54 2.59 2.51  -0.21   8.04 1.00      967     1555
##  u[4]       0.12   0.13 2.35 2.05  -3.69   3.91 1.00     1062      776
##  u[5]       0.70   0.66 2.41 2.11  -3.19   4.73 1.00     1252     1226
##  u[6]      -2.86  -2.69 2.58 2.42  -7.34   0.90 1.00     1021     1042
##
##  # showing 10 of 37 rows (change via 'max_rows' argument or 'cmdstanr_max_rows' option)
```