Lab Exercises 7_Jongtaek Lee

Jongtaek Lee

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```
library(tidybayes)
library(tidyr)
library(stringr)
library(bayesplot)
```

```
## This is bayesplot version 1.11.1
## - Online documentation and vignettes at mc-stan.org/bayesplot
## - bayesplot theme set to bayesplot::theme_default()
##    * Does _not_ affect other ggplot2 plots
##    * See ?bayesplot_theme_set for details on theme setting
```

```
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
## The following objects are masked from 'package:stats':
##
##     filter, lag
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(ggplot2)
```

```
observe.i <- c(
  5,13,18,5,10,18,29,10,15,22,4,11,10,22,13,14,17,21,25,6,11,21,13,5,19,18,14,17,3,10,
  7,3,12,11,6,16,13,6,9,10,4,9,11,12,23,18,12,7,13,12,12,13,6,14,7,18,13,9,6,8,7,6,16,4,6,12,5,5,
  17,5,7,2,9,7,6,12,13,17,5,5,6,12,10,16,10,16,15,18,6,12,6,8,33,15,14,18,25,14,2,73,13,14,6,20,8,
  12,10,3,11,3,11,13,11,13,10,5,18,10,23,5,9,2,11,9,11,6,11,5,19,15,4,8,9,6,4,4,2,12,12,11,9,7,7,
  8,12,11,23,7,16,46,9,18,12,13,14,14,3,9,15,6,13,13,12,8,11,5,9,8,22,9,2,10,6,10,12,9,11,32,5,11,
  9,11,11,0,9,3,11,11,11,5,4,8,9,30,110)
expect.i <- c(
    6.17,8.44,7.23,5.62,4.18,29.35,11.79,12.35,7.28,9.40,3.77,3.41,8.70,9.57,8.18,4.35,
    4.91,10.66,16.99,2.94,3.07,5.50,6.47,4.85,9.85,6.95,5.74,5.70,2.22,3.46,4.40,4.05,5.74,6.36,5.13,
    16.99,6.19,5.56,11.69,4.69,6.25,10.84,8.40,13.19,9.25,16.98,8.39,2.86,9.70,12.12,12.94,9.77,
    10.34,5.09,3.29,17.19,5.42,11.39,8.33,4.97,7.14,6.74,17.01,5.80,4.84,12.00,4.50,4.39,16.35,6.02,
    6.42,5.26,4.59,11.86,4.05,5.48,13.13,8.72,2.87,2.13,4.48,5.85,6.67,6.11,5.78,12.31,10.56,10.23,
    2.52,6.22,14.29,5.71,37.93,7.81,9.86,11.61,18.52,12.28,5.41,61.96,8.55,12.07,4.29,19.42,8.25,
    12.90,4.76,5.56,11.11,4.76,10.48,13.13,12.94,14.61,9.26,6.94,16.82,33.49,20.91,5.32,6.77,8.70,
    12.94,16.07,8.87,7.79,14.60,5.10,24.42,17.78,4.04,7.84,9.89,8.45,5.06,4.49,6.25,9.16,12.37,8.40,
    9.57,5.83,9.21,9.64,9.09,12.94,17.42,10.29,7.14,92.50,14.29,15.61,6.00,8.55,15.22,18.42,5.77,
```

```
    18.37,13.16,7.69,14.61,15.85,12.77,7.41,14.86,6.94,5.66,9.88,102.16,7.63,5.13,7.58,8.00,12.82,
    18.75,12.33,5.88,64.64,8.62,12.09,11.11,14.10,10.48,7.00,10.23,6.82,15.71,9.65,8.59,8.33,6.06,
    12.31,8.91,50.10,288.00)
aff.i <- c(0.2415,0.2309,0.3999,0.2977,0.3264,0.3346,0.4150,0.4202,0.1023,0.1752,
        0.2548,0.3248,0.2287,0.2520,0.2058,0.2785,0.2528,0.1847,0.3736,0.2411,
        0.3700,0.2997,0.2883,0.2427,0.3782,0.1865,0.2633,0.2978,0.3541,0.4176,
        0.2910,0.3431,0.1168,0.2195,0.2911,0.4297,0.2119,0.2698,0.0874,0.3204,
        0.1839,0.1796,0.2471,0.2016,0.1560,0.3162,0.0732,0.1490,0.2283,0.1187,
        0.3500,0.2915,0.1339,0.0995,0.2355,0.2392,0.0877,0.3571,0.1014,0.0363,
        0.1665,0.1226,0.2186,0.1279,0.0842,0.0733,0.0377,0.2216,0.3062,0.0310,
        0.0755,0.0583,0.2546,0.2933,0.1682,0.2518,0.1971,0.1473,0.2311,0.2471,
        0.3063,0.1526,0.1487,0.3537,0.2753,0.0849,0.1013,0.1622,0.1267,0.2376,
        0.0737,0.2755,0.0152,0.1415,0.1344,0.1058,0.0545,0.1047,0.1335,0.3134,
        0.1326,0.1222,0.1992,0.0620,0.1313,0.0848,0.2687,0.1396,0.1234,0.0997,
        0.0694,0.1022,0.0779,0.0253,0.1012,0.0999,0.0828,0.2950,0.0778,0.1388,
        0.2449,0.0978,0.1144,0.1038,0.1613,0.1921,0.2714,0.1467,0.1783,0.1790,
        0.1482,0.1383,0.0805,0.0619,0.1934,0.1315,0.1050,0.0702,0.1002,0.1445,
        0.0353,0.0400,0.1385,0.0491,0.0520,0.0640,0.1017,0.0837,0.1462,0.0958,
        0.0745,0.2942,0.2278,0.1347,0.0907,0.1238,0.1773,0.0623,0.0742,0.1003,
        0.0590,0.0719,0.0652,0.1687,0.1199,0.1768,0.1638,0.1360,0.0832,0.2174,
        0.1662,0.2023,0.1319,0.0526,0.0287,0.0405,0.1616,0.0730,0.1005,0.0743,
        0.0577,0.0481,0.1002,0.0433,0.0838,0.1124,0.2265,0.0436,0.1402,0.0313,
        0.0359,0.0696,0.0618,0.0932,0.0097)
```

Question 1

Explain a bit more what the `expect.i` variable is. For example, if a particular area has an expected deaths of 16, what does this mean?

It means that, given the age distribution of the male population in that region and considering the overall mortality rates from lip cancer at the national level, one would expect to observe 16 deaths due to lip cancer in that region under normal circumstances, assuming that the region's population conforms to the national mortality trends without any additional local risk factors or interventions altering the outcome.

Question 2

Run four different models in Stan with three different set-ups for estimating θ_i, that is the relative risk of lip cancer in each region:

1. Intercept α_i is same in each region $= \alpha$
2. Intercept α_i is different in each region and modeled separately
3. Intercept α_i is different in each region and the intercept is modeled hierarchically

Note in all three cases, use the proportion of male population working outside in each region as a covariate.

```
library(rstan)
```

```
## Loading required package: StanHeaders
```

```
##
## rstan version 2.32.5 (Stan version 2.32.2)
```

```
## For execution on a local, multicore CPU with excess RAM we recommend calling
## options(mc.cores = parallel::detectCores()).
## To avoid recompilation of unchanged Stan programs, we recommend calling
## rstan_options(auto_write = TRUE)
## For within-chain threading using `reduce_sum()` or `map_rect()` Stan functions,
```

```
## change `threads_per_chain` option:
## rstan_options(threads_per_chain = 1)
```

```
## Do not specify '-march=native' in 'LOCAL_CPPFLAGS' or a Makevars file
```

```
##
## Attaching package: 'rstan'
```

```
## The following object is masked from 'package:tidyr':
##
##     extract
```

```
data_list <- list(
  N = length(observe.i),
  y = observe.i,
  log_exp = expect.i,
  x = aff.i
)
```

Case1

```
library(rstan)

# Define Stan model for complete pooling as a string
stan_model_complete_pooling <- '
data {
  int<lower=0> N;  // Number of regions
  int y[N];  // Observed deaths, as integer array
  vector[N] log_exp;  // Expected deaths
  vector[N] x;  // Proportion of male population working outside
}

parameters {
  real alpha;  // Common intercept
  real beta;  // Slope for aff
}

transformed parameters {
  vector[N] log_theta;

  log_theta = alpha + beta*x;
}

model {
  y ~ poisson_log(log_theta + log_exp);

  // Priors
  alpha ~ normal(0, 1);
  beta ~ normal(0, 1);
}

'

# Run the model
fit_complete_pooling <- stan(
  model_code = stan_model_complete_pooling,
  data = data_list,
```

```
  chains = 4,
  iter = 2000,
  warmup = 1000
)
```

```
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 7.2e-05 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 0.72 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1:
## Chain 1:  Elapsed Time: 7.5 seconds (Warm-up)
## Chain 1:                1.216 seconds (Sampling)
## Chain 1:                8.716 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 4.7e-05 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0.47 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
## Chain 2:
## Chain 2: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2:
## Chain 2:  Elapsed Time: 7.474 seconds (Warm-up)
## Chain 2:                1.337 seconds (Sampling)
## Chain 2:                8.811 seconds (Total)
```

```
## Chain 2:
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 3).
## Chain 3:
## Chain 3: Gradient evaluation took 0.000192 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 1.92 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3:
## Chain 3:
## Chain 3: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3:
## Chain 3:  Elapsed Time: 7.024 seconds (Warm-up)
## Chain 3:                1.509 seconds (Sampling)
## Chain 3:                8.533 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 4.7e-05 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0.47 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
## Chain 4:
## Chain 4: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4:
## Chain 4:  Elapsed Time: 7.457 seconds (Warm-up)
## Chain 4:                1.059 seconds (Sampling)
## Chain 4:                8.516 seconds (Total)
## Chain 4:

## Warning: There were 28 transitions after warmup that exceeded the maximum treedepth. Increase max_tr
## https://mc-stan.org/misc/warnings.html#maximum-treedepth-exceeded
```

```
## Warning: There were 4 chains where the estimated Bayesian Fraction of Missing Information was low. Se
## https://mc-stan.org/misc/warnings.html#bfmi-low

## Warning: Examine the pairs() plot to diagnose sampling problems

## Warning: The largest R-hat is 2.27, indicating chains have not mixed.
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#r-hat

## Warning: Bulk Effective Samples Size (ESS) is too low, indicating posterior means and medians may be
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#bulk-ess

## Warning: Tail Effective Samples Size (ESS) is too low, indicating posterior variances and tail quanti
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#tail-ess
```

```
summary(fit_complete_pooling)$summary
```

```
##                       mean      se_mean           sd          2.5%
## alpha             -280.43679 8.091604e-02 1.956096e-01 -2.808283e+02
## beta                31.83057 8.344479e+00 2.011779e+01 -3.694275e-01
## log_theta[1]      -272.74970 1.934325e+00 4.663818e+00 -2.802161e+02
## log_theta[2]      -273.08711 1.845874e+00 4.450572e+00 -2.802123e+02
## log_theta[3]      -267.70774 3.256090e+00 7.850461e+00 -2.802776e+02
## log_theta[4]      -270.96082 2.403285e+00 5.794431e+00 -2.802404e+02
## log_theta[5]      -270.04729 2.642771e+00 6.371808e+00 -2.802516e+02
## log_theta[6]      -269.78628 2.711196e+00 6.536774e+00 -2.802546e+02
## log_theta[7]      -267.22710 3.382091e+00 8.154238e+00 -2.802836e+02
## log_theta[8]      -267.06158 3.425483e+00 8.258851e+00 -2.802855e+02
## log_theta[9]      -277.18052 7.727767e-01 1.863481e+00 -2.801652e+02
## log_theta[10]     -274.86007 1.381087e+00 3.330025e+00 -2.801904e+02
## log_theta[11]     -272.32636 2.045307e+00 4.931383e+00 -2.802209e+02
## log_theta[12]     -270.09822 2.629420e+00 6.339620e+00 -2.802510e+02
## log_theta[13]     -273.15713 1.827516e+00 4.406313e+00 -2.802115e+02
## log_theta[14]     -272.41548 2.021942e+00 4.875053e+00 -2.802199e+02
## log_theta[15]     -273.88605 1.636428e+00 3.945620e+00 -2.802032e+02
## log_theta[16]     -271.57197 2.243071e+00 5.408171e+00 -2.802312e+02
## log_theta[17]     -272.39002 2.028618e+00 4.891148e+00 -2.802202e+02
## log_theta[18]     -274.55768 1.460359e+00 3.521141e+00 -2.801947e+02
## log_theta[19]     -268.54488 3.036630e+00 7.321364e+00 -2.802686e+02
## log_theta[20]     -272.76243 1.930987e+00 4.655771e+00 -2.802160e+02
## log_theta[21]     -268.65947 3.006590e+00 7.248941e+00 -2.802673e+02
## log_theta[22]     -270.89716 2.419973e+00 5.834666e+00 -2.802411e+02
## log_theta[23]     -271.26003 2.324846e+00 5.605324e+00 -2.802358e+02
## log_theta[24]     -272.71151 1.944339e+00 4.687960e+00 -2.802165e+02
## log_theta[25]     -268.39846 3.075015e+00 7.413906e+00 -2.802703e+02
## log_theta[26]     -274.50038 1.475379e+00 3.557352e+00 -2.801956e+02
## log_theta[27]     -272.05580 2.116235e+00 5.102383e+00 -2.802244e+02
## log_theta[28]     -270.95764 2.404119e+00 5.796442e+00 -2.802404e+02
## log_theta[29]     -269.16558 2.873913e+00 6.929069e+00 -2.802616e+02
## log_theta[30]     -267.14434 3.403787e+00 8.206545e+00 -2.802845e+02
## log_theta[31]     -271.17409 2.347377e+00 5.659642e+00 -2.802371e+02
## log_theta[32]     -269.51572 2.782124e+00 6.707774e+00 -2.802577e+02
## log_theta[33]     -276.71898 8.937710e-01 2.155176e+00 -2.801701e+02
## log_theta[34]     -273.44998 1.750747e+00 4.221231e+00 -2.802081e+02
## log_theta[35]     -271.17091 2.348211e+00 5.661654e+00 -2.802372e+02
```

```
## log_theta[36]     -266.75919 3.504755e+00 8.449969e+00 -2.802889e+02
## log_theta[37]     -273.69189 1.687329e+00 4.068338e+00 -2.802054e+02
## log_theta[38]     -271.84890 2.170474e+00 5.233148e+00 -2.802273e+02
## log_theta[39]     -277.65479 6.484450e-01 1.563745e+00 -2.801602e+02
## log_theta[40]     -270.23827 2.592704e+00 6.251102e+00 -2.802494e+02
## log_theta[41]     -274.58314 1.453684e+00 3.505047e+00 -2.801943e+02
## log_theta[42]     -274.72002 1.417803e+00 3.418541e+00 -2.801922e+02
## log_theta[43]     -272.57145 1.981054e+00 4.776477e+00 -2.802181e+02
## log_theta[44]     -274.01974 1.601381e+00 3.861127e+00 -2.802016e+02
## log_theta[45]     -275.47122 1.220873e+00 2.943770e+00 -2.801844e+02
## log_theta[46]     -270.37196 2.557657e+00 6.166608e+00 -2.802477e+02
## log_theta[47]     -278.10679 5.299547e-01 1.278098e+00 -2.801549e+02
## log_theta[48]     -275.69403 1.162462e+00 2.802949e+00 -2.801811e+02
## log_theta[49]     -273.16987 1.824178e+00 4.398266e+00 -2.802113e+02
## log_theta[50]     -276.65850 9.096254e-01 2.193398e+00 -2.801708e+02
## log_theta[51]     -269.29609 2.839701e+00 6.846586e+00 -2.802601e+02
## log_theta[52]     -271.15817 2.351549e+00 5.669701e+00 -2.802374e+02
## log_theta[53]     -276.17467 1.036461e+00 2.499178e+00 -2.801756e+02
## log_theta[54]     -277.26964 7.494124e-01 1.807154e+00 -2.801642e+02
## log_theta[55]     -272.94069 1.884258e+00 4.543113e+00 -2.802139e+02
## log_theta[56]     -272.82291 1.915133e+00 4.617548e+00 -2.802153e+02
## log_theta[57]     -277.64524 6.509483e-01 1.569780e+00 -2.801603e+02
## log_theta[58]     -269.07009 2.898946e+00 6.989422e+00 -2.802627e+02
## log_theta[59]     -277.20917 7.652668e-01 1.845376e+00 -2.801647e+02
## log_theta[60]     -279.28134 2.220534e-01 5.359511e-01 -2.801349e+02
## log_theta[61]     -275.13700 1.308490e+00 3.155003e+00 -2.801881e+02
## log_theta[62]     -276.53436 9.421688e-01 2.271854e+00 -2.801720e+02
## log_theta[63]     -273.47862 1.743237e+00 4.203125e+00 -2.802078e+02
## log_theta[64]     -276.36566 9.863943e-01 2.378475e+00 -2.801734e+02
## log_theta[65]     -277.75665 6.217429e-01 1.499373e+00 -2.801592e+02
## log_theta[66]     -278.10361 5.307891e-01 1.280110e+00 -2.801550e+02
## log_theta[67]     -279.23677 2.337348e-01 5.640989e-01 -2.801355e+02
## log_theta[68]     -273.38313 1.768270e+00 4.263478e+00 -2.802089e+02
## log_theta[69]     -270.69026 2.474213e+00 5.965431e+00 -2.802436e+02
## log_theta[70]     -279.45004 1.778320e-01 4.294120e-01 -2.801330e+02
## log_theta[71]     -278.03358 5.491467e-01 1.324364e+00 -2.801560e+02
## log_theta[72]     -278.58106 4.056242e-01 9.783874e-01 -2.801479e+02
## log_theta[73]     -272.33272 2.043638e+00 4.927359e+00 -2.802209e+02
## log_theta[74]     -271.10088 2.366569e+00 5.705913e+00 -2.802383e+02
## log_theta[75]     -275.08288 1.322676e+00 3.189202e+00 -2.801886e+02
## log_theta[76]     -272.42185 2.020273e+00 4.871030e+00 -2.802198e+02
## log_theta[77]     -274.16298 1.563831e+00 3.770598e+00 -2.802000e+02
## log_theta[78]     -275.74814 1.148277e+00 2.768749e+00 -2.801802e+02
## log_theta[79]     -273.08074 1.847543e+00 4.454595e+00 -2.802123e+02
## log_theta[80]     -272.57145 1.981054e+00 4.776477e+00 -2.802181e+02
## log_theta[81]     -270.68708 2.475047e+00 5.967443e+00 -2.802436e+02
## log_theta[82]     -275.57944 1.192502e+00 2.875371e+00 -2.801828e+02
## log_theta[83]     -275.70358 1.159959e+00 2.796914e+00 -2.801809e+02
## log_theta[84]     -269.17831 2.870575e+00 6.921022e+00 -2.802615e+02
## log_theta[85]     -271.67383 2.216368e+00 5.343795e+00 -2.802297e+02
## log_theta[86]     -277.73437 6.275840e-01 1.513454e+00 -2.801594e+02
## log_theta[87]     -277.21235 7.644323e-01 1.843364e+00 -2.801647e+02
## log_theta[88]     -275.27387 1.272609e+00 3.068498e+00 -2.801870e+02
## log_theta[89]     -276.40385 9.763810e-01 2.354335e+00 -2.801729e+02
```

```
## log_theta[90]     -272.87384 1.901782e+00 4.585360e+00 -2.802147e+02
## log_theta[91]     -278.09087 5.341269e-01 1.288156e+00 -2.801553e+02
## log_theta[92]     -271.66746 2.218037e+00 5.347818e+00 -2.802298e+02
## log_theta[93]     -279.95296 4.604804e-02 1.127644e-01 -2.801343e+02
## log_theta[94]     -275.93276 1.099879e+00 2.652069e+00 -2.801775e+02
## log_theta[95]     -276.15876 1.040633e+00 2.509237e+00 -2.801757e+02
## log_theta[96]     -277.06911 8.019822e-01 1.933890e+00 -2.801670e+02
## log_theta[97]     -278.70202 3.739160e-01 9.019557e-01 -2.801448e+02
## log_theta[98]     -277.10413 7.928034e-01 1.911761e+00 -2.801666e+02
## log_theta[99]     -276.18740 1.033123e+00 2.491131e+00 -2.801755e+02
## log_theta[100]    -270.46108 2.534293e+00 6.110278e+00 -2.802465e+02
## log_theta[101]    -276.21605 1.025613e+00 2.473026e+00 -2.801752e+02
## log_theta[102]    -276.54709 9.388310e-01 2.263808e+00 -2.801719e+02
## log_theta[103]    -274.09614 1.581354e+00 3.812845e+00 -2.802008e+02
## log_theta[104]    -278.46329 4.364981e-01 1.052810e+00 -2.801501e+02
## log_theta[105]    -276.25743 1.014765e+00 2.446873e+00 -2.801749e+02
## log_theta[106]    -277.73755 6.267495e-01 1.511443e+00 -2.801594e+02
## log_theta[107]    -271.88391 2.161295e+00 5.211018e+00 -2.802268e+02
## log_theta[108]    -275.99324 1.084024e+00 2.613846e+00 -2.801770e+02
## log_theta[109]    -276.50889 9.488443e-01 2.287948e+00 -2.801721e+02
## log_theta[110]    -277.26328 7.510812e-01 1.811178e+00 -2.801643e+02
## log_theta[111]    -278.22774 4.982461e-01 1.201660e+00 -2.801529e+02
## log_theta[112]    -277.18370 7.719423e-01 1.861469e+00 -2.801651e+02
## log_theta[113]    -277.95718 5.691732e-01 1.372642e+00 -2.801569e+02
## log_theta[114]    -279.63147 1.302762e-01 3.148965e-01 -2.801310e+02
## log_theta[115]    -277.21553 7.635979e-01 1.841353e+00 -2.801647e+02
## log_theta[116]    -277.25691 7.527501e-01 1.815201e+00 -2.801643e+02
## log_theta[117]    -277.80121 6.100607e-01 1.471210e+00 -2.801586e+02
## log_theta[118]    -271.04677 2.380754e+00 5.740113e+00 -2.802391e+02
## log_theta[119]    -277.96037 5.683388e-01 1.370631e+00 -2.801569e+02
## log_theta[120]    -276.01870 1.077349e+00 2.597752e+00 -2.801768e+02
## log_theta[121]    -272.64148 1.962696e+00 4.732218e+00 -2.802173e+02
## log_theta[122]    -277.32376 7.352268e-01 1.772956e+00 -2.801635e+02
## log_theta[123]    -276.79537 8.737444e-01 2.106895e+00 -2.801696e+02
## log_theta[124]    -277.13277 7.852934e-01 1.893656e+00 -2.801662e+02
## log_theta[125]    -275.30251 1.265099e+00 3.050392e+00 -2.801868e+02
## log_theta[126]    -274.32213 1.522108e+00 3.670010e+00 -2.801982e+02
## log_theta[127]    -271.79797 2.183825e+00 5.265336e+00 -2.802280e+02
## log_theta[128]    -275.76724 1.143270e+00 2.756679e+00 -2.801799e+02
## log_theta[129]    -274.76139 1.406955e+00 3.392389e+00 -2.801915e+02
## log_theta[130]    -274.73911 1.412796e+00 3.406471e+00 -2.801919e+02
## log_theta[131]    -275.71950 1.155787e+00 2.786855e+00 -2.801807e+02
## log_theta[132]    -276.03462 1.073177e+00 2.587694e+00 -2.801767e+02
## log_theta[133]    -277.87443 5.908686e-01 1.424943e+00 -2.801578e+02
## log_theta[134]    -278.46647 4.356636e-01 1.050798e+00 -2.801500e+02
## log_theta[135]    -274.28075 1.532956e+00 3.696163e+00 -2.801986e+02
## log_theta[136]    -276.25107 1.016434e+00 2.450897e+00 -2.801750e+02
## log_theta[137]    -277.09458 7.953067e-01 1.917796e+00 -2.801667e+02
## log_theta[138]    -278.20228 5.049216e-01 1.217752e+00 -2.801532e+02
## log_theta[139]    -277.24736 7.552535e-01 1.821236e+00 -2.801644e+02
## log_theta[140]    -275.83727 1.124912e+00 2.712421e+00 -2.801789e+02
## log_theta[141]    -279.31317 2.137096e-01 5.158467e-01 -2.801341e+02
## log_theta[142]    -279.16356 2.529259e-01 6.103451e-01 -2.801364e+02
## log_theta[143]    -276.02825 1.074845e+00 2.591717e+00 -2.801767e+02
```

```
## log_theta[144]    -278.87391 3.288572e-01 7.933475e-01 -2.801419e+02
## log_theta[145]    -278.78160 3.530554e-01 8.516732e-01 -2.801437e+02
## log_theta[146]    -278.39963 4.531867e-01 1.093039e+00 -2.801508e+02
## log_theta[147]    -277.19962 7.677701e-01 1.851411e+00 -2.801648e+02
## log_theta[148]    -277.77257 6.175707e-01 1.489315e+00 -2.801590e+02
## log_theta[149]    -275.78316 1.139098e+00 2.746620e+00 -2.801797e+02
## log_theta[150]    -277.38742 7.185380e-01 1.732723e+00 -2.801625e+02
## log_theta[151]    -278.06541 5.408024e-01 1.304249e+00 -2.801556e+02
## log_theta[152]    -271.07223 2.374079e+00 5.724019e+00 -2.802387e+02
## log_theta[153]    -273.18578 1.820006e+00 4.388207e+00 -2.802112e+02
## log_theta[154]    -276.14921 1.043137e+00 2.515272e+00 -2.801758e+02
## log_theta[155]    -277.54975 6.759815e-01 1.630129e+00 -2.801611e+02
## log_theta[156]    -276.49616 9.521821e-01 2.295995e+00 -2.801722e+02
## log_theta[157]    -274.79323 1.398610e+00 3.372271e+00 -2.801910e+02
## log_theta[158]    -278.45374 4.390014e-01 1.058844e+00 -2.801502e+02
## log_theta[159]    -278.07496 5.382991e-01 1.298214e+00 -2.801555e+02
## log_theta[160]    -277.24418 7.560879e-01 1.823248e+00 -2.801644e+02
## log_theta[161]    -278.55878 4.114652e-01 9.924672e-01 -2.801486e+02
## log_theta[162]    -278.14817 5.191070e-01 1.251948e+00 -2.801539e+02
## log_theta[163]    -278.36143 4.631999e-01 1.117177e+00 -2.801513e+02
## log_theta[164]    -275.06697 1.326848e+00 3.199261e+00 -2.801887e+02
## log_theta[165]    -276.62030 9.196388e-01 2.217538e+00 -2.801714e+02
## log_theta[166]    -274.80914 1.394438e+00 3.362213e+00 -2.801908e+02
## log_theta[167]    -275.22294 1.285960e+00 3.100686e+00 -2.801874e+02
## log_theta[168]    -276.10783 1.053984e+00 2.541424e+00 -2.801761e+02
## log_theta[169]    -277.78848 6.133985e-01 1.479257e+00 -2.801588e+02
## log_theta[170]    -273.51682 1.733223e+00 4.178984e+00 -2.802074e+02
## log_theta[171]    -275.14654 1.305987e+00 3.148968e+00 -2.801880e+02
## log_theta[172]    -273.99746 1.607222e+00 3.875209e+00 -2.802019e+02
## log_theta[173]    -276.23833 1.019772e+00 2.458944e+00 -2.801751e+02
## log_theta[174]    -278.76250 3.580619e-01 8.637409e-01 -2.801439e+02
## log_theta[175]    -279.52325 1.586422e-01 3.831928e-01 -2.801324e+02
## log_theta[176]    -279.14765 2.570979e-01 6.203991e-01 -2.801366e+02
## log_theta[177]    -275.29297 1.267602e+00 3.056428e+00 -2.801868e+02
## log_theta[178]    -278.11315 5.282858e-01 1.274075e+00 -2.801548e+02
## log_theta[179]    -277.23781 7.577568e-01 1.827271e+00 -2.801645e+02
## log_theta[180]    -278.07177 5.391335e-01 1.300226e+00 -2.801556e+02
## log_theta[181]    -278.60016 4.006176e-01 9.663190e-01 -2.801474e+02
## log_theta[182]    -278.90574 3.205130e-01 7.732357e-01 -2.801416e+02
## log_theta[183]    -277.24736 7.552535e-01 1.821236e+00 -2.801644e+02
## log_theta[184]    -279.05852 2.804612e-01 6.767043e-01 -2.801384e+02
## log_theta[185]    -277.76938 6.184051e-01 1.491326e+00 -2.801590e+02
## log_theta[186]    -276.85903 8.570555e-01 2.066661e+00 -2.801692e+02
## log_theta[187]    -273.22716 1.809158e+00 4.362054e+00 -2.802107e+02
## log_theta[188]    -279.04897 2.829644e-01 6.827372e-01 -2.801387e+02
## log_theta[189]    -275.97414 1.089031e+00 2.625917e+00 -2.801772e+02
## log_theta[190]    -279.44049 1.803350e-01 4.354414e-01 -2.801332e+02
## log_theta[191]    -279.29407 2.187159e-01 5.279092e-01 -2.801346e+02
## log_theta[192]    -278.22138 4.999150e-01 1.205683e+00 -2.801530e+02
## log_theta[193]    -278.46966 4.348292e-01 1.048787e+00 -2.801500e+02
## log_theta[194]    -277.47018 6.968425e-01 1.680420e+00 -2.801619e+02
## log_theta[195]    -280.12803 3.296391e-04 1.917783e-02 -2.801658e+02
## lp__           -618353.78297 2.756435e+03 6.670236e+03 -6.294646e+05
##                         25%           50%           75%         97.5%
```

```
## alpha           -280.5770   -280.40874   -280.29014   -280.12826
## beta              16.9880     29.68885     44.65905     70.69339
## log_theta[1]    -276.1901   -273.26405   -269.76951   -263.72641
## log_theta[2]    -276.3698   -273.57917   -270.24318   -264.47576
## log_theta[3]    -273.5011   -268.56030   -262.69753   -252.52846
## log_theta[4]    -275.2363   -271.59468   -267.26114   -259.75340
## log_theta[5]    -274.7489   -270.74256   -265.97968   -257.72447
## log_theta[6]    -274.6097   -270.49910   -265.61356   -257.14478
## log_theta[7]    -273.2446   -268.11197   -262.02227   -251.46098
## log_theta[8]    -273.1563   -267.95758   -261.78973   -251.09337
## log_theta[9]    -278.5521   -277.40042   -275.98087   -273.56130
## log_theta[10]   -277.3149   -275.23507   -272.73088   -268.40937
## log_theta[11]   -275.9647   -272.86865   -269.17503   -262.78617
## log_theta[12]   -274.7761   -270.79006   -266.05112   -257.83759
## log_theta[13]   -276.4071   -273.64458   -270.34149   -264.63129
## log_theta[14]   -276.0123   -272.95189   -269.30029   -262.98412
## log_theta[15]   -276.7954   -274.32537   -271.36446   -266.24854
## log_theta[16]   -275.5623   -272.16474   -268.11760   -261.11072
## log_theta[17]   -275.9987   -272.92811   -269.26450   -262.92756
## log_theta[18]   -277.1541   -274.95265   -272.30662   -267.73853
## log_theta[19]   -273.9477   -269.34116   -263.87221   -254.38771
## log_theta[20]   -276.1969   -273.27594   -269.78738   -263.75468
## log_theta[21]   -274.0088   -269.44805   -264.03295   -254.64221
## log_theta[22]   -275.2023   -271.53530   -267.17184   -259.61201
## log_theta[23]   -275.3960   -271.87377   -267.68077   -260.41792
## log_theta[24]   -276.1697   -273.22837   -269.71589   -263.64157
## log_theta[25]   -273.8696   -269.20459   -263.66682   -254.06252
## log_theta[26]   -277.1236   -274.89914   -272.22624   -267.61142
## log_theta[27]   -275.8207   -272.61604   -268.79543   -262.18527
## log_theta[28]   -275.2346   -271.59171   -267.25667   -259.74633
## log_theta[29]   -274.2785   -269.92013   -264.74288   -255.76625
## log_theta[30]   -273.2005   -268.03478   -261.90600   -251.27717
## log_theta[31]   -275.3502   -271.79361   -267.56029   -260.22705
## log_theta[32]   -274.4654   -270.24673   -265.23403   -256.54388
## log_theta[33]   -278.3046   -276.97154   -275.33468   -272.53627
## log_theta[34]   -276.5629   -273.91808   -270.75260   -265.28111
## log_theta[35]   -275.3485   -271.79064   -267.55583   -260.21998
## log_theta[36]   -272.9950   -267.67552   -261.36525   -250.42177
## log_theta[37]   -276.6918   -274.14402   -271.09210   -265.81778
## log_theta[38]   -275.7103   -272.42305   -268.50557   -261.72576
## log_theta[39]   -278.8064   -277.83879   -276.64546   -274.61460
## log_theta[40]   -274.8507   -270.92070   -266.24758   -258.14864
## log_theta[41]   -277.1676   -274.97643   -272.34234   -267.79502
## log_theta[42]   -277.2404   -275.10427   -272.53435   -268.09867
## log_theta[43]   -276.0953   -273.09756   -269.51938   -263.33052
## log_theta[44]   -276.8668   -274.45023   -271.55199   -266.54512
## log_theta[45]   -277.6408   -275.80587   -273.58861   -269.76519
## log_theta[46]   -274.9220   -271.04540   -266.43511   -258.44555
## log_theta[47]   -279.0476   -278.26090   -277.27784   -275.62021
## log_theta[48]   -277.7587   -276.01397   -273.90132   -270.25997
## log_theta[49]   -276.4139   -273.65647   -270.35937   -264.65957
## log_theta[50]   -278.2725   -276.91452   -275.25021   -272.40196
## log_theta[51]   -274.3482   -270.04186   -264.92595   -256.05609
## log_theta[52]   -275.3417   -271.77876   -267.53797   -260.19170
```

```
## log_theta[53]     -278.0143    -276.46066    -274.57402    -271.32709
## log_theta[54]     -278.6003    -277.48176    -276.10590    -273.75924
## log_theta[55]     -276.2918    -273.44242    -270.03763    -264.15057
## log_theta[56]     -276.2291    -273.33242    -269.87229    -263.88900
## log_theta[57]     -278.8014    -277.82994    -276.63204    -274.59340
## log_theta[58]     -274.2275    -269.83106    -264.60893    -255.55416
## log_theta[59]     -278.5676    -277.42657    -276.02106    -273.62492
## log_theta[60]     -279.6745    -279.34838    -278.91785    -278.23292
## log_theta[61]     -277.4627    -275.49371    -273.11954    -269.02373
## log_theta[62]     -278.2064    -276.79747    -275.07697    -272.12626
## log_theta[63]     -276.5781    -273.94484    -270.79282    -265.34466
## log_theta[64]     -278.1160    -276.63840    -274.84168    -271.75159
## log_theta[65]     -278.8603    -277.93362    -276.78817    -274.84085
## log_theta[66]     -279.0459    -278.25800    -277.27338    -275.61315
## log_theta[67]     -279.6500    -279.30766    -278.85547    -278.13376
## log_theta[68]     -276.5273    -273.85565    -270.65876    -265.13281
## log_theta[69]     -275.0918    -271.34231    -266.88161    -259.15250
## log_theta[70]     -279.7641    -279.50542    -279.15494    -278.60350
## log_theta[71]     -279.0086    -278.19263    -277.17530    -275.45689
## log_theta[72]     -279.3007    -278.69914    -277.93797    -276.67197
## log_theta[73]     -275.9681    -272.87460    -269.18398    -262.80031
## log_theta[74]     -275.3111    -271.72532    -267.45760    -260.06445
## log_theta[75]     -277.4338    -275.44318    -273.04360    -268.90368
## log_theta[76]     -276.0157    -272.95784    -269.30923    -262.99826
## log_theta[77]     -276.9434    -274.58401    -271.75292    -266.86289
## log_theta[78]     -277.7874    -276.06451    -273.97695    -270.38015
## log_theta[79]     -276.3664    -273.57323    -270.23424    -264.46162
## log_theta[80]     -276.0953    -273.09756    -269.51938    -263.33052
## log_theta[81]     -275.0901    -271.33934    -266.87715    -259.14543
## log_theta[82]     -277.6981    -275.90695    -273.74050    -270.00548
## log_theta[83]     -277.7638    -276.02289    -273.91467    -270.28118
## log_theta[84]     -274.2853    -269.93201    -264.76074    -255.79452
## log_theta[85]     -275.6167    -272.25975    -268.26030    -261.33694
## log_theta[86]     -278.8486    -277.91284    -276.75696    -274.79136
## log_theta[87]     -278.5694    -277.42947    -276.02552    -273.63199
## log_theta[88]     -277.5357    -275.62155    -273.31164    -269.32738
## log_theta[89]     -278.1366    -276.67442    -274.89496    -271.83642
## log_theta[90]     -276.2562    -273.37999    -269.94378    -264.00211
## log_theta[91]     -279.0392    -278.24627    -277.25555    -275.58491
## log_theta[92]     -275.6133    -272.25381    -268.25138    -261.32281
## log_theta[93]     -280.0373    -279.96976    -279.87132    -279.71742
## log_theta[94]     -277.8853    -276.23694    -274.23497    -270.79016
## log_theta[95]     -278.0058    -276.44596    -274.55166    -271.29178
## log_theta[96]     -278.4923    -277.29875    -275.82458    -273.31388
## log_theta[97]     -279.3654    -278.81142    -278.10718    -276.94210
## log_theta[98]     -278.5111    -277.33070    -275.87370    -273.39164
## log_theta[99]     -278.0210    -276.47241    -274.59189    -271.35533
## log_theta[100]    -274.9695    -271.12854    -266.56013    -258.64350
## log_theta[101]    -278.0363    -276.49886    -274.63208    -271.41890
## log_theta[102]    -278.2132    -276.80947    -275.09473    -272.15454
## log_theta[103]    -276.9076    -274.52158    -271.65915    -266.71460
## log_theta[104]    -279.2379    -278.58944    -277.77412    -276.41080
## log_theta[105]    -278.0583    -276.53718    -274.69012    -271.51071
## log_theta[106]    -278.8503    -277.91580    -276.76142    -274.79843
```

```
## log_theta[107]    -275.7290    -272.45571    -268.55462    -261.80353
## log_theta[108]    -277.9174    -276.29315    -274.31950    -270.92447
## log_theta[109]    -278.1928    -276.77346    -275.04145    -272.06971
## log_theta[110]    -278.5969    -277.47595    -276.09697    -273.74510
## log_theta[111]    -279.1122    -278.37232    -277.44582    -275.88845
## log_theta[112]    -278.5538    -277.40333    -275.98533    -273.56837
## log_theta[113]    -278.9677    -278.12068    -277.06830    -275.28629
## log_theta[114]    -279.8614    -279.67398    -279.41173    -279.00255
## log_theta[115]    -278.5711    -277.43238    -276.02999    -273.63906
## log_theta[116]    -278.5935    -277.47014    -276.08804    -273.73096
## log_theta[117]    -278.8837    -277.97489    -276.85058    -274.93984
## log_theta[118]    -275.2822    -271.67484    -267.38169    -259.94427
## log_theta[119]    -278.9694    -278.12368    -277.07275    -275.29336
## log_theta[120]    -277.9310    -276.31666    -274.35509    -270.98102
## log_theta[121]    -276.1325    -273.16297    -269.61758    -263.48605
## log_theta[122]    -278.6296    -277.53114    -276.18181    -273.87941
## log_theta[123]    -278.3455    -277.04357    -275.44140    -272.70593
## log_theta[124]    -278.5264    -277.35685    -275.91389    -273.45526
## log_theta[125]    -277.5510    -275.64831    -273.35184    -269.39093
## log_theta[126]    -277.0284    -274.73265    -271.97618    -267.21597
## log_theta[127]    -275.6830    -272.37554    -268.43422    -261.61265
## log_theta[128]    -277.7975    -276.08235    -274.00364    -270.42256
## log_theta[129]    -277.2624    -275.14291    -272.59240    -268.19047
## log_theta[130]    -277.2506    -275.12210    -272.56114    -268.14103
## log_theta[131]    -277.7722    -276.03775    -273.93691    -270.31652
## log_theta[132]    -277.9395    -276.33135    -274.37733    -271.01637
## log_theta[133]    -278.9232    -278.04277    -276.95270    -275.10246
## log_theta[134]    -279.2396    -278.59238    -277.77856    -276.41786
## log_theta[135]    -277.0063    -274.69401    -271.91813    -267.12417
## log_theta[136]    -278.0549    -276.53127    -274.68119    -271.49659
## log_theta[137]    -278.5060    -277.32199    -275.86030    -273.37043
## log_theta[138]    -279.0986    -278.34881    -277.41049    -275.83198
## log_theta[139]    -278.5883    -277.46143    -276.07464    -273.70975
## log_theta[140]    -277.8346    -276.14775    -274.10151    -270.57808
## log_theta[141]    -279.6917    -279.37785    -278.96241    -278.30340
## log_theta[142]    -279.6110    -279.24015    -278.75335    -277.97112
## log_theta[143]    -277.9361    -276.32548    -274.36844    -271.00223
## log_theta[144]    -279.4568    -278.97184    -278.34790    -277.32505
## log_theta[145]    -279.4075    -278.88566    -278.21856    -277.11994
## log_theta[146]    -279.2040    -278.53040    -277.68546    -276.26962
## log_theta[147]    -278.5625    -277.41785    -276.00766    -273.60371
## log_theta[148]    -278.8687    -277.94843    -276.81046    -274.87620
## log_theta[149]    -277.8059    -276.09721    -274.02588    -270.45791
## log_theta[150]    -278.6637    -277.59018    -276.27112    -274.02079
## log_theta[151]    -279.0255    -278.22250    -277.21988    -275.52802
## log_theta[152]    -275.2958    -271.69860    -267.41741    -260.00083
## log_theta[153]    -276.4224    -273.67133    -270.38171    -264.69492
## log_theta[154]    -278.0007    -276.43715    -274.53824    -271.27059
## log_theta[155]    -278.7504    -277.74126    -276.49851    -274.38132
## log_theta[156]    -278.1860    -276.76145    -275.02370    -272.04143
## log_theta[157]    -277.2793    -275.17264    -272.63707    -268.26108
## log_theta[158]    -279.2328    -278.58053    -277.76080    -276.38962
## log_theta[159]    -279.0306    -278.23145    -277.23326    -275.54935
## log_theta[160]    -278.5866    -277.45852    -276.07018    -273.70268
```

```
## log_theta[161]    -279.2888    -278.67844    -277.90708    -276.62256
## log_theta[162]    -279.0697    -278.29864    -277.33543    -275.71198
## log_theta[163]    -279.1836    -278.49523    -277.63239    -276.18492
## log_theta[164]    -277.4253    -275.42831    -273.02126    -268.86837
## log_theta[165]    -278.2522    -276.87850    -275.19686    -272.31713
## log_theta[166]    -277.2878    -275.18751    -272.65941    -268.29639
## log_theta[167]    -277.5086    -275.57398    -273.24016    -269.21439
## log_theta[168]    -277.9786    -276.39894    -274.48008    -271.17879
## log_theta[169]    -278.8770    -277.96313    -276.83275    -274.91155
## log_theta[170]    -276.5984    -273.98051    -270.84644    -265.42940
## log_theta[171]    -277.4678    -275.50263    -273.13294    -269.04491
## log_theta[172]    -276.8549    -274.42942    -271.52074    -266.49569
## log_theta[173]    -278.0481    -276.51945    -274.66333    -271.46834
## log_theta[174]    -279.3974    -278.86788    -278.19177    -277.07726
## log_theta[175]    -279.8034    -279.57352    -279.25816    -278.76399
## log_theta[176]    -279.6026    -279.22526    -278.73102    -277.93591
## log_theta[177]    -277.5459    -275.63939    -273.33844    -269.36974
## log_theta[178]    -279.0510    -278.26671    -277.28676    -275.63433
## log_theta[179]    -278.5832    -277.45271    -276.06125    -273.68854
## log_theta[180]    -279.0289    -278.22847    -277.22880    -275.54224
## log_theta[181]    -279.3110    -278.71673    -277.96445    -276.71449
## log_theta[182]    -279.4737    -279.00120    -278.39236    -277.39558
## log_theta[183]    -278.5883    -277.46143    -276.07464    -273.70975
## log_theta[184]    -279.5544    -279.14284    -278.60607    -277.73684
## log_theta[185]    -278.8670    -277.94549    -276.80600    -274.86913
## log_theta[186]    -278.3795    -277.10359    -275.53057    -272.84731
## log_theta[187]    -276.4445    -273.70998    -270.43980    -264.78680
## log_theta[188]    -279.5493    -279.13411    -278.59269    -277.71551
## log_theta[189]    -277.9072    -276.27552    -274.29281    -270.88205
## log_theta[190]    -279.7589    -279.49640    -279.14133    -278.58273
## log_theta[191]    -279.6815    -279.36034    -278.93567    -278.26120
## log_theta[192]    -279.1088    -278.36644    -277.43699    -275.87433
## log_theta[193]    -279.2413    -278.59531    -277.78300    -276.42492
## log_theta[194]    -278.7079    -277.66706    -276.38722    -274.20459
## log_theta[195]    -280.1411    -280.12836    -280.11462    -280.09134
## lp__           -623237.5617 -618871.74954 -613932.82847 -605877.88959
##                       n_eff      Rhat
## alpha              5.844010 2.4026783
## beta               5.812490 2.4369775
## log_theta[1]       5.813321 2.4361765
## log_theta[2]       5.813365 2.4361336
## log_theta[3]       5.812963 2.4365235
## log_theta[4]       5.813145 2.4363471
## log_theta[5]       5.813081 2.4364090
## log_theta[6]       5.813065 2.4364246
## log_theta[7]       5.812944 2.4365416
## log_theta[8]       5.812938 2.4365475
## log_theta[9]       5.814895 2.4346322
## log_theta[10]      5.813702 2.4358049
## log_theta[11]      5.813271 2.4362246
## log_theta[12]      5.813084 2.4364059
## log_theta[13]      5.813375 2.4361241
## log_theta[14]      5.813281 2.4362150
## log_theta[15]      5.813491 2.4360112
```

```
## log_theta[16]     5.813196 2.4362975
## log_theta[17]     5.813278 2.4362178
## log_theta[18]     5.813627 2.4358776
## log_theta[19]     5.812999 2.4364882
## log_theta[20]     5.813322 2.4361750
## log_theta[21]     5.813004 2.4364830
## log_theta[22]     5.813140 2.4363518
## log_theta[23]     5.813169 2.4363237
## log_theta[24]     5.813316 2.4361811
## log_theta[25]     5.812992 2.4364948
## log_theta[26]     5.813614 2.4358904
## log_theta[27]     5.813242 2.4362525
## log_theta[28]     5.813145 2.4363473
## log_theta[29]     5.813030 2.4364583
## log_theta[30]     5.812941 2.4365446
## log_theta[31]     5.813162 2.4363306
## log_theta[32]     5.813049 2.4364398
## log_theta[33]     5.814506 2.4350160
## log_theta[34]     5.813418 2.4360820
## log_theta[35]     5.813162 2.4363309
## log_theta[36]     5.812927 2.4365579
## log_theta[37]     5.813457 2.4360441
## log_theta[38]     5.813222 2.4362725
## log_theta[39]     5.815479 2.4340534
## log_theta[40]     5.813093 2.4363971
## log_theta[41]     5.813633 2.4358718
## log_theta[42]     5.813666 2.4358397
## log_theta[43]     5.813299 2.4361975
## log_theta[44]     5.813515 2.4359872
## log_theta[45]     5.813886 2.4356246
## log_theta[46]     5.813102 2.4363884
## log_theta[47]     5.816358 2.4331805
## log_theta[48]     5.813968 2.4355446
## log_theta[49]     5.813376 2.4361224
## log_theta[50]     5.814464 2.4350574
## log_theta[51]     5.813037 2.4364516
## log_theta[52]     5.813161 2.4363319
## log_theta[53]     5.814180 2.4353363
## log_theta[54]     5.814987 2.4345409
## log_theta[55]     5.813345 2.4361528
## log_theta[56]     5.813330 2.4361676
## log_theta[57]     5.815465 2.4340677
## log_theta[58]     5.813025 2.4364632
## log_theta[59]     5.814923 2.4346036
## log_theta[60]     5.825529 2.4239951
## log_theta[61]     5.813779 2.4357294
## log_theta[62]     5.814382 2.4351374
## log_theta[63]     5.813422 2.4360777
## log_theta[64]     5.814282 2.4352362
## log_theta[65]     5.815642 2.4338919
## log_theta[66]     5.816350 2.4331883
## log_theta[67]     5.824566 2.4249606
## log_theta[68]     5.813408 2.4360920
## log_theta[69]     5.813125 2.4363668
```

```
## log_theta[70]     5.830807 2.4187122
## log_theta[71]     5.816184 2.4333536
## log_theta[72]     5.818004 2.4315379
## log_theta[73]     5.813272 2.4362240
## log_theta[74]     5.813156 2.4363364
## log_theta[75]     5.813763 2.4357449
## log_theta[76]     5.813282 2.4362143
## log_theta[77]     5.813543 2.4359602
## log_theta[78]     5.813989 2.4355238
## log_theta[79]     5.813364 2.4361345
## log_theta[80]     5.813299 2.4361975
## log_theta[81]     5.813124 2.4363670
## log_theta[82]     5.813925 2.4355869
## log_theta[83]     5.813972 2.4355410
## log_theta[84]     5.813031 2.4364577
## log_theta[85]     5.813205 2.4362885
## log_theta[86]     5.815605 2.4339287
## log_theta[87]     5.814927 2.4346004
## log_theta[88]     5.813821 2.4356885
## log_theta[89]     5.814304 2.4352147
## log_theta[90]     5.813336 2.4361613
## log_theta[91]     5.816319 2.4332194
## log_theta[92]     5.813205 2.4362891
## log_theta[93]     5.996832 2.2701571
## log_theta[94]     5.814066 2.4354480
## log_theta[95]     5.814172 2.4353441
## log_theta[96]     5.814788 2.4347375
## log_theta[97]     5.818652 2.4308895
## log_theta[98]     5.814820 2.4347054
## log_theta[99]     5.814187 2.4353300
## log_theta[100]    5.813108 2.4363825
## log_theta[101]    5.814201 2.4353156
## log_theta[102]    5.814390 2.4351295
## log_theta[103]    5.813530 2.4359730
## log_theta[104]    5.817485 2.4320566
## log_theta[105]    5.814223 2.4352943
## log_theta[106]    5.815610 2.4339235
## log_theta[107]    5.813225 2.4362692
## log_theta[108]    5.814093 2.4354215
## log_theta[109]    5.814367 2.4351530
## log_theta[110]    5.814980 2.4345477
## log_theta[111]    5.816682 2.4328578
## log_theta[112]    5.814898 2.4346291
## log_theta[113]    5.816017 2.4335190
## log_theta[114]    5.842591 2.4070122
## log_theta[115]    5.814930 2.4345972
## log_theta[116]    5.814973 2.4345544
## log_theta[117]    5.815719 2.4338158
## log_theta[118]    5.813152 2.4363405
## log_theta[119]    5.816024 2.4335124
## log_theta[120]    5.814105 2.4354101
## log_theta[121]    5.813307 2.4361894
## log_theta[122]    5.815046 2.4344821
## log_theta[123]    5.814561 2.4349611
```

```
## log_theta[124]    5.814848 2.4346785
## log_theta[125]    5.813830 2.4356796
## log_theta[126]    5.813575 2.4359284
## log_theta[127]    5.813217 2.4362772
## log_theta[128]    5.813997 2.4355163
## log_theta[129]    5.813677 2.4358296
## log_theta[130]    5.813671 2.4358351
## log_theta[131]    5.813978 2.4355349
## log_theta[132]    5.814112 2.4354028
## log_theta[133]    5.815853 2.4336828
## log_theta[134]    5.817498 2.4320438
## log_theta[135]    5.813567 2.4359369
## log_theta[136]    5.814219 2.4352976
## log_theta[137]    5.814812 2.4347143
## log_theta[138]    5.816609 2.4329299
## log_theta[139]    5.814963 2.4345644
## log_theta[140]    5.814025 2.4354882
## log_theta[141]    5.826304 2.4232183
## log_theta[142]    5.823235 2.4262957
## log_theta[143]    5.814109 2.4354057
## log_theta[144]    5.819857 2.4296834
## log_theta[145]    5.819161 2.4303803
## log_theta[146]    5.817241 2.4323003
## log_theta[147]    5.814914 2.4346132
## log_theta[148]    5.815669 2.4338652
## log_theta[149]    5.814003 2.4355100
## log_theta[150]    5.815120 2.4344093
## log_theta[151]    5.816258 2.4332802
## log_theta[152]    5.813154 2.4363386
## log_theta[153]    5.813379 2.4361202
## log_theta[154]    5.814167 2.4353488
## log_theta[155]    5.815327 2.4342039
## log_theta[156]    5.814359 2.4351607
## log_theta[157]    5.813685 2.4358217
## log_theta[158]    5.817447 2.4320946
## log_theta[159]    5.816280 2.4332576
## log_theta[160]    5.814960 2.4345677
## log_theta[161]    5.817898 2.4316437
## log_theta[162]    5.816463 2.4330756
## log_theta[163]    5.817105 2.4324360
## log_theta[164]    5.813759 2.4357494
## log_theta[165]    5.814438 2.4350827
## log_theta[166]    5.813689 2.4358178
## log_theta[167]    5.813805 2.4357040
## log_theta[168]    5.814147 2.4353687
## log_theta[169]    5.815696 2.4338379
## log_theta[170]    5.813428 2.4360719
## log_theta[171]    5.813782 2.4357266
## log_theta[172]    5.813511 2.4359913
## log_theta[173]    5.814213 2.4353042
## log_theta[174]    5.819032 2.4305095
## log_theta[175]    5.834410 2.4151199
## log_theta[176]    5.822980 2.4265515
## log_theta[177]    5.813827 2.4356825
```

```
## log_theta[178]    5.816374 2.4331647
## log_theta[179]    5.814953 2.4345743
## log_theta[180]    5.816273 2.4332652
## log_theta[181]    5.818098 2.4314442
## log_theta[182]    5.820128 2.4294112
## log_theta[183]    5.814963 2.4345644
## log_theta[184]    5.821732 2.4278026
## log_theta[185]    5.815664 2.4338705
## log_theta[186]    5.814610 2.4349130
## log_theta[187]    5.813385 2.4361144
## log_theta[188]    5.821615 2.4279208
## log_theta[189]    5.814085 2.4354300
## log_theta[190]    5.830413 2.4191061
## log_theta[191]    5.825829 2.4236939
## log_theta[192]    5.816663 2.4328761
## log_theta[193]    5.817511 2.4320309
## log_theta[194]    5.815222 2.4343084
## log_theta[195] 3384.711948 0.9994594
## lp__              5.855810 2.4170876
```

Case2

```
# Define Stan model for no pooling as a string
stan_model_no_pooling <- '
data {
  int<lower=0> N;  // Number of regions
  int y[N];  // Observed deaths in each region as integer array
  vector[N] log_exp;  // Expected deaths in each region
  vector[N] x;  // Proportion of male population working outside in each region
}

parameters {
  vector[N] alpha;  // Intercept for each region
  real beta;  // Slope for aff
}

transformed parameters {
  vector[N] log_theta;

  log_theta = alpha + beta*x;
}

model {
  y ~ poisson_log(log_theta + log_exp);


  // Priors
  alpha ~ normal(0, 1);
  beta ~ normal(0, 1);
}
'

# Run the model
fit_no_pooling <- stan(
  model_code = stan_model_no_pooling,
```

```
  data = data_list,
  chains = 4,
  iter = 2000,
  warmup = 1000
)
```

```
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 9.6e-05 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 0.96 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1:
## Chain 1:  Elapsed Time: 2.479 seconds (Warm-up)
## Chain 1:                46.771 seconds (Sampling)
## Chain 1:                49.25 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 3.9e-05 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0.39 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
## Chain 2:
## Chain 2: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2:
## Chain 2:  Elapsed Time: 2.336 seconds (Warm-up)
## Chain 2:                56.013 seconds (Sampling)
```

```
## Chain 2:                58.349 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 3).
## Chain 3:
## Chain 3: Gradient evaluation took 3.7e-05 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 0.37 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3:
## Chain 3:
## Chain 3: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3:
## Chain 3:  Elapsed Time: 2.663 seconds (Warm-up)
## Chain 3:                47.138 seconds (Sampling)
## Chain 3:                49.801 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 4e-05 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0.4 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
## Chain 4:
## Chain 4: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4:
## Chain 4:  Elapsed Time: 3.469 seconds (Warm-up)
## Chain 4:                45.281 seconds (Sampling)
## Chain 4:                48.75 seconds (Total)
## Chain 4:

## Warning: There were 3983 transitions after warmup that exceeded the maximum treedepth. Increase max_
```

```
## https://mc-stan.org/misc/warnings.html#maximum-treedepth-exceeded

## Warning: There were 4 chains where the estimated Bayesian Fraction of Missing Information was low. Se
## https://mc-stan.org/misc/warnings.html#bfmi-low

## Warning: Examine the pairs() plot to diagnose sampling problems

## Warning: The largest R-hat is 4.31, indicating chains have not mixed.
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#r-hat

## Warning: Bulk Effective Samples Size (ESS) is too low, indicating posterior means and medians may be
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#bulk-ess

## Warning: Tail Effective Samples Size (ESS) is too low, indicating posterior variances and tail quanti
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#tail-ess
```

```
summary(fit_no_pooling)$summary
```

```
##                      mean      se_mean           sd          2.5%
## alpha[1]       -2.073197e-02 1.021159e+00 1.444560e+00 -1.827745e+00
## alpha[2]       -3.577716e-01 8.825243e-01 1.248476e+00 -1.554078e+00
## alpha[3]       -8.145116e-01 6.395222e-01 9.046730e-01 -1.770589e+00
## alpha[4]       -3.156522e-02 4.857602e-01 6.872632e-01 -1.162915e+00
## alpha[5]        7.012331e-01 7.742022e-01 1.095211e+00 -1.109843e+00
## alpha[6]       -6.558278e-02 7.137492e-01 1.009729e+00 -1.453805e+00
## alpha[7]       -1.524412e-01 7.921229e-01 1.120621e+00 -1.853496e+00
## alpha[8]        3.695963e-02 1.147163e+00 1.622777e+00 -1.767852e+00
## alpha[9]       -8.901184e-01 2.260236e-01 3.204672e-01 -1.308624e+00
## alpha[10]      -8.331484e-01 3.871247e-01 5.478280e-01 -1.343604e+00
## alpha[11]      -4.502179e-01 8.451496e-01 1.195656e+00 -1.785406e+00
## alpha[12]      -4.511004e-01 7.340360e-01 1.038422e+00 -1.721486e+00
## alpha[13]      -1.256113e+00 3.549918e-01 5.022386e-01 -1.849456e+00
## alpha[14]      -3.923723e-01 6.335803e-01 8.963909e-01 -1.920106e+00
## alpha[15]       2.263760e-01 9.417005e-01 1.332172e+00 -1.295295e+00
## alpha[16]      -1.573893e-01 8.610673e-01 1.218083e+00 -1.606778e+00
## alpha[17]      -4.973194e-01 6.357356e-01 8.993704e-01 -1.281550e+00
## alpha[18]       9.455156e-01 4.381741e-01 6.199160e-01  2.166485e-01
## alpha[19]      -3.396983e-01 9.902530e-01 1.400952e+00 -1.789307e+00
## alpha[20]       2.101764e-01 5.506954e-01 7.790717e-01 -9.570075e-01
## alpha[21]       6.633002e-01 9.071991e-01 1.283316e+00 -1.415212e+00
## alpha[22]       8.330348e-01 4.134689e-01 5.851731e-01 -7.347556e-02
## alpha[23]       3.353017e-01 7.153466e-01 1.011938e+00 -9.164278e-01
## alpha[24]      -1.531014e+00 2.107147e-01 2.982379e-01 -1.918122e+00
## alpha[25]       4.028538e-01 4.742370e-01 6.709811e-01 -7.679255e-01
## alpha[26]      -2.208185e-01 1.155162e+00 1.634113e+00 -2.047181e+00
## alpha[27]       6.265941e-01 8.409824e-01 1.189707e+00 -1.276409e+00
## alpha[28]       6.982653e-01 6.807651e-01 9.630342e-01 -5.450807e-01
## alpha[29]      -6.105418e-01 5.203573e-01 7.361194e-01 -1.505867e+00
## alpha[30]       6.880099e-01 3.691859e-01 5.223017e-01 -2.211773e-01
## alpha[31]       1.005385e+00 7.334112e-01 1.037523e+00 -7.857176e-01
## alpha[32]      -9.105539e-01 5.004377e-01 7.082665e-01 -1.429011e+00
## alpha[33]       1.861007e-01 6.828665e-01 9.660031e-01 -1.068681e+00
## alpha[34]      -6.242481e-02 9.952625e-01 1.407983e+00 -1.542341e+00
## alpha[35]       3.137665e-01 5.064496e-01 7.165579e-01 -3.699883e-01
```

```
## alpha[36]       5.688952e-01 3.118234e-01 4.412051e-01 -1.461724e-01
## alpha[37]       6.444991e-01 3.851117e-01 5.450113e-01  1.490954e-02
## alpha[38]       6.693694e-02 1.064053e+00 1.505216e+00 -1.559774e+00
## alpha[39]       2.428112e-01 9.090719e-01 1.285968e+00 -1.288628e+00
## alpha[40]       3.227281e-01 8.110834e-01 1.147437e+00 -1.495699e+00
## alpha[41]      -6.792257e-01 6.398332e-01 9.051111e-01 -1.600441e+00
## alpha[42]       9.319389e-01 7.707247e-01 1.090344e+00 -7.796185e-01
## alpha[43]      -2.961720e-01 8.082964e-01 1.143439e+00 -1.877400e+00
## alpha[44]      -1.103438e-01 8.526373e-01 1.206156e+00 -1.672899e+00
## alpha[45]      -1.078632e+00 3.657984e-01 5.177836e-01 -1.833188e+00
## alpha[46]       1.950870e-01 9.204996e-01 1.302141e+00 -1.154115e+00
## alpha[47]      -1.004930e+00 7.832747e-01 1.108074e+00 -1.955240e+00
## alpha[48]      -3.485576e-01 4.383278e-01 6.202807e-01 -1.229635e+00
## alpha[49]       8.019155e-01 7.030104e-01 9.945908e-01 -2.870396e-01
## alpha[50]      -9.574868e-02 9.413849e-01 1.331682e+00 -1.587863e+00
## alpha[51]      -9.560154e-01 5.102113e-01 7.217724e-01 -1.634215e+00
## alpha[52]       7.343291e-03 1.063438e+00 1.504320e+00 -1.982194e+00
## alpha[53]      -1.685212e-01 1.063189e+00 1.504004e+00 -1.951538e+00
## alpha[54]      -1.471555e-02 4.840961e-01 6.849951e-01 -1.178154e+00
## alpha[55]      -3.465750e-01 6.981807e-01 9.877050e-01 -1.940810e+00
## alpha[56]       4.507104e-01 3.547554e-01 5.019076e-01 -2.694680e-01
## alpha[57]      -1.073530e+00 6.219265e-01 8.798928e-01 -1.894926e+00
## alpha[58]       3.443128e-01 1.023209e+00 1.447451e+00 -1.590452e+00
## alpha[59]       2.847785e-02 9.155538e-01 1.295230e+00 -1.359395e+00
## alpha[60]      -8.713602e-01 7.801287e-01 1.103603e+00 -1.980195e+00
## alpha[61]      -3.846441e-01 4.519671e-01 6.394135e-01 -1.312147e+00
## alpha[62]       2.359592e-01 2.450805e-01 3.471959e-01 -1.614167e-01
## alpha[63]       2.820738e-01 7.056957e-01 9.983447e-01 -9.523729e-01
## alpha[64]       2.866854e-01 3.919918e-01 5.547608e-01 -5.044571e-01
## alpha[65]      -4.363697e-01 3.230294e-01 4.570509e-01 -1.080827e+00
## alpha[66]      -4.781209e-01 8.616888e-01 1.218958e+00 -1.781273e+00
## alpha[67]      -4.366325e-02 2.922423e-01 4.134855e-01 -7.490747e-01
## alpha[68]      -1.695620e-01 7.894287e-01 1.116739e+00 -1.798678e+00
## alpha[69]      -3.636048e-01 7.555532e-01 1.068880e+00 -1.650874e+00
## alpha[70]      -4.482354e-01 6.977432e-01 9.871015e-01 -1.935901e+00
## alpha[71]       7.536307e-01 8.517010e-01 1.204893e+00 -1.287515e+00
## alpha[72]      -5.185972e-01 6.341061e-01 8.971507e-01 -1.495204e+00
## alpha[73]      -9.724830e-02 8.593465e-01 1.215641e+00 -1.978742e+00
## alpha[74]       5.262276e-02 7.382869e-01 1.044457e+00 -1.405572e+00
## alpha[75]      -7.408327e-01 6.205394e-01 8.779653e-01 -1.652575e+00
## alpha[76]      -6.091308e-03 1.053310e+00 1.490025e+00 -1.914475e+00
## alpha[77]       2.473806e-01 9.781047e-01 1.383668e+00 -1.291461e+00
## alpha[78]       1.310546e+00 4.079758e-01 5.772809e-01  6.335388e-01
## alpha[79]       3.501323e-01 8.282887e-01 1.171794e+00 -1.582273e+00
## alpha[80]      -7.537058e-02 1.108887e+00 1.568643e+00 -1.677541e+00
## alpha[81]       5.118920e-01 5.300798e-01 7.500389e-01 -4.844469e-01
## alpha[82]       3.757201e-01 9.376166e-01 1.326351e+00 -1.848234e+00
## alpha[83]      -8.232427e-01 6.386032e-01 9.033954e-01 -1.868546e+00
## alpha[84]      -2.104557e-01 6.905439e-01 9.769054e-01 -1.559237e+00
## alpha[85]      -1.506715e-01 9.853862e-01 1.393953e+00 -1.898423e+00
## alpha[86]       8.779219e-01 3.552619e-01 5.028065e-01  3.756697e-01
## alpha[87]       4.755711e-01 9.140793e-01 1.293061e+00 -1.425429e+00
## alpha[88]      -3.252404e-01 9.709236e-01 1.373484e+00 -1.534054e+00
## alpha[89]      -8.561850e-02 1.209210e+00 1.710540e+00 -1.842231e+00
```

```
## alpha[90]       1.045564e+00 6.609118e-01 9.349562e-01 -3.042223e-01
## alpha[91]       7.321682e-01 5.875119e-01 8.311283e-01 -1.227183e-01
## alpha[92]       1.545723e-01 5.229461e-01 7.401178e-01 -8.113810e-01
## alpha[93]      -2.616284e+01 5.551233e-01 1.407808e+00 -2.780624e+01
## alpha[94]      -9.864376e-01 6.560886e-01 9.281185e-01 -1.958557e+00
## alpha[95]       8.091987e-01 2.726480e-01 3.858535e-01  2.669312e-01
## alpha[96]       1.359456e-01 8.425121e-01 1.191890e+00 -1.637350e+00
## alpha[97]       5.515958e-01 3.997420e-01 5.656201e-01 -4.196574e-01
## alpha[98]       7.791852e-01 5.411664e-01 7.655595e-01 -4.172533e-01
## alpha[99]       3.971958e-01 1.014004e+00 1.434428e+00 -1.992961e+00
## alpha[100]      3.737078e-01 8.818632e-01 1.247720e+00 -1.505686e+00
## alpha[101]      5.422564e-01 5.344206e-01 7.559969e-01 -1.950264e-01
## alpha[102]      9.655960e-01 7.568371e-01 1.070693e+00 -8.007461e-01
## alpha[103]      3.707921e-01 6.720659e-01 9.507038e-01 -7.614823e-01
## alpha[104]      9.168245e-01 3.964583e-01 5.612768e-01 -7.932973e-02
## alpha[105]      3.200161e-01 7.339374e-01 1.038296e+00 -1.455743e+00
## alpha[106]      3.246397e-01 2.915860e-01 4.125643e-01 -1.357755e-01
## alpha[107]      9.812777e-02 6.452688e-01 9.128566e-01 -1.030095e+00
## alpha[108]      4.864443e-02 1.184547e+00 1.675783e+00 -1.942375e+00
## alpha[109]      1.146055e-01 7.404189e-01 1.047416e+00 -1.202508e+00
## alpha[110]      6.711732e-01 7.249385e-01 1.025497e+00 -1.065692e+00
## alpha[111]     -4.193507e-01 7.366654e-01 1.042104e+00 -1.528656e+00
## alpha[112]      2.722613e-01 6.293451e-01 8.904797e-01 -6.439230e-01
## alpha[113]      1.357599e+00 3.190085e-01 4.513732e-01  5.726238e-01
## alpha[114]      3.614084e-01 7.129747e-01 1.008704e+00 -7.218412e-01
## alpha[115]      8.879408e-01 1.130479e-01 1.602956e-01  7.034243e-01
## alpha[116]     -2.771414e-01 4.465356e-01 6.322175e-01 -1.335515e+00
## alpha[117]     -3.428462e-01 8.728029e-01 1.234664e+00 -1.658861e+00
## alpha[118]      7.266424e-02 9.126210e-01 1.291031e+00 -1.676333e+00
## alpha[119]     -1.650647e-01 7.370422e-01 1.042680e+00 -1.970807e+00
## alpha[120]      3.318081e-01 8.345191e-01 1.180617e+00 -1.539776e+00
## alpha[121]     -6.802885e-01 4.951006e-01 7.004341e-01 -1.618358e+00
## alpha[122]     -4.979107e-01 6.910811e-01 9.776608e-01 -1.363879e+00
## alpha[123]     -8.986293e-01 6.154119e-01 8.705811e-01 -1.727345e+00
## alpha[124]     -1.202033e-01 1.014730e+00 1.435441e+00 -1.686391e+00
## alpha[125]     -6.045026e-02 7.397480e-01 1.046489e+00 -1.799218e+00
## alpha[126]     -4.187785e-01 5.597989e-01 7.919720e-01 -1.735648e+00
## alpha[127]     -1.234455e+00 4.046736e-01 5.725936e-01 -1.698960e+00
## alpha[128]     -1.999946e-01 7.951943e-01 1.124902e+00 -1.265244e+00
## alpha[129]      1.320368e+00 2.926619e-01 4.142023e-01  8.717483e-01
## alpha[130]     -7.949666e-01 6.840341e-01 9.676703e-01 -1.777696e+00
## alpha[131]     -6.744253e-01 5.925587e-01 8.382968e-01 -1.219631e+00
## alpha[132]     -5.564124e-01 1.062437e+00 1.502961e+00 -1.950399e+00
## alpha[133]     -1.371140e+00 4.779552e-01 6.763298e-01 -1.965196e+00
## alpha[134]      3.613344e-01 9.104890e-01 1.288073e+00 -1.429749e+00
## alpha[135]      2.184268e-01 4.718224e-01 6.676467e-01 -7.058937e-01
## alpha[136]     -7.835220e-02 8.928360e-01 1.263065e+00 -1.729152e+00
## alpha[137]     -5.290003e-01 6.857515e-01 9.700885e-01 -1.857083e+00
## alpha[138]      6.662109e-01 4.850024e-01 6.862073e-01 -8.569190e-02
## alpha[139]      2.095874e-01 6.733135e-01 9.525034e-01 -7.570481e-01
## alpha[140]     -2.199361e-01 1.036626e+00 1.466424e+00 -1.911555e+00
## alpha[141]      4.613022e-01 8.665423e-01 1.225849e+00 -1.533068e+00
## alpha[142]     -3.087041e-01 1.077382e+00 1.524040e+00 -1.936257e+00
## alpha[143]     -7.855715e-01 4.250697e-01 6.013941e-01 -1.598388e+00
```

```
## alpha[144]      2.984840e-01 7.448574e-01 1.053696e+00 -8.377515e-01
## alpha[145]     -3.613448e-01 5.023780e-01 7.108489e-01 -1.252176e+00
## alpha[146]      1.440464e-01 4.836927e-01 6.843140e-01 -9.064149e-01
## alpha[147]     -5.240409e-01 6.345803e-01 8.977461e-01 -1.233070e+00
## alpha[148]     -1.300998e-03 9.750914e-01 1.379384e+00 -1.737768e+00
## alpha[149]      3.519752e-01 9.523972e-01 1.347334e+00 -1.262065e+00
## alpha[150]     -3.957484e+01 3.522885e+00 8.890150e+00 -4.977441e+01
## alpha[151]      1.073132e-01 1.037503e-01 1.488444e-01 -3.812292e-02
## alpha[152]     -6.631545e-01 6.161276e-01 8.716115e-01 -2.001027e+00
## alpha[153]     -4.191334e-01 7.551570e-01 1.068300e+00 -1.947004e+00
## alpha[154]      4.643039e-01 8.388700e-01 1.186731e+00 -1.459197e+00
## alpha[155]     -2.404121e-01 9.557823e-01 1.352081e+00 -1.811014e+00
## alpha[156]      7.720761e-02 9.061626e-01 1.281850e+00 -1.894633e+00
## alpha[157]     -6.494834e-01 6.395478e-01 9.047583e-01 -1.550366e+00
## alpha[158]     -8.706552e-01 3.739904e-01 5.293263e-01 -1.539077e+00
## alpha[159]      6.632310e-01 8.240925e-01 1.165873e+00 -1.329776e+00
## alpha[160]      4.504593e-01 6.504858e-01 9.202742e-01 -8.413124e-01
## alpha[161]     -6.471197e-01 8.183213e-01 1.157757e+00 -1.874654e+00
## alpha[162]      7.759599e-02 6.796499e-01 9.615766e-01 -1.072638e+00
## alpha[163]     -6.240019e-01 8.314774e-01 1.176265e+00 -1.468756e+00
## alpha[164]     -3.805128e-01 6.295913e-01 8.906599e-01 -1.756412e+00
## alpha[165]      2.044618e-01 8.843171e-01 1.250998e+00 -1.636055e+00
## alpha[166]     -9.190536e-01 5.104037e-01 7.221182e-01 -1.950222e+00
## alpha[167]      8.205599e-01 8.965560e-01 1.268360e+00 -1.322577e+00
## alpha[168]      2.833833e-01 6.159093e-01 8.713365e-01 -8.660992e-01
## alpha[169]     -5.570760e+01 3.056995e+00 7.712277e+00 -6.456773e+01
## alpha[170]     -4.982588e-01 8.131223e-01 1.150365e+00 -1.728589e+00
## alpha[171]      3.387452e-01 1.058495e+00 1.497365e+00 -1.586281e+00
## alpha[172]     -3.053904e-01 1.008365e+00 1.426426e+00 -1.969063e+00
## alpha[173]      1.130594e+00 5.093936e-01 7.209084e-01 -1.076883e-01
## alpha[174]      2.251334e-01 1.107164e+00 1.566189e+00 -1.813384e+00
## alpha[175]     -4.527817e-01 5.499775e-01 7.847849e-01 -1.235971e+00
## alpha[176]     -7.461021e-02 9.282199e-01 1.313072e+00 -1.874136e+00
## alpha[177]      6.317920e-01 4.492329e-01 6.358304e-01 -8.209640e-02
## alpha[178]     -2.021374e+01 3.930398e+00 8.619820e+00 -3.139483e+01
## alpha[179]      2.942293e-01 6.461114e-01 9.140588e-01 -1.126587e+00
## alpha[180]     -4.034609e-02 8.627679e-01 1.220509e+00 -1.708868e+00
## alpha[181]     -8.509759e-01 6.238232e-01 8.825481e-01 -1.836970e+00
## alpha[182]      6.407894e-01 6.101662e-01 8.632094e-01 -4.098135e-01
## alpha[183]      2.977338e-01 6.330974e-01 8.956301e-01 -9.895357e-01
## alpha[184]     -5.401518e-01 6.889602e-01 9.746042e-01 -1.615024e+00
## alpha[185]      3.247374e-01 5.318172e-01 7.526602e-01 -5.789573e-01
## alpha[186]     -3.743300e-01 9.874711e-01 1.396879e+00 -1.729500e+00
## alpha[187]     -1.600584e+00 1.049770e-01 1.492881e-01 -1.821563e+00
## alpha[188]     -1.073912e+00 5.513178e-01 7.799708e-01 -1.780521e+00
## alpha[189]     -2.413561e-01 4.340931e-01 6.141956e-01 -7.190279e-01
## alpha[190]      7.999535e-01 2.576084e-01 3.647299e-01  4.044916e-01
## alpha[191]     -5.582806e-01 5.530848e-01 7.824918e-01 -1.524613e+00
## alpha[192]      6.588111e-01 7.133361e-01 1.009092e+00 -4.636563e-01
## alpha[193]     -3.224391e-01 6.014854e-01 8.509071e-01 -1.202344e+00
## alpha[194]      3.404946e-01 1.016243e+00 1.701146e+00 -4.018198e+00
## alpha[195]     -2.771320e+02 3.603682e-01 9.112465e-01 -2.781813e+02
## beta           -5.061140e+02 3.722584e+01 9.393399e+01 -7.159062e+02
## log_theta[1]   -1.222473e+02 8.986937e+00 2.268541e+01 -1.726729e+02
```

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## log_theta[2]   -1.172195e+02 8.983049e+00 2.214356e+01 -1.659816e+02
## log_theta[3]   -2.032095e+02 1.501204e+01 3.771494e+01 -2.871659e+02
## log_theta[4]   -1.507017e+02 1.116108e+01 2.805812e+01 -2.130380e+02
## log_theta[5]   -1.644944e+02 1.262677e+01 3.122085e+01 -2.336559e+02
## log_theta[6]   -1.694113e+02 1.194501e+01 3.082065e+01 -2.387825e+02
## log_theta[7]   -2.101897e+02 1.578355e+01 3.938537e+01 -2.978395e+02
## log_theta[8]   -2.126321e+02 1.578605e+01 3.964547e+01 -3.006979e+02
## log_theta[9]   -5.266558e+01 3.713925e+00 9.495285e+00 -7.389621e+01
## log_theta[10]  -8.950432e+01 6.668714e+00 1.663229e+01 -1.264145e+02
## log_theta[11]  -1.294081e+02 9.243990e+00 2.364424e+01 -1.823991e+02
## log_theta[12]  -1.648369e+02 1.259500e+01 3.110353e+01 -2.334962e+02
## log_theta[13]  -1.170044e+02 8.523903e+00 2.149822e+01 -1.649416e+02
## log_theta[14]  -1.279331e+02 9.676838e+00 2.402548e+01 -1.813352e+02
## log_theta[15]  -1.039319e+02 7.461643e+00 1.909905e+01 -1.469921e+02
## log_theta[16]  -1.411101e+02 1.059460e+01 2.643132e+01 -1.999681e+02
## log_theta[17]  -1.284429e+02 9.176651e+00 2.346798e+01 -1.808604e+02
## log_theta[18]  -9.253374e+01 6.988236e+00 1.748069e+01 -1.313195e+02
## log_theta[19]  -1.894239e+02 1.324679e+01 3.430399e+01 -2.665105e+02
## log_theta[20]  -1.218139e+02 9.267888e+00 2.299546e+01 -1.727797e+02
## log_theta[21]  -1.865989e+02 1.432041e+01 3.540316e+01 -2.649658e+02
## log_theta[22]  -1.508493e+02 1.126683e+01 2.829017e+01 -2.138441e+02
## log_theta[23]  -1.455774e+02 1.086700e+01 2.724064e+01 -2.060522e+02
## log_theta[24]  -1.243649e+02 9.127207e+00 2.290610e+01 -1.753891e+02
## log_theta[25]  -1.910095e+02 1.419718e+01 3.566842e+01 -2.706111e+02
## log_theta[26]  -9.461108e+01 6.978843e+00 1.755570e+01 -1.341629e+02
## log_theta[27]  -1.326332e+02 9.757495e+00 2.467637e+01 -1.878937e+02
## log_theta[28]  -1.500225e+02 1.116067e+01 2.806539e+01 -2.126371e+02
## log_theta[29]  -1.798255e+02 1.291577e+01 3.294684e+01 -2.537044e+02
## log_theta[30]  -2.106652e+02 1.574759e+01 3.946721e+01 -2.984506e+02
## log_theta[31]  -1.462738e+02 1.075686e+01 2.724419e+01 -2.069407e+02
## log_theta[32]  -1.745583e+02 1.252479e+01 3.194092e+01 -2.460920e+02
## log_theta[33]  -5.892801e+01 4.881967e+00 1.159063e+01 -8.417139e+01
## log_theta[34]  -1.111544e+02 8.652105e+00 2.117923e+01 -1.576824e+02
## log_theta[35]  -1.470160e+02 1.089198e+01 2.740629e+01 -2.081010e+02
## log_theta[36]  -2.169083e+02 1.611597e+01 4.050681e+01 -3.072789e+02
## log_theta[37]  -1.066011e+02 7.658946e+00 1.963221e+01 -1.505552e+02
## log_theta[38]  -1.364826e+02 9.479632e+00 2.466101e+01 -1.919662e+02
## log_theta[39]  -4.399155e+01 2.692160e+00 7.513598e+00 -6.138880e+01
## log_theta[40]  -1.618362e+02 1.161998e+01 2.973470e+01 -2.285710e+02
## log_theta[41]  -9.375359e+01 6.686703e+00 1.708576e+01 -1.320899e+02
## log_theta[42]  -8.996613e+01 7.029393e+00 1.727718e+01 -1.282486e+02
## log_theta[43]  -1.253569e+02 9.007420e+00 2.298440e+01 -1.766169e+02
## log_theta[44]  -1.021429e+02 7.699305e+00 1.916336e+01 -1.444844e+02
## log_theta[45]  -8.003241e+01 6.060513e+00 1.495224e+01 -1.130961e+02
## log_theta[46]  -1.598382e+02 1.175651e+01 2.968683e+01 -2.263442e+02
## log_theta[47]  -3.805247e+01 2.723156e+00 6.875635e+00 -5.340307e+01
## log_theta[48]  -7.575954e+01 5.710401e+00 1.419279e+01 -1.072886e+02
## log_theta[49]  -1.147439e+02 8.768436e+00 2.176475e+01 -1.627798e+02
## log_theta[50]  -6.017148e+01 4.204014e+00 1.089059e+01 -8.493931e+01
## log_theta[51]  -1.780959e+02 1.304609e+01 3.290032e+01 -2.512363e+02
## log_theta[52]  -1.475249e+02 1.160680e+01 2.826996e+01 -2.097137e+02
## log_theta[53]  -6.793718e+01 4.727145e+00 1.227266e+01 -9.574322e+01
## log_theta[54]  -5.037306e+01 3.606849e+00 9.230062e+00 -7.095023e+01
## log_theta[55]  -1.195364e+02 8.472421e+00 2.176948e+01 -1.686189e+02
```

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## log_theta[56]  -1.206118e+02 8.811383e+00 2.235779e+01 -1.706185e+02
## log_theta[57]  -4.545973e+01 3.366839e+00 8.361517e+00 -6.427047e+01
## log_theta[58]  -1.803890e+02 1.341816e+01 3.369130e+01 -2.550113e+02
## log_theta[59]  -5.129148e+01 3.947411e+00 9.729828e+00 -7.314149e+01
## log_theta[60]  -1.924330e+01 1.380235e+00 3.447449e+00 -2.698697e+01
## log_theta[61]  -8.465262e+01 6.226622e+00 1.567365e+01 -1.195989e+02
## log_theta[62]  -6.181362e+01 4.715530e+00 1.169770e+01 -8.766794e+01
## log_theta[63]  -1.103544e+02 8.381979e+00 2.082569e+01 -1.566077e+02
## log_theta[64]  -6.444529e+01 4.668277e+00 1.190172e+01 -9.113161e+01
## log_theta[65]  -4.305117e+01 3.380876e+00 8.202334e+00 -6.107031e+01
## log_theta[66]  -3.757628e+01 2.885139e+00 7.072490e+00 -5.326356e+01
## log_theta[67]  -1.912416e+01 1.555719e+00 3.717089e+00 -2.739638e+01
## log_theta[68]  -1.123244e+02 8.041573e+00 2.056379e+01 -1.582336e+02
## log_theta[69]  -1.553357e+02 1.156852e+01 2.896748e+01 -2.197234e+02
## log_theta[70]  -1.613777e+01 1.061318e+00 2.803124e+00 -2.264011e+01
## log_theta[71]  -3.745798e+01 3.182672e+00 7.517792e+00 -5.387465e+01
## log_theta[72]  -3.002504e+01 1.998163e+00 5.268367e+00 -4.209863e+01
## log_theta[73]  -1.289539e+02 9.705386e+00 2.418332e+01 -1.823374e+02
## log_theta[74]  -1.483906e+02 1.095653e+01 2.759965e+01 -2.096366e+02
## log_theta[75]  -8.586921e+01 6.180927e+00 1.571141e+01 -1.209068e+02
## log_theta[76]  -1.274456e+02 8.730562e+00 2.287329e+01 -1.790231e+02
## log_theta[77]  -9.950769e+01 6.945126e+00 1.804638e+01 -1.403610e+02
## log_theta[78]  -7.324004e+01 5.508997e+00 1.387000e+01 -1.041078e+02
## log_theta[79]  -1.166128e+02 8.699351e+00 2.182830e+01 -1.653019e+02
## log_theta[80]  -1.251361e+02 9.250646e+00 2.327641e+01 -1.767950e+02
## log_theta[81]  -1.545108e+02 1.119318e+01 2.852570e+01 -2.183221e+02
## log_theta[82]  -7.685727e+01 5.135520e+00 1.367041e+01 -1.081233e+02
## log_theta[83]  -7.608239e+01 5.662447e+00 1.412225e+01 -1.076664e+02
## log_theta[84]  -1.792230e+02 1.299190e+01 3.302019e+01 -2.530900e+02
## log_theta[85]  -1.394839e+02 1.034293e+01 2.597104e+01 -1.975776e+02
## log_theta[86]  -4.209116e+01 2.985640e+00 7.766165e+00 -5.959836e+01
## log_theta[87]  -5.079378e+01 3.412678e+00 9.079574e+00 -7.131122e+01
## log_theta[88]  -8.241693e+01 5.907660e+00 1.508538e+01 -1.163826e+02
## log_theta[89]  -6.421026e+01 5.552438e+00 1.286551e+01 -9.198552e+01
## log_theta[90]  -1.192071e+02 8.732780e+00 2.218526e+01 -1.688935e+02
## log_theta[91]  -3.656843e+01 3.009821e+00 7.232075e+00 -5.228162e+01
## log_theta[92]  -1.392798e+02 1.051211e+01 2.617735e+01 -1.972483e+02
## log_theta[93]  -3.385578e+01 8.007084e-03 1.361459e-01 -3.412956e+01
## log_theta[94]  -7.260157e+01 5.183197e+00 1.319437e+01 -1.022880e+02
## log_theta[95]  -6.721252e+01 4.921740e+00 1.252399e+01 -9.524487e+01
## log_theta[96]  -5.341091e+01 4.425779e+00 1.050339e+01 -7.641560e+01
## log_theta[97]  -2.703162e+01 2.041705e+00 5.139545e+00 -3.835108e+01
## log_theta[98]  -5.221095e+01 3.870624e+00 9.803478e+00 -7.414006e+01
## log_theta[99]  -6.716902e+01 5.444794e+00 1.309421e+01 -9.643782e+01
## log_theta[100] -1.582424e+02 1.189039e+01 2.971684e+01 -2.244815e+02
## log_theta[101] -6.656846e+01 5.233908e+00 1.280627e+01 -9.473654e+01
## log_theta[102] -6.088153e+01 5.047490e+00 1.205768e+01 -8.737695e+01
## log_theta[103] -1.004471e+02 7.632805e+00 1.896922e+01 -1.423141e+02
## log_theta[104] -3.046224e+01 2.099514e+00 5.573372e+00 -4.319640e+01
## log_theta[105] -6.613275e+01 4.482582e+00 1.184239e+01 -9.300197e+01
## log_theta[106] -4.259383e+01 3.232693e+00 8.054265e+00 -6.052755e+01
## log_theta[107] -1.358947e+02 1.035413e+01 2.565632e+01 -1.928367e+02
## log_theta[108] -7.060487e+01 5.368828e+00 1.331473e+01 -9.995955e+01
## log_theta[109] -6.233986e+01 4.419815e+00 1.138603e+01 -8.806045e+01
```

```
## log_theta[110] -4.978839e+01 3.364785e+00 8.941341e+00 -7.025897e+01
## log_theta[111] -3.554366e+01 2.983431e+00 6.980935e+00 -5.051017e+01
## log_theta[112] -5.145259e+01 3.870553e+00 9.679938e+00 -7.313384e+01
## log_theta[113] -3.806868e+01 3.094956e+00 7.544504e+00 -5.469828e+01
## log_theta[114] -1.244328e+01 9.709398e-01 2.410549e+00 -1.808962e+01
## log_theta[115] -5.033079e+01 3.716292e+00 9.445415e+00 -7.149621e+01
## log_theta[116] -5.083793e+01 3.843709e+00 9.529017e+00 -7.201845e+01
## log_theta[117] -4.224908e+01 2.852260e+00 7.499953e+00 -5.948169e+01
## log_theta[118] -1.492310e+02 1.060300e+01 2.725241e+01 -2.107598e+02
## log_theta[119] -3.954073e+01 3.028381e+00 7.466866e+00 -5.613485e+01
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## log_theta[121] -1.246276e+02 9.402078e+00 2.334456e+01 -1.763948e+02
## log_theta[122] -4.999586e+01 3.652893e+00 9.200341e+00 -7.076005e+01
## log_theta[123] -5.879807e+01 4.594307e+00 1.114090e+01 -8.321144e+01
## log_theta[124] -5.265484e+01 3.790696e+00 9.665195e+00 -7.485944e+01
## log_theta[125] -8.169664e+01 6.140482e+00 1.531494e+01 -1.154867e+02
## log_theta[126] -9.764328e+01 7.356081e+00 1.829154e+01 -1.383048e+02
## log_theta[127] -1.385938e+02 9.862601e+00 2.520379e+01 -1.951329e+02
## log_theta[128] -7.444692e+01 5.502309e+00 1.383154e+01 -1.056179e+02
## log_theta[129] -8.891976e+01 6.769496e+00 1.690617e+01 -1.264499e+02
## log_theta[130] -9.138937e+01 6.616140e+00 1.675935e+01 -1.289696e+02
## log_theta[131] -7.568052e+01 5.200709e+00 1.354375e+01 -1.062208e+02
## log_theta[132] -7.055198e+01 5.841477e+00 1.379480e+01 -1.003941e+02
## log_theta[133] -4.211332e+01 3.313193e+00 7.932742e+00 -5.930788e+01
## log_theta[134] -3.096712e+01 2.835246e+00 6.418402e+00 -4.527214e+01
## log_theta[135] -9.766402e+01 7.494526e+00 1.851730e+01 -1.386068e+02
## log_theta[136] -6.663234e+01 5.054152e+00 1.254309e+01 -9.454116e+01
## log_theta[137] -5.367097e+01 3.694466e+00 9.603737e+00 -7.546023e+01
## log_theta[138] -3.486299e+01 2.425685e+00 6.370867e+00 -4.940001e+01
## log_theta[139] -5.050303e+01 3.320256e+00 8.912433e+00 -7.085448e+01
## log_theta[140] -7.335341e+01 5.000609e+00 1.311941e+01 -1.033437e+02
## log_theta[141] -1.740452e+01 1.800625e+00 3.856535e+00 -2.640282e+01
## log_theta[142] -2.055326e+01 1.070207e+00 3.225977e+00 -2.802843e+01
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## log_theta[144] -2.455171e+01 2.398078e+00 5.250768e+00 -3.562280e+01
## log_theta[145] -2.667927e+01 1.815081e+00 4.742311e+00 -3.746461e+01
## log_theta[146] -3.224725e+01 2.320063e+00 5.939200e+00 -4.548062e+01
## log_theta[147] -5.199583e+01 3.508905e+00 9.220698e+00 -7.288818e+01
## log_theta[148] -4.236304e+01 3.699394e+00 8.531136e+00 -6.067024e+01
## log_theta[149] -7.364189e+01 4.912575e+00 1.309394e+01 -1.034497e+02
## log_theta[150] -8.806056e+01 4.429389e-02 1.526016e-01 -8.840170e+01
## log_theta[151] -3.759818e+01 2.833716e+00 7.072172e+00 -5.325883e+01
## log_theta[152] -1.495619e+02 1.110041e+01 2.781454e+01 -2.111197e+02
## log_theta[153] -1.157119e+02 8.580155e+00 2.151631e+01 -1.633687e+02
## log_theta[154] -6.770925e+01 4.448521e+00 1.196632e+01 -9.502603e+01
## log_theta[155] -4.614495e+01 2.782536e+00 7.784869e+00 -6.417774e+01
## log_theta[156] -6.257970e+01 4.762348e+00 1.181377e+01 -8.866080e+01
## log_theta[157] -9.038349e+01 6.797361e+00 1.689241e+01 -1.278100e+02
## log_theta[158] -3.240156e+01 2.084488e+00 5.557689e+00 -4.507634e+01
## log_theta[159] -3.689043e+01 3.247873e+00 7.532623e+00 -5.362405e+01
## log_theta[160] -5.031277e+01 3.553915e+00 9.208061e+00 -7.118427e+01
## log_theta[161] -3.050784e+01 2.731748e+00 6.147021e+00 -4.385618e+01
## log_theta[162] -3.631200e+01 2.881075e+00 6.998315e+00 -5.187475e+01
## log_theta[163] -3.362263e+01 2.427009e+00 6.121848e+00 -4.785495e+01
```

```
## log_theta[164] -8.576194e+01 5.846082e+00 1.532245e+01 -1.204772e+02
## log_theta[165] -6.047861e+01 4.625142e+00 1.145753e+01 -8.564520e+01
## log_theta[166] -9.040001e+01 6.903071e+00 1.698505e+01 -1.279130e+02
## log_theta[167] -8.208091e+01 6.683430e+00 1.606032e+01 -1.173912e+02
## log_theta[168] -6.854812e+01 5.448816e+00 1.322537e+01 -9.768800e+01
## log_theta[169] -9.781628e+01 4.093430e-02 1.554443e-01 -9.815390e+01
## log_theta[170] -1.105274e+02 8.399709e+00 2.077957e+01 -1.566112e+02
## log_theta[171] -8.377740e+01 5.694421e+00 1.501757e+01 -1.176898e+02
## log_theta[172] -1.026922e+02 7.831873e+00 1.935632e+01 -1.454922e+02
## log_theta[173] -6.562584e+01 4.826832e+00 1.229384e+01 -9.301496e+01
## log_theta[174] -2.639646e+01 2.301495e+00 5.336692e+00 -3.795036e+01
## log_theta[175] -1.497825e+01 1.053370e+00 2.665666e+00 -2.105182e+01
## log_theta[176] -2.057223e+01 1.252895e+00 3.490293e+00 -2.889027e+01
## log_theta[177] -8.115623e+01 6.148711e+00 1.533680e+01 -1.151782e+02
## log_theta[178] -5.716006e+01 1.421778e+00 2.201320e+00 -6.067579e+01
## log_theta[179] -5.057023e+01 4.057792e+00 9.813176e+00 -7.209648e+01
## log_theta[180] -3.764462e+01 2.950996e+00 7.196587e+00 -5.354194e+01
## log_theta[181] -3.005375e+01 2.577812e+00 5.906895e+00 -4.269723e+01
## log_theta[182] -2.370329e+01 1.585499e+00 4.263429e+00 -3.354900e+01
## log_theta[183] -5.041489e+01 3.990258e+00 9.720624e+00 -7.176657e+01
## log_theta[184] -2.245489e+01 1.896662e+00 4.392922e+00 -3.222444e+01
## log_theta[185] -4.208761e+01 3.454636e+00 8.258455e+00 -6.018949e+01
## log_theta[186] -5.726154e+01 4.799466e+00 1.127079e+01 -8.157535e+01
## log_theta[187] -1.162354e+02 8.489218e+00 2.134116e+01 -1.638799e+02
## log_theta[188] -2.314048e+01 1.589300e+00 4.056372e+00 -3.248991e+01
## log_theta[189] -7.119854e+01 5.472988e+00 1.347206e+01 -1.009263e+02
## log_theta[190] -1.504141e+01 1.330371e+00 3.136485e+00 -2.184864e+01
## log_theta[191] -1.872777e+01 1.284361e+00 3.308627e+00 -2.623411e+01
## log_theta[192] -3.456672e+01 2.759752e+00 6.736777e+00 -4.930016e+01
## log_theta[193] -3.160028e+01 2.253096e+00 5.750390e+00 -4.441560e+01
## log_theta[194] -4.682933e+01 2.909530e+00 7.977070e+00 -6.549855e+01
## log_theta[195] -2.820413e+02 8.025129e-04 4.984029e-02 -2.821411e+02
## lp__           -3.507351e+05 3.436493e+04 8.850766e+04 -5.561000e+05
##                          25%           50%           75%         97.5%
## alpha[1]       -1.261422e+00  6.890328e-02  1.298047e+00  1.608289e+00
## alpha[2]       -1.395608e+00 -7.499514e-01  2.844247e-01  1.628853e+00
## alpha[3]       -1.685485e+00 -8.861120e-01 -1.950156e-02  2.906917e-01
## alpha[4]       -2.989330e-01  1.940168e-01  4.538658e-01  6.721362e-01
## alpha[5]        3.082822e-01  1.073452e+00  1.474735e+00  1.760872e+00
## alpha[6]       -5.757056e-01 -1.152396e-01  4.024337e-01  1.415713e+00
## alpha[7]       -8.310286e-01  5.122770e-02  7.373209e-01  1.107958e+00
## alpha[8]       -1.495373e+00  6.538865e-02  1.618724e+00  1.763772e+00
## alpha[9]       -1.077356e+00 -9.517004e-01 -7.714595e-01 -3.459400e-01
## alpha[10]      -1.328423e+00 -9.945332e-01 -5.004994e-01  2.346325e-02
## alpha[11]      -1.129043e+00 -7.732387e-01 -7.406816e-02  1.500609e+00
## alpha[12]      -1.157638e+00 -6.009095e-01  1.138732e-01  1.129832e+00
## alpha[13]      -1.716480e+00 -1.253464e+00 -7.994366e-01 -6.633943e-01
## alpha[14]      -6.207115e-01 -7.663333e-03  1.911945e-01  3.990680e-01
## alpha[15]      -9.733235e-01  1.241804e-01  1.323220e+00  1.940908e+00
## alpha[16]      -9.048169e-01 -3.800743e-01  3.640849e-01  1.746105e+00
## alpha[17]      -1.245819e+00 -8.406425e-01 -8.006584e-02  9.619946e-01
## alpha[18]       3.857854e-01  9.113638e-01  1.460007e+00  1.746003e+00
## alpha[19]      -1.332456e+00 -7.505805e-01  2.367505e-01  1.966033e+00
## alpha[20]      -2.095197e-01  2.954191e-01  7.220783e-01  1.202307e+00
```

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## alpha[21]       9.207857e-02  1.122681e+00  1.692620e+00  1.838799e+00
## alpha[22]       4.720908e-01  9.990965e-01  1.359024e+00  1.415369e+00
## alpha[23]      -5.244114e-01  3.363914e-01  1.178775e+00  1.588944e+00
## alpha[24]      -1.717350e+00 -1.563389e+00 -1.371437e+00 -1.078835e+00
## alpha[25]       3.019590e-01  7.405569e-01  8.496869e-01  8.942064e-01
## alpha[26]      -1.695097e+00 -3.744282e-01  1.109433e+00  1.902677e+00
## alpha[27]       4.721445e-02  1.028443e+00  1.629930e+00  1.712255e+00
## alpha[28]      -1.015782e-01  8.035695e-01  1.594292e+00  1.746273e+00
## alpha[29]      -1.038753e+00 -7.429343e-01 -3.109707e-01  5.513822e-01
## alpha[30]       6.403867e-01  9.543701e-01  1.006852e+00  1.065968e+00
## alpha[31]       8.575396e-01  1.497376e+00  1.656386e+00  1.825150e+00
## alpha[32]      -1.367798e+00 -1.254327e+00 -8.067280e-01  3.276510e-01
## alpha[33]      -5.333502e-01  1.626816e-01  8.922719e-01  1.490437e+00
## alpha[34]      -1.455067e+00 -1.256648e-01  1.236909e+00  1.583680e+00
## alpha[35]      -2.531972e-01  6.175327e-02  6.517766e-01  1.482997e+00
## alpha[36]       4.515018e-01  6.594713e-01  7.843669e-01  1.102367e+00
## alpha[37]       1.282792e-01  6.202359e-01  1.145915e+00  1.312215e+00
## alpha[38]      -1.366021e+00 -1.731733e-02  1.443011e+00  1.836872e+00
## alpha[39]      -8.319340e-01  1.484650e-01  1.226596e+00  1.958247e+00
## alpha[40]      -2.629985e-01  6.480495e-01  1.259669e+00  1.468851e+00
## alpha[41]      -1.237874e+00 -9.710787e-01 -4.043882e-01  8.206580e-01
## alpha[42]       3.344749e-01  1.271330e+00  1.860496e+00  1.976217e+00
## alpha[43]      -9.192511e-01 -3.050923e-01  2.785520e-01  1.339124e+00
## alpha[44]      -1.069695e+00 -8.583707e-02  8.642605e-01  1.406776e+00
## alpha[45]      -1.442439e+00 -9.544015e-01 -5.943827e-01 -5.602530e-01
## alpha[46]      -1.097562e+00  2.001872e-01  1.491152e+00  1.530824e+00
## alpha[47]      -1.870296e+00 -1.452583e+00 -5.907064e-01  8.505508e-01
## alpha[48]      -7.171003e-01 -3.392875e-01  8.654250e-02  4.808504e-01
## alpha[49]      -1.490258e-01  7.929875e-01  1.793817e+00  1.877247e+00
## alpha[50]      -1.326272e+00 -1.487135e-01  1.090704e+00  1.499406e+00
## alpha[51]      -1.507808e+00 -1.209011e+00 -6.576788e-01  2.343379e-01
## alpha[52]      -1.197815e+00  2.120547e-01  1.417054e+00  1.577225e+00
## alpha[53]      -1.352645e+00 -3.524295e-01  8.172140e-01  1.998963e+00
## alpha[54]      -2.304040e-01  2.462940e-01  4.970123e-01  5.954027e-01
## alpha[55]      -6.090424e-01 -1.573572e-01  1.172755e-01  8.366020e-01
## alpha[56]       1.605885e-01  4.602090e-01  7.598457e-01  1.139458e+00
## alpha[57]      -1.835596e+00 -1.341836e+00 -5.974344e-01  3.168406e-01
## alpha[58]      -7.833916e-01  4.903082e-01  1.630274e+00  1.974309e+00
## alpha[59]      -1.027763e+00 -2.750843e-01  8.249359e-01  1.989928e+00
## alpha[60]      -1.657850e+00 -1.215456e+00 -4.439699e-01  9.322793e-01
## alpha[61]      -8.340039e-01 -2.700408e-01  1.702549e-01  3.100853e-01
## alpha[62]      -5.983515e-02  1.722319e-01  4.701175e-01  7.663737e-01
## alpha[63]      -5.110104e-01  2.208125e-01  1.003409e+00  1.661279e+00
## alpha[64]      -1.340940e-01  4.015987e-01  8.122944e-01  8.462984e-01
## alpha[65]      -7.564273e-01 -4.091672e-01 -9.531563e-02  1.519693e-01
## alpha[66]      -1.169817e+00 -8.439757e-01 -1.476090e-01  1.535175e+00
## alpha[67]      -1.631079e-01  1.255390e-01  2.494725e-01  3.185127e-01
## alpha[68]      -7.230623e-01 -1.109876e-01  4.442511e-01  1.345220e+00
## alpha[69]      -1.073407e+00 -5.465108e-01  1.782860e-01  1.283484e+00
## alpha[70]      -1.062857e+00 -2.342246e-01  4.024223e-01  5.807210e-01
## alpha[71]       3.910421e-01  1.224189e+00  1.616400e+00  1.810865e+00
## alpha[72]      -1.415478e+00 -4.778681e-01  3.657754e-01  4.188401e-01
## alpha[73]      -4.542904e-01  7.843569e-02  4.288572e-01  1.451461e+00
## alpha[74]      -5.886188e-01  5.913201e-02  6.887981e-01  1.499572e+00
```

```
## alpha[75]      -1.202675e+00 -1.022544e+00 -5.706243e-01  7.394862e-01
## alpha[76]      -1.239447e+00  1.026777e-01  1.342064e+00  1.672894e+00
## alpha[77]      -1.072965e+00  3.041986e-01  1.613408e+00  1.681323e+00
## alpha[78]       7.768293e-01  1.333888e+00  1.887164e+00  1.904699e+00
## alpha[79]      -1.248885e-01  7.879812e-01  1.229098e+00  1.449038e+00
## alpha[80]      -1.644635e+00 -1.472121e-01  1.428385e+00  1.656186e+00
## alpha[81]       1.643889e-01  4.288802e-01  8.062596e-01  1.647310e+00
## alpha[82]      -6.074282e-02  9.307209e-01  1.360712e+00  1.492202e+00
## alpha[83]      -1.399554e+00 -1.018010e+00 -4.370784e-01  6.202611e-01
## alpha[84]      -9.514002e-01 -2.939169e-02  7.216025e-01  7.650796e-01
## alpha[85]      -9.179969e-01 -3.546455e-01  4.171877e-01  2.001540e+00
## alpha[86]       5.545948e-01  7.062830e-01  1.001327e+00  1.725109e+00
## alpha[87]      -3.599782e-01  7.042784e-01  1.536420e+00  1.923132e+00
## alpha[88]      -1.116244e+00 -8.970177e-01 -1.088649e-01  2.024755e+00
## alpha[89]      -1.781445e+00 -1.349449e-01  1.585147e+00  1.749936e+00
## alpha[90]       3.899497e-01  1.266942e+00  1.899624e+00  1.977400e+00
## alpha[91]       2.384166e-02  5.261143e-01  1.230667e+00  2.011111e+00
## alpha[92]      -4.906252e-01  2.799480e-01  8.831095e-01  9.065251e-01
## alpha[93]      -2.717135e+01 -2.679117e+01 -2.521097e+01 -2.301962e+01
## alpha[94]      -1.796321e+00 -1.187547e+00 -3.905587e-01  3.884965e-01
## alpha[95]       5.726604e-01  8.111761e-01  1.022778e+00  1.363732e+00
## alpha[96]      -4.428511e-01  2.254825e-01  8.485089e-01  1.696740e+00
## alpha[97]       4.202293e-01  8.242427e-01  9.321998e-01  1.008989e+00
## alpha[98]       4.885919e-01  9.015125e-01  1.216511e+00  1.715035e+00
## alpha[99]      -1.315923e-01  1.032259e+00  1.525504e+00  1.535339e+00
## alpha[100]     -4.479452e-01  7.044523e-01  1.496292e+00  1.611144e+00
## alpha[101]      3.086138e-02  2.794659e-01  7.920808e-01  1.802887e+00
## alpha[102]      5.380527e-01  1.353801e+00  1.757470e+00  1.987581e+00
## alpha[103]     -4.808618e-01  3.952363e-01  1.247557e+00  1.455239e+00
## alpha[104]      8.383730e-01  1.171861e+00  1.254290e+00  1.389329e+00
## alpha[105]      1.735815e-01  7.294211e-01  8.891427e-01  1.273013e+00
## alpha[106]      7.449450e-02  2.161140e-01  4.668517e-01  9.991543e-01
## alpha[107]     -6.183804e-01  3.067384e-02  7.576050e-01  1.354624e+00
## alpha[108]     -1.451122e+00  1.687709e-01  1.717231e+00  1.768927e+00
## alpha[109]     -5.340716e-01 -2.329464e-02  6.396037e-01  1.699382e+00
## alpha[110]      5.142877e-01  1.060234e+00  1.219153e+00  1.633724e+00
## alpha[111]     -1.198548e+00 -6.863680e-01  8.657648e-02  1.231521e+00
## alpha[112]     -4.215443e-01  1.070264e-02  7.487995e-01  1.686766e+00
## alpha[113]      1.277247e+00  1.595938e+00  1.650294e+00  1.685268e+00
## alpha[114]     -5.233983e-01  1.592660e-01  1.081660e+00  1.807943e+00
## alpha[115]      7.516763e-01  8.592375e-01  9.593453e-01  1.153935e+00
## alpha[116]     -4.820101e-01 -1.259221e-01  1.542325e-01  4.044131e-01
## alpha[117]     -1.521998e+00 -4.456384e-01  7.470229e-01  1.166772e+00
## alpha[118]     -9.058140e-01  1.561184e-01  1.139194e+00  1.636192e+00
## alpha[119]     -3.191395e-01  3.992771e-01  5.223991e-01  5.464211e-01
## alpha[120]     -2.684734e-01  6.425162e-01  1.226351e+00  1.585272e+00
## alpha[121]     -1.063294e+00 -7.314678e-01 -3.682642e-01  3.687725e-01
## alpha[122]     -1.183352e+00 -8.995043e-01 -1.975099e-01  1.162726e+00
## alpha[123]     -1.539708e+00 -1.199739e+00 -5.762883e-01  5.395789e-01
## alpha[124]     -1.421784e+00 -2.986916e-01  9.852046e-01  1.818006e+00
## alpha[125]     -3.166208e-01  2.573549e-01  5.143065e-01  1.046524e+00
## alpha[126]     -7.214349e-01 -1.023472e-01  2.122662e-01  2.702776e-01
## alpha[127]     -1.587158e+00 -1.499870e+00 -1.132268e+00 -2.390179e-01
## alpha[128]     -8.311391e-01 -6.204390e-01  3.551144e-03  1.705050e+00
```

```
## alpha[129]      1.035684e+00  1.203716e+00  1.485207e+00  2.015538e+00
## alpha[130]     -1.731060e+00 -9.313478e-01  8.430506e-03  4.657977e-01
## alpha[131]     -1.183567e+00 -1.133113e+00 -6.152683e-01  7.915382e-01
## alpha[132]     -1.880077e+00 -1.036486e+00  2.946437e-01  1.774175e+00
## alpha[133]     -1.903841e+00 -1.653329e+00 -1.120552e+00 -2.297120e-01
## alpha[134]     -5.878247e-01  5.111103e-01  1.516239e+00  1.789846e+00
## alpha[135]     -2.637375e-01  2.568414e-01  7.405058e-01  1.076509e+00
## alpha[136]     -6.668260e-01 -2.071987e-01  3.748727e-01  1.830319e+00
## alpha[137]     -1.141030e+00 -5.481493e-01  6.665223e-02  8.190587e-01
## alpha[138]      2.908644e-02  5.985626e-01  1.212314e+00  1.591152e+00
## alpha[139]     -7.037771e-01  5.765788e-02  9.689373e-01  1.475793e+00
## alpha[140]     -1.508908e+00 -3.557185e-01  9.069197e-01  1.743469e+00
## alpha[141]     -4.400636e-02  8.420835e-01  1.367155e+00  1.677763e+00
## alpha[142]     -1.785950e+00 -2.994404e-01  1.182944e+00  1.288782e+00
## alpha[143]     -1.258755e+00 -7.370555e-01 -2.863921e-01 -5.753384e-02
## alpha[144]     -7.285823e-01  3.339482e-01  1.346505e+00  1.383361e+00
## alpha[145]     -8.974739e-01 -4.485962e-01  1.177964e-01  6.577120e-01
## alpha[146]     -2.276687e-01  2.414428e-01  6.208939e-01  9.794948e-01
## alpha[147]     -1.123071e+00 -9.475447e-01 -3.323107e-01  1.017553e+00
## alpha[148]     -1.154188e+00  3.643524e-02  1.169382e+00  1.671808e+00
## alpha[149]     -8.248422e-01  3.307965e-01  1.545494e+00  1.981520e+00
## alpha[150]     -4.594385e+01 -4.380705e+01 -3.348405e+01 -1.971045e+01
## alpha[151]     -2.917933e-02  6.408291e-02  2.061463e-01  3.889912e-01
## alpha[152]     -1.172858e+00 -4.397666e-01  8.668581e-02  2.151694e-01
## alpha[153]     -1.156813e+00 -2.520158e-01  4.594404e-01  8.168385e-01
## alpha[154]      2.411181e-02  7.601764e-01  1.238986e+00  1.770839e+00
## alpha[155]     -1.269230e+00 -4.853396e-01  5.757919e-01  1.774576e+00
## alpha[156]     -6.329074e-01  3.793146e-01  1.072770e+00  1.459824e+00
## alpha[157]     -1.524186e+00 -8.106626e-01  8.117846e-02  5.531313e-01
## alpha[158]     -1.194357e+00 -9.477003e-01 -6.139313e-01 -3.719776e-02
## alpha[159]      4.179321e-01  1.180476e+00  1.384879e+00  1.676546e+00
## alpha[160]     -1.795904e-01  5.061071e-01  1.117687e+00  1.653381e+00
## alpha[161]     -1.743687e+00 -7.976184e-01  2.828808e-01  9.192032e-01
## alpha[162]     -7.556624e-01  1.474376e-02  8.518749e-01  1.352442e+00
## alpha[163]     -1.338044e+00 -1.208644e+00 -5.246510e-01  1.441018e+00
## alpha[164]     -6.697048e-01 -2.670290e-01  3.990935e-02  7.539933e-01
## alpha[165]     -5.957165e-01  4.015806e-01  1.188011e+00  1.655508e+00
## alpha[166]     -1.414237e+00 -8.343387e-01 -3.544180e-01 -4.055510e-02
## alpha[167]      4.211883e-01  1.317987e+00  1.727008e+00  1.958025e+00
## alpha[168]     -3.929256e-01  3.190855e-01  1.011669e+00  1.354388e+00
## alpha[169]     -6.124246e+01 -5.938884e+01 -5.043668e+01 -3.852585e+01
## alpha[170]     -1.411854e+00 -7.923976e-01  1.267119e-01  1.297382e+00
## alpha[171]     -9.143961e-01  5.274978e-01  1.756069e+00  1.931628e+00
## alpha[172]     -1.573009e+00 -3.553552e-01  9.082110e-01  1.459623e+00
## alpha[173]      9.811794e-01  1.466773e+00  1.549392e+00  1.760316e+00
## alpha[174]     -1.058750e+00  4.337817e-01  1.711041e+00  1.850771e+00
## alpha[175]     -1.204237e+00 -7.661030e-01  2.943342e-01  6.622188e-01
## alpha[176]     -6.454766e-01 -1.421558e-01  4.437595e-01  1.857877e+00
## alpha[177]      3.687202e-02  5.606694e-01  1.132577e+00  1.504438e+00
## alpha[178]     -2.576448e+01 -2.305983e+01 -1.347314e+01 -2.766629e+00
## alpha[179]     -1.034602e-02  4.308406e-01  7.203788e-01  1.455994e+00
## alpha[180]     -6.035585e-01 -9.566765e-02  4.401678e-01  1.755778e+00
## alpha[181]     -1.700431e+00 -8.679058e-01 -3.226853e-02  1.765031e-01
## alpha[182]     -1.277654e-01  6.926494e-01  1.468588e+00  1.592357e+00
```

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## alpha[183]     -2.213462e-01  3.390462e-01  8.524557e-01  1.506973e+00
## alpha[184]     -1.442842e+00 -6.117417e-01  2.849822e-01  6.881560e-01
## alpha[185]     -3.260291e-01  2.655723e-01  1.009682e+00  1.272430e+00
## alpha[186]     -1.254409e+00 -8.711387e-01  2.380785e-02  1.963065e+00
## alpha[187]     -1.726886e+00 -1.587712e+00 -1.453491e+00 -1.438264e+00
## alpha[188]     -1.512968e+00 -1.376536e+00 -9.636930e-01  2.654003e-01
## alpha[189]     -6.677805e-01 -5.480570e-01 -9.635887e-02  8.132826e-01
## alpha[190]      4.637324e-01  7.354762e-01  1.069561e+00  1.331341e+00
## alpha[191]     -1.105657e+00 -6.713430e-01 -9.200203e-02  6.164153e-01
## alpha[192]     -2.923130e-01  6.464528e-01  1.590625e+00  1.817877e+00
## alpha[193]     -1.125103e+00 -4.633315e-01  3.171174e-01  8.594652e-01
## alpha[194]     -3.109470e-01  7.833055e-01  1.756768e+00  2.012908e+00
## alpha[195]     -2.777820e+02 -2.775537e+02 -2.765075e+02 -2.750976e+02
## beta           -5.712618e+02 -4.612459e+02 -4.388731e+02 -3.981404e+02
## log_theta[1]   -1.376969e+02 -1.126391e+02 -1.061163e+02 -9.495228e+01
## log_theta[2]   -1.324818e+02 -1.078038e+02 -1.015367e+02 -9.031841e+01
## log_theta[3]   -2.290606e+02 -1.860695e+02 -1.763540e+02 -1.589346e+02
## log_theta[4]   -1.700425e+02 -1.383280e+02 -1.301467e+02 -1.179216e+02
## log_theta[5]   -1.864015e+02 -1.488791e+02 -1.422346e+02 -1.285873e+02
## log_theta[6]   -1.902537e+02 -1.544039e+02 -1.474211e+02 -1.346266e+02
## log_theta[7]   -2.377571e+02 -1.905866e+02 -1.829151e+02 -1.646260e+02
## log_theta[8]   -2.396702e+02 -1.948240e+02 -1.846998e+02 -1.655374e+02
## log_theta[9]   -5.910938e+01 -4.813607e+01 -4.568599e+01 -4.195964e+01
## log_theta[10]  -1.009656e+02 -8.211033e+01 -7.763769e+01 -6.978772e+01
## log_theta[11]  -1.454240e+02 -1.179836e+02 -1.117892e+02 -1.031733e+02
## log_theta[12]  -1.865121e+02 -1.507398e+02 -1.421632e+02 -1.282154e+02
## log_theta[13]  -1.318370e+02 -1.063355e+02 -1.014628e+02 -9.270024e+01
## log_theta[14]  -1.446975e+02 -1.161366e+02 -1.104735e+02 -1.004400e+02
## log_theta[15]  -1.171964e+02 -9.350117e+01 -9.098655e+01 -8.281731e+01
## log_theta[16]  -1.596846e+02 -1.268909e+02 -1.225845e+02 -1.115357e+02
## log_theta[17]  -1.443397e+02 -1.176817e+02 -1.109431e+02 -1.018946e+02
## log_theta[18]  -1.045143e+02 -8.463464e+01 -8.021235e+01 -7.180519e+01
## log_theta[19]  -2.124997e+02 -1.729711e+02 -1.648684e+02 -1.505238e+02
## log_theta[20]  -1.378753e+02 -1.107699e+02 -1.058607e+02 -9.482822e+01
## log_theta[21]  -2.112412e+02 -1.700250e+02 -1.606627e+02 -1.455010e+02
## log_theta[22]  -1.704428e+02 -1.368938e+02 -1.304715e+02 -1.186700e+02
## log_theta[23]  -1.641944e+02 -1.335798e+02 -1.260738e+02 -1.131954e+02
## log_theta[24]  -1.403229e+02 -1.130756e+02 -1.080885e+02 -9.810286e+01
## log_theta[25]  -2.156735e+02 -1.737431e+02 -1.659688e+02 -1.497130e+02
## log_theta[26]  -1.068514e+02 -8.509467e+01 -8.166339e+01 -7.583321e+01
## log_theta[27]  -1.498074e+02 -1.200787e+02 -1.160492e+02 -1.043274e+02
## log_theta[28]  -1.694646e+02 -1.358169e+02 -1.296804e+02 -1.184955e+02
## log_theta[29]  -2.021980e+02 -1.644769e+02 -1.561122e+02 -1.418683e+02
## log_theta[30]  -2.379918e+02 -1.915697e+02 -1.823214e+02 -1.653244e+02
## log_theta[31]  -1.648305e+02 -1.344784e+02 -1.262078e+02 -1.142696e+02
## log_theta[32]  -1.962844e+02 -1.594203e+02 -1.519101e+02 -1.377921e+02
## log_theta[33]  -6.728338e+01 -5.329135e+01 -5.092751e+01 -4.504304e+01
## log_theta[34]  -1.258164e+02 -1.025499e+02 -9.503919e+01 -8.580319e+01
## log_theta[35]  -1.660694e+02 -1.328888e+02 -1.276704e+02 -1.160978e+02
## log_theta[36]  -2.450019e+02 -1.976178e+02 -1.881984e+02 -1.700149e+02
## log_theta[37]  -1.199378e+02 -9.748660e+01 -9.229450e+01 -8.416704e+01
## log_theta[38]  -1.529494e+02 -1.254265e+02 -1.179651e+02 -1.087121e+02
## log_theta[39]  -4.867510e+01 -4.060027e+01 -3.853812e+01 -3.608747e+01
## log_theta[40]  -1.821728e+02 -1.463681e+02 -1.405651e+02 -1.290498e+02
```

```
## log_theta[41]  -1.053134e+02 -8.553048e+01 -8.098153e+01 -7.480573e+01
## log_theta[42]  -1.021822e+02 -8.132753e+01 -7.855357e+01 -6.969624e+01
## log_theta[43]  -1.409368e+02 -1.154021e+02 -1.079252e+02 -9.894049e+01
## log_theta[44]  -1.153059e+02 -9.441386e+01 -8.736985e+01 -7.959208e+01
## log_theta[45]  -9.054123e+01 -7.261847e+01 -6.944984e+01 -6.267102e+01
## log_theta[46]  -1.803606e+02 -1.443350e+02 -1.383788e+02 -1.269500e+02
## log_theta[47]  -4.286276e+01 -3.448609e+01 -3.271133e+01 -3.110072e+01
## log_theta[48]  -8.561498e+01 -6.918938e+01 -6.516491e+01 -5.942589e+01
## log_theta[49]  -1.296923e+02 -1.053976e+02 -9.838410e+01 -8.912400e+01
## log_theta[50]  -6.765929e+01 -5.429384e+01 -5.250346e+01 -4.849957e+01
## log_theta[51]  -2.005959e+02 -1.629102e+02 -1.538456e+02 -1.403052e+02
## log_theta[52]  -1.675922e+02 -1.333073e+02 -1.278120e+02 -1.144816e+02
## log_theta[53]  -7.633276e+01 -6.133365e+01 -5.908248e+01 -5.524131e+01
## log_theta[54]  -5.652913e+01 -4.672819e+01 -4.329231e+01 -3.952993e+01
## log_theta[55]  -1.345348e+02 -1.078789e+02 -1.042877e+02 -9.565399e+01
## log_theta[56]  -1.358720e+02 -1.103528e+02 -1.045218e+02 -9.462900e+01
## log_theta[57]  -5.107109e+01 -4.218508e+01 -3.875402e+01 -3.581693e+01
## log_theta[58]  -2.034407e+02 -1.657398e+02 -1.561893e+02 -1.402214e+02
## log_theta[59]  -5.779067e+01 -4.791279e+01 -4.324830e+01 -4.001823e+01
## log_theta[60]  -2.155319e+01 -1.784679e+01 -1.667210e+01 -1.547000e+01
## log_theta[61]  -9.541071e+01 -7.737748e+01 -7.376671e+01 -6.616572e+01
## log_theta[62]  -6.995592e+01 -5.654609e+01 -5.329000e+01 -4.804781e+01
## log_theta[63]  -1.247797e+02 -1.010292e+02 -9.462511e+01 -8.624015e+01
## log_theta[64]  -7.265563e+01 -5.818388e+01 -5.588637e+01 -5.136427e+01
## log_theta[65]  -4.887253e+01 -3.905524e+01 -3.726915e+01 -3.339066e+01
## log_theta[66]  -4.257331e+01 -3.418475e+01 -3.198297e+01 -3.015538e+01
## log_theta[67]  -2.178065e+01 -1.708627e+01 -1.641063e+01 -1.496518e+01
## log_theta[68]  -1.261722e+02 -1.034260e+02 -9.741251e+01 -8.808707e+01
## log_theta[69]  -1.752939e+02 -1.419212e+02 -1.337497e+02 -1.220999e+02
## log_theta[70]  -1.790367e+01 -1.521169e+01 -1.373722e+01 -1.318758e+01
## log_theta[71]  -4.284136e+01 -3.449575e+01 -3.249363e+01 -2.826730e+01
## log_theta[72]  -3.360004e+01 -2.723794e+01 -2.620892e+01 -2.451658e+01
## log_theta[73]  -1.455587e+02 -1.189729e+02 -1.110810e+02 -9.991830e+01
## log_theta[74]  -1.672899e+02 -1.364197e+02 -1.276576e+02 -1.163504e+02
## log_theta[75]  -9.652953e+01 -7.905302e+01 -7.382945e+01 -6.798284e+01
## log_theta[76]  -1.427467e+02 -1.166880e+02 -1.104786e+02 -1.021143e+02
## log_theta[77]  -1.118905e+02 -8.969779e+01 -8.732202e+01 -7.974769e+01
## log_theta[78]  -8.269269e+01 -6.707461e+01 -6.337660e+01 -5.676512e+01
## log_theta[79]  -1.317820e+02 -1.062498e+02 -1.019205e+02 -9.085492e+01
## log_theta[80]  -1.411367e+02 -1.151191e+02 -1.088863e+02 -9.707357e+01
## log_theta[81]  -1.739116e+02 -1.414311e+02 -1.340007e+02 -1.214279e+02
## log_theta[82]  -8.592349e+01 -6.947104e+01 -6.742221e+01 -6.256929e+01
## log_theta[83]  -8.591690e+01 -6.968490e+01 -6.524169e+01 -5.999221e+01
## log_theta[84]  -2.018750e+02 -1.624503e+02 -1.554616e+02 -1.423668e+02
## log_theta[85]  -1.576451e+02 -1.255926e+02 -1.219981e+02 -1.101579e+02
## log_theta[86]  -4.728378e+01 -3.856166e+01 -3.655211e+01 -3.309444e+01
## log_theta[87]  -5.661598e+01 -4.762613e+01 -4.368310e+01 -4.034301e+01
## log_theta[88]  -9.255876e+01 -7.607713e+01 -7.060256e+01 -6.554230e+01
## log_theta[89]  -7.354573e+01 -5.800436e+01 -5.530764e+01 -4.894805e+01
## log_theta[90]  -1.345317e+02 -1.078338e+02 -1.041546e+02 -9.397018e+01
## log_theta[91]  -4.163335e+01 -3.376648e+01 -3.203293e+01 -2.733134e+01
## log_theta[92]  -1.574378e+02 -1.272857e+02 -1.200331e+02 -1.088510e+02
## log_theta[93]  -3.394149e+01 -3.385247e+01 -3.376787e+01 -3.360030e+01
## log_theta[94]  -8.180706e+01 -6.527791e+01 -6.357129e+01 -5.806044e+01
```

```
## log_theta[95]  -7.577210e+01 -6.112655e+01 -5.853606e+01 -5.280029e+01
## log_theta[96]  -6.098921e+01 -4.740521e+01 -4.607314e+01 -4.156834e+01
## log_theta[97]  -3.045022e+01 -2.531453e+01 -2.307284e+01 -2.068982e+01
## log_theta[98]  -5.897086e+01 -4.749289e+01 -4.577675e+01 -4.066038e+01
## log_theta[99]  -7.647858e+01 -6.005586e+01 -5.748297e+01 -5.266467e+01
## log_theta[100] -1.789500e+02 -1.430832e+02 -1.366742e+02 -1.248564e+02
## log_theta[101] -7.551459e+01 -6.104764e+01 -5.760997e+01 -5.100938e+01
## log_theta[102] -6.954312e+01 -5.532602e+01 -5.180900e+01 -4.671270e+01
## log_theta[103] -1.134540e+02 -9.245894e+01 -8.610939e+01 -7.814818e+01
## log_theta[104] -3.422155e+01 -2.746329e+01 -2.657217e+01 -2.466577e+01
## log_theta[105] -7.405748e+01 -5.988237e+01 -5.769328e+01 -5.371446e+01
## log_theta[106] -4.827229e+01 -3.819168e+01 -3.699161e+01 -3.359553e+01
## log_theta[107] -1.539580e+02 -1.227609e+02 -1.179503e+02 -1.064736e+02
## log_theta[108] -7.978723e+01 -6.530210e+01 -6.238074e+01 -5.386411e+01
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## log_theta[110] -5.582888e+01 -4.499921e+01 -4.340599e+01 -4.075783e+01
## log_theta[111] -4.047798e+01 -3.300245e+01 -3.154780e+01 -2.640168e+01
## log_theta[112] -5.803298e+01 -4.761120e+01 -4.373814e+01 -4.034182e+01
## log_theta[113] -4.347446e+01 -3.440820e+01 -3.254422e+01 -2.933984e+01
## log_theta[114] -1.386992e+01 -1.216329e+01 -1.029557e+01 -9.309732e+00
## log_theta[115] -5.678614e+01 -4.579759e+01 -4.366886e+01 -3.949624e+01
## log_theta[116] -5.758230e+01 -4.601347e+01 -4.458197e+01 -3.983007e+01
## log_theta[117] -4.736947e+01 -3.828731e+01 -3.669513e+01 -3.460243e+01
## log_theta[118] -1.678099e+02 -1.346737e+02 -1.305168e+02 -1.191126e+02
## log_theta[119] -4.483178e+01 -3.616749e+01 -3.451831e+01 -3.069065e+01
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## log_theta[121] -1.408925e+02 -1.136427e+02 -1.082528e+02 -9.713543e+01
## log_theta[122] -5.614532e+01 -4.631077e+01 -4.264432e+01 -3.962155e+01
## log_theta[123] -6.654043e+01 -5.417796e+01 -5.124812e+01 -4.502072e+01
## log_theta[124] -5.913642e+01 -4.740520e+01 -4.577383e+01 -4.298863e+01
## log_theta[125] -9.213764e+01 -7.576348e+01 -7.013556e+01 -6.317971e+01
## log_theta[126] -1.104576e+02 -8.855615e+01 -8.523958e+01 -7.628778e+01
## log_theta[127] -1.557228e+02 -1.265390e+02 -1.206965e+02 -1.097552e+02
## log_theta[128] -8.394229e+01 -6.815852e+01 -6.376403e+01 -5.896529e+01
## log_theta[129] -1.006174e+02 -8.135043e+01 -7.677230e+01 -6.901529e+01
## log_theta[130] -1.030316e+02 -8.269530e+01 -7.908598e+01 -7.303388e+01
## log_theta[131] -8.484097e+01 -6.925344e+01 -6.614652e+01 -6.016920e+01
## log_theta[132] -8.025245e+01 -6.550795e+01 -6.011220e+01 -5.331194e+01
## log_theta[133] -4.767617e+01 -3.897280e+01 -3.628884e+01 -3.229191e+01
## log_theta[134] -3.544823e+01 -2.871619e+01 -2.557938e+01 -2.323316e+01
## log_theta[135] -1.105187e+02 -8.925907e+01 -8.409068e+01 -7.592159e+01
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## log_theta[137] -6.027656e+01 -4.837894e+01 -4.681031e+01 -4.363649e+01
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## log_theta[139] -5.628211e+01 -4.653241e+01 -4.391119e+01 -4.060276e+01
## log_theta[140] -8.228068e+01 -6.618345e+01 -6.468677e+01 -5.890550e+01
## log_theta[141] -2.016256e+01 -1.511242e+01 -1.451933e+01 -1.358388e+01
## log_theta[142] -2.209305e+01 -1.982377e+01 -1.835310e+01 -1.616464e+01
## log_theta[143] -7.979128e+01 -6.396591e+01 -6.166862e+01 -5.673754e+01
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## log_theta[146] -3.620396e+01 -3.010307e+01 -2.787922e+01 -2.498291e+01
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## log_theta[148] -4.856880e+01 -3.874982e+01 -3.611579e+01 -3.231545e+01
```

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## log_theta[149] -8.220741e+01 -6.765567e+01 -6.384534e+01 -5.944120e+01
## log_theta[150] -8.814828e+01 -8.804314e+01 -8.795349e+01 -8.780791e+01
## log_theta[151] -4.251942e+01 -3.438424e+01 -3.248316e+01 -2.929754e+01
## log_theta[152] -1.686976e+02 -1.375095e+02 -1.289941e+02 -1.169242e+02
## log_theta[153] -1.304423e+02 -1.066095e+02 -1.001530e+02 -8.993965e+01
## log_theta[154] -7.555928e+01 -6.148888e+01 -5.929685e+01 -5.504697e+01
## log_theta[155] -5.103897e+01 -4.253563e+01 -4.049978e+01 -3.790260e+01
## log_theta[156] -7.056530e+01 -5.855928e+01 -5.309280e+01 -4.834022e+01
## log_theta[157] -1.020047e+02 -8.313980e+01 -7.750279e+01 -7.070271e+01
## log_theta[158] -3.609826e+01 -2.946586e+01 -2.861717e+01 -2.632439e+01
## log_theta[159] -4.232136e+01 -3.260391e+01 -3.139196e+01 -2.846174e+01
## log_theta[160] -5.662008e+01 -4.539083e+01 -4.364700e+01 -4.075162e+01
## log_theta[161] -3.475492e+01 -2.878288e+01 -2.552912e+01 -2.257649e+01
## log_theta[162] -4.103124e+01 -3.405115e+01 -3.049998e+01 -2.792613e+01
## log_theta[163] -3.752673e+01 -3.109788e+01 -2.889818e+01 -2.698637e+01
## log_theta[164] -9.597490e+01 -7.791336e+01 -7.493837e+01 -6.891310e+01
## log_theta[165] -6.825009e+01 -5.644978e+01 -5.216974e+01 -4.609741e+01
## log_theta[166] -1.022355e+02 -8.269181e+01 -7.786744e+01 -7.047537e+01
## log_theta[167] -9.363831e+01 -7.449823e+01 -7.014211e+01 -6.329780e+01
## log_theta[168] -7.797168e+01 -6.207358e+01 -5.975037e+01 -5.278811e+01
## log_theta[169] -9.791276e+01 -9.779881e+01 -9.770632e+01 -9.755606e+01
## log_theta[170] -1.252672e+02 -9.943071e+01 -9.652054e+01 -8.681570e+01
## log_theta[171] -9.360763e+01 -7.759664e+01 -7.225772e+01 -6.681966e+01
## log_theta[172] -1.160953e+02 -9.501309e+01 -8.762538e+01 -7.981644e+01
## log_theta[173] -7.391710e+01 -6.054737e+01 -5.641211e+01 -5.115312e+01
## log_theta[174] -3.003074e+01 -2.497266e+01 -2.281699e+01 -1.910346e+01
## log_theta[175] -1.669766e+01 -1.429298e+01 -1.272937e+01 -1.178740e+01
## log_theta[176] -2.248179e+01 -1.913612e+01 -1.853912e+01 -1.581287e+01
## log_theta[177] -9.162837e+01 -7.430321e+01 -7.034362e+01 -6.284365e+01
## log_theta[178] -5.863660e+01 -5.620108e+01 -5.517191e+01 -5.502672e+01
## log_theta[179] -5.754271e+01 -4.611334e+01 -4.464144e+01 -3.856634e+01
## log_theta[180] -4.273772e+01 -3.455781e+01 -3.210329e+01 -2.978426e+01
## log_theta[181] -3.439778e+01 -2.720396e+01 -2.584082e+01 -2.309498e+01
## log_theta[182] -2.654555e+01 -2.147245e+01 -2.051410e+01 -1.955128e+01
## log_theta[183] -5.724620e+01 -4.618268e+01 -4.436738e+01 -3.840981e+01
## log_theta[184] -2.534297e+01 -2.144511e+01 -1.856733e+01 -1.708447e+01
## log_theta[185] -4.803416e+01 -3.767604e+01 -3.649864e+01 -3.248184e+01
## log_theta[186] -6.524537e+01 -5.291345e+01 -5.037273e+01 -4.280731e+01
## log_theta[187] -1.310598e+02 -1.059633e+02 -1.010703e+02 -9.167176e+01
## log_theta[188] -2.567644e+01 -2.173601e+01 -1.988610e+01 -1.868103e+01
## log_theta[189] -8.062263e+01 -6.531413e+01 -6.163870e+01 -5.501076e+01
## log_theta[190] -1.727738e+01 -1.390114e+01 -1.262562e+01 -1.115390e+01
## log_theta[191] -2.095765e+01 -1.741473e+01 -1.628234e+01 -1.466551e+01
## log_theta[192] -3.921700e+01 -3.211100e+01 -3.059562e+01 -2.591311e+01
## log_theta[193] -3.548693e+01 -2.944350e+01 -2.784605e+01 -2.447693e+01
## log_theta[194] -5.199857e+01 -4.154733e+01 -4.109180e+01 -4.104449e+01
## log_theta[195] -2.820762e+02 -2.820409e+02 -2.820073e+02 -2.819456e+02
## lp__           -4.072140e+05 -3.063169e+05 -2.878773e+05 -2.561074e+05
##                      n_eff        Rhat
## alpha[1]          2.001172 203.6895999
## alpha[2]          2.001276 159.3332298
## alpha[3]          2.001115 158.3447252
## alpha[4]          2.001715  58.4568129
## alpha[5]          2.001182 127.2589366
```

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## alpha[6]          2.001329 129.1675546
## alpha[7]          2.001395 114.6005742
## alpha[8]          2.001092 185.9351318
## alpha[9]          2.010294  27.6515500
## alpha[10]         2.002565  77.8809013
## alpha[11]         2.001451 142.6658510
## alpha[12]         2.001304 129.1089898
## alpha[13]         2.001628  79.5954470
## alpha[14]         2.001665 101.6533832
## alpha[15]         2.001222 170.4812009
## alpha[16]         2.001151 146.2410871
## alpha[17]         2.001354 116.0456236
## alpha[18]         2.001577  77.7455856
## alpha[19]         2.001492 125.2780086
## alpha[20]         2.001391 104.3087739
## alpha[21]         2.001068 202.5341116
## alpha[22]         2.003009  49.7993792
## alpha[23]         2.001126 145.0550157
## alpha[24]         2.003253  50.1489268
## alpha[25]         2.001841  79.4031013
## alpha[26]         2.001146 210.9147612
## alpha[27]         2.001272 109.0486393
## alpha[28]         2.001192 157.6944700
## alpha[29]         2.001212 119.9532368
## alpha[30]         2.001486  74.1648867
## alpha[31]         2.001244 105.7825428
## alpha[32]         2.003057  49.7962717
## alpha[33]         2.001177 168.2879392
## alpha[34]         2.001335 142.1292408
## alpha[35]         2.001844  92.5866973
## alpha[36]         2.001998  89.1882805
## alpha[37]         2.002800  55.2716940
## alpha[38]         2.001113 239.0995336
## alpha[39]         2.001079 205.3303634
## alpha[40]         2.001368 106.9089629
## alpha[41]         2.001107 154.8047382
## alpha[42]         2.001375 130.3356838
## alpha[43]         2.001173 161.6805388
## alpha[44]         2.001143 179.0986646
## alpha[45]         2.003609  66.9801038
## alpha[46]         2.001101 192.7719651
## alpha[47]         2.001285 133.2954965
## alpha[48]         2.002527  65.9689595
## alpha[49]         2.001545  90.9581161
## alpha[50]         2.001090 207.5615497
## alpha[51]         2.001245 136.8118657
## alpha[52]         2.001042 236.2970835
## alpha[53]         2.001139 227.9139481
## alpha[54]         2.002220  89.8441383
## alpha[55]         2.001331 119.8739731
## alpha[56]         2.001656  75.0292114
## alpha[57]         2.001619 100.2457905
## alpha[58]         2.001148 147.2219900
## alpha[59]         2.001364 133.1922142
```

```
## alpha[60]         2.001213 154.4029826
## alpha[61]         2.001474  82.2660953
## alpha[62]         2.006927  34.1034340
## alpha[63]         2.001364 143.5587014
## alpha[64]         2.002892  41.3697626
## alpha[65]         2.001912  64.5175417
## alpha[66]         2.001137 187.9111704
## alpha[67]         2.001863  80.5893533
## alpha[68]         2.001142 174.7557197
## alpha[69]         2.001373 126.9545014
## alpha[70]         2.001393 121.2579662
## alpha[71]         2.001348 123.3122925
## alpha[72]         2.001736  92.5225209
## alpha[73]         2.001123 193.9875424
## alpha[74]         2.001386 136.8895488
## alpha[75]         2.001778  88.7013795
## alpha[76]         2.001125 152.7810201
## alpha[77]         2.001212 164.8479656
## alpha[78]         2.002191  71.4692065
## alpha[79]         2.001424 123.9257163
## alpha[80]         2.001123 166.7589120
## alpha[81]         2.002096  90.0990288
## alpha[82]         2.001088 180.5275671
## alpha[83]         2.001214 148.4458759
## alpha[84]         2.001347 122.1357746
## alpha[85]         2.001166 153.9861658
## alpha[86]         2.003109  43.5116716
## alpha[87]         2.001107 196.2811859
## alpha[88]         2.001138 168.9521957
## alpha[89]         2.001073 261.3476856
## alpha[90]         2.001223 129.3816133
## alpha[91]         2.001257 116.4607236
## alpha[92]         2.003032  65.4436021
## alpha[93]         6.431433   2.1697692
## alpha[94]         2.001160 161.9484874
## alpha[95]         2.002812  44.9395105
## alpha[96]         2.001337 131.2003211
## alpha[97]         2.002121  82.6897609
## alpha[98]         2.001226 126.1465070
## alpha[99]         2.001143 242.5502511
## alpha[100]        2.001851  97.4376509
## alpha[101]        2.001123 141.7397188
## alpha[102]        2.001360 117.8344183
## alpha[103]        2.001090 182.5462707
## alpha[104]        2.004284  38.0957446
## alpha[105]        2.001355  98.1257151
## alpha[106]        2.001935  57.9025238
## alpha[107]        2.001353 132.0126151
## alpha[108]        2.001388 166.4944916
## alpha[109]        2.001166 163.8915285
## alpha[110]        2.001089 176.7470419
## alpha[111]        2.001160 134.3109575
## alpha[112]        2.002029  79.3814214
## alpha[113]        2.002013  52.5597900
```

```
## alpha[114]        2.001607 106.8732380
## alpha[115]        2.010564  18.2533565
## alpha[116]        2.004569  36.9876524
## alpha[117]        2.001082 191.9160883
## alpha[118]        2.001209 150.4762295
## alpha[119]        2.001325 116.4847733
## alpha[120]        2.001452 108.5220231
## alpha[121]        2.001463 101.7452408
## alpha[122]        2.001329  96.0371926
## alpha[123]        2.001182 138.6171840
## alpha[124]        2.001104 177.1015589
## alpha[125]        2.001250 140.3289320
## alpha[126]        2.001500 101.9704587
## alpha[127]        2.002088  68.1546581
## alpha[128]        2.001164 157.5407673
## alpha[129]        2.003053  36.9403812
## alpha[130]        2.001241 103.7611911
## alpha[131]        2.001395 114.4554904
## alpha[132]        2.001192 122.2160868
## alpha[133]        2.002362  61.5853227
## alpha[134]        2.001389 115.2155628
## alpha[135]        2.002333  56.1145200
## alpha[136]        2.001280 180.5744572
## alpha[137]        2.001194 155.2940115
## alpha[138]        2.001810  72.0069832
## alpha[139]        2.001237 175.2951260
## alpha[140]        2.001130 189.3716561
## alpha[141]        2.001219 137.6029191
## alpha[142]        2.001029 356.9213270
## alpha[143]        2.001696  74.2237927
## alpha[144]        2.001173 120.8015678
## alpha[145]        2.002135  75.0003155
## alpha[146]        2.001574  81.3972629
## alpha[147]        2.001400  93.6563505
## alpha[148]        2.001151 139.9500665
## alpha[149]        2.001310 163.1858999
## alpha[150]        6.368266   2.2154968
## alpha[151]        2.058192  12.0804073
## alpha[152]        2.001265 143.7418488
## alpha[153]        2.001300 107.2416077
## alpha[154]        2.001314 149.4339136
## alpha[155]        2.001185 122.1731563
## alpha[156]        2.001070 217.7690931
## alpha[157]        2.001332 113.3220380
## alpha[158]        2.003208  62.1800671
## alpha[159]        2.001477 102.7912239
## alpha[160]        2.001515  82.9062626
## alpha[161]        2.001645  91.2790045
## alpha[162]        2.001692 110.9418543
## alpha[163]        2.001289 136.1885963
## alpha[164]        2.001273 134.6438238
## alpha[165]        2.001230 166.3796342
## alpha[166]        2.001654 105.0757385
## alpha[167]        2.001385 140.4694145
```

```
## alpha[168]        2.001420 107.2524904
## alpha[169]        6.364668   2.2137080
## alpha[170]        2.001517  86.1005851
## alpha[171]        2.001140 160.5848055
## alpha[172]        2.001074 271.6061113
## alpha[173]        2.002872  67.9910073
## alpha[174]        2.001082 210.4479334
## alpha[175]        2.036158  17.8502520
## alpha[176]        2.001130 158.6790707
## alpha[177]        2.003270  53.0130914
## alpha[178]        4.809760   2.5390213
## alpha[179]        2.001398 114.8425545
## alpha[180]        2.001216 113.3370546
## alpha[181]        2.001492  89.2396961
## alpha[182]        2.001410 109.2611327
## alpha[183]        2.001319 117.8997022
## alpha[184]        2.001098 174.3810268
## alpha[185]        2.002964  36.9815277
## alpha[186]        2.001101 185.3631637
## alpha[187]        2.022375  14.9546700
## alpha[188]        2.001486  93.9433190
## alpha[189]        2.001924  77.1078484
## alpha[190]        2.004577  34.0514928
## alpha[191]        2.001595  68.9136543
## alpha[192]        2.001120 166.1698882
## alpha[193]        2.001309  99.9759015
## alpha[194]        2.802130   4.3708227
## alpha[195]        6.394093   2.2062073
## beta              6.367318   2.2143062
## log_theta[1]      6.371914   2.2138608
## log_theta[2]      6.076414   2.2621191
## log_theta[3]      6.311714   2.2234138
## log_theta[4]      6.319817   2.2222045
## log_theta[5]      6.113711   2.2559040
## log_theta[6]      6.657494   2.1697832
## log_theta[7]      6.226732   2.2371831
## log_theta[8]      6.307251   2.2243376
## log_theta[9]      6.536566   2.1868654
## log_theta[10]     6.220418   2.2384013
## log_theta[11]     6.542321   2.1871098
## log_theta[12]     6.098496   2.2586691
## log_theta[13]     6.361036   2.2156765
## log_theta[14]     6.164208   2.2479682
## log_theta[15]     6.551707   2.1860891
## log_theta[16]     6.223987   2.2378225
## log_theta[17]     6.540076   2.1877441
## log_theta[18]     6.257226   2.2321344
## log_theta[19]     6.706069   2.1626269
## log_theta[20]     6.156339   2.2486528
## log_theta[21]     6.111857   2.2565456
## log_theta[22]     6.304746   2.2249101
## log_theta[23]     6.283691   2.2279533
## log_theta[24]     6.298345   2.2249283
## log_theta[25]     6.311951   2.2231925
```

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## log_theta[26]     6.328043   2.2197930
## log_theta[27]     6.395670   2.2098581
## log_theta[28]     6.323556   2.2215183
## log_theta[29]     6.507094   2.1922676
## log_theta[30]     6.281233   2.2281477
## log_theta[31]     6.414703   2.2066651
## log_theta[32]     6.503601   2.1931271
## log_theta[33]     5.636690   2.3438808
## log_theta[34]     5.992068   2.2762259
## log_theta[35]     6.331214   2.2195123
## log_theta[36]     6.317472   2.2223244
## log_theta[37]     6.570529   2.1830764
## log_theta[38]     6.767662   2.1531883
## log_theta[39]     7.789224   2.0206541
## log_theta[40]     6.548115   2.1861328
## log_theta[41]     6.528967   2.1888902
## log_theta[42]     6.041016   2.2700301
## log_theta[43]     6.511267   2.1915030
## log_theta[44]     6.194985   2.2421333
## log_theta[45]     6.086869   2.2603899
## log_theta[46]     6.376326   2.2130339
## log_theta[47]     6.375004   2.2136380
## log_theta[48]     6.177351   2.2457164
## log_theta[49]     6.161167   2.2484734
## log_theta[50]     6.710805   2.1618984
## log_theta[51]     6.359743   2.2155923
## log_theta[52]     5.932325   2.2876705
## log_theta[53]     6.740301   2.1580275
## log_theta[54]     6.548673   2.1858925
## log_theta[55]     6.602085   2.1779408
## log_theta[56]     6.438276   2.2028662
## log_theta[57]     6.167733   2.2467181
## log_theta[58]     6.304482   2.2242819
## log_theta[59]     6.075550   2.2639678
## log_theta[60]     6.238642   2.2364612
## log_theta[61]     6.336289   2.2192443
## log_theta[62]     6.153748   2.2495003
## log_theta[63]     6.173133   2.2465258
## log_theta[64]     6.499893   2.1936681
## log_theta[65]     5.885948   2.2965029
## log_theta[66]     6.009125   2.2744575
## log_theta[67]     5.708783   2.3251631
## log_theta[68]     6.539197   2.1871735
## log_theta[69]     6.269974   2.2299609
## log_theta[70]     6.975795   2.1271390
## log_theta[71]     5.579521   2.3522391
## log_theta[72]     6.951690   2.1274189
## log_theta[73]     6.208777   2.2400929
## log_theta[74]     6.345435   2.2177408
## log_theta[75]     6.461346   2.2007320
## log_theta[76]     6.863932   2.1394264
## log_theta[77]     6.751803   2.1565604
## log_theta[78]     6.338809   2.2187593
## log_theta[79]     6.296019   2.2260803
```

```
## log_theta[80]     6.331225   2.2202525
## log_theta[81]     6.494796   2.1948896
## log_theta[82]     7.085883   2.1090027
## log_theta[83]     6.220129   2.2387017
## log_theta[84]     6.459724   2.1998830
## log_theta[85]     6.305092   2.2242494
## log_theta[86]     6.766097   2.1548331
## log_theta[87]     7.078484   2.1101244
## log_theta[88]     6.520507   2.1906210
## log_theta[89]     5.368917   2.3981532
## log_theta[90]     6.453926   2.2007206
## log_theta[91]     5.773572   2.3163372
## log_theta[92]     6.201138   2.2413596
## log_theta[93]   289.108240   1.0192957
## log_theta[94]     6.480102   2.1967644
## log_theta[95]     6.475127   2.1974826
## log_theta[96]     5.632223   2.3439706
## log_theta[97]     6.336700   2.2202144
## log_theta[98]     6.415027   2.2061912
## log_theta[99]     5.783570   2.3149419
## log_theta[100]    6.246164   2.2349411
## log_theta[101]    5.986783   2.2781742
## log_theta[102]    5.706588   2.3292520
## log_theta[103]    6.176332   2.2453366
## log_theta[104]    7.046911   2.1164345
## log_theta[105]    6.979471   2.1231814
## log_theta[106]    6.207589   2.2404308
## log_theta[107]    6.139906   2.2517186
## log_theta[108]    6.150431   2.2497615
## log_theta[109]    6.636459   2.1725260
## log_theta[110]    7.061399   2.1125921
## log_theta[111]    5.475140   2.3765540
## log_theta[112]    6.254594   2.2327828
## log_theta[113]    5.942269   2.2867988
## log_theta[114]    6.163781   2.2507589
## log_theta[115]    6.459851   2.1994551
## log_theta[116]    6.146039   2.2510838
## log_theta[117]    6.914152   2.1326275
## log_theta[118]    6.606215   2.1771258
## log_theta[119]    6.079328   2.2629958
## log_theta[120]    6.772490   2.1527353
## log_theta[121]    6.164865   2.2480792
## log_theta[122]    6.343574   2.2175966
## log_theta[123]    5.880317   2.2975316
## log_theta[124]    6.501045   2.1929996
## log_theta[125]    6.220502   2.2383362
## log_theta[126]    6.183119   2.2450838
## log_theta[127]    6.530535   2.1887543
## log_theta[128]    6.319037   2.2215211
## log_theta[129]    6.237028   2.2354274
## log_theta[130]    6.416600   2.2070273
## log_theta[131]    6.781920   2.1522979
## log_theta[132]    5.576808   2.3545983
## log_theta[133]    5.732619   2.3231047
```

```
## log_theta[134]    5.124747   2.4481888
## log_theta[135]    6.104736   2.2577011
## log_theta[136]    6.159030   2.2492362
## log_theta[137]    6.757363   2.1544120
## log_theta[138]    6.898080   2.1364228
## log_theta[139]    7.205258   2.0929951
## log_theta[140]    6.883076   2.1371394
## log_theta[141]    4.587202   2.5881794
## log_theta[142]    9.086296   1.8895993
## log_theta[143]    6.483850   2.1955479
## log_theta[144]    4.794232   2.5332565
## log_theta[145]    6.826343   2.1456047
## log_theta[146]    6.553242   2.1842521
## log_theta[147]    6.905328   2.1341160
## log_theta[148]    5.318053   2.4097437
## log_theta[149]    7.104320   2.1072413
## log_theta[150]   11.869449   1.3069705
## log_theta[151]    6.228637   2.2392318
## log_theta[152]    6.278646   2.2287803
## log_theta[153]    6.288476   2.2268286
## log_theta[154]    7.235860   2.0894815
## log_theta[155]    7.827463   2.0168758
## log_theta[156]    6.153675   2.2497608
## log_theta[157]    6.175931   2.2457538
## log_theta[158]    7.108691   2.1033420
## log_theta[159]    5.378912   2.3956970
## log_theta[160]    6.713086   2.1612716
## log_theta[161]    5.063471   2.4652752
## log_theta[162]    5.900352   2.2954557
## log_theta[163]    6.362421   2.2161262
## log_theta[164]    6.869522   2.1391854
## log_theta[165]    6.136662   2.2529707
## log_theta[166]    6.054090   2.2660230
## log_theta[167]    5.774437   2.3157194
## log_theta[168]    5.891304   2.2954030
## log_theta[169]   14.420317   1.2643433
## log_theta[170]    6.119906   2.2544721
## log_theta[171]    6.955046   2.1271016
## log_theta[172]    6.108216   2.2570272
## log_theta[173]    6.487100   2.1962370
## log_theta[174]    5.376802   2.3972869
## log_theta[175]    6.403974   2.2004952
## log_theta[176]    7.760589   2.0253279
## log_theta[177]    6.221589   2.2383638
## log_theta[178]    2.397191   4.1576082
## log_theta[179]    5.848435   2.3034699
## log_theta[180]    5.947245   2.2849466
## log_theta[181]    5.250688   2.4231578
## log_theta[182]    7.230793   2.0869245
## log_theta[183]    5.934529   2.2883859
## log_theta[184]    5.364471   2.3972076
## log_theta[185]    5.714695   2.3266102
## log_theta[186]    5.514710   2.3670487
## log_theta[187]    6.319761   2.2212468
```

```
## log_theta[188]    6.514240   2.1920584
## log_theta[189]    6.059249   2.2657406
## log_theta[190]    5.558285   2.3642104
## log_theta[191]    6.636230   2.1702194
## log_theta[192]    5.958873   2.2824587
## log_theta[193]    6.513814   2.1911215
## log_theta[194]    7.516942   2.0360888
## log_theta[195] 3857.065190   0.9999456
## lp__              6.633316   2.1307773
```

Case3

```
# Stan model code for Hierarchical Model
stan_model_code_hm <- '
data {
  int<lower=0> N; // Number of observations
  int y[N];
  vector[N] log_exp;
  vector[N] x;
}

parameters {
  vector[N] alpha;
  real<lower=0> sigma;
  real beta;
  real mu;
}
transformed parameters {
  vector[N] log_theta;
  log_theta = alpha + beta*x;
}
model {
  y ~ poisson_log(log_theta+log_exp);
  alpha ~ normal(mu, sigma);
  beta ~ normal(0,1);
  mu ~ normal(0,1);
  sigma ~ normal(0,1);
}
'
# Compile and fit the model
fit_hm <- stan(model_code = stan_model_code_hm,
               data = data_list,
               chains = 4,
               iter = 2000,
               warmup = 1000)
```

```
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 0.000159 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 1.59 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 2000 [  0%]  (Warmup)
```

```
## Chain 1: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1:
## Chain 1:  Elapsed Time: 1.709 seconds (Warm-up)
## Chain 1:                31.661 seconds (Sampling)
## Chain 1:                33.37 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 3.4e-05 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 0.34 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
## Chain 2:
## Chain 2: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 2: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2:
## Chain 2:  Elapsed Time: 0.529 seconds (Warm-up)
## Chain 2:                14.692 seconds (Sampling)
## Chain 2:                15.221 seconds (Total)
## Chain 2:
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 3).
## Chain 3:
## Chain 3: Gradient evaluation took 1.8e-05 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 0.18 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3:
## Chain 3:
## Chain 3: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3: Iteration:  800 / 2000 [ 40%]  (Warmup)
```

```
## Chain 3: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3:
## Chain 3:  Elapsed Time: 3.149 seconds (Warm-up)
## Chain 3:                16.013 seconds (Sampling)
## Chain 3:                19.162 seconds (Total)
## Chain 3:
##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 4).
## Chain 4:
## Chain 4: Gradient evaluation took 1.7e-05 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 0.17 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4:
## Chain 4:
## Chain 4: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4:
## Chain 4:  Elapsed Time: 0.853 seconds (Warm-up)
## Chain 4:                16.075 seconds (Sampling)
## Chain 4:                16.928 seconds (Total)
## Chain 4:

## Warning: There were 3899 transitions after warmup that exceeded the maximum treedepth. Increase max_
## https://mc-stan.org/misc/warnings.html#maximum-treedepth-exceeded

## Warning: There were 4 chains where the estimated Bayesian Fraction of Missing Information was low. S
## https://mc-stan.org/misc/warnings.html#bfmi-low

## Warning: Examine the pairs() plot to diagnose sampling problems

## Warning: The largest R-hat is 4.31, indicating chains have not mixed.
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#r-hat

## Warning: Bulk Effective Samples Size (ESS) is too low, indicating posterior means and medians may be
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#bulk-ess

## Warning: Tail Effective Samples Size (ESS) is too low, indicating posterior variances and tail quant
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#tail-ess
```

```
# Print the summary of the model fit
summary(fit_hm)$summary
```

```
##                          mean      se_mean           sd          2.5%
## alpha[1]       -9.649117e-02 5.301119e-01 7.523682e-01 -1.049160e+00
## alpha[2]        1.743654e-01 7.470485e-01 1.057914e+00 -1.454180e+00
## alpha[3]        1.160493e+00 4.079624e-01 5.821130e-01  1.556390e-02
## alpha[4]        3.694134e-01 7.967039e-01 1.127502e+00 -1.545255e+00
## alpha[5]       -1.955463e-01 2.961364e-01 4.191699e-01 -5.978623e-01
## alpha[6]       -3.033955e-01 5.167264e-01 7.946794e-01 -1.349533e+00
## alpha[7]        1.402219e+00 4.939056e-01 9.108199e-01  8.702562e-01
## alpha[8]       -6.852755e-01 8.502741e-01 1.203171e+00 -1.694642e+00
## alpha[9]        1.622630e-01 3.425612e-01 4.929946e-01 -7.450514e-01
## alpha[10]      -2.826282e-01 1.153083e+00 1.632081e+00 -1.886190e+00
## alpha[11]      -3.324551e-01 2.700670e-01 3.828624e-01 -7.747536e-01
## alpha[12]      -2.030936e-02 6.641128e-01 9.408752e-01 -1.565339e+00
## alpha[13]      -5.411278e-01 6.216310e-01 8.794443e-01 -1.773773e+00
## alpha[14]      -2.756730e-01 5.845213e-01 8.290778e-01 -1.034158e+00
## alpha[15]      -4.705849e-01 6.242273e-01 8.845245e-01 -1.358274e+00
## alpha[16]       7.750613e-01 3.681130e-01 5.240389e-01  1.877077e-01
## alpha[17]       2.213138e-01 8.352453e-01 1.182113e+00 -1.687087e+00
## alpha[18]       9.507110e-02 1.015426e+00 1.436600e+00 -1.490503e+00
## alpha[19]       1.814687e-01 1.360751e+00 1.935190e+00 -1.740718e+00
## alpha[20]       1.135584e+00 5.563587e-01 7.876580e-01 -2.020383e-01
## alpha[21]       3.847217e-01 9.526613e-01 1.348033e+00 -1.951640e+00
## alpha[22]       5.907787e-02 7.797420e-01 1.118648e+00 -1.760415e+00
## alpha[23]       6.531127e-01 3.961994e-01 5.633622e-01 -3.253776e-01
## alpha[24]       2.847380e-01 8.196464e-01 1.159546e+00 -1.216178e+00
## alpha[25]      -3.154304e-01 8.716340e-01 1.233099e+00 -1.647093e+00
## alpha[26]       4.664925e-01 6.647456e-01 9.412519e-01 -6.337533e-01
## alpha[27]       2.129378e-01 4.819200e-01 6.837220e-01 -9.515166e-01
## alpha[28]      -1.822473e-01 6.030823e-01 8.589462e-01 -8.722717e-01
## alpha[29]       1.703045e-01 7.912675e-01 1.120060e+00 -1.161243e+00
## alpha[30]      -9.439434e-01 4.269491e-01 6.059555e-01 -1.770912e+00
## alpha[31]      -1.721612e-02 3.340449e-01 4.731553e-01 -3.591027e-01
## alpha[32]       4.631003e-01 4.619643e-01 6.548070e-01 -6.307924e-01
## alpha[33]       1.018278e+00 3.110281e-01 4.487744e-01  5.886301e-01
## alpha[34]      -7.380551e-01 3.311375e-01 4.687040e-01 -1.372647e+00
## alpha[35]       1.050965e+00 9.954023e-01 1.409375e+00 -1.546410e+00
## alpha[36]      -3.713824e-01 7.710692e-01 1.091156e+00 -1.532986e+00
## alpha[37]       5.846123e-01 9.263241e-01 1.310422e+00 -1.605003e+00
## alpha[38]       3.195042e-01 4.553435e-01 6.495966e-01 -6.296951e-01
## alpha[39]       5.903767e-01 6.146366e-01 8.699518e-01 -6.553648e-01
## alpha[40]       4.988873e-01 9.687442e-01 1.370811e+00 -1.530811e+00
## alpha[41]      -3.172518e-01 3.027910e-01 4.289133e-01 -1.063719e+00
## alpha[42]       2.979106e-02 6.752455e-01 9.554784e-01 -9.861421e-01
## alpha[43]      -2.696523e-01 4.829802e-01 6.840012e-01 -1.319865e+00
## alpha[44]       9.132554e-01 7.059430e-01 1.000367e+00 -7.518619e-01
## alpha[45]      -7.835410e-01 6.707377e-01 9.514997e-01 -1.978153e+00
## alpha[46]       3.935868e-02 7.847765e-01 1.111718e+00 -1.339898e+00
## alpha[47]      -9.122321e-01 7.987486e-01 1.140411e+00 -1.715661e+00
## alpha[48]      -5.380187e-02 9.479976e-01 1.341785e+00 -1.662454e+00
## alpha[49]       5.524047e-01 7.123133e-01 1.008170e+00 -7.348004e-01
## alpha[50]      -4.736080e-01 3.415587e-01 4.887352e-01 -8.620038e-01
```

```
## alpha[51]       5.561563e-01 1.061035e+00 1.503982e+00 -1.027350e+00
## alpha[52]      -1.260493e+00 3.794836e-01 5.384089e-01 -1.956032e+00
## alpha[53]      -9.090023e-02 4.408072e-01 6.238893e-01 -7.593417e-01
## alpha[54]      -5.725022e-01 4.525011e-01 6.447015e-01 -1.600545e+00
## alpha[55]      -5.245509e-02 7.468884e-01 1.057451e+00 -1.706069e+00
## alpha[56]      -8.981698e-01 6.590212e-01 9.325112e-01 -1.898420e+00
## alpha[57]      -3.821922e-01 9.458114e-01 1.339744e+00 -1.632040e+00
## alpha[58]       5.079977e-01 8.979009e-01 1.270659e+00 -1.492610e+00
## alpha[59]       2.449032e-01 6.702669e-01 9.515823e-01 -1.322303e+00
## alpha[60]      -2.009215e-01 7.597288e-01 1.075818e+00 -1.598129e+00
## alpha[61]       2.249117e-01 4.647705e-01 6.580519e-01 -8.005391e-01
## alpha[62]      -3.774889e-01 8.024015e-01 1.135208e+00 -1.636379e+00
## alpha[63]       2.512642e-01 8.502663e-01 1.206864e+00 -1.731532e+00
## alpha[64]       1.888441e-01 8.219447e-01 1.162831e+00 -1.744830e+00
## alpha[65]       1.175928e-01 3.664378e-01 5.419616e-01 -6.022494e-01
## alpha[66]      -5.190595e-02 8.906878e-01 1.278662e+00 -1.463622e+00
## alpha[67]       6.542150e-01 8.696979e-01 1.231150e+00 -1.451004e+00
## alpha[68]      -1.785625e-01 1.250739e+00 1.771218e+00 -2.014794e+00
## alpha[69]       4.450853e-01 3.403020e-01 4.818890e-01 -7.788094e-02
## alpha[70]      -4.079857e-01 9.272036e-01 1.311977e+00 -1.818723e+00
## alpha[71]       1.040383e+00 3.382826e-01 4.790722e-01  2.442417e-01
## alpha[72]      -4.813654e-01 6.359213e-01 9.000441e-01 -1.895508e+00
## alpha[73]      -2.098577e-01 7.703580e-01 1.089905e+00 -1.210850e+00
## alpha[74]      -1.961777e-01 7.568807e-01 1.070773e+00 -1.714079e+00
## alpha[75]       9.083675e-01 7.125812e-01 1.008482e+00 -8.228952e-01
## alpha[76]      -5.821003e-01 3.217212e-01 4.556578e-01 -1.369437e+00
## alpha[77]      -3.294584e-01 3.057948e-01 4.346506e-01 -8.339080e-01
## alpha[78]       1.722501e-01 3.542942e-01 5.083610e-01 -5.001094e-01
## alpha[79]       8.308916e-01 4.869479e-01 6.904399e-01 -2.866251e-01
## alpha[80]      -2.806511e-01 1.282436e-01 1.841603e-01 -4.948325e-01
## alpha[81]       1.220114e+00 3.471076e-01 4.923098e-01  6.195026e-01
## alpha[82]      -4.842061e-01 4.863687e-01 6.898644e-01 -1.560913e+00
## alpha[83]       3.560885e-01 5.786799e-01 8.190907e-01 -1.047714e+00
## alpha[84]       1.014285e+00 7.455712e-01 1.085340e+00 -2.217584e-02
## alpha[85]      -1.735332e-01 9.380158e-01 1.328572e+00 -1.922556e+00
## alpha[86]       2.878905e-01 7.221358e-01 1.022359e+00 -7.395603e-01
## alpha[87]       3.262731e-01 1.389424e-01 2.059449e-01  3.021018e-02
## alpha[88]      -1.813286e-01 9.861887e-01 1.399926e+00 -1.762614e+00
## alpha[89]      -1.256958e-02 2.085862e-01 2.963654e-01 -5.490993e-01
## alpha[90]       1.108431e+00 5.723569e-01 8.183573e-01 -2.457740e-02
## alpha[91]       3.597870e-01 7.450245e-01 1.129493e+00 -1.453875e+00
## alpha[92]       2.159215e-01 5.965012e-01 8.454438e-01 -1.142093e+00
## alpha[93]      -2.858137e+01 1.649468e+00 2.608583e+00 -3.305590e+01
## alpha[94]       2.212719e-02 9.083007e-01 1.285297e+00 -1.619763e+00
## alpha[95]       1.822358e-01 8.690458e-01 1.229465e+00 -1.646554e+00
## alpha[96]       7.234062e-01 1.054262e+00 1.493454e+00 -1.871400e+00
## alpha[97]      -1.847628e+00 2.010553e+00 3.010505e+00 -8.303736e+00
## alpha[98]      -3.451464e-01 1.040292e+00 1.472016e+00 -1.956387e+00
## alpha[99]       7.245181e-03 8.312083e-01 1.180684e+00 -1.575443e+00
## alpha[100]     -4.622681e+00 6.082719e+00 9.392423e+00 -2.698165e+01
## alpha[101]      1.198353e+00 4.746623e-01 6.718621e-01  3.009940e-01
## alpha[102]      2.298156e-02 8.659917e-01 1.225249e+00 -1.547950e+00
## alpha[103]      6.177155e-01 5.267662e-01 7.467931e-01 -6.788476e-01
## alpha[104]     -1.754341e+00 1.781028e+00 2.715735e+00 -7.376718e+00
```

```
## alpha[105]     -5.295637e-01 2.527497e-01 3.587704e-01 -1.074216e+00
## alpha[106]      4.101284e-02 8.931670e-01 1.263825e+00 -1.568059e+00
## alpha[107]      1.244243e+00 2.462477e-01 3.492139e-01  7.768059e-01
## alpha[108]      7.129247e-01 6.031049e-01 8.537943e-01 -2.592800e-01
## alpha[109]     -1.402834e+00 2.399469e-01 3.397379e-01 -1.786796e+00
## alpha[110]     -3.967370e-01 6.178290e-01 8.742490e-01 -1.509791e+00
## alpha[111]     -3.192753e-01 8.689788e-01 1.229352e+00 -1.735137e+00
## alpha[112]     -7.274650e-03 1.265000e+00 1.789836e+00 -1.874756e+00
## alpha[113]     -6.395303e-01 9.229111e-01 1.317046e+00 -1.878126e+00
## alpha[114]     -1.881658e+00 2.918679e+00 4.155047e+00 -9.839022e+00
## alpha[115]      2.560936e-02 1.167846e+00 1.652451e+00 -1.664567e+00
## alpha[116]      9.546318e-02 2.040606e-01 3.044079e-01 -3.980477e-01
## alpha[117]     -6.749845e-01 5.331026e-01 1.154715e+00 -2.652264e+00
## alpha[118]     -1.005180e+00 9.068734e-01 1.283041e+00 -1.787720e+00
## alpha[119]     -2.467887e+00 2.059005e+00 3.129210e+00 -9.481483e+00
## alpha[120]      8.279003e-01 4.688137e-01 6.649557e-01 -1.754172e-01
## alpha[121]      1.214086e+00 2.074853e-01 3.000334e-01  6.762776e-01
## alpha[122]      1.137238e+00 4.847387e-01 6.910533e-01 -3.406575e-02
## alpha[123]      1.752332e-03 9.262981e-01 1.311264e+00 -1.745670e+00
## alpha[124]      3.960569e-02 3.634766e-01 6.559953e-01 -1.277805e+00
## alpha[125]     -3.014573e-01 9.588847e-01 1.356484e+00 -1.887456e+00
## alpha[126]      5.277051e-01 9.428278e-01 1.333860e+00 -9.437332e-01
## alpha[127]     -4.439901e-02 7.590259e-01 1.073837e+00 -1.872472e+00
## alpha[128]      4.484087e-02 7.753765e-01 1.096953e+00 -1.351087e+00
## alpha[129]      2.111819e-01 7.677253e-01 1.255033e+00 -2.303837e+00
## alpha[130]      2.525330e-01 8.987045e-01 1.272134e+00 -1.898449e+00
## alpha[131]     -8.338363e-01 6.337849e-01 9.065116e-01 -1.943566e+00
## alpha[132]      4.597619e-02 3.694727e-01 5.233081e-01 -8.456878e-01
## alpha[133]      5.914793e-01 9.117202e-01 1.290610e+00 -1.406559e+00
## alpha[134]      8.533382e-01 8.383806e-01 1.186274e+00 -1.149720e+00
## alpha[135]      5.630090e-01 6.853237e-01 9.715848e-01 -7.293480e-01
## alpha[136]      5.207525e-01 1.989582e-01 2.817030e-01  6.061214e-02
## alpha[137]      8.945473e-01 7.146943e-01 1.011373e+00 -5.849493e-01
## alpha[138]      9.118273e-01 6.202112e-01 8.780775e-01 -1.733468e-02
## alpha[139]      7.292839e-01 5.372894e-01 7.665179e-01 -7.541258e-01
## alpha[140]      1.254480e-01 8.180422e-01 1.157303e+00 -1.254491e+00
## alpha[141]     -9.093634e-01 9.919630e-01 1.407724e+00 -2.214078e+00
## alpha[142]      1.447612e-01 9.926985e-01 1.404721e+00 -1.831990e+00
## alpha[143]      5.695093e-01 1.024242e+00 1.449892e+00 -1.956301e+00
## alpha[144]     -1.749486e-01 8.832165e-01 1.314621e+00 -1.632439e+00
## alpha[145]     -1.642505e-01 8.541757e-01 1.208406e+00 -1.808285e+00
## alpha[146]     -4.307474e-01 5.398480e-01 1.046061e+00 -2.883306e+00
## alpha[147]     -1.530161e-01 7.788542e-01 1.413256e+00 -2.605577e+00
## alpha[148]     -1.161280e+00 2.013384e-01 2.856748e-01 -1.535083e+00
## alpha[149]      1.027337e-01 5.531663e-01 7.836093e-01 -6.666579e-01
## alpha[150]     -5.174633e+01 1.037415e+01 1.636441e+01 -7.944490e+01
## alpha[151]     -1.098275e+00 3.816030e-01 6.764215e-01 -2.850843e+00
## alpha[152]     -3.342000e-01 5.925021e-01 8.531544e-01 -1.698600e+00
## alpha[153]      7.044415e-01 2.385094e-01 3.754559e-01  1.509096e-01
## alpha[154]      9.661232e-01 8.461331e-01 1.197174e+00 -1.072225e+00
## alpha[155]      1.947655e-01 6.955479e-01 1.049919e+00 -1.409655e+00
## alpha[156]     -1.900022e-01 5.832524e-01 8.564041e-01 -1.922164e+00
## alpha[157]      1.185027e+00 2.865313e-01 4.056015e-01  6.194961e-01
## alpha[158]     -3.512140e-01 2.183470e+00 3.262239e+00 -7.731175e+00
```

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## alpha[159]      5.352091e-01 7.781126e-01 1.105330e+00 -1.550816e+00
## alpha[160]      1.479122e-01 7.993590e-01 1.130866e+00 -1.374146e+00
## alpha[161]     -6.672584e-01 6.086722e-01 1.189222e+00 -3.161029e+00
## alpha[162]     -5.836292e-01 1.069674e+00 1.608475e+00 -4.343237e+00
## alpha[163]     -1.050824e+00 4.818305e-01 7.966750e-01 -2.649751e+00
## alpha[164]      1.913011e-01 9.315454e-01 1.317822e+00 -1.887277e+00
## alpha[165]     -3.975526e-01 3.940891e-01 5.580944e-01 -1.074425e+00
## alpha[166]      1.043382e+00 8.151129e-01 1.153432e+00 -9.420636e-01
## alpha[167]      2.087210e-01 6.253883e-01 8.852326e-01 -9.227115e-01
## alpha[168]      7.305881e-01 8.474843e-01 1.201952e+00 -1.563655e+00
## alpha[169]     -6.700589e+01 9.009294e+00 1.421196e+01 -9.101622e+01
## alpha[170]      7.013546e-01 8.953081e-01 1.266877e+00 -1.310374e+00
## alpha[171]     -3.339385e-01 3.655470e-01 5.173572e-01 -9.005224e-01
## alpha[172]     -1.344981e+00 5.186222e-01 7.342892e-01 -2.007491e+00
## alpha[173]      6.410155e-01 3.478810e-01 4.942396e-01 -4.402321e-02
## alpha[174]     -1.784462e-01 9.347920e-01 1.464832e+00 -1.751946e+00
## alpha[175]     -2.765742e+00 4.178358e+00 5.923457e+00 -1.358067e+01
## alpha[176]     -3.505314e-02 1.066137e+00 1.614611e+00 -2.493246e+00
## alpha[177]     -6.281603e-01 3.285630e-01 4.661991e-01 -1.371679e+00
## alpha[178]     -3.049357e+01 9.059642e+00 1.441699e+01 -5.416997e+01
## alpha[179]      5.742270e-01 7.636469e-01 1.081891e+00 -1.306005e+00
## alpha[180]     -7.026601e-02 6.340646e-01 9.461866e-01 -1.484528e+00
## alpha[181]      1.878381e-01 6.830444e-01 1.079367e+00 -1.315710e+00
## alpha[182]     -8.252834e-01 1.118593e+00 1.698051e+00 -3.390463e+00
## alpha[183]      8.783816e-01 7.374399e-01 1.044387e+00 -6.716737e-01
## alpha[184]     -4.468231e-01 4.378620e-01 6.201250e-01 -1.088508e+00
## alpha[185]      1.211232e-01 8.456299e-01 1.196463e+00 -1.772908e+00
## alpha[186]      2.366240e-01 8.424335e-01 1.191884e+00 -9.665599e-01
## alpha[187]      1.046105e+00 7.074935e-01 1.001346e+00 -5.452314e-01
## alpha[188]     -5.408372e-02 3.035399e-01 4.741191e-01 -8.939583e-01
## alpha[189]     -5.432864e-02 4.210184e-01 5.964388e-01 -8.048793e-01
## alpha[190]      1.403592e-01 6.603999e-01 9.665121e-01 -8.713332e-01
## alpha[191]      1.218238e+00 1.813189e-01 2.908978e-01  6.570217e-01
## alpha[192]      3.626411e-01 6.040139e-01 9.160120e-01 -6.923390e-01
## alpha[193]      4.084553e-01 5.996248e-01 8.503401e-01 -8.362844e-01
## alpha[194]     -9.777473e+00 1.057751e+01 1.500743e+01 -3.771997e+01
## alpha[195]     -2.795511e+02 1.050946e+00 1.659058e+00 -2.824053e+02
## sigma           1.470459e+01 2.705844e-01 5.605747e-01  1.370029e+01
## beta           -3.855093e+02 1.082878e+02 1.708241e+02 -6.978157e+02
## mu              8.210616e-02 5.008405e-01 7.094330e-01 -1.065986e+00
## log_theta[1]   -9.319699e+01 2.587218e+01 4.090680e+01 -1.685057e+02
## log_theta[2]   -8.883974e+01 2.442211e+01 3.871670e+01 -1.605671e+02
## log_theta[3]   -1.530047e+02 4.289809e+01 6.780948e+01 -2.775704e+02
## log_theta[4]   -1.143967e+02 3.144257e+01 4.985736e+01 -2.067173e+02
## log_theta[5]   -1.260258e+02 3.517771e+01 5.555012e+01 -2.277134e+02
## log_theta[6]   -1.292948e+02 3.638067e+01 5.736432e+01 -2.337960e+02
## log_theta[7]   -1.585841e+02 4.547763e+01 7.161141e+01 -2.885501e+02
## log_theta[8]   -1.626763e+02 4.636357e+01 7.286678e+01 -2.945234e+02
## log_theta[9]   -3.927534e+01 1.078961e+01 1.712070e+01 -7.099009e+01
## log_theta[10]  -6.782386e+01 1.927180e+01 3.031056e+01 -1.220391e+02
## log_theta[11]  -9.856023e+01 2.781669e+01 4.380799e+01 -1.782630e+02
## log_theta[12]  -1.252337e+02 3.510254e+01 5.540182e+01 -2.261607e+02
## log_theta[13]  -8.870711e+01 2.465832e+01 3.893179e+01 -1.602156e+02
## log_theta[14]  -9.742402e+01 2.702094e+01 4.271460e+01 -1.757278e+02
```

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## log_theta[15]  -7.980840e+01 2.204077e+01 3.485157e+01 -1.440852e+02
## log_theta[16]  -1.065893e+02 3.043139e+01 4.792233e+01 -1.938854e+02
## log_theta[17]  -9.723544e+01 2.668357e+01 4.232198e+01 -1.757116e+02
## log_theta[18]  -7.110850e+01 2.058101e+01 3.228649e+01 -1.298982e+02
## log_theta[19]  -1.438448e+02 4.130320e+01 6.490010e+01 -2.608761e+02
## log_theta[20]  -9.181071e+01 2.632717e+01 4.146210e+01 -1.674169e+02
## log_theta[21]  -1.422537e+02 4.035654e+01 6.357602e+01 -2.582875e+02
## log_theta[22]  -1.154781e+02 3.246534e+01 5.122503e+01 -2.091391e+02
## log_theta[23]  -1.104892e+02 3.127825e+01 4.932951e+01 -2.004147e+02
## log_theta[24]  -9.327837e+01 2.570625e+01 4.073725e+01 -1.687259e+02
## log_theta[25]  -1.461151e+02 4.099652e+01 6.466020e+01 -2.640152e+02
## log_theta[26]  -7.143100e+01 1.980805e+01 3.137553e+01 -1.295378e+02
## log_theta[27]  -1.012917e+02 2.806311e+01 4.441635e+01 -1.831443e+02
## log_theta[28]  -1.149869e+02 3.223138e+01 5.086044e+01 -2.082468e+02
## log_theta[29]  -1.363385e+02 3.890273e+01 6.119197e+01 -2.472914e+02
## log_theta[30]  -1.619326e+02 4.495180e+01 7.100011e+01 -2.921409e+02
## log_theta[31]  -1.122004e+02 3.136623e+01 4.952789e+01 -2.029511e+02
## log_theta[32]  -1.318051e+02 3.737428e+01 5.889062e+01 -2.391678e+02
## log_theta[33]  -4.400921e+01 1.294501e+01 2.033398e+01 -8.075920e+01
## log_theta[34]  -8.535735e+01 2.401514e+01 3.780506e+01 -1.541018e+02
## log_theta[35]  -1.111708e+02 3.051418e+01 4.847145e+01 -2.012208e+02
## log_theta[36]  -1.660247e+02 4.628013e+01 7.308635e+01 -2.998433e+02
## log_theta[37]  -8.110481e+01 2.292471e+01 3.616908e+01 -1.467520e+02
## log_theta[38]  -1.036909e+02 2.893107e+01 4.573489e+01 -1.878670e+02
## log_theta[39]  -3.310314e+01 9.023896e+00 1.438209e+01 -6.031987e+01
## log_theta[40]  -1.230183e+02 3.382888e+01 5.365087e+01 -2.221102e+02
## log_theta[41]  -7.121242e+01 2.001525e+01 3.154140e+01 -1.287216e+02
## log_theta[42]  -6.920768e+01 1.912390e+01 3.027320e+01 -1.253466e+02
## log_theta[43]  -9.552901e+01 2.637731e+01 4.173688e+01 -1.723809e+02
## log_theta[44]  -7.680542e+01 2.209901e+01 3.478019e+01 -1.402428e+02
## log_theta[45]  -6.092299e+01 1.685144e+01 2.660294e+01 -1.092930e+02
## log_theta[46]  -1.218587e+02 3.471672e+01 5.461843e+01 -2.209002e+02
## log_theta[47]  -2.913151e+01 7.730407e+00 1.226907e+01 -5.134863e+01
## log_theta[48]  -5.749469e+01 1.636250e+01 2.573746e+01 -1.038671e+02
## log_theta[49]  -8.745937e+01 2.518527e+01 3.958619e+01 -1.590955e+02
## log_theta[50]  -4.623356e+01 1.320077e+01 2.071903e+01 -8.358097e+01
## log_theta[51]  -1.343721e+02 3.857499e+01 6.064491e+01 -2.441554e+02
## log_theta[52]  -1.136365e+02 3.173873e+01 5.001455e+01 -2.047651e+02
## log_theta[53]  -5.171060e+01 1.420229e+01 2.250065e+01 -9.307442e+01
## log_theta[54]  -3.893068e+01 1.046194e+01 1.661345e+01 -6.986553e+01
## log_theta[55]  -9.083990e+01 2.606475e+01 4.094022e+01 -1.648703e+02
## log_theta[56]  -9.311200e+01 2.546020e+01 4.031059e+01 -1.672512e+02
## log_theta[57]  -3.419136e+01 9.061867e+00 1.444235e+01 -6.100820e+01
## log_theta[58]  -1.371574e+02 3.853813e+01 6.083731e+01 -2.477531e+02
## log_theta[59]  -3.884574e+01 1.140620e+01 1.786097e+01 -7.130056e+01
## log_theta[60]  -1.419491e+01 4.031949e+00 6.333549e+00 -2.489600e+01
## log_theta[61]  -6.396239e+01 1.836975e+01 2.886970e+01 -1.161732e+02
## log_theta[62]  -4.764093e+01 1.397176e+01 2.182080e+01 -8.684280e+01
## log_theta[63]  -8.402107e+01 2.357999e+01 3.723442e+01 -1.516588e+02
## log_theta[64]  -4.911780e+01 1.309857e+01 2.091234e+01 -8.854408e+01
## log_theta[65]  -3.234229e+01 9.028823e+00 1.428449e+01 -5.870007e+01
## log_theta[66]  -2.830974e+01 8.386949e+00 1.308018e+01 -5.113865e+01
## log_theta[67]  -1.387949e+01 4.551652e+00 7.033816e+00 -2.603902e+01
## log_theta[68]  -8.560743e+01 2.496432e+01 3.908230e+01 -1.554986e+02
```

```
## log_theta[69]  -1.175979e+02 3.315740e+01 5.230678e+01 -2.131223e+02
## log_theta[70]  -1.235877e+01 2.986624e+00 4.832451e+00 -2.238900e+01
## log_theta[71]  -2.806557e+01 8.350806e+00 1.311812e+01 -5.192463e+01
## log_theta[72]  -2.295656e+01 6.187559e+00 9.803021e+00 -4.058304e+01
## log_theta[73]  -9.836053e+01 2.835263e+01 4.447868e+01 -1.784327e+02
## log_theta[74]  -1.132661e+02 3.189605e+01 5.027230e+01 -2.044622e+02
## log_theta[75]  -6.393430e+01 1.850625e+01 2.910053e+01 -1.162453e+02
## log_theta[76]  -9.765335e+01 2.695018e+01 4.261887e+01 -1.760228e+02
## log_theta[77]  -7.631335e+01 2.146060e+01 3.382255e+01 -1.379663e+02
## log_theta[78]  -5.661327e+01 1.580621e+01 2.498648e+01 -1.022700e+02
## log_theta[79]  -8.826031e+01 2.521845e+01 3.972649e+01 -1.606876e+02
## log_theta[80]  -9.554000e+01 2.673886e+01 4.218997e+01 -1.726935e+02
## log_theta[81]  -1.168614e+02 3.303955e+01 5.215842e+01 -2.123342e+02
## log_theta[82]  -5.931293e+01 1.679052e+01 2.640499e+01 -1.073024e+02
## log_theta[83]  -5.696915e+01 1.555619e+01 2.471772e+01 -1.029441e+02
## log_theta[84]  -1.353404e+02 3.893505e+01 6.123805e+01 -2.462589e+02
## log_theta[85]  -1.063042e+02 2.948505e+01 4.662089e+01 -1.921513e+02
## log_theta[86]  -3.244185e+01 9.039644e+00 1.431243e+01 -5.948807e+01
## log_theta[87]  -3.872582e+01 1.091950e+01 1.724336e+01 -7.035164e+01
## log_theta[88]  -6.271094e+01 1.824489e+01 2.857554e+01 -1.135532e+02
## log_theta[89]  -4.885660e+01 1.352958e+01 2.140675e+01 -8.823905e+01
## log_theta[90]  -9.048858e+01 2.602700e+01 4.096979e+01 -1.647006e+02
## log_theta[91]  -2.805225e+01 7.703760e+00 1.222376e+01 -5.073707e+01
## log_theta[92]  -1.059919e+02 3.019551e+01 4.751746e+01 -1.923231e+02
## log_theta[93]  -3.444111e+01 3.706120e-03 1.696150e-01 -3.478383e+01
## log_theta[94]  -5.452744e+01 1.499296e+01 2.375769e+01 -9.832181e+01
## log_theta[95]  -5.163022e+01 1.491154e+01 2.340913e+01 -9.449297e+01
## log_theta[96]  -4.006348e+01 1.195494e+01 1.870706e+01 -7.424089e+01
## log_theta[97]  -2.285789e+01 4.070238e+00 7.103514e+00 -3.831818e+01
## log_theta[98]  -4.070797e+01 1.091453e+01 1.735856e+01 -7.288436e+01
## log_theta[99]  -5.145825e+01 1.399126e+01 2.223071e+01 -9.327796e+01
## log_theta[100] -1.254413e+02 2.760077e+01 4.563206e+01 -2.179705e+02
## log_theta[101] -4.992018e+01 1.463100e+01 2.299507e+01 -9.136231e+01
## log_theta[102] -4.708626e+01 1.358976e+01 2.132291e+01 -8.619249e+01
## log_theta[103] -7.617574e+01 2.176950e+01 3.428152e+01 -1.387210e+02
## log_theta[104] -2.565592e+01 5.144648e+00 8.661451e+00 -4.295910e+01
## log_theta[105] -5.114694e+01 1.424206e+01 2.246126e+01 -9.222897e+01
## log_theta[106] -3.265018e+01 8.501255e+00 1.363817e+01 -5.826868e+01
## log_theta[107] -1.023421e+02 2.924417e+01 4.608331e+01 -1.864118e+02
## log_theta[108] -5.310418e+01 1.482469e+01 2.348005e+01 -9.614241e+01
## log_theta[109] -4.897468e+01 1.343594e+01 2.117254e+01 -8.763660e+01
## log_theta[110] -3.883202e+01 1.042052e+01 1.656109e+01 -6.999513e+01
## log_theta[111] -2.707362e+01 6.886313e+00 1.107155e+01 -4.778312e+01
## log_theta[112] -3.940633e+01 1.196219e+01 1.859276e+01 -7.297760e+01
## log_theta[113] -3.067071e+01 8.752321e+00 1.369693e+01 -5.604993e+01
## log_theta[114] -1.163504e+01 5.253491e-01 1.863273e+00 -1.692488e+01
## log_theta[115] -3.898793e+01 1.185807e+01 1.842758e+01 -7.204324e+01
## log_theta[116] -3.841692e+01 1.083084e+01 1.708802e+01 -6.944146e+01
## log_theta[117] -3.259516e+01 9.021569e+00 1.418574e+01 -5.889702e+01
## log_theta[118] -1.147304e+02 3.164995e+01 5.002535e+01 -2.066835e+02
## log_theta[119] -3.246051e+01 6.426940e+00 1.083098e+01 -5.524088e+01
## log_theta[120] -5.268079e+01 1.463802e+01 2.321922e+01 -9.547421e+01
## log_theta[121] -9.319715e+01 2.661288e+01 4.195548e+01 -1.697317e+02
## log_theta[122] -3.656557e+01 1.066056e+01 1.680075e+01 -6.693085e+01
```

```
## log_theta[123] -4.410051e+01 1.314451e+01 2.049475e+01 -8.013625e+01
## log_theta[124] -3.997626e+01 1.113187e+01 1.757966e+01 -7.215141e+01
## log_theta[125] -6.248411e+01 1.807227e+01 2.831690e+01 -1.132280e+02
## log_theta[126] -7.352864e+01 2.125133e+01 3.338229e+01 -1.334519e+02
## log_theta[127] -1.046716e+02 2.968220e+01 4.672905e+01 -1.896955e+02
## log_theta[128] -5.650938e+01 1.626710e+01 2.554100e+01 -1.022647e+02
## log_theta[129] -6.852513e+01 1.902749e+01 3.007303e+01 -1.235730e+02
## log_theta[130] -6.875364e+01 1.976162e+01 3.105400e+01 -1.255913e+02
## log_theta[131] -5.796632e+01 1.649322e+01 2.586871e+01 -1.046854e+02
## log_theta[132] -5.326996e+01 1.460941e+01 2.316061e+01 -9.606809e+01
## log_theta[133] -3.044202e+01 9.137448e+00 1.427894e+01 -5.533602e+01
## log_theta[134] -2.300969e+01 6.977010e+00 1.091774e+01 -4.295541e+01
## log_theta[135] -7.399449e+01 2.142318e+01 3.364642e+01 -1.344310e+02
## log_theta[136] -5.017372e+01 1.435312e+01 2.260531e+01 -9.126970e+01
## log_theta[137] -3.958393e+01 1.186626e+01 1.856235e+01 -7.288376e+01
## log_theta[138] -2.615093e+01 7.923737e+00 1.239902e+01 -4.805601e+01
## log_theta[139] -3.789875e+01 1.031429e+01 1.645408e+01 -6.869351e+01
## log_theta[140] -5.558065e+01 1.504974e+01 2.393610e+01 -9.989453e+01
## log_theta[141] -1.451784e+01 3.669284e+00 5.832413e+00 -2.623663e+01
## log_theta[142] -1.527561e+01 4.072055e+00 6.510403e+00 -2.675191e+01
## log_theta[143] -5.282353e+01 1.401407e+01 2.243870e+01 -9.535621e+01
## log_theta[144] -1.910346e+01 5.460798e+00 8.554305e+00 -3.426610e+01
## log_theta[145] -2.021074e+01 5.041797e+00 8.153840e+00 -3.625320e+01
## log_theta[146] -2.510334e+01 6.650192e+00 1.055986e+01 -4.518959e+01
## log_theta[147] -3.935931e+01 1.082706e+01 1.710440e+01 -7.049717e+01
## log_theta[148] -3.342841e+01 9.199232e+00 1.447036e+01 -5.973529e+01
## log_theta[149] -5.625873e+01 1.578291e+01 2.491683e+01 -1.016722e+02
## log_theta[150] -8.867812e+01 2.429055e-03 1.489898e-01 -8.898696e+01
## log_theta[151] -2.981872e+01 7.810458e+00 1.238577e+01 -5.304302e+01
## log_theta[152] -1.137510e+02 3.206437e+01 5.052418e+01 -2.057359e+02
## log_theta[153] -8.711458e+01 2.473979e+01 3.901536e+01 -1.583382e+02
## log_theta[154] -5.096198e+01 1.482465e+01 2.330915e+01 -9.357869e+01
## log_theta[155] -3.477093e+01 1.004694e+01 1.575978e+01 -6.386542e+01
## log_theta[156] -4.791606e+01 1.297492e+01 2.059582e+01 -8.619461e+01
## log_theta[157] -6.716578e+01 1.937960e+01 3.051535e+01 -1.226570e+02
## log_theta[158] -2.436844e+01 4.454657e+00 7.893357e+00 -4.185767e+01
## log_theta[159] -2.806958e+01 7.267279e+00 1.171713e+01 -5.045078e+01
## log_theta[160] -3.851867e+01 1.028809e+01 1.641875e+01 -6.949436e+01
## log_theta[161] -2.341231e+01 6.147210e+00 9.754115e+00 -4.208091e+01
## log_theta[162] -2.830175e+01 6.714279e+00 1.093957e+01 -4.967610e+01
## log_theta[163] -2.618603e+01 6.816165e+00 1.081240e+01 -4.615377e+01
## log_theta[164] -6.484412e+01 1.895262e+01 2.968199e+01 -1.185891e+02
## log_theta[165] -4.662012e+01 1.333806e+01 2.092998e+01 -8.438192e+01
## log_theta[166] -6.711467e+01 1.939977e+01 3.052049e+01 -1.220842e+02
## log_theta[167] -6.293771e+01 1.823870e+01 2.861438e+01 -1.142920e+02
## log_theta[168] -5.169868e+01 1.389036e+01 2.217869e+01 -9.351655e+01
## log_theta[169] -9.908027e+01 3.478084e-03 2.150714e-01 -9.952124e+01
## log_theta[170] -8.310837e+01 2.402215e+01 3.774478e+01 -1.513791e+02
## log_theta[171] -6.440559e+01 1.795775e+01 2.834132e+01 -1.164098e+02
## log_theta[172] -7.933352e+01 2.184082e+01 3.447593e+01 -1.426386e+02
## log_theta[173] -5.020766e+01 1.421040e+01 2.244325e+01 -9.140072e+01
## log_theta[174] -2.045624e+01 5.855385e+00 9.164161e+00 -3.775088e+01
## log_theta[175] -1.382986e+01 1.060080e+00 2.598607e+00 -1.950823e+01
## log_theta[176] -1.564818e+01 4.098004e+00 6.543697e+00 -2.874144e+01
```

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## log_theta[177] -6.292647e+01 1.749823e+01 2.760623e+01 -1.133773e+02
## log_theta[178] -5.863575e+01 1.471151e+00 2.458657e+00 -6.142585e+01
## log_theta[179] -3.816946e+01 1.013808e+01 1.624864e+01 -6.890691e+01
## log_theta[180] -2.871361e+01 8.427806e+00 1.316149e+01 -5.193395e+01
## log_theta[181] -2.205605e+01 6.108802e+00 9.659632e+00 -3.939436e+01
## log_theta[182] -1.936828e+01 4.813574e+00 7.707436e+00 -3.387281e+01
## log_theta[183] -3.774965e+01 1.127638e+01 1.765792e+01 -6.917539e+01
## log_theta[184] -1.713938e+01 4.969365e+00 7.757999e+00 -3.073883e+01
## log_theta[185] -3.218456e+01 8.338896e+00 1.339838e+01 -5.780737e+01
## log_theta[186] -4.309462e+01 1.272803e+01 1.989934e+01 -7.922525e+01
## log_theta[187] -8.627176e+01 2.496383e+01 3.924327e+01 -1.573060e+02
## log_theta[188] -1.686229e+01 4.626549e+00 7.316359e+00 -3.060158e+01
## log_theta[189] -5.410274e+01 1.516337e+01 2.392179e+01 -9.763271e+01
## log_theta[190] -1.192608e+01 3.342809e+00 5.278326e+00 -2.214681e+01
## log_theta[191] -1.262155e+01 3.811064e+00 6.028663e+00 -2.367714e+01
## log_theta[192] -2.646881e+01 7.907484e+00 1.234438e+01 -4.896987e+01
## log_theta[193] -2.341602e+01 6.987550e+00 1.092789e+01 -4.348859e+01
## log_theta[194] -4.570694e+01 1.896105e+00 6.715242e+00 -6.613840e+01
## log_theta[195] -2.832905e+02 1.426553e-03 9.400217e-02 -2.834822e+02
## lp__           -2.199094e+05 7.391185e+04 1.268191e+05 -4.978769e+05
##                          25%           50%           75%         97.5%
## alpha[1]       -5.051663e-01 -3.059151e-01  1.180007e-01  1.147609e+00
## alpha[2]       -3.296588e-01  2.290404e-01  7.906815e-01  1.595021e+00
## alpha[3]        1.022130e+00  1.408004e+00  1.597271e+00  1.641554e+00
## alpha[4]       -2.332634e-02  7.202547e-01  1.140959e+00  1.524200e+00
## alpha[5]       -4.897661e-01 -3.489907e-01 -5.525184e-02  5.224697e-01
## alpha[6]       -8.145524e-01 -6.164112e-01  6.230680e-01  9.291248e-01
## alpha[7]        8.867605e-01  1.029239e+00  1.050290e+00  4.002832e+00
## alpha[8]       -1.565787e+00 -1.190481e+00 -3.479476e-01  1.404529e+00
## alpha[9]       -1.027166e-01  2.858113e-01  6.143235e-01  6.339393e-01
## alpha[10]      -1.840075e+00 -7.329633e-01  1.089861e+00  1.955236e+00
## alpha[11]      -6.769322e-01 -3.721558e-01 -3.792073e-02  2.371623e-01
## alpha[12]      -4.971606e-01  4.318019e-01  6.878573e-01  8.823465e-01
## alpha[13]      -1.210031e+00 -4.056245e-01  2.066847e-01  4.634608e-01
## alpha[14]      -9.790102e-01 -4.913316e-01 -1.826453e-02  1.116471e+00
## alpha[15]      -1.112172e+00 -8.355734e-01 -1.794253e-01  1.015919e+00
## alpha[16]       2.854287e-01  7.333346e-01  1.253810e+00  1.500733e+00
## alpha[17]      -4.313996e-01  4.650388e-01  1.129909e+00  1.539604e+00
## alpha[18]      -1.246113e+00 -1.687506e-02  1.434987e+00  1.838026e+00
## alpha[19]      -1.729440e+00  1.728213e-02  1.780817e+00  2.924643e+00
## alpha[20]       9.577704e-01  1.374920e+00  1.675573e+00  1.887819e+00
## alpha[21]       7.407349e-02  1.011118e+00  1.211244e+00  1.544796e+00
## alpha[22]      -8.612809e-01  7.466333e-01  9.160201e-01  1.080494e+00
## alpha[23]       4.920278e-01  9.774761e-01  1.037635e+00  1.065722e+00
## alpha[24]      -6.575974e-01  3.251224e-01  1.276178e+00  1.680442e+00
## alpha[25]      -1.220000e+00 -6.576389e-01  3.112761e-01  1.627066e+00
## alpha[26]      -3.060141e-01  2.823095e-01  1.128711e+00  1.825097e+00
## alpha[27]      -1.883790e-01  3.974797e-01  8.188579e-01  8.878018e-01
## alpha[28]      -7.855318e-01 -7.584325e-01  1.551311e-01  1.285095e+00
## alpha[29]      -7.990216e-01  1.375164e-01  1.063870e+00  1.653190e+00
## alpha[30]      -1.332514e+00 -1.004947e+00 -5.590064e-01 -7.206378e-02
## alpha[31]      -3.104610e-01 -2.593463e-01  5.344906e-02  8.184438e-01
## alpha[32]       1.803028e-01  6.423336e-01  1.047492e+00  1.072193e+00
## alpha[33]       6.407419e-01  8.769887e-01  1.217568e+00  1.915728e+00
```

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## alpha[34]      -1.043265e+00 -7.494253e-01 -4.464746e-01 -4.560055e-02
## alpha[35]       9.625411e-01  1.803680e+00  1.938490e+00  1.985796e+00
## alpha[36]      -1.055663e+00 -6.654893e-01 -8.233843e-02  1.439975e+00
## alpha[37]       1.134195e-01  1.167070e+00  1.582154e+00  1.667471e+00
## alpha[38]       6.643736e-02  1.997542e-01  5.313726e-01  1.340386e+00
## alpha[39]       1.335461e-01  5.697415e-01  1.050464e+00  1.847961e+00
## alpha[40]      -4.488456e-01  8.146134e-01  1.791985e+00  1.809188e+00
## alpha[41]      -4.386681e-01 -1.107792e-01 -2.952599e-02  4.576978e-02
## alpha[42]      -5.716735e-01 -2.781359e-01  3.524924e-01  1.619349e+00
## alpha[43]      -6.269445e-01 -2.371616e-01  1.620951e-01  6.437890e-01
## alpha[44]       6.014024e-01  1.170686e+00  1.704478e+00  1.880743e+00
## alpha[45]      -1.277965e+00 -1.015810e+00 -2.564590e-01  6.889207e-01
## alpha[46]      -9.199180e-01  9.731579e-02  9.790592e-01  1.427706e+00
## alpha[47]      -1.693503e+00 -1.666998e+00 -2.533371e-01  1.030658e+00
## alpha[48]      -1.109675e+00 -3.002807e-01  9.579235e-01  1.858124e+00
## alpha[49]      -2.922997e-01  6.561870e-01  1.465936e+00  1.708708e+00
## alpha[50]      -7.718117e-01 -6.892456e-01 -4.934428e-01  5.088727e-01
## alpha[51]      -9.106448e-01  5.292632e-01  1.935610e+00  2.412118e+00
## alpha[52]      -1.709989e+00 -1.305046e+00 -6.725023e-01 -6.540555e-01
## alpha[53]      -6.535064e-01 -2.254194e-01  3.572962e-01  8.121512e-01
## alpha[54]      -1.056830e+00 -4.871193e-01  1.682436e-02  1.268914e-01
## alpha[55]      -3.939414e-01  1.026750e-01  4.428612e-01  1.375621e+00
## alpha[56]      -1.395663e+00 -1.191767e+00 -7.053936e-01  6.628199e-01
## alpha[57]      -1.537595e+00 -7.787750e-01  2.134956e-01  1.789696e+00
## alpha[58]      -1.853384e-01  8.940134e-01  1.407641e+00  1.922429e+00
## alpha[59]      -1.437457e-01  5.767182e-01  9.322448e-01  1.316279e+00
## alpha[60]      -9.132596e-01 -3.536477e-01  5.023256e-01  1.387627e+00
## alpha[61]      -4.989972e-02  3.154399e-01  5.863351e-01  1.107565e+00
## alpha[62]      -1.387474e+00 -5.124932e-01  4.875016e-01  1.188586e+00
## alpha[63]      -5.617553e-01  8.187831e-01  1.191994e+00  1.350793e+00
## alpha[64]      -2.396020e-01  5.535433e-01  9.862644e-01  1.380937e+00
## alpha[65]      -5.687635e-01  4.255210e-01  5.599165e-01  7.593212e-01
## alpha[66]      -1.243685e+00 -4.404599e-01  1.291340e+00  1.558858e+00
## alpha[67]       3.826727e-01  1.212243e+00  1.448956e+00  1.712854e+00
## alpha[68]      -1.836312e+00 -4.446736e-01  1.145600e+00  2.384558e+00
## alpha[69]       7.123680e-02  3.015997e-01  7.471516e-01  1.204916e+00
## alpha[70]      -1.123275e+00 -8.114452e-01 -8.153541e-02  1.782177e+00
## alpha[71]       8.519961e-01  1.185978e+00  1.432552e+00  1.461289e+00
## alpha[72]      -1.036596e+00 -2.592918e-01  2.081015e-01  5.176273e-01
## alpha[73]      -8.727650e-01 -6.471278e-01  2.430622e-02  1.671319e+00
## alpha[74]      -8.269902e-01 -1.833427e-01  5.105206e-01  1.238149e+00
## alpha[75]       6.532677e-01  1.333087e+00  1.561764e+00  1.829913e+00
## alpha[76]      -6.839184e-01 -4.803156e-01 -3.353600e-01 -6.021563e-02
## alpha[77]      -7.376374e-01 -4.461067e-01  1.078453e-01  2.297870e-01
## alpha[78]      -3.762900e-01  2.802792e-01  5.329499e-01  8.568022e-01
## alpha[79]       5.645205e-01  9.270765e-01  1.356059e+00  1.594104e+00
## alpha[80]      -4.718804e-01 -3.126963e-01 -1.851804e-01  1.382696e-02
## alpha[81]       6.958123e-01  1.319138e+00  1.704606e+00  1.734083e+00
## alpha[82]      -8.674351e-01 -3.852978e-01  1.626433e-01  1.908088e-01
## alpha[83]       1.233854e-01  5.745997e-01  8.692511e-01  1.241302e+00
## alpha[84]       8.665025e-02  7.283367e-01  1.439215e+00  3.139465e+00
## alpha[85]      -1.363333e+00  4.025710e-02  9.837412e-01  1.375400e+00
## alpha[86]      -5.864556e-01  4.322847e-02  6.928537e-01  1.966650e+00
## alpha[87]       1.518571e-01  3.319950e-01  4.356848e-01  6.707373e-01
```

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## alpha[88]      -1.430835e+00 -2.869081e-01  8.931500e-01  1.963338e+00
## alpha[89]      -9.912580e-02  2.517397e-02  1.303871e-01  3.730723e-01
## alpha[90]       4.912013e-01  1.042650e+00  1.892116e+00  2.108985e+00
## alpha[91]      -8.809296e-01  6.224583e-01  1.061660e+00  1.899801e+00
## alpha[92]      -1.828381e-01  4.828625e-01  8.618746e-01  1.133574e+00
## alpha[93]      -2.935281e+01 -2.793341e+01 -2.758444e+01 -2.381439e+01
## alpha[94]      -1.070890e+00  9.416747e-02  1.110915e+00  1.589871e+00
## alpha[95]      -5.132184e-01  3.280567e-01  1.096141e+00  1.695981e+00
## alpha[96]       4.716556e-01  1.455140e+00  1.705367e+00  1.784957e+00
## alpha[97]      -1.477142e+00 -1.344944e+00 -4.992413e-01  1.678078e+00
## alpha[98]      -1.594108e+00 -6.030244e-01  5.203702e-01  1.881101e+00
## alpha[99]      -9.874630e-01 -6.000840e-02  1.013296e+00  1.473284e+00
## alpha[100]     -8.601867e-01 -8.297223e-02  6.991458e-01  1.484439e+00
## alpha[101]      6.631690e-01  1.274355e+00  1.815751e+00  1.950722e+00
## alpha[102]     -9.007870e-01 -5.481880e-02  9.513181e-01  1.708786e+00
## alpha[103]      4.555928e-01  1.048106e+00  1.114208e+00  1.130038e+00
## alpha[104]     -1.696320e+00 -1.672056e+00 -1.357152e-01  1.811927e+00
## alpha[105]     -7.222326e-01 -4.875039e-01 -2.987993e-01 -5.184451e-02
## alpha[106]     -9.815708e-01  2.469889e-02  1.051745e+00  1.656531e+00
## alpha[107]      9.544840e-01  1.283494e+00  1.553606e+00  1.702130e+00
## alpha[108]     -7.464022e-02  6.320041e-01  1.282778e+00  1.958681e+00
## alpha[109]     -1.682927e+00 -1.480624e+00 -1.164657e+00 -8.911263e-01
## alpha[110]     -8.136941e-01 -5.535659e-01 -1.310291e-01  9.896613e-01
## alpha[111]     -1.225368e+00 -5.521780e-01  3.594202e-01  1.556797e+00
## alpha[112]     -1.761462e+00 -6.093524e-02  1.784689e+00  1.865827e+00
## alpha[113]     -1.803600e+00 -1.390484e+00  4.273335e-01  1.361649e+00
## alpha[114]     -1.784957e+00 -1.988284e-01  2.977356e-01  1.798288e+00
## alpha[115]     -1.620756e+00 -5.213698e-02  1.529405e+00  1.994362e+00
## alpha[116]     -2.291616e-01  2.029864e-01  3.862659e-01  4.027544e-01
## alpha[117]     -1.847083e+00 -6.930882e-01  5.649378e-01  1.552389e+00
## alpha[118]     -1.766864e+00 -1.739379e+00 -9.179731e-01  1.223687e+00
## alpha[119]     -1.915827e+00 -1.477644e+00 -6.789214e-01  4.839710e-01
## alpha[120]      3.403100e-01  8.906630e-01  1.469018e+00  1.552139e+00
## alpha[121]      1.079980e+00  1.358037e+00  1.404369e+00  1.541551e+00
## alpha[122]      7.595264e-01  1.391186e+00  1.695230e+00  1.773008e+00
## alpha[123]     -7.338498e-01 -7.634972e-02  6.098380e-01  2.017848e+00
## alpha[124]     -5.532581e-01 -5.329050e-03  6.657227e-01  9.369602e-01
## alpha[125]     -1.539024e+00 -2.249116e-01  1.012677e+00  1.155781e+00
## alpha[126]     -7.408605e-01  5.082880e-01  1.871202e+00  1.966080e+00
## alpha[127]     -2.858728e-01  3.823173e-01  6.818469e-01  8.736263e-01
## alpha[128]     -9.023956e-01  1.469007e-01  1.119019e+00  1.216601e+00
## alpha[129]     -1.229606e+00  6.922807e-01  9.827503e-01  1.736334e+00
## alpha[130]     -3.180186e-02  6.668357e-01  1.153793e+00  1.418803e+00
## alpha[131]     -1.622636e+00 -8.416651e-01 -1.060153e-01  5.780220e-01
## alpha[132]     -1.935518e-01  2.550799e-01  4.495356e-01  5.518978e-01
## alpha[133]     -1.288973e-01  9.215328e-01  1.727860e+00  1.870543e+00
## alpha[134]      5.807910e-01  1.326262e+00  1.507035e+00  1.981628e+00
## alpha[135]     -1.625986e-01  5.882880e-01  1.256324e+00  1.938216e+00
## alpha[136]      4.138632e-01  5.918031e-01  6.834956e-01  8.544461e-01
## alpha[137]      2.069307e-01  1.092424e+00  1.723557e+00  2.062393e+00
## alpha[138]      4.861283e-02  8.341597e-01  1.810012e+00  1.854474e+00
## alpha[139]      5.213744e-01  9.403725e-01  1.222532e+00  1.550585e+00
## alpha[140]     -8.697405e-01  2.759890e-02  1.020608e+00  1.671025e+00
## alpha[141]     -1.701365e+00 -1.628513e+00 -7.597264e-01  1.550132e+00
```

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## alpha[142]     -9.455739e-01  3.212464e-01  1.228253e+00  1.856780e+00
## alpha[143]      1.372105e-01  1.118807e+00  1.610062e+00  1.878833e+00
## alpha[144]     -1.332131e+00 -8.895191e-01  1.336269e+00  1.773174e+00
## alpha[145]     -1.096569e+00 -3.253714e-02  9.031638e-01  1.206450e+00
## alpha[146]     -1.237246e+00  2.246151e-01  5.397123e-01  5.886114e-01
## alpha[147]     -1.002087e+00 -9.617171e-01  1.673593e+00  1.871647e+00
## alpha[148]     -1.414406e+00 -1.138889e+00 -8.879619e-01 -8.373893e-01
## alpha[149]     -4.997926e-01 -1.632252e-01  5.351998e-01  1.392526e+00
## alpha[150]     -5.504526e+01 -4.761638e+01 -4.605850e+01 -2.180993e+01
## alpha[151]     -1.483925e+00 -7.630839e-01 -6.165909e-01 -3.795206e-01
## alpha[152]     -7.165147e-01 -3.356458e-01  4.836436e-01  5.612983e-01
## alpha[153]      2.823838e-01  6.623981e-01  1.077160e+00  1.167131e+00
## alpha[154]      6.448420e-01  1.518623e+00  1.739181e+00  1.982149e+00
## alpha[155]     -1.006605e+00  3.282484e-01  1.283791e+00  1.377255e+00
## alpha[156]     -6.606743e-01 -3.347432e-01  2.606515e-01  1.069721e+00
## alpha[157]      8.816761e-01  1.216792e+00  1.505967e+00  1.708856e+00
## alpha[158]      3.485787e-01  1.220674e+00  1.805497e+00  1.866683e+00
## alpha[159]      9.239652e-02  9.348012e-01  1.451042e+00  1.494231e+00
## alpha[160]     -6.406470e-01  1.155320e-01  9.217349e-01  1.690006e+00
## alpha[161]     -1.507179e+00 -5.656326e-01  8.304572e-01  8.779763e-01
## alpha[162]     -7.617930e-01 -1.738849e-01  3.898296e-01  1.051922e+00
## alpha[163]     -1.768946e+00 -8.710677e-01 -4.713368e-01  2.875964e-02
## alpha[164]     -4.282735e-01  5.191682e-01  1.121403e+00  1.647795e+00
## alpha[165]     -8.194490e-01 -4.652662e-01 -6.659057e-02  4.742751e-01
## alpha[166]      8.362834e-01  1.570687e+00  1.844406e+00  1.900232e+00
## alpha[167]     -4.318808e-01  1.358407e-01  7.528129e-01  1.540157e+00
## alpha[168]      4.951276e-01  1.286047e+00  1.547794e+00  1.691856e+00
## alpha[169]     -6.983759e+01 -6.342876e+01 -6.205569e+01 -4.104280e+01
## alpha[170]      6.383170e-02  1.106364e+00  1.720237e+00  1.987290e+00
## alpha[171]     -6.557729e-01 -4.819177e-01 -1.675980e-01  5.319856e-01
## alpha[172]     -1.825894e+00 -1.642675e+00 -1.196487e+00 -8.983685e-02
## alpha[173]      1.809170e-01  7.258514e-01  1.013491e+00  1.291697e+00
## alpha[174]     -1.739813e+00 -7.044297e-01  1.770881e+00  1.990787e+00
## alpha[175]     -3.337816e+00 -2.868634e-01  1.353029e+00  1.906730e+00
## alpha[176]     -1.828039e+00  1.020059e+00  1.422232e+00  1.619184e+00
## alpha[177]     -8.934183e-01 -4.547220e-01 -3.350350e-01 -8.366067e-02
## alpha[178]     -3.481434e+01 -2.771252e+01 -2.436724e+01 -4.088668e+00
## alpha[179]      3.219022e-01  8.226778e-01  1.137726e+00  1.846173e+00
## alpha[180]     -5.181816e-01 -1.452647e-01  4.543797e-01  1.568849e+00
## alpha[181]     -9.632236e-01  2.481091e-02  1.245563e+00  1.788079e+00
## alpha[182]     -1.672686e+00 -1.566788e+00  4.270230e-01  1.960161e+00
## alpha[183]      2.130308e-01  1.122801e+00  1.748764e+00  2.044134e+00
## alpha[184]     -1.059350e+00 -5.158454e-01  1.255401e-01  3.410204e-01
## alpha[185]     -4.751522e-01  3.682359e-01  9.802202e-01  1.488252e+00
## alpha[186]     -9.577535e-01  1.927224e-01  1.409449e+00  1.555995e+00
## alpha[187]      5.733235e-01  1.311749e+00  1.744225e+00  2.188351e+00
## alpha[188]     -3.222772e-01 -2.149479e-01  3.317208e-01  7.182985e-01
## alpha[189]     -4.278698e-01 -2.016295e-01  2.758704e-01  8.726193e-01
## alpha[190]     -8.279128e-01 -2.129514e-02  7.667386e-01  1.698895e+00
## alpha[191]      9.202145e-01  1.271425e+00  1.442946e+00  1.612313e+00
## alpha[192]     -3.966530e-01 -1.814989e-01  1.363675e+00  1.734426e+00
## alpha[193]     -1.257483e-01  3.939742e-01  1.128183e+00  1.450741e+00
## alpha[194]     -9.452951e+00 -1.561934e+00 -9.332992e-01  6.771794e-01
## alpha[195]     -2.799917e+02 -2.791367e+02 -2.789335e+02 -2.765209e+02
```

```
## sigma           1.430637e+01  1.465726e+01  1.508803e+01  1.587103e+01
## beta           -4.449333e+02 -4.285663e+02 -3.544121e+02 -9.657181e+01
## mu             -2.711708e-01  3.141746e-01  5.889169e-01  8.945911e-01
## log_theta[1]   -1.065422e+02 -1.033939e+02 -8.587072e+01 -2.411383e+01
## log_theta[2]   -1.014100e+02 -9.827272e+01 -8.182034e+01 -2.356149e+01
## log_theta[3]   -1.763516e+02 -1.697979e+02 -1.407682e+02 -3.824212e+01
## log_theta[4]   -1.318592e+02 -1.263778e+02 -1.051183e+02 -3.024168e+01
## log_theta[5]   -1.456736e+02 -1.401538e+02 -1.154433e+02 -3.211166e+01
## log_theta[6]   -1.500217e+02 -1.441443e+02 -1.182487e+02 -3.141384e+01
## log_theta[7]   -1.837059e+02 -1.769291e+02 -1.461821e+02 -3.606132e+01
## log_theta[8]   -1.879250e+02 -1.815209e+02 -1.497185e+02 -3.917296e+01
## log_theta[9]   -4.493290e+01 -4.333287e+01 -3.634658e+01 -1.014886e+01
## log_theta[10]  -7.944435e+01 -7.567562e+01 -6.219469e+01 -1.616223e+01
## log_theta[11]  -1.135721e+02 -1.096940e+02 -9.083536e+01 -2.445101e+01
## log_theta[12]  -1.457290e+02 -1.391464e+02 -1.144585e+02 -3.122907e+01
## log_theta[13]  -1.017175e+02 -9.829949e+01 -8.120071e+01 -2.307176e+01
## log_theta[14]  -1.128699e+02 -1.076611e+02 -8.983148e+01 -2.495874e+01
## log_theta[15]  -9.090726e+01 -8.838360e+01 -7.326075e+01 -2.096486e+01
## log_theta[16]  -1.228464e+02 -1.188876e+02 -9.817056e+01 -2.539950e+01
## log_theta[17]  -1.111432e+02 -1.076360e+02 -8.928024e+01 -2.589062e+01
## log_theta[18]  -8.196846e+01 -7.904496e+01 -6.444035e+01 -1.655410e+01
## log_theta[19]  -1.675540e+02 -1.599348e+02 -1.332482e+02 -3.314428e+01
## log_theta[20]  -1.057569e+02 -1.022511e+02 -8.407846e+01 -2.173294e+01
## log_theta[21]  -1.637766e+02 -1.581785e+02 -1.301117e+02 -3.483691e+01
## log_theta[22]  -1.326090e+02 -1.280294e+02 -1.067385e+02 -2.852558e+01
## log_theta[23]  -1.284064e+02 -1.228633e+02 -1.012185e+02 -2.678685e+01
## log_theta[24]  -1.064872e+02 -1.030667e+02 -8.592030e+01 -2.459913e+01
## log_theta[25]  -1.696931e+02 -1.631939e+02 -1.328757e+02 -3.667103e+01
## log_theta[26]  -8.226339e+01 -7.944545e+01 -6.486571e+01 -1.845037e+01
## log_theta[27]  -1.170424e+02 -1.122551e+02 -9.288371e+01 -2.612232e+01
## log_theta[28]  -1.315750e+02 -1.277067e+02 -1.058591e+02 -2.900485e+01
## log_theta[29]  -1.585376e+02 -1.524737e+02 -1.243523e+02 -3.257557e+01
## log_theta[30]  -1.859915e+02 -1.799232e+02 -1.489831e+02 -4.187762e+01
## log_theta[31]  -1.296581e+02 -1.242779e+02 -1.033817e+02 -2.840741e+01
## log_theta[32]  -1.522818e+02 -1.472637e+02 -1.205631e+02 -3.226254e+01
## log_theta[33]  -5.095920e+01 -4.928235e+01 -4.057105e+01 -9.393459e+00
## log_theta[34]  -9.890632e+01 -9.487118e+01 -7.851023e+01 -2.123389e+01
## log_theta[35]  -1.275428e+02 -1.228435e+02 -1.022545e+02 -2.933950e+01
## log_theta[36]  -1.923692e+02 -1.837398e+02 -1.529319e+02 -4.237961e+01
## log_theta[37]  -9.542871e+01 -9.018179e+01 -7.367778e+01 -1.971847e+01
## log_theta[38]  -1.189066e+02 -1.151716e+02 -9.556586e+01 -2.626940e+01
## log_theta[39]  -3.769659e+01 -3.621395e+01 -3.004996e+01 -9.051916e+00
## log_theta[40]  -1.423876e+02 -1.360401e+02 -1.125719e+02 -3.230768e+01
## log_theta[41]  -8.202566e+01 -7.941570e+01 -6.515482e+01 -1.786992e+01
## log_theta[42]  -7.884451e+01 -7.635016e+01 -6.334345e+01 -1.821995e+01
## log_theta[43]  -1.094236e+02 -1.057668e+02 -8.826426e+01 -2.509707e+01
## log_theta[44]  -8.807429e+01 -8.556432e+01 -7.042663e+01 -1.786911e+01
## log_theta[45]  -7.116606e+01 -6.806953e+01 -5.502338e+01 -1.564405e+01
## log_theta[46]  -1.412842e+02 -1.353620e+02 -1.127872e+02 -2.921737e+01
## log_theta[47]  -3.407038e+01 -3.250163e+01 -2.625512e+01 -7.901317e+00
## log_theta[48]  -6.768301e+01 -6.490197e+01 -5.134496e+01 -1.396361e+01
## log_theta[49]  -1.017219e+02 -9.830583e+01 -7.944441e+01 -2.034240e+01
## log_theta[50]  -5.352463e+01 -5.167931e+01 -4.255789e+01 -1.092602e+01
## log_theta[51]  -1.565498e+02 -1.508235e+02 -1.221278e+02 -3.138992e+01
```

```
## log_theta[52]  -1.315796e+02 -1.265858e+02 -1.040026e+02 -2.886663e+01
## log_theta[53]  -6.002316e+01 -5.704980e+01 -4.748095e+01 -1.361480e+01
## log_theta[54]  -4.438656e+01 -4.284221e+01 -3.569278e+01 -1.088738e+01
## log_theta[55]  -1.047702e+02 -1.011698e+02 -8.385189e+01 -2.140249e+01
## log_theta[56]  -1.074593e+02 -1.026288e+02 -8.609306e+01 -2.498979e+01
## log_theta[57]  -4.030118e+01 -3.818800e+01 -3.015981e+01 -9.726460e+00
## log_theta[58]  -1.599313e+02 -1.525115e+02 -1.250575e+02 -3.404867e+01
## log_theta[59]  -4.539658e+01 -4.297295e+01 -3.537867e+01 -8.508266e+00
## log_theta[60]  -1.749873e+01 -1.595098e+01 -1.217569e+01 -3.326849e+00
## log_theta[61]  -7.389515e+01 -7.120725e+01 -5.915804e+01 -1.508010e+01
## log_theta[62]  -5.505672e+01 -5.315965e+01 -4.337433e+01 -1.072424e+01
## log_theta[63]  -9.857492e+01 -9.331429e+01 -7.664196e+01 -2.072749e+01
## log_theta[64]  -5.577285e+01 -5.391258e+01 -4.511224e+01 -1.406038e+01
## log_theta[65]  -3.723726e+01 -3.578876e+01 -2.940817e+01 -7.898979e+00
## log_theta[66]  -3.385450e+01 -3.210019e+01 -2.528521e+01 -6.599973e+00
## log_theta[67]  -1.735979e+01 -1.536248e+01 -1.228235e+01 -2.148502e+00
## log_theta[68]  -1.004531e+02 -9.670006e+01 -7.737437e+01 -1.900908e+01
## log_theta[69]  -1.359694e+02 -1.304227e+02 -1.084097e+02 -2.907778e+01
## log_theta[70]  -1.422746e+01 -1.384663e+01 -1.018728e+01 -4.764194e+00
## log_theta[71]  -3.230231e+01 -3.140783e+01 -2.559609e+01 -5.870782e+00
## log_theta[72]  -2.758509e+01 -2.480719e+01 -2.073234e+01 -6.242756e+00
## log_theta[73]  -1.138294e+02 -1.101128e+02 -9.040268e+01 -2.292907e+01
## log_theta[74]  -1.319744e+02 -1.264550e+02 -1.029682e+02 -2.808171e+01
## log_theta[75]  -7.532324e+01 -7.134558e+01 -5.832469e+01 -1.451321e+01
## log_theta[76]  -1.124513e+02 -1.081066e+02 -8.993558e+01 -2.559348e+01
## log_theta[77]  -8.847901e+01 -8.513085e+01 -6.972087e+01 -1.902371e+01
## log_theta[78]  -6.584313e+01 -6.270900e+01 -5.198330e+01 -1.410025e+01
## log_theta[79]  -1.015846e+02 -9.826107e+01 -8.100429e+01 -2.109906e+01
## log_theta[80]  -1.099909e+02 -1.062139e+02 -8.786693e+01 -2.430739e+01
## log_theta[81]  -1.346477e+02 -1.303240e+02 -1.070848e+02 -2.863225e+01
## log_theta[82]  -6.793330e+01 -6.602272e+01 -5.448690e+01 -1.456066e+01
## log_theta[83]  -6.546757e+01 -6.316019e+01 -5.202025e+01 -1.542999e+01
## log_theta[84]  -1.570753e+02 -1.506977e+02 -1.249092e+02 -3.103708e+01
## log_theta[85]  -1.217792e+02 -1.175822e+02 -9.819555e+01 -2.736216e+01
## log_theta[86]  -3.762434e+01 -3.543492e+01 -2.903967e+01 -8.513866e+00
## log_theta[87]  -4.446637e+01 -4.312683e+01 -3.561772e+01 -9.456204e+00
## log_theta[88]  -7.364805e+01 -6.997893e+01 -5.812518e+01 -1.369555e+01
## log_theta[89]  -5.636541e+01 -5.425149e+01 -4.476371e+01 -1.263759e+01
## log_theta[90]  -1.055314e+02 -1.012860e+02 -8.241670e+01 -2.082469e+01
## log_theta[91]  -3.218979e+01 -3.118151e+01 -2.529927e+01 -8.471506e+00
## log_theta[92]  -1.225349e+02 -1.186166e+02 -9.675557e+01 -2.578132e+01
## log_theta[93]  -3.455093e+01 -3.443445e+01 -3.432457e+01 -3.411714e+01
## log_theta[94]  -6.222584e+01 -6.041927e+01 -5.012214e+01 -1.453997e+01
## log_theta[95]  -5.915315e+01 -5.776826e+01 -4.662693e+01 -1.215822e+01
## log_theta[96]  -4.777377e+01 -4.400151e+01 -3.609114e+01 -8.559501e+00
## log_theta[97]  -2.557180e+01 -2.459805e+01 -1.912722e+01 -1.177450e+01
## log_theta[98]  -4.660118e+01 -4.533124e+01 -3.704839e+01 -1.138527e+01
## log_theta[99]  -5.903517e+01 -5.627547e+01 -4.704114e+01 -1.392188e+01
## log_theta[100] -1.398769e+02 -1.340830e+02 -1.106897e+02 -5.609027e+01
## log_theta[101] -5.858600e+01 -5.611598e+01 -4.519491e+01 -1.084298e+01
## log_theta[102] -5.416321e+01 -5.265725e+01 -4.228071e+01 -1.117285e+01
## log_theta[103] -8.782345e+01 -8.485882e+01 -6.960730e+01 -1.812820e+01
## log_theta[104] -2.903659e+01 -2.775207e+01 -2.193874e+01 -1.182954e+01
## log_theta[105] -5.857074e+01 -5.672752e+01 -4.718138e+01 -1.307253e+01
```

```
## log_theta[106] -3.831177e+01 -3.581277e+01 -2.921566e+01 -9.682566e+00
## log_theta[107] -1.184698e+02 -1.138291e+02 -9.423162e+01 -2.435508e+01
## log_theta[108] -6.209776e+01 -5.910269e+01 -4.802598e+01 -1.329981e+01
## log_theta[109] -5.593597e+01 -5.435925e+01 -4.515394e+01 -1.317903e+01
## log_theta[110] -4.401880e+01 -4.265935e+01 -3.529055e+01 -1.111823e+01
## log_theta[111] -3.173400e+01 -2.937675e+01 -2.451134e+01 -8.425179e+00
## log_theta[112] -4.629445e+01 -4.442961e+01 -3.479084e+01 -8.212747e+00
## log_theta[113] -3.579576e+01 -3.422259e+01 -2.692610e+01 -8.300726e+00
## log_theta[114] -1.209131e+01 -1.125588e+01 -1.082262e+01 -9.099841e+00
## log_theta[115] -4.575552e+01 -4.380723e+01 -3.470805e+01 -7.853456e+00
## log_theta[116] -4.474019e+01 -4.276014e+01 -3.513837e+01 -9.316646e+00
## log_theta[117] -3.721049e+01 -3.623824e+01 -2.877203e+01 -1.008055e+01
## log_theta[118] -1.329081e+02 -1.280572e+02 -1.040611e+02 -3.014106e+01
## log_theta[119] -3.580491e+01 -3.452465e+01 -2.812578e+01 -1.573814e+01
## log_theta[120] -6.118224e+01 -5.835535e+01 -4.802285e+01 -1.353639e+01
## log_theta[121] -1.076038e+02 -1.040688e+02 -8.543951e+01 -2.210870e+01
## log_theta[122] -4.330497e+01 -4.063670e+01 -3.334525e+01 -7.828198e+00
## log_theta[123] -5.241910e+01 -4.980440e+01 -3.986214e+01 -9.244127e+00
## log_theta[124] -4.660580e+01 -4.460408e+01 -3.594699e+01 -1.133699e+01
## log_theta[125] -7.315524e+01 -7.075372e+01 -5.616960e+01 -1.442708e+01
## log_theta[126] -8.609802e+01 -8.187053e+01 -6.796128e+01 -1.685556e+01
## log_theta[127] -1.200876e+02 -1.163602e+02 -9.635448e+01 -2.560462e+01
## log_theta[128] -6.586974e+01 -6.302015e+01 -5.220998e+01 -1.313356e+01
## log_theta[129] -8.023699e+01 -7.624367e+01 -6.177819e+01 -1.941507e+01
## log_theta[130] -7.974225e+01 -7.599505e+01 -6.274330e+01 -1.626042e+01
## log_theta[131] -6.743421e+01 -6.527302e+01 -5.248074e+01 -1.444959e+01
## log_theta[132] -6.143200e+01 -5.891697e+01 -4.891160e+01 -1.414347e+01
## log_theta[133] -3.691814e+01 -3.376544e+01 -2.757506e+01 -6.153040e+00
## log_theta[134] -2.795628e+01 -2.528288e+01 -2.013496e+01 -4.736427e+00
## log_theta[135] -8.663400e+01 -8.299512e+01 -6.730792e+01 -1.681332e+01
## log_theta[136] -5.836543e+01 -5.592337e+01 -4.594363e+01 -1.185533e+01
## log_theta[137] -4.640736e+01 -4.462343e+01 -3.548946e+01 -8.149591e+00
## log_theta[138] -3.109397e+01 -2.952753e+01 -2.376277e+01 -5.111367e+00
## log_theta[139] -4.371038e+01 -4.166739e+01 -3.488522e+01 -9.969010e+00
## log_theta[140] -6.476225e+01 -6.154822e+01 -5.029581e+01 -1.513596e+01
## log_theta[141] -1.703827e+01 -1.629592e+01 -1.190524e+01 -5.540013e+00
## log_theta[142] -1.927922e+01 -1.590639e+01 -1.333041e+01 -4.236052e+00
## log_theta[143] -5.984499e+01 -5.787729e+01 -4.866953e+01 -1.510399e+01
## log_theta[144] -2.328500e+01 -2.206884e+01 -1.576848e+01 -5.382151e+00
## log_theta[145] -2.342178e+01 -2.159043e+01 -1.797412e+01 -6.759412e+00
## log_theta[146] -2.903601e+01 -2.710912e+01 -2.234462e+01 -8.474596e+00
## log_theta[147] -4.601227e+01 -4.381492e+01 -3.523104e+01 -1.197398e+01
## log_theta[148] -3.822978e+01 -3.709398e+01 -3.085441e+01 -8.992625e+00
## log_theta[149] -6.531426e+01 -6.229681e+01 -5.214184e+01 -1.389656e+01
## log_theta[150] -8.877369e+01 -8.867205e+01 -8.857815e+01 -8.839355e+01
## log_theta[151] -3.391053e+01 -3.259561e+01 -2.713526e+01 -1.001255e+01
## log_theta[152] -1.312402e+02 -1.261831e+02 -1.055914e+02 -2.780625e+01
## log_theta[153] -1.006859e+02 -9.676039e+01 -8.045795e+01 -2.083390e+01
## log_theta[154] -5.960025e+01 -5.640920e+01 -4.591189e+01 -1.169703e+01
## log_theta[155] -4.080954e+01 -3.809763e+01 -3.111971e+01 -9.302304e+00
## log_theta[156] -5.501400e+01 -5.273768e+01 -4.447709e+01 -1.389489e+01
## log_theta[157] -7.811846e+01 -7.477969e+01 -6.166818e+01 -1.547955e+01
## log_theta[158] -2.688200e+01 -2.513044e+01 -2.149295e+01 -1.200528e+01
## log_theta[159] -3.240197e+01 -3.063581e+01 -2.548875e+01 -8.714848e+00
```

```
## log_theta[160] -4.415689e+01 -4.249404e+01 -3.463408e+01 -1.103495e+01
## log_theta[161] -2.664028e+01 -2.583551e+01 -2.015904e+01 -7.974164e+00
## log_theta[162] -3.225431e+01 -3.035816e+01 -2.580435e+01 -1.122544e+01
## log_theta[163] -3.062107e+01 -2.903356e+01 -2.328020e+01 -8.845818e+00
## log_theta[164] -7.529067e+01 -7.201098e+01 -5.927467e+01 -1.464563e+01
## log_theta[165] -5.364661e+01 -5.202481e+01 -4.298436e+01 -1.110020e+01
## log_theta[166] -7.921350e+01 -7.476681e+01 -6.115371e+01 -1.534215e+01
## log_theta[167] -7.363102e+01 -7.059392e+01 -5.730144e+01 -1.429303e+01
## log_theta[168] -5.889473e+01 -5.677777e+01 -4.769350e+01 -1.470041e+01
## log_theta[169] -9.921919e+01 -9.907385e+01 -9.893550e+01 -9.868110e+01
## log_theta[170] -9.615766e+01 -9.261524e+01 -7.696202e+01 -1.901139e+01
## log_theta[171] -7.370320e+01 -7.139381e+01 -5.925885e+01 -1.662962e+01
## log_theta[172] -9.051764e+01 -8.777723e+01 -7.291733e+01 -2.127288e+01
## log_theta[173] -5.789488e+01 -5.594700e+01 -4.572831e+01 -1.218263e+01
## log_theta[174] -2.410481e+01 -2.328795e+01 -1.689622e+01 -6.126854e+00
## log_theta[175] -1.617158e+01 -1.289584e+01 -1.170467e+01 -1.060296e+01
## log_theta[176] -1.932456e+01 -1.591617e+01 -1.316788e+01 -5.685828e+00
## log_theta[177] -7.234313e+01 -6.966964e+01 -5.834089e+01 -1.611345e+01
## log_theta[178] -6.105758e+01 -5.830566e+01 -5.616029e+01 -5.503908e+01
## log_theta[179] -4.372960e+01 -4.172647e+01 -3.540558e+01 -1.067668e+01
## log_theta[180] -3.432462e+01 -3.184791e+01 -2.606570e+01 -7.050653e+00
## log_theta[181] -2.644933e+01 -2.434602e+01 -1.943264e+01 -6.537782e+00
## log_theta[182] -2.285763e+01 -2.210490e+01 -1.559844e+01 -7.369825e+00
## log_theta[183] -4.404137e+01 -4.251139e+01 -3.471147e+01 -7.670587e+00
## log_theta[184] -2.024397e+01 -1.930350e+01 -1.564169e+01 -3.839278e+00
## log_theta[185] -3.663616e+01 -3.527937e+01 -2.906586e+01 -9.869788e+00
## log_theta[186] -4.996393e+01 -4.813359e+01 -3.878893e+01 -9.501041e+00
## log_theta[187] -9.982092e+01 -9.608358e+01 -7.983567e+01 -1.966993e+01
## log_theta[188] -1.924132e+01 -1.858831e+01 -1.506528e+01 -5.091596e+00
## log_theta[189] -6.295081e+01 -5.983735e+01 -4.996395e+01 -1.361761e+01
## log_theta[190] -1.410478e+01 -1.341455e+01 -9.826798e+00 -3.807446e+00
## log_theta[191] -1.497098e+01 -1.401979e+01 -1.143552e+01 -2.740879e+00
## log_theta[192] -3.099103e+01 -2.944411e+01 -2.345741e+01 -6.513819e+00
## log_theta[193] -2.769027e+01 -2.582942e+01 -2.080233e+01 -5.282162e+00
## log_theta[194] -4.681386e+01 -4.175416e+01 -4.110876e+01 -4.105032e+01
## log_theta[195] -2.833549e+02 -2.832880e+02 -2.832247e+02 -2.831109e+02
## lp__           -2.521195e+05 -2.392410e+05 -1.856451e+05 -2.489424e+04
##                      n_eff        Rhat
## alpha[1]          2.014307  27.5929780
## alpha[2]          2.005411  48.5086001
## alpha[3]          2.035984  18.1159367
## alpha[4]          2.002814  45.9346377
## alpha[5]          2.003534  37.4252932
## alpha[6]          2.365171   6.2503063
## alpha[7]          3.400769   3.3512037
## alpha[8]          2.002335  55.2653988
## alpha[9]          2.071132  12.9544771
## alpha[10]         2.003377  44.2016580
## alpha[11]         2.009752  17.5994963
## alpha[12]         2.007153  23.1134275
## alpha[13]         2.001481  77.8041259
## alpha[14]         2.011824  25.5108919
## alpha[15]         2.007864  25.8117193
## alpha[16]         2.026585  14.2161957
```

```
## alpha[17]         2.003040  51.0198089
## alpha[18]         2.001589  90.9852546
## alpha[19]         2.022506  20.4586933
## alpha[20]         2.004313  44.9736349
## alpha[21]         2.002275  72.5076679
## alpha[22]         2.058188  14.1316479
## alpha[23]         2.021844  21.1463441
## alpha[24]         2.001348  90.4295639
## alpha[25]         2.001372 106.8639631
## alpha[26]         2.004937  34.6896197
## alpha[27]         2.012840  30.0213886
## alpha[28]         2.028518  16.5418302
## alpha[29]         2.003715  31.1145070
## alpha[30]         2.014324  16.5711558
## alpha[31]         2.006309  24.6589362
## alpha[32]         2.009138  28.9478681
## alpha[33]         2.081886  12.3074298
## alpha[34]         2.003460  33.4715634
## alpha[35]         2.004729  56.8581401
## alpha[36]         2.002565  75.7458473
## alpha[37]         2.001226 109.3112748
## alpha[38]         2.035210  17.5852152
## alpha[39]         2.003335  42.9512687
## alpha[40]         2.002336  93.1546861
## alpha[41]         2.006564  20.4787477
## alpha[42]         2.002250  72.6739627
## alpha[43]         2.005650  26.5140867
## alpha[44]         2.008072  38.3733609
## alpha[45]         2.012389  26.9181342
## alpha[46]         2.006768  22.3502252
## alpha[47]         2.038461  12.8796723
## alpha[48]         2.003325  35.1856219
## alpha[49]         2.003205  72.5843565
## alpha[50]         2.047466  13.2694046
## alpha[51]         2.009211  44.3367769
## alpha[52]         2.012975  14.3429443
## alpha[53]         2.003169  54.8114588
## alpha[54]         2.029916  19.7801159
## alpha[55]         2.004515  41.0691044
## alpha[56]         2.002209  47.9912740
## alpha[57]         2.006479  33.9568699
## alpha[58]         2.002631  39.4712687
## alpha[59]         2.015567  21.6848742
## alpha[60]         2.005212  50.0576949
## alpha[61]         2.004671  34.7555072
## alpha[62]         2.001556  71.4840639
## alpha[63]         2.014685  24.9383250
## alpha[64]         2.001465  81.4536589
## alpha[65]         2.187442   6.2964312
## alpha[66]         2.060916  12.1221028
## alpha[67]         2.003940  29.7839660
## alpha[68]         2.005446  45.5285857
## alpha[69]         2.005234  27.5296889
## alpha[70]         2.002175  61.8060691
```

```
## alpha[71]         2.005592  26.2567311
## alpha[72]         2.003184  43.4962166
## alpha[73]         2.001669  67.2588850
## alpha[74]         2.001427  77.5253097
## alpha[75]         2.002938  38.8059247
## alpha[76]         2.005941  24.1307449
## alpha[77]         2.020320  20.2091750
## alpha[78]         2.058811  13.8703821
## alpha[79]         2.010420  25.7278133
## alpha[80]         2.062151   6.7093456
## alpha[81]         2.011632  20.4396849
## alpha[82]         2.011853  22.6949936
## alpha[83]         2.003490  30.2500798
## alpha[84]         2.119108   9.6253760
## alpha[85]         2.006089  34.4069351
## alpha[86]         2.004329  27.6197045
## alpha[87]         2.197011   6.5616118
## alpha[88]         2.015070  21.4169651
## alpha[89]         2.018756  14.4793640
## alpha[90]         2.044335  12.2657842
## alpha[91]         2.298401   7.0650441
## alpha[92]         2.008847  27.5620614
## alpha[93]         2.501046   3.3058791
## alpha[94]         2.002384  83.2579360
## alpha[95]         2.001460  89.5408530
## alpha[96]         2.006718  40.4813129
## alpha[97]         2.242061   6.1755556
## alpha[98]         2.002234  86.1228875
## alpha[99]         2.017659  28.7704205
## alpha[100]        2.384294   4.9993241
## alpha[101]        2.003506  37.5582016
## alpha[102]        2.001802  61.3920894
## alpha[103]        2.009855  31.0499744
## alpha[104]        2.325057   5.4578288
## alpha[105]        2.014892  17.7922478
## alpha[106]        2.002205  48.8834385
## alpha[107]        2.011124  21.9214520
## alpha[108]        2.004107  37.7138948
## alpha[109]        2.004738  26.4013095
## alpha[110]        2.002321  59.6419946
## alpha[111]        2.001400  88.9383369
## alpha[112]        2.001914  60.6903629
## alpha[113]        2.036489  14.9767791
## alpha[114]        2.026652  16.4487203
## alpha[115]        2.002100  52.0453031
## alpha[116]        2.225327   5.6497053
## alpha[117]        4.691673   3.3543200
## alpha[118]        2.001648  95.5100878
## alpha[119]        2.309695   5.3906125
## alpha[120]        2.011800  22.7700602
## alpha[121]        2.091052   9.6809393
## alpha[122]        2.032393  13.4783854
## alpha[123]        2.003913  44.2047002
## alpha[124]        3.257231   3.8284248
```

```
## alpha[125]        2.001227 124.9364226
## alpha[126]        2.001500  87.2474224
## alpha[127]        2.001537  80.6706845
## alpha[128]        2.001477  78.5447221
## alpha[129]        2.672384   4.0794100
## alpha[130]        2.003695  31.5216173
## alpha[131]        2.045799  14.6903846
## alpha[132]        2.006088  29.1074254
## alpha[133]        2.003857  40.0420853
## alpha[134]        2.002108  75.4411414
## alpha[135]        2.009879  23.2623852
## alpha[136]        2.004746  34.4848458
## alpha[137]        2.002546  46.5463263
## alpha[138]        2.004410  26.5974123
## alpha[139]        2.035298  16.0128603
## alpha[140]        2.001440 102.0422915
## alpha[141]        2.013929  21.7952031
## alpha[142]        2.002374  52.1335120
## alpha[143]        2.003854  56.2436527
## alpha[144]        2.215475   7.8701670
## alpha[145]        2.001389  91.7047310
## alpha[146]        3.754663   3.8512813
## alpha[147]        3.292528   4.4490714
## alpha[148]        2.013217  18.1884056
## alpha[149]        2.006725  33.3302033
## alpha[150]        2.488257   3.3955481
## alpha[151]        3.142037   4.3331494
## alpha[152]        2.073364  11.6916314
## alpha[153]        2.478032   3.9799885
## alpha[154]        2.001874  62.1042932
## alpha[155]        2.278546   6.4895591
## alpha[156]        2.155978   5.9405916
## alpha[157]        2.003803  35.1547017
## alpha[158]        2.232221   6.1882026
## alpha[159]        2.017896  19.9737314
## alpha[160]        2.001421  79.0013184
## alpha[161]        3.817323   3.4698901
## alpha[162]        2.261130   8.0699200
## alpha[163]        2.733845   5.1300532
## alpha[164]        2.001270 124.6764717
## alpha[165]        2.005518  42.0284240
## alpha[166]        2.002389  42.9273570
## alpha[167]        2.003619  38.7655199
## alpha[168]        2.011458  32.3706536
## alpha[169]        2.488437   3.3922764
## alpha[170]        2.002274  46.4952161
## alpha[171]        2.003062  43.6241172
## alpha[172]        2.004620  27.4164052
## alpha[173]        2.018430  17.9786576
## alpha[174]        2.455532   5.6642941
## alpha[175]        2.009737  24.2875548
## alpha[176]        2.293560   6.6349697
## alpha[177]        2.013287  23.6918094
## alpha[178]        2.532368   3.4838277
```

```
## alpha[179]        2.007159  29.3076955
## alpha[180]        2.226827   7.8691299
## alpha[181]        2.497124   5.8462120
## alpha[182]        2.304396   6.5580823
## alpha[183]        2.005716  48.4099497
## alpha[184]        2.005783  41.9056809
## alpha[185]        2.001878  54.8730623
## alpha[186]        2.001689 102.4333569
## alpha[187]        2.003197  60.5983388
## alpha[188]        2.439739   5.8675999
## alpha[189]        2.006918  22.5027483
## alpha[190]        2.141906   9.2802435
## alpha[191]        2.573919   3.8489373
## alpha[192]        2.299897   6.2894287
## alpha[193]        2.011065  18.8850015
## alpha[194]        2.013007  26.2189800
## alpha[195]        2.492081   3.3426407
## sigma             4.292018   1.3791604
## beta              2.488510   3.3967811
## mu                2.006429  21.4977798
## log_theta[1]      2.499914   3.3667240
## log_theta[2]      2.513219   3.3340390
## log_theta[3]      2.498647   3.3707316
## log_theta[4]      2.514331   3.3296397
## log_theta[5]      2.493646   3.3837772
## log_theta[6]      2.486236   3.4073275
## log_theta[7]      2.479527   3.4266272
## log_theta[8]      2.470048   3.4492041
## log_theta[9]      2.517861   3.3255429
## log_theta[10]     2.473680   3.4385255
## log_theta[11]     2.480252   3.4185226
## log_theta[12]     2.490984   3.3915689
## log_theta[13]     2.492767   3.3853341
## log_theta[14]     2.498916   3.3699895
## log_theta[15]     2.500295   3.3655668
## log_theta[16]     2.479889   3.4209896
## log_theta[17]     2.515615   3.3270022
## log_theta[18]     2.460982   3.4758830
## log_theta[19]     2.469013   3.4535019
## log_theta[20]     2.480243   3.4195326
## log_theta[21]     2.481754   3.4166187
## log_theta[22]     2.489570   3.3967954
## log_theta[23]     2.487303   3.4016066
## log_theta[24]     2.511342   3.3368495
## log_theta[25]     2.487598   3.3993466
## log_theta[26]     2.508987   3.3429450
## log_theta[27]     2.505038   3.3539525
## log_theta[28]     2.490017   3.3941496
## log_theta[29]     2.474165   3.4372232
## log_theta[30]     2.494732   3.3804399
## log_theta[31]     2.493303   3.3841947
## log_theta[32]     2.482827   3.4128951
## log_theta[33]     2.467403   3.4611192
## log_theta[34]     2.478162   3.4253538
```

```
## log_theta[35]     2.523298   3.3087425
## log_theta[36]     2.493925   3.3821218
## log_theta[37]     2.489243   3.3942508
## log_theta[38]     2.498999   3.3700729
## log_theta[39]     2.540128   3.2692679
## log_theta[40]     2.515233   3.3283973
## log_theta[41]     2.483360   3.4112622
## log_theta[42]     2.505900   3.3515767
## log_theta[43]     2.503681   3.3572392
## log_theta[44]     2.476957   3.4304827
## log_theta[45]     2.492213   3.3890474
## log_theta[46]     2.475147   3.4347219
## log_theta[47]     2.518944   3.3272912
## log_theta[48]     2.474184   3.4356679
## log_theta[49]     2.470552   3.4483638
## log_theta[50]     2.463430   3.4695072
## log_theta[51]     2.471594   3.4459050
## log_theta[52]     2.483211   3.4117899
## log_theta[53]     2.510000   3.3396756
## log_theta[54]     2.521709   3.3158254
## log_theta[55]     2.467137   3.4572742
## log_theta[56]     2.506771   3.3492707
## log_theta[57]     2.540039   3.2666123
## log_theta[58]     2.492061   3.3873142
## log_theta[59]     2.452046   3.5020494
## log_theta[60]     2.467540   3.4688484
## log_theta[61]     2.469892   3.4494098
## log_theta[62]     2.439155   3.5423775
## log_theta[63]     2.493457   3.3858859
## log_theta[64]     2.548926   3.2484269
## log_theta[65]     2.503035   3.3649190
## log_theta[66]     2.432312   3.5528632
## log_theta[67]     2.388053   3.7135179
## log_theta[68]     2.450873   3.5078987
## log_theta[69]     2.488601   3.3969323
## log_theta[70]     2.618024   3.1011481
## log_theta[71]     2.467666   3.4569662
## log_theta[72]     2.510043   3.3457636
## log_theta[73]     2.461031   3.4744013
## log_theta[74]     2.484183   3.4083284
## log_theta[75]     2.472662   3.4397207
## log_theta[76]     2.500809   3.3645477
## log_theta[77]     2.483871   3.4105974
## log_theta[78]     2.498934   3.3710407
## log_theta[79]     2.481553   3.4170619
## log_theta[80]     2.489618   3.3938709
## log_theta[81]     2.492187   3.3866929
## log_theta[82]     2.473113   3.4415554
## log_theta[83]     2.524701   3.3034433
## log_theta[84]     2.473780   3.4409037
## log_theta[85]     2.500099   3.3667115
## log_theta[86]     2.506825   3.3489912
## log_theta[87]     2.493667   3.3853325
## log_theta[88]     2.453048   3.5028292
```

```
## log_theta[89]     2.503414   3.3580498
## log_theta[90]     2.477873   3.4269141
## log_theta[91]     2.517699   3.3012829
## log_theta[92]     2.476405   3.4289671
## log_theta[93]  2094.544001   1.0028991
## log_theta[94]     2.510925   3.3385590
## log_theta[95]     2.464481   3.4649147
## log_theta[96]     2.448592   3.5187479
## log_theta[97]     3.045838   2.5892220
## log_theta[98]     2.529398   3.2944649
## log_theta[99]     2.524602   3.3075558
## log_theta[100]    2.733366   2.9068863
## log_theta[101]    2.470141   3.4486969
## log_theta[102]    2.461893   3.4718837
## log_theta[103]    2.479837   3.4217291
## log_theta[104]    2.834458   2.7810686
## log_theta[105]    2.487268   3.4010470
## log_theta[106]    2.573632   3.1935622
## log_theta[107]    2.483184   3.4109630
## log_theta[108]    2.508575   3.3444057
## log_theta[109]    2.483190   3.4110784
## log_theta[110]    2.525798   3.2998793
## log_theta[111]    2.584897   3.1694831
## log_theta[112]    2.415831   3.6194699
## log_theta[113]    2.449065   3.4997116
## log_theta[114]   12.579310   1.4250381
## log_theta[115]    2.414954   3.6239826
## log_theta[116]    2.489196   3.3980077
## log_theta[117]    2.472521   3.4229252
## log_theta[118]    2.498241   3.3715428
## log_theta[119]    2.840057   2.7758671
## log_theta[120]    2.516116   3.3255457
## log_theta[121]    2.485385   3.4063447
## log_theta[122]    2.483691   3.4118500
## log_theta[123]    2.431064   3.5676182
## log_theta[124]    2.493931   3.3671259
## log_theta[125]    2.455082   3.4923338
## log_theta[126]    2.467517   3.4556390
## log_theta[127]    2.478459   3.4241238
## log_theta[128]    2.465219   3.4631988
## log_theta[129]    2.497994   3.3558023
## log_theta[130]    2.469392   3.4511659
## log_theta[131]    2.460020   3.4731804
## log_theta[132]    2.513246   3.3296593
## log_theta[133]    2.441979   3.5298254
## log_theta[134]    2.448652   3.5100472
## log_theta[135]    2.466662   3.4588697
## log_theta[136]    2.480439   3.4187152
## log_theta[137]    2.447024   3.5176715
## log_theta[138]    2.448583   3.5127859
## log_theta[139]    2.544888   3.2606395
## log_theta[140]    2.529583   3.2923834
## log_theta[141]    2.526585   3.2856718
## log_theta[142]    2.556163   3.2308308
```

```
## log_theta[143]    2.563698   3.2178351
## log_theta[144]    2.453902   3.4765917
## log_theta[145]    2.615494   3.1126816
## log_theta[146]    2.521434   3.2947545
## log_theta[147]    2.495716   3.3552503
## log_theta[148]    2.474320   3.4376810
## log_theta[149]    2.492363   3.3888623
## log_theta[150] 3762.170882   0.9996062
## log_theta[151]    2.514741   3.3124996
## log_theta[152]    2.482866   3.4136759
## log_theta[153]    2.487020   3.4027110
## log_theta[154]    2.472205   3.4422384
## log_theta[155]    2.460553   3.4622052
## log_theta[156]    2.519700   3.3079419
## log_theta[157]    2.479404   3.4221647
## log_theta[158]    3.139749   2.5184668
## log_theta[159]    2.599552   3.1361897
## log_theta[160]    2.546890   3.2526005
## log_theta[161]    2.517791   3.3041663
## log_theta[162]    2.654617   3.0253308
## log_theta[163]    2.516311   3.3019035
## log_theta[164]    2.452717   3.5001073
## log_theta[165]    2.462365   3.4713468
## log_theta[166]    2.475083   3.4330294
## log_theta[167]    2.461391   3.4741388
## log_theta[168]    2.549441   3.2428707
## log_theta[169] 3823.714189   0.9997141
## log_theta[170]    2.468825   3.4522745
## log_theta[171]    2.490783   3.3904204
## log_theta[172]    2.491691   3.3880669
## log_theta[173]    2.494359   3.3804433
## log_theta[174]    2.449484   3.4854465
## log_theta[175]    6.009024   1.7927602
## log_theta[176]    2.549774   3.2298202
## log_theta[177]    2.489006   3.3966735
## log_theta[178]    2.793069   2.9936149
## log_theta[179]    2.568754   3.2093100
## log_theta[180]    2.438828   3.5304585
## log_theta[181]    2.500398   3.3431311
## log_theta[182]    2.563803   3.2016526
## log_theta[183]    2.452108   3.5034677
## log_theta[184]    2.437236   3.5597410
## log_theta[185]    2.581591   3.1757305
## log_theta[186]    2.444300   3.5252476
## log_theta[187]    2.471199   3.4459598
## log_theta[188]    2.500780   3.3469948
## log_theta[189]    2.488834   3.3949859
## log_theta[190]    2.493270   3.3668314
## log_theta[191]    2.502359   3.3440335
## log_theta[192]    2.437036   3.5342629
## log_theta[193]    2.445811   3.5218141
## log_theta[194]   12.542922   1.4127499
## log_theta[195] 4342.103347   1.0000157
## lp__              2.944024   2.6231467
```

Question 3

Make two plots (appropriately labeled and described) that illustrate the differences in estimated θ_i's across regions and the differences in θs across models.

```
# Aggregate results from models 1, 2, and 3
mod1 <- fit_complete_pooling |>
  gather_draws(log_theta[i]) |>
  median_qi() |>
  rename(median_mod1 = .value,
         lower_mod1 = .lower,
         upper_mod1 = .upper) |>
  select(i, median_mod1:upper_mod1)

mod2 <- fit_no_pooling |>
  gather_draws(log_theta[i]) |>
  median_qi() |>
  rename(median_mod2 = .value,
         lower_mod2 = .lower,
         upper_mod2 = .upper) |>
  select(i, median_mod2:upper_mod2)

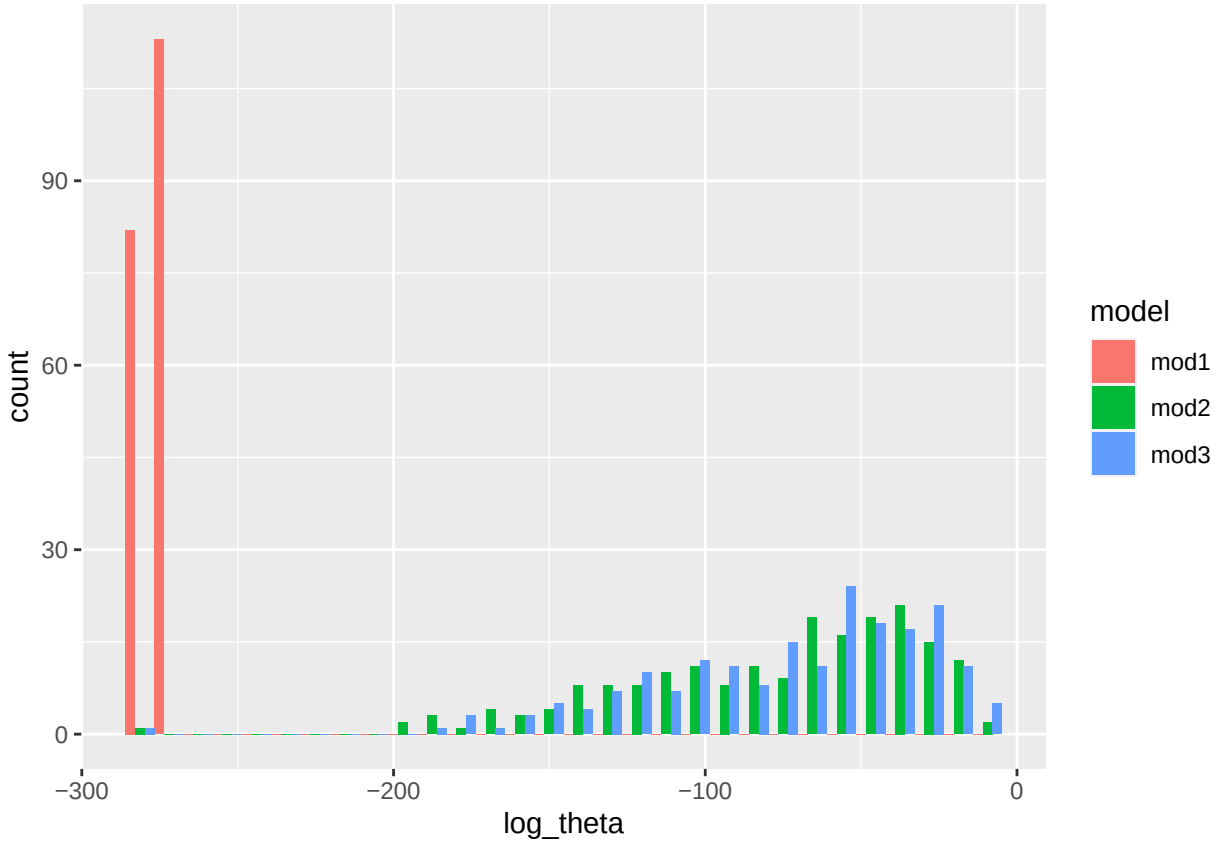
mod3 <- fit_hm |>
  gather_draws(log_theta[i]) |>
  median_qi() |>
  rename(median_mod3 = .value,
         lower_mod3 = .lower,
         upper_mod3 = .upper) |>
  select(i, median_mod3:upper_mod3)

result <- mod1 |>
  left_join(mod2) |>
  left_join(mod3)
```

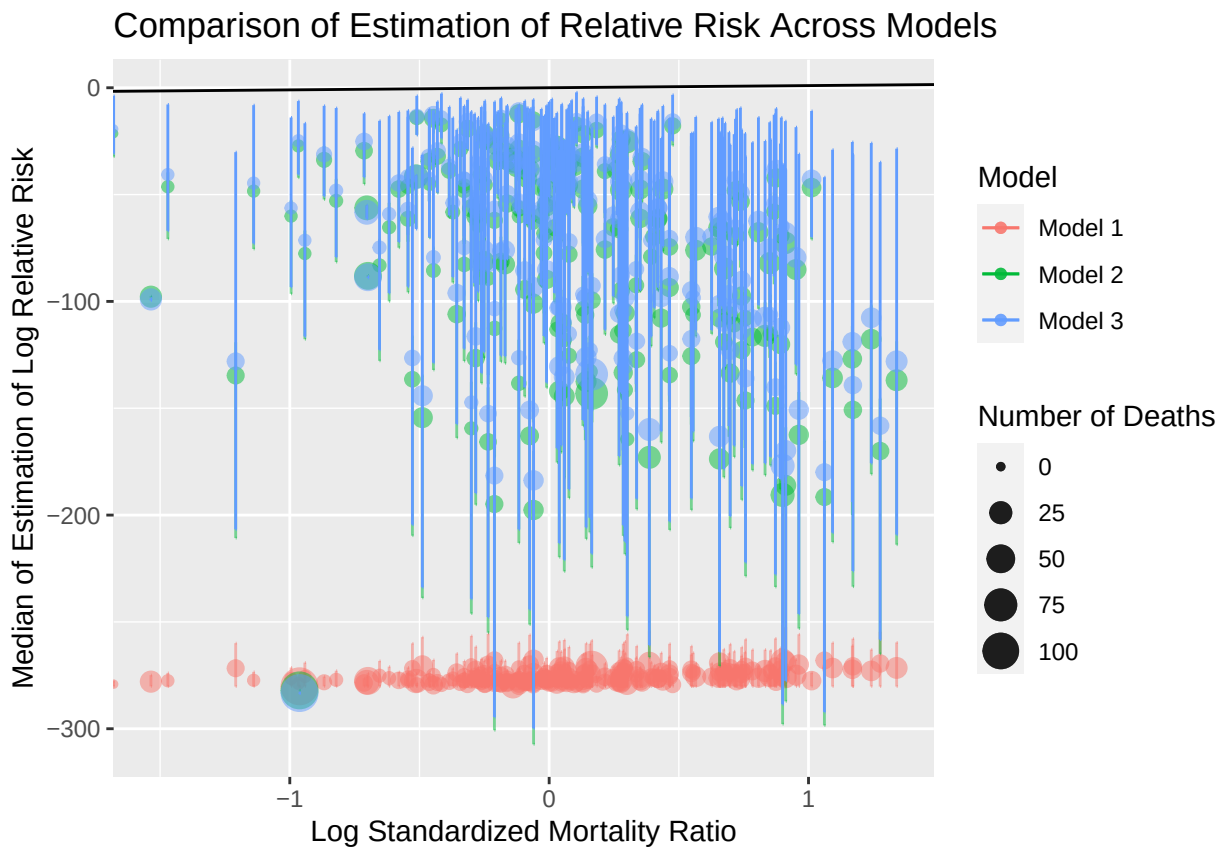
```
## Joining with `by = join_by(i)`
## Joining with `by = join_by(i)`
```

```
# Histogram of median log_theta estimates for each model
result |>
  select(median_mod1, median_mod2, median_mod3) |>
  pivot_longer(median_mod1:median_mod3, names_to = "model", values_to = "log_theta") |>
  mutate(model = str_remove(model, "median_")) |>
  ggplot(aes(log_theta, fill = model)) +
  geom_histogram(position = "dodge")
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



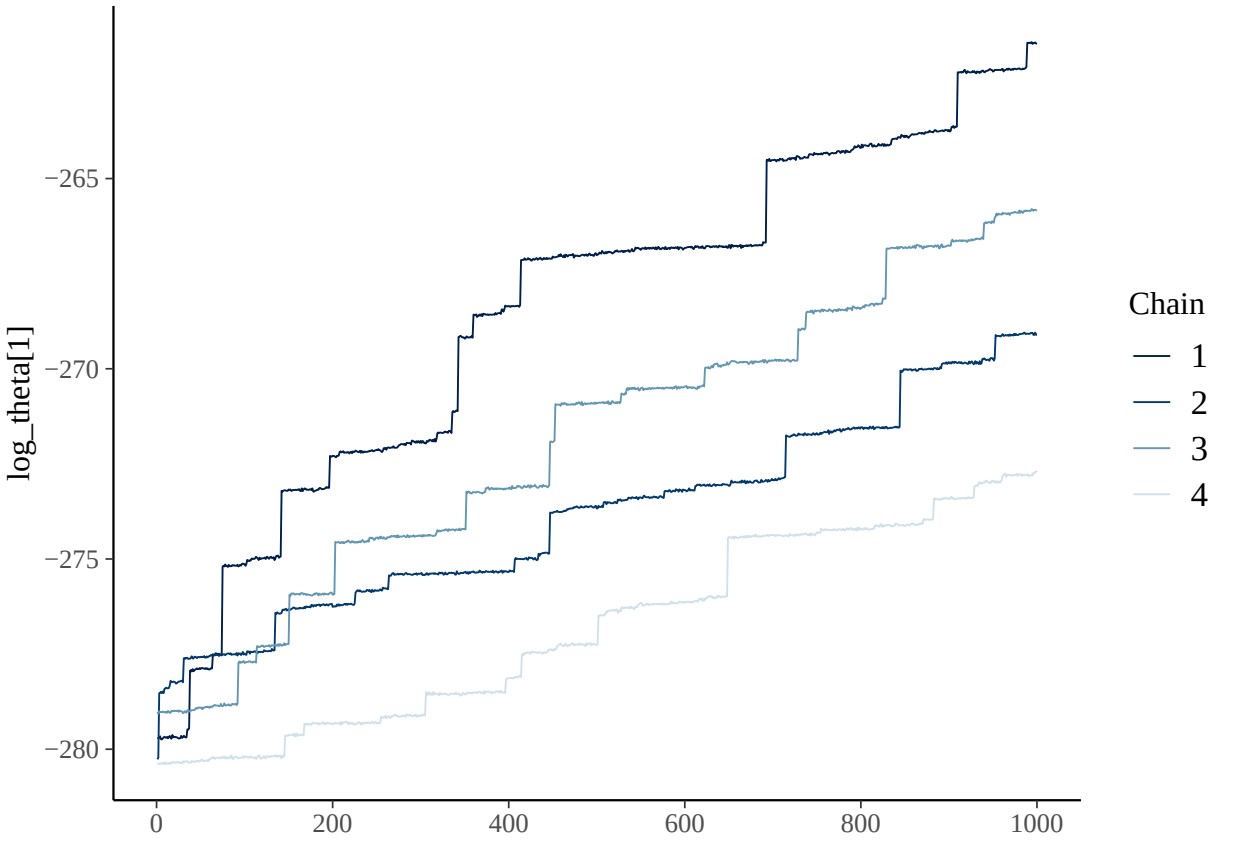

```
# Scatter plot of median log_theta vs. log SMR, with error bars and point sizes based on observed death
result |>
  mutate(deaths = observe.i) |>
  mutate(log_theta = log(observe.i / expect.i)) |>
  ggplot(aes(log_theta, median_mod1, color = "Model 1")) +
  geom_point(aes(size = deaths), alpha = 0.5) +
  geom_errorbar(aes(ymin = lower_mod1, ymax = upper_mod1, color = "Model 1"), alpha = 0.5) +
  geom_abline(slope = 1, intercept = 0) +
  geom_point(aes(log_theta, median_mod2, color = "Model 2", size = deaths), alpha = 0.5) +
  geom_errorbar(aes(ymin = lower_mod2, ymax = upper_mod2, color = "Model 2"), alpha = 0.5) +
  geom_point(aes(log_theta, median_mod3, color = "Model 3", size = deaths), alpha = 0.5) +
  geom_errorbar(aes(ymin = lower_mod3, ymax = upper_mod3, color = "Model 3")) +
  labs(
    title = "Comparison of Estimation of Relative Risk Across Models",
    x = "Log Standardized Mortality Ratio",
    y = "Median of Estimation of Log Relative Risk",
    color = "Model",
    size = "Number of Deaths"
  )
```



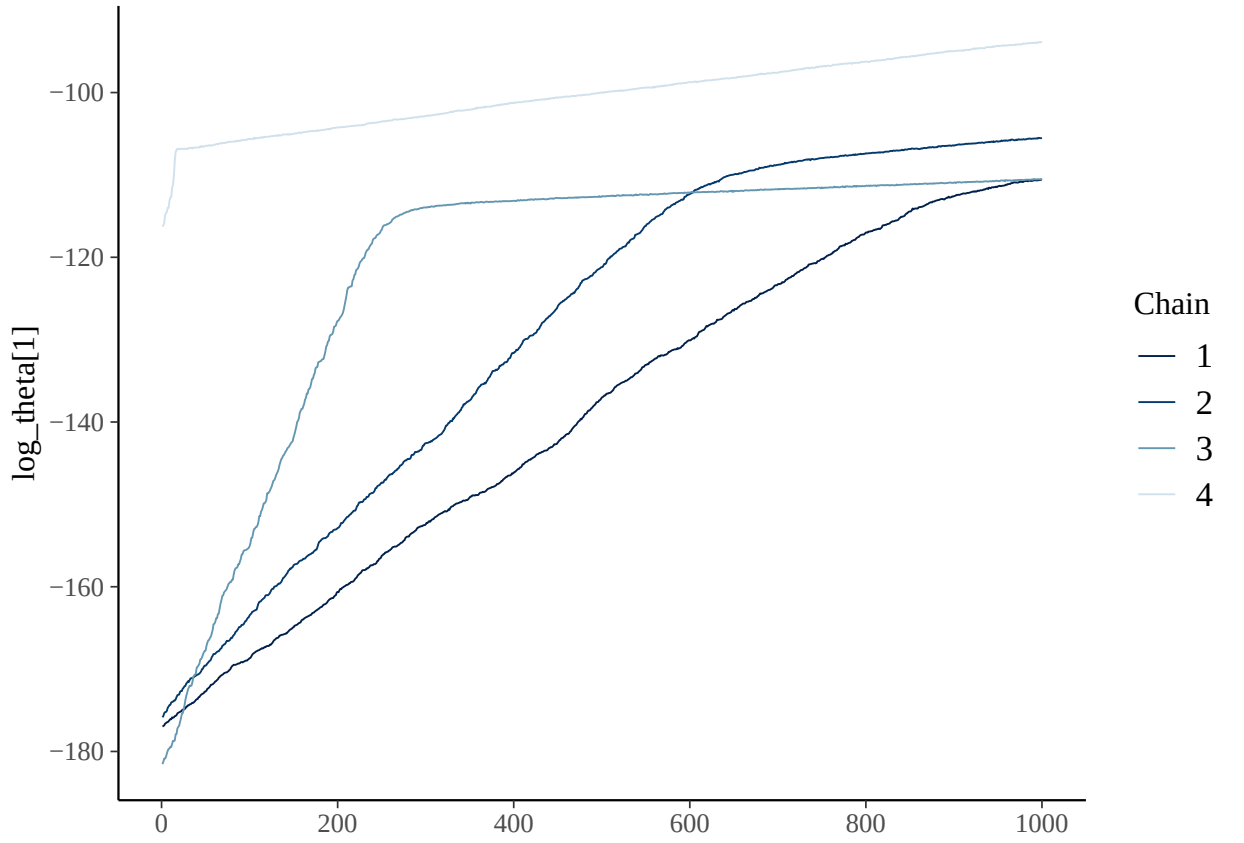
Question 4

Using tool of your choice, decide which model is the best, and justify your choice.

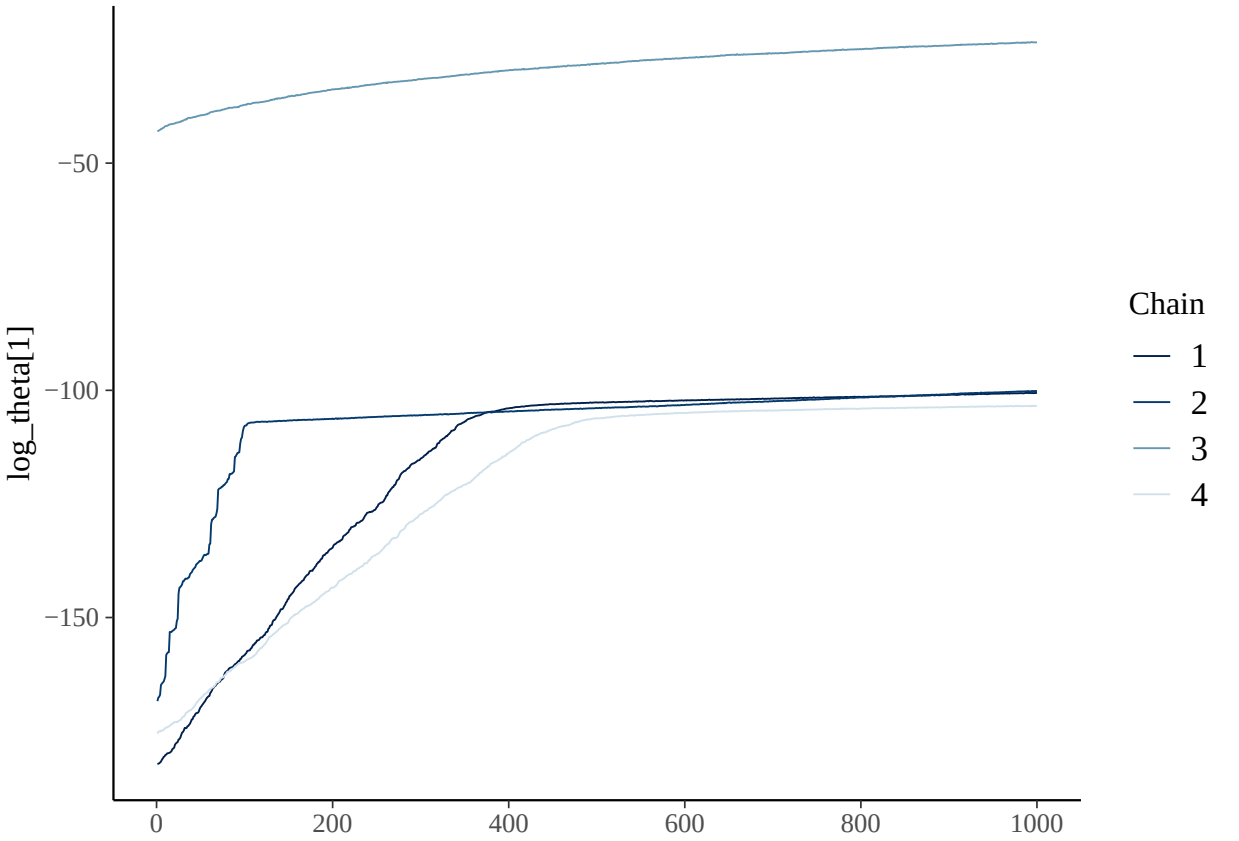
```
# For fit_complete_pooling
mcmc_trace(as.array(fit_complete_pooling), pars = "log_theta[1]")
```




```
# For fit_no_pooling
mcmc_trace(as.array(fit_no_pooling), pars = "log_theta[1]")
```




```
# For fit_hm
mcmc_trace(as.array(fit_hm), pars = "log_theta[1]")
```



Based on the traceplot for each model, the complete-pooling shows the best convergence for log_theta[1]. Therefoer, the model is the best.