Untitled

2024-06-18

```r
rm(list = ls(all = TRUE))
```

```r
#install.packages("dplyr")
library(ETAS.inlabru)
library(ggplot2)
#install.packages("dplyr")
library(dplyr)

# Increase/decrease num.cores if you have more/fewer cores on your computer.
# future::multisession works on both Windows, MacOS, and Linux
num.cores <- 2
future::plan(future::multisession, workers = num.cores)
INLA::inla.setOption(num.threads = num.cores)
# To deactivate parallelism, run
#    future::plan(future::sequential)
#    INLA::inla.setOption(num.threads = 1)
```

#How high-magnitude events affect the distribution of alpha #Firstly, classify into 4 groups based on the number of high-magnitude events

```r
# Set seeds to ensure repeatability of results
set.seed(1)
# set true ETAS parameters
#The selection of parameters refers to
#Bayesian modeling of the temporal evolution of seismicity

 #using the ETAS.inlabru package
true.param <- list(mu = 0.1, K = 0.089, alpha = 2.29, c = 0.11, p = 1.08)
# set magnitude distribution parameter
beta.p <- 2.35
M0=2.5
# set starting time of the synthetic catalogue
T1 <- 0
# set end time of the synthetic catalogue
T2 <- 1000

# Set the number of catalogues
n_catalogues <-1000

# Set the threshold for earthquakes
M_threshold <- 5.0

# Initialize seismic event grouping
groups <- list(
```

```r
  "No high magnitude events" = list(),
  "1-2 high magnitude events" = list(),
  "3-4 high magnitude events" = list(),
  "5+ high magnitude events" = list()
)

# Generate each catalogue in a loop
for (i in 1:n_catalogues) {
  # generate temporal catalogue
  synth_catalogue <- generate_temporal_ETAS_synthetic(
    theta = true.param, beta = beta.p, M0 = M0, T1 = T1, T2 = T2, Ht = NULL
  )

  # bind
  ETAS.cat <- bind_rows(synth_catalogue) %>%
    arrange(ts)

  # Calculate the number of earthquakes greater than the threshold
  n_major_events <- sum(ETAS.cat$magnitudes >= M_threshold)

  # Classification of earthquake catalogs
  if (n_major_events == 0 && length(groups[["No high magnitude events"]])<3) {
    groups[["No high magnitude events"]] <-
      c(groups[["No high magnitude events"]], list(ETAS.cat))
  } else if (n_major_events >=1 && n_major_events <= 2 &&
            length(groups[["1-2 high magnitude events"]])< 3)
    {
    groups[["1-2 high magnitude events"]] <-
      c(groups[["1-2 high magnitude events"]], list(ETAS.cat))
  } else if (n_major_events >= 3 && n_major_events <= 4 &&
            length(groups[["3-4 high magnitude events"]])< 3)
    {
    groups[["3-4 high magnitude events"]] <-
      c(groups[["3-4 high magnitude events"]], list(ETAS.cat))
  } else if(n_major_events >=5  &&
            length(groups[["5+ high magnitude events"]])<3) {
    groups[["5+ high magnitude events"]] <-
      c(groups[["5+ high magnitude events"]], list(ETAS.cat))
  }
  if(length(groups[["No high magnitude events"]])>=3 &&
     length(groups[["1-2 high magnitude events"]])>= 3 &&
     length(groups[["3-4 high magnitude events"]])>=3 &&
     length(groups[["5+ high magnitude events"]])>= 3){
  break
}
}

#check
sapply(groups, length)
```

```
##  No high magnitude events 1-2 high magnitude events 3-4 high magnitude events
##                         3                         3                         3
##  5+ high magnitude events
```

```
##                                    3
```

#Form scatter and line charts separately by group
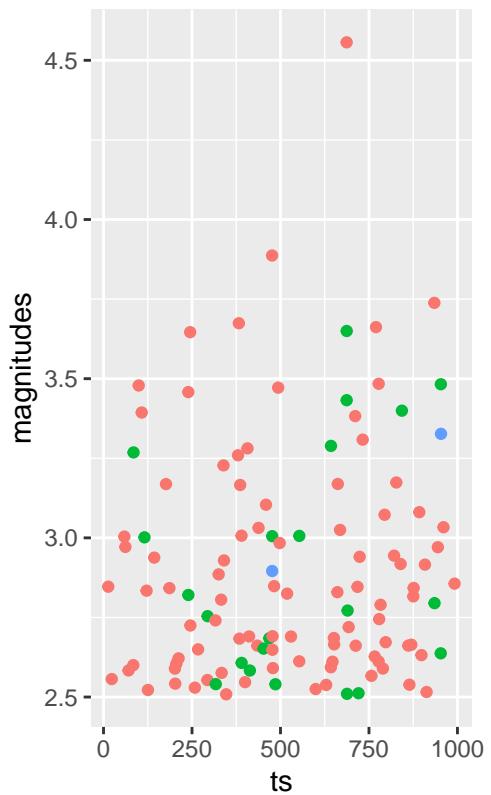
```r
library(ggplot2)
library(gridExtra)
```
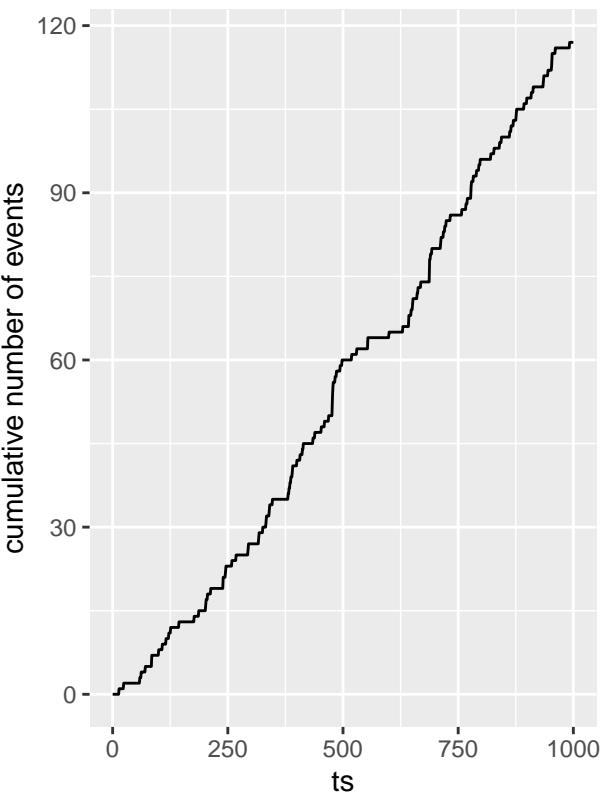
```
##
##     'gridExtra'

## The following object is masked from 'package:dplyr':
##
##     combine
```

```r
group_name <-"No high magnitude events"
first_group <- groups[[group_name]]
#Prepare a list to save all graphics
all_plots <-list()
#loop each sequence in the first group and draw graphs separately
for(i in seq_along(first_group)){
  catalogue <-first_group[[i]]
#Create a scatter plot of time magnitude
  pl1 <-ggplot(catalogue, aes(ts, magnitudes, color = as.factor(gen)))+
  geom_point()+
  labs(color = "gen")+
  ggtitle(
    paste(
      "Scatter Plot of Time vs Magnitude for No high magnitude events - Sample",
      i))
  t.breaks <- T1:T2
  N.cumsum<-vapply(t.breaks,\(x) sum(catalogue$ts<x),0)
  df.to.cumsum.plot <-data.frame(ts =t.breaks, N.cum = N.cumsum)
  pl2<-ggplot(df.to.cumsum.plot,aes(ts,N.cum))+
  geom_line() +
  ylab("cumulative number of events")+
  ggtitle(
    paste(
      "Cumulative Number of Events for No high magnitude events - Sample", i))
  combined_plot<-grid.arrange(pl1,pl2,nrow=1)
  all_plots[[i]]<- pl1
}
```

```
grid.arrange(grobs=all_plots,nco1=2)
```
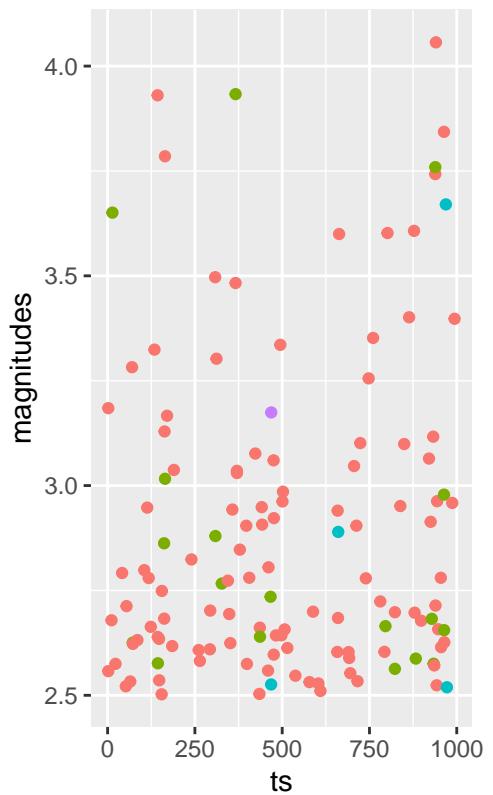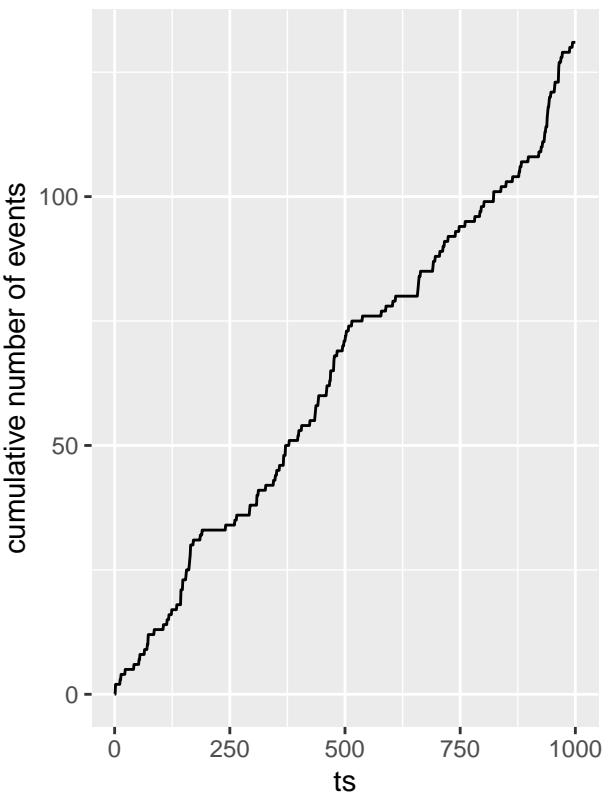
Scatter Plot of Time vs Magnitude for No high magnitude events – Sample 1
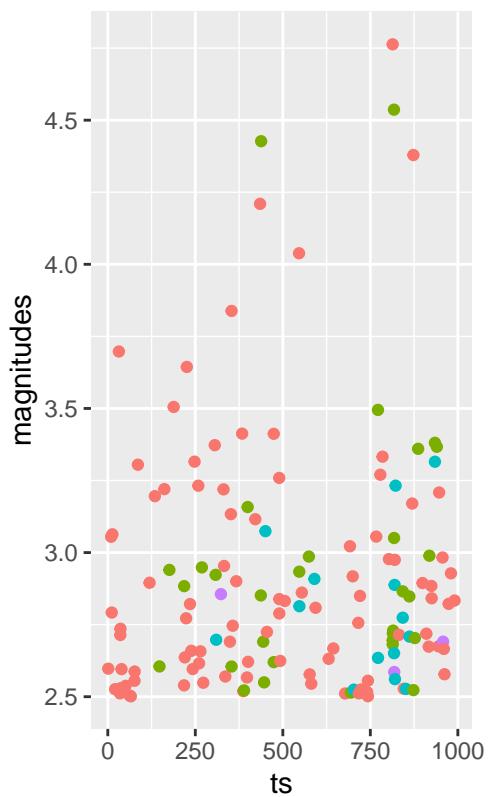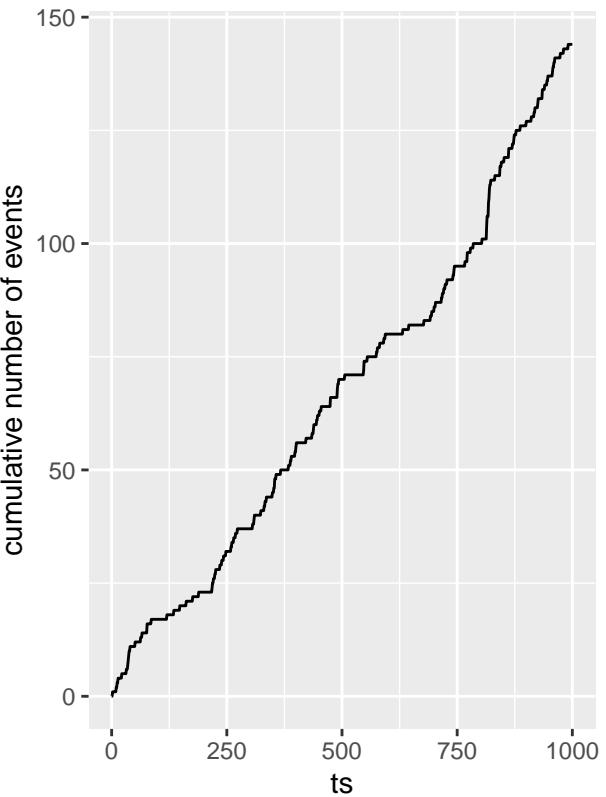
Scatter Plot of Time vs Magnitude for No high magnitude events – Sample 2
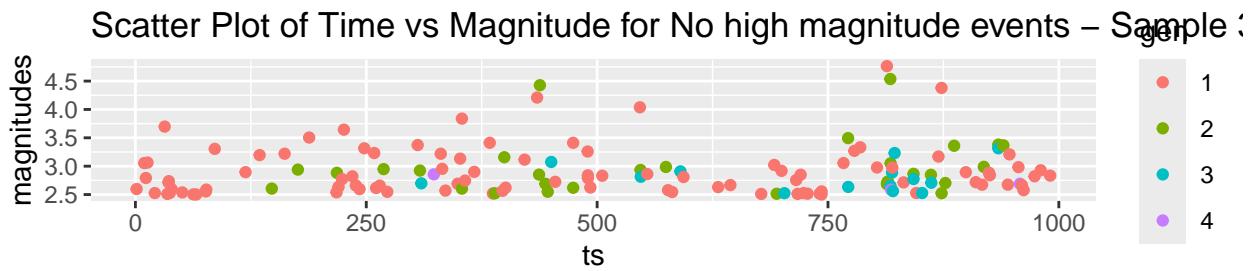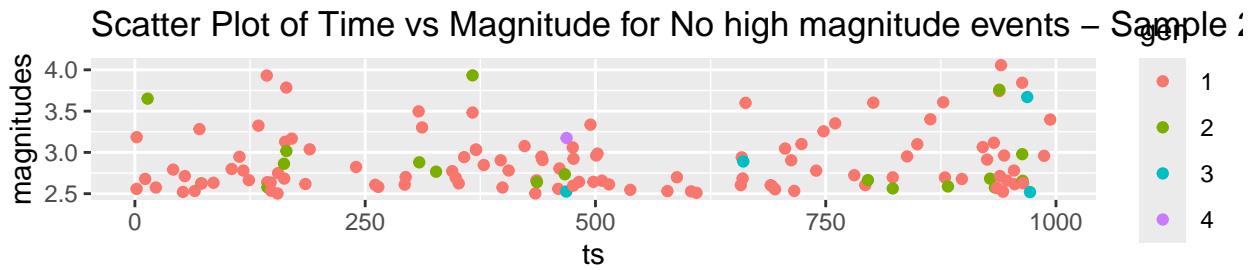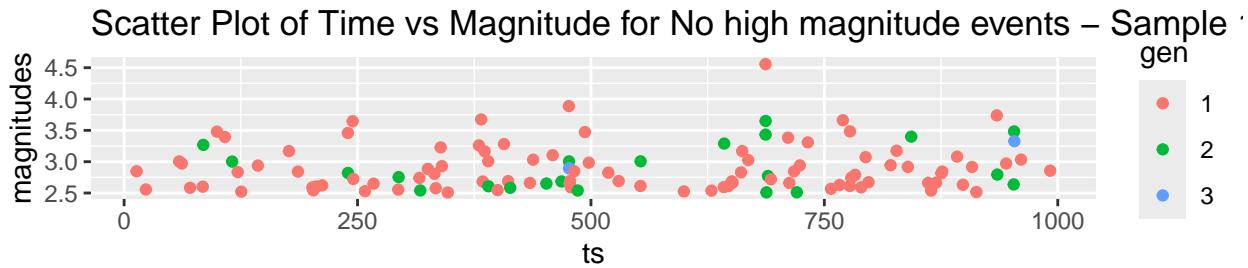
Scatter Plot of Time vs Magnitude for No high magnitude events – Sample 3
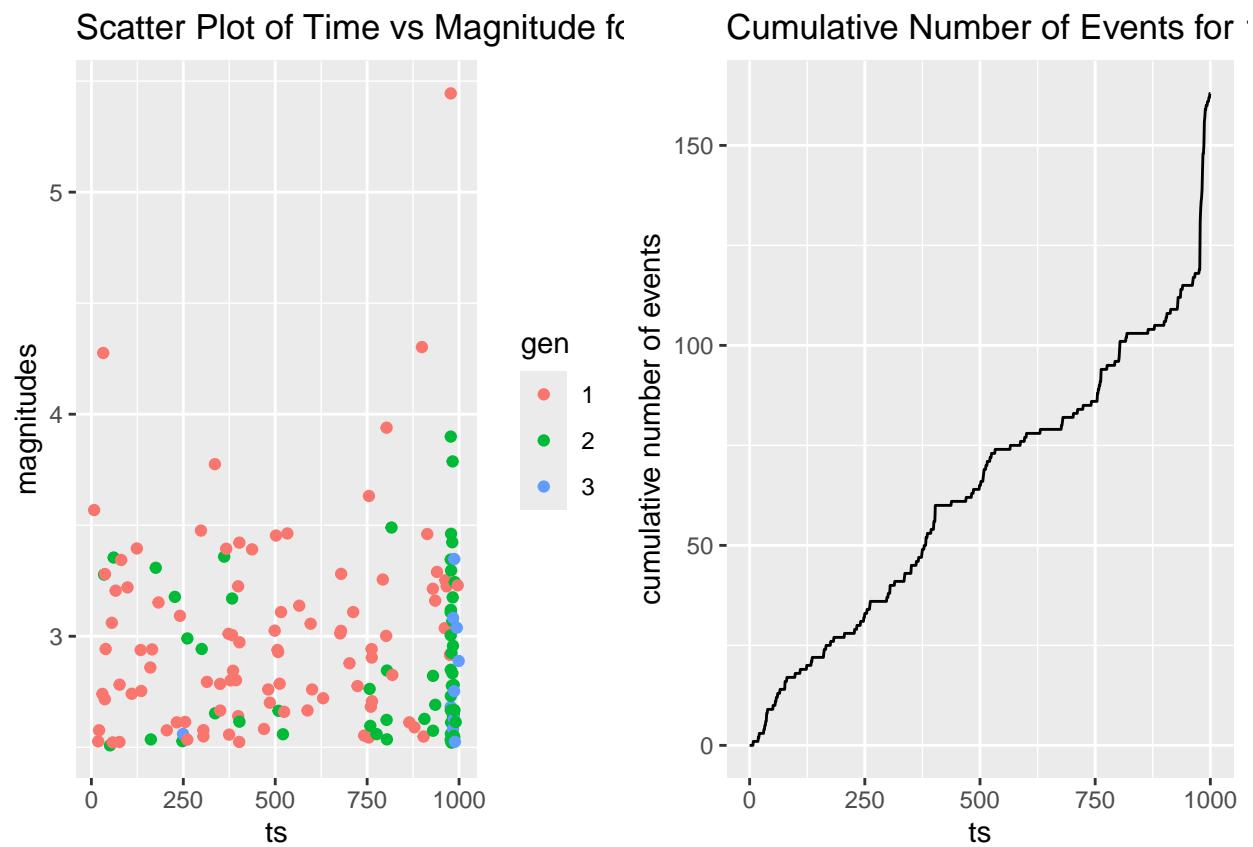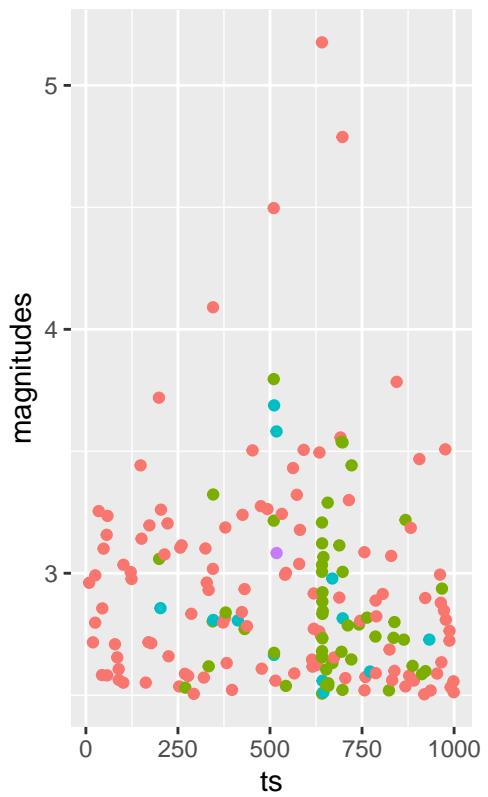
```r
group_name <-"1-2 high magnitude events"
second_group <- groups[[group_name]]
#Prepare a list to save all graphics
all_plots <-list()
#Traverse each sequence in the first group and draw graphs separately
for(i in seq_along(second_group)){
  catalogue <-second_group[[i]]
#Create a scatter plot of time magnitude
  pl1 <-ggplot(catalogue, aes(ts, magnitudes, color = as.factor(gen)))+
  geom_point()+
  labs(color = "gen")+
  ggtitle(
    paste(
      "Scatter Plot of Time vs Magnitude for 1-2 high magnitude events - Sample"
      , i))
  t.breaks <- T1:T2
  N.cumsum<-vapply(t.breaks,\(x) sum(catalogue$ts<x),0)
  df.to.cumsum.plot <-data.frame(ts =t.breaks, N.cum = N.cumsum)
  pl2<-ggplot(df.to.cumsum.plot,aes(ts,N.cum))+
  geom_line() +
  ylab("cumulative number of events")+
  ggtitle(
    paste("Cumulative Number of Events for 1-2 high magnitude events - Sample",
        i))
  combined_plot<-grid.arrange(pl1,pl2,nrow=1)
  all_plots[[i]]<- pl1
```

```
}
```

Scatter Plot of Time vs Magnitude fo

## Cumulative Number of Events for

```
grid.arrange(grobs=all_plots,nco1=2)
```

Scatter Plot of Time vs Magnitude for 1–2 high magnitude events – Sample 1
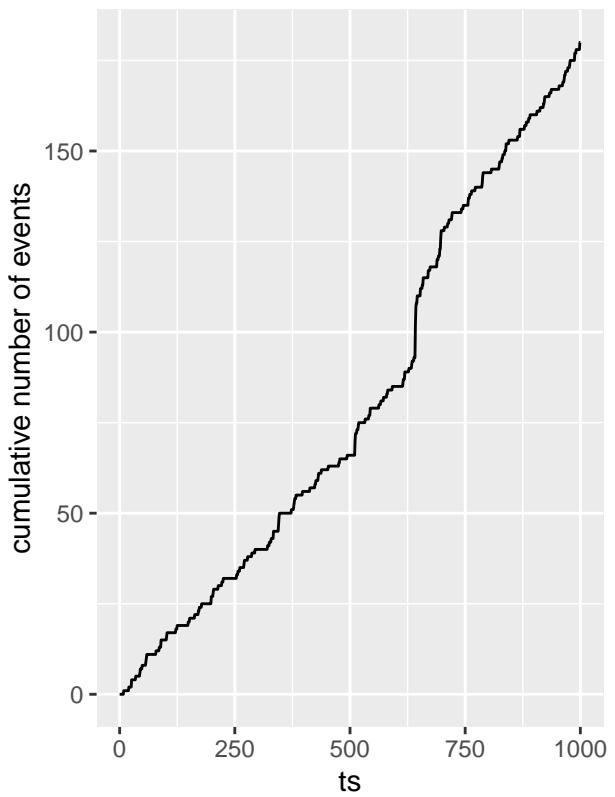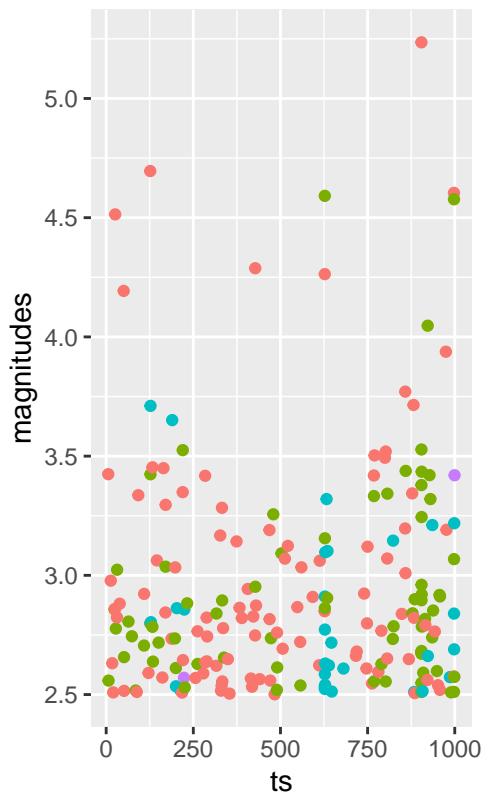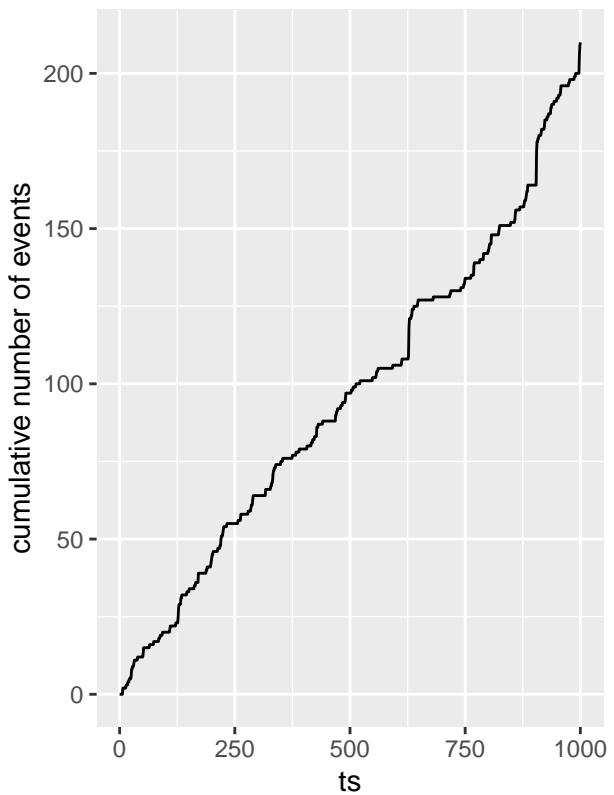
Scatter Plot of Time vs Magnitude for 1–2 high magnitude events – Sample 2
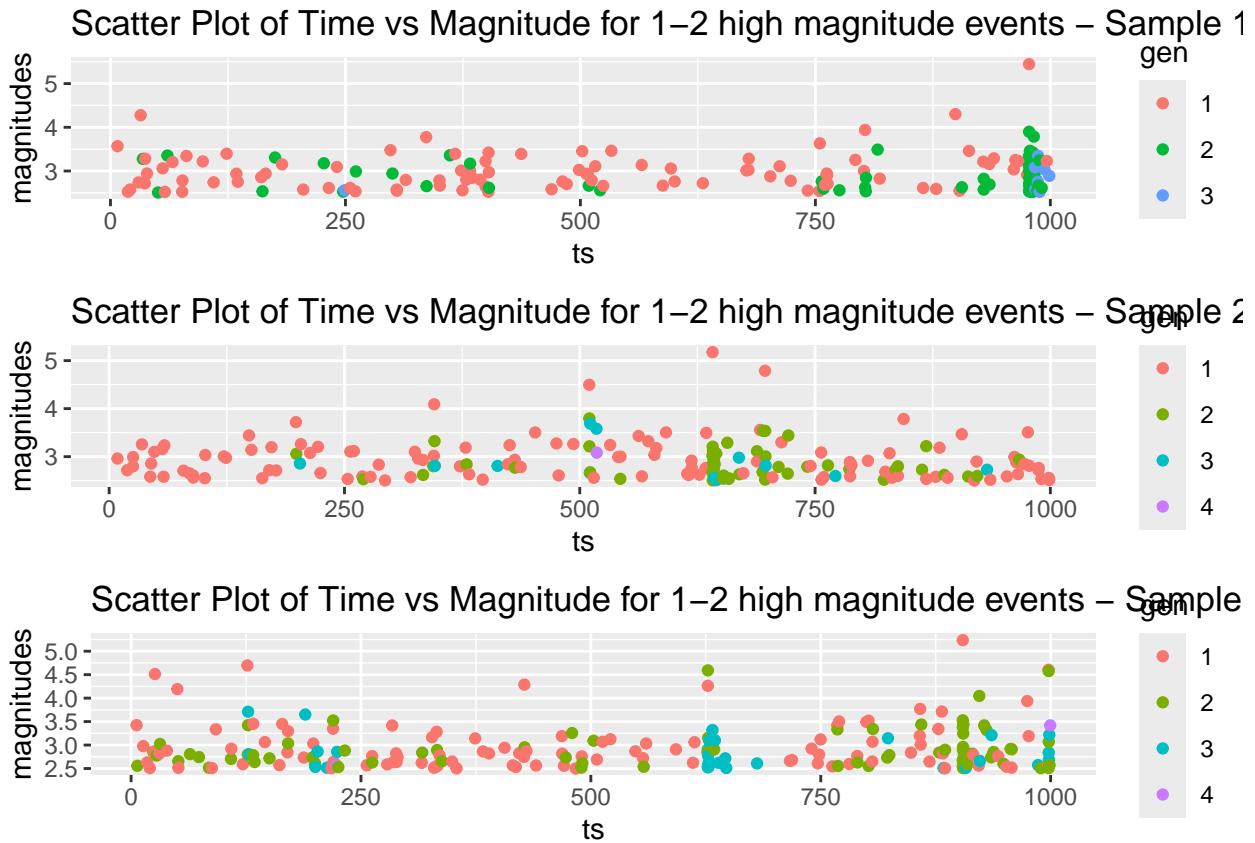
Scatter Plot of Time vs Magnitude for 1–2 high magnitude events – Sample
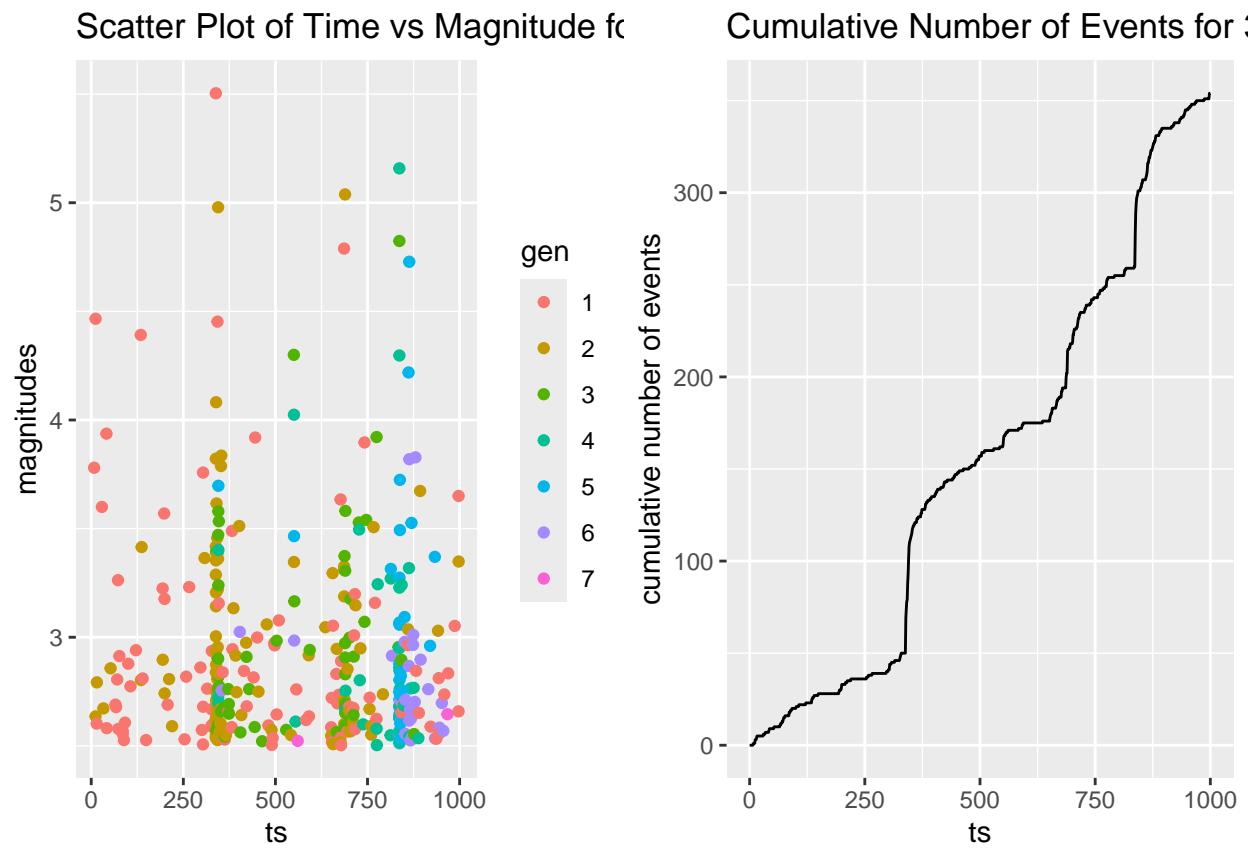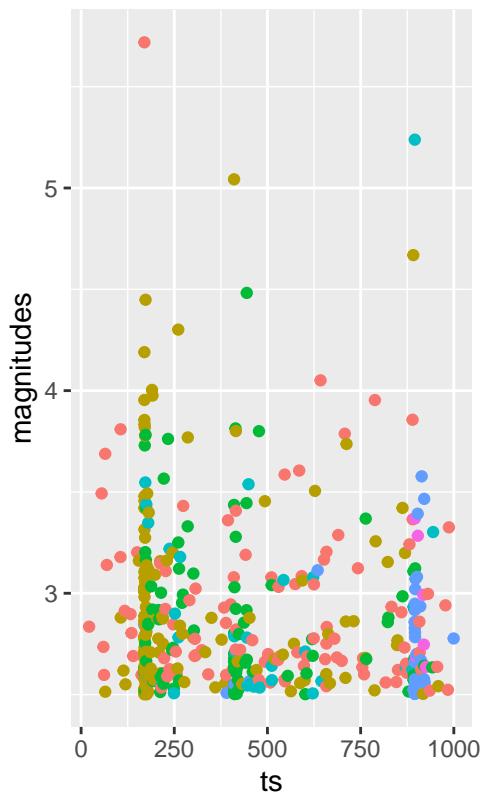
```r
group_name <-"3-4 high magnitude events"
third_group <- groups[[group_name]]
#Prepare a list to save all graphics
all_plots <-list()
#Traverse each sequence in the group and draw graphs separately
for(i in seq_along(third_group)){
  catalogue <-third_group[[i]]
#Create a scatter plot of time magnitude
  pl1 <-ggplot(catalogue, aes(ts, magnitudes, color = as.factor(gen)))+
  geom_point()+
  labs(color = "gen")+
  ggtitle(
    paste(
      "Scatter Plot of Time vs Magnitude for 3-4 high magnitude events -Sample",
      i))
  t.breaks <- T1:T2
  N.cumsum<-vapply(t.breaks,\(x) sum(catalogue$ts<x),0)
  df.to.cumsum.plot <-data.frame(ts =t.breaks, N.cum = N.cumsum)
  pl2<-ggplot(df.to.cumsum.plot,aes(ts,N.cum))+
  geom_line() +
  ylab("cumulative number of events")+
  ggtitle(
    paste("Cumulative Number of Events for 3-4 high magnitude events - Sample",
        i))

  combined_plot<-grid.arrange(pl1,pl2,nrow=1)
```
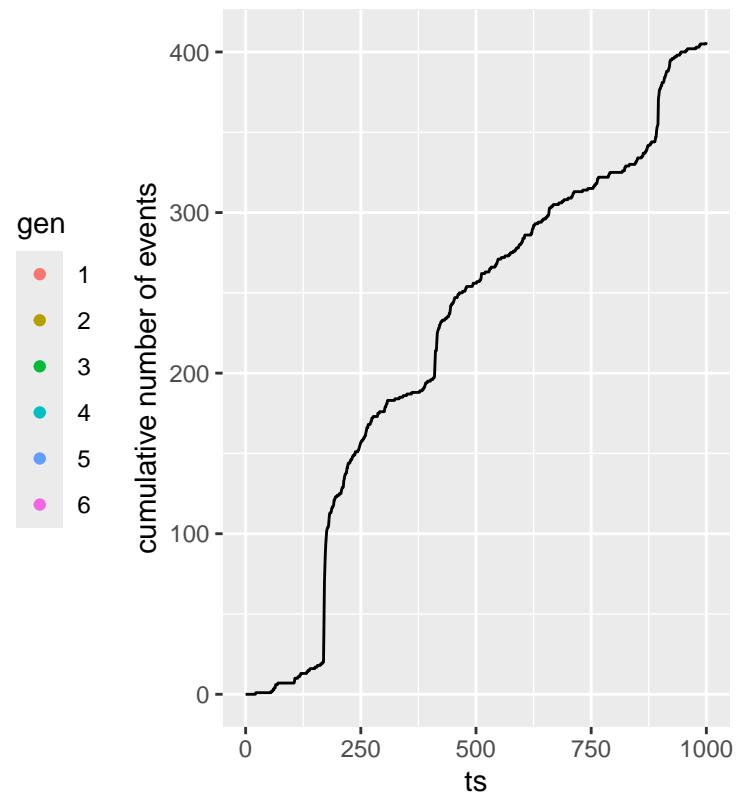
```
  all_plots[[i]]<- pl1
}
```


Scatter Plot of Time vs Magnitude fo

Cumulative Number of Events for

Scatter Plot of Time vs Magnitude for

Cumulative Number of Events for 3

```
grid.arrange(grobs=all_plots,nco1=2)
```

Scatter Plot of Time vs Magnitude for 3–4 high magnitude events –Sample 1
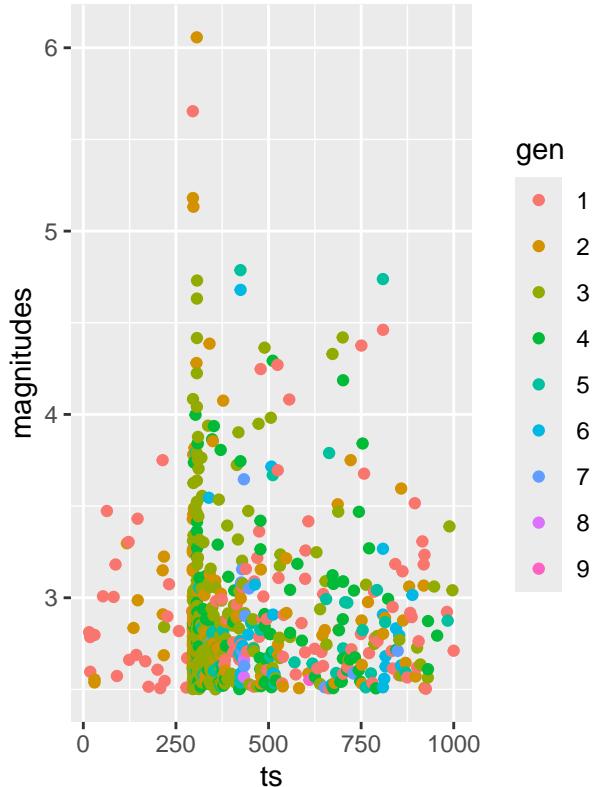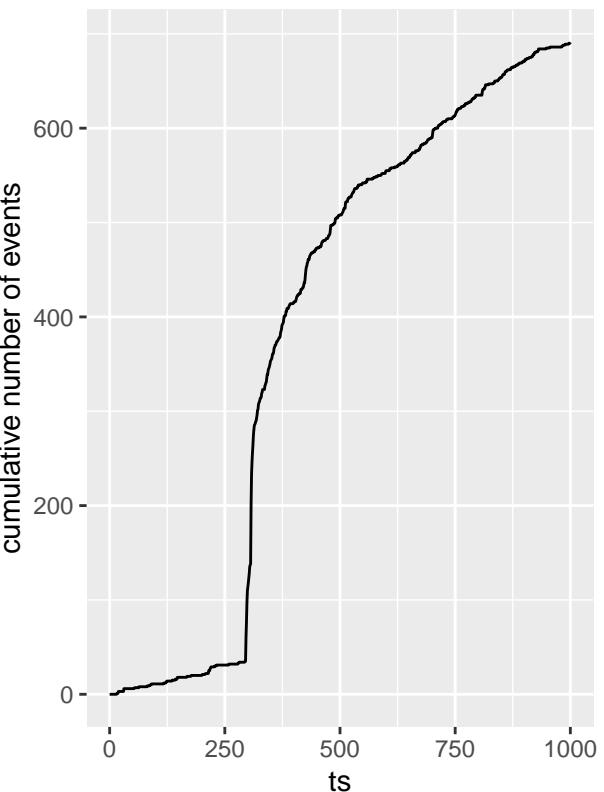
Scatter Plot of Time vs Magnitude for 3–4 high magnitude events –Sample 2
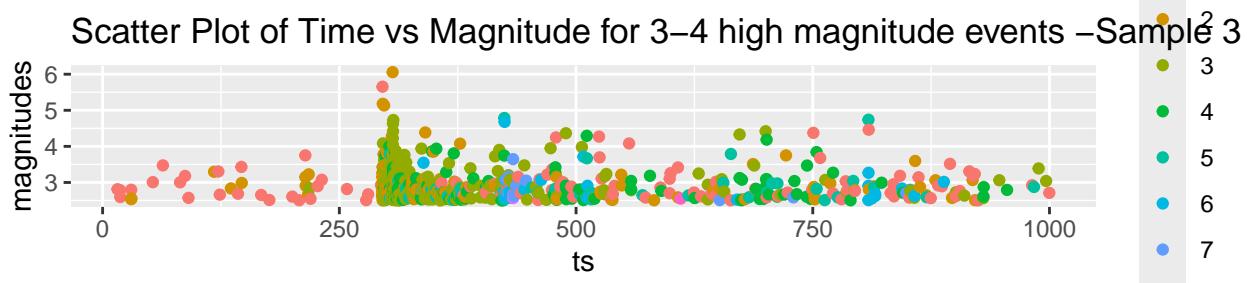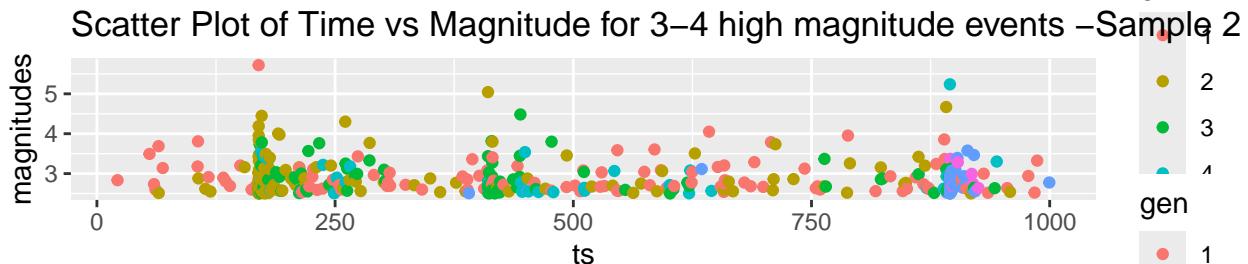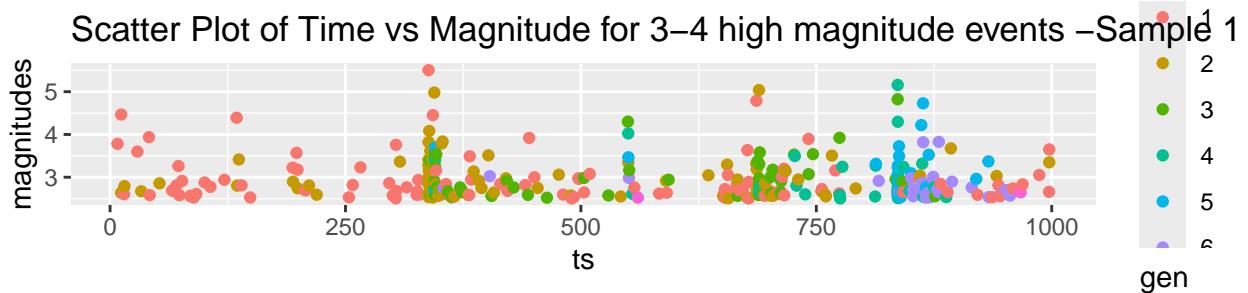
Scatter Plot of Time vs Magnitude for 3–4 high magnitude events –Sample 3
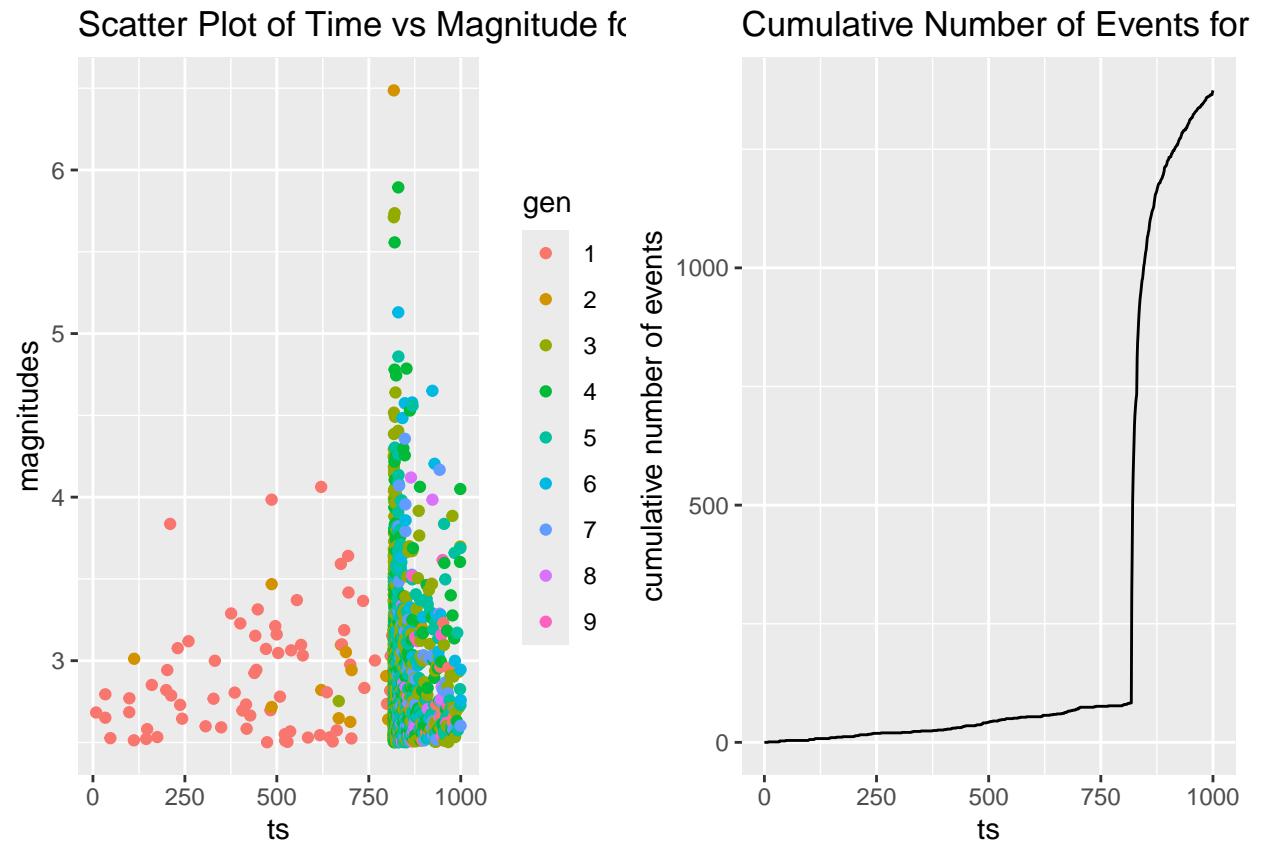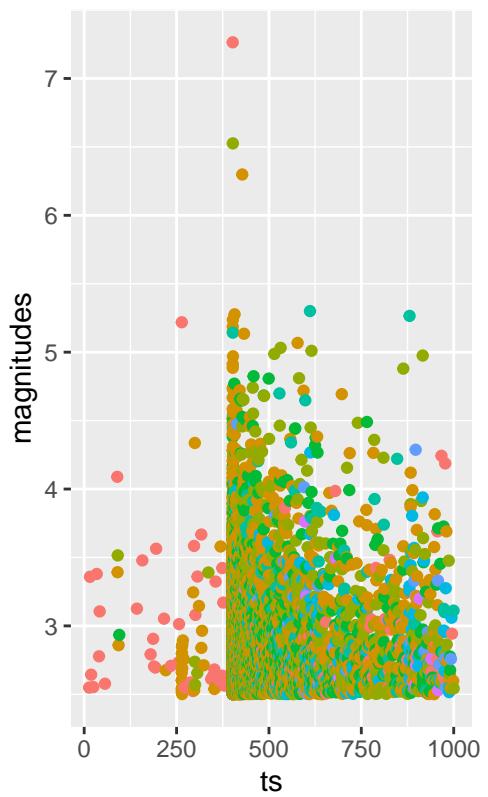
```r
group_name <-"5+ high magnitude events"
fourth_group <- groups[[group_name]]
#Prepare a list to save all graphics
all_plots <-list()
#Traverse each sequence in the  group and draw graphs separately
for(i in seq_along(fourth_group)){
  catalogue <-fourth_group[[i]]
#Create a scatter plot of time magnitude
  pl1 <-ggplot(catalogue, aes(ts, magnitudes, color = as.factor(gen)))+
  geom_point()+
  labs(color = "gen")+
  ggtitle(paste(
    "Scatter Plot of Time vs Magnitude for 5+ high magnitude events - Sample"
              , i))

  t.breaks <- T1:T2
  N.cumsum<-vapply(t.breaks,\(x) sum(catalogue$ts<x),0)
  df.to.cumsum.plot <-data.frame(ts =t.breaks, N.cum = N.cumsum)
  pl2<-ggplot(df.to.cumsum.plot,aes(ts,N.cum))+
  geom_line() +
  ylab("cumulative number of events")+
  ggtitle(paste(
    "Cumulative Number of Events for 5+ high magnitude events - Sample", i))

  combined_plot<-grid.arrange(pl1,pl2,nrow=1)
  all_plots[[i]]<- pl1
```

```
}
```

Scatter Plot of Time vs Magnitude fo


Cumulative Number of Events for

Scatter Plot of Time vs Magnitude for   Cumulative Number of Events for

```
grid.arrange(grobs=all_plots,nco1=2)
```

Scatter Plot of Time vs Magnitude for 5+ high magnitude events – Sample 1
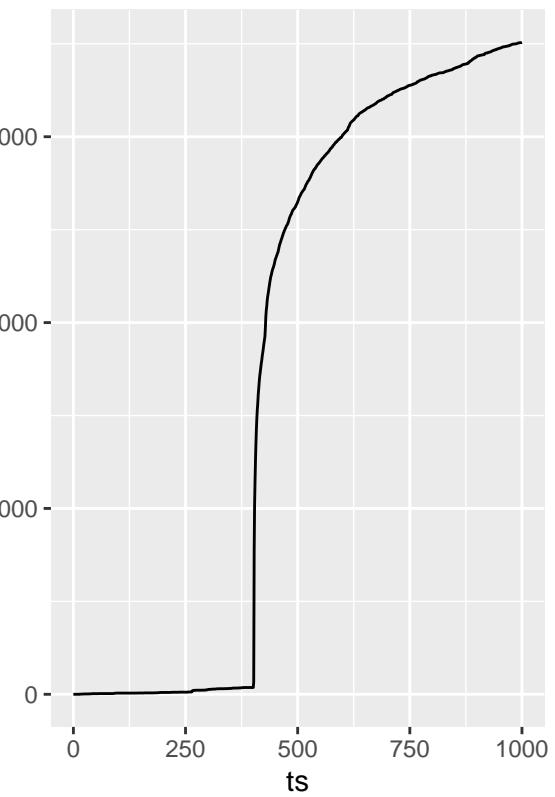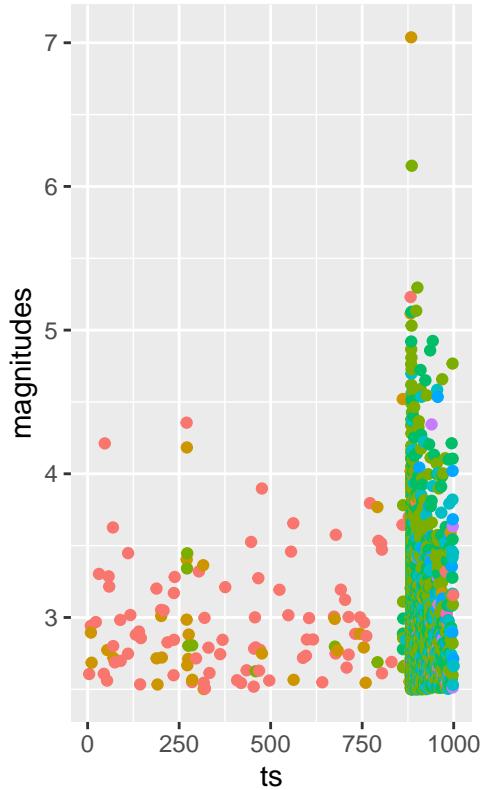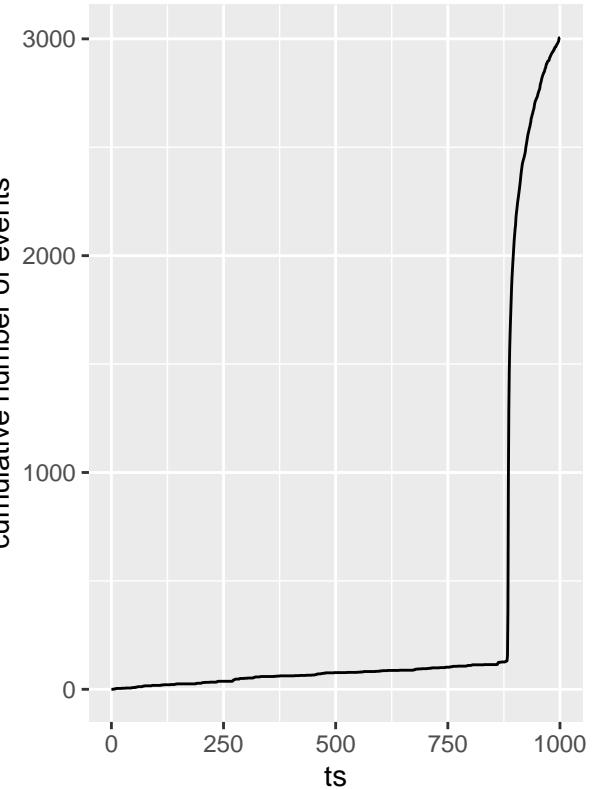
Scatter Plot of Time vs Magnitude for 5+ high magnitude events – Sample 2
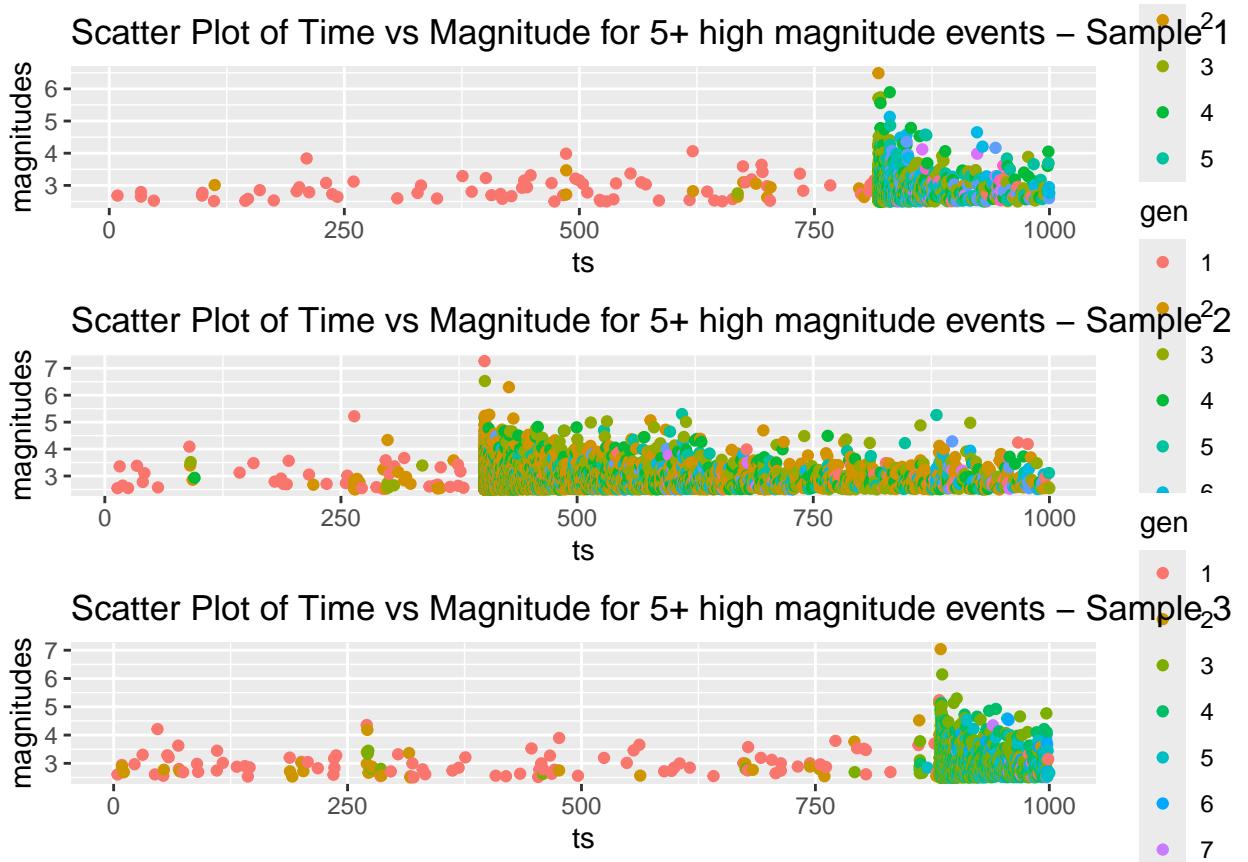
Scatter Plot of Time vs Magnitude for 5+ high magnitude events – Sample 3

#Fit models to generate posterior distribution

```r
# Define a universal prior distribution
link.f <- list(
  mu = \(x) gamma_t(x, 0.3, 0.6),
  K = \(x) unif_t(x, 0, 10),
  alpha = \(x) unif_t(x, 0, 5),
  c_ = \(x) unif_t(x, 0, 10),
  p = \(x) unif_t(x, 1, 10)
)


inv.link.f <- list(
  mu = \(x) inv_gamma_t(x, 0.3, 0.6),
  K = \(x) inv_unif_t(x, 0, 10),
  alpha = \(x) inv_unif_t(x, 0, 5),
  c_ = \(x) inv_unif_t(x, 0, 10),
  p = \(x) inv_unif_t(x, 1, 10)
)


# set up list of initial values
th.init <- list(
  th.mu = inv.link.f$mu(0.5),
  th.K = inv.link.f$K(0.1),
  th.alpha = inv.link.f$alpha(1),
  th.c = inv.link.f$c_(0.1),
  th.p = inv.link.f$p(1.1)
)
```

```r
# set up list of bru options
bru.opt.list <- list(
  bru_verbose = 3, # type of visual output
  bru_max_iter = 70, # maximum number of iterations
  # bru_method = list(max_step = 0.5),
  bru_initial = th.init
) # parameters initial values
```

```r
library(ggplot2)
library(gridExtra)

# select data
group_no_major_events <- groups[["No high magnitude events"]]

# fit model
synth_fit1 <- Temporal.ETAS(
  total.data = group_no_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f,
  coef.t = 1,
  delta.t = 0.1,
  N.max = 5,
  bru.opt = bru.opt.list
)
```

```
## Start creating grid...
## Finished creating grid, time  0.1644392
```

```
## iinla: Evaluate component inputs
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate component simplifications
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Construct inla stack
```

```
## iinla: Model initialisation completed
```

```
## iinla: Iteration 1 [max:70]
```

```
## iinla: Step rescaling: 61.8%, Contract (norm0 = 98.35, norm1 = 63.45, norm01 = 44.58)
```

```
## iinla: Step rescaling: 38.2%, Contract (norm0 = 41.42, norm1 = 18, norm01 = 44.58)
```

```
## iinla: Step rescaling: 36.83%, Approx Optimisation (norm0 = 38.89, norm1 = 17.78, norm01 = 44.58)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 87.7%, Approx Optimisation (norm0 = 30.68, norm1 = 5.31, norm01 = 30.26)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 245% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 86.33%, Approx Optimisation (norm0 = 16.97, norm1 = 5.221, norm01 = 18.77)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 95.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 22.16, norm1 = 6.706, norm01 = 15.53)

## iinla: Step rescaling: 100%, Overstep (norm0 = 14.38, norm1 = 1.269, norm01 = 15.53)

## iinla: Step rescaling: 108.4%, Approx Optimisation (norm0 = 15.49, norm1 = 0.6029, norm01 = 15.53)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 28.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 19.41, norm1 = 5.881, norm01 = 13.55)

## iinla: Step rescaling: 100%, Overstep (norm0 = 12.56, norm1 = 1.018, norm01 = 13.55)

## iinla: Step rescaling: 108.5%, Approx Optimisation (norm0 = 13.54, norm1 = 0.2757, norm01 = 13.55)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 25.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 14.65, norm1 = 4.538, norm01 = 10.13)

## iinla: Step rescaling: 100%, Overstep (norm0 = 9.45, norm1 = 0.7095, norm01 = 10.13)

## iinla: Step rescaling: 107.7%, Approx Optimisation (norm0 = 10.13, norm1 = 0.2145, norm01 = 10.13)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 20.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 11.07, norm1 = 3.636, norm01 = 7.444)

## iinla: Step rescaling: 100%, Overstep (norm0 = 7.065, norm1 = 0.3936, norm01 = 7.444)

## iinla: Step rescaling: 105.6%, Approx Optimisation (norm0 = 7.441, norm1 = 0.1171, norm01 = 7.444)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 8.208, norm1 = 2.821, norm01 = 5.39)

## iinla: Step rescaling: 100%, Overstep (norm0 = 5.191, norm1 = 0.207, norm01 = 5.39)

## iinla: Step rescaling: 104%, Approx Optimisation (norm0 = 5.389, norm1 = 0.06154, norm01 = 5.39)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 6.038, norm1 = 2.146, norm01 = 3.894)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.793, norm1 = 0.1055, norm01 = 3.894)

## iinla: Step rescaling: 102.7%, Approx Optimisation (norm0 = 3.893, norm1 = 0.03179, norm01 = 3.894)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.48% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 4.435, norm1 = 1.612, norm01 = 2.823)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.772, norm1 = 0.05369, norm01 = 2.823)

## iinla: Step rescaling: 101.9%, Approx Optimisation (norm0 = 2.823, norm1 = 0.01659, norm01 = 2.823)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.36% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.264, norm1 = 1.205, norm01 = 2.06)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.033, norm1 = 0.02764, norm01 = 2.06)

## iinla: Step rescaling: 101.3%, Approx Optimisation (norm0 = 2.06, norm1 = 0.008806, norm01 = 2.06)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.98% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.411, norm1 = 0.8991, norm01 = 1.512)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.499, norm1 = 0.01447, norm01 = 1.512)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.512, norm1 = 0.004755, norm01 = 1.512)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.08% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.789, norm1 = 0.6715, norm01 = 1.117)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.11, norm1 = 0.007708, norm01 = 1.117)

## iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 1.117, norm1 = 0.002606, norm01 = 1.117)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.47% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.332, norm1 = 0.5023, norm01 = 0.8293)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.8254, norm1 = 0.004167, norm01 = 0.8293)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 0.8293, norm1 = 0.001444, norm01 = 0.829;

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.06% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.9947, norm1 = 0.3765, norm01 = 0.6182)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.6161, norm1 = 0.002282, norm01 = 0.6182)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.6182, norm1 = 0.0008078, norm01 = 0.618

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.772% of SD, and line search is active [stop if: <10% and line s
```

```
## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.7451, norm1 = 0.2827, norm01 = 0.4624)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.4612, norm1 = 0.001262, norm01 = 0.4624)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.4624, norm1 = 0.0004548, norm01 = 0.46

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.567% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.5593, norm1 = 0.2126, norm01 = 0.3467)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.3461, norm1 = 0.0007037, norm01 = 0.3467)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.3467, norm1 = 0.0002572, norm01 = 0.346

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.419% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.4206, norm1 = 0.1601, norm01 = 0.2605)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.2602, norm1 = 0.0003947, norm01 = 0.2605)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.2605, norm1 = 0.0001459, norm01 = 0.260

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.313% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.3167, norm1 = 0.1206, norm01 = 0.1961)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.1959, norm1 = 0.0002224, norm01 = 0.1961)
```

```
## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.1961, norm1 = 8.306e-05, norm01 = 0.196

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.235% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.2388, norm1 = 0.09102, norm01 = 0.1478)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.1476, norm1 = 0.0001257, norm01 = 0.1478)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.1478, norm1 = 4.734e-05, norm01 = 0.147

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.178% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 21 [max:70]
```

```r
synth_fit2 <- Temporal.ETAS(
  total.data = group_no_major_events[[2]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f,
  coef.t = 1,
  delta.t = 0.1,
  N.max = 5,
  bru.opt = bru.opt.list
)
```

```
## Start creating grid...
## Finished creating grid, time  0.170819

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation
```

```
## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 93.14, norm1 = 59.31, norm01 = 42.41)

## iinla: Step rescaling: 38.2%, Contract (norm0 = 39.63, norm1 = 16.57, norm01 = 42.41)

## iinla: Step rescaling: 36.92%, Approx Optimisation (norm0 = 37.38, norm1 = 16.39, norm01 = 42.41)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 81.21%, Approx Optimisation (norm0 = 26.32, norm1 = 6.823, norm01 = 26.64)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 224% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 85.3%, Approx Optimisation (norm0 = 19.74, norm1 = 6.859, norm01 = 22.56)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 87.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 93.45%, Approx Optimisation (norm0 = 13.21, norm1 = 1.6, norm01 = 13.46)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 34.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 5 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 17.08, norm1 = 5.42, norm01 = 11.67)

## iinla: Step rescaling: 100%, Overstep (norm0 = 10.97, norm1 = 0.7196, norm01 = 11.67)

## iinla: Step rescaling: 106.9%, Approx Optimisation (norm0 = 11.67, norm1 = 0.1638, norm01 = 11.67)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 15.07, norm1 = 4.807, norm01 = 10.27)

## iinla: Step rescaling: 100%, Overstep (norm0 = 9.664, norm1 = 0.6315, norm01 = 10.27)

## iinla: Step rescaling: 106.7%, Approx Optimisation (norm0 = 10.27, norm1 = 0.1896, norm01 = 10.27)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 13, norm1 = 4.221, norm01 = 8.787)

## iinla: Step rescaling: 100%, Overstep (norm0 = 8.311, norm1 = 0.5004, norm01 = 8.787)

## iinla: Step rescaling: 106%, Approx Optimisation (norm0 = 8.783, norm1 = 0.1673, norm01 = 8.787)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 15.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 11.35, norm1 = 3.774, norm01 = 7.588)

## iinla: Step rescaling: 100%, Overstep (norm0 = 7.228, norm1 = 0.3797, norm01 = 7.588)

## iinla: Step rescaling: 105.2%, Approx Optimisation (norm0 = 7.584, norm1 = 0.1318, norm01 = 7.588)
```

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 12.9% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 9 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 9.991, norm1 = 3.382, norm01 = 6.615)

iinla: Step rescaling: 100%, Overstep (norm0 = 6.338, norm1 = 0.2944, norm01 = 6.615)

iinla: Step rescaling: 104.5%, Approx Optimisation (norm0 = 6.613, norm1 = 0.1066, norm01 = 6.615)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 10.8% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 10 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 8.858, norm1 = 3.042, norm01 = 5.821)

iinla: Step rescaling: 100%, Overstep (norm0 = 5.604, norm1 = 0.2325, norm01 = 5.821)

iinla: Step rescaling: 104%, Approx Optimisation (norm0 = 5.819, norm1 = 0.0884, norm01 = 5.821)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 9.18% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 11 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 7.906, norm1 = 2.748, norm01 = 5.161)

iinla: Step rescaling: 100%, Overstep (norm0 = 4.989, norm1 = 0.1865, norm01 = 5.161)

iinla: Step rescaling: 103.5%, Approx Optimisation (norm0 = 5.16, norm1 = 0.0748, norm01 = 5.161)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 7.89% of SD, and line search is active [stop if: <10% and line se

```
## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 7.094, norm1 = 2.492, norm01 = 4.606)

## iinla: Step rescaling: 100%, Overstep (norm0 = 4.467, norm1 = 0.1514, norm01 = 4.606)

## iinla: Step rescaling: 103.2%, Approx Optimisation (norm0 = 4.604, norm1 = 0.06409, norm01 = 4.606)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.84% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 6.393, norm1 = 2.266, norm01 = 4.13)

## iinla: Step rescaling: 100%, Overstep (norm0 = 4.018, norm1 = 0.1238, norm01 = 4.13)

## iinla: Step rescaling: 102.8%, Approx Optimisation (norm0 = 4.129, norm1 = 0.05525, norm01 = 4.13)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.98% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 5.78, norm1 = 2.065, norm01 = 3.718)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.627, norm1 = 0.1017, norm01 = 3.718)

## iinla: Step rescaling: 102.5%, Approx Optimisation (norm0 = 3.717, norm1 = 0.04768, norm01 = 3.718)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.26% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 5.236, norm1 = 1.884, norm01 = 3.354)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.28, norm1 = 0.08374, norm01 = 3.354)
```

iinla: Step rescaling: 102.3%, Approx Optimisation (norm0 = 3.353, norm1 = 0.04103, norm01 = 3.354)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 4.64% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 16 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 4.748, norm1 = 1.719, norm01 = 3.031)

iinla: Step rescaling: 100%, Overstep (norm0 = 2.971, norm1 = 0.0689, norm01 = 3.031)

iinla: Step rescaling: 102%, Approx Optimisation (norm0 = 3.03, norm1 = 0.03509, norm01 = 3.031)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 4.13% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 17 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 4.306, norm1 = 1.568, norm01 = 2.739)

iinla: Step rescaling: 100%, Overstep (norm0 = 2.691, norm1 = 0.05655, norm01 = 2.739)

iinla: Step rescaling: 101.8%, Approx Optimisation (norm0 = 2.739, norm1 = 0.02979, norm01 = 2.739)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 3.94% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 18 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 3.903, norm1 = 1.429, norm01 = 2.475)

iinla: Step rescaling: 100%, Overstep (norm0 = 2.436, norm1 = 0.04623, norm01 = 2.475)

iinla: Step rescaling: 101.6%, Approx Optimisation (norm0 = 2.475, norm1 = 0.02506, norm01 = 2.475)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

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```
## iinla: Max deviation from previous: 3.71% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.534, norm1 = 1.3, norm01 = 2.235)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.204, norm1 = 0.03761, norm01 = 2.235)

## iinla: Step rescaling: 101.4%, Approx Optimisation (norm0 = 2.235, norm1 = 0.02088, norm01 = 2.235)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.47% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.196, norm1 = 1.18, norm01 = 2.016)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.991, norm1 = 0.03044, norm01 = 2.016)

## iinla: Step rescaling: 101.3%, Approx Optimisation (norm0 = 2.016, norm1 = 0.01724, norm01 = 2.016)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.21% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.885, norm1 = 1.07, norm01 = 1.815)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.795, norm1 = 0.0245, norm01 = 1.815)

## iinla: Step rescaling: 101.1%, Approx Optimisation (norm0 = 1.815, norm1 = 0.01411, norm01 = 1.815)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.94% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.6, norm1 = 0.9674, norm01 = 1.633)
```

iinla: Step rescaling: 100%, Overstep (norm0 = 1.616, norm1 = 0.01962, norm01 = 1.633)

iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 1.632, norm1 = 0.01144, norm01 = 1.633)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.67% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 23 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 2.339, norm1 = 0.873, norm01 = 1.466)

iinla: Step rescaling: 100%, Overstep (norm0 = 1.453, norm1 = 0.01564, norm01 = 1.466)

iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.466, norm1 = 0.009214, norm01 = 1.466)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.41% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 24 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 2.1, norm1 = 0.7862, norm01 = 1.314)

iinla: Step rescaling: 100%, Overstep (norm0 = 1.304, norm1 = 0.01241, norm01 = 1.314)

iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 1.314, norm1 = 0.007368, norm01 = 1.314)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.17% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 25 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.883, norm1 = 0.7066, norm01 = 1.177)

iinla: Step rescaling: 100%, Overstep (norm0 = 1.169, norm1 = 0.009806, norm01 = 1.177)

iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 1.177, norm1 = 0.005858, norm01 = 1.177)

iinla: Evaluate component linearisations

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.93% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 26 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.686, norm1 = 0.634, norm01 = 1.052)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.046, norm1 = 0.007726, norm01 = 1.052)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 1.052, norm1 = 0.004634, norm01 = 1.052)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.72% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 27 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.508, norm1 = 0.568, norm01 = 0.9396)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.9347, norm1 = 0.006071, norm01 = 0.9396)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 0.9396, norm1 = 0.00365, norm01 = 0.9396)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.52% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 28 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.346, norm1 = 0.5082, norm01 = 0.8383)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.8345, norm1 = 0.00476, norm01 = 0.8383)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 0.8383, norm1 = 0.002865, norm01 = 0.8383

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.34% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 29 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 1.201, norm1 = 0.454, norm01 = 0.7472)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.7443, norm1 = 0.003725, norm01 = 0.7472)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 0.7472, norm1 = 0.002243, norm01 = 0.747

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.18% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 30 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.071, norm1 = 0.4052, norm01 = 0.6655)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.6632, norm1 = 0.002912, norm01 = 0.6655)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 0.6655, norm1 = 0.001752, norm01 = 0.665

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.04% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 31 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.9537, norm1 = 0.3614, norm01 = 0.5924)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.5906, norm1 = 0.002274, norm01 = 0.5924)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.5924, norm1 = 0.001366, norm01 = 0.592

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.931% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 32 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.8489, norm1 = 0.3219, norm01 = 0.5269)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.5255, norm1 = 0.001775, norm01 = 0.5269)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.5269, norm1 = 0.001064, norm01 = 0.5269
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.835% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 33 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.7551, norm1 = 0.2866, norm01 = 0.4685)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.4674, norm1 = 0.001384, norm01 = 0.4685)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.4685, norm1 = 0.0008281, norm01 = 0.468

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.748% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 34 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.6714, norm1 = 0.255, norm01 = 0.4163)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.4155, norm1 = 0.00108, norm01 = 0.4163)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.4163, norm1 = 0.0006441, norm01 = 0.41

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.669% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 35 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.5966, norm1 = 0.2268, norm01 = 0.3698)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.3691, norm1 = 0.0008418, norm01 = 0.3698)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.3698, norm1 = 0.0005007, norm01 = 0.369

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.598% of SD, and line search is active [stop if: <10% and line
```

```
## iinla: Iteration 36 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.53, norm1 = 0.2016, norm01 = 0.3284)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.3279, norm1 = 0.0006564, norm01 = 0.3284)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.3284, norm1 = 0.0003892, norm01 = 0.328

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.534% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 37 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.4706, norm1 = 0.1791, norm01 = 0.2915)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.2911, norm1 = 0.0005119, norm01 = 0.2915)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.2915, norm1 = 0.0003026, norm01 = 0.29

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.477% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 38 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.4178, norm1 = 0.1591, norm01 = 0.2587)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.2584, norm1 = 0.0003992, norm01 = 0.2587)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.2587, norm1 = 0.0002353, norm01 = 0.258

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.425% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 39 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.3708, norm1 = 0.1412, norm01 = 0.2296)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.2293, norm1 = 0.0003114, norm01 = 0.2296)
```

```
## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.2296, norm1 = 0.000183, norm01 = 0.229

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.379% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 40 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.329, norm1 = 0.1254, norm01 = 0.2037)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.2035, norm1 = 0.000243, norm01 = 0.2037)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.2037, norm1 = 0.0001423, norm01 = 0.203

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.337% of SD, and line search is inactive [stop if: <10% and lin

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 41 [max:70]
```

```r
synth_fit3 <- Temporal.ETAS(
  total.data = group_no_major_events[[3]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f,
  coef.t = 1,
  delta.t = 0.1,
  N.max = 5,
  bru.opt = bru.opt.list
)
```

```
## Start creating grid...
## Finished creating grid, time  0.1978512

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation
```

```
## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 111.1, norm1 = 70.27, norm01 = 50.7)

## iinla: Step rescaling: 38.2%, Contract (norm0 = 45.75, norm1 = 18.89, norm01 = 50.7)

## iinla: Step rescaling: 37.93%, Approx Optimisation (norm0 = 45.2, norm1 = 18.87, norm01 = 50.7)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 76.5%, Approx Optimisation (norm0 = 32.38, norm1 = 7.553, norm01 = 33.13)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 204% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 33.82, norm1 = 15.14, norm01 = 20.95)

## iinla: Step rescaling: 100%, Overstep (norm0 = 20.78, norm1 = 3.519, norm01 = 20.95)

## iinla: Step rescaling: 96.79%, Approx Optimisation (norm0 = 20.12, norm1 = 3.426, norm01 = 20.95)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 65% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 19.73, norm1 = 7.774, norm01 = 12.52)

## iinla: Step rescaling: 100%, Overstep (norm0 = 12.35, norm1 = 1.487, norm01 = 12.52)

## iinla: Step rescaling: 99.25%, Approx Optimisation (norm0 = 12.26, norm1 = 1.485, norm01 = 12.52)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 47% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 13.21, norm1 = 4.725, norm01 = 8.615)

## iinla: Step rescaling: 100%, Overstep (norm0 = 8.346, norm1 = 0.6222, norm01 = 8.615)

## iinla: Step rescaling: 102.6%, Approx Optimisation (norm0 = 8.552, norm1 = 0.5851, norm01 = 8.615)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 31.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 9.661, norm1 = 3.26, norm01 = 6.431)

## iinla: Step rescaling: 100%, Overstep (norm0 = 6.144, norm1 = 0.359, norm01 = 6.431)

## iinla: Step rescaling: 104.7%, Approx Optimisation (norm0 = 6.417, norm1 = 0.2313, norm01 = 6.431)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 7.992, norm1 = 2.747, norm01 = 5.256)

## iinla: Step rescaling: 100%, Overstep (norm0 = 5.058, norm1 = 0.232, norm01 = 5.256)

## iinla: Step rescaling: 104%, Approx Optimisation (norm0 = 5.252, norm1 = 0.1272, norm01 = 5.256)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.4% of SD, and line search is active [stop if: <10% and line s
```

```
## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 7.067, norm1 = 2.516, norm01 = 4.556)

## iinla: Step rescaling: 100%, Overstep (norm0 = 4.438, norm1 = 0.1406, norm01 = 4.556)

## iinla: Step rescaling: 102.7%, Approx Optimisation (norm0 = 4.553, norm1 = 0.08062, norm01 = 4.556)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.12% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 6.453, norm1 = 2.352, norm01 = 4.104)

## iinla: Step rescaling: 100%, Overstep (norm0 = 4.032, norm1 = 0.08959, norm01 = 4.104)

## iinla: Step rescaling: 101.8%, Approx Optimisation (norm0 = 4.103, norm1 = 0.05512, norm01 = 4.104)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 6.027, norm1 = 2.227, norm01 = 3.801)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.754, norm1 = 0.06135, norm01 = 3.801)

## iinla: Step rescaling: 101.3%, Approx Optimisation (norm0 = 3.8, norm1 = 0.04007, norm01 = 3.801)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.48% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 5.725, norm1 = 2.134, norm01 = 3.592)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.559, norm1 = 0.04467, norm01 = 3.592)
```

iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 3.592, norm1 = 0.03061, norm01 = 3.592)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 7.18% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 12 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 5.506, norm1 = 2.064, norm01 = 3.443)

iinla: Step rescaling: 100%, Overstep (norm0 = 3.419, norm1 = 0.03426, norm01 = 3.443)

iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 3.443, norm1 = 0.02441, norm01 = 3.443)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 6.92% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 13 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 5.338, norm1 = 2.008, norm01 = 3.331)

iinla: Step rescaling: 100%, Overstep (norm0 = 3.312, norm1 = 0.02765, norm01 = 3.331)

iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 3.331, norm1 = 0.0203, norm01 = 3.331)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 6.67% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 14 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 5.197, norm1 = 1.959, norm01 = 3.238)

iinla: Step rescaling: 100%, Overstep (norm0 = 3.222, norm1 = 0.02358, norm01 = 3.238)

iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 3.238, norm1 = 0.01768, norm01 = 3.238)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 6.52% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 15 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 5.061, norm1 = 1.91, norm01 = 3.152)

iinla: Step rescaling: 100%, Overstep (norm0 = 3.138, norm1 = 0.02137, norm01 = 3.152)

iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 3.152, norm1 = 0.01615, norm01 = 3.152)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 6.62% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 16 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 4.917, norm1 = 1.855, norm01 = 3.062)

iinla: Step rescaling: 100%, Overstep (norm0 = 3.048, norm1 = 0.0205, norm01 = 3.062)

iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 3.061, norm1 = 0.01543, norm01 = 3.062)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 6.64% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 17 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 4.752, norm1 = 1.792, norm01 = 2.96)

iinla: Step rescaling: 100%, Overstep (norm0 = 2.946, norm1 = 0.02056, norm01 = 2.96)

iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 2.96, norm1 = 0.01524, norm01 = 2.96)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 6.56% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 18 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 4.561, norm1 = 1.718, norm01 = 2.843)

iinla: Step rescaling: 100%, Overstep (norm0 = 2.829, norm1 = 0.02115, norm01 = 2.843)

iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 2.843, norm1 = 0.01534, norm01 = 2.843)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 6.36% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 19 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 4.344, norm1 = 1.634, norm01 = 2.71)

iinla: Step rescaling: 100%, Overstep (norm0 = 2.695, norm1 = 0.02189, norm01 = 2.71)

iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 2.71, norm1 = 0.01549, norm01 = 2.71)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 6.05% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 20 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 4.102, norm1 = 1.54, norm01 = 2.562)

iinla: Step rescaling: 100%, Overstep (norm0 = 2.546, norm1 = 0.02247, norm01 = 2.562)

iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 2.562, norm1 = 0.01554, norm01 = 2.562)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 5.63% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 21 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 3.844, norm1 = 1.441, norm01 = 2.403)

iinla: Step rescaling: 100%, Overstep (norm0 = 2.386, norm1 = 0.02271, norm01 = 2.403)

iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 2.403, norm1 = 0.01538, norm01 = 2.403)

iinla: Evaluate component linearisations

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.13% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.575, norm1 = 1.338, norm01 = 2.237)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.22, norm1 = 0.02253, norm01 = 2.237)

## iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 2.237, norm1 = 0.01499, norm01 = 2.237)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.55% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 23 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.305, norm1 = 1.236, norm01 = 2.07)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.053, norm1 = 0.02195, norm01 = 2.07)

## iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 2.07, norm1 = 0.01443, norm01 = 2.07)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.94% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 24 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.041, norm1 = 1.136, norm01 = 1.905)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.889, norm1 = 0.02108, norm01 = 1.905)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.905, norm1 = 0.01375, norm01 = 1.905)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.54% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 25 [max:70]
```

iinla: Step rescaling: 162%, Expand (norm0 = 2.787, norm1 = 1.04, norm01 = 1.747)

iinla: Step rescaling: 100%, Overstep (norm0 = 1.732, norm1 = 0.02002, norm01 = 1.747)

iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.747, norm1 = 0.01303, norm01 = 1.747)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 3.27% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 26 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 2.549, norm1 = 0.9507, norm01 = 1.598)

iinla: Step rescaling: 100%, Overstep (norm0 = 1.584, norm1 = 0.01887, norm01 = 1.598)

iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.598, norm1 = 0.01234, norm01 = 1.598)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 3.03% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 27 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 2.328, norm1 = 0.8679, norm01 = 1.46)

iinla: Step rescaling: 100%, Overstep (norm0 = 1.447, norm1 = 0.01773, norm01 = 1.46)

iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.46, norm1 = 0.01171, norm01 = 1.46)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.82% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 28 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 2.126, norm1 = 0.7924, norm01 = 1.334)

iinla: Step rescaling: 100%, Overstep (norm0 = 1.322, norm1 = 0.01664, norm01 = 1.334)

iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.334, norm1 = 0.01117, norm01 = 1.334)

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.64% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 29 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.944, norm1 = 0.7241, norm01 = 1.22)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.208, norm1 = 0.01565, norm01 = 1.22)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 1.22, norm1 = 0.01071, norm01 = 1.22)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.49% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 30 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.78, norm1 = 0.663, norm01 = 1.117)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.107, norm1 = 0.01476, norm01 = 1.117)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 1.117, norm1 = 0.01032, norm01 = 1.117)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.36% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 31 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.634, norm1 = 0.6085, norm01 = 1.026)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.016, norm1 = 0.01396, norm01 = 1.026)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 1.026, norm1 = 0.009984, norm01 = 1.026)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.51% of SD, and line search is active [stop if: <10% and line se
```

iinla: Iteration 32 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.504, norm1 = 0.5601, norm01 = 0.9444)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.9352, norm1 = 0.01324, norm01 = 0.9444)

iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 0.9443, norm1 = 0.009687, norm01 = 0.9444)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.64% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 33 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.389, norm1 = 0.5173, norm01 = 0.8723)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.8638, norm1 = 0.01258, norm01 = 0.8723)

iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 0.8721, norm1 = 0.009406, norm01 = 0.8723)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.75% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 34 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.287, norm1 = 0.4793, norm01 = 0.8083)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.8004, norm1 = 0.01196, norm01 = 0.8083)

iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 0.8081, norm1 = 0.009118, norm01 = 0.8083)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.83% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 35 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.196, norm1 = 0.4455, norm01 = 0.7512)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.7439, norm1 = 0.01135, norm01 = 0.7512)

```
## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 0.7511, norm1 = 0.008806, norm01 = 0.7512)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.89% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 36 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.115, norm1 = 0.4153, norm01 = 0.7)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.6932, norm1 = 0.01075, norm01 = 0.7)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 0.6998, norm1 = 0.008456, norm01 = 0.7)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.91% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 37 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.041, norm1 = 0.3879, norm01 = 0.6535)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.6473, norm1 = 0.01012, norm01 = 0.6535)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 0.6534, norm1 = 0.008057, norm01 = 0.6535)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.91% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 38 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.9736, norm1 = 0.3629, norm01 = 0.611)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.6052, norm1 = 0.009462, norm01 = 0.611)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 0.6108, norm1 = 0.007606, norm01 = 0.611]

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

iinla: Max deviation from previous: 2.88% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 39 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.9109, norm1 = 0.3397, norm01 = 0.5715)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.5662, norm1 = 0.008775, norm01 = 0.5715)

iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 0.5714, norm1 = 0.007103, norm01 = 0.5715

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.82% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 40 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.8523, norm1 = 0.3181, norm01 = 0.5345)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.5297, norm1 = 0.008059, norm01 = 0.5345)

iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 0.5344, norm1 = 0.006555, norm01 = 0.5345

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.74% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 41 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.7968, norm1 = 0.2976, norm01 = 0.4994)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.4951, norm1 = 0.007325, norm01 = 0.4994)

iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 0.4993, norm1 = 0.005974, norm01 = 0.4994

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.63% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 42 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.7439, norm1 = 0.2781, norm01 = 0.4661)

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 0.4622, norm1 = 0.006584, norm01 = 0.4661)

## iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 0.466, norm1 = 0.005374, norm01 = 0.4661)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.51% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 43 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.6934, norm1 = 0.2595, norm01 = 0.4341)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.4307, norm1 = 0.005851, norm01 = 0.4341)

## iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 0.4341, norm1 = 0.004771, norm01 = 0.4341

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.37% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 44 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.645, norm1 = 0.2416, norm01 = 0.4036)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.4005, norm1 = 0.005141, norm01 = 0.4036)

## iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 0.4035, norm1 = 0.004182, norm01 = 0.4036

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.22% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 45 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.5987, norm1 = 0.2245, norm01 = 0.3743)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.3716, norm1 = 0.004468, norm01 = 0.3743)

## iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 0.3743, norm1 = 0.003621, norm01 = 0.3743

## iinla: Evaluate component linearisations
```

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.07% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 46 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.5544, norm1 = 0.2081, norm01 = 0.3464)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.3441, norm1 = 0.003843, norm01 = 0.3464)

iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 0.3464, norm1 = 0.003098, norm01 = 0.3464

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 1.91% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 47 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.5123, norm1 = 0.1926, norm01 = 0.3198)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.3179, norm1 = 0.003273, norm01 = 0.3198)

iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 0.3198, norm1 = 0.002622, norm01 = 0.3198

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 1.75% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 48 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.4724, norm1 = 0.1778, norm01 = 0.2947)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.293, norm1 = 0.002763, norm01 = 0.2947)

iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 0.2947, norm1 = 0.002198, norm01 = 0.2947

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 1.6% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 49 [max:70]

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iinla: Step rescaling: 162%, Expand (norm0 = 0.4347, norm1 = 0.1638, norm01 = 0.271)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.2696, norm1 = 0.002314, norm01 = 0.271)

iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 0.271, norm1 = 0.001826, norm01 = 0.271)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 1.45% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 50 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.3993, norm1 = 0.1506, norm01 = 0.2487)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.2475, norm1 = 0.001925, norm01 = 0.2487)

iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 0.2487, norm1 = 0.001505, norm01 = 0.2487

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 1.31% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 51 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.3661, norm1 = 0.1382, norm01 = 0.2279)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.2269, norm1 = 0.001591, norm01 = 0.2279)

iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 0.2279, norm1 = 0.001233, norm01 = 0.2279

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 1.18% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 52 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.3352, norm1 = 0.1267, norm01 = 0.2085)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.2077, norm1 = 0.001309, norm01 = 0.2085)

iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 0.2085, norm1 = 0.001004, norm01 = 0.2085

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 1.06% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 53 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.3065, norm1 = 0.1159, norm01 = 0.1905)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.1898, norm1 = 0.001072, norm01 = 0.1905)

iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 0.1905, norm1 = 0.0008139, norm01 = 0.190

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.949% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 54 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.2798, norm1 = 0.106, norm01 = 0.1739)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.1733, norm1 = 0.0008743, norm01 = 0.1739)

iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.1739, norm1 = 0.0006574, norm01 = 0.173

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.848% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 55 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.2552, norm1 = 0.09671, norm01 = 0.1585)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.158, norm1 = 0.0007114, norm01 = 0.1585)

iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.1585, norm1 = 0.0005295, norm01 = 0.158

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.757% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 56 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.2325, norm1 = 0.08818, norm01 = 0.1443)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.1439, norm1 = 0.0005774, norm01 = 0.1443)

iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.1443, norm1 = 0.0004255, norm01 = 0.144

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.676% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 57 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.2116, norm1 = 0.08032, norm01 = 0.1313)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.131, norm1 = 0.0004679, norm01 = 0.1313)

iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.1313, norm1 = 0.0003414, norm01 = 0.13

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.602% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 58 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.1925, norm1 = 0.07309, norm01 = 0.1194)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.1191, norm1 = 0.0003787, norm01 = 0.1194)

iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.1194, norm1 = 0.0002737, norm01 = 0.119

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.537% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 59 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.1749, norm1 = 0.06646, norm01 = 0.1084)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.1082, norm1 = 0.0003061, norm01 = 0.1084)

```
## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.1084, norm1 = 0.0002192, norm01 = 0.108

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.478% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 60 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.1588, norm1 = 0.06038, norm01 = 0.09844)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.09827, norm1 = 0.0002473, norm01 = 0.09844)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.09844, norm1 = 0.0001756, norm01 = 0.09

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.426% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 61 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.1441, norm1 = 0.05483, norm01 = 0.08931)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.08917, norm1 = 0.0001997, norm01 = 0.08931)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.08931, norm1 = 0.0001406, norm01 = 0.08

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.38% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 62 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.1307, norm1 = 0.04975, norm01 = 0.08099)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.08087, norm1 = 0.0001613, norm01 = 0.08099)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.08098, norm1 = 0.0001127, norm01 = 0.08

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

iinla: Max deviation from previous: 0.339% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 63 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.1185, norm1 = 0.04511, norm01 = 0.0734)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.0733, norm1 = 0.0001302, norm01 = 0.0734)

iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.0734, norm1 = 9.03e-05, norm01 = 0.073

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.303% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 64 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.1074, norm1 = 0.04089, norm01 = 0.06649)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.06641, norm1 = 0.0001051, norm01 = 0.06649)

iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.06649, norm1 = 7.241e-05, norm01 = 0.0

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.27% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 65 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.09725, norm1 = 0.03705, norm01 = 0.06021)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.06014, norm1 = 8.489e-05, norm01 = 0.06021)

iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.0602, norm1 = 5.81e-05, norm01 = 0.060

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.242% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 66 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.08804, norm1 = 0.03355, norm01 = 0.05449)

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 0.05444, norm1 = 6.855e-05, norm01 = 0.05449)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.0545, norm1 = 4.665e-05, norm01 = 0.054

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.216% of SD, and line search is inactive [stop if: <10% and lin

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 67 [max:70]
```

```r
# Obtain posterior distribution
post_list1 <- get_posterior_param(input.list = list(model.fit = synth_fit1, link.functions = link.f))
post_list2 <- get_posterior_param(input.list = list(model.fit = synth_fit2, link.functions = link.f))
post_list3 <- get_posterior_param(input.list = list(model.fit = synth_fit3, link.functions = link.f))

# Set data classification identifiers
post_list1$post.df$cat.used <- "No high magnitude events - 1"
post_list2$post.df$cat.used <- "No high magnitude events - 2"
post_list3$post.df$cat.used <- "No high magnitude events - 3"

# Bind all posterior distribution data
bind_post_df <- rbind(post_list1$post.df, post_list2$post.df, post_list3$post.df)

# Filter out alpha data for analysis
alpha_data <- bind_post_df[bind_post_df$param == "alpha", ]

# Draw graphics using ggplot
ggplot(alpha_data, aes(x = x, y = y, color = cat.used)) +
  geom_line() +
  facet_wrap(~param, scales = "free") +
  xlab("Parameter value") +
  ylab("Probability density function") +
  geom_vline(data = data.frame(x = true.param$alpha), aes(xintercept = x), linetype = 2) +
  theme_bw()
```
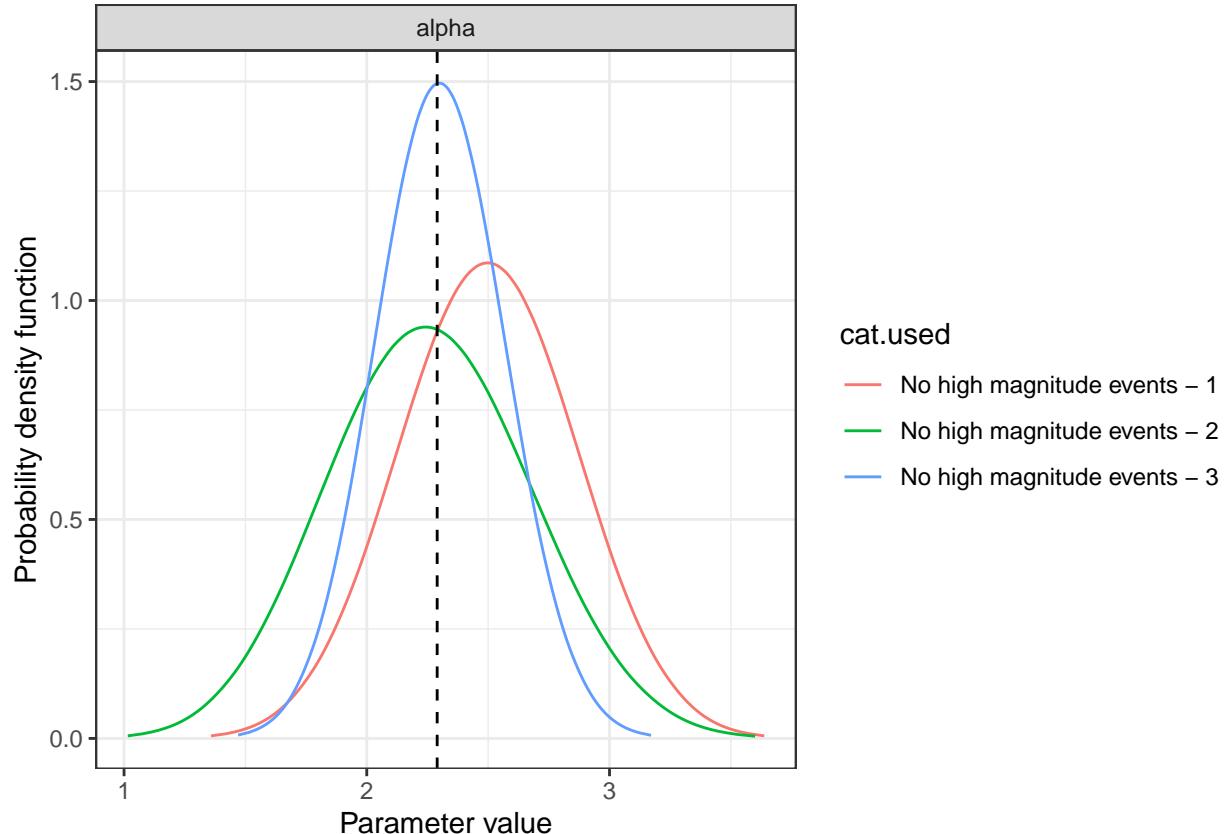
```r
library(ggplot2)
library(gridExtra)

# select data
group_1_2_major_events <- groups[["1-2 high magnitude events"]]

# Fitting the model for the datasets in the "1-2 high magnitude events" group
synth_fit1_12 <- Temporal.ETAS(
  total.data = group_1_2_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f,
  coef.t = 1,
  delta.t = 0.1,
  N.max = 5,
  bru.opt = bru.opt.list
)
```

```
## Start creating grid...
## Finished creating grid, time  0.6820459


## iinla: Evaluate component inputs


## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 164.9, norm1 = 151.4, norm01 = 69.55)

## iinla: Step rescaling: 38.2%, Contract (norm0 = 61.57, norm1 = 60.94, norm01 = 69.55)

## iinla: Step rescaling: 27.05%, Approx Optimisation (norm0 = 32.66, norm1 = 51.9, norm01 = 69.55)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 78.29%, Approx Optimisation (norm0 = 50.16, norm1 = 24.24, norm01 = 61.58)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 241% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 105.5, norm1 = 36.56, norm01 = 69.08)

## iinla: Step rescaling: 100%, Overstep (norm0 = 66.71, norm1 = 2.778, norm01 = 69.08)

## iinla: Step rescaling: 103.6%, Approx Optimisation (norm0 = 69.03, norm1 = 1.518, norm01 = 69.08)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 46.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 75.01, norm1 = 22.17, norm01 = 52.99)
```

iinla: Step rescaling: 100%, Overstep (norm0 = 48.77, norm1 = 4.405, norm01 = 52.99)

iinla: Step rescaling: 109.4%, Approx Optimisation (norm0 = 52.94, norm1 = 1.463, norm01 = 52.99)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 90.7% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 5 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 47.75, norm1 = 14.13, norm01 = 33.96)

iinla: Step rescaling: 100%, Overstep (norm0 = 31.13, norm1 = 3.213, norm01 = 33.96)

iinla: Step rescaling: 109.5%, Approx Optimisation (norm0 = 33.82, norm1 = 1.75, norm01 = 33.96)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 65.8% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 6 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 31.75, norm1 = 9.96, norm01 = 22.44)

iinla: Step rescaling: 100%, Overstep (norm0 = 20.64, norm1 = 2.494, norm01 = 22.44)

iinla: Step rescaling: 108%, Approx Optimisation (norm0 = 22.15, norm1 = 1.958, norm01 = 22.44)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 48.7% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 7 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 23.37, norm1 = 7.996, norm01 = 16.25)

iinla: Step rescaling: 100%, Overstep (norm0 = 15.07, norm1 = 2.12, norm01 = 16.25)

iinla: Step rescaling: 105.6%, Approx Optimisation (norm0 = 15.86, norm1 = 1.956, norm01 = 16.25)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 46.4% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 8 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 18.97, norm1 = 7.005, norm01 = 12.9)

iinla: Step rescaling: 100%, Overstep (norm0 = 12.11, norm1 = 1.882, norm01 = 12.9)

iinla: Step rescaling: 103.2%, Approx Optimisation (norm0 = 12.48, norm1 = 1.84, norm01 = 12.9)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 44.7% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 9 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 16.58, norm1 = 6.482, norm01 = 11.03)

iinla: Step rescaling: 100%, Overstep (norm0 = 10.48, norm1 = 1.73, norm01 = 11.03)

iinla: Step rescaling: 101.3%, Approx Optimisation (norm0 = 10.61, norm1 = 1.724, norm01 = 11.03)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 41.8% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 10 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 15.26, norm1 = 6.226, norm01 = 9.95)

iinla: Step rescaling: 100%, Overstep (norm0 = 9.563, norm1 = 1.647, norm01 = 9.95)

iinla: Step rescaling: 99.69%, Approx Optimisation (norm0 = 9.534, norm1 = 1.647, norm01 = 9.95)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 38.9% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 11 [max:70]

```
## iinla: Step rescaling: 162%, Expand (norm0 = 14.49, norm1 = 6.107, norm01 = 9.297)

## iinla: Step rescaling: 100%, Overstep (norm0 = 9.018, norm1 = 1.611, norm01 = 9.297)

## iinla: Step rescaling: 98.45%, Approx Optimisation (norm0 = 8.881, norm1 = 1.605, norm01 = 9.297)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 36.1% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 13.93, norm1 = 6.011, norm01 = 8.829)

## iinla: Step rescaling: 100%, Overstep (norm0 = 8.624, norm1 = 1.586, norm01 = 8.829)

## iinla: Step rescaling: 97.54%, Approx Optimisation (norm0 = 8.414, norm1 = 1.572, norm01 = 8.829)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 34.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 13.31, norm1 = 5.811, norm01 = 8.364)

## iinla: Step rescaling: 100%, Overstep (norm0 = 8.21, norm1 = 1.52, norm01 = 8.364)

## iinla: Step rescaling: 97.03%, Approx Optimisation (norm0 = 7.967, norm1 = 1.5, norm01 = 8.364)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 32.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 12.44, norm1 = 5.404, norm01 = 7.776)

## iinla: Step rescaling: 100%, Overstep (norm0 = 7.662, norm1 = 1.359, norm01 = 7.776)

## iinla: Step rescaling: 97.06%, Approx Optimisation (norm0 = 7.437, norm1 = 1.34, norm01 = 7.776)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 29.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 11.27, norm1 = 4.784, norm01 = 7.017)

## iinla: Step rescaling: 100%, Overstep (norm0 = 6.942, norm1 = 1.087, norm01 = 7.017)

## iinla: Step rescaling: 97.58%, Approx Optimisation (norm0 = 6.775, norm1 = 1.074, norm01 = 7.017)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 26.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 9.871, norm1 = 4.061, norm01 = 6.114)

## iinla: Step rescaling: 100%, Overstep (norm0 = 6.081, norm1 = 0.7635, norm01 = 6.114)

## iinla: Step rescaling: 98.26%, Approx Optimisation (norm0 = 5.975, norm1 = 0.7562, norm01 = 6.114)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 23.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 98.75%, Approx Optimisation (norm0 = 5.076, norm1 = 0.4699, norm01 = 5.139)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 19.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.02%, Approx Optimisation (norm0 = 4.158, norm1 = 0.263, norm01 = 4.182)
```

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 16.1% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 19 [max:70]

iinla: Step rescaling: 99.19%, Approx Optimisation (norm0 = 3.308, norm1 = 0.1357, norm01 = 3.316)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 12.8% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 20 [max:70]

iinla: Step rescaling: 99.34%, Approx Optimisation (norm0 = 2.583, norm1 = 0.06594, norm01 = 2.586)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 9.94% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 21 [max:70]

iinla: Step rescaling: 99.49%, Approx Optimisation (norm0 = 2, norm1 = 0.03081, norm01 = 2)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 7.64% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 22 [max:70]

iinla: Step rescaling: 99.62%, Approx Optimisation (norm0 = 1.547, norm1 = 0.01408, norm01 = 1.547)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 5.85% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 23 [max:70]

```
## iinla: Step rescaling: 99.73%, Approx Optimisation (norm0 = 1.202, norm1 = 0.006396, norm01 = 1.202)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.48% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 24 [max:70]

## iinla: Step rescaling: 99.81%, Approx Optimisation (norm0 = 0.9408, norm1 = 0.002924, norm01 = 0.9409

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.45% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 25 [max:70]

## iinla: Step rescaling: 99.87%, Approx Optimisation (norm0 = 0.7419, norm1 = 0.001361, norm01 = 0.7419

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.68% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 26 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 0.5892, norm1 = 0.0006502, norm01 = 0.589

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.09% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 27 [max:70]
```

```
synth_fit2_12 <- Temporal.ETAS(
  total.data = group_1_2_major_events[[2]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f,
  coef.t = 1,
  delta.t = 0.1,
  N.max = 5,
  bru.opt = bru.opt.list
)
```

```
## Start creating grid...
## Finished creating grid, time  0.565578

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 162.3, norm1 = 130.9, norm01 = 60.47)

## iinla: Step rescaling: 38.2%, Contract (norm0 = 64.21, norm1 = 44.23, norm01 = 60.47)

## iinla: Step rescaling: 29.71%, Approx Optimisation (norm0 = 40.58, norm1 = 37.03, norm01 = 60.47)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 76.75%, Approx Optimisation (norm0 = 44.82, norm1 = 20.36, norm01 = 50.57)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 121% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 48.8, norm1 = 25.88, norm01 = 37.96)

## iinla: Step rescaling: 100%, Overstep (norm0 = 32.65, norm1 = 13.7, norm01 = 37.96)

## iinla: Step rescaling: 93.4%, Approx Optimisation (norm0 = 30.75, norm1 = 13.56, norm01 = 37.96)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 127% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 29.4, norm1 = 12.62, norm01 = 18.48)

## iinla: Step rescaling: 100%, Overstep (norm0 = 18.43, norm1 = 3.421, norm01 = 18.48)

## iinla: Step rescaling: 95.63%, Approx Optimisation (norm0 = 17.64, norm1 = 3.331, norm01 = 18.48)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 68.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 14.62, norm1 = 4.96, norm01 = 9.664)

## iinla: Step rescaling: 100%, Overstep (norm0 = 9.271, norm1 = 0.4043, norm01 = 9.664)

## iinla: Step rescaling: 104.4%, Approx Optimisation (norm0 = 9.662, norm1 = 0.1018, norm01 = 9.664)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 9.517, norm1 = 3.598, norm01 = 5.92)

## iinla: Step rescaling: 100%, Overstep (norm0 = 5.897, norm1 = 0.02479, norm01 = 5.92)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 5.92, norm1 = 0.009261, norm01 = 5.92)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.47% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 5.92, norm1 = 2.26, norm01 = 3.66)
```

iinla: Step rescaling: 100%, Overstep (norm0 = 3.66, norm1 = 0.003132, norm01 = 3.66)

iinla: Step rescaling: 100%, Approx Optimisation (norm0 = 3.66, norm1 = 0.003043, norm01 = 3.66)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 7.15% of SD, and line search is inactive [stop if: <10% and line

iinla: Convergence criterion met, running final INLA integration with known theta mode.

iinla: Iteration 8 [max:70]

```
synth_fit3_12 <- Temporal.ETAS(
  total.data = group_1_2_major_events[[3]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f,
  coef.t = 1,
  delta.t = 0.1,
  N.max = 5,
  bru.opt = bru.opt.list
)
```

Start creating grid...
Finished creating grid, time 0.5250769

iinla: Evaluate component inputs

iinla: Evaluate component linearisations

iinla: Evaluate component simplifications

iinla: Evaluate predictor linearisation

iinla: Construct inla stack

iinla: Model initialisation completed

iinla: Iteration 1 [max:70]

iinla: Step rescaling: 61.8%, Contract (norm0 = 230.2, norm1 = 205, norm01 = 87.04)

iinla: Step rescaling: 38.2%, Contract (norm0 = 85.72, norm1 = 76.05, norm01 = 87.04)

iinla: Step rescaling: 27.04%, Approx Optimisation (norm0 = 44.98, norm1 = 62.48, norm01 = 87.04)

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 72.15%, Approx Optimisation (norm0 = 64.88, norm1 = 33.97, norm01 = 77.53)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 159% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 77.99, norm1 = 31.89, norm01 = 54.34)

## iinla: Step rescaling: 100%, Overstep (norm0 = 50.34, norm1 = 11.42, norm01 = 54.34)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 50.59, norm1 = 11.41, norm01 = 54.34)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 118% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 47.85, norm1 = 17, norm01 = 33.8)

## iinla: Step rescaling: 100%, Overstep (norm0 = 31.32, norm1 = 5.638, norm01 = 33.8)

## iinla: Step rescaling: 103.5%, Approx Optimisation (norm0 = 32.32, norm1 = 5.51, norm01 = 33.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 100% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 39.06, norm1 = 13.83, norm01 = 25.56)

## iinla: Step rescaling: 100%, Overstep (norm0 = 24.74, norm1 = 1.789, norm01 = 25.56)
```

```
## iinla: Step rescaling: 102.7%, Approx Optimisation (norm0 = 25.39, norm1 = 1.656, norm01 = 25.56)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 57.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 29.45, norm1 = 10.39, norm01 = 19.07)

## iinla: Step rescaling: 100%, Overstep (norm0 = 18.53, norm1 = 0.5751, norm01 = 19.07)

## iinla: Step rescaling: 103%, Approx Optimisation (norm0 = 19.06, norm1 = 0.2109, norm01 = 19.07)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 36.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 22.39, norm1 = 8.205, norm01 = 14.19)

## iinla: Step rescaling: 100%, Overstep (norm0 = 13.97, norm1 = 0.2248, norm01 = 14.19)

## iinla: Step rescaling: 101.6%, Approx Optimisation (norm0 = 14.19, norm1 = 0.05707, norm01 = 14.19)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 30.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 16.7, norm1 = 6.259, norm01 = 10.44)

## iinla: Step rescaling: 100%, Overstep (norm0 = 10.37, norm1 = 0.07613, norm01 = 10.44)

## iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 10.44, norm1 = 0.01758, norm01 = 10.44)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 23.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 12.36, norm1 = 4.675, norm01 = 7.68)

## iinla: Step rescaling: 100%, Overstep (norm0 = 7.653, norm1 = 0.02803, norm01 = 7.68)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 7.68, norm1 = 0.00633, norm01 = 7.68)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 17.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 9.136, norm1 = 3.473, norm01 = 5.663)

## iinla: Step rescaling: 100%, Overstep (norm0 = 5.653, norm1 = 0.0107, norm01 = 5.663)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 5.663, norm1 = 0.003198, norm01 = 5.663)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 13% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 6.763, norm1 = 2.578, norm01 = 4.186)

## iinla: Step rescaling: 100%, Overstep (norm0 = 4.182, norm1 = 0.004043, norm01 = 4.186)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 4.186, norm1 = 0.002069, norm01 = 4.186)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.63% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 12 [max:70]
```

```r
# Obtain posterior distribution
post_list1_12 <-
  get_posterior_param(input.list = list(model.fit = synth_fit1_12,
                                        link.functions = link.f))
post_list2_12 <-
  get_posterior_param(input.list = list(model.fit = synth_fit2_12,
                                        link.functions = link.f))
post_list3_12 <-
  get_posterior_param(input.list = list(model.fit = synth_fit3_12,
                                        link.functions = link.f))

# Set data classification identifiers
post_list1_12$post.df$cat.used <- "1-2 high magnitude events - 1"
post_list2_12$post.df$cat.used <- "1-2 high magnitude events - 2"
post_list3_12$post.df$cat.used <- "1-2 high magnitude events - 3"

# Bind all posterior distribution data
bind_post_df_12 <- rbind(post_list1_12$post.df, post_list2_12$post.df,
                         post_list3_12$post.df)

# Filter out alpha data
alpha_data_12 <- bind_post_df_12[bind_post_df_12$param == "alpha", ]

# Draw graphics using ggplot
ggplot(alpha_data_12, aes(x = x, y = y, color = cat.used)) +
  geom_line() +
  facet_wrap(~param, scales = "free") +
  xlab("Parameter value") +
  ylab("Probability density function") +
  geom_vline(data = data.frame(x = true.param$alpha),
             aes(xintercept = x), linetype = 2) +
  theme_bw()
```
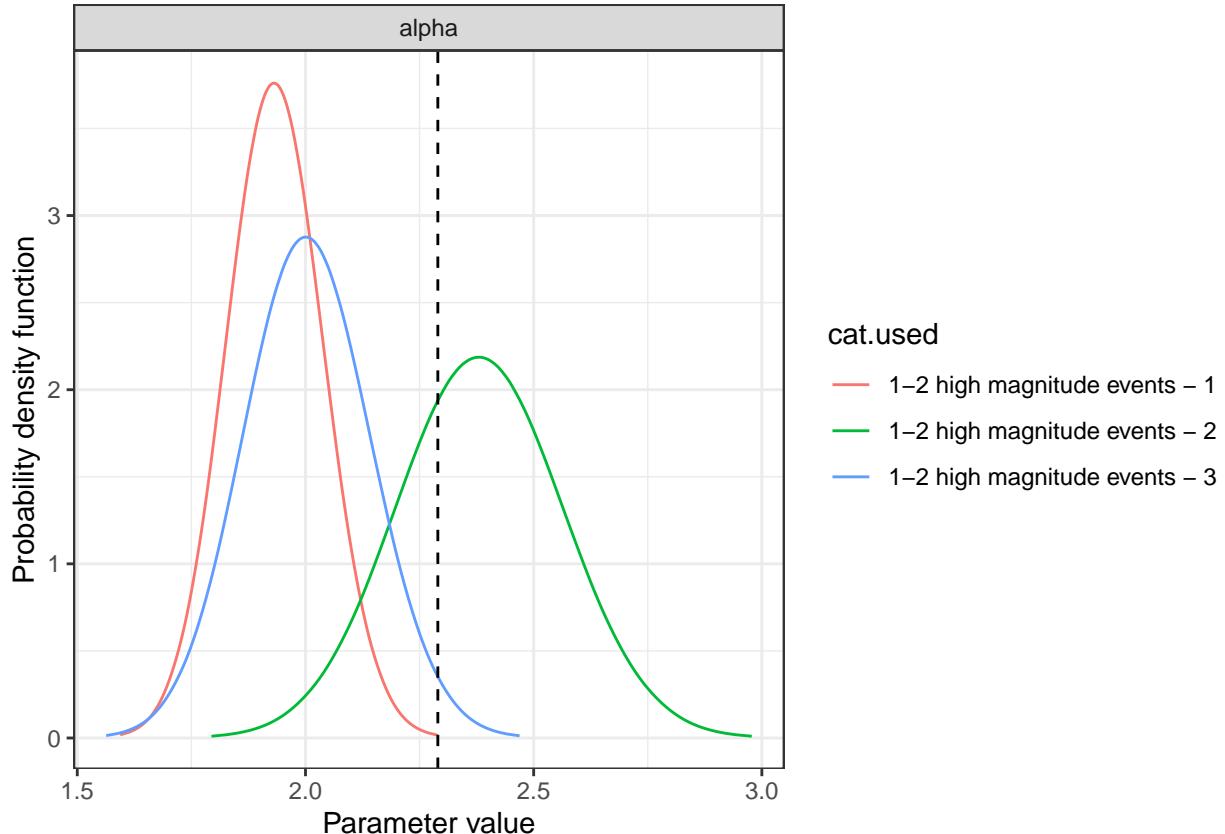
```r
# Load necessary libraries
library(ggplot2)

# Setting group name and retrieving the data for "3-4 high magnitude events"
group_3_4_major_events <- groups[["3-4 high magnitude events"]]

# Fitting the model for the datasets in the "3-4 high magnitude events" group
synth.fit1_3_4 <- Temporal.ETAS(
  total.data = group_3_4_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f,
  coef.t = 1,
  delta.t = 0.1,
  N.max = 5,
  bru.opt = bru.opt.list
)
```

```
## Start creating grid...
## Finished creating grid, time  0.8855278


## iinla: Evaluate component inputs


## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 306.6, norm1 = 373.6, norm01 = 270.8)

## iinla: Step rescaling: 26.71%, Approx Optimisation (norm0 = 72.07, norm1 = 218.6, norm01 = 270.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 384.6, norm1 = 290.2, norm01 = 240.8)

## iinla: Step rescaling: 100%, Overstep (norm0 = 219, norm1 = 121.5, norm01 = 240.8)

## iinla: Step rescaling: 80.55%, Approx Optimisation (norm0 = 176, norm1 = 106.5, norm01 = 240.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 351% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 226.7, norm1 = 79.57, norm01 = 148.1)

## iinla: Step rescaling: 100%, Overstep (norm0 = 143.3, norm1 = 7.732, norm01 = 148.1)

## iinla: Step rescaling: 103.2%, Approx Optimisation (norm0 = 147.6, norm1 = 6.353, norm01 = 148.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 148% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 4 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 96.66, norm1 = 29.34, norm01 = 70.36)

## iinla: Step rescaling: 100%, Overstep (norm0 = 63.53, norm1 = 9.274, norm01 = 70.36)

## iinla: Step rescaling: 109.7%, Approx Optimisation (norm0 = 69.04, norm1 = 7.338, norm01 = 70.36)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 162% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 67.82, norm1 = 21.92, norm01 = 46.48)

## iinla: Step rescaling: 100%, Overstep (norm0 = 43.59, norm1 = 3.775, norm01 = 46.48)

## iinla: Step rescaling: 106.5%, Approx Optimisation (norm0 = 46.23, norm1 = 2.678, norm01 = 46.48)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 92.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 47.52, norm1 = 16.51, norm01 = 31.3)

## iinla: Step rescaling: 100%, Overstep (norm0 = 30.1, norm1 = 1.878, norm01 = 31.3)

## iinla: Step rescaling: 103.7%, Approx Optimisation (norm0 = 31.18, norm1 = 1.531, norm01 = 31.3)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 89.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 35.51, norm1 = 12.87, norm01 = 22.81)

## iinla: Step rescaling: 100%, Overstep (norm0 = 22.27, norm1 = 1.111, norm01 = 22.81)

## iinla: Step rescaling: 102.1%, Approx Optimisation (norm0 = 22.74, norm1 = 1.009, norm01 = 22.81)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 77.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 27.1, norm1 = 10.07, norm01 = 17.12)

## iinla: Step rescaling: 100%, Overstep (norm0 = 16.89, norm1 = 0.6846, norm01 = 17.12)

## iinla: Step rescaling: 101.2%, Approx Optimisation (norm0 = 17.08, norm1 = 0.6567, norm01 = 17.12)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 60.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 20.9, norm1 = 7.885, norm01 = 13.06)

## iinla: Step rescaling: 100%, Overstep (norm0 = 12.97, norm1 = 0.4158, norm01 = 13.06)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 13.04, norm1 = 0.4094, norm01 = 13.06)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 45.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 16.26, norm1 = 6.189, norm01 = 10.1)

## iinla: Step rescaling: 100%, Overstep (norm0 = 10.07, norm1 = 0.2483, norm01 = 10.1)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 10.09, norm1 = 0.2475, norm01 = 10.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 34.2% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 12.75, norm1 = 4.874, norm01 = 7.882)

## iinla: Step rescaling: 100%, Overstep (norm0 = 7.878, norm1 = 0.1467, norm01 = 7.882)

## iinla: Step rescaling: 99.99%, Approx Optimisation (norm0 = 7.878, norm1 = 0.1467, norm01 = 7.882)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 25.5% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 6.2, norm1 = 0.08582, norm01 = 6.201)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 19% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 4.91, norm1 = 0.04977, norm01 = 4.911)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 3.91, norm1 = 0.0287, norm01 = 3.911)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 3.13, norm1 = 0.01649, norm01 = 3.13)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.14% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.85%, Approx Optimisation (norm0 = 2.517, norm1 = 0.009459, norm01 = 2.517)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.62% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 2.033, norm1 = 0.005424, norm01 = 2.033)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.39% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.9%, Approx Optimisation (norm0 = 1.649, norm1 = 0.003114, norm01 = 1.649)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 1.343, norm1 = 0.001792, norm01 = 1.343)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.59% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 20 [max:70]
```

```r
input_list1_3_4 <- list(
  model.fit = synth.fit1_3_4,
  link.functions = link.f
)

synth.fit2_3_4 <- Temporal.ETAS(
  total.data = group_3_4_major_events[[2]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f,
  coef.t = 1,
  delta.t = 0.1,
  N.max = 5,
  bru.opt = bru.opt.list
)
```

```
## Start creating grid...
## Finished creating grid, time  0.918371


## iinla: Evaluate component inputs


## iinla: Evaluate component linearisations


## iinla: Evaluate component simplifications


## iinla: Evaluate predictor linearisation


## iinla: Construct inla stack


## iinla: Model initialisation completed


## iinla: Iteration 1 [max:70]


## iinla: Step rescaling: 61.8%, Contract (norm0 = 361.5, norm1 = 495.9, norm01 = 376.3)


## iinla: Step rescaling: 26.36%, Approx Optimisation (norm0 = 89.15, norm1 = 309.1, norm01 = 376.3)


## iinla: Evaluate component linearisations


## iinla: Evaluate predictor linearisation


## iinla: Iteration 2 [max:70]


## iinla: Step rescaling: 162%, Expand (norm0 = 454, norm1 = 275, norm01 = 330.3)


## iinla: Step rescaling: 100%, Overstep (norm0 = 282.5, norm1 = 131.3, norm01 = 330.3)


## iinla: Step rescaling: 90.39%, Approx Optimisation (norm0 = 257.3, norm1 = 127.7, norm01 = 330.3)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 416% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 238.7, norm1 = 78.06, norm01 = 162.6)

## iinla: Step rescaling: 100%, Overstep (norm0 = 153.4, norm1 = 12.66, norm01 = 162.6)

## iinla: Step rescaling: 105.8%, Approx Optimisation (norm0 = 161.6, norm1 = 9.477, norm01 = 162.6)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 213% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 104.6, norm1 = 38.89, norm01 = 75.08)

## iinla: Step rescaling: 100%, Overstep (norm0 = 67.98, norm1 = 14.14, norm01 = 75.08)

## iinla: Step rescaling: 104.8%, Approx Optimisation (norm0 = 70.92, norm1 = 13.76, norm01 = 75.08)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 151% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 78.79, norm1 = 27.8, norm01 = 53.11)

## iinla: Step rescaling: 100%, Overstep (norm0 = 50.18, norm1 = 5.947, norm01 = 53.11)

## iinla: Step rescaling: 104.2%, Approx Optimisation (norm0 = 52.17, norm1 = 5.584, norm01 = 53.11)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 108% of SD, and line search is active [stop if: <10% and line se
```

iinla: Iteration 6 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 61.58, norm1 = 22.69, norm01 = 39.47)

iinla: Step rescaling: 100%, Overstep (norm0 = 38.55, norm1 = 2.603, norm01 = 39.47)

iinla: Step rescaling: 101.8%, Approx Optimisation (norm0 = 39.22, norm1 = 2.515, norm01 = 39.47)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 76.9% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 7 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 51.47, norm1 = 19.55, norm01 = 32.17)

iinla: Step rescaling: 100%, Overstep (norm0 = 31.94, norm1 = 1.496, norm01 = 32.17)

iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 32.07, norm1 = 1.491, norm01 = 32.17)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 82% of SD, and line search is active [stop if: <10% and line sea

iinla: Iteration 8 [max:70]

iinla: Step rescaling: 99.75%, Approx Optimisation (norm0 = 26.67, norm1 = 1.037, norm01 = 26.73)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 73.1% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 9 [max:70]

iinla: Step rescaling: 99.51%, Approx Optimisation (norm0 = 22.12, norm1 = 0.7231, norm01 = 22.15)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 59.8% of SD, and line search is active [stop if: <10% and line se

```
## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 99.42%, Approx Optimisation (norm0 = 18.36, norm1 = 0.4897, norm01 = 18.38)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 47.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 99.41%, Approx Optimisation (norm0 = 15.3, norm1 = 0.3242, norm01 = 15.31)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 37.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.43%, Approx Optimisation (norm0 = 12.8, norm1 = 0.2114, norm01 = 12.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 29.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.48%, Approx Optimisation (norm0 = 10.75, norm1 = 0.1366, norm01 = 10.75)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 25% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.54%, Approx Optimisation (norm0 = 9.053, norm1 = 0.08768, norm01 = 9.054)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

iinla: Max deviation from previous: 21.3% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 15 [max:70]

iinla: Step rescaling: 99.6%, Approx Optimisation (norm0 = 7.646, norm1 = 0.05611, norm01 = 7.647)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 18.2% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 16 [max:70]

iinla: Step rescaling: 99.66%, Approx Optimisation (norm0 = 6.474, norm1 = 0.03585, norm01 = 6.474)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 15.5% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 17 [max:70]

iinla: Step rescaling: 99.71%, Approx Optimisation (norm0 = 5.494, norm1 = 0.0229, norm01 = 5.494)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 13.2% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 18 [max:70]

iinla: Step rescaling: 99.76%, Approx Optimisation (norm0 = 4.67, norm1 = 0.01465, norm01 = 4.67)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 11.2% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 19 [max:70]

iinla: Step rescaling: 99.8%, Approx Optimisation (norm0 = 3.977, norm1 = 0.009385, norm01 = 3.977)

iinla: Evaluate component linearisations

84

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.56% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 3.392, norm1 = 0.006032, norm01 = 3.392)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.15% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 99.87%, Approx Optimisation (norm0 = 2.897, norm1 = 0.003891, norm01 = 2.897)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.95% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 2.477, norm1 = 0.002521, norm01 = 2.477)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.93% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 23 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 2.12, norm1 = 0.001642, norm01 = 2.12)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.07% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 24 [max:70]
```

```r
input_list2_3_4 <- list(
  model.fit = synth.fit2_3_4,
  link.functions = link.f
)

synth.fit3_3_4 <- Temporal.ETAS(
  total.data = group_3_4_major_events[[3]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f,
  coef.t = 1,
  delta.t = 0.1,
  N.max = 5,
  bru.opt = bru.opt.list
)
```

```
## Start creating grid...
## Finished creating grid, time  1.871343


## iinla: Evaluate component inputs


## iinla: Evaluate component linearisations


## iinla: Evaluate component simplifications


## iinla: Evaluate predictor linearisation


## iinla: Construct inla stack


## iinla: Model initialisation completed


## iinla: Iteration 1 [max:70]


## iinla: Step rescaling: 61.8%, Contract (norm0 = 499.6, norm1 = 853.7, norm01 = 985)


## iinla: Step rescaling: 40.29%, Approx Optimisation (norm0 = 309.6, norm1 = 743.3, norm01 = 985)


## iinla: Evaluate component linearisations


## iinla: Evaluate predictor linearisation


## iinla: Iteration 2 [max:70]


## iinla: Step rescaling: 162%, Expand (norm0 = 1002, norm1 = 278.3, norm01 = 771)


## iinla: Step rescaling: 100%, Overstep (norm0 = 673.5, norm1 = 122, norm01 = 771)


## iinla: Step rescaling: 113.6%, Approx Optimisation (norm0 = 751.1, norm1 = 91.54, norm01 = 771)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 636% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 296.5, norm1 = 95.9, norm01 = 201.5)

## iinla: Step rescaling: 100%, Overstep (norm0 = 190.1, norm1 = 13.03, norm01 = 201.5)

## iinla: Step rescaling: 106.2%, Approx Optimisation (norm0 = 201.1, norm1 = 6.966, norm01 = 201.5)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 467% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 182.4, norm1 = 56.63, norm01 = 127.1)

## iinla: Step rescaling: 100%, Overstep (norm0 = 118, norm1 = 10.87, norm01 = 127.1)

## iinla: Step rescaling: 107.9%, Approx Optimisation (norm0 = 126.5, norm1 = 6.667, norm01 = 127.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 232% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 129.4, norm1 = 42.87, norm01 = 87.69)

## iinla: Step rescaling: 100%, Overstep (norm0 = 82.83, norm1 = 6.775, norm01 = 87.69)

## iinla: Step rescaling: 105.6%, Approx Optimisation (norm0 = 87.19, norm1 = 5.16, norm01 = 87.69)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 162% of SD, and line search is active [stop if: <10% and line sea
```

```
## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 103.5, norm1 = 36.75, norm01 = 67.82)

## iinla: Step rescaling: 100%, Overstep (norm0 = 65.38, norm1 = 4.856, norm01 = 67.82)

## iinla: Step rescaling: 103.2%, Approx Optimisation (norm0 = 67.36, norm1 = 4.426, norm01 = 67.82)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 151% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 88.81, norm1 = 33.1, norm01 = 56.54)

## iinla: Step rescaling: 100%, Overstep (norm0 = 55.46, norm1 = 3.704, norm01 = 56.54)

## iinla: Step rescaling: 101.3%, Approx Optimisation (norm0 = 56.18, norm1 = 3.633, norm01 = 56.54)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 131% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 77.98, norm1 = 29.9, norm01 = 48.65)

## iinla: Step rescaling: 100%, Overstep (norm0 = 48.32, norm1 = 2.812, norm01 = 48.65)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 48.4, norm1 = 2.811, norm01 = 48.65)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 108% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 99.48%, Approx Optimisation (norm0 = 42.44, norm1 = 2.087, norm01 = 42.59)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 87.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 99.13%, Approx Optimisation (norm0 = 37.66, norm1 = 1.512, norm01 = 37.75)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 70.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 98.98%, Approx Optimisation (norm0 = 33.69, norm1 = 1.082, norm01 = 33.74)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 64% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 98.96%, Approx Optimisation (norm0 = 30.26, norm1 = 0.769, norm01 = 30.29)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 58.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99%, Approx Optimisation (norm0 = 27.23, norm1 = 0.5456, norm01 = 27.24)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 53.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.08%, Approx Optimisation (norm0 = 24.51, norm1 = 0.3873, norm01 = 24.52)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 48.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.18%, Approx Optimisation (norm0 = 22.06, norm1 = 0.2754, norm01 = 22.07)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 44% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.27%, Approx Optimisation (norm0 = 19.84, norm1 = 0.1964, norm01 = 19.84)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 39.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.36%, Approx Optimisation (norm0 = 17.83, norm1 = 0.1406, norm01 = 17.83)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 35.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.44%, Approx Optimisation (norm0 = 16, norm1 = 0.101, norm01 = 16)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 31.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]
```

```
## iinla: Step rescaling: 99.52%, Approx Optimisation (norm0 = 14.36, norm1 = 0.07287, norm01 = 14.36)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 28.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 99.58%, Approx Optimisation (norm0 = 12.87, norm1 = 0.05283, norm01 = 12.87)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 25.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 99.64%, Approx Optimisation (norm0 = 11.53, norm1 = 0.03847, norm01 = 11.53)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 22.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 99.68%, Approx Optimisation (norm0 = 10.33, norm1 = 0.02816, norm01 = 10.33)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 20.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 23 [max:70]

## iinla: Step rescaling: 99.73%, Approx Optimisation (norm0 = 9.244, norm1 = 0.02071, norm01 = 9.244)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.2% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 24 [max:70]

## iinla: Step rescaling: 99.76%, Approx Optimisation (norm0 = 8.271, norm1 = 0.01531, norm01 = 8.271)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 16.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 25 [max:70]

## iinla: Step rescaling: 99.79%, Approx Optimisation (norm0 = 7.399, norm1 = 0.01138, norm01 = 7.399)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 26 [max:70]

## iinla: Step rescaling: 99.82%, Approx Optimisation (norm0 = 6.617, norm1 = 0.008496, norm01 = 6.617)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 12.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 27 [max:70]

## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 5.916, norm1 = 0.006374, norm01 = 5.916)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 11.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 28 [max:70]

## iinla: Step rescaling: 99.86%, Approx Optimisation (norm0 = 5.288, norm1 = 0.004805, norm01 = 5.288)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 10.3% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 29 [max:70]
```

```
## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 4.726, norm1 = 0.003639, norm01 = 4.726)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 9.17% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 30 [max:70]
```

```
## iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 4.223, norm1 = 0.002767, norm01 = 4.223)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 8.18% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 31 [max:70]
```

```
## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 3.773, norm1 = 0.002114, norm01 = 3.773)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 7.3% of SD, and line search is inactive [stop if: <10% and line s
```

```
## iinla: Convergence criterion met, running final INLA integration with known theta mode.
```

```
## iinla: Iteration 32 [max:70]
```

```r
input_list3_3_4 <- list(
  model.fit = synth.fit3_3_4,
  link.functions = link.f
)

# Getting posterior parameters for each model
post.list1_3_4 <- get_posterior_param(input_list1_3_4)
post.list2_3_4 <- get_posterior_param(input_list2_3_4)
post.list3_3_4 <- get_posterior_param(input_list3_3_4)

# Setting data category identifiers
post.list1_3_4$post.df$cat.used <- "3-4 high magnitude events 1"
post.list2_3_4$post.df$cat.used <- "3-4 high magnitude events 2"
```

```
post.list3_3_4$post.df$cat.used <- "3-4 high magnitude events 3"

# Binding all posterior distribution data frames
bind.post.df_3_4 <- rbind(post.list1_3_4$post.df, post.list2_3_4$post.df,
                          post.list3_3_4$post.df)

# Selecting alpha data for analysis
alpha_data_3_4 <- bind.post.df_3_4[bind.post.df_3_4$param == "alpha", ]

# Creating a dashed line data frame
vline_data_3_4 <- data.frame(x = true.param$alpha)

# Using ggplot to create the plot
ggplot(alpha_data_3_4, aes(x = x, y = y, color = cat.used)) +
  geom_line() +
  facet_wrap(~param, scales = "free") +
  xlab("Parameter value") +
  ylab("Probability density function") +
  geom_vline(data = vline_data_3_4, aes(xintercept = x), linetype = 2)+
  theme_bw()
```
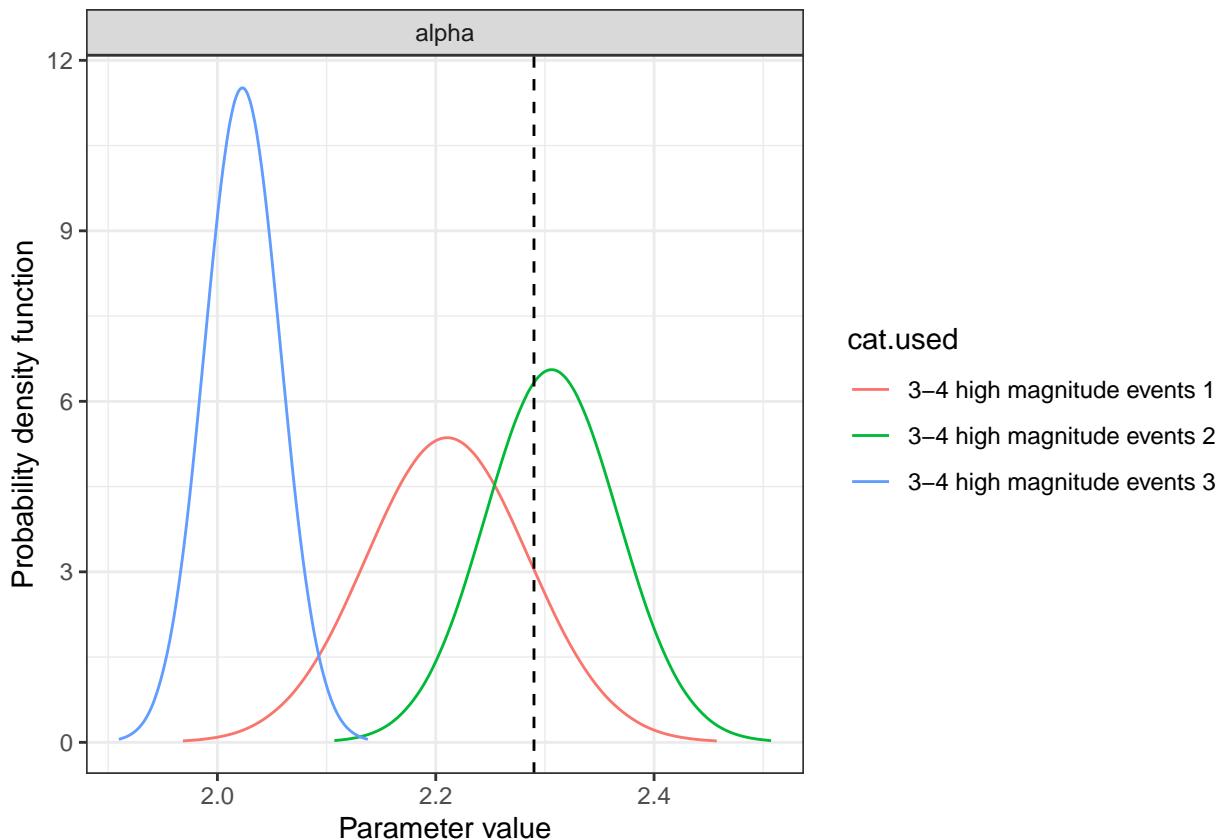


```
# Load necessary libraries
library(ggplot2)

# Setting the group name and retrieving the data for "5+ high magnitude events"
```

```r
group_5_plus_major_events <- groups[["5+ high magnitude events"]]

# Fitting the model for the first dataset in the "5+ high magnitude events"group
synth.fit1_5_plus <- Temporal.ETAS(
  total.data = group_5_plus_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f,
  coef.t = 1,
  delta.t = 0.1,
  N.max = 5,
  bru.opt = bru.opt.list
)
```

```
## Start creating grid...
## Finished creating grid, time  2.582808


## iinla: Evaluate component inputs


## iinla: Evaluate component linearisations


## iinla: Evaluate component simplifications


## iinla: Evaluate predictor linearisation


## iinla: Construct inla stack


## iinla: Model initialisation completed


## iinla: Iteration 1 [max:70]


## iinla: Step rescaling: 162%, Expand (norm0 = 7581, norm1 = 9318, norm01 = 4031)


## iinla: Step rescaling: 100%, Overstep (norm0 = 3303, norm1 = 4928, norm01 = 4031)


## iinla: Step rescaling: 45.5%, Approx Optimisation (norm0 = 1311, norm1 = 2935, norm01 = 4031)


## iinla: Evaluate component linearisations


## iinla: Evaluate predictor linearisation


## iinla: Iteration 2 [max:70]


## iinla: Step rescaling: 162%, Expand (norm0 = 3744, norm1 = 795.6, norm01 = 2966)


## iinla: Step rescaling: 100%, Overstep (norm0 = 2556, norm1 = 418.1, norm01 = 2966)


## iinla: Step rescaling: 119.5%, Approx Optimisation (norm0 = 2961, norm1 = 105.6, norm01 = 2966)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1650% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 362.1, norm1 = 133.7, norm01 = 228.4)

## iinla: Step rescaling: 100%, Overstep (norm0 = 225.5, norm1 = 3.365, norm01 = 228.4)

## iinla: Step rescaling: 101.3%, Approx Optimisation (norm0 = 228.4, norm1 = 1.782, norm01 = 228.4)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 938% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 205.4, norm1 = 73.25, norm01 = 133.9)

## iinla: Step rescaling: 100%, Overstep (norm0 = 129.4, norm1 = 9.053, norm01 = 133.9)

## iinla: Step rescaling: 103%, Approx Optimisation (norm0 = 133.1, norm1 = 8.244, norm01 = 133.9)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 300% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 185.8, norm1 = 72.78, norm01 = 114.8)

## iinla: Step rescaling: 100%, Overstep (norm0 = 114.7, norm1 = 7.674, norm01 = 114.8)

## iinla: Step rescaling: 99.44%, Approx Optimisation (norm0 = 114, norm1 = 7.647, norm01 = 114.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 148% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 98.05%, Approx Optimisation (norm0 = 100.5, norm1 = 5.36, norm01 = 100.9)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 148% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 97.46%, Approx Optimisation (norm0 = 90.7, norm1 = 3.727, norm01 = 90.93)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 146% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 97.3%, Approx Optimisation (norm0 = 83.3, norm1 = 2.687, norm01 = 83.42)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 140% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 97.36%, Approx Optimisation (norm0 = 77.2, norm1 = 2.016, norm01 = 77.27)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 131% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 97.53%, Approx Optimisation (norm0 = 71.78, norm1 = 1.556, norm01 = 71.83)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 122% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 97.74%, Approx Optimisation (norm0 = 66.78, norm1 = 1.219, norm01 = 66.81)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 112% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 97.97%, Approx Optimisation (norm0 = 62.06, norm1 = 0.9639, norm01 = 62.09)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 103% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 98.18%, Approx Optimisation (norm0 = 57.6, norm1 = 0.766, norm01 = 57.61)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 94.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 98.38%, Approx Optimisation (norm0 = 53.37, norm1 = 0.6113, norm01 = 53.38)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 86.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 98.55%, Approx Optimisation (norm0 = 49.38, norm1 = 0.4895, norm01 = 49.39)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 79.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 98.71%, Approx Optimisation (norm0 = 45.63, norm1 = 0.3933, norm01 = 45.64)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 72.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 98.85%, Approx Optimisation (norm0 = 42.12, norm1 = 0.3171, norm01 = 42.12)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 66% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 98.97%, Approx Optimisation (norm0 = 38.84, norm1 = 0.2563, norm01 = 38.84)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 60.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.08%, Approx Optimisation (norm0 = 35.78, norm1 = 0.2078, norm01 = 35.78)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 55.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 99.17%, Approx Optimisation (norm0 = 32.94, norm1 = 0.1689, norm01 = 32.94)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 50.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 99.25%, Approx Optimisation (norm0 = 30.3, norm1 = 0.1376, norm01 = 30.3)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 46.1% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 99.33%, Approx Optimisation (norm0 = 27.86, norm1 = 0.1124, norm01 = 27.86)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 42.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 23 [max:70]

## iinla: Step rescaling: 99.39%, Approx Optimisation (norm0 = 25.6, norm1 = 0.09195, norm01 = 25.6)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 38.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 24 [max:70]

## iinla: Step rescaling: 99.45%, Approx Optimisation (norm0 = 23.52, norm1 = 0.07538, norm01 = 23.52)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 35.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 25 [max:70]
```

```
## iinla: Step rescaling: 99.51%, Approx Optimisation (norm0 = 21.6, norm1 = 0.06191, norm01 = 21.6)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 32.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 26 [max:70]

## iinla: Step rescaling: 99.55%, Approx Optimisation (norm0 = 19.82, norm1 = 0.05093, norm01 = 19.82)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 29.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 27 [max:70]

## iinla: Step rescaling: 99.6%, Approx Optimisation (norm0 = 18.19, norm1 = 0.04196, norm01 = 18.19)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 27% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 28 [max:70]

## iinla: Step rescaling: 99.63%, Approx Optimisation (norm0 = 16.69, norm1 = 0.03462, norm01 = 16.69)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 24.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 29 [max:70]

## iinla: Step rescaling: 99.67%, Approx Optimisation (norm0 = 15.31, norm1 = 0.0286, norm01 = 15.31)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 22.6% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 30 [max:70]

## iinla: Step rescaling: 99.7%, Approx Optimisation (norm0 = 14.04, norm1 = 0.02366, norm01 = 14.04)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 20.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 31 [max:70]

## iinla: Step rescaling: 99.73%, Approx Optimisation (norm0 = 12.87, norm1 = 0.01959, norm01 = 12.87)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 32 [max:70]

## iinla: Step rescaling: 99.75%, Approx Optimisation (norm0 = 11.8, norm1 = 0.01624, norm01 = 11.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 17.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 33 [max:70]

## iinla: Step rescaling: 99.77%, Approx Optimisation (norm0 = 10.81, norm1 = 0.01347, norm01 = 10.81)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 15.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 34 [max:70]

## iinla: Step rescaling: 99.79%, Approx Optimisation (norm0 = 9.911, norm1 = 0.01118, norm01 = 9.911)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 14.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 35 [max:70]

## iinla: Step rescaling: 99.81%, Approx Optimisation (norm0 = 9.082, norm1 = 0.009294, norm01 = 9.082)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 13.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 36 [max:70]

## iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 8.321, norm1 = 0.007728, norm01 = 8.321)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 12.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 37 [max:70]

## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 7.624, norm1 = 0.006431, norm01 = 7.624)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 11.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 38 [max:70]

## iinla: Step rescaling: 99.86%, Approx Optimisation (norm0 = 6.984, norm1 = 0.005355, norm01 = 6.984)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 39 [max:70]

## iinla: Step rescaling: 99.87%, Approx Optimisation (norm0 = 6.398, norm1 = 0.004462, norm01 = 6.398)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.27% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 40 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 5.86, norm1 = 0.003719, norm01 = 5.86)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.48% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 41 [max:70]

## iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 5.368, norm1 = 0.003102, norm01 = 5.367)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.76% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 42 [max:70]

## iinla: Step rescaling: 99.9%, Approx Optimisation (norm0 = 4.916, norm1 = 0.002589, norm01 = 4.916)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.1% of SD, and line search is inactive [stop if: <10% and line s

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 43 [max:70]
```

```r
input_list1_5_plus <- list(
  model.fit = synth.fit1_5_plus,
  link.functions = link.f
)

# Repeat the process for the second dataset in the "5+ high magnitude events"
#group
synth.fit2_5_plus <- Temporal.ETAS(
  total.data = group_5_plus_major_events[[2]],
  M0 = M0,
  T1 = T1,
```

```
  T2 = T2,
  link.functions = link.f,
  coef.t = 1,
  delta.t = 0.1,
  N.max = 5,
  bru.opt = bru.opt.list
)
```

Start creating grid...
Finished creating grid, time 13.4831

iinla: Evaluate component inputs

iinla: Evaluate component linearisations

iinla: Evaluate component simplifications

iinla: Evaluate predictor linearisation

iinla: Construct inla stack

iinla: Model initialisation completed

iinla: Iteration 1 [max:70]

iinla: Step rescaling: 84.68%, Approx Optimisation (norm0 = 9.382e+25, norm1 = 3.418e+23, norm01 = 9

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Iteration 2 [max:70]

iinla: Step rescaling: 61.8%, Contract (norm0 = 34910, norm1 = 3357, norm01 = 31800)

iinla: Step rescaling: 57.85%, Approx Optimisation (norm0 = 31550, norm1 = 1199, norm01 = 31800)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 11400% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 3 [max:70]

iinla: Step rescaling: 83.59%, Approx Optimisation (norm0 = 2814, norm1 = 276, norm01 = 2856)

iinla: Evaluate component linearisations

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7900% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 567.9, norm1 = 211.1, norm01 = 376.4)

## iinla: Step rescaling: 100%, Overstep (norm0 = 359.4, norm1 = 45.37, norm01 = 376.4)

## iinla: Step rescaling: 102.5%, Approx Optimisation (norm0 = 368.1, norm1 = 44.5, norm01 = 376.4)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 175% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 160.9, norm1 = 60.58, norm01 = 100.3)

## iinla: Step rescaling: 100%, Overstep (norm0 = 99.75, norm1 = 0.5593, norm01 = 100.3)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 100.3, norm1 = 0.1568, norm01 = 100.3)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 108% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 82.07, norm1 = 31.21, norm01 = 50.86)

## iinla: Step rescaling: 100%, Overstep (norm0 = 50.77, norm1 = 0.1099, norm01 = 50.86)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 50.86, norm1 = 0.07055, norm01 = 50.86)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 70.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 80.68, norm1 = 30.69, norm01 = 49.99)

## iinla: Step rescaling: 100%, Overstep (norm0 = 49.91, norm1 = 0.1162, norm01 = 49.99)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 49.99, norm1 = 0.0839, norm01 = 49.99)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 53.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 77.78, norm1 = 29.59, norm01 = 48.19)

## iinla: Step rescaling: 100%, Overstep (norm0 = 48.12, norm1 = 0.1051, norm01 = 48.19)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 48.19, norm1 = 0.07275, norm01 = 48.19)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 41.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 74.77, norm1 = 28.44, norm01 = 46.32)

## iinla: Step rescaling: 100%, Overstep (norm0 = 46.25, norm1 = 0.09389, norm01 = 46.32)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 46.32, norm1 = 0.06142, norm01 = 46.32)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 32.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 71.82, norm1 = 27.33, norm01 = 44.5)

## iinla: Step rescaling: 100%, Overstep (norm0 = 44.43, norm1 = 0.0843, norm01 = 44.5)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 44.5, norm1 = 0.05219, norm01 = 44.5)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 27.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 68.94, norm1 = 26.23, norm01 = 42.71)

## iinla: Step rescaling: 100%, Overstep (norm0 = 42.65, norm1 = 0.0761, norm01 = 42.71)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 42.71, norm1 = 0.04481, norm01 = 42.71)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 26.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 66.12, norm1 = 25.16, norm01 = 40.96)

## iinla: Step rescaling: 100%, Overstep (norm0 = 40.9, norm1 = 0.06899, norm01 = 40.96)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 40.96, norm1 = 0.03886, norm01 = 40.96)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 25.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 63.35, norm1 = 24.11, norm01 = 39.24)

## iinla: Step rescaling: 100%, Overstep (norm0 = 39.18, norm1 = 0.06274, norm01 = 39.24)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 39.24, norm1 = 0.03401, norm01 = 39.24)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 24.6% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 60.64, norm1 = 23.08, norm01 = 37.56)

## iinla: Step rescaling: 100%, Overstep (norm0 = 37.51, norm1 = 0.05716, norm01 = 37.56)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 37.56, norm1 = 0.02999, norm01 = 37.56)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 23.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 58, norm1 = 22.08, norm01 = 35.92)

## iinla: Step rescaling: 100%, Overstep (norm0 = 35.88, norm1 = 0.05213, norm01 = 35.92)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 35.92, norm1 = 0.02662, norm01 = 35.92)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 22.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 55.44, norm1 = 21.11, norm01 = 34.33)

## iinla: Step rescaling: 100%, Overstep (norm0 = 34.29, norm1 = 0.04757, norm01 = 34.33)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 34.33, norm1 = 0.02376, norm01 = 34.33)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 21.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 52.96, norm1 = 20.17, norm01 = 32.79)

## iinla: Step rescaling: 100%, Overstep (norm0 = 32.76, norm1 = 0.04341, norm01 = 32.79)
```

iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 32.79, norm1 = 0.02129, norm01 = 32.79)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 20.7% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 18 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 50.57, norm1 = 19.26, norm01 = 31.31)

iinla: Step rescaling: 100%, Overstep (norm0 = 31.27, norm1 = 0.03962, norm01 = 31.31)

iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 31.31, norm1 = 0.01914, norm01 = 31.31)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 19.8% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 19 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 48.26, norm1 = 18.38, norm01 = 29.88)

iinla: Step rescaling: 100%, Overstep (norm0 = 29.85, norm1 = 0.03615, norm01 = 29.88)

iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 29.88, norm1 = 0.01725, norm01 = 29.88)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 18.9% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 20 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 46.04, norm1 = 17.54, norm01 = 28.5)

iinla: Step rescaling: 100%, Overstep (norm0 = 28.47, norm1 = 0.03297, norm01 = 28.5)

iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 28.5, norm1 = 0.01559, norm01 = 28.5)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 18.1% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 21 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 43.91, norm1 = 16.73, norm01 = 27.18)

iinla: Step rescaling: 100%, Overstep (norm0 = 27.15, norm1 = 0.03006, norm01 = 27.18)

iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 27.18, norm1 = 0.0141, norm01 = 27.18)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 17.3% of SD, and line search is inactive [stop if: <10% and line

iinla: Iteration 22 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 41.87, norm1 = 15.95, norm01 = 25.91)

iinla: Step rescaling: 100%, Overstep (norm0 = 25.89, norm1 = 0.0274, norm01 = 25.91)

iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 25.91, norm1 = 0.01278, norm01 = 25.91)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 16.5% of SD, and line search is inactive [stop if: <10% and line

iinla: Iteration 23 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 39.91, norm1 = 15.21, norm01 = 24.7)

iinla: Step rescaling: 100%, Overstep (norm0 = 24.68, norm1 = 0.02496, norm01 = 24.7)

iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 24.7, norm1 = 0.01158, norm01 = 24.7)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 15.7% of SD, and line search is inactive [stop if: <10% and line

iinla: Iteration 24 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 38.04, norm1 = 14.5, norm01 = 23.54)

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 23.52, norm1 = 0.02274, norm01 = 23.54)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 23.54, norm1 = 0.01051, norm01 = 23.54)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 15% of SD, and line search is inactive [stop if: <10% and line se

## iinla: Iteration 25 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 36.25, norm1 = 13.81, norm01 = 22.43)

## iinla: Step rescaling: 100%, Overstep (norm0 = 22.41, norm1 = 0.0207, norm01 = 22.43)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 22.43, norm1 = 0.00954, norm01 = 22.43)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.3% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 26 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 34.54, norm1 = 13.16, norm01 = 21.37)

## iinla: Step rescaling: 100%, Overstep (norm0 = 21.35, norm1 = 0.01884, norm01 = 21.37)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 21.37, norm1 = 0.008663, norm01 = 21.37)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 13.6% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 27 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 32.9, norm1 = 12.54, norm01 = 20.36)

## iinla: Step rescaling: 100%, Overstep (norm0 = 20.34, norm1 = 0.01714, norm01 = 20.36)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 20.36, norm1 = 0.007868, norm01 = 20.36)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 13% of SD, and line search is inactive [stop if: <10% and line s

## iinla: Iteration 28 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 31.34, norm1 = 11.95, norm01 = 19.39)

## iinla: Step rescaling: 100%, Overstep (norm0 = 19.38, norm1 = 0.0156, norm01 = 19.39)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 19.39, norm1 = 0.007148, norm01 = 19.39)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 12.4% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 29 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 29.85, norm1 = 11.38, norm01 = 18.47)

## iinla: Step rescaling: 100%, Overstep (norm0 = 18.46, norm1 = 0.01418, norm01 = 18.47)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 18.47, norm1 = 0.006494, norm01 = 18.47)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 11.8% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 30 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 28.43, norm1 = 10.84, norm01 = 17.59)

## iinla: Step rescaling: 100%, Overstep (norm0 = 17.58, norm1 = 0.0129, norm01 = 17.59)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 17.59, norm1 = 0.0059, norm01 = 17.59)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 11.2% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 31 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 27.08, norm1 = 10.33, norm01 = 16.75)

## iinla: Step rescaling: 100%, Overstep (norm0 = 16.74, norm1 = 0.01172, norm01 = 16.75)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 16.75, norm1 = 0.005361, norm01 = 16.75)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.7% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 32 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 25.79, norm1 = 9.835, norm01 = 15.95)

## iinla: Step rescaling: 100%, Overstep (norm0 = 15.94, norm1 = 0.01065, norm01 = 15.95)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 15.95, norm1 = 0.00487, norm01 = 15.95)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.2% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 33 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 24.56, norm1 = 9.367, norm01 = 15.19)

## iinla: Step rescaling: 100%, Overstep (norm0 = 15.18, norm1 = 0.00968, norm01 = 15.19)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 15.19, norm1 = 0.004424, norm01 = 15.19)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.71% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 34 [max:70]
```

```r
input_list2_5_plus <- list(
  model.fit = synth.fit2_5_plus,
  link.functions = link.f
)

# And for the third dataset
synth.fit3_5_plus <- Temporal.ETAS(
  total.data = group_5_plus_major_events[[3]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f,
  coef.t = 1,
  delta.t = 0.1,
  N.max = 5,
  bru.opt = bru.opt.list
)
```

```
## Start creating grid...
## Finished creating grid, time  6.826629


## iinla: Evaluate component inputs


## iinla: Evaluate component linearisations


## iinla: Evaluate component simplifications


## iinla: Evaluate predictor linearisation


## iinla: Construct inla stack


## iinla: Model initialisation completed


## iinla: Iteration 1 [max:70]


## iinla: Step rescaling: 85.08%, Approx Optimisation (norm0 = 3.292e+09, norm1 = 461500000, norm01 = 3


## iinla: Evaluate component linearisations


## iinla: Evaluate predictor linearisation


## iinla: Iteration 2 [max:70]


## iinla: Step rescaling: 61.8%, Contract (norm0 = 15880, norm1 = 2250, norm01 = 13720)


## iinla: Step rescaling: 55.84%, Approx Optimisation (norm0 = 13530, norm1 = 603.8, norm01 = 13720)


## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7600% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 93.49%, Approx Optimisation (norm0 = 943.8, norm1 = 19.97, norm01 = 944.3)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4830% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 414.4, norm1 = 154.5, norm01 = 259.9)

## iinla: Step rescaling: 100%, Overstep (norm0 = 257.5, norm1 = 2.482, norm01 = 259.9)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 259.9, norm1 = 0.7592, norm01 = 259.9)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 257% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 385.2, norm1 = 143.3, norm01 = 241.9)

## iinla: Step rescaling: 100%, Overstep (norm0 = 239.5, norm1 = 2.615, norm01 = 241.9)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 241.9, norm1 = 1.064, norm01 = 241.9)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 229% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 343, norm1 = 126.8, norm01 = 216.3)

## iinla: Step rescaling: 100%, Overstep (norm0 = 213.6, norm1 = 2.931, norm01 = 216.3)
```

```
## iinla: Step rescaling: 101.2%, Approx Optimisation (norm0 = 216.3, norm1 = 1.307, norm01 = 216.3)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 199% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 309.6, norm1 = 114.2, norm01 = 195.4)

## iinla: Step rescaling: 100%, Overstep (norm0 = 192.9, norm1 = 2.863, norm01 = 195.4)

## iinla: Step rescaling: 101.3%, Approx Optimisation (norm0 = 195.4, norm1 = 1.35, norm01 = 195.4)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 178% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 280, norm1 = 103.3, norm01 = 176.8)

## iinla: Step rescaling: 100%, Overstep (norm0 = 174.5, norm1 = 2.612, norm01 = 176.8)

## iinla: Step rescaling: 101.3%, Approx Optimisation (norm0 = 176.7, norm1 = 1.282, norm01 = 176.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 161% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 253.5, norm1 = 93.6, norm01 = 159.9)

## iinla: Step rescaling: 100%, Overstep (norm0 = 157.9, norm1 = 2.313, norm01 = 159.9)

## iinla: Step rescaling: 101.3%, Approx Optimisation (norm0 = 159.9, norm1 = 1.172, norm01 = 159.9)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

iinla: Max deviation from previous: 146% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 10 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 229.6, norm1 = 84.92, norm01 = 144.7)

iinla: Step rescaling: 100%, Overstep (norm0 = 143, norm1 = 2.02, norm01 = 144.7)

iinla: Step rescaling: 101.2%, Approx Optimisation (norm0 = 144.7, norm1 = 1.05, norm01 = 144.7)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 133% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 11 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 208.1, norm1 = 77.11, norm01 = 131.1)

iinla: Step rescaling: 100%, Overstep (norm0 = 129.6, norm1 = 1.751, norm01 = 131.1)

iinla: Step rescaling: 101.2%, Approx Optimisation (norm0 = 131, norm1 = 0.9316, norm01 = 131.1)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 121% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 12 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 188.8, norm1 = 70.08, norm01 = 118.8)

iinla: Step rescaling: 100%, Overstep (norm0 = 117.5, norm1 = 1.511, norm01 = 118.8)

iinla: Step rescaling: 101.1%, Approx Optimisation (norm0 = 118.8, norm1 = 0.8204, norm01 = 118.8)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 111% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 13 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 171.4, norm1 = 63.74, norm01 = 107.7)

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 106.6, norm1 = 1.3, norm01 = 107.7)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 107.7, norm1 = 0.7188, norm01 = 107.7)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 101% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 155.8, norm1 = 58.02, norm01 = 97.78)

## iinla: Step rescaling: 100%, Overstep (norm0 = 96.85, norm1 = 1.116, norm01 = 97.78)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 97.78, norm1 = 0.6271, norm01 = 97.78)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 92.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 141.7, norm1 = 52.84, norm01 = 88.83)

## iinla: Step rescaling: 100%, Overstep (norm0 = 88.04, norm1 = 0.9566, norm01 = 88.83)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 88.83, norm1 = 0.5453, norm01 = 88.83)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 84.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 128.9, norm1 = 48.17, norm01 = 80.77)

## iinla: Step rescaling: 100%, Overstep (norm0 = 80.09, norm1 = 0.8185, norm01 = 80.77)

## iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 80.76, norm1 = 0.4728, norm01 = 80.77)

## iinla: Evaluate component linearisations
```

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 76.8% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 17 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 117.4, norm1 = 43.93, norm01 = 73.49)

iinla: Step rescaling: 100%, Overstep (norm0 = 72.92, norm1 = 0.6994, norm01 = 73.49)

iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 73.48, norm1 = 0.4089, norm01 = 73.49)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 70.2% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 18 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 107, norm1 = 40.1, norm01 = 66.92)

iinla: Step rescaling: 100%, Overstep (norm0 = 66.43, norm1 = 0.597, norm01 = 66.92)

iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 66.91, norm1 = 0.3529, norm01 = 66.92)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 64.2% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 19 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 97.59, norm1 = 36.62, norm01 = 60.98)

iinla: Step rescaling: 100%, Overstep (norm0 = 60.57, norm1 = 0.5091, norm01 = 60.98)

iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 60.97, norm1 = 0.3039, norm01 = 60.98)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 58.7% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 20 [max:70]

```
## iinla: Step rescaling: 162%, Expand (norm0 = 89.05, norm1 = 33.46, norm01 = 55.6)

## iinla: Step rescaling: 100%, Overstep (norm0 = 55.25, norm1 = 0.4338, norm01 = 55.6)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 55.6, norm1 = 0.2613, norm01 = 55.6)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 53.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 81.32, norm1 = 30.59, norm01 = 50.73)

## iinla: Step rescaling: 100%, Overstep (norm0 = 50.44, norm1 = 0.3694, norm01 = 50.73)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 50.73, norm1 = 0.2244, norm01 = 50.73)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 49.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 74.29, norm1 = 27.98, norm01 = 46.32)

## iinla: Step rescaling: 100%, Overstep (norm0 = 46.07, norm1 = 0.3144, norm01 = 46.32)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 46.32, norm1 = 0.1924, norm01 = 46.32)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 45% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 23 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 67.91, norm1 = 25.6, norm01 = 42.31)

## iinla: Step rescaling: 100%, Overstep (norm0 = 42.1, norm1 = 0.2674, norm01 = 42.31)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 42.31, norm1 = 0.1647, norm01 = 42.31)
```

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 41.3% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 24 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 62.11, norm1 = 23.44, norm01 = 38.67)

iinla: Step rescaling: 100%, Overstep (norm0 = 38.5, norm1 = 0.2273, norm01 = 38.67)

iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 38.67, norm1 = 0.1409, norm01 = 38.67)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 37.8% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 25 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 56.83, norm1 = 21.46, norm01 = 35.37)

iinla: Step rescaling: 100%, Overstep (norm0 = 35.21, norm1 = 0.1931, norm01 = 35.37)

iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 35.37, norm1 = 0.1204, norm01 = 35.37)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 34.7% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 26 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 52.02, norm1 = 19.66, norm01 = 32.36)

iinla: Step rescaling: 100%, Overstep (norm0 = 32.23, norm1 = 0.164, norm01 = 32.36)

iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 32.36, norm1 = 0.1028, norm01 = 32.36)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 31.8% of SD, and line search is active [stop if: <10% and line s

```
## iinla: Iteration 27 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 47.63, norm1 = 18.02, norm01 = 29.61)

## iinla: Step rescaling: 100%, Overstep (norm0 = 29.51, norm1 = 0.1393, norm01 = 29.61)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 29.61, norm1 = 0.0877, norm01 = 29.61)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 29.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 28 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 43.64, norm1 = 16.52, norm01 = 27.12)

## iinla: Step rescaling: 100%, Overstep (norm0 = 27.02, norm1 = 0.1182, norm01 = 27.12)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 27.12, norm1 = 0.07477, norm01 = 27.12)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 26.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 29 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 39.99, norm1 = 15.15, norm01 = 24.84)

## iinla: Step rescaling: 100%, Overstep (norm0 = 24.76, norm1 = 0.1003, norm01 = 24.84)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 24.84, norm1 = 0.0637, norm01 = 24.84)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 24.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 30 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 36.65, norm1 = 13.89, norm01 = 22.76)

## iinla: Step rescaling: 100%, Overstep (norm0 = 22.69, norm1 = 0.08512, norm01 = 22.76)
```

```
## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 22.76, norm1 = 0.05424, norm01 = 22.76)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 22.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 31 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 33.61, norm1 = 12.75, norm01 = 20.86)

## iinla: Step rescaling: 100%, Overstep (norm0 = 20.81, norm1 = 0.0722, norm01 = 20.86)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 20.86, norm1 = 0.04616, norm01 = 20.86)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 20.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 32 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 30.82, norm1 = 11.7, norm01 = 19.13)

## iinla: Step rescaling: 100%, Overstep (norm0 = 19.08, norm1 = 0.06123, norm01 = 19.13)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 19.13, norm1 = 0.03927, norm01 = 19.13)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 19% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 33 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 28.28, norm1 = 10.74, norm01 = 17.54)

## iinla: Step rescaling: 100%, Overstep (norm0 = 17.5, norm1 = 0.05192, norm01 = 17.54)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 17.54, norm1 = 0.03339, norm01 = 17.54)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

iinla: Max deviation from previous: 17.4% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 34 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 25.95, norm1 = 9.857, norm01 = 16.09)

iinla: Step rescaling: 100%, Overstep (norm0 = 16.06, norm1 = 0.04402, norm01 = 16.09)

iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 16.09, norm1 = 0.02838, norm01 = 16.09)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 16% of SD, and line search is active [stop if: <10% and line sea

iinla: Iteration 35 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 23.82, norm1 = 9.051, norm01 = 14.77)

iinla: Step rescaling: 100%, Overstep (norm0 = 14.74, norm1 = 0.03731, norm01 = 14.77)

iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 14.77, norm1 = 0.02411, norm01 = 14.77)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 14.7% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 36 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 21.86, norm1 = 8.312, norm01 = 13.55)

iinla: Step rescaling: 100%, Overstep (norm0 = 13.53, norm1 = 0.03163, norm01 = 13.55)

iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 13.55, norm1 = 0.02048, norm01 = 13.55)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 13.5% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 37 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 20.07, norm1 = 7.634, norm01 = 12.44)

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 12.42, norm1 = 0.0268, norm01 = 12.44)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 12.44, norm1 = 0.01739, norm01 = 12.44)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 12.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 38 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 18.43, norm1 = 7.013, norm01 = 11.42)

## iinla: Step rescaling: 100%, Overstep (norm0 = 11.4, norm1 = 0.02271, norm01 = 11.42)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 11.42, norm1 = 0.01476, norm01 = 11.42)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 11.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 39 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 16.93, norm1 = 6.443, norm01 = 10.49)

## iinla: Step rescaling: 100%, Overstep (norm0 = 10.47, norm1 = 0.01924, norm01 = 10.49)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 10.49, norm1 = 0.01253, norm01 = 10.49)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 40 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 15.55, norm1 = 5.92, norm01 = 9.631)

## iinla: Step rescaling: 100%, Overstep (norm0 = 9.619, norm1 = 0.0163, norm01 = 9.631)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 9.631, norm1 = 0.01063, norm01 = 9.631)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.64% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 41 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 14.29, norm1 = 5.44, norm01 = 8.846)

## iinla: Step rescaling: 100%, Overstep (norm0 = 8.836, norm1 = 0.01381, norm01 = 8.846)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 8.846, norm1 = 0.009021, norm01 = 8.846)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.86% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 42 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 13.13, norm1 = 4.999, norm01 = 8.127)

## iinla: Step rescaling: 100%, Overstep (norm0 = 8.118, norm1 = 0.0117, norm01 = 8.127)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 8.127, norm1 = 0.007652, norm01 = 8.127)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.14% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 43 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 12.06, norm1 = 4.595, norm01 = 7.467)

## iinla: Step rescaling: 100%, Overstep (norm0 = 7.459, norm1 = 0.009911, norm01 = 7.467)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 7.467, norm1 = 0.006489, norm01 = 7.467)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.49% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 44 [max:70]
```

```r
input_list3_5_plus <- list(
  model.fit = synth.fit3_5_plus,
  link.functions = link.f
)


# Extracting posterior parameters for each model
post.list1_5_plus <- get_posterior_param(input_list1_5_plus)
post.list2_5_plus <- get_posterior_param(input_list2_5_plus)
post.list3_5_plus <- get_posterior_param(input_list3_5_plus)


# Setting data category identifiers
post.list1_5_plus$post.df$cat.used <- "5+ high magnitude events 1"
post.list2_5_plus$post.df$cat.used <- "5+ high magnitude events 2"
post.list3_5_plus$post.df$cat.used <- "5+ high magnitude events 3"


# Binding  posterior distribution
bind.post.df_5_plus <- rbind(post.list1_5_plus$post.df,
                             post.list2_5_plus$post.df,
                             post.list3_5_plus$post.df)


# Selecting alpha
alpha_data_5_plus <- bind.post.df_5_plus[bind.post.df_5_plus$param == "alpha", ]


# Creating a dashed line
vline_data_5_plus <- data.frame(x = true.param$alpha)


# Using ggplot to create the plot
ggplot(alpha_data_5_plus, aes(x = x, y = y, color = cat.used)) +
  geom_line() +
  facet_wrap(~param, scales = "free") +
  xlab("Parameter value") +
  ylab("Probability density function") +
  geom_vline(data = vline_data_5_plus, aes(xintercept = x), linetype = 2) +
  theme_bw()
```
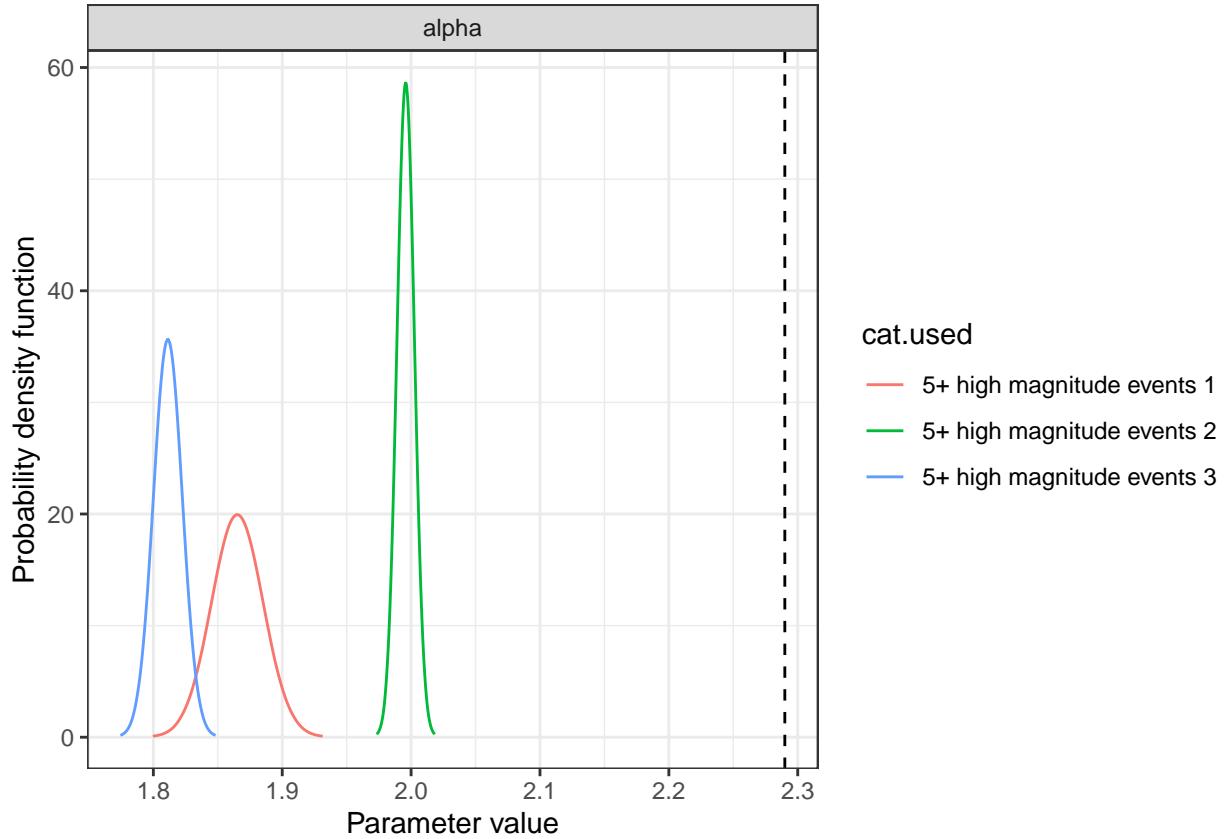
#Exploring whether the highest magnitude affects the alpha posterior #distribution

#First classify according to the highest magnitude, then fit the model, #and finally compare the posterior distribution.

```
# Initialize group
groups2 <- list(
  "5_to_5.5" = list(),
  "5.5_to_6" = list(),
  "6_plus" = list()
)

# Generate each earthquake catalogue in a loop until metting all  criteria
while (length(groups2[["5_to_5.5"]]) < 2 || length(groups2[["5.5_to_6"]]) < 2 ||
       length(groups2[["6_plus"]]) < 2) {
  # Generate temporary catalogue
  synth_catalogue <- generate_temporal_ETAS_synthetic(
    theta = true.param, beta = beta.p, M0 = M0, T1 = T1, T2 = T2, Ht = NULL
  )

  # bind catalogues
  ETAS.cat <- bind_rows(synth_catalogue) %>%
    arrange(ts)

  # Calculate the number of earthquakes greater than the threshold
  n_major_events <- sum(ETAS.cat$magnitudes >= M_threshold)
  max_mag <- max(ETAS.cat$magnitudes)
```

```r
  # Classification of earthquake categories
  if (n_major_events == 5) {
    if (max_mag >= 5.0 && max_mag < 5.5 && length(groups2[["5_to_5.5"]]) < 2) {
      groups2[["5_to_5.5"]] <- c(groups2[["5_to_5.5"]], list(ETAS.cat))
    } else if (max_mag >= 5.5 && max_mag < 6.0 &&
                length(groups2[["5.5_to_6"]]) < 2) {
      groups2[["5.5_to_6"]] <- c(groups2[["5.5_to_6"]], list(ETAS.cat))
    } else if (max_mag >= 6.0 && length(groups2[["6_plus"]]) < 2) {
      groups2[["6_plus"]] <- c(groups2[["6_plus"]], list(ETAS.cat))
    }
  }
}

# check information
sapply(groups, length)
```

```
##  No high magnitude events 1-2 high magnitude events 3-4 high magnitude events
##                         3                         3                         3
##  5+ high magnitude events
##                         3
```

```r
sapply(groups2, length)
```

```
## 5_to_5.5 5.5_to_6   6_plus
##        2        2        2
```

#plot alpha

```r
library(ggplot2)
set.seed(1)
# Define a function for the model to merge and draw plots for each group
fit_and_plot_group <- function(group_data, group_name) {
  post_df_list <- list()  # Store posterior data

  # Loop through each catalogue for fitting and posterior extraction
  for (i in seq_along(group_data)) {
    synth.fit <- Temporal.ETAS(
      total.data = group_data[[i]],
      M0 = M0,
      T1 = T1,
      T2 = T2,
      link.functions = link.f,
      coef.t = 1,
      delta.t = 0.1,
      N.max = 5,
      bru.opt = bru.opt.list
    )

    # creat input list
    input_list <- list(
      model.fit = synth.fit,
```

```r
    link.functions = link.f
  )

  # get posterior
  post_list <- get_posterior_param(input_list)
  post_list$post.df$cat.used <- paste("Cat", i)  #Mark classification

  # save posterior data
  post_df_list[[i]] <- post_list$post.df
}

# bind posterior data

bind.post.df <- do.call(rbind, post_df_list)

  # plot
  alpha_data <- bind.post.df[bind.post.df$param == "alpha", ]
  p <- ggplot(alpha_data, aes(x = x, y = y, color = cat.used)) +
    geom_line() +
    facet_wrap(~param, scales = "free") +
    xlab("Parameter value") +
    ylab("Probability density function") +
    geom_vline(data = data.frame(x = true.param$alpha),
               aes(xintercept = x), linetype = 2) +
    ggtitle(paste("Posterior Distribution of Alpha for", group_name)) +
    #theme_minimal()
    theme_bw()

  return(p)
}

# Loop  each group name, fit the model and generate a graph
group_names <- c("5_to_5.5", "5.5_to_6", "6_plus")
all_plots <- lapply(group_names, function(gn) fit_and_plot_group(groups2[[gn]],
                                                                  gn))
```

```
## Start creating grid...
## Finished creating grid, time  0.66187

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]
```

```
## iinla: Step rescaling: 61.8%, Contract (norm0 = 314.1, norm1 = 385.3, norm01 = 273.6)

## iinla: Step rescaling: 26.11%, Approx Optimisation (norm0 = 70.44, norm1 = 222, norm01 = 273.6)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 413.2, norm1 = 354.9, norm01 = 244.7)

## iinla: Step rescaling: 100%, Overstep (norm0 = 220.9, norm1 = 147.5, norm01 = 244.7)

## iinla: Step rescaling: 74.67%, Approx Optimisation (norm0 = 163, norm1 = 121.6, norm01 = 244.7)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 328% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 247.4, norm1 = 90.6, norm01 = 157.1)

## iinla: Step rescaling: 100%, Overstep (norm0 = 154.4, norm1 = 4.312, norm01 = 157.1)

## iinla: Step rescaling: 101.6%, Approx Optimisation (norm0 = 156.9, norm1 = 3.516, norm01 = 157.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 121% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 108.2, norm1 = 31.76, norm01 = 77.48)

## iinla: Step rescaling: 100%, Overstep (norm0 = 70.73, norm1 = 7.809, norm01 = 77.48)

## iinla: Step rescaling: 109.9%, Approx Optimisation (norm0 = 77.04, norm1 = 4.552, norm01 = 77.48)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 166% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 79.8, norm1 = 24.73, norm01 = 55.64)

## iinla: Step rescaling: 100%, Overstep (norm0 = 51.67, norm1 = 4.692, norm01 = 55.64)

## iinla: Step rescaling: 107.8%, Approx Optimisation (norm0 = 55.4, norm1 = 2.826, norm01 = 55.64)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 114% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 57.08, norm1 = 18.84, norm01 = 38.69)

## iinla: Step rescaling: 100%, Overstep (norm0 = 36.56, norm1 = 2.882, norm01 = 38.69)

## iinla: Step rescaling: 105.6%, Approx Optimisation (norm0 = 38.5, norm1 = 2.125, norm01 = 38.69)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 114% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 41.91, norm1 = 14.56, norm01 = 27.66)

## iinla: Step rescaling: 100%, Overstep (norm0 = 26.56, norm1 = 1.821, norm01 = 27.66)

## iinla: Step rescaling: 103.8%, Approx Optimisation (norm0 = 27.53, norm1 = 1.536, norm01 = 27.66)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 90.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 31.23, norm1 = 11.3, norm01 = 20.11)
```

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 19.6, norm1 = 1.107, norm01 = 20.11)

## iinla: Step rescaling: 102.3%, Approx Optimisation (norm0 = 20.03, norm1 = 1.016, norm01 = 20.11)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 65.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 23.69, norm1 = 8.826, norm01 = 14.96)

## iinla: Step rescaling: 100%, Overstep (norm0 = 14.75, norm1 = 0.6529, norm01 = 14.96)

## iinla: Step rescaling: 101.1%, Approx Optimisation (norm0 = 14.92, norm1 = 0.6323, norm01 = 14.96)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 50.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 18.3, norm1 = 6.945, norm01 = 11.4)

## iinla: Step rescaling: 100%, Overstep (norm0 = 11.34, norm1 = 0.3797, norm01 = 11.4)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 11.38, norm1 = 0.3776, norm01 = 11.4)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 38.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 14.37, norm1 = 5.51, norm01 = 8.881)

## iinla: Step rescaling: 100%, Overstep (norm0 = 8.88, norm1 = 0.2196, norm01 = 8.881)

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 8.873, norm1 = 0.2195, norm01 = 8.881)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 29.5% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.71%, Approx Optimisation (norm0 = 7.04, norm1 = 0.1253, norm01 = 7.044)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 22.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.64%, Approx Optimisation (norm0 = 5.665, norm1 = 0.07083, norm01 = 5.666)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 16.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.64%, Approx Optimisation (norm0 = 4.61, norm1 = 0.03982, norm01 = 4.611)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 12.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.68%, Approx Optimisation (norm0 = 3.786, norm1 = 0.02237, norm01 = 3.786)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.73%, Approx Optimisation (norm0 = 3.133, norm1 = 0.0126, norm01 = 3.133)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.76% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.78%, Approx Optimisation (norm0 = 2.607, norm1 = 0.007143, norm01 = 2.607)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.28% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.82%, Approx Optimisation (norm0 = 2.18, norm1 = 0.004085, norm01 = 2.18)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.06% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.86%, Approx Optimisation (norm0 = 1.83, norm1 = 0.002363, norm01 = 1.83)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.05% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 1.541, norm1 = 0.001385, norm01 = 1.541)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.22% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 21 [max:70]
```

```
## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 1.3, norm1 = 0.0008245, norm01 = 1.3)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.53% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 22 [max:70]

## Start creating grid...
## Finished creating grid, time  0.8506639

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 245.7, norm1 = 337.6, norm01 = 335.7)

## iinla: Step rescaling: 34.78%, Approx Optimisation (norm0 = 106.1, norm1 = 258.9, norm01 = 335.7)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 409.6, norm1 = 169.4, norm01 = 294.7)

## iinla: Step rescaling: 100%, Overstep (norm0 = 264.5, norm1 = 67.37, norm01 = 294.7)

## iinla: Step rescaling: 102.3%, Approx Optimisation (norm0 = 270, norm1 = 67.05, norm01 = 294.7)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 351% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 221, norm1 = 69.23, norm01 = 153.4)

## iinla: Step rescaling: 100%, Overstep (norm0 = 143, norm1 = 12.77, norm01 = 153.4)

## iinla: Step rescaling: 107.3%, Approx Optimisation (norm0 = 152.7, norm1 = 8.262, norm01 = 153.4)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 265% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 118.7, norm1 = 35.9, norm01 = 84.43)

## iinla: Step rescaling: 100%, Overstep (norm0 = 77.38, norm1 = 8.761, norm01 = 84.43)

## iinla: Step rescaling: 109%, Approx Optimisation (norm0 = 83.72, norm1 = 5.967, norm01 = 84.43)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 178% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 80.22, norm1 = 26.15, norm01 = 54.48)

## iinla: Step rescaling: 100%, Overstep (norm0 = 51.39, norm1 = 3.813, norm01 = 54.48)

## iinla: Step rescaling: 106%, Approx Optimisation (norm0 = 54.3, norm1 = 2.449, norm01 = 54.48)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 115% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 56.55, norm1 = 19.47, norm01 = 37.33)
```

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 35.85, norm1 = 2.118, norm01 = 37.33)

## iinla: Step rescaling: 104%, Approx Optimisation (norm0 = 37.22, norm1 = 1.607, norm01 = 37.33)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 87.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 42.69, norm1 = 15.27, norm01 = 27.6)

## iinla: Step rescaling: 100%, Overstep (norm0 = 26.84, norm1 = 1.349, norm01 = 27.6)

## iinla: Step rescaling: 102.6%, Approx Optimisation (norm0 = 27.52, norm1 = 1.163, norm01 = 27.6)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 75.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 33.14, norm1 = 12.17, norm01 = 21.08)

## iinla: Step rescaling: 100%, Overstep (norm0 = 20.71, norm1 = 0.872, norm01 = 21.08)

## iinla: Step rescaling: 101.6%, Approx Optimisation (norm0 = 21.03, norm1 = 0.8087, norm01 = 21.08)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 59.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 26.16, norm1 = 9.787, norm01 = 16.43)

## iinla: Step rescaling: 100%, Overstep (norm0 = 16.26, norm1 = 0.5541, norm01 = 16.43)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 16.41, norm1 = 0.5357, norm01 = 16.43)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 45.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 20.92, norm1 = 7.922, norm01 = 13.03)

## iinla: Step rescaling: 100%, Overstep (norm0 = 12.96, norm1 = 0.3468, norm01 = 13.03)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 13.01, norm1 = 0.3432, norm01 = 13.03)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 34.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 16.92, norm1 = 6.456, norm01 = 10.48)

## iinla: Step rescaling: 100%, Overstep (norm0 = 10.46, norm1 = 0.2152, norm01 = 10.48)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 10.47, norm1 = 0.2151, norm01 = 10.48)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 26.9% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.9%, Approx Optimisation (norm0 = 8.531, norm1 = 0.1328, norm01 = 8.534)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 20.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.81%, Approx Optimisation (norm0 = 7.025, norm1 = 0.08123, norm01 = 7.027)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 15.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.78%, Approx Optimisation (norm0 = 5.84, norm1 = 0.04942, norm01 = 5.84)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 13.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.78%, Approx Optimisation (norm0 = 4.895, norm1 = 0.03, norm01 = 4.895)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 11.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.8%, Approx Optimisation (norm0 = 4.132, norm1 = 0.01823, norm01 = 4.132)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.82%, Approx Optimisation (norm0 = 3.51, norm1 = 0.01112, norm01 = 3.51)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.42% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.85%, Approx Optimisation (norm0 = 2.997, norm1 = 0.006821, norm01 = 2.997)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.24% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.87%, Approx Optimisation (norm0 = 2.57, norm1 = 0.004218, norm01 = 2.57)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.23% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 2.212, norm1 = 0.002634, norm01 = 2.212)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.37% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 1.909, norm1 = 0.001664, norm01 = 1.909)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.63% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 22 [max:70]

## Start creating grid...
## Finished creating grid, time  1.441358

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications
```

```
## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 38.87%, Approx Optimisation (norm0 = 344, norm1 = 870.5, norm01 = 1148)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1238, norm1 = 353.1, norm01 = 907.8)

## iinla: Step rescaling: 100%, Overstep (norm0 = 814.3, norm1 = 112.9, norm01 = 907.8)

## iinla: Step rescaling: 111.5%, Approx Optimisation (norm0 = 897.3, norm1 = 74.92, norm01 = 907.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 741% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 268.7, norm1 = 85.75, norm01 = 185.2)

## iinla: Step rescaling: 100%, Overstep (norm0 = 173.3, norm1 = 15.32, norm01 = 185.2)

## iinla: Step rescaling: 106.8%, Approx Optimisation (norm0 = 184.2, norm1 = 10.66, norm01 = 185.2)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 497% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 165.9, norm1 = 58.02, norm01 = 113.9)

## iinla: Step rescaling: 100%, Overstep (norm0 = 106.4, norm1 = 14.52, norm01 = 113.9)
```

```
## iinla: Step rescaling: 104.9%, Approx Optimisation (norm0 = 111.2, norm1 = 13.62, norm01 = 113.9)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 216% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 131.7, norm1 = 48.74, norm01 = 85.19)

## iinla: Step rescaling: 100%, Overstep (norm0 = 82.64, norm1 = 7.54, norm01 = 85.19)

## iinla: Step rescaling: 101.9%, Approx Optimisation (norm0 = 84.2, norm1 = 7.369, norm01 = 85.19)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 130% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 115.3, norm1 = 44.14, norm01 = 72.11)

## iinla: Step rescaling: 100%, Overstep (norm0 = 71.51, norm1 = 4.417, norm01 = 72.11)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 71.7, norm1 = 4.413, norm01 = 72.11)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 107% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 99.43%, Approx Optimisation (norm0 = 65.03, norm1 = 3.087, norm01 = 65.24)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 107% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]
```

```
## iinla: Step rescaling: 99.01%, Approx Optimisation (norm0 = 59.48, norm1 = 2.311, norm01 = 59.62)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 97.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 98.84%, Approx Optimisation (norm0 = 54.25, norm1 = 1.735, norm01 = 54.33)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 89.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 98.81%, Approx Optimisation (norm0 = 49.41, norm1 = 1.288, norm01 = 49.46)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 85.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 98.85%, Approx Optimisation (norm0 = 45.01, norm1 = 0.9482, norm01 = 45.04)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 79.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 98.93%, Approx Optimisation (norm0 = 41, norm1 = 0.6965, norm01 = 41.02)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 73.6% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.03%, Approx Optimisation (norm0 = 37.33, norm1 = 0.512, norm01 = 37.34)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 67.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.13%, Approx Optimisation (norm0 = 33.97, norm1 = 0.3773, norm01 = 33.97)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 61.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.22%, Approx Optimisation (norm0 = 30.88, norm1 = 0.279, norm01 = 30.89)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 56.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.31%, Approx Optimisation (norm0 = 28.06, norm1 = 0.2072, norm01 = 28.06)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 50.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.39%, Approx Optimisation (norm0 = 25.48, norm1 = 0.1545, norm01 = 25.48)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 46.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.46%, Approx Optimisation (norm0 = 23.12, norm1 = 0.1157, norm01 = 23.12)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 41.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.53%, Approx Optimisation (norm0 = 20.98, norm1 = 0.08712, norm01 = 20.98)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 37.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 99.58%, Approx Optimisation (norm0 = 19.02, norm1 = 0.06589, norm01 = 19.02)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 34.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 99.63%, Approx Optimisation (norm0 = 17.25, norm1 = 0.05007, norm01 = 17.25)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 30.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 99.67%, Approx Optimisation (norm0 = 15.63, norm1 = 0.03823, norm01 = 15.63)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 27.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 23 [max:70]

## iinla: Step rescaling: 99.71%, Approx Optimisation (norm0 = 14.17, norm1 = 0.02934, norm01 = 14.17)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 25.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 24 [max:70]

## iinla: Step rescaling: 99.74%, Approx Optimisation (norm0 = 12.84, norm1 = 0.02262, norm01 = 12.84)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 22.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 25 [max:70]

## iinla: Step rescaling: 99.77%, Approx Optimisation (norm0 = 11.63, norm1 = 0.01752, norm01 = 11.63)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 20.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 26 [max:70]

## iinla: Step rescaling: 99.8%, Approx Optimisation (norm0 = 10.54, norm1 = 0.01363, norm01 = 10.54)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 27 [max:70]

## iinla: Step rescaling: 99.82%, Approx Optimisation (norm0 = 9.547, norm1 = 0.01064, norm01 = 9.547)
```

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 16.8% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 28 [max:70]

iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 8.647, norm1 = 0.00835, norm01 = 8.647)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 15.2% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 29 [max:70]

iinla: Step rescaling: 99.86%, Approx Optimisation (norm0 = 7.832, norm1 = 0.006576, norm01 = 7.832)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 13.8% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 30 [max:70]

iinla: Step rescaling: 99.87%, Approx Optimisation (norm0 = 7.093, norm1 = 0.005197, norm01 = 7.093)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 12.4% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 31 [max:70]

iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 6.423, norm1 = 0.004122, norm01 = 6.423)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 11.3% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 32 [max:70]

```
## iinla: Step rescaling: 99.9%, Approx Optimisation (norm0 = 5.817, norm1 = 0.003279, norm01 = 5.817)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 33 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 5.267, norm1 = 0.002617, norm01 = 5.267)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.2% of SD, and line search is inactive [stop if: <10% and line s

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 34 [max:70]

## Start creating grid...
## Finished creating grid, time  0.7158651

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 310.5, norm1 = 502.7, norm01 = 461.1)

## iinla: Step rescaling: 30.84%, Approx Optimisation (norm0 = 115.5, norm1 = 372.6, norm01 = 461.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 569, norm1 = 171.2, norm01 = 433.5)

## iinla: Step rescaling: 100%, Overstep (norm0 = 376.5, norm1 = 78.87, norm01 = 433.5)

## iinla: Step rescaling: 111.9%, Approx Optimisation (norm0 = 415.2, norm1 = 66.48, norm01 = 433.5)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 573% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 285.7, norm1 = 87.43, norm01 = 199.1)

## iinla: Step rescaling: 100%, Overstep (norm0 = 185, norm1 = 15.34, norm01 = 199.1)

## iinla: Step rescaling: 108.1%, Approx Optimisation (norm0 = 198.7, norm1 = 6.66, norm01 = 199.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 425% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 122.5, norm1 = 37.03, norm01 = 86.81)

## iinla: Step rescaling: 100%, Overstep (norm0 = 79.73, norm1 = 8.535, norm01 = 86.81)

## iinla: Step rescaling: 109%, Approx Optimisation (norm0 = 86.24, norm1 = 5.463, norm01 = 86.81)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 221% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 77.35, norm1 = 26.25, norm01 = 51.64)

## iinla: Step rescaling: 100%, Overstep (norm0 = 49.24, norm1 = 3.485, norm01 = 51.64)

## iinla: Step rescaling: 104.6%, Approx Optimisation (norm0 = 51.41, norm1 = 2.721, norm01 = 51.64)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 133% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 57.57, norm1 = 21.26, norm01 = 36.68)

## iinla: Step rescaling: 100%, Overstep (norm0 = 35.99, norm1 = 2.021, norm01 = 36.68)

## iinla: Step rescaling: 101.5%, Approx Optimisation (norm0 = 36.52, norm1 = 1.948, norm01 = 36.68)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 100% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 44.79, norm1 = 17.19, norm01 = 27.78)

## iinla: Step rescaling: 100%, Overstep (norm0 = 27.71, norm1 = 1.209, norm01 = 27.78)

## iinla: Step rescaling: 99.98%, Approx Optimisation (norm0 = 27.7, norm1 = 1.209, norm01 = 27.78)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 66.3% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 99.06%, Approx Optimisation (norm0 = 21.89, norm1 = 0.6964, norm01 = 21.92)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 53.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 98.69%, Approx Optimisation (norm0 = 18.11, norm1 = 0.3946, norm01 = 18.12)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 48.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 98.72%, Approx Optimisation (norm0 = 15.34, norm1 = 0.2237, norm01 = 15.35)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 42.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 98.91%, Approx Optimisation (norm0 = 13.08, norm1 = 0.1281, norm01 = 13.08)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 36.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.11%, Approx Optimisation (norm0 = 11.15, norm1 = 0.07486, norm01 = 11.15)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 31% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.29%, Approx Optimisation (norm0 = 9.481, norm1 = 0.04489, norm01 = 9.481)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 26.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]
```

iinla: Step rescaling: 99.43%, Approx Optimisation (norm0 = 8.038, norm1 = 0.02767, norm01 = 8.039)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 22.3% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 15 [max:70]

iinla: Step rescaling: 99.54%, Approx Optimisation (norm0 = 6.8, norm1 = 0.0175, norm01 = 6.8)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 18.8% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 16 [max:70]

iinla: Step rescaling: 99.63%, Approx Optimisation (norm0 = 5.741, norm1 = 0.01133, norm01 = 5.741)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 15.9% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 17 [max:70]

iinla: Step rescaling: 99.7%, Approx Optimisation (norm0 = 4.841, norm1 = 0.007475, norm01 = 4.841)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 13.3% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 18 [max:70]

iinla: Step rescaling: 99.75%, Approx Optimisation (norm0 = 4.078, norm1 = 0.005009, norm01 = 4.078)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 11.2% of SD, and line search is active [stop if: <10% and line s

```
## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.79%, Approx Optimisation (norm0 = 3.433, norm1 = 0.003397, norm01 = 3.433)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.42% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 2.888, norm1 = 0.002326, norm01 = 2.888)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.92% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 99.86%, Approx Optimisation (norm0 = 2.429, norm1 = 0.001605, norm01 = 2.429)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.65% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 2.043, norm1 = 0.001113, norm01 = 2.043)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.58% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 23 [max:70]

## iinla: Step rescaling: 99.9%, Approx Optimisation (norm0 = 1.718, norm1 = 0.000776, norm01 = 1.718)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 4.69% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 24 [max:70]

## Start creating grid...
## Finished creating grid, time  1.984976

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 84.69%, Approx Optimisation (norm0 = 5.755e+09, norm1 = 126800000, norm01 = 5

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 4802, norm1 = 666.4, norm01 = 4192)

## iinla: Step rescaling: 56.16%, Approx Optimisation (norm0 = 4093, norm1 = 276.5, norm01 = 4192)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3790% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 89.47%, Approx Optimisation (norm0 = 635.2, norm1 = 42, norm01 = 639.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 1840% of SD, and line search is active [stop if: <10% and line se
## iinla: Iteration 4 [max:70]
## iinla: Step rescaling: 98.72%, Approx Optimisation (norm0 = 47.46, norm1 = 3.809, norm01 = 47.91)
## iinla: Evaluate component linearisations
## iinla: Evaluate predictor linearisation
## iinla: Max deviation from previous: 149% of SD, and line search is active [stop if: <10% and line se
## iinla: Iteration 5 [max:70]
## iinla: Step rescaling: 98.54%, Approx Optimisation (norm0 = 38.56, norm1 = 0.2006, norm01 = 38.56)
## iinla: Evaluate component linearisations
## iinla: Evaluate predictor linearisation
## iinla: Max deviation from previous: 77.8% of SD, and line search is active [stop if: <10% and line se
## iinla: Iteration 6 [max:70]
## iinla: Step rescaling: 99.08%, Approx Optimisation (norm0 = 37.3, norm1 = 0.09165, norm01 = 37.3)
## iinla: Evaluate component linearisations
## iinla: Evaluate predictor linearisation
## iinla: Max deviation from previous: 64.5% of SD, and line search is active [stop if: <10% and line se
## iinla: Iteration 7 [max:70]
## iinla: Step rescaling: 99.35%, Approx Optimisation (norm0 = 33.8, norm1 = 0.05288, norm01 = 33.8)
## iinla: Evaluate component linearisations
## iinla: Evaluate predictor linearisation
## iinla: Max deviation from previous: 58.6% of SD, and line search is active [stop if: <10% and line se
## iinla: Iteration 8 [max:70]
## iinla: Step rescaling: 99.48%, Approx Optimisation (norm0 = 30.4, norm1 = 0.0369, norm01 = 30.4)
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 53.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 99.55%, Approx Optimisation (norm0 = 27.22, norm1 = 0.02821, norm01 = 27.22)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 47.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 99.6%, Approx Optimisation (norm0 = 24.3, norm1 = 0.02231, norm01 = 24.3)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 43% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 99.64%, Approx Optimisation (norm0 = 21.64, norm1 = 0.01782, norm01 = 21.64)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 38.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.68%, Approx Optimisation (norm0 = 19.24, norm1 = 0.01423, norm01 = 19.24)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 34.3% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.71%, Approx Optimisation (norm0 = 17.08, norm1 = 0.01133, norm01 = 17.08)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 30.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.74%, Approx Optimisation (norm0 = 15.13, norm1 = 0.008972, norm01 = 15.13)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 26.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.77%, Approx Optimisation (norm0 = 13.39, norm1 = 0.007066, norm01 = 13.39)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 23.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.8%, Approx Optimisation (norm0 = 11.83, norm1 = 0.005536, norm01 = 11.83)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 20.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.82%, Approx Optimisation (norm0 = 10.45, norm1 = 0.004317, norm01 = 10.45)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]
```

```
## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 9.211, norm1 = 0.003351, norm01 = 9.211)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 16.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.86%, Approx Optimisation (norm0 = 8.116, norm1 = 0.002592, norm01 = 8.116)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 7.146, norm1 = 0.001998, norm01 = 7.146)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 12.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 6.288, norm1 = 0.001537, norm01 = 6.288)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 5.53, norm1 = 0.001179, norm01 = 5.53)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.43% of SD, and line search is inactive [stop if: <10% and line
```

```
## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 23 [max:70]

## Start creating grid...
## Finished creating grid, time  2.27924

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 38.2%, Approx Optimisation (norm0 = 508.2, norm1 = 1371, norm01 = 1791)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1830, norm1 = 444.1, norm01 = 1413)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1233, norm1 = 195.3, norm01 = 1413)

## iinla: Step rescaling: 116.4%, Approx Optimisation (norm0 = 1402, norm1 = 94.53, norm01 = 1413)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1100% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 349.9, norm1 = 115.1, norm01 = 235.6)

## iinla: Step rescaling: 100%, Overstep (norm0 = 223.5, norm1 = 13.77, norm01 = 235.6)

## iinla: Step rescaling: 105.6%, Approx Optimisation (norm0 = 235.2, norm1 = 7.167, norm01 = 235.6)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 664% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 201.6, norm1 = 67.96, norm01 = 138.6)

## iinla: Step rescaling: 100%, Overstep (norm0 = 129.5, norm1 = 15.37, norm01 = 138.6)

## iinla: Step rescaling: 105.8%, Approx Optimisation (norm0 = 136.5, norm1 = 13.62, norm01 = 138.6)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 271% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 155.1, norm1 = 58.24, norm01 = 99.75)

## iinla: Step rescaling: 100%, Overstep (norm0 = 97.09, norm1 = 9.177, norm01 = 99.75)

## iinla: Step rescaling: 101.5%, Approx Optimisation (norm0 = 98.48, norm1 = 9.066, norm01 = 99.75)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 150% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 98.96%, Approx Optimisation (norm0 = 79.78, norm1 = 5.633, norm01 = 80.37)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 125% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 97.94%, Approx Optimisation (norm0 = 69.02, norm1 = 3.474, norm01 = 69.27)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 123% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 97.65%, Approx Optimisation (norm0 = 61.49, norm1 = 2.164, norm01 = 61.6)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 117% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 97.73%, Approx Optimisation (norm0 = 55.56, norm1 = 1.378, norm01 = 55.6)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 109% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 97.96%, Approx Optimisation (norm0 = 50.45, norm1 = 0.9008, norm01 = 50.47)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 99.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 98.23%, Approx Optimisation (norm0 = 45.81, norm1 = 0.6035, norm01 = 45.82)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 90% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 12 [max:70]
```

```
## iinla: Step rescaling: 98.5%, Approx Optimisation (norm0 = 41.51, norm1 = 0.4138, norm01 = 41.52)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 80.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 98.73%, Approx Optimisation (norm0 = 37.52, norm1 = 0.2901, norm01 = 37.52)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 72.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 98.92%, Approx Optimisation (norm0 = 33.84, norm1 = 0.2076, norm01 = 33.84)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 64.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.07%, Approx Optimisation (norm0 = 30.47, norm1 = 0.1514, norm01 = 30.47)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 57.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.2%, Approx Optimisation (norm0 = 27.41, norm1 = 0.1122, norm01 = 27.41)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 51.7% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.31%, Approx Optimisation (norm0 = 24.64, norm1 = 0.0843, norm01 = 24.64)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 46.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.4%, Approx Optimisation (norm0 = 22.14, norm1 = 0.06407, norm01 = 22.14)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 41.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.48%, Approx Optimisation (norm0 = 19.89, norm1 = 0.04916, norm01 = 19.89)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 36.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 99.54%, Approx Optimisation (norm0 = 17.87, norm1 = 0.03802, norm01 = 17.87)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 32.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 99.59%, Approx Optimisation (norm0 = 16.06, norm1 = 0.0296, norm01 = 16.06)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 29.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 99.64%, Approx Optimisation (norm0 = 14.43, norm1 = 0.02317, norm01 = 14.43)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 26.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 23 [max:70]

## iinla: Step rescaling: 99.68%, Approx Optimisation (norm0 = 12.97, norm1 = 0.01822, norm01 = 12.97)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 23.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 24 [max:70]

## iinla: Step rescaling: 99.72%, Approx Optimisation (norm0 = 11.66, norm1 = 0.01438, norm01 = 11.66)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 21.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 25 [max:70]

## iinla: Step rescaling: 99.75%, Approx Optimisation (norm0 = 10.49, norm1 = 0.01139, norm01 = 10.49)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 19% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 26 [max:70]

## iinla: Step rescaling: 99.78%, Approx Optimisation (norm0 = 9.433, norm1 = 0.009051, norm01 = 9.433)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 17% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 27 [max:70]

## iinla: Step rescaling: 99.8%, Approx Optimisation (norm0 = 8.486, norm1 = 0.007209, norm01 = 8.486)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 15.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 28 [max:70]

## iinla: Step rescaling: 99.82%, Approx Optimisation (norm0 = 7.636, norm1 = 0.005755, norm01 = 7.636)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 13.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 29 [max:70]

## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 6.873, norm1 = 0.004604, norm01 = 6.873)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 12.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 30 [max:70]

## iinla: Step rescaling: 99.86%, Approx Optimisation (norm0 = 6.187, norm1 = 0.00369, norm01 = 6.186)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 11.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 31 [max:70]

## iinla: Step rescaling: 99.87%, Approx Optimisation (norm0 = 5.57, norm1 = 0.002962, norm01 = 5.57)
```

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 9.98% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 32 [max:70]

iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 5.015, norm1 = 0.002381, norm01 = 5.015)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 8.98% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 33 [max:70]

iinla: Step rescaling: 99.9%, Approx Optimisation (norm0 = 4.517, norm1 = 0.001917, norm01 = 4.517)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 8.08% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 34 [max:70]

iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 4.068, norm1 = 0.001545, norm01 = 4.068)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 7.27% of SD, and line search is inactive [stop if: <10% and line
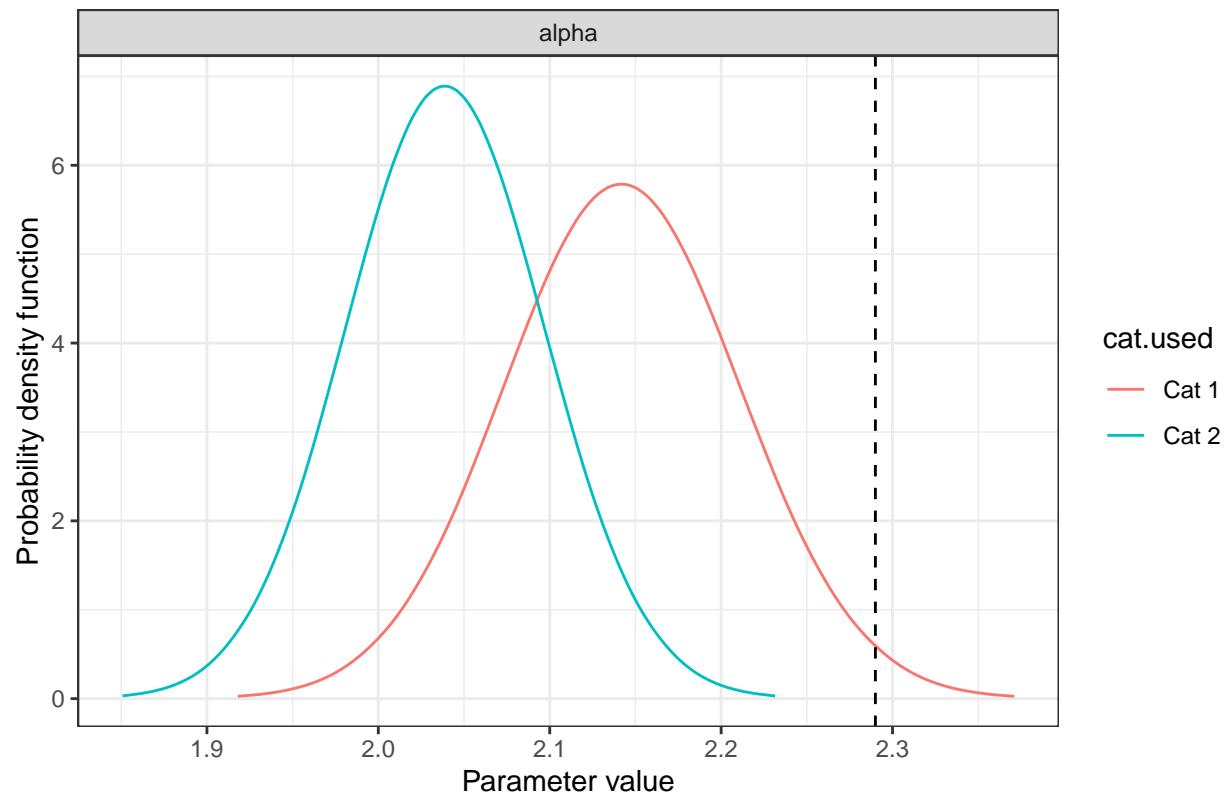
iinla: Convergence criterion met, running final INLA integration with known theta mode.

iinla: Iteration 35 [max:70]
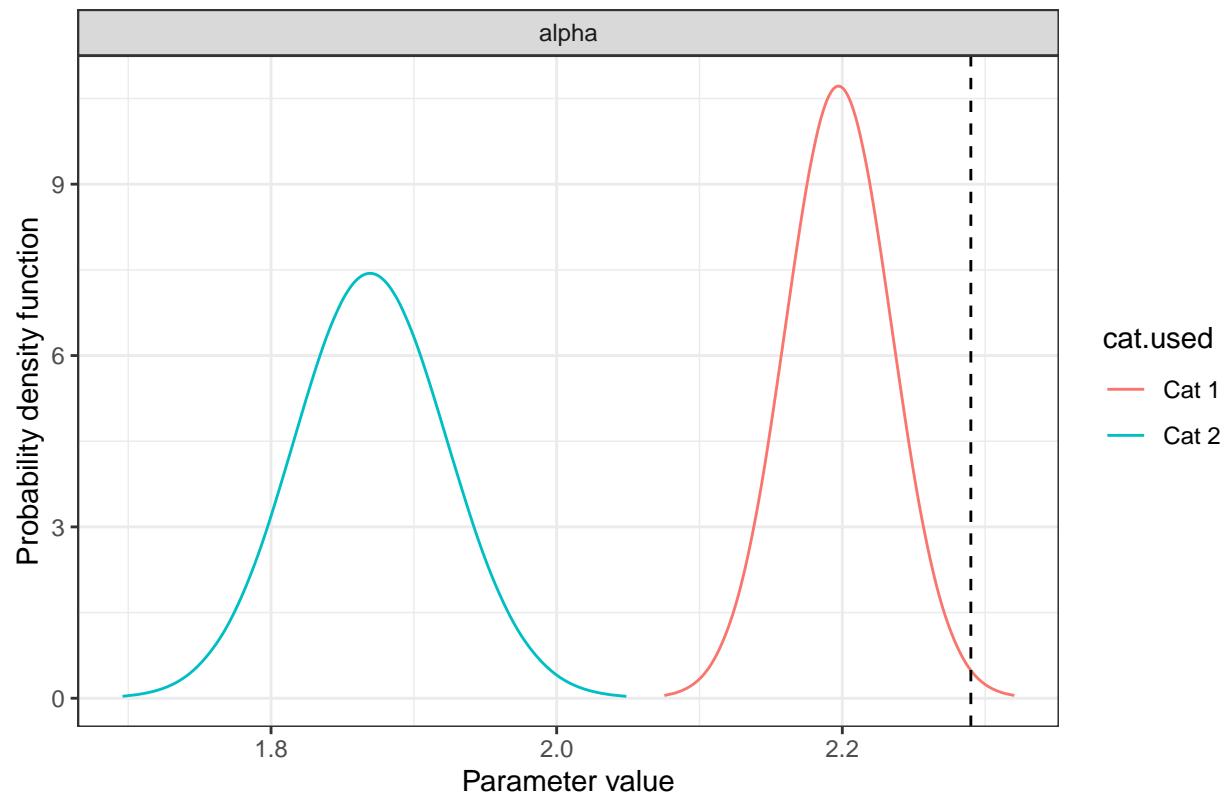
```r
# view results
lapply(all_plots, print)
```
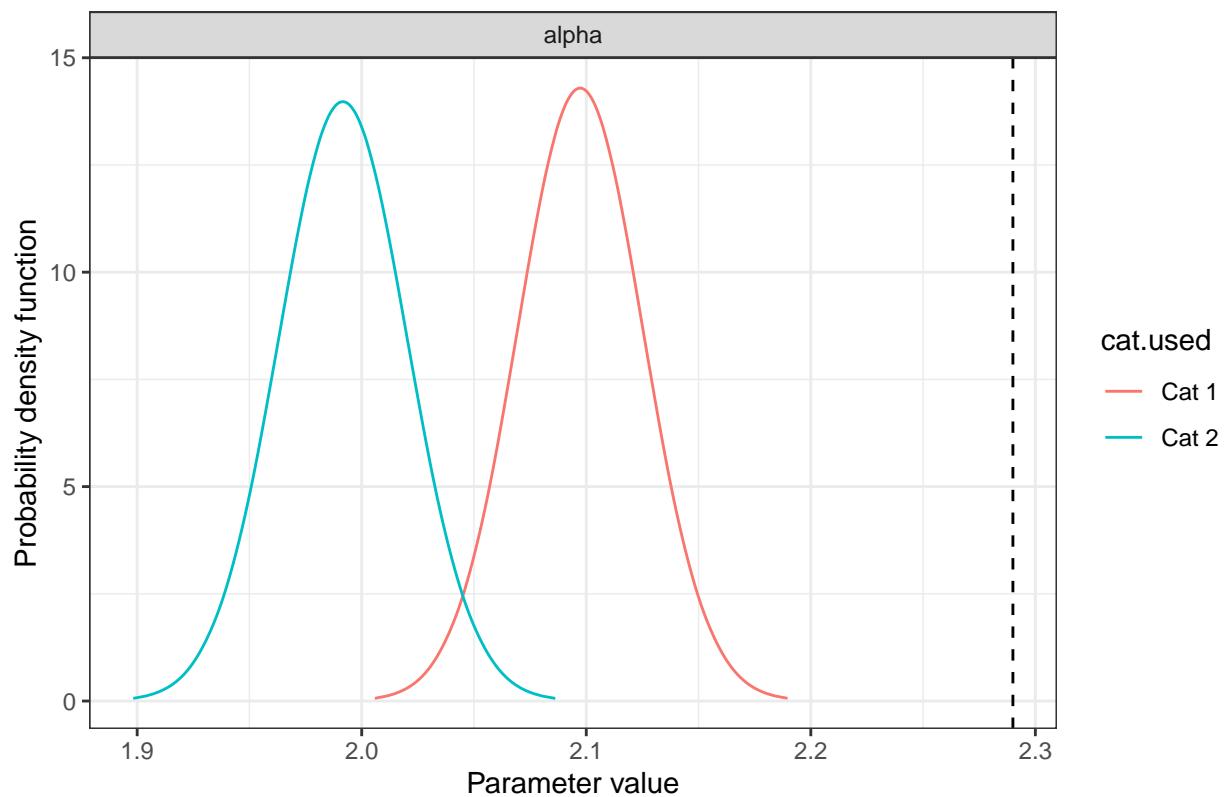
Posterior Distribution of Alpha for 5_to_5.5

Posterior Distribution of Alpha for 5.5_to_6
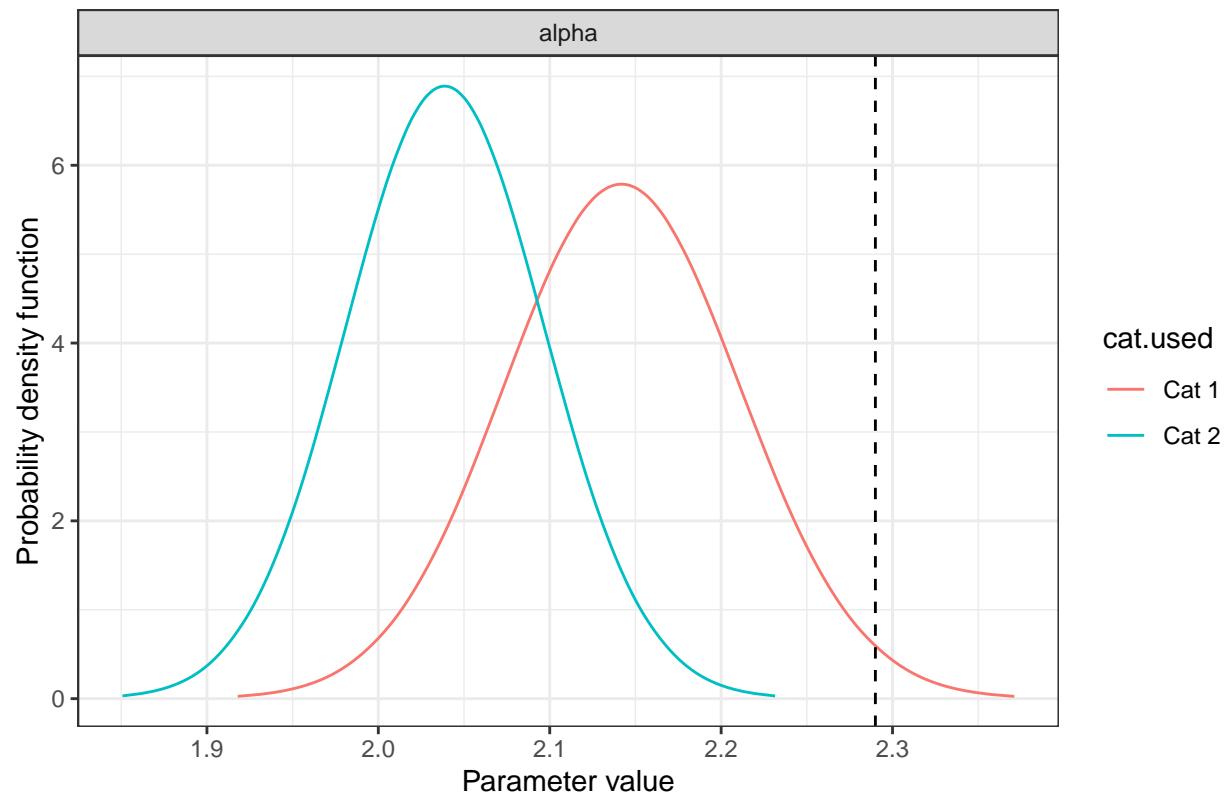
Posterior Distribution of Alpha for 6_plus
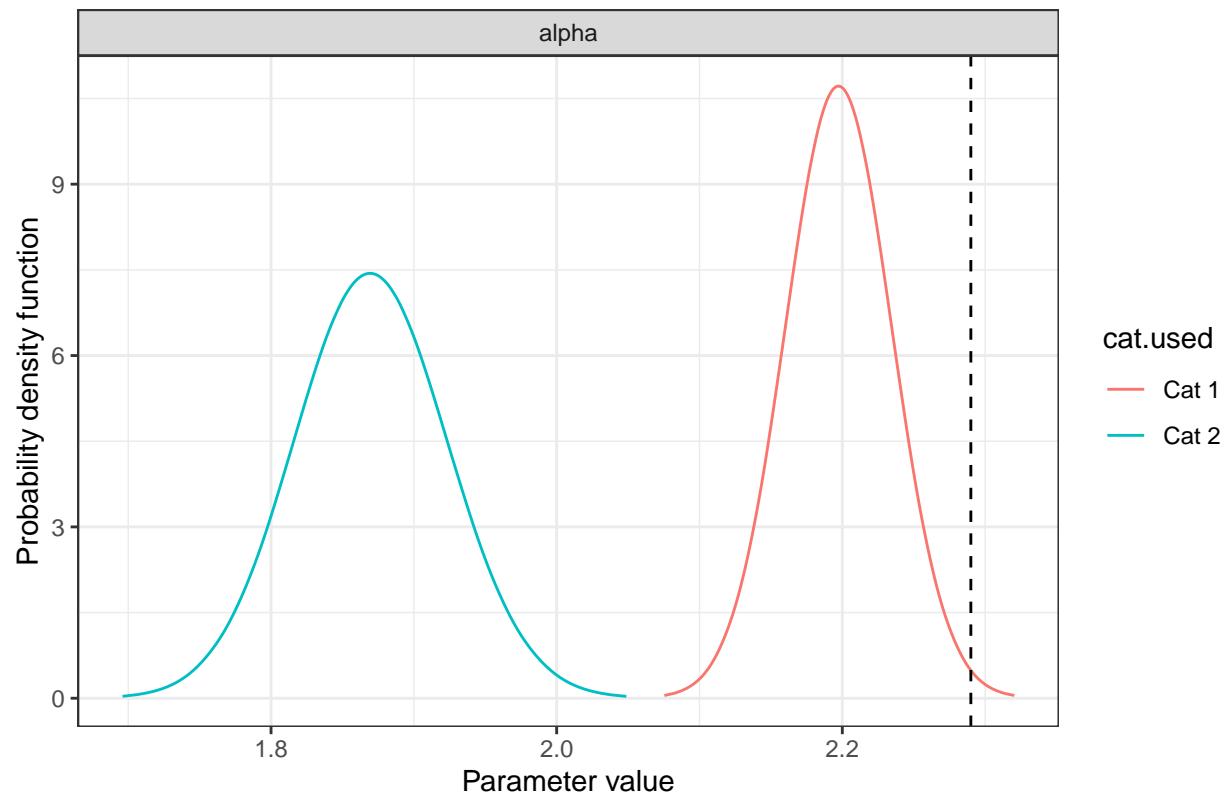

```
## [[1]]
```

Posterior Distribution of Alpha for 5_to_5.5
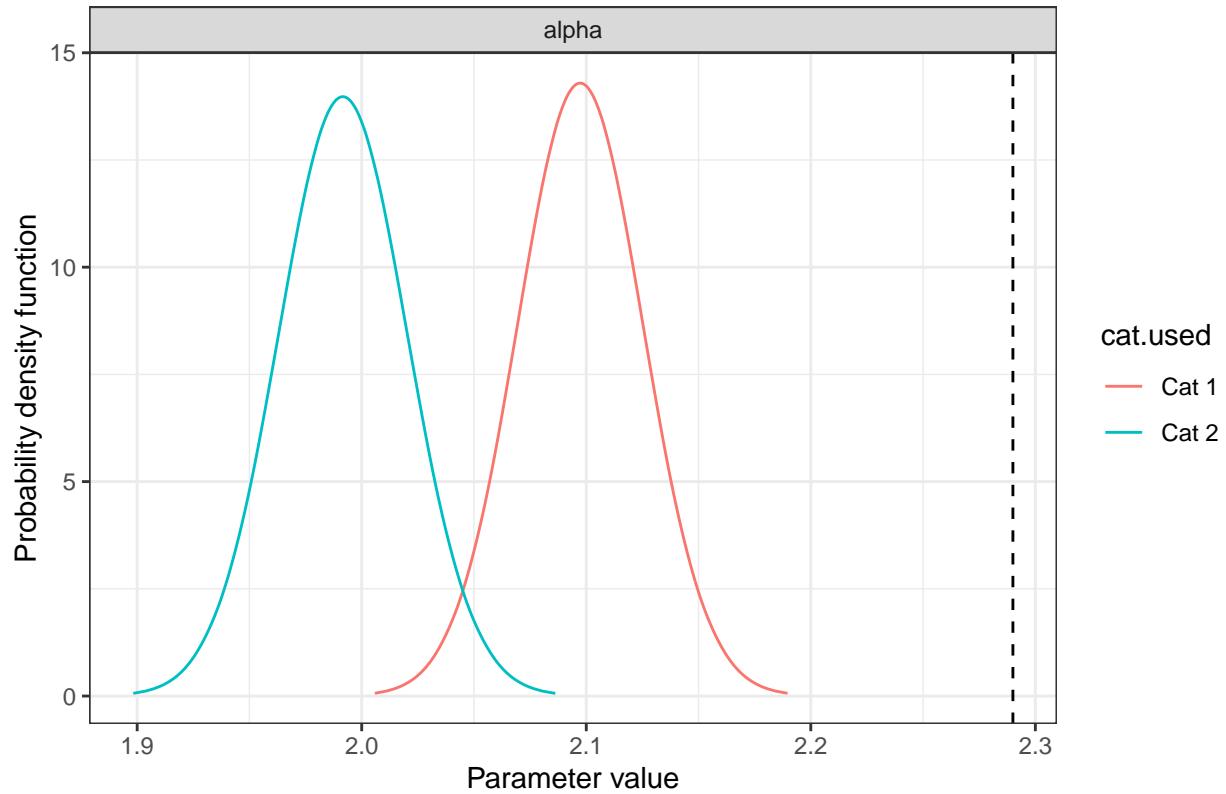

```
##
## [[2]]
```

Posterior Distribution of Alpha for 5.5_to_6


```
##
## [[3]]
```

Posterior Distribution of Alpha for 6_plus

#Classified by the number of highest magnitudes,

#Then, among the same number of high magnitude earthquakes,

#sort them by the value of the highest magnitude,

#Then fit the model and compare the posterior distribution.

```
set.seed(1)
# Initialize new group for n_major_events == 0, 3, and 5
new_group <- list(
  "0 high magnitude events" = list(),
  "3 high magnitude events" = list(),
  "5 high magnitude events" = list()
)

# Generate each catalogue in a loop for new_group
for (i in 1:n_catalogues) {
  # Generate temporal catalogue
  synth_catalogue <- generate_temporal_ETAS_synthetic(
    theta = true.param, beta = beta.p, M0 = M0, T1 = T1, T2 = T2, Ht = NULL
  )

  # Bind catalogues
  ETAS.cat <- bind_rows(synth_catalogue) %>%
    arrange(ts)

  # Calculate the number of earthquakes greater than the threshold
```

```r
  n_major_events <- sum(ETAS.cat$magnitudes >= M_threshold)

  # Add to new group for 0, 1, 3, and 5 high magnitude events
  if (n_major_events == 0 &&
      length(new_group[["0 high magnitude events"]]) < 3) {
    new_group[["0 high magnitude events"]] <-
      c(new_group[["0 high magnitude events"]],
                                  list(ETAS.cat))
  } else if (n_major_events == 3 &&
             length(new_group[["3 high magnitude events"]]) < 3) {
    new_group[["3 high magnitude events"]] <-
      c(new_group[["3 high magnitude events"]],
                                  list(ETAS.cat))
  } else if (n_major_events == 5 &&
             length(new_group[["5 high magnitude events"]]) < 3) {
    new_group[["5 high magnitude events"]] <-
      c(new_group[["5 high magnitude events"]],
                                  list(ETAS.cat))
  }

  if (length(new_group[["0 high magnitude events"]]) >= 3 &&
      length(new_group[["3 high magnitude events"]]) >= 3 &&
      length(new_group[["5 high magnitude events"]]) >= 3) {
    break
  }
}

# Check the length of each group
sapply(new_group, length)
```

```
## 0 high magnitude events 3 high magnitude events 5 high magnitude events
##                       3                       3                       3
```

#Plot alpha

```r
library(dplyr)
library(ggplot2)
library(gridExtra)

set.seed(1)  # Ensure reproducibility

# Function to process catalogs based on high magnitude event threshold
process_catalogs <- function(event_threshold, event_label) {
  # Filter catalogs
  filtered_catalogs <-
    Filter(function(cat) sum(cat$magnitudes >= M_threshold) == event_threshold,
                          new_group[[event_label]])

  # Randomly select three catalogs
  sampled_catalogs <- sample(filtered_catalogs, 3)

  # Determine the maximum magnitude for each catalog
  catalogs_with_max_mag <- lapply(sampled_catalogs, function(cat) {
```

```r
    data.frame(catalog = I(list(cat)), max_mag = max(cat$magnitudes))
  })

  # Convert the list to a data frame and sort by max_mag
  sorted_catalogs <- do.call(rbind, catalogs_with_max_mag) %>%
    arrange(max_mag) %>%
    `$`('catalog')

  # Define labels based on sorted order
  labels <- c("Lowest Max Mag", "Middle Max Mag", "Highest Max Mag")

  # Model fitting and posterior extraction
  post_df_list <- lapply(seq_along(sorted_catalogs), function(i) {
    cat_data <- sorted_catalogs[[i]]
    synth.fit <- Temporal.ETAS(
      total.data = cat_data,
      M0 = M0,
      T1 = T1,
      T2 = T2,
      link.functions = link.f,
      coef.t = 1,
      delta.t = 0.1,
      N.max = 5,
      bru.opt = bru.opt.list
    )

    post_list <-
      get_posterior_param(list(model.fit = synth.fit, link.functions = link.f))
    post_list$post.df$cat.used <- labels[i]
    post_list$post.df
  })

  # Combine all posterior distributions
  bind_post_df <- do.call(rbind, post_df_list)

  # Filter for alpha data and analyze
  alpha_data <- bind_post_df[bind_post_df$param == "alpha", ]

  # Plot using ggplot
  p <- ggplot(alpha_data, aes(x = x, y = y, color = cat.used)) +
    geom_line() +
    facet_wrap(~param, scales = "free") +
    xlab("Parameter value") +
    ylab("Probability density function") +
    geom_vline(data = data.frame(x = true.param$alpha), aes(xintercept = x),
               linetype = 2) +
    ggtitle(paste(" Posterior Distribution for", event_label)) +
    theme_bw()

  return(p)
}

# List of events to process
```

```r
event_list <- list("0 high magnitude events" = 0,
                    "3 high magnitude events" = 3, "5 high magnitude events" = 5)

# Apply the function to each event type and store plots
plot_list <- lapply(names(event_list),
                    function(label) process_catalogs(event_list[[label]],
                                                     label))
```

```
## Start creating grid...
## Finished creating grid, time  0.184005

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 93.14, norm1 = 59.31, norm01 = 42.41)

## iinla: Step rescaling: 38.2%, Contract (norm0 = 39.63, norm1 = 16.57, norm01 = 42.41)

## iinla: Step rescaling: 36.92%, Approx Optimisation (norm0 = 37.38, norm1 = 16.39, norm01 = 42.41)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 81.21%, Approx Optimisation (norm0 = 26.32, norm1 = 6.823, norm01 = 26.64)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 224% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 85.3%, Approx Optimisation (norm0 = 19.74, norm1 = 6.859, norm01 = 22.56)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 87.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 93.45%, Approx Optimisation (norm0 = 13.21, norm1 = 1.6, norm01 = 13.46)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 34.3% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 17.08, norm1 = 5.42, norm01 = 11.67)

## iinla: Step rescaling: 100%, Overstep (norm0 = 10.97, norm1 = 0.7196, norm01 = 11.67)

## iinla: Step rescaling: 106.9%, Approx Optimisation (norm0 = 11.67, norm1 = 0.1638, norm01 = 11.67)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 15.07, norm1 = 4.807, norm01 = 10.27)

## iinla: Step rescaling: 100%, Overstep (norm0 = 9.664, norm1 = 0.6315, norm01 = 10.27)

## iinla: Step rescaling: 106.7%, Approx Optimisation (norm0 = 10.27, norm1 = 0.1896, norm01 = 10.27)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 13, norm1 = 4.221, norm01 = 8.787)
```

iinla: Step rescaling: 100%, Overstep (norm0 = 8.311, norm1 = 0.5004, norm01 = 8.787)

iinla: Step rescaling: 106%, Approx Optimisation (norm0 = 8.783, norm1 = 0.1673, norm01 = 8.787)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 15.7% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 8 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 11.35, norm1 = 3.774, norm01 = 7.588)

iinla: Step rescaling: 100%, Overstep (norm0 = 7.228, norm1 = 0.3797, norm01 = 7.588)

iinla: Step rescaling: 105.2%, Approx Optimisation (norm0 = 7.584, norm1 = 0.1318, norm01 = 7.588)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 12.9% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 9 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 9.991, norm1 = 3.382, norm01 = 6.615)

iinla: Step rescaling: 100%, Overstep (norm0 = 6.338, norm1 = 0.2944, norm01 = 6.615)

iinla: Step rescaling: 104.5%, Approx Optimisation (norm0 = 6.613, norm1 = 0.1066, norm01 = 6.615)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 10.8% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 10 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 8.858, norm1 = 3.042, norm01 = 5.821)

iinla: Step rescaling: 100%, Overstep (norm0 = 5.604, norm1 = 0.2325, norm01 = 5.821)

iinla: Step rescaling: 104%, Approx Optimisation (norm0 = 5.819, norm1 = 0.0884, norm01 = 5.821)

iinla: Evaluate component linearisations

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.18% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 7.906, norm1 = 2.748, norm01 = 5.161)

## iinla: Step rescaling: 100%, Overstep (norm0 = 4.989, norm1 = 0.1865, norm01 = 5.161)

## iinla: Step rescaling: 103.5%, Approx Optimisation (norm0 = 5.16, norm1 = 0.0748, norm01 = 5.161)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.89% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 7.094, norm1 = 2.492, norm01 = 4.606)

## iinla: Step rescaling: 100%, Overstep (norm0 = 4.467, norm1 = 0.1514, norm01 = 4.606)

## iinla: Step rescaling: 103.2%, Approx Optimisation (norm0 = 4.604, norm1 = 0.06409, norm01 = 4.606)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.84% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 6.393, norm1 = 2.266, norm01 = 4.13)

## iinla: Step rescaling: 100%, Overstep (norm0 = 4.018, norm1 = 0.1238, norm01 = 4.13)

## iinla: Step rescaling: 102.8%, Approx Optimisation (norm0 = 4.129, norm1 = 0.05525, norm01 = 4.13)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.98% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 5.78, norm1 = 2.065, norm01 = 3.718)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.627, norm1 = 0.1017, norm01 = 3.718)

## iinla: Step rescaling: 102.5%, Approx Optimisation (norm0 = 3.717, norm1 = 0.04768, norm01 = 3.718)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.26% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 5.236, norm1 = 1.884, norm01 = 3.354)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.28, norm1 = 0.08374, norm01 = 3.354)

## iinla: Step rescaling: 102.3%, Approx Optimisation (norm0 = 3.353, norm1 = 0.04103, norm01 = 3.354)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.64% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 4.748, norm1 = 1.719, norm01 = 3.031)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.971, norm1 = 0.0689, norm01 = 3.031)

## iinla: Step rescaling: 102%, Approx Optimisation (norm0 = 3.03, norm1 = 0.03509, norm01 = 3.031)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.13% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 4.306, norm1 = 1.568, norm01 = 2.739)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.691, norm1 = 0.05655, norm01 = 2.739)

## iinla: Step rescaling: 101.8%, Approx Optimisation (norm0 = 2.739, norm1 = 0.02979, norm01 = 2.739)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.94% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.903, norm1 = 1.429, norm01 = 2.475)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.436, norm1 = 0.04623, norm01 = 2.475)

## iinla: Step rescaling: 101.6%, Approx Optimisation (norm0 = 2.475, norm1 = 0.02506, norm01 = 2.475)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.71% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.534, norm1 = 1.3, norm01 = 2.235)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.204, norm1 = 0.03761, norm01 = 2.235)

## iinla: Step rescaling: 101.4%, Approx Optimisation (norm0 = 2.235, norm1 = 0.02088, norm01 = 2.235)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.47% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.196, norm1 = 1.18, norm01 = 2.016)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.991, norm1 = 0.03044, norm01 = 2.016)

## iinla: Step rescaling: 101.3%, Approx Optimisation (norm0 = 2.016, norm1 = 0.01724, norm01 = 2.016)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.21% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.885, norm1 = 1.07, norm01 = 1.815)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.795, norm1 = 0.0245, norm01 = 1.815)

## iinla: Step rescaling: 101.1%, Approx Optimisation (norm0 = 1.815, norm1 = 0.01411, norm01 = 1.815)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.94% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.6, norm1 = 0.9674, norm01 = 1.633)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.616, norm1 = 0.01962, norm01 = 1.633)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 1.632, norm1 = 0.01144, norm01 = 1.633)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.67% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 23 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.339, norm1 = 0.873, norm01 = 1.466)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.453, norm1 = 0.01564, norm01 = 1.466)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.466, norm1 = 0.009214, norm01 = 1.466)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.41% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 24 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.1, norm1 = 0.7862, norm01 = 1.314)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.304, norm1 = 0.01241, norm01 = 1.314)
```

```
## iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 1.314, norm1 = 0.007368, norm01 = 1.314)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.17% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 25 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.883, norm1 = 0.7066, norm01 = 1.177)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.169, norm1 = 0.009806, norm01 = 1.177)

## iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 1.177, norm1 = 0.005858, norm01 = 1.177)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.93% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 26 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.686, norm1 = 0.634, norm01 = 1.052)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.046, norm1 = 0.007726, norm01 = 1.052)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 1.052, norm1 = 0.004634, norm01 = 1.052)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.72% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 27 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.508, norm1 = 0.568, norm01 = 0.9396)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.9347, norm1 = 0.006071, norm01 = 0.9396)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 0.9396, norm1 = 0.00365, norm01 = 0.9396]

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

iinla: Max deviation from previous: 1.52% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 28 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.346, norm1 = 0.5082, norm01 = 0.8383)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.8345, norm1 = 0.00476, norm01 = 0.8383)

iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 0.8383, norm1 = 0.002865, norm01 = 0.8383

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 1.34% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 29 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.201, norm1 = 0.454, norm01 = 0.7472)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.7443, norm1 = 0.003725, norm01 = 0.7472)

iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 0.7472, norm1 = 0.002243, norm01 = 0.7472

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 1.18% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 30 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.071, norm1 = 0.4052, norm01 = 0.6655)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.6632, norm1 = 0.002912, norm01 = 0.6655)

iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 0.6655, norm1 = 0.001752, norm01 = 0.6655

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 1.04% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 31 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.9537, norm1 = 0.3614, norm01 = 0.5924)

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 0.5906, norm1 = 0.002274, norm01 = 0.5924)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.5924, norm1 = 0.001366, norm01 = 0.5924

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.931% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 32 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.8489, norm1 = 0.3219, norm01 = 0.5269)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.5255, norm1 = 0.001775, norm01 = 0.5269)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.5269, norm1 = 0.001064, norm01 = 0.5269

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.835% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 33 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.7551, norm1 = 0.2866, norm01 = 0.4685)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.4674, norm1 = 0.001384, norm01 = 0.4685)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.4685, norm1 = 0.0008281, norm01 = 0.468

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.748% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 34 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.6714, norm1 = 0.255, norm01 = 0.4163)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.4155, norm1 = 0.00108, norm01 = 0.4163)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.4163, norm1 = 0.0006441, norm01 = 0.416

## iinla: Evaluate component linearisations
```

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.669% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 35 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.5966, norm1 = 0.2268, norm01 = 0.3698)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.3691, norm1 = 0.0008418, norm01 = 0.3698)

iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.3698, norm1 = 0.0005007, norm01 = 0.369

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.598% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 36 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.53, norm1 = 0.2016, norm01 = 0.3284)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.3279, norm1 = 0.0006564, norm01 = 0.3284)

iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.3284, norm1 = 0.0003892, norm01 = 0.328

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.534% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 37 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.4706, norm1 = 0.1791, norm01 = 0.2915)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.2911, norm1 = 0.0005119, norm01 = 0.2915)

iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.2915, norm1 = 0.0003026, norm01 = 0.29

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.477% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 38 [max:70]

```
## iinla: Step rescaling: 162%, Expand (norm0 = 0.4178, norm1 = 0.1591, norm01 = 0.2587)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.2584, norm1 = 0.0003992, norm01 = 0.2587)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.2587, norm1 = 0.0002353, norm01 = 0.258

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.425% of SD, and line search is active [stop if: <10% and line :

## iinla: Iteration 39 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.3708, norm1 = 0.1412, norm01 = 0.2296)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.2293, norm1 = 0.0003114, norm01 = 0.2296)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.2296, norm1 = 0.000183, norm01 = 0.2296

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.379% of SD, and line search is active [stop if: <10% and line :

## iinla: Iteration 40 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.329, norm1 = 0.1254, norm01 = 0.2037)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.2035, norm1 = 0.000243, norm01 = 0.2037)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.2037, norm1 = 0.0001423, norm01 = 0.203

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.337% of SD, and line search is inactive [stop if: <10% and lin

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 41 [max:70]

## Start creating grid...
## Finished creating grid, time  0.1777551

## iinla: Evaluate component inputs
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 98.35, norm1 = 63.45, norm01 = 44.58)

## iinla: Step rescaling: 38.2%, Contract (norm0 = 41.42, norm1 = 18, norm01 = 44.58)

## iinla: Step rescaling: 36.83%, Approx Optimisation (norm0 = 38.89, norm1 = 17.78, norm01 = 44.58)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 87.7%, Approx Optimisation (norm0 = 30.68, norm1 = 5.31, norm01 = 30.26)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 245% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 86.33%, Approx Optimisation (norm0 = 16.97, norm1 = 5.221, norm01 = 18.77)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 95.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 22.16, norm1 = 6.706, norm01 = 15.53)

## iinla: Step rescaling: 100%, Overstep (norm0 = 14.38, norm1 = 1.269, norm01 = 15.53)
```

```
## iinla: Step rescaling: 108.4%, Approx Optimisation (norm0 = 15.49, norm1 = 0.6029, norm01 = 15.53)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 28.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 19.41, norm1 = 5.881, norm01 = 13.55)

## iinla: Step rescaling: 100%, Overstep (norm0 = 12.56, norm1 = 1.018, norm01 = 13.55)

## iinla: Step rescaling: 108.5%, Approx Optimisation (norm0 = 13.54, norm1 = 0.2757, norm01 = 13.55)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 25.3% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 14.65, norm1 = 4.538, norm01 = 10.13)

## iinla: Step rescaling: 100%, Overstep (norm0 = 9.45, norm1 = 0.7095, norm01 = 10.13)

## iinla: Step rescaling: 107.7%, Approx Optimisation (norm0 = 10.13, norm1 = 0.2145, norm01 = 10.13)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 20.1% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 11.07, norm1 = 3.636, norm01 = 7.444)

## iinla: Step rescaling: 100%, Overstep (norm0 = 7.065, norm1 = 0.3936, norm01 = 7.444)

## iinla: Step rescaling: 105.6%, Approx Optimisation (norm0 = 7.441, norm1 = 0.1171, norm01 = 7.444)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 14.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 8.208, norm1 = 2.821, norm01 = 5.39)

## iinla: Step rescaling: 100%, Overstep (norm0 = 5.191, norm1 = 0.207, norm01 = 5.39)

## iinla: Step rescaling: 104%, Approx Optimisation (norm0 = 5.389, norm1 = 0.06154, norm01 = 5.39)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 6.038, norm1 = 2.146, norm01 = 3.894)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.793, norm1 = 0.1055, norm01 = 3.894)

## iinla: Step rescaling: 102.7%, Approx Optimisation (norm0 = 3.893, norm1 = 0.03179, norm01 = 3.894)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.48% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 4.435, norm1 = 1.612, norm01 = 2.823)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.772, norm1 = 0.05369, norm01 = 2.823)

## iinla: Step rescaling: 101.9%, Approx Optimisation (norm0 = 2.823, norm1 = 0.01659, norm01 = 2.823)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.36% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.264, norm1 = 1.205, norm01 = 2.06)
```

iinla: Step rescaling: 100%, Overstep (norm0 = 2.033, norm1 = 0.02764, norm01 = 2.06)

iinla: Step rescaling: 101.3%, Approx Optimisation (norm0 = 2.06, norm1 = 0.008806, norm01 = 2.06)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.98% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 12 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 2.411, norm1 = 0.8991, norm01 = 1.512)

iinla: Step rescaling: 100%, Overstep (norm0 = 1.499, norm1 = 0.01447, norm01 = 1.512)

iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.512, norm1 = 0.004755, norm01 = 1.512)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.08% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 13 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.789, norm1 = 0.6715, norm01 = 1.117)

iinla: Step rescaling: 100%, Overstep (norm0 = 1.11, norm1 = 0.007708, norm01 = 1.117)

iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 1.117, norm1 = 0.002606, norm01 = 1.117)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 1.47% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 14 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.332, norm1 = 0.5023, norm01 = 0.8293)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.8254, norm1 = 0.004167, norm01 = 0.8293)

iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 0.8293, norm1 = 0.001444, norm01 = 0.8293

iinla: Evaluate component linearisations

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.06% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.9947, norm1 = 0.3765, norm01 = 0.6182)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.6161, norm1 = 0.002282, norm01 = 0.6182)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.6182, norm1 = 0.0008078, norm01 = 0.618

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.772% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.7451, norm1 = 0.2827, norm01 = 0.4624)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.4612, norm1 = 0.001262, norm01 = 0.4624)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.4624, norm1 = 0.0004548, norm01 = 0.462

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.567% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.5593, norm1 = 0.2126, norm01 = 0.3467)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.3461, norm1 = 0.0007037, norm01 = 0.3467)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.3467, norm1 = 0.0002572, norm01 = 0.346

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.419% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 0.4206, norm1 = 0.1601, norm01 = 0.2605)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.2602, norm1 = 0.0003947, norm01 = 0.2605)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.2605, norm1 = 0.0001459, norm01 = 0.260

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.313% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.3167, norm1 = 0.1206, norm01 = 0.1961)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.1959, norm1 = 0.0002224, norm01 = 0.1961)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.1961, norm1 = 8.306e-05, norm01 = 0.196

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.235% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.2388, norm1 = 0.09102, norm01 = 0.1478)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.1476, norm1 = 0.0001257, norm01 = 0.1478)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.1478, norm1 = 4.734e-05, norm01 = 0.147

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.178% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 21 [max:70]

## Start creating grid...
## Finished creating grid, time   0.3655891

## iinla: Evaluate component inputs
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 111.1, norm1 = 70.27, norm01 = 50.7)

## iinla: Step rescaling: 38.2%, Contract (norm0 = 45.75, norm1 = 18.89, norm01 = 50.7)

## iinla: Step rescaling: 37.93%, Approx Optimisation (norm0 = 45.2, norm1 = 18.87, norm01 = 50.7)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 76.5%, Approx Optimisation (norm0 = 32.38, norm1 = 7.553, norm01 = 33.13)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 204% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 33.82, norm1 = 15.14, norm01 = 20.95)

## iinla: Step rescaling: 100%, Overstep (norm0 = 20.78, norm1 = 3.519, norm01 = 20.95)

## iinla: Step rescaling: 96.79%, Approx Optimisation (norm0 = 20.12, norm1 = 3.426, norm01 = 20.95)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 65% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 4 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 19.73, norm1 = 7.774, norm01 = 12.52)

## iinla: Step rescaling: 100%, Overstep (norm0 = 12.35, norm1 = 1.487, norm01 = 12.52)

## iinla: Step rescaling: 99.25%, Approx Optimisation (norm0 = 12.26, norm1 = 1.485, norm01 = 12.52)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 47% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 13.21, norm1 = 4.725, norm01 = 8.615)

## iinla: Step rescaling: 100%, Overstep (norm0 = 8.346, norm1 = 0.6222, norm01 = 8.615)

## iinla: Step rescaling: 102.6%, Approx Optimisation (norm0 = 8.552, norm1 = 0.5851, norm01 = 8.615)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 31.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 9.661, norm1 = 3.26, norm01 = 6.431)

## iinla: Step rescaling: 100%, Overstep (norm0 = 6.144, norm1 = 0.359, norm01 = 6.431)

## iinla: Step rescaling: 104.7%, Approx Optimisation (norm0 = 6.417, norm1 = 0.2313, norm01 = 6.431)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 7.992, norm1 = 2.747, norm01 = 5.256)

## iinla: Step rescaling: 100%, Overstep (norm0 = 5.058, norm1 = 0.232, norm01 = 5.256)

## iinla: Step rescaling: 104%, Approx Optimisation (norm0 = 5.252, norm1 = 0.1272, norm01 = 5.256)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 7.067, norm1 = 2.516, norm01 = 4.556)

## iinla: Step rescaling: 100%, Overstep (norm0 = 4.438, norm1 = 0.1406, norm01 = 4.556)

## iinla: Step rescaling: 102.7%, Approx Optimisation (norm0 = 4.553, norm1 = 0.08062, norm01 = 4.556)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.12% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 6.453, norm1 = 2.352, norm01 = 4.104)

## iinla: Step rescaling: 100%, Overstep (norm0 = 4.032, norm1 = 0.08959, norm01 = 4.104)

## iinla: Step rescaling: 101.8%, Approx Optimisation (norm0 = 4.103, norm1 = 0.05512, norm01 = 4.104)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 6.027, norm1 = 2.227, norm01 = 3.801)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.754, norm1 = 0.06135, norm01 = 3.801)

## iinla: Step rescaling: 101.3%, Approx Optimisation (norm0 = 3.8, norm1 = 0.04007, norm01 = 3.801)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.48% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 5.725, norm1 = 2.134, norm01 = 3.592)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.559, norm1 = 0.04467, norm01 = 3.592)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 3.592, norm1 = 0.03061, norm01 = 3.592)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.18% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 5.506, norm1 = 2.064, norm01 = 3.443)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.419, norm1 = 0.03426, norm01 = 3.443)

## iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 3.443, norm1 = 0.02441, norm01 = 3.443)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.92% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 5.338, norm1 = 2.008, norm01 = 3.331)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.312, norm1 = 0.02765, norm01 = 3.331)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 3.331, norm1 = 0.0203, norm01 = 3.331)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.67% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 5.197, norm1 = 1.959, norm01 = 3.238)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.222, norm1 = 0.02358, norm01 = 3.238)
```

```
## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 3.238, norm1 = 0.01768, norm01 = 3.238)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.52% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 5.061, norm1 = 1.91, norm01 = 3.152)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.138, norm1 = 0.02137, norm01 = 3.152)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 3.152, norm1 = 0.01615, norm01 = 3.152)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.62% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 4.917, norm1 = 1.855, norm01 = 3.062)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.048, norm1 = 0.0205, norm01 = 3.062)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 3.061, norm1 = 0.01543, norm01 = 3.062)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.64% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 4.752, norm1 = 1.792, norm01 = 2.96)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.946, norm1 = 0.02056, norm01 = 2.96)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 2.96, norm1 = 0.01524, norm01 = 2.96)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

iinla: Max deviation from previous: 6.56% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 18 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 4.561, norm1 = 1.718, norm01 = 2.843)

iinla: Step rescaling: 100%, Overstep (norm0 = 2.829, norm1 = 0.02115, norm01 = 2.843)

iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 2.843, norm1 = 0.01534, norm01 = 2.843)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 6.36% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 19 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 4.344, norm1 = 1.634, norm01 = 2.71)

iinla: Step rescaling: 100%, Overstep (norm0 = 2.695, norm1 = 0.02189, norm01 = 2.71)

iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 2.71, norm1 = 0.01549, norm01 = 2.71)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 6.05% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 20 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 4.102, norm1 = 1.54, norm01 = 2.562)

iinla: Step rescaling: 100%, Overstep (norm0 = 2.546, norm1 = 0.02247, norm01 = 2.562)

iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 2.562, norm1 = 0.01554, norm01 = 2.562)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 5.63% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 21 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 3.844, norm1 = 1.441, norm01 = 2.403)

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 2.386, norm1 = 0.02271, norm01 = 2.403)

## iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 2.403, norm1 = 0.01538, norm01 = 2.403)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.13% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.575, norm1 = 1.338, norm01 = 2.237)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.22, norm1 = 0.02253, norm01 = 2.237)

## iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 2.237, norm1 = 0.01499, norm01 = 2.237)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.55% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 23 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.305, norm1 = 1.236, norm01 = 2.07)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.053, norm1 = 0.02195, norm01 = 2.07)

## iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 2.07, norm1 = 0.01443, norm01 = 2.07)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.94% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 24 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.041, norm1 = 1.136, norm01 = 1.905)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.889, norm1 = 0.02108, norm01 = 1.905)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.905, norm1 = 0.01375, norm01 = 1.905)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.54% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 25 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.787, norm1 = 1.04, norm01 = 1.747)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.732, norm1 = 0.02002, norm01 = 1.747)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.747, norm1 = 0.01303, norm01 = 1.747)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.27% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 26 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.549, norm1 = 0.9507, norm01 = 1.598)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.584, norm1 = 0.01887, norm01 = 1.598)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.598, norm1 = 0.01234, norm01 = 1.598)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.03% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 27 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.328, norm1 = 0.8679, norm01 = 1.46)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.447, norm1 = 0.01773, norm01 = 1.46)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.46, norm1 = 0.01171, norm01 = 1.46)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.82% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 28 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 2.126, norm1 = 0.7924, norm01 = 1.334)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.322, norm1 = 0.01664, norm01 = 1.334)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 1.334, norm1 = 0.01117, norm01 = 1.334)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.64% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 29 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.944, norm1 = 0.7241, norm01 = 1.22)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.208, norm1 = 0.01565, norm01 = 1.22)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 1.22, norm1 = 0.01071, norm01 = 1.22)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.49% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 30 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.78, norm1 = 0.663, norm01 = 1.117)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.107, norm1 = 0.01476, norm01 = 1.117)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 1.117, norm1 = 0.01032, norm01 = 1.117)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.36% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 31 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.634, norm1 = 0.6085, norm01 = 1.026)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.016, norm1 = 0.01396, norm01 = 1.026)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 1.026, norm1 = 0.009984, norm01 = 1.026)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.51% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 32 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.504, norm1 = 0.5601, norm01 = 0.9444)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.9352, norm1 = 0.01324, norm01 = 0.9444)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 0.9443, norm1 = 0.009687, norm01 = 0.9444)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.64% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 33 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.389, norm1 = 0.5173, norm01 = 0.8723)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.8638, norm1 = 0.01258, norm01 = 0.8723)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 0.8721, norm1 = 0.009406, norm01 = 0.8723)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.75% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 34 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.287, norm1 = 0.4793, norm01 = 0.8083)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.8004, norm1 = 0.01196, norm01 = 0.8083)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 0.8081, norm1 = 0.009118, norm01 = 0.8083)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.83% of SD, and line search is active [stop if: <10% and line s
```

iinla: Iteration 35 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.196, norm1 = 0.4455, norm01 = 0.7512)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.7439, norm1 = 0.01135, norm01 = 0.7512)

iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 0.7511, norm1 = 0.008806, norm01 = 0.7512)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.89% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 36 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.115, norm1 = 0.4153, norm01 = 0.7)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.6932, norm1 = 0.01075, norm01 = 0.7)

iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 0.6998, norm1 = 0.008456, norm01 = 0.7)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.91% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 37 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.041, norm1 = 0.3879, norm01 = 0.6535)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.6473, norm1 = 0.01012, norm01 = 0.6535)

iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 0.6534, norm1 = 0.008057, norm01 = 0.6535)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.91% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 38 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.9736, norm1 = 0.3629, norm01 = 0.611)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.6052, norm1 = 0.009462, norm01 = 0.611)

```
## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 0.6108, norm1 = 0.007606, norm01 = 0.611)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.88% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 39 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.9109, norm1 = 0.3397, norm01 = 0.5715)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.5662, norm1 = 0.008775, norm01 = 0.5715)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 0.5714, norm1 = 0.007103, norm01 = 0.5715

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.82% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 40 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.8523, norm1 = 0.3181, norm01 = 0.5345)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.5297, norm1 = 0.008059, norm01 = 0.5345)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 0.5344, norm1 = 0.006555, norm01 = 0.5345

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.74% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 41 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.7968, norm1 = 0.2976, norm01 = 0.4994)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.4951, norm1 = 0.007325, norm01 = 0.4994)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 0.4993, norm1 = 0.005974, norm01 = 0.4994

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

iinla: Max deviation from previous: 2.63% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 42 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.7439, norm1 = 0.2781, norm01 = 0.4661)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.4622, norm1 = 0.006584, norm01 = 0.4661)

iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 0.466, norm1 = 0.005374, norm01 = 0.4661]

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.51% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 43 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.6934, norm1 = 0.2595, norm01 = 0.4341)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.4307, norm1 = 0.005851, norm01 = 0.4341)

iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 0.4341, norm1 = 0.004771, norm01 = 0.434

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.37% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 44 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.645, norm1 = 0.2416, norm01 = 0.4036)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.4005, norm1 = 0.005141, norm01 = 0.4036)

iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 0.4035, norm1 = 0.004182, norm01 = 0.403

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.22% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 45 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.5987, norm1 = 0.2245, norm01 = 0.3743)

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 0.3716, norm1 = 0.004468, norm01 = 0.3743)

## iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 0.3743, norm1 = 0.003621, norm01 = 0.374

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.07% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 46 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.5544, norm1 = 0.2081, norm01 = 0.3464)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.3441, norm1 = 0.003843, norm01 = 0.3464)

## iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 0.3464, norm1 = 0.003098, norm01 = 0.3464

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.91% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 47 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.5123, norm1 = 0.1926, norm01 = 0.3198)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.3179, norm1 = 0.003273, norm01 = 0.3198)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 0.3198, norm1 = 0.002622, norm01 = 0.3198

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.75% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 48 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.4724, norm1 = 0.1778, norm01 = 0.2947)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.293, norm1 = 0.002763, norm01 = 0.2947)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 0.2947, norm1 = 0.002198, norm01 = 0.294

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 49 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.4347, norm1 = 0.1638, norm01 = 0.271)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.2696, norm1 = 0.002314, norm01 = 0.271)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 0.271, norm1 = 0.001826, norm01 = 0.271)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.45% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 50 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.3993, norm1 = 0.1506, norm01 = 0.2487)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.2475, norm1 = 0.001925, norm01 = 0.2487)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 0.2487, norm1 = 0.001505, norm01 = 0.248

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.31% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 51 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.3661, norm1 = 0.1382, norm01 = 0.2279)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.2269, norm1 = 0.001591, norm01 = 0.2279)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 0.2279, norm1 = 0.001233, norm01 = 0.2279

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.18% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 52 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 0.3352, norm1 = 0.1267, norm01 = 0.2085)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.2077, norm1 = 0.001309, norm01 = 0.2085)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 0.2085, norm1 = 0.001004, norm01 = 0.208

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.06% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 53 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.3065, norm1 = 0.1159, norm01 = 0.1905)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.1898, norm1 = 0.001072, norm01 = 0.1905)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 0.1905, norm1 = 0.0008139, norm01 = 0.19

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.949% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 54 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.2798, norm1 = 0.106, norm01 = 0.1739)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.1733, norm1 = 0.0008743, norm01 = 0.1739)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.1739, norm1 = 0.0006574, norm01 = 0.17

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.848% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 55 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.2552, norm1 = 0.09671, norm01 = 0.1585)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.158, norm1 = 0.0007114, norm01 = 0.1585)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.1585, norm1 = 0.0005295, norm01 = 0.158
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.757% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 56 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.2325, norm1 = 0.08818, norm01 = 0.1443)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.1439, norm1 = 0.0005774, norm01 = 0.1443)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 0.1443, norm1 = 0.0004255, norm01 = 0.144

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.676% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 57 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.2116, norm1 = 0.08032, norm01 = 0.1313)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.131, norm1 = 0.0004679, norm01 = 0.1313)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.1313, norm1 = 0.0003414, norm01 = 0.13

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.602% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 58 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.1925, norm1 = 0.07309, norm01 = 0.1194)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.1191, norm1 = 0.0003787, norm01 = 0.1194)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.1194, norm1 = 0.0002737, norm01 = 0.119

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.537% of SD, and line search is active [stop if: <10% and line s
```

iinla: Iteration 59 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.1749, norm1 = 0.06646, norm01 = 0.1084)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.1082, norm1 = 0.0003061, norm01 = 0.1084)

iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.1084, norm1 = 0.0002192, norm01 = 0.108

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.478% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 60 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.1588, norm1 = 0.06038, norm01 = 0.09844)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.09827, norm1 = 0.0002473, norm01 = 0.09844)

iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.09844, norm1 = 0.0001756, norm01 = 0.09

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.426% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 61 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.1441, norm1 = 0.05483, norm01 = 0.08931)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.08917, norm1 = 0.0001997, norm01 = 0.08931)

iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.08931, norm1 = 0.0001406, norm01 = 0.08

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 0.38% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 62 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 0.1307, norm1 = 0.04975, norm01 = 0.08099)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.08087, norm1 = 0.0001613, norm01 = 0.08099)

```
## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.08098, norm1 = 0.0001127, norm01 = 0.08

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.339% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 63 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.1185, norm1 = 0.04511, norm01 = 0.0734)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.0733, norm1 = 0.0001302, norm01 = 0.0734)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.0734, norm1 = 9.03e-05, norm01 = 0.0734

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.303% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 64 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.1074, norm1 = 0.04089, norm01 = 0.06649)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.06641, norm1 = 0.0001051, norm01 = 0.06649)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.06649, norm1 = 7.241e-05, norm01 = 0.0

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.27% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 65 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.09725, norm1 = 0.03705, norm01 = 0.06021)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.06014, norm1 = 8.489e-05, norm01 = 0.06021)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.0602, norm1 = 5.81e-05, norm01 = 0.0602

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 0.242% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 66 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.08804, norm1 = 0.03355, norm01 = 0.05449)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.05444, norm1 = 6.855e-05, norm01 = 0.05449)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.0545, norm1 = 4.665e-05, norm01 = 0.054

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 0.216% of SD, and line search is inactive [stop if: <10% and lin

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 67 [max:70]

## Start creating grid...
## Finished creating grid, time   0.6841669

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 306.6, norm1 = 373.6, norm01 = 270.8)

## iinla: Step rescaling: 26.71%, Approx Optimisation (norm0 = 72.07, norm1 = 218.6, norm01 = 270.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 384.6, norm1 = 290.2, norm01 = 240.8)
```

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 219, norm1 = 121.5, norm01 = 240.8)

## iinla: Step rescaling: 80.55%, Approx Optimisation (norm0 = 176, norm1 = 106.5, norm01 = 240.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 351% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 226.7, norm1 = 79.57, norm01 = 148.1)

## iinla: Step rescaling: 100%, Overstep (norm0 = 143.3, norm1 = 7.732, norm01 = 148.1)

## iinla: Step rescaling: 103.2%, Approx Optimisation (norm0 = 147.6, norm1 = 6.353, norm01 = 148.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 148% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 96.66, norm1 = 29.34, norm01 = 70.36)

## iinla: Step rescaling: 100%, Overstep (norm0 = 63.53, norm1 = 9.274, norm01 = 70.36)

## iinla: Step rescaling: 109.7%, Approx Optimisation (norm0 = 69.04, norm1 = 7.338, norm01 = 70.36)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 162% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 67.82, norm1 = 21.92, norm01 = 46.48)

## iinla: Step rescaling: 100%, Overstep (norm0 = 43.59, norm1 = 3.775, norm01 = 46.48)

## iinla: Step rescaling: 106.5%, Approx Optimisation (norm0 = 46.23, norm1 = 2.678, norm01 = 46.48)

## iinla: Evaluate component linearisations
```

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 92.2% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 6 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 47.52, norm1 = 16.51, norm01 = 31.3)

iinla: Step rescaling: 100%, Overstep (norm0 = 30.1, norm1 = 1.878, norm01 = 31.3)

iinla: Step rescaling: 103.7%, Approx Optimisation (norm0 = 31.18, norm1 = 1.531, norm01 = 31.3)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 89.1% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 7 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 35.51, norm1 = 12.87, norm01 = 22.81)

iinla: Step rescaling: 100%, Overstep (norm0 = 22.27, norm1 = 1.111, norm01 = 22.81)

iinla: Step rescaling: 102.1%, Approx Optimisation (norm0 = 22.74, norm1 = 1.009, norm01 = 22.81)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 77.5% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 8 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 27.1, norm1 = 10.07, norm01 = 17.12)

iinla: Step rescaling: 100%, Overstep (norm0 = 16.89, norm1 = 0.6846, norm01 = 17.12)

iinla: Step rescaling: 101.2%, Approx Optimisation (norm0 = 17.08, norm1 = 0.6567, norm01 = 17.12)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 60.8% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 9 [max:70]

```
## iinla: Step rescaling: 162%, Expand (norm0 = 20.9, norm1 = 7.885, norm01 = 13.06)

## iinla: Step rescaling: 100%, Overstep (norm0 = 12.97, norm1 = 0.4158, norm01 = 13.06)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 13.04, norm1 = 0.4094, norm01 = 13.06)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 45.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 16.26, norm1 = 6.189, norm01 = 10.1)

## iinla: Step rescaling: 100%, Overstep (norm0 = 10.07, norm1 = 0.2483, norm01 = 10.1)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 10.09, norm1 = 0.2475, norm01 = 10.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 34.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 12.75, norm1 = 4.874, norm01 = 7.882)

## iinla: Step rescaling: 100%, Overstep (norm0 = 7.878, norm1 = 0.1467, norm01 = 7.882)

## iinla: Step rescaling: 99.99%, Approx Optimisation (norm0 = 7.878, norm1 = 0.1467, norm01 = 7.882)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 25.5% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 6.2, norm1 = 0.08582, norm01 = 6.201)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 19% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 4.91, norm1 = 0.04977, norm01 = 4.911)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 3.91, norm1 = 0.0287, norm01 = 3.911)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 3.13, norm1 = 0.01649, norm01 = 3.13)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.14% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.85%, Approx Optimisation (norm0 = 2.517, norm1 = 0.009459, norm01 = 2.517)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.62% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 2.033, norm1 = 0.005424, norm01 = 2.033)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.39% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.9%, Approx Optimisation (norm0 = 1.649, norm1 = 0.003114, norm01 = 1.649)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 1.343, norm1 = 0.001792, norm01 = 1.343)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.59% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 20 [max:70]

## Start creating grid...
## Finished creating grid, time  0.812757

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 361.5, norm1 = 495.9, norm01 = 376.3)

## iinla: Step rescaling: 26.36%, Approx Optimisation (norm0 = 89.15, norm1 = 309.1, norm01 = 376.3)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 454, norm1 = 275, norm01 = 330.3)

## iinla: Step rescaling: 100%, Overstep (norm0 = 282.5, norm1 = 131.3, norm01 = 330.3)

## iinla: Step rescaling: 90.39%, Approx Optimisation (norm0 = 257.3, norm1 = 127.7, norm01 = 330.3)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 416% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 238.7, norm1 = 78.06, norm01 = 162.6)

## iinla: Step rescaling: 100%, Overstep (norm0 = 153.4, norm1 = 12.66, norm01 = 162.6)

## iinla: Step rescaling: 105.8%, Approx Optimisation (norm0 = 161.6, norm1 = 9.477, norm01 = 162.6)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 213% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 104.6, norm1 = 38.89, norm01 = 75.08)

## iinla: Step rescaling: 100%, Overstep (norm0 = 67.98, norm1 = 14.14, norm01 = 75.08)

## iinla: Step rescaling: 104.8%, Approx Optimisation (norm0 = 70.92, norm1 = 13.76, norm01 = 75.08)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 151% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 78.79, norm1 = 27.8, norm01 = 53.11)

## iinla: Step rescaling: 100%, Overstep (norm0 = 50.18, norm1 = 5.947, norm01 = 53.11)

## iinla: Step rescaling: 104.2%, Approx Optimisation (norm0 = 52.17, norm1 = 5.584, norm01 = 53.11)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 108% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 61.58, norm1 = 22.69, norm01 = 39.47)

## iinla: Step rescaling: 100%, Overstep (norm0 = 38.55, norm1 = 2.603, norm01 = 39.47)

## iinla: Step rescaling: 101.8%, Approx Optimisation (norm0 = 39.22, norm1 = 2.515, norm01 = 39.47)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 76.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 51.47, norm1 = 19.55, norm01 = 32.17)

## iinla: Step rescaling: 100%, Overstep (norm0 = 31.94, norm1 = 1.496, norm01 = 32.17)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 32.07, norm1 = 1.491, norm01 = 32.17)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 82% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 99.75%, Approx Optimisation (norm0 = 26.67, norm1 = 1.037, norm01 = 26.73)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 73.1% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 99.51%, Approx Optimisation (norm0 = 22.12, norm1 = 0.7231, norm01 = 22.15)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 59.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 99.42%, Approx Optimisation (norm0 = 18.36, norm1 = 0.4897, norm01 = 18.38)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 47.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 99.41%, Approx Optimisation (norm0 = 15.3, norm1 = 0.3242, norm01 = 15.31)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 37.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.43%, Approx Optimisation (norm0 = 12.8, norm1 = 0.2114, norm01 = 12.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 29.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.48%, Approx Optimisation (norm0 = 10.75, norm1 = 0.1366, norm01 = 10.75)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 25% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.54%, Approx Optimisation (norm0 = 9.053, norm1 = 0.08768, norm01 = 9.054)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 21.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.6%, Approx Optimisation (norm0 = 7.646, norm1 = 0.05611, norm01 = 7.647)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.66%, Approx Optimisation (norm0 = 6.474, norm1 = 0.03585, norm01 = 6.474)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 15.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.71%, Approx Optimisation (norm0 = 5.494, norm1 = 0.0229, norm01 = 5.494)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 13.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.76%, Approx Optimisation (norm0 = 4.67, norm1 = 0.01465, norm01 = 4.67)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 11.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.8%, Approx Optimisation (norm0 = 3.977, norm1 = 0.009385, norm01 = 3.977)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.56% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 3.392, norm1 = 0.006032, norm01 = 3.392)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.15% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 99.87%, Approx Optimisation (norm0 = 2.897, norm1 = 0.003891, norm01 = 2.897)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.95% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 2.477, norm1 = 0.002521, norm01 = 2.477)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.93% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 23 [max:70]
```

iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 2.12, norm1 = 0.001642, norm01 = 2.12)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 5.07% of SD, and line search is inactive [stop if: <10% and line

iinla: Convergence criterion met, running final INLA integration with known theta mode.

iinla: Iteration 24 [max:70]

Start creating grid...
Finished creating grid, time 1.024628

iinla: Evaluate component inputs

iinla: Evaluate component linearisations

iinla: Evaluate component simplifications

iinla: Evaluate predictor linearisation

iinla: Construct inla stack

iinla: Model initialisation completed

iinla: Iteration 1 [max:70]

iinla: Step rescaling: 61.8%, Contract (norm0 = 373.1, norm1 = 593.9, norm01 = 528.4)

iinla: Step rescaling: 29.89%, Approx Optimisation (norm0 = 129.1, norm1 = 430.9, norm01 = 528.4)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Iteration 2 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 617.2, norm1 = 195.8, norm01 = 463.4)

iinla: Step rescaling: 100%, Overstep (norm0 = 403.8, norm1 = 89.28, norm01 = 463.4)

iinla: Step rescaling: 110%, Approx Optimisation (norm0 = 439.4, norm1 = 79.21, norm01 = 463.4)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

```
## iinla: Max deviation from previous: 573% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 250.1, norm1 = 78.75, norm01 = 172.1)

## iinla: Step rescaling: 100%, Overstep (norm0 = 161.1, norm1 = 12.37, norm01 = 172.1)

## iinla: Step rescaling: 107.1%, Approx Optimisation (norm0 = 171.7, norm1 = 6.3, norm01 = 172.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 341% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 126.8, norm1 = 39.4, norm01 = 89.89)

## iinla: Step rescaling: 100%, Overstep (norm0 = 82.46, norm1 = 10.03, norm01 = 89.89)

## iinla: Step rescaling: 108.4%, Approx Optimisation (norm0 = 88.78, norm1 = 7.685, norm01 = 89.89)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 180% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 95.45, norm1 = 33, norm01 = 63.74)

## iinla: Step rescaling: 100%, Overstep (norm0 = 60.68, norm1 = 5.378, norm01 = 63.74)

## iinla: Step rescaling: 104.3%, Approx Optimisation (norm0 = 63.17, norm1 = 4.749, norm01 = 63.74)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 112% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 79.79, norm1 = 29.86, norm01 = 50.72)
```

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 49.79, norm1 = 3.419, norm01 = 50.72)

## iinla: Step rescaling: 101.2%, Approx Optimisation (norm0 = 50.38, norm1 = 3.368, norm01 = 50.72)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 94.1% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 70.52, norm1 = 27.4, norm01 = 43.58)

## iinla: Step rescaling: 100%, Overstep (norm0 = 43.55, norm1 = 2.403, norm01 = 43.58)

## iinla: Step rescaling: 99.61%, Approx Optimisation (norm0 = 43.38, norm1 = 2.397, norm01 = 43.58)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 79.1% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 98.86%, Approx Optimisation (norm0 = 38.43, norm1 = 1.662, norm01 = 38.54)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 79.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 98.59%, Approx Optimisation (norm0 = 34.48, norm1 = 1.121, norm01 = 34.53)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 76.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 98.58%, Approx Optimisation (norm0 = 31.06, norm1 = 0.7424, norm01 = 31.08)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 71.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 98.69%, Approx Optimisation (norm0 = 27.95, norm1 = 0.4865, norm01 = 27.96)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 65.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 98.85%, Approx Optimisation (norm0 = 25.07, norm1 = 0.3176, norm01 = 25.08)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 58.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.02%, Approx Optimisation (norm0 = 22.41, norm1 = 0.2075, norm01 = 22.42)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 52.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.17%, Approx Optimisation (norm0 = 19.97, norm1 = 0.1362, norm01 = 19.97)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 46.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]
```

```
## iinla: Step rescaling: 99.3%, Approx Optimisation (norm0 = 17.75, norm1 = 0.09004, norm01 = 17.75)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 41.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.41%, Approx Optimisation (norm0 = 15.74, norm1 = 0.06006, norm01 = 15.74)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 36.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.5%, Approx Optimisation (norm0 = 13.94, norm1 = 0.04049, norm01 = 13.94)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 32.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.58%, Approx Optimisation (norm0 = 12.33, norm1 = 0.02762, norm01 = 12.33)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 28.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.64%, Approx Optimisation (norm0 = 10.9, norm1 = 0.01908, norm01 = 10.9)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 24.8% of SD, and line search is active [stop if: <10% and line s
```

```
## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 99.69%, Approx Optimisation (norm0 = 9.622, norm1 = 0.01334, norm01 = 9.622)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 21.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 99.73%, Approx Optimisation (norm0 = 8.492, norm1 = 0.009451, norm01 = 8.492)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 19.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 99.77%, Approx Optimisation (norm0 = 7.492, norm1 = 0.00677, norm01 = 7.492)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 16.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 23 [max:70]

## iinla: Step rescaling: 99.8%, Approx Optimisation (norm0 = 6.607, norm1 = 0.004903, norm01 = 6.607)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 24 [max:70]

## iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 5.825, norm1 = 0.003586, norm01 = 5.825)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

iinla: Max deviation from previous: 13% of SD, and line search is active [stop if: <10% and line sea

iinla: Iteration 25 [max:70]

iinla: Step rescaling: 99.85%, Approx Optimisation (norm0 = 5.134, norm1 = 0.002646, norm01 = 5.134)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 11.4% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 26 [max:70]

iinla: Step rescaling: 99.87%, Approx Optimisation (norm0 = 4.524, norm1 = 0.001968, norm01 = 4.524)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 10% of SD, and line search is active [stop if: <10% and line sea

iinla: Iteration 27 [max:70]

iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 3.986, norm1 = 0.001473, norm01 = 3.986)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 8.82% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 28 [max:70]

iinla: Step rescaling: 99.9%, Approx Optimisation (norm0 = 3.511, norm1 = 0.001109, norm01 = 3.511)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 7.75% of SD, and line search is inactive [stop if: <10% and line

iinla: Convergence criterion met, running final INLA integration with known theta mode.

iinla: Iteration 29 [max:70]

Start creating grid...
Finished creating grid, time 0.8335001

```
## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 361.2, norm1 = 541.2, norm01 = 447.2)

## iinla: Step rescaling: 27.96%, Approx Optimisation (norm0 = 106, norm1 = 366.7, norm01 = 447.2)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 502, norm1 = 204.7, norm01 = 383.8)

## iinla: Step rescaling: 100%, Overstep (norm0 = 328.4, norm1 = 101.7, norm01 = 383.8)

## iinla: Step rescaling: 103.9%, Approx Optimisation (norm0 = 339.6, norm1 = 100.4, norm01 = 383.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 528% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 200.4, norm1 = 64.42, norm01 = 136.7)

## iinla: Step rescaling: 100%, Overstep (norm0 = 128.7, norm1 = 9.385, norm01 = 136.7)

## iinla: Step rescaling: 106.4%, Approx Optimisation (norm0 = 136.4, norm1 = 5.354, norm01 = 136.7)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 226% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 99.72, norm1 = 35.93, norm01 = 68.63)

## iinla: Step rescaling: 100%, Overstep (norm0 = 63.88, norm1 = 9.925, norm01 = 68.63)

## iinla: Step rescaling: 104.4%, Approx Optimisation (norm0 = 66.48, norm1 = 9.539, norm01 = 68.63)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 135% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 80.61, norm1 = 29.62, norm01 = 52.5)

## iinla: Step rescaling: 100%, Overstep (norm0 = 50.71, norm1 = 4.858, norm01 = 52.5)

## iinla: Step rescaling: 102.3%, Approx Optimisation (norm0 = 51.84, norm1 = 4.722, norm01 = 52.5)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 101% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 71.29, norm1 = 27.47, norm01 = 44.56)

## iinla: Step rescaling: 100%, Overstep (norm0 = 44.21, norm1 = 3.033, norm01 = 44.56)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 44.25, norm1 = 3.033, norm01 = 44.56)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 112% of SD, and line search is inactive [stop if: <10% and line s

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 99.05%, Approx Optimisation (norm0 = 39.09, norm1 = 2.245, norm01 = 39.28)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 104% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 98.59%, Approx Optimisation (norm0 = 34.5, norm1 = 1.673, norm01 = 34.61)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 88.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 98.44%, Approx Optimisation (norm0 = 30.52, norm1 = 1.216, norm01 = 30.59)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 72.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 98.46%, Approx Optimisation (norm0 = 27.16, norm1 = 0.8693, norm01 = 27.2)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 63.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 98.55%, Approx Optimisation (norm0 = 24.26, norm1 = 0.6166, norm01 = 24.29)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 57.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 12 [max:70]
```

iinla: Step rescaling: 98.69%, Approx Optimisation (norm0 = 21.74, norm1 = 0.4358, norm01 = 21.75)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 51.6% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 13 [max:70]

iinla: Step rescaling: 98.84%, Approx Optimisation (norm0 = 19.52, norm1 = 0.3075, norm01 = 19.52)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 46.2% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 14 [max:70]

iinla: Step rescaling: 98.99%, Approx Optimisation (norm0 = 17.55, norm1 = 0.217, norm01 = 17.55)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 41.3% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 15 [max:70]

iinla: Step rescaling: 99.13%, Approx Optimisation (norm0 = 15.8, norm1 = 0.1533, norm01 = 15.8)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 37% of SD, and line search is active [stop if: <10% and line sear

iinla: Iteration 16 [max:70]

iinla: Step rescaling: 99.25%, Approx Optimisation (norm0 = 14.24, norm1 = 0.1085, norm01 = 14.24)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 33.2% of SD, and line search is active [stop if: <10% and line se

```
## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.36%, Approx Optimisation (norm0 = 12.85, norm1 = 0.07708, norm01 = 12.85)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 29.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.45%, Approx Optimisation (norm0 = 11.6, norm1 = 0.05498, norm01 = 11.6)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 26.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.53%, Approx Optimisation (norm0 = 10.49, norm1 = 0.03942, norm01 = 10.49)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 24% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 99.6%, Approx Optimisation (norm0 = 9.489, norm1 = 0.02844, norm01 = 9.489)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 21.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 99.65%, Approx Optimisation (norm0 = 8.59, norm1 = 0.02065, norm01 = 8.591)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 19.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 99.7%, Approx Optimisation (norm0 = 7.782, norm1 = 0.01512, norm01 = 7.782)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 17.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 23 [max:70]

## iinla: Step rescaling: 99.73%, Approx Optimisation (norm0 = 7.054, norm1 = 0.01116, norm01 = 7.054)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 15.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 24 [max:70]

## iinla: Step rescaling: 99.77%, Approx Optimisation (norm0 = 6.397, norm1 = 0.008306, norm01 = 6.397)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.3% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 25 [max:70]

## iinla: Step rescaling: 99.8%, Approx Optimisation (norm0 = 5.803, norm1 = 0.006239, norm01 = 5.803)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 12.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 26 [max:70]

## iinla: Step rescaling: 99.82%, Approx Optimisation (norm0 = 5.267, norm1 = 0.004728, norm01 = 5.267)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 11.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 27 [max:70]

## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 4.782, norm1 = 0.003616, norm01 = 4.782)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 28 [max:70]

## iinla: Step rescaling: 99.86%, Approx Optimisation (norm0 = 4.343, norm1 = 0.00279, norm01 = 4.343)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.58% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 29 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 3.945, norm1 = 0.00217, norm01 = 3.945)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.68% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 30 [max:70]

## iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 3.584, norm1 = 0.001701, norm01 = 3.584)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.87% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 31 [max:70]

## iinla: Step rescaling: 99.9%, Approx Optimisation (norm0 = 3.257, norm1 = 0.001343, norm01 = 3.257)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.13% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 32 [max:70]

## Start creating grid...
## Finished creating grid, time  1.125107

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 392.2, norm1 = 634.9, norm01 = 637.3)

## iinla: Step rescaling: 34.23%, Approx Optimisation (norm0 = 178, norm1 = 501.5, norm01 = 637.3)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 713.8, norm1 = 226.6, norm01 = 526.2)

## iinla: Step rescaling: 100%, Overstep (norm0 = 468.6, norm1 = 85.75, norm01 = 526.2)

## iinla: Step rescaling: 109.4%, Approx Optimisation (norm0 = 507.7, norm1 = 74.85, norm01 = 526.2)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 603% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 228.5, norm1 = 70.62, norm01 = 159)

## iinla: Step rescaling: 100%, Overstep (norm0 = 147.8, norm1 = 12.73, norm01 = 159)

## iinla: Step rescaling: 107.8%, Approx Optimisation (norm0 = 158.5, norm1 = 6.858, norm01 = 159)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 373% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 135.7, norm1 = 42.51, norm01 = 95.55)

## iinla: Step rescaling: 100%, Overstep (norm0 = 88.05, norm1 = 10.1, norm01 = 95.55)

## iinla: Step rescaling: 108%, Approx Optimisation (norm0 = 94.52, norm1 = 7.668, norm01 = 95.55)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 189% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 97.83, norm1 = 33.6, norm01 = 65.52)

## iinla: Step rescaling: 100%, Overstep (norm0 = 62.3, norm1 = 5.479, norm01 = 65.52)

## iinla: Step rescaling: 104.5%, Approx Optimisation (norm0 = 64.96, norm1 = 4.77, norm01 = 65.52)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 130% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 77.54, norm1 = 28.68, norm01 = 49.67)

## iinla: Step rescaling: 100%, Overstep (norm0 = 48.54, norm1 = 3.446, norm01 = 49.67)
```

```
## iinla: Step rescaling: 101.6%, Approx Optimisation (norm0 = 49.32, norm1 = 3.355, norm01 = 49.67)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 117% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 65.35, norm1 = 25.12, norm01 = 40.69)

## iinla: Step rescaling: 100%, Overstep (norm0 = 40.47, norm1 = 2.304, norm01 = 40.69)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 40.49, norm1 = 2.304, norm01 = 40.69)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 94% of SD, and line search is inactive [stop if: <10% and line s

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 99.29%, Approx Optimisation (norm0 = 34.56, norm1 = 1.539, norm01 = 34.67)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 73.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 99%, Approx Optimisation (norm0 = 30.12, norm1 = 1.015, norm01 = 30.17)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 61.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 98.96%, Approx Optimisation (norm0 = 26.51, norm1 = 0.6685, norm01 = 26.53)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 55.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 99.02%, Approx Optimisation (norm0 = 23.42, norm1 = 0.4426, norm01 = 23.43)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 50.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.12%, Approx Optimisation (norm0 = 20.71, norm1 = 0.2951, norm01 = 20.72)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 44.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.24%, Approx Optimisation (norm0 = 18.32, norm1 = 0.1983, norm01 = 18.32)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 39.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.34%, Approx Optimisation (norm0 = 16.19, norm1 = 0.1343, norm01 = 16.19)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 35.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.44%, Approx Optimisation (norm0 = 14.3, norm1 = 0.09168, norm01 = 14.3)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 31.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.52%, Approx Optimisation (norm0 = 12.62, norm1 = 0.06311, norm01 = 12.62)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 27.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.59%, Approx Optimisation (norm0 = 11.14, norm1 = 0.04379, norm01 = 11.14)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 24.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.65%, Approx Optimisation (norm0 = 9.819, norm1 = 0.03063, norm01 = 9.819)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 21.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.7%, Approx Optimisation (norm0 = 8.654, norm1 = 0.0216, norm01 = 8.654)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 20 [max:70]
```

iinla: Step rescaling: 99.74%, Approx Optimisation (norm0 = 7.623, norm1 = 0.01535, norm01 = 7.624)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 16.4% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 21 [max:70]

iinla: Step rescaling: 99.78%, Approx Optimisation (norm0 = 6.714, norm1 = 0.01099, norm01 = 6.714)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 14.4% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 22 [max:70]

iinla: Step rescaling: 99.81%, Approx Optimisation (norm0 = 5.911, norm1 = 0.007921, norm01 = 5.911)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 12.6% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 23 [max:70]

iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 5.203, norm1 = 0.005749, norm01 = 5.203)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 11.1% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 24 [max:70]

iinla: Step rescaling: 99.86%, Approx Optimisation (norm0 = 4.578, norm1 = 0.004199, norm01 = 4.578)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 9.75% of SD, and line search is active [stop if: <10% and line s

```
## iinla: Iteration 25 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 4.028, norm1 = 0.003086, norm01 = 4.028)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.56% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 26 [max:70]

## iinla: Step rescaling: 99.9%, Approx Optimisation (norm0 = 3.543, norm1 = 0.00228, norm01 = 3.543)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.52% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 27 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 3.115, norm1 = 0.001693, norm01 = 3.116)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.6% of SD, and line search is inactive [stop if: <10% and line s

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 28 [max:70]

## Start creating grid...
## Finished creating grid, time  0.994504

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed
```

```
## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 1004, norm1 = 1727, norm01 = 1264)

## iinla: Step rescaling: 23.61%, Approx Optimisation (norm0 = 220.8, norm1 = 1085, norm01 = 1264)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1260, norm1 = 336, norm01 = 1112)

## iinla: Step rescaling: 100%, Overstep (norm0 = 879.5, norm1 = 280.3, norm01 = 1112)

## iinla: Step rescaling: 120.1%, Approx Optimisation (norm0 = 1012, norm1 = 226.6, norm01 = 1112)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1300% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 221.7, norm1 = 80.81, norm01 = 140.9)

## iinla: Step rescaling: 100%, Overstep (norm0 = 138.5, norm1 = 2.473, norm01 = 140.9)

## iinla: Step rescaling: 101.8%, Approx Optimisation (norm0 = 140.9, norm1 = 0.5128, norm01 = 140.9)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 271% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 97.38%, Approx Optimisation (norm0 = 40.51, norm1 = 3.933, norm01 = 41.06)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 119% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 96.96%, Approx Optimisation (norm0 = 37.53, norm1 = 3.384, norm01 = 37.97)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 112% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 96.35%, Approx Optimisation (norm0 = 35.59, norm1 = 2.92, norm01 = 35.93)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 109% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 96.06%, Approx Optimisation (norm0 = 34.12, norm1 = 2.521, norm01 = 34.38)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 104% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 96%, Approx Optimisation (norm0 = 32.92, norm1 = 2.176, norm01 = 33.12)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 99.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 96.08%, Approx Optimisation (norm0 = 31.82, norm1 = 1.873, norm01 = 31.97)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 95.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 96.25%, Approx Optimisation (norm0 = 30.73, norm1 = 1.604, norm01 = 30.85)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 90.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 96.48%, Approx Optimisation (norm0 = 29.59, norm1 = 1.364, norm01 = 29.68)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 85.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 96.74%, Approx Optimisation (norm0 = 28.39, norm1 = 1.151, norm01 = 28.46)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 80.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 97.01%, Approx Optimisation (norm0 = 27.12, norm1 = 0.9632, norm01 = 27.17)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 75.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 97.28%, Approx Optimisation (norm0 = 25.79, norm1 = 0.8004, norm01 = 25.83)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 71% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 97.54%, Approx Optimisation (norm0 = 24.42, norm1 = 0.6608, norm01 = 24.44)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 66.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 97.78%, Approx Optimisation (norm0 = 23.02, norm1 = 0.5426, norm01 = 23.04)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 61.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 98.01%, Approx Optimisation (norm0 = 21.61, norm1 = 0.4436, norm01 = 21.62)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 56.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 98.21%, Approx Optimisation (norm0 = 20.21, norm1 = 0.3615, norm01 = 20.22)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 52.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 98.39%, Approx Optimisation (norm0 = 18.84, norm1 = 0.2939, norm01 = 18.84)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 48.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 98.56%, Approx Optimisation (norm0 = 17.5, norm1 = 0.2386, norm01 = 17.51)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 44.3% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 98.71%, Approx Optimisation (norm0 = 16.21, norm1 = 0.1935, norm01 = 16.21)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 40.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 22 [max:70]

## iinla: Step rescaling: 98.84%, Approx Optimisation (norm0 = 14.97, norm1 = 0.1569, norm01 = 14.98)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 37.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 23 [max:70]

## iinla: Step rescaling: 98.96%, Approx Optimisation (norm0 = 13.8, norm1 = 0.1271, norm01 = 13.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 34% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 24 [max:70]
```

iinla: Step rescaling: 99.07%, Approx Optimisation (norm0 = 12.69, norm1 = 0.1031, norm01 = 12.69)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 31% of SD, and line search is active [stop if: <10% and line sea

iinla: Iteration 25 [max:70]

iinla: Step rescaling: 99.16%, Approx Optimisation (norm0 = 11.64, norm1 = 0.08356, norm01 = 11.65)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 28.3% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 26 [max:70]

iinla: Step rescaling: 99.25%, Approx Optimisation (norm0 = 10.67, norm1 = 0.06777, norm01 = 10.67)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 25.7% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 27 [max:70]

iinla: Step rescaling: 99.32%, Approx Optimisation (norm0 = 9.757, norm1 = 0.05498, norm01 = 9.757)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 23.4% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 28 [max:70]

iinla: Step rescaling: 99.39%, Approx Optimisation (norm0 = 8.911, norm1 = 0.04461, norm01 = 8.912)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 21.3% of SD, and line search is active [stop if: <10% and line s

```
## iinla: Iteration 29 [max:70]

## iinla: Step rescaling: 99.45%, Approx Optimisation (norm0 = 8.129, norm1 = 0.03622, norm01 = 8.129)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 19.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 30 [max:70]

## iinla: Step rescaling: 99.51%, Approx Optimisation (norm0 = 7.407, norm1 = 0.02941, norm01 = 7.407)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 17.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 31 [max:70]

## iinla: Step rescaling: 99.56%, Approx Optimisation (norm0 = 6.742, norm1 = 0.02389, norm01 = 6.742)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 15.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 32 [max:70]

## iinla: Step rescaling: 99.6%, Approx Optimisation (norm0 = 6.132, norm1 = 0.01941, norm01 = 6.132)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 33 [max:70]

## iinla: Step rescaling: 99.64%, Approx Optimisation (norm0 = 5.572, norm1 = 0.01577, norm01 = 5.572)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 13.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 34 [max:70]

## iinla: Step rescaling: 99.68%, Approx Optimisation (norm0 = 5.06, norm1 = 0.01282, norm01 = 5.06)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 11.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 35 [max:70]

## iinla: Step rescaling: 99.71%, Approx Optimisation (norm0 = 4.592, norm1 = 0.01042, norm01 = 4.592)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 36 [max:70]

## iinla: Step rescaling: 99.74%, Approx Optimisation (norm0 = 4.165, norm1 = 0.008477, norm01 = 4.165)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.73% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 37 [max:70]

## iinla: Step rescaling: 99.76%, Approx Optimisation (norm0 = 3.776, norm1 = 0.006894, norm01 = 3.776)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 38 [max:70]

## iinla: Step rescaling: 99.79%, Approx Optimisation (norm0 = 3.421, norm1 = 0.005607, norm01 = 3.421)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.96% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 39 [max:70]

## iinla: Step rescaling: 99.81%, Approx Optimisation (norm0 = 3.099, norm1 = 0.004561, norm01 = 3.099)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 40 [max:70]

## iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 2.806, norm1 = 0.00371, norm01 = 2.806)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.51% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 41 [max:70]

## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 2.54, norm1 = 0.003019, norm01 = 2.54)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.89% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 42 [max:70]

## iinla: Step rescaling: 99.86%, Approx Optimisation (norm0 = 2.298, norm1 = 0.002456, norm01 = 2.298)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.32% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 43 [max:70]

## iinla: Step rescaling: 99.87%, Approx Optimisation (norm0 = 2.079, norm1 = 0.001999, norm01 = 2.079)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.81% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 44 [max:70]

## iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 1.88, norm1 = 0.001626, norm01 = 1.88)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.35% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 45 [max:70]

## iinla: Step rescaling: 99.9%, Approx Optimisation (norm0 = 1.7, norm1 = 0.001323, norm01 = 1.7)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.93% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 46 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 1.537, norm1 = 0.001077, norm01 = 1.537)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.55% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 47 [max:70]
```
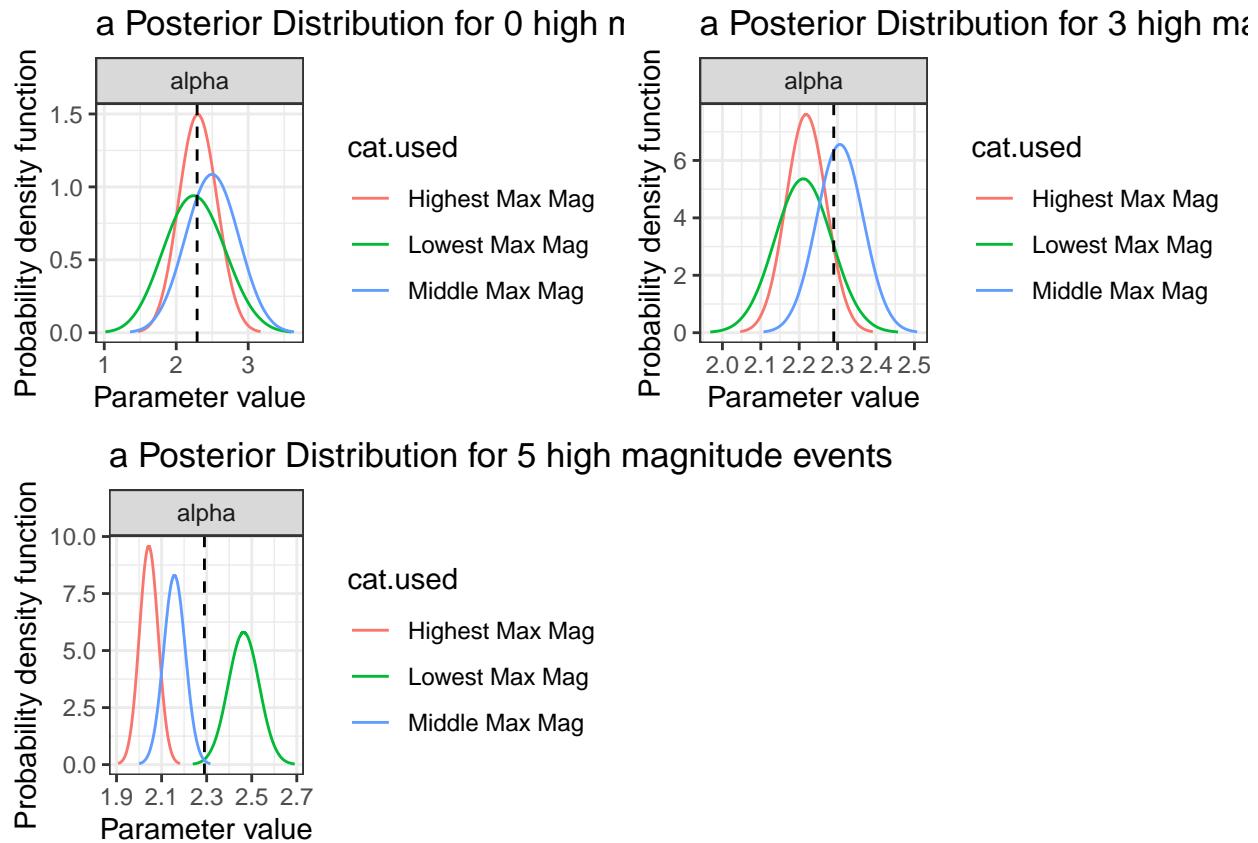
```r
# Example calculation for a suitable number of columns

num_plots <- length(plot_list)
num_columns <- ifelse(num_plots <= 2, num_plots, 2)
# Adjust '2' to change max columns

grid.arrange(grobs = plot_list, ncol = num_columns)
```

a Posterior Distribution for 0 high m

a Posterior Distribution for 3 high ma

a Posterior Distribution for 5 high magnitude events

#Exploring the posterior distribution changes of parameters #under different settings and the relationships between parameters

#First,fixed no parameter

```r
# set up list of bru options
bru.opt.list <- list(
  bru_verbose = 3,  # type of visual output
  bru_max_iter = 70,  # maximum number of iterations
  bru_initial = th.init  # parameters initial values
)

# Fit the model with all parameters
all_params.fit <- Temporal.ETAS(
  total.data = group_3_4_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f,
  coef.t. = 1,
  delta.t. = 0.1,
  N.max. = 5,
  bru.opt = bru.opt.list
)
```

```
## Start creating grid...
## Finished creating grid, time  0.704206
```

```
## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 306.6, norm1 = 373.6, norm01 = 270.8)

## iinla: Step rescaling: 26.71%, Approx Optimisation (norm0 = 72.07, norm1 = 218.6, norm01 = 270.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 384.6, norm1 = 290.2, norm01 = 240.8)

## iinla: Step rescaling: 100%, Overstep (norm0 = 219, norm1 = 121.5, norm01 = 240.8)

## iinla: Step rescaling: 80.55%, Approx Optimisation (norm0 = 176, norm1 = 106.5, norm01 = 240.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 351% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 226.7, norm1 = 79.57, norm01 = 148.1)

## iinla: Step rescaling: 100%, Overstep (norm0 = 143.3, norm1 = 7.732, norm01 = 148.1)

## iinla: Step rescaling: 103.2%, Approx Optimisation (norm0 = 147.6, norm1 = 6.353, norm01 = 148.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

iinla: Max deviation from previous: 148% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 4 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 96.66, norm1 = 29.34, norm01 = 70.36)

iinla: Step rescaling: 100%, Overstep (norm0 = 63.53, norm1 = 9.274, norm01 = 70.36)

iinla: Step rescaling: 109.7%, Approx Optimisation (norm0 = 69.04, norm1 = 7.338, norm01 = 70.36)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 162% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 5 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 67.82, norm1 = 21.92, norm01 = 46.48)

iinla: Step rescaling: 100%, Overstep (norm0 = 43.59, norm1 = 3.775, norm01 = 46.48)

iinla: Step rescaling: 106.5%, Approx Optimisation (norm0 = 46.23, norm1 = 2.678, norm01 = 46.48)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 92.2% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 6 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 47.52, norm1 = 16.51, norm01 = 31.3)

iinla: Step rescaling: 100%, Overstep (norm0 = 30.1, norm1 = 1.878, norm01 = 31.3)

iinla: Step rescaling: 103.7%, Approx Optimisation (norm0 = 31.18, norm1 = 1.531, norm01 = 31.3)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 89.1% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 7 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 35.51, norm1 = 12.87, norm01 = 22.81)

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 22.27, norm1 = 1.111, norm01 = 22.81)

## iinla: Step rescaling: 102.1%, Approx Optimisation (norm0 = 22.74, norm1 = 1.009, norm01 = 22.81)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 77.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 27.1, norm1 = 10.07, norm01 = 17.12)

## iinla: Step rescaling: 100%, Overstep (norm0 = 16.89, norm1 = 0.6846, norm01 = 17.12)

## iinla: Step rescaling: 101.2%, Approx Optimisation (norm0 = 17.08, norm1 = 0.6567, norm01 = 17.12)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 60.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 20.9, norm1 = 7.885, norm01 = 13.06)

## iinla: Step rescaling: 100%, Overstep (norm0 = 12.97, norm1 = 0.4158, norm01 = 13.06)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 13.04, norm1 = 0.4094, norm01 = 13.06)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 45.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 16.26, norm1 = 6.189, norm01 = 10.1)

## iinla: Step rescaling: 100%, Overstep (norm0 = 10.07, norm1 = 0.2483, norm01 = 10.1)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 10.09, norm1 = 0.2475, norm01 = 10.1)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 34.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 12.75, norm1 = 4.874, norm01 = 7.882)

## iinla: Step rescaling: 100%, Overstep (norm0 = 7.878, norm1 = 0.1467, norm01 = 7.882)

## iinla: Step rescaling: 99.99%, Approx Optimisation (norm0 = 7.878, norm1 = 0.1467, norm01 = 7.882)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 25.5% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 6.2, norm1 = 0.08582, norm01 = 6.201)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 19% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 4.91, norm1 = 0.04977, norm01 = 4.911)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 3.91, norm1 = 0.0287, norm01 = 3.911)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.7% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 3.13, norm1 = 0.01649, norm01 = 3.13)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.14% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.85%, Approx Optimisation (norm0 = 2.517, norm1 = 0.009459, norm01 = 2.517)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.62% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 2.033, norm1 = 0.005424, norm01 = 2.033)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.39% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.9%, Approx Optimisation (norm0 = 1.649, norm1 = 0.003114, norm01 = 1.649)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 1.343, norm1 = 0.001792, norm01 = 1.343)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.59% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 20 [max:70]
```

```r
# obtain posterior
all_params.post <- get_posterior_param(input.list = list(
  model.fit = all_params.fit,
  link.functions = link.f
))
all_params.post$post.df$cat.used <- "No Fixed parameters"
```

```r
df.true.param <- data.frame(
  x = unlist(true.param),
  param = names(true.param)
)
```

#Fixed K

```r
# Adjust priors to fix K parameter close to its true value
fixed_K_link_functions <- list(
  mu = \(x) gamma_t(x, 0.3, 0.6),
  K = \(x) gamma_t(x,true.param$K*10000, 10000),
  alpha = \(x) unif_t(x, 0, 5),
  c_ = \(x) unif_t(x, 0, 10),
  p = \(x) unif_t(x, 1, 10)
)
```

```r
# Inverse transformations list for fixed priors
fixed_K_inv_link_functions <- list(
  mu = \(x) inv_gamma_t(x, 0.3, 0.6),
  K = \(x) inv_gamma_t(x, true.param$K*10000, 10000),
  alpha = \(x) inv_unif_t(x, 0, 5),
  c_ = \(x) inv_unif_t(x, 0, 10),
  p = \(x) inv_unif_t(x, 1, 10)
)
```

```r
# Initial values for the fixed K parameters model
fixed_K_initial_values <- list(
  th.mu = fixed_K_inv_link_functions$mu(0.5),
  th.K = true.param$K,
  th.alpha = fixed_K_inv_link_functions$alpha(1),
  th.c = fixed_K_inv_link_functions$c_(0.1),
  th.p = fixed_K_inv_link_functions$p(1.1)
)
```

```r
# Set up list of bru options

bru_opt_list_fixed_K <- list(
  bru_verbose = 3,
  bru_max_iter = 70,
  bru_initial = fixed_K_initial_values
)
```

```r
# Fit the model with fixed K parameter
fixed_K_params_fit <- Temporal.ETAS(
  total.data = group_3_4_major_events[[1]],
```

```
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = fixed_K_link_functions,
  coef.t. = 1,
  delta.t. = 0.1,
  N.max. = 5,
  bru.opt = bru_opt_list_fixed_K
)
```

```
## Start creating grid...
## Finished creating grid, time  0.7005191
```

```
## iinla: Evaluate component inputs
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate component simplifications
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Construct inla stack
```

```
## iinla: Model initialisation completed
```

```
## iinla: Iteration 1 [max:70]
```

```
## iinla: Step rescaling: 61.8%, Contract (norm0 = 360.9, norm1 = 419.2, norm01 = 290.3)
```

```
## iinla: Step rescaling: 26.36%, Approx Optimisation (norm0 = 82.22, norm1 = 239.5, norm01 = 290.3)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Iteration 2 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 410.2, norm1 = 170.5, norm01 = 258.7)
```

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 252.9, norm1 = 55.9, norm01 = 258.7)
```

```
## iinla: Step rescaling: 95.61%, Approx Optimisation (norm0 = 241.7, norm1 = 55.78, norm01 = 258.7)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 484% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 174.4, norm1 = 62.41, norm01 = 112.1)

## iinla: Step rescaling: 100%, Overstep (norm0 = 109.4, norm1 = 3.175, norm01 = 112.1)

## iinla: Step rescaling: 102.5%, Approx Optimisation (norm0 = 112, norm1 = 1.79, norm01 = 112.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 218% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 101.1, norm1 = 34.41, norm01 = 66.79)

## iinla: Step rescaling: 100%, Overstep (norm0 = 64.3, norm1 = 2.672, norm01 = 66.79)

## iinla: Step rescaling: 104%, Approx Optimisation (norm0 = 66.75, norm1 = 1.03, norm01 = 66.79)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 123% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 71.13, norm1 = 24.93, norm01 = 46.42)

## iinla: Step rescaling: 100%, Overstep (norm0 = 45.04, norm1 = 2.021, norm01 = 46.42)

## iinla: Step rescaling: 103%, Approx Optimisation (norm0 = 46.33, norm1 = 1.55, norm01 = 46.42)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 140% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 50.24, norm1 = 17.97, norm01 = 32.49)

## iinla: Step rescaling: 100%, Overstep (norm0 = 31.65, norm1 = 1.554, norm01 = 32.49)
```

```
## iinla: Step rescaling: 102.4%, Approx Optimisation (norm0 = 32.4, norm1 = 1.361, norm01 = 32.49)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 118% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 35.5, norm1 = 12.77, norm01 = 22.85)

## iinla: Step rescaling: 100%, Overstep (norm0 = 22.31, norm1 = 0.9925, norm01 = 22.85)

## iinla: Step rescaling: 102.3%, Approx Optimisation (norm0 = 22.8, norm1 = 0.8586, norm01 = 22.85)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 88.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 25.18, norm1 = 9.104, norm01 = 16.12)

## iinla: Step rescaling: 100%, Overstep (norm0 = 15.78, norm1 = 0.5736, norm01 = 16.12)

## iinla: Step rescaling: 102.1%, Approx Optimisation (norm0 = 16.1, norm1 = 0.474, norm01 = 16.12)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 64.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 18.01, norm1 = 6.562, norm01 = 11.47)

## iinla: Step rescaling: 100%, Overstep (norm0 = 11.26, norm1 = 0.3172, norm01 = 11.47)

## iinla: Step rescaling: 101.8%, Approx Optimisation (norm0 = 11.46, norm1 = 0.2475, norm01 = 11.47)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

iinla: Max deviation from previous: 46% of SD, and line search is active [stop if: <10% and line sea

iinla: Iteration 10 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 13.01, norm1 = 4.78, norm01 = 8.233)

iinla: Step rescaling: 100%, Overstep (norm0 = 8.113, norm1 = 0.1719, norm01 = 8.233)

iinla: Step rescaling: 101.5%, Approx Optimisation (norm0 = 8.23, norm1 = 0.1258, norm01 = 8.233)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 32.7% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 11 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 9.477, norm1 = 3.511, norm01 = 5.968)

iinla: Step rescaling: 100%, Overstep (norm0 = 5.9, norm1 = 0.0924, norm01 = 5.968)

iinla: Step rescaling: 101.2%, Approx Optimisation (norm0 = 5.967, norm1 = 0.06322, norm01 = 5.968)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 23.8% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 12 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 6.958, norm1 = 2.596, norm01 = 4.362)

iinla: Step rescaling: 100%, Overstep (norm0 = 4.324, norm1 = 0.04954, norm01 = 4.362)

iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 4.362, norm1 = 0.03164, norm01 = 4.362)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 18.1% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 13 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 5.14, norm1 = 1.929, norm01 = 3.211)

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 3.19, norm1 = 0.02659, norm01 = 3.211)

## iinla: Step rescaling: 100.7%, Approx Optimisation (norm0 = 3.211, norm1 = 0.01587, norm01 = 3.211)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 13.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.814, norm1 = 1.438, norm01 = 2.376)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.364, norm1 = 0.01431, norm01 = 2.376)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 2.376, norm1 = 0.008003, norm01 = 2.376)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.839, norm1 = 1.074, norm01 = 1.765)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.759, norm1 = 0.007733, norm01 = 1.765)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 1.765, norm1 = 0.004069, norm01 = 1.765)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.67% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.118, norm1 = 0.8031, norm01 = 1.315)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.311, norm1 = 0.004193, norm01 = 1.315)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 1.315, norm1 = 0.002088, norm01 = 1.315)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.73% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.582, norm1 = 0.6009, norm01 = 0.9808)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.9788, norm1 = 0.002282, norm01 = 0.9808)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.9808, norm1 = 0.001082, norm01 = 0.9808

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.28% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.182, norm1 = 0.4497, norm01 = 0.7324)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.7313, norm1 = 0.001246, norm01 = 0.7324)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.7324, norm1 = 0.0005664, norm01 = 0.732

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.19% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.8835, norm1 = 0.3365, norm01 = 0.547)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.5464, norm1 = 0.0006825, norm01 = 0.547)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.547, norm1 = 0.0002994, norm01 = 0.547

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.38% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 20 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 0.6603, norm1 = 0.2517, norm01 = 0.4086)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.4083, norm1 = 0.000375, norm01 = 0.4086)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.4086, norm1 = 0.0001598, norm01 = 0.408

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.77% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 21 [max:70]
```

```r
# Obtain posterior distribution

fixed_K_params_post <- get_posterior_param(input.list = list(
  model.fit = fixed_K_params_fit,
  link.functions = fixed_K_link_functions
))

# Set model identifiers for drawing

fixed_K_params_post$post.df$cat.used <- "Fixed K on the true value"
```

#Wrong K

```r
# Adjust priors to wrong K parameter
wrong_K_link_functions <- list(
  mu = \(x) gamma_t(x, 0.3, 0.6),
  K = \(x) gamma_t(x,1.5*true.param$K*10000, 10000),
  alpha = \(x) unif_t(x, 0, 5),
  c_ = \(x) unif_t(x, 0, 10),
  p = \(x) unif_t(x, 1, 10)
)

# Inverse transformations list for wrong priors
wrong_K_inv_link_functions <- list(
  mu = \(x) inv_gamma_t(x, 0.3, 0.6),
  K = \(x) inv_gamma_t(x, 1.5*true.param$K*10000, 10000),
  alpha = \(x) inv_unif_t(x, 0, 5),
  c_ = \(x) inv_unif_t(x, 0, 10),
  p = \(x) inv_unif_t(x, 1, 10)
)

# Initial values for the wrong K parameters model
wrong_K_initial_values <- list(
  th.mu = wrong_K_inv_link_functions$mu(0.5),
  th.K = 1.5*true.param$K,
```

```
    th.alpha = wrong_K_inv_link_functions$alpha(1),
    th.c = wrong_K_inv_link_functions$c_(0.1),
    th.p = wrong_K_inv_link_functions$p(1.1)
)



bru_opt_list_wrong_K <- list(
  bru_verbose = 3,
  bru_max_iter = 70,
  bru_initial = wrong_K_initial_values
)



# Fit the model with wrong K parameter
wrong_K_params_fit <- Temporal.ETAS(
  total.data = group_3_4_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = wrong_K_link_functions,
  coef.t. = 1,
  delta.t. = 0.1,
  N.max. = 5,
  bru.opt = bru_opt_list_wrong_K
)
```

```
## Start creating grid...
## Finished creating grid, time  0.6736181

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 360.1, norm1 = 402, norm01 = 282.7)

## iinla: Step rescaling: 27.35%, Approx Optimisation (norm0 = 86.98, norm1 = 229.2, norm01 = 282.7)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 397.8, norm1 = 173.5, norm01 = 250.2)

## iinla: Step rescaling: 100%, Overstep (norm0 = 244.4, norm1 = 59.63, norm01 = 250.2)

## iinla: Step rescaling: 94.46%, Approx Optimisation (norm0 = 230.8, norm1 = 58.95, norm01 = 250.2)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 510% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 164.8, norm1 = 60.88, norm01 = 103.9)

## iinla: Step rescaling: 100%, Overstep (norm0 = 102.7, norm1 = 1.855, norm01 = 103.9)

## iinla: Step rescaling: 101.2%, Approx Optimisation (norm0 = 103.9, norm1 = 1.364, norm01 = 103.9)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 209% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 83.5, norm1 = 28.72, norm01 = 54.85)

## iinla: Step rescaling: 100%, Overstep (norm0 = 52.96, norm1 = 2.083, norm01 = 54.85)

## iinla: Step rescaling: 103.7%, Approx Optimisation (norm0 = 54.82, norm1 = 0.9211, norm01 = 54.85)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 119% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 61.67, norm1 = 21.65, norm01 = 40.23)

## iinla: Step rescaling: 100%, Overstep (norm0 = 39, norm1 = 1.839, norm01 = 40.23)
```

```
## iinla: Step rescaling: 103%, Approx Optimisation (norm0 = 40.14, norm1 = 1.442, norm01 = 40.23)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 131% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 44.61, norm1 = 15.95, norm01 = 28.84)

## iinla: Step rescaling: 100%, Overstep (norm0 = 28.08, norm1 = 1.342, norm01 = 28.84)

## iinla: Step rescaling: 102.5%, Approx Optimisation (norm0 = 28.76, norm1 = 1.156, norm01 = 28.84)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 108% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 32.08, norm1 = 11.57, norm01 = 20.61)

## iinla: Step rescaling: 100%, Overstep (norm0 = 20.13, norm1 = 0.8479, norm01 = 20.61)

## iinla: Step rescaling: 102.2%, Approx Optimisation (norm0 = 20.57, norm1 = 0.7293, norm01 = 20.61)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 81.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 23.13, norm1 = 8.406, norm01 = 14.76)

## iinla: Step rescaling: 100%, Overstep (norm0 = 14.48, norm1 = 0.498, norm01 = 14.76)

## iinla: Step rescaling: 101.9%, Approx Optimisation (norm0 = 14.75, norm1 = 0.4177, norm01 = 14.76)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 59.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 16.77, norm1 = 6.141, norm01 = 10.64)

## iinla: Step rescaling: 100%, Overstep (norm0 = 10.47, norm1 = 0.282, norm01 = 10.64)

## iinla: Step rescaling: 101.6%, Approx Optimisation (norm0 = 10.63, norm1 = 0.2285, norm01 = 10.64)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 43.3% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 12.24, norm1 = 4.516, norm01 = 7.726)

## iinla: Step rescaling: 100%, Overstep (norm0 = 7.625, norm1 = 0.1567, norm01 = 7.726)

## iinla: Step rescaling: 101.3%, Approx Optimisation (norm0 = 7.723, norm1 = 0.1218, norm01 = 7.726)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 31.3% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 8.989, norm1 = 3.341, norm01 = 5.651)

## iinla: Step rescaling: 100%, Overstep (norm0 = 5.592, norm1 = 0.08631, norm01 = 5.651)

## iinla: Step rescaling: 101%, Approx Optimisation (norm0 = 5.65, norm1 = 0.06404, norm01 = 5.651)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 22.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 6.645, norm1 = 2.484, norm01 = 4.162)
```

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 4.128, norm1 = 0.04734, norm01 = 4.162)

## iinla: Step rescaling: 100.8%, Approx Optimisation (norm0 = 4.161, norm1 = 0.03342, norm01 = 4.162)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 16.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 4.939, norm1 = 1.855, norm01 = 3.084)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.064, norm1 = 0.02595, norm01 = 3.084)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 3.083, norm1 = 0.01739, norm01 = 3.084)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 12.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.687, norm1 = 1.39, norm01 = 2.296)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.285, norm1 = 0.01425, norm01 = 2.296)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 2.296, norm1 = 0.009058, norm01 = 2.296)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.78% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.761, norm1 = 1.045, norm01 = 1.717)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.711, norm1 = 0.007839, norm01 = 1.717)

## iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 1.717, norm1 = 0.004732, norm01 = 1.717)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 2.074, norm1 = 0.7864, norm01 = 1.287)

## iinla: Step rescaling: 100%, Overstep (norm0 = 1.284, norm1 = 0.004325, norm01 = 1.287)

## iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 1.287, norm1 = 0.002485, norm01 = 1.287)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.58% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.56, norm1 = 0.5927, norm01 = 0.9675)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.9655, norm1 = 0.002394, norm01 = 0.9675)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.9675, norm1 = 0.001312, norm01 = 0.967

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.21% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.175, norm1 = 0.447, norm01 = 0.7281)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.7269, norm1 = 0.001329, norm01 = 0.7281)

## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.7281, norm1 = 0.000698, norm01 = 0.728

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.17% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 0.8857, norm1 = 0.3373, norm01 = 0.5484)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.5478, norm1 = 0.0007399, norm01 = 0.5484)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.5484, norm1 = 0.0003741, norm01 = 0.548

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.39% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.6678, norm1 = 0.2545, norm01 = 0.4133)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.4129, norm1 = 0.0004132, norm01 = 0.4133)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.4133, norm1 = 0.000202, norm01 = 0.4133

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.79% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 21 [max:70]
```

```r
#Obtain posterior distribution
wrong_K_params_post <- get_posterior_param(input.list = list(
  model.fit = wrong_K_params_fit,
  link.functions = wrong_K_link_functions
))

# Set model identifiers for drawing

wrong_K_params_post$post.df$cat.used <- "Wrong K"

# Merge posterior distribution data frames for plotting
bind_post_df <- rbind(all_params.post$post.df, fixed_K_params_post$post.df,
                      wrong_K_params_post$post.df)
```
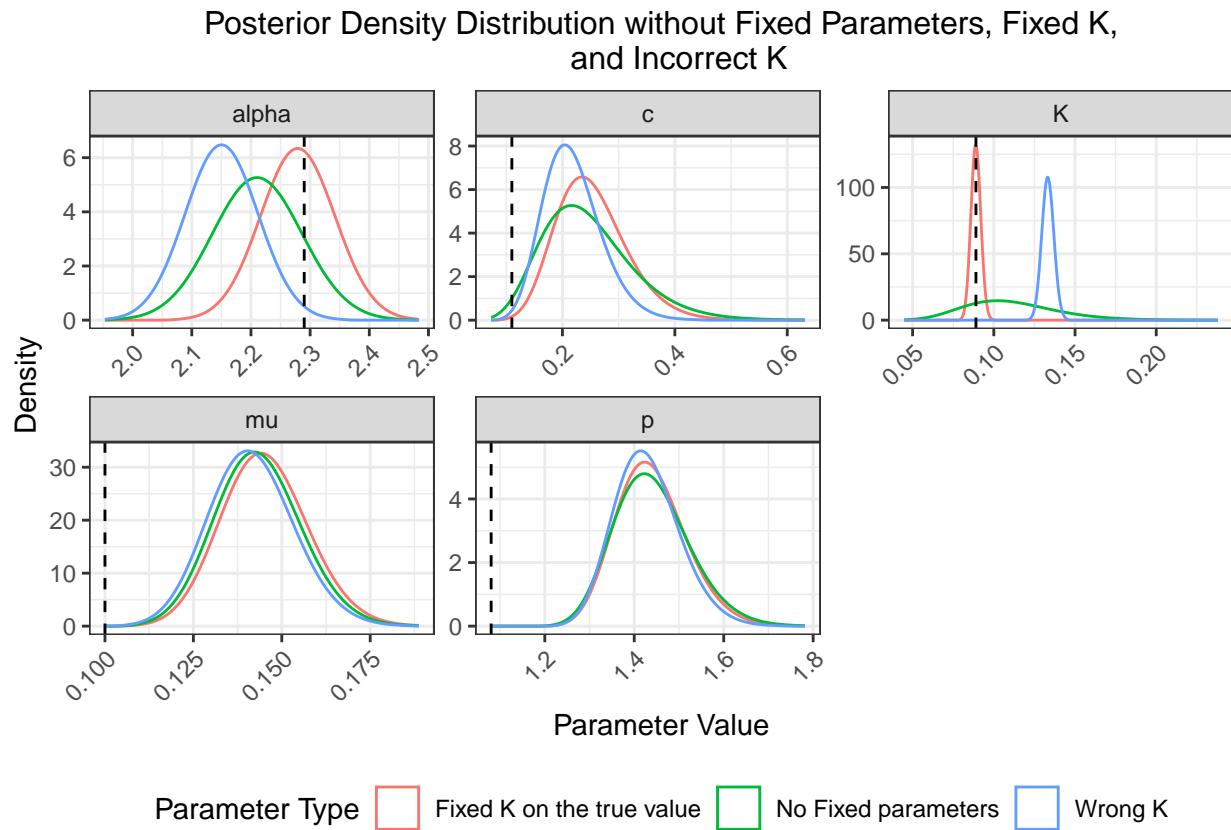
#Plot

```r
library(ggplot2)
#plot Posterior density distributions for All Params, Fixed K, and Wrong K

ggplot(bind_post_df, aes(x = x, color = cat.used)) +
  geom_density(alpha = 0.5, fill = NA) +  # Set the filling  transparent
  facet_wrap(~param, scales = "free") +
  xlab("Parameter Value") +  # X-axis label
  ylab("Density") +  # Y-axis label
  geom_vline(data = df.true.param, aes(xintercept = x), linetype = "dashed",
             color = "black") +  # add true value
  theme_minimal() +
  labs(
    title = "Posterior Density Distribution without Fixed Parameters, Fixed K,
    and Incorrect K",
    color = "Parameter Type",
    linetype = "Line Type"
  ) +
  theme_bw() +
  theme(
    axis.text.x = element_text(angle = 45, hjust = 1),
    legend.position = "bottom",
    plot.title = element_text(size = 12, hjust = 0.5)
  )
```

Posterior Density Distribution without Fixed Parameters, Fixed K, and Incorrect K

#Check

```r
# Kolmogorov-Smirnov
#ks_test <- ks.test(all_params.post$post.df$x, fixed_K_params_post$post.df$x)

# print p value
#print(ks_test$p.value)#
```

#Fixed mu

```r
# Adjust priors to specifically fix parameter 'mu' close to its true value
link.f_fixed_mu <- list(
  mu = \(x) gamma_t(x, true.param$mu * 10000, 10000),
  K = \(x) unif_t(x, 0, 10),
  alpha = \(x) unif_t(x, 0, 5),
  c_ = \(x) unif_t(x, 0, 10),
  p = \(x) unif_t(x, 1, 10)
)

# Inverse transformations list specifically for the fixed 'mu' scenario
inv_link.f_fixed_mu <- list(
  mu = \(x) inv_gamma_t(x, true.param$mu * 10000, 10000),
  K = \(x) inv_unif_t(x, 0, 10),
  alpha = \(x) inv_unif_t(x, 0, 5),
  c_ = \(x) inv_unif_t(x, 0, 10),
  p = \(x) inv_unif_t(x, 1, 10)
)

# Initial values specifically adjusted for the fixed 'mu' scenario
init_values_fixed_mu <- list(
  th.mu = true.param$mu,  # Setting directly to true value
  th.K = inv_link.f_fixed_mu$K(0.1),
  th.alpha = inv_link.f_fixed_mu$alpha(1),
  th.c = inv_link.f_fixed_mu$c_(0.1),
  th.p = inv_link.f_fixed_mu$p(1.1)
)

# Optimization options specifically set for the fixed 'mu' scenario
opt_list_fixed_mu <- list(
  bru_verbose = 3,
  bru_max_iter = 70,
  bru_initial = init_values_fixed_mu
)

# Fit the model with 'mu' fixed
fixed_mu_fit <- Temporal.ETAS(
  total.data = group_3_4_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f_fixed_mu,
  coef.t. = 1,
  delta.t. = 0.1,
  N.max. = 5,
  bru.opt = opt_list_fixed_mu
```

```
)
```

```
## Start creating grid...
## Finished creating grid, time  0.693872

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations

## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1409, norm1 = 1650, norm01 = 579.3)

## iinla: Step rescaling: 100%, Overstep (norm0 = 519.9, norm1 = 695.5, norm01 = 579.3)

## iinla: Step rescaling: 47.17%, Approx Optimisation (norm0 = 210.1, norm1 = 405, norm01 = 579.3)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 573.3, norm1 = 181.1, norm01 = 394.8)

## iinla: Step rescaling: 100%, Overstep (norm0 = 368.9, norm1 = 30.12, norm01 = 394.8)

## iinla: Step rescaling: 107.2%, Approx Optimisation (norm0 = 393.7, norm1 = 17, norm01 = 394.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 422% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 101.1, norm1 = 32.81, norm01 = 73.02)

## iinla: Step rescaling: 100%, Overstep (norm0 = 66.1, norm1 = 10.7, norm01 = 73.02)
```

```
## iinla: Step rescaling: 108.2%, Approx Optimisation (norm0 = 70.94, norm1 = 9.433, norm01 = 73.02)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 161% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 62.95, norm1 = 23.06, norm01 = 41.1)

## iinla: Step rescaling: 100%, Overstep (norm0 = 39.64, norm1 = 3.876, norm01 = 41.1)

## iinla: Step rescaling: 102.4%, Approx Optimisation (norm0 = 40.57, norm1 = 3.759, norm01 = 41.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 97% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 48.81, norm1 = 19.06, norm01 = 30.13)

## iinla: Step rescaling: 100%, Overstep (norm0 = 30.12, norm1 = 1.844, norm01 = 30.13)

## iinla: Step rescaling: 99.47%, Approx Optimisation (norm0 = 29.96, norm1 = 1.837, norm01 = 30.13)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 79.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 98.69%, Approx Optimisation (norm0 = 24.44, norm1 = 0.8715, norm01 = 24.48)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 68.5% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 7 [max:70]
```

```
## iinla: Step rescaling: 98.73%, Approx Optimisation (norm0 = 20.85, norm1 = 0.3987, norm01 = 20.86)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 59.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 98.99%, Approx Optimisation (norm0 = 18.02, norm1 = 0.1865, norm01 = 18.03)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 51.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 99.22%, Approx Optimisation (norm0 = 15.51, norm1 = 0.09339, norm01 = 15.51)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 44% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 99.4%, Approx Optimisation (norm0 = 13.21, norm1 = 0.05072, norm01 = 13.21)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 37% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 99.52%, Approx Optimisation (norm0 = 11.16, norm1 = 0.02963, norm01 = 11.16)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 30.9% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.62%, Approx Optimisation (norm0 = 9.362, norm1 = 0.01828, norm01 = 9.362)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 25.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.69%, Approx Optimisation (norm0 = 7.821, norm1 = 0.01171, norm01 = 7.821)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 21.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.74%, Approx Optimisation (norm0 = 6.516, norm1 = 0.007694, norm01 = 6.516)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 17.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.79%, Approx Optimisation (norm0 = 5.419, norm1 = 0.005133, norm01 = 5.419)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 4.501, norm1 = 0.003459, norm01 = 4.501)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 12.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.86%, Approx Optimisation (norm0 = 3.736, norm1 = 0.002346, norm01 = 3.736)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.99% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 3.1, norm1 = 0.001598, norm01 = 3.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.27% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 2.571, norm1 = 0.001092, norm01 = 2.571)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.85% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 20 [max:70]
```

```r
# Retrieve posterior distributions specifically for the fixed 'mu' scenario
posterior_fixed_mu <- get_posterior_param(input.list = list(
  model.fit = fixed_mu_fit,
  link.functions = link.f_fixed_mu
))

# Set model identifier specifically mentioning 'Fixed mu' for plotting
posterior_fixed_mu$post.df$cat.used <- "Fixed mu on the true value"
```

#wrong mu

```r
# Adjust priors to specifically wrong parameter 'mu'
link.f_wrong_mu <- list(
  mu = \(x) gamma_t(x, 1.5*true.param$mu * 10000, 10000),
  K = \(x) unif_t(x, 0, 10),
  alpha = \(x) unif_t(x, 0, 5),
  c_ = \(x) unif_t(x, 0, 10),
  p = \(x) unif_t(x, 1, 10)
)

# Inverse transformations list specifically for the wrong 'mu' scenario
inv_link.f_wrong_mu <- list(
  mu = \(x) inv_gamma_t(x, 1.5*true.param$mu * 10000, 10000),
  K = \(x) inv_unif_t(x, 0, 10),
  alpha = \(x) inv_unif_t(x, 0, 5),
  c_ = \(x) inv_unif_t(x, 0, 10),
  p = \(x) inv_unif_t(x, 1, 10)
)

# Initial values specifically adjusted for the wrong 'mu' scenario
init_values_wrong_mu <- list(
  th.mu = 1.5*true.param$mu,  # Setting directly to true value
  th.K = inv_link.f_wrong_mu$K(0.1),
  th.alpha = inv_link.f_wrong_mu$alpha(1),
  th.c = inv_link.f_wrong_mu$c_(0.1),
  th.p = inv_link.f_wrong_mu$p(1.1)
)

# Optimization options specifically set for the wrong 'mu' scenario
opt_list_wrong_mu <- list(
  bru_verbose = 3,
  bru_max_iter = 70,
  bru_initial = init_values_wrong_mu
)

# Fit the model with 'mu' wrong
wrong_mu_fit <- Temporal.ETAS(
  total.data =group_3_4_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f_wrong_mu,
  coef.t. = 1,
  delta.t. = 0.1,
  N.max. = 5,
  bru.opt = opt_list_wrong_mu
)
```

```
## Start creating grid...
## Finished creating grid, time  0.8179789


## iinla: Evaluate component inputs


## iinla: Evaluate component linearisations
```

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```
## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 38.44%, Approx Optimisation (norm0 = 152.9, norm1 = 369.7, norm01 = 497.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 501.1, norm1 = 155.9, norm01 = 365.3)

## iinla: Step rescaling: 100%, Overstep (norm0 = 328.6, norm1 = 52.57, norm01 = 365.3)

## iinla: Step rescaling: 109.4%, Approx Optimisation (norm0 = 356.1, norm1 = 44.01, norm01 = 365.3)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 415% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 98.7, norm1 = 34.35, norm01 = 72.22)

## iinla: Step rescaling: 100%, Overstep (norm0 = 64.76, norm1 = 12.83, norm01 = 72.22)

## iinla: Step rescaling: 107%, Approx Optimisation (norm0 = 68.8, norm1 = 12.08, norm01 = 72.22)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 196% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 61.07, norm1 = 23.04, norm01 = 39.54)
```

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 38.29, norm1 = 4.186, norm01 = 39.54)

## iinla: Step rescaling: 101.5%, Approx Optimisation (norm0 = 38.87, norm1 = 4.143, norm01 = 39.54)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 105% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 99.13%, Approx Optimisation (norm0 = 29.75, norm1 = 1.848, norm01 = 29.92)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 80.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 98.61%, Approx Optimisation (norm0 = 25.25, norm1 = 0.9147, norm01 = 25.3)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 68.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 98.66%, Approx Optimisation (norm0 = 21.88, norm1 = 0.464, norm01 = 21.89)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 60.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 98.88%, Approx Optimisation (norm0 = 19.01, norm1 = 0.2387, norm01 = 19.01)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 52.1% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 99.1%, Approx Optimisation (norm0 = 16.42, norm1 = 0.1268, norm01 = 16.42)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 44.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 99.29%, Approx Optimisation (norm0 = 14.06, norm1 = 0.07048, norm01 = 14.06)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 37.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 99.44%, Approx Optimisation (norm0 = 11.92, norm1 = 0.0411, norm01 = 11.92)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 31.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.55%, Approx Optimisation (norm0 = 10.03, norm1 = 0.02498, norm01 = 10.03)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 26.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.63%, Approx Optimisation (norm0 = 8.391, norm1 = 0.01568, norm01 = 8.391)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 21.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.7%, Approx Optimisation (norm0 = 6.986, norm1 = 0.01007, norm01 = 6.986)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.76%, Approx Optimisation (norm0 = 5.796, norm1 = 0.006578, norm01 = 5.796)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 15% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.8%, Approx Optimisation (norm0 = 4.797, norm1 = 0.004342, norm01 = 4.797)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 12.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 3.963, norm1 = 0.002887, norm01 = 3.963)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.87%, Approx Optimisation (norm0 = 3.27, norm1 = 0.00193, norm01 = 3.27)
```

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 8.36% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 19 [max:70]

iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 2.695, norm1 = 0.001295, norm01 = 2.695)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 6.87% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 20 [max:70]

iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 2.22, norm1 = 0.0008706, norm01 = 2.22)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 5.65% of SD, and line search is inactive [stop if: <10% and line

iinla: Convergence criterion met, running final INLA integration with known theta mode.

iinla: Iteration 21 [max:70]

```r
# Retrieve posterior distributions specifically for the wrong 'mu' scenario
posterior_wrong_mu <- get_posterior_param(input.list = list(
  model.fit = wrong_mu_fit,
  link.functions = link.f_wrong_mu
))

# Set model identifier specifically mentioning 'wrong mu' for plotting
posterior_wrong_mu$post.df$cat.used <- "wrong mu"
```

#plot
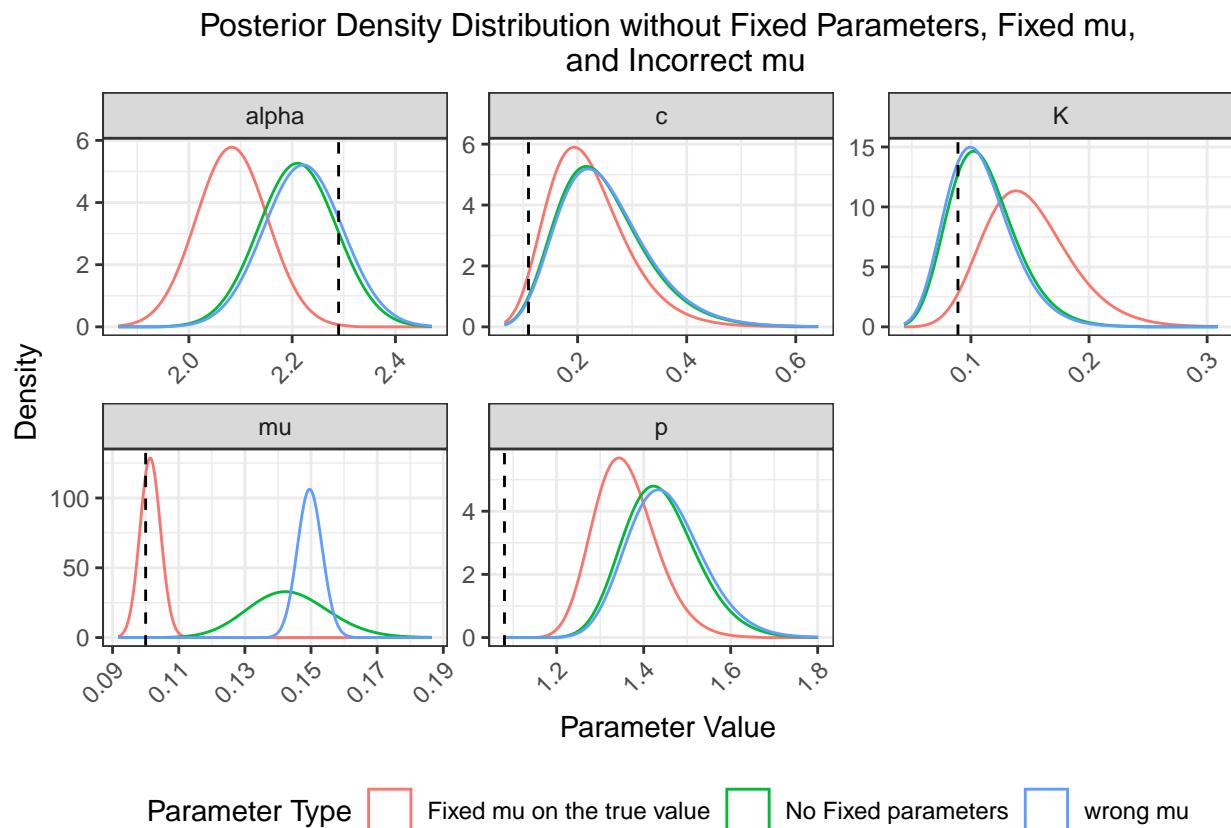
```r
# Merge posterior distribution data frames for plotting
bind_post_df <- rbind(all_params.post$post.df, posterior_fixed_mu$post.df,
                      posterior_wrong_mu$post.df)
```

```
# Plot the posterior density distributions
ggplot(bind_post_df, aes(x = x, color = cat.used)) +
  geom_density(alpha = 0.5, fill = NA) +
  facet_wrap(~param, scales = "free") +
  xlab("Parameter Value") +
  ylab("Density") +
  geom_vline(data = df.true.param, aes(xintercept = x), linetype = "dashed",
             color = "black") +
  theme_minimal() +
  labs(
    title = "Posterior Density Distribution without Fixed Parameters, Fixed mu,
    and Incorrect mu",
    color = "Parameter Type",
    linetype = "Line Type"
  ) +
  theme_bw() +
  theme(
    axis.text.x = element_text(angle = 45, hjust = 1),
    legend.position = "bottom",
    plot.title = element_text(size = 12, hjust = 0.5)
  )
```


Posterior Density Distribution without Fixed Parameters, Fixed mu, and Incorrect mu

#check

```r
# ks test
#ks_test <- ks.test(all_params.post$post.df$x, posterior_fixed_mu$post.df$x)

# p value
#print(ks_test$p.value)
```

#fixed alpha

```r
# Adjust priors to specifically fix parameter 'alpha' close to its true value
link.f_fixed_alpha <- list(
  mu = \(x) gamma_t(x, 0.3, 0.6),
  K = \(x) unif_t(x, 0, 10),
  alpha = \(x) gamma_t(x, true.param$alpha * 10000, 10000),
  c_ = \(x) unif_t(x, 0, 10),
  p = \(x) unif_t(x, 1, 10)
)

# Inverse transformations list specifically for the fixed 'alpha' scenario
inv_link.f_fixed_alpha <- list(
  mu = \(x) inv_gamma_t(x, 0.3, 0.6),
  K = \(x) inv_unif_t(x, 0, 10),
  alpha = \(x) inv_gamma_t(x, true.param$alpha * 10000, 10000),
  c_ = \(x) inv_unif_t(x, 0, 10),
  p = \(x) inv_unif_t(x, 1, 10)
)

# Initial values specifically adjusted for the fixed 'alpha' scenario
init_values_fixed_alpha <- list(
  th.mu = inv_link.f_fixed_alpha$mu(0.5),
  th.K = inv_link.f_fixed_alpha$K(0.1),
  th.alpha = true.param$alpha,  # Setting directly to true value
  th.c = inv_link.f_fixed_alpha$c_(0.1),
  th.p = inv_link.f_fixed_alpha$p(1.1)
)

# Optimization options specifically set for the fixed 'alpha' scenario
opt_list_fixed_alpha <- list(
  bru_verbose = 3,
  bru_max_iter = 70,
  bru_initial = init_values_fixed_alpha
)

# Fit the model with 'alpha' fixed
fixed_alpha_fit <- Temporal.ETAS(
  total.data =group_3_4_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f_fixed_alpha,
  coef.t. = 1,
  delta.t. = 0.1,
  N.max. = 5,
  bru.opt = opt_list_fixed_alpha
```

```
)
```

```
## Start creating grid...
## Finished creating grid, time  0.7847891
```

```
## iinla: Evaluate component inputs
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate component simplifications
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Construct inla stack
```

```
## iinla: Model initialisation completed
```

```
## iinla: Iteration 1 [max:70]
```

```
## iinla: Step rescaling: 61.8%, Contract (norm0 = 249.6, norm1 = 141.3, norm01 = 144.5)
```

```
## iinla: Step rescaling: 38.2%, Contract (norm0 = 110.1, norm1 = 60.63, norm01 = 144.5)
```

```
## iinla: Step rescaling: 41.47%, Approx Optimisation (norm0 = 125.9, norm1 = 58.8, norm01 = 144.5)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Iteration 2 [max:70]
```

```
## iinla: Step rescaling: 87.55%, Approx Optimisation (norm0 = 67.71, norm1 = 23.66, norm01 = 77.33)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 338% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 3 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 82.94, norm1 = 30.46, norm01 = 52.49)
```

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 51.73, norm1 = 0.8403, norm01 = 52.49)
```

```
## iinla: Step rescaling: 101.5%, Approx Optimisation (norm0 = 52.49, norm1 = 0.3608, norm01 = 52.49)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 20.3% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 29.32, norm1 = 10.69, norm01 = 18.63)

## iinla: Step rescaling: 100%, Overstep (norm0 = 18.32, norm1 = 0.3216, norm01 = 18.63)

## iinla: Step rescaling: 101.7%, Approx Optimisation (norm0 = 18.63, norm1 = 0.06691, norm01 = 18.63)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 57.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 19.12, norm1 = 6.943, norm01 = 12.18)

## iinla: Step rescaling: 100%, Overstep (norm0 = 11.96, norm1 = 0.2482, norm01 = 12.18)

## iinla: Step rescaling: 101.9%, Approx Optimisation (norm0 = 12.18, norm1 = 0.1083, norm01 = 12.18)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 37.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 13.79, norm1 = 5.06, norm01 = 8.728)

## iinla: Step rescaling: 100%, Overstep (norm0 = 8.6, norm1 = 0.1461, norm01 = 8.728)

## iinla: Step rescaling: 101.5%, Approx Optimisation (norm0 = 8.727, norm1 = 0.07148, norm01 = 8.728)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 27.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 7 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 10.03, norm1 = 3.718, norm01 = 6.314)

## iinla: Step rescaling: 100%, Overstep (norm0 = 6.243, norm1 = 0.08076, norm01 = 6.314)

## iinla: Step rescaling: 101.1%, Approx Optimisation (norm0 = 6.314, norm1 = 0.03989, norm01 = 6.314)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 20.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 7.335, norm1 = 2.739, norm01 = 4.596)

## iinla: Step rescaling: 100%, Overstep (norm0 = 4.557, norm1 = 0.04415, norm01 = 4.596)

## iinla: Step rescaling: 100.9%, Approx Optimisation (norm0 = 4.595, norm1 = 0.02163, norm01 = 4.596)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 15.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 5.383, norm1 = 2.022, norm01 = 3.361)

## iinla: Step rescaling: 100%, Overstep (norm0 = 3.34, norm1 = 0.02412, norm01 = 3.361)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 3.361, norm1 = 0.01171, norm01 = 3.361)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 11.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 3.961, norm1 = 1.494, norm01 = 2.467)

## iinla: Step rescaling: 100%, Overstep (norm0 = 2.455, norm1 = 0.0132, norm01 = 2.467)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 2.467, norm1 = 0.006361, norm01 = 2.467)
```

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 8.79% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 11 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 2.921, norm1 = 1.105, norm01 = 1.815)

iinla: Step rescaling: 100%, Overstep (norm0 = 1.809, norm1 = 0.007233, norm01 = 1.815)

iinla: Step rescaling: 100.4%, Approx Optimisation (norm0 = 1.815, norm1 = 0.003468, norm01 = 1.815)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 6.56% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 12 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 2.157, norm1 = 0.8184, norm01 = 1.339)

iinla: Step rescaling: 100%, Overstep (norm0 = 1.335, norm1 = 0.003971, norm01 = 1.339)

iinla: Step rescaling: 100.3%, Approx Optimisation (norm0 = 1.339, norm1 = 0.001897, norm01 = 1.339)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 4.88% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 13 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 1.595, norm1 = 0.6062, norm01 = 0.9889)

iinla: Step rescaling: 100%, Overstep (norm0 = 0.987, norm1 = 0.002183, norm01 = 0.9889)

iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 0.9889, norm1 = 0.001041, norm01 = 0.9889

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 3.63% of SD, and line search is active [stop if: <10% and line s

```
## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 1.18, norm1 = 0.4492, norm01 = 0.7313)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.7302, norm1 = 0.001202, norm01 = 0.7313)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.7313, norm1 = 0.0005726, norm01 = 0.73

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.8742, norm1 = 0.333, norm01 = 0.5412)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.5406, norm1 = 0.0006632, norm01 = 0.5412)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.5412, norm1 = 0.0003159, norm01 = 0.54

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2% of SD, and line search is active [stop if: <10% and line sear

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 0.6477, norm1 = 0.2469, norm01 = 0.4008)

## iinla: Step rescaling: 100%, Overstep (norm0 = 0.4005, norm1 = 0.0003664, norm01 = 0.4008)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 0.4008, norm1 = 0.0001748, norm01 = 0.40

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.49% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 17 [max:70]
```

```r
# Retrieve posterior distributions specifically for the fixed 'alpha' scenario
posterior_fixed_alpha <- get_posterior_param(input.list = list(
  model.fit = fixed_alpha_fit,
  link.functions = link.f_fixed_alpha
))

# Set model identifier specifically mentioning 'Fixed alpha' for plotting
posterior_fixed_alpha$post.df$cat.used <- "Fixed alpha on the true value"
```

#wrong alpha

```r
# Adjust priors to specifically wrong parameter 'alpha'
link.f_wrong_alpha <- list(
  mu = \(x) gamma_t(x, 0.3, 0.6),
  K = \(x) unif_t(x, 0, 10),
  alpha = \(x) gamma_t(x, 1.5*true.param$alpha * 10000, 10000),
  c_ = \(x) unif_t(x, 0, 10),
  p = \(x) unif_t(x, 1, 10)
)

# Inverse transformations list specifically for the wrong 'alpha' scenario
inv_link.f_wrong_alpha <- list(
  mu = \(x) inv_gamma_t(x, 0.3, 0.6),
  K = \(x) inv_unif_t(x, 0, 10),
  alpha = \(x) inv_gamma_t(x, 1.5*true.param$alpha * 10000, 10000),
  c_ = \(x) inv_unif_t(x, 0, 10),
  p = \(x) inv_unif_t(x, 1, 10)
)

# Initial values specifically adjusted for the wrong 'alpha' scenario
init_values_wrong_alpha <- list(
  th.mu = inv_link.f_wrong_alpha$mu(0.5),
  th.K = inv_link.f_wrong_alpha$K(0.1),
  th.alpha = 1.5*true.param$alpha,  # Setting directly to true value
  th.c = inv_link.f_wrong_alpha$c_(0.1),
  th.p = inv_link.f_wrong_alpha$p(1.1)
)

# Optimization options specifically set for the wrong 'alpha' scenario
opt_list_wrong_alpha <- list(
  bru_verbose = 3,
  bru_max_iter = 70,
  bru_initial = init_values_wrong_alpha
)

# Fit the model with 'alpha' wrong
wrong_alpha_fit <- Temporal.ETAS(
  total.data = group_3_4_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f_wrong_alpha,
  coef.t. = 1,
```

```
  delta.t. = 0.1,
  N.max. = 5,
  bru.opt = opt_list_wrong_alpha
)
```

```
## Start creating grid...
## Finished creating grid, time  0.4760039
```

```
## iinla: Evaluate component inputs
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate component simplifications
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Construct inla stack
```

```
## iinla: Model initialisation completed
```

```
## iinla: Iteration 1 [max:70]
```

```
## iinla: Step rescaling: 86.42%, Approx Optimisation (norm0 = 1190, norm1 = 18.42, norm01 = 1190)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Iteration 2 [max:70]
```

```
## iinla: Step rescaling: 59.14%, Approx Optimisation (norm0 = 17.29, norm1 = 13.17, norm01 = 25.2)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 885% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 3 [max:70]
```

```
## iinla: Step rescaling: 75.27%, Approx Optimisation (norm0 = 18.6, norm1 = 4.738, norm01 = 19.96)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 178% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 81.45%, Approx Optimisation (norm0 = 22.57, norm1 = 2.844, norm01 = 23.03)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 170% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 86.65%, Approx Optimisation (norm0 = 21.49, norm1 = 1.77, norm01 = 21.68)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 134% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 90.54%, Approx Optimisation (norm0 = 18.43, norm1 = 1.051, norm01 = 18.51)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 101% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 93.42%, Approx Optimisation (norm0 = 14.79, norm1 = 0.5778, norm01 = 14.82)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 72.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 95.48%, Approx Optimisation (norm0 = 11.37, norm1 = 0.3005, norm01 = 11.38)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 51.6% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 96.9%, Approx Optimisation (norm0 = 8.478, norm1 = 0.1515, norm01 = 8.482)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 36.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 97.86%, Approx Optimisation (norm0 = 6.2, norm1 = 0.07526, norm01 = 6.202)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 25.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 98.53%, Approx Optimisation (norm0 = 4.475, norm1 = 0.03713, norm01 = 4.475)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 17.8% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 98.98%, Approx Optimisation (norm0 = 3.201, norm1 = 0.01827, norm01 = 3.201)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 12.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.29%, Approx Optimisation (norm0 = 2.276, norm1 = 0.008977, norm01 = 2.276)

## iinla: Evaluate component linearisations
```

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 8.69% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 14 [max:70]

iinla: Step rescaling: 99.51%, Approx Optimisation (norm0 = 1.611, norm1 = 0.004408, norm01 = 1.612)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 6.09% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 15 [max:70]

iinla: Step rescaling: 99.66%, Approx Optimisation (norm0 = 1.138, norm1 = 0.002163, norm01 = 1.138)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 4.26% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 16 [max:70]

iinla: Step rescaling: 99.76%, Approx Optimisation (norm0 = 0.8018, norm1 = 0.001061, norm01 = 0.8018

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.99% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 17 [max:70]

iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 0.5643, norm1 = 0.0005193, norm01 = 0.564

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 2.09% of SD, and line search is active [stop if: <10% and line s

iinla: Iteration 18 [max:70]

iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 0.3967, norm1 = 0.0002538, norm01 = 0.39(

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.47% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.92%, Approx Optimisation (norm0 = 0.2787, norm1 = 0.0001238, norm01 = 0.278

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1.03% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 20 [max:70]
```

```r
# Retrieve posterior distributions specifically for the wrong 'alpha' scenario
posterior_wrong_alpha <- get_posterior_param(input.list = list(
  model.fit = wrong_alpha_fit,
  link.functions = link.f_wrong_alpha
))

# Set model identifier specifically mentioning 'wrong alpha' for plotting
posterior_wrong_alpha$post.df$cat.used <- "wrong alpha"
```

#plot

```r
# Merge posterior distribution data frames for plotting
bind_post_df <- rbind(all_params.post$post.df, posterior_fixed_alpha$post.df,
                      posterior_wrong_alpha$post.df)

# Plot the posterior density distributions
ggplot(bind_post_df, aes(x = x, color = cat.used)) +
  geom_density(alpha = 0.5, fill = NA) +
  facet_wrap(~param, scales = "free") +
  xlab("Parameter Value") +
  ylab("Density") +
  geom_vline(data = df.true.param, aes(xintercept = x), linetype = "dashed",
             color = "black") +
  theme_minimal() +
  labs(
    title = "Posterior Density Distribution without Fixed Parameters,
    Fixed alpha, and Incorrect alpha",
    color = "Parameter Type",
    linetype = "Line Type"
  ) +
  theme_bw() +
```
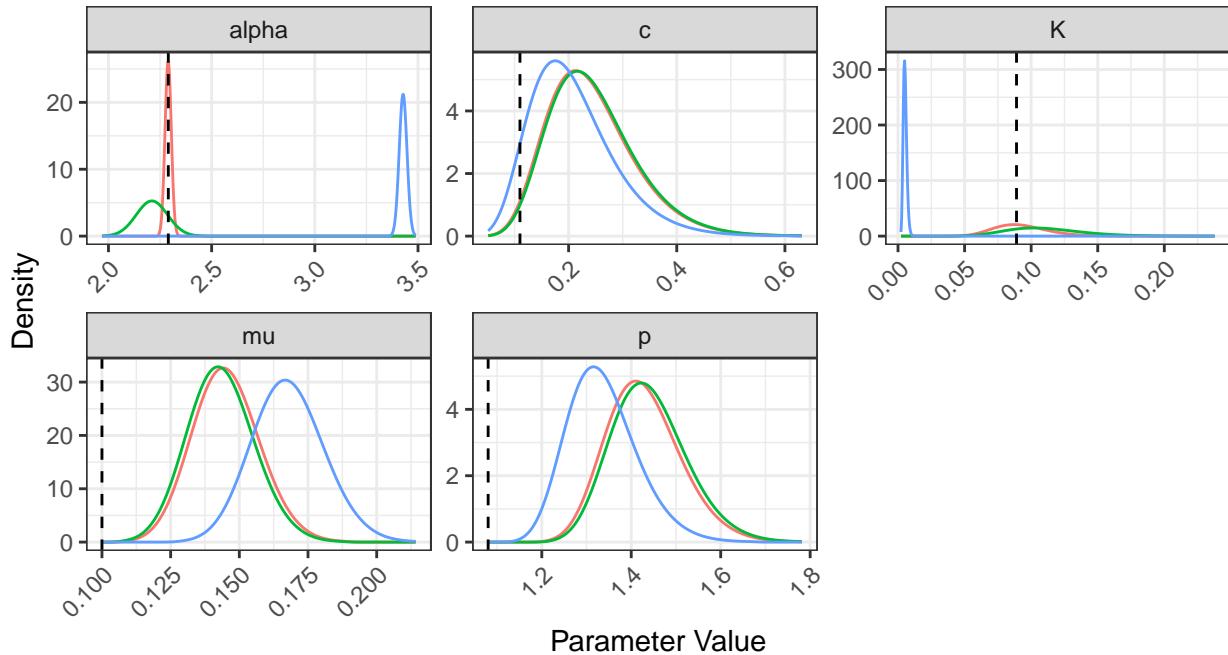
```
theme(
  axis.text.x = element_text(angle = 45, hjust = 1),
  ##Rotate the X-axis text 45 degrees and adjust alignment
  legend.position = "bottom",  # Set legend position
  plot.title = element_text(size = 12, hjust = 0.5)  # set title position
)
```

Posterior Density Distribution without Fixed Parameters, Fixed alpha, and Incorrect alpha

#check

```
# ks test
#ks_test <- ks.test(all_params.post$post.df$x, posterior_fixed_alpha$post.df$x)

# p value
#print(ks_test$p.value)
```

#fix c

```
# Adjust priors to fix some parameters close to their true values
fixed.link.f <- list(
  mu = \(x) gamma_t(x, 0.3, 0.6),
  K = \(x)  unif_t(x, 0, 10),
  alpha = \(x) unif_t(x, 0, 5) ,
  c_ = \(x) gamma_t(x, true.param$c*5000,5000),
  p = \(x) unif_t(x, 1, 10)
)
```

```r
# Inverse transformations list for fixed priors
inv.fixed.link.f <- list(
  mu = \(x) inv_gamma_t(x, 0.3, 0.6),
  K = \(x) inv_unif_t(x, 0, 10),
  alpha = \(x) inv_unif_t(x, 0, 5),
  c_ = \(x) inv_gamma_t(x, true.param$c*5000, 5000),
  p = \(x) inv_unif_t(x, 1, 10)
)

# Initial values for the fixed parameters model
fixed.th.init <- list(
  th.mu = inv.fixed.link.f$mu(0.5),
  th.K = inv.fixed.link.f$K(0.1),
  th.alpha = inv.fixed.link.f$alpha(1),
  th.c = true.param$c,
  th.p = inv.fixed.link.f$p(1.1)
)




bru.opt.list.fix <- list(
  bru_verbose = 3,
  bru_max_iter = 70,
  bru_initial = fixed.th.init
)

# Fit the model with some fixed parameters
fixed_params.fit <- Temporal.ETAS(
  total.data =group_3_4_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = fixed.link.f,
  coef.t. = 1,
  delta.t. = 0.1,
  N.max. = 5,
  bru.opt = bru.opt.list.fix
)
```

```
## Start creating grid...
## Finished creating grid, time  0.461328


## iinla: Evaluate component inputs


## iinla: Evaluate component linearisations


## iinla: Evaluate component simplifications


## iinla: Evaluate predictor linearisation


## iinla: Construct inla stack
```

```
## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 332, norm1 = 418.4, norm01 = 312.6)

## iinla: Step rescaling: 27.01%, Approx Optimisation (norm0 = 81.41, norm1 = 252.2, norm01 = 312.6)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 425.6, norm1 = 346.4, norm01 = 272.4)

## iinla: Step rescaling: 100%, Overstep (norm0 = 240.2, norm1 = 139.7, norm01 = 272.4)

## iinla: Step rescaling: 80.62%, Approx Optimisation (norm0 = 194.6, norm1 = 122.2, norm01 = 272.4)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 664% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 236, norm1 = 89.82, norm01 = 146.2)

## iinla: Step rescaling: 100%, Overstep (norm0 = 146.1, norm1 = 1.578, norm01 = 146.2)

## iinla: Step rescaling: 100.1%, Approx Optimisation (norm0 = 146.2, norm1 = 1.575, norm01 = 146.2)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 217% of SD, and line search is inactive [stop if: <10% and line s

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 96.73, norm1 = 28.11, norm01 = 69.68)

## iinla: Step rescaling: 100%, Overstep (norm0 = 63.43, norm1 = 7.249, norm01 = 69.68)

## iinla: Step rescaling: 110.2%, Approx Optimisation (norm0 = 69.23, norm1 = 4.281, norm01 = 69.68)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 245% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 65.2, norm1 = 20.84, norm01 = 45.85)

## iinla: Step rescaling: 100%, Overstep (norm0 = 42.29, norm1 = 5.156, norm01 = 45.85)

## iinla: Step rescaling: 107.6%, Approx Optimisation (norm0 = 45.21, norm1 = 4.208, norm01 = 45.85)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 230% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 43.91, norm1 = 15.32, norm01 = 29.33)

## iinla: Step rescaling: 100%, Overstep (norm0 = 27.91, norm1 = 2.687, norm01 = 29.33)

## iinla: Step rescaling: 104.1%, Approx Optimisation (norm0 = 29.01, norm1 = 2.444, norm01 = 29.33)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 158% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 31.32, norm1 = 11.55, norm01 = 20.11)

## iinla: Step rescaling: 100%, Overstep (norm0 = 19.62, norm1 = 1.431, norm01 = 20.11)

## iinla: Step rescaling: 101.8%, Approx Optimisation (norm0 = 19.96, norm1 = 1.387, norm01 = 20.11)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 107% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 23.23, norm1 = 8.81, norm01 = 14.56)

## iinla: Step rescaling: 100%, Overstep (norm0 = 14.42, norm1 = 0.7707, norm01 = 14.56)

## iinla: Step rescaling: 100.5%, Approx Optimisation (norm0 = 14.5, norm1 = 0.7669, norm01 = 14.56)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 73.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 17.64, norm1 = 6.782, norm01 = 10.92)

## iinla: Step rescaling: 100%, Overstep (norm0 = 10.9, norm1 = 0.4184, norm01 = 10.92)

## iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 10.89, norm1 = 0.4183, norm01 = 10.92)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 51.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 99.62%, Approx Optimisation (norm0 = 8.361, norm1 = 0.2264, norm01 = 8.37)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 37.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 99.54%, Approx Optimisation (norm0 = 6.511, norm1 = 0.122, norm01 = 6.515)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 26.7% of SD, and line search is active [stop if: <10% and line s
```

```
## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.56%, Approx Optimisation (norm0 = 5.124, norm1 = 0.06561, norm01 = 5.125)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 19.4% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.61%, Approx Optimisation (norm0 = 4.066, norm1 = 0.03529, norm01 = 4.066)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.68%, Approx Optimisation (norm0 = 3.25, norm1 = 0.019, norm01 = 3.251)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.74%, Approx Optimisation (norm0 = 2.616, norm1 = 0.01027, norm01 = 2.616)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.55% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.8%, Approx Optimisation (norm0 = 2.118, norm1 = 0.005575, norm01 = 2.118)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 5.98% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 17 [max:70]
```

```
## iinla: Step rescaling: 99.85%, Approx Optimisation (norm0 = 1.724, norm1 = 0.003048, norm01 = 1.724)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 4.76% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 18 [max:70]
```

```
## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 1.41, norm1 = 0.001682, norm01 = 1.41)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 3.8% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 19 [max:70]
```

```
## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 1.158, norm1 = 0.0009381, norm01 = 1.158)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 3.05% of SD, and line search is inactive [stop if: <10% and line
```

```
## iinla: Convergence criterion met, running final INLA integration with known theta mode.
```

```
## iinla: Iteration 20 [max:70]
```

```r
fixed_params.post <- get_posterior_param(input.list = list(
  model.fit = fixed_params.fit,
  link.functions = fixed.link.f
))

# Set model identifiers for plot

fixed_params.post$post.df$cat.used <- "Fixed c on the true value"
```

#wrong c

```r
# Adjust transformations for wrong c
wrong_c_link.f <- list(
  mu = \(x) gamma_t(x, 0.3, 0.6),
  K = \(x) unif_t(x, 0, 10),
  alpha = \(x) unif_t(x, 0, 5),
  c_ = \(x) gamma_t(x, 1.5 * true.param$c * 5000, 5000),
  # Intentionally wrong by setting it to half its true value
  p = \(x) unif_t(x, 1, 10)
)

# Inverse transformations for wrong c
inv_wrong_c_link.f <- list(
  mu = \(x) inv_gamma_t(x, 0.3, 0.6),
  K = \(x) inv_unif_t(x, 0, 10),
  alpha = \(x) inv_unif_t(x, 0, 5),
  c_ = \(x) inv_gamma_t(x,1.5 * true.param$c * 5000, 5000),
  # Corresponding inverse transformation
  p = \(x) inv_unif_t(x, 1, 10)
)

# Initial values for the wrong c model
wrong_c_th.init <- list(
  th.mu = inv_wrong_c_link.f$mu(0.5),
  th.K = inv_wrong_c_link.f$K(0.1),
  th.alpha = inv_wrong_c_link.f$alpha(1),
  th.c = 1.5 * true.param$c,  # Using the wrong initial value for c
  th.p = inv_wrong_c_link.f$p(1.1)
)

bru.opt.list.wrong.c <- list(
  bru_verbose = 3,  # Increase debug info
  bru_max_iter = 70,
  bru_initial = wrong_c_th.init
)

# Fit the model with wrong c parameter
wrong_c_params.fit <- Temporal.ETAS(
  total.data =group_3_4_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = wrong_c_link.f,
  coef.t. = 1,
  delta.t. = 0.1,
  N.max. = 5,
  bru.opt = bru.opt.list.wrong.c
)
```

```
## Start creating grid...
## Finished creating grid, time  0.4675181

## iinla: Evaluate component inputs

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate component simplifications

## iinla: Evaluate predictor linearisation

## iinla: Construct inla stack

## iinla: Model initialisation completed

## iinla: Iteration 1 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 355.7, norm1 = 415.7, norm01 = 307.8)

## iinla: Step rescaling: 27.83%, Approx Optimisation (norm0 = 89.28, norm1 = 244.2, norm01 = 307.8)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Iteration 2 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 438.5, norm1 = 342, norm01 = 264.4)

## iinla: Step rescaling: 100%, Overstep (norm0 = 244.9, norm1 = 132.9, norm01 = 264.4)

## iinla: Step rescaling: 80.3%, Approx Optimisation (norm0 = 195.9, norm1 = 114.1, norm01 = 264.4)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 725% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 99.57%, Approx Optimisation (norm0 = 125.5, norm1 = 1.48, norm01 = 125.6)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 167% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 76.93, norm1 = 24.63, norm01 = 53.19)

## iinla: Step rescaling: 100%, Overstep (norm0 = 49.61, norm1 = 4.759, norm01 = 53.19)
```

```
## iinla: Step rescaling: 106.9%, Approx Optimisation (norm0 = 52.81, norm1 = 3.504, norm01 = 53.19)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 201% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 59.04, norm1 = 20.49, norm01 = 39.71)

## iinla: Step rescaling: 100%, Overstep (norm0 = 37.62, norm1 = 3.892, norm01 = 39.71)

## iinla: Step rescaling: 104.5%, Approx Optimisation (norm0 = 39.21, norm1 = 3.541, norm01 = 39.71)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 196% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 42.89, norm1 = 15.72, norm01 = 27.73)

## iinla: Step rescaling: 100%, Overstep (norm0 = 26.93, norm1 = 2.177, norm01 = 27.73)

## iinla: Step rescaling: 102.1%, Approx Optimisation (norm0 = 27.49, norm1 = 2.102, norm01 = 27.73)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 141% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 32.16, norm1 = 12.19, norm01 = 20.22)

## iinla: Step rescaling: 100%, Overstep (norm0 = 19.99, norm1 = 1.211, norm01 = 20.22)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 20.11, norm1 = 1.205, norm01 = 20.22)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 99.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 24.7, norm1 = 9.507, norm01 = 15.29)

## iinla: Step rescaling: 100%, Overstep (norm0 = 15.27, norm1 = 0.6766, norm01 = 15.29)

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 15.25, norm1 = 0.6763, norm01 = 15.29)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 71.1% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 99.55%, Approx Optimisation (norm0 = 11.82, norm1 = 0.3757, norm01 = 11.84)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 51.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 99.45%, Approx Optimisation (norm0 = 9.29, norm1 = 0.2075, norm01 = 9.297)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 37.6% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 99.46%, Approx Optimisation (norm0 = 7.371, norm1 = 0.1143, norm01 = 7.373)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 27.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]
```

```
## iinla: Step rescaling: 99.53%, Approx Optimisation (norm0 = 5.889, norm1 = 0.06289, norm01 = 5.89)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 20.3% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.6%, Approx Optimisation (norm0 = 4.732, norm1 = 0.03465, norm01 = 4.733)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 15% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.68%, Approx Optimisation (norm0 = 3.822, norm1 = 0.01915, norm01 = 3.822)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 11.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.74%, Approx Optimisation (norm0 = 3.102, norm1 = 0.01062, norm01 = 3.102)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.71% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.8%, Approx Optimisation (norm0 = 2.528, norm1 = 0.005926, norm01 = 2.528)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.96% of SD, and line search is active [stop if: <10% and line s
```

```
## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 2.068, norm1 = 0.00333, norm01 = 2.068)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.58% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 1.698, norm1 = 0.001888, norm01 = 1.698)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.49% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 1.398, norm1 = 0.001082, norm01 = 1.398)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.62% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 20 [max:70]
```

```r
# Get the posterior distribution
wrong_c_params.post <- get_posterior_param(input.list = list(
  model.fit = wrong_c_params.fit,
  link.functions = wrong_c_link.f
))

# Set the model identifier for plotting
wrong_c_params.post$post.df$cat.used <- "Wrong c"
```

#Plot
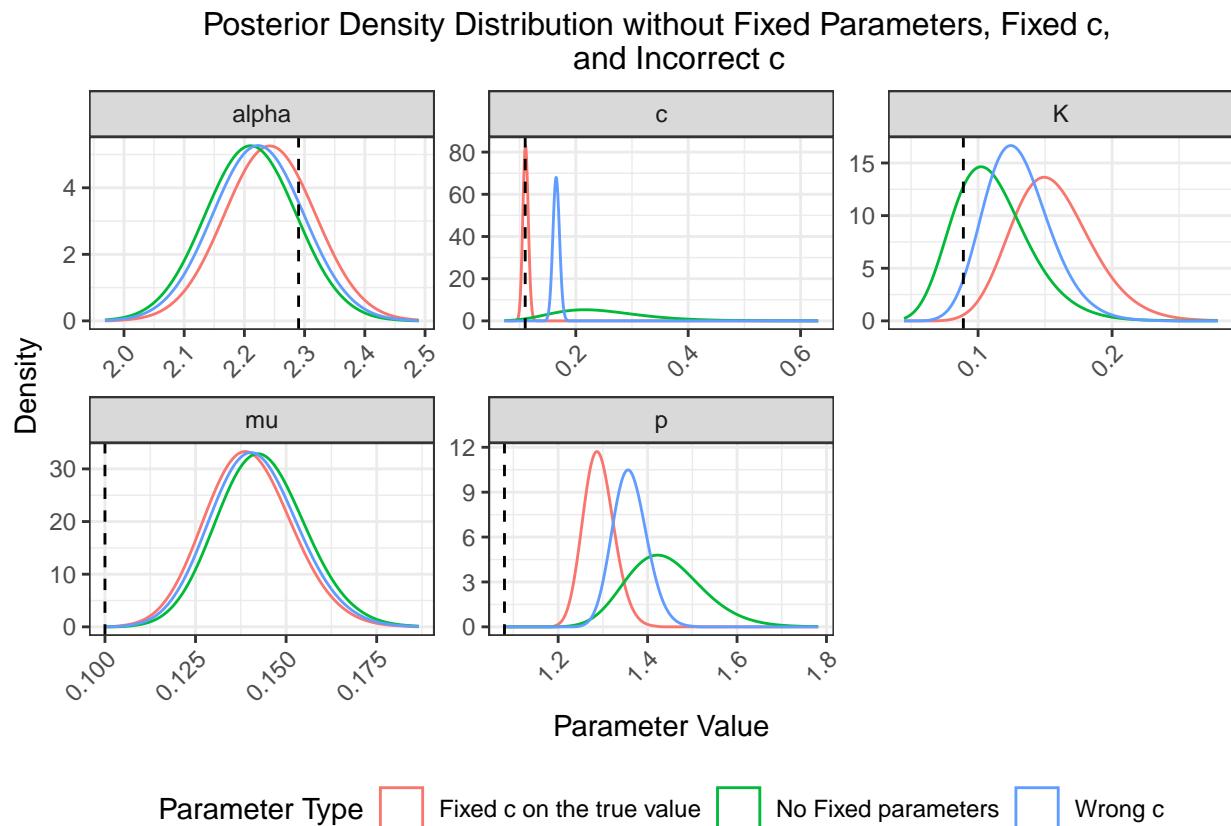
```r
# bind posterior data
bind.post.df <- rbind(all_params.post$post.df, fixed_params.post$post.df,
                      wrong_c_params.post$post.df)

# Plot the posterior density distributions
ggplot(bind.post.df, aes(x = x, color = cat.used)) +
  geom_density(alpha = 0.5, fill = NA) +
  facet_wrap(~param, scales = "free") +
  xlab("Parameter Value") +
  ylab("Density") +
  geom_vline(data = df.true.param, aes(xintercept = x), linetype = "dashed",
             color = "black") +
  theme_minimal() +
  labs(
    title = "Posterior Density Distribution without Fixed Parameters, Fixed c,
    and Incorrect c",
    color = "Parameter Type",
    linetype = "Line Type"
  ) +
  theme_bw() +
  theme(
    axis.text.x = element_text(angle = 45, hjust = 1),
    legend.position = "bottom",
    plot.title = element_text(size = 12, hjust = 0.5)
  )
```


Posterior Density Distribution without Fixed Parameters, Fixed c, and Incorrect c

#check

```r
# ks test
#ks_test <- ks.test(all_params.post$post.df$x, fixed_params.post$post.df$x)

# p value
#print(ks_test$p.value)
```

#fixed p

```r
# Adjust priors to specifically fix parameter 'p' close to its true value
link.f_fixed_p <- list(
  mu = \(x) gamma_t(x, 0.3, 0.6),
  K = \(x) unif_t(x, 0, 10),
  alpha = \(x) unif_t(x, 0, 5),
  c_ = \(x) unif_t(x, 0, 10),
  p = \(x) gamma_t(x, true.param$p * 10000, 10000)
)

# Inverse transformations list specifically for the fixed 'p' scenario
inv_link.f_fixed_p <- list(
  mu = \(x) inv_gamma_t(x, 0.3, 0.6),
  K = \(x) inv_unif_t(x, 0, 10),
  alpha = \(x) inv_unif_t(x, 0, 5),
  c_ = \(x) inv_unif_t(x, 0, 10),
  p = \(x) inv_gamma_t(x, true.param$p * 10000, 10000)
)

# Initial values specifically adjusted for the fixed 'p' scenario
init_values_fixed_p <- list(
  th.mu = inv_link.f_fixed_p$mu(0.5),
  th.K = inv_link.f_fixed_p$K(0.1),
  th.alpha = inv_link.f_fixed_p$alpha(1),
  th.c = inv_link.f_fixed_p$c_(0.1),
  th.p = true.param$p  # Setting directly to true value
)

# Optimization options specifically set for the fixed 'p' scenario
opt_list_fixed_p <- list(
  bru_verbose = 3,
  bru_max_iter = 70,
  bru_initial = init_values_fixed_p
)

# Fit the model with 'p' fixed
fixed_p_fit <- Temporal.ETAS(
  total.data = group_3_4_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f_fixed_p,
  coef.t. = 1,
  delta.t. = 0.1,
  N.max. = 5,
```

```
  bru.opt = opt_list_fixed_p
)
```

```
## Start creating grid...
## Finished creating grid, time  0.4660959
```

```
## iinla: Evaluate component inputs
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate component simplifications
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Construct inla stack
```

```
## iinla: Model initialisation completed
```

```
## iinla: Iteration 1 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 465.3, norm1 = 529.7, norm01 = 221.5)
```

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 198.2, norm1 = 244.8, norm01 = 221.5)
```

```
## iinla: Step rescaling: 50.8%, Approx Optimisation (norm0 = 87.49, norm1 = 158.7, norm01 = 221.5)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Iteration 2 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 175.1, norm1 = 186.3, norm01 = 170.7)
```

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 110.9, norm1 = 100.5, norm01 = 170.7)
```

```
## iinla: Step rescaling: 79.33%, Approx Optimisation (norm0 = 94.09, norm1 = 93.97, norm01 = 170.7)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 187% of SD, and line search is active [stop if: <10% and line se
```

```
## iinla: Iteration 3 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 190, norm1 = 48.2, norm01 = 151.2)
```

iinla: Step rescaling: 100%, Overstep (norm0 = 130.4, norm1 = 24.48, norm01 = 151.2)

iinla: Step rescaling: 116.1%, Approx Optimisation (norm0 = 147.4, norm1 = 16.9, norm01 = 151.2)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 245% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 4 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 63.83, norm1 = 22.43, norm01 = 44.34)

iinla: Step rescaling: 100%, Overstep (norm0 = 41.13, norm1 = 6.144, norm01 = 44.34)

iinla: Step rescaling: 105.2%, Approx Optimisation (norm0 = 43.1, norm1 = 5.799, norm01 = 44.34)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 284% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 5 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 37.1, norm1 = 16.27, norm01 = 23.1)

iinla: Step rescaling: 100%, Overstep (norm0 = 22.78, norm1 = 4.015, norm01 = 23.1)

iinla: Step rescaling: 97.04%, Approx Optimisation (norm0 = 22.11, norm1 = 3.952, norm01 = 23.1)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 155% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 6 [max:70]

iinla: Step rescaling: 97.5%, Approx Optimisation (norm0 = 14.01, norm1 = 1.189, norm01 = 14.16)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 85.4% of SD, and line search is active [stop if: <10% and line s

```
## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 97.43%, Approx Optimisation (norm0 = 9.816, norm1 = 0.4764, norm01 = 9.85)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 54.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 98.19%, Approx Optimisation (norm0 = 6.966, norm1 = 0.1791, norm01 = 6.972)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 33.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 98.81%, Approx Optimisation (norm0 = 5.008, norm1 = 0.06803, norm01 = 5.009)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 20.9% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 99.25%, Approx Optimisation (norm0 = 3.655, norm1 = 0.02609, norm01 = 3.655)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 12.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 99.54%, Approx Optimisation (norm0 = 2.723, norm1 = 0.01022, norm01 = 2.723)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 8.89% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.72%, Approx Optimisation (norm0 = 2.077, norm1 = 0.004145, norm01 = 2.077)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.37% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.82%, Approx Optimisation (norm0 = 1.62, norm1 = 0.001768, norm01 = 1.62)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.67% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.89%, Approx Optimisation (norm0 = 1.289, norm1 = 0.0008028, norm01 = 1.289]

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.51% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.92%, Approx Optimisation (norm0 = 1.042, norm1 = 0.0003911, norm01 = 1.042]

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 2.7% of SD, and line search is inactive [stop if: <10% and line s

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 16 [max:70]
```

```r
# Retrieve posterior distributions specifically for the fixed 'p' scenario
posterior_fixed_p <- get_posterior_param(input.list = list(
  model.fit = fixed_p_fit,
  link.functions = link.f_fixed_p
))

# Set model identifier specifically mentioning 'Fixed p' for plotting
posterior_fixed_p$post.df$cat.used <- "Fixed p on the true value"
```

#wrong p

```r
# Adjust priors to specifically fix parameter 'p' close to its true value
link.f_wrong_p <- list(
  mu = \(x) gamma_t(x, 0.3, 0.6),
  K = \(x) unif_t(x, 0, 10),
  alpha = \(x) unif_t(x, 0, 5),
  c_ = \(x) unif_t(x, 0, 10),
  p = \(x) gamma_t(x,1.5* true.param$p * 10000, 10000)
)

# Inverse transformations list specifically for the fixed 'p' scenario
inv_link.f_wrong_p <- list(
  mu = \(x) inv_gamma_t(x, 0.3, 0.6),
  K = \(x) inv_unif_t(x, 0, 10),
  alpha = \(x) inv_unif_t(x, 0, 5),
  c_ = \(x) inv_unif_t(x, 0, 10),
  p = \(x) inv_gamma_t(x, 1.5*true.param$p * 10000, 10000)
)

# Initial values specifically adjusted for the fixed 'p' scenario
init_values_wrong_p <- list(
  th.mu = inv_link.f_wrong_p$mu(0.5),
  th.K = inv_link.f_wrong_p$K(0.1),
  th.alpha = inv_link.f_wrong_p$alpha(1),
  th.c = inv_link.f_wrong_p$c_(0.1),
  th.p = 1.5*true.param$p  # Setting directly to true value
)

# Optimization options specifically set for the fixed 'p' scenario
opt_list_wrong_p <- list(
  bru_verbose = 3,
  bru_max_iter = 70,
  bru_initial = init_values_wrong_p
)

# Fit the model with 'p' wrong
wrong_p_fit <- Temporal.ETAS(
  total.data = group_3_4_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f_wrong_p,
  coef.t. = 1,
```

```
  delta.t. = 0.1,
  N.max. = 5,
  bru.opt = opt_list_wrong_p
)
```

```
## Start creating grid...
## Finished creating grid, time  0.4884021
```

```
## iinla: Evaluate component inputs
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate component simplifications
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Construct inla stack
```

```
## iinla: Model initialisation completed
```

```
## iinla: Iteration 1 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 266.8, norm1 = 90.21, norm01 = 223.3)
```

```
## iinla: Step rescaling: 100%, Overstep (norm0 = 186.5, norm1 = 52.43, norm01 = 223.3)
```

```
## iinla: Step rescaling: 111.5%, Approx Optimisation (norm0 = 203.4, norm1 = 48.47, norm01 = 223.3)
```

```
## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation
```

```
## iinla: Iteration 2 [max:70]
```

```
## iinla: Step rescaling: 162%, Expand (norm0 = 222400, norm1 = 157700, norm01 = 368000)
```

```
## iinla: Step rescaling: 262%, Expand (norm0 = 240600, norm1 = 138800, norm01 = 368000)
```

```
## iinla: Step rescaling: 424%, Expand (norm0 = 247500, norm1 = 129700, norm01 = 368000)
```

```
## iinla: Step rescaling: 685%, Expand (norm0 = 235600, norm1 = 139100, norm01 = 368000)
```

```
## iinla: Step rescaling: 424%, Overstep (norm0 = 247500, norm1 = 129700, norm01 = 368000)
```

```
## iinla: Step rescaling: 362.9%, Approx Optimisation (norm0 = 247200, norm1 = 130800, norm01 = 368000)
```

```
## iinla: Optimisation did not improve on previous solution.
```

```
## iinla: Step rescaling: 200%, Maximum step length (norm0 = 231500, norm1 = 148700, norm01 = 368000)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 720000% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 3 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 5263, norm1 = 2758, norm01 = 2613)

## iinla: Step rescaling: 38.2%, Contract (norm0 = 2035, norm1 = 672.4, norm01 = 2613)

## iinla: Step rescaling: 44.36%, Approx Optimisation (norm0 = 2655, norm1 = 454.3, norm01 = 2613)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3680% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 228900, norm1 = 46430, norm01 = 274000)

## iinla: Step rescaling: 262%, Expand (norm0 = 250800, norm1 = 31920, norm01 = 274000)

## iinla: Step rescaling: 424%, Expand (norm0 = 271400, norm1 = 36440, norm01 = 274000)

## iinla: Step rescaling: 262%, Overstep (norm0 = 250800, norm1 = 31920, norm01 = 274000)

## iinla: Step rescaling: 176%, Approx Optimisation (norm0 = 233900, norm1 = 42010, norm01 = 274000)

## iinla: Optimisation did not improve on previous solution.

## iinla: Step rescaling: 200%, Maximum step length (norm0 = 240100, norm1 = 37090, norm01 = 274000)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 1130000% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 61.8%, Contract (norm0 = 220200, norm1 = 216000, norm01 = 4392)
```

```
## iinla: Step rescaling: 38.2%, Contract (norm0 = 76150, norm1 = 71910, norm01 = 4392)

## iinla: Step rescaling: 23.61%, Contract (norm0 = 25250, norm1 = 21030, norm01 = 4392)

## iinla: Step rescaling: 14.59%, Contract (norm0 = 8008, norm1 = 3897, norm01 = 4392)

## iinla: Step rescaling: 9.017%, Contract (norm0 = 2506, norm1 = 2026, norm01 = 4392)

## iinla: Step rescaling: 11.98%, Approx Optimisation (norm0 = 4969, norm1 = 1252, norm01 = 4392)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4460% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 87.56%, Approx Optimisation (norm0 = 951.6, norm1 = 7.994, norm01 = 951.9)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 40100% of SD, and line search is active [stop if: <10% and line

## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 131.2, norm1 = 50.82, norm01 = 91.71)

## iinla: Step rescaling: 100%, Overstep (norm0 = 84.74, norm1 = 16.19, norm01 = 91.71)

## iinla: Step rescaling: 103.2%, Approx Optimisation (norm0 = 87.22, norm1 = 16.01, norm01 = 91.71)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 553% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 118.5, norm1 = 43.93, norm01 = 82.29)

## iinla: Step rescaling: 100%, Overstep (norm0 = 76.37, norm1 = 12.95, norm01 = 82.29)

## iinla: Step rescaling: 103.9%, Approx Optimisation (norm0 = 79.15, norm1 = 12.64, norm01 = 82.29)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 336% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 85.95, norm1 = 36.6, norm01 = 55.04)

## iinla: Step rescaling: 100%, Overstep (norm0 = 53.46, norm1 = 9.373, norm01 = 55.04)

## iinla: Step rescaling: 98.49%, Approx Optimisation (norm0 = 52.66, norm1 = 9.331, norm01 = 55.04)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 262% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 95.29%, Approx Optimisation (norm0 = 39.4, norm1 = 5.882, norm01 = 40.62)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 179% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 94.7%, Approx Optimisation (norm0 = 31.55, norm1 = 3.287, norm01 = 32.03)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 127% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 95.45%, Approx Optimisation (norm0 = 25.78, norm1 = 1.665, norm01 = 25.94)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation
```

```
## iinla: Max deviation from previous: 95.1% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 96.62%, Approx Optimisation (norm0 = 21.05, norm1 = 0.7746, norm01 = 21.09)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 69.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 97.72%, Approx Optimisation (norm0 = 17.08, norm1 = 0.3371, norm01 = 17.09)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 50.3% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 98.56%, Approx Optimisation (norm0 = 13.79, norm1 = 0.1402, norm01 = 13.79)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 35.4% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.14%, Approx Optimisation (norm0 = 11.12, norm1 = 0.05708, norm01 = 11.12)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 24.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.5%, Approx Optimisation (norm0 = 8.979, norm1 = 0.0233, norm01 = 8.979)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 18.1% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.71%, Approx Optimisation (norm0 = 7.275, norm1 = 0.009741, norm01 = 7.275)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 13.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.82%, Approx Optimisation (norm0 = 5.917, norm1 = 0.004254, norm01 = 5.917)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.7% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 20 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 4.831, norm1 = 0.001993, norm01 = 4.831)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 9.17% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 21 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 3.956, norm1 = 0.001036, norm01 = 3.956)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 7.82% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 22 [max:70]
```

```
# Retrieve posterior distributions specifically for the wrong 'p' scenario
posterior_wrong_p <- get_posterior_param(input.list = list(
  model.fit = wrong_p_fit,
  link.functions = link.f_wrong_p
))

# Set model identifier specifically mentioning 'wrong p' for plotting
```

#plot
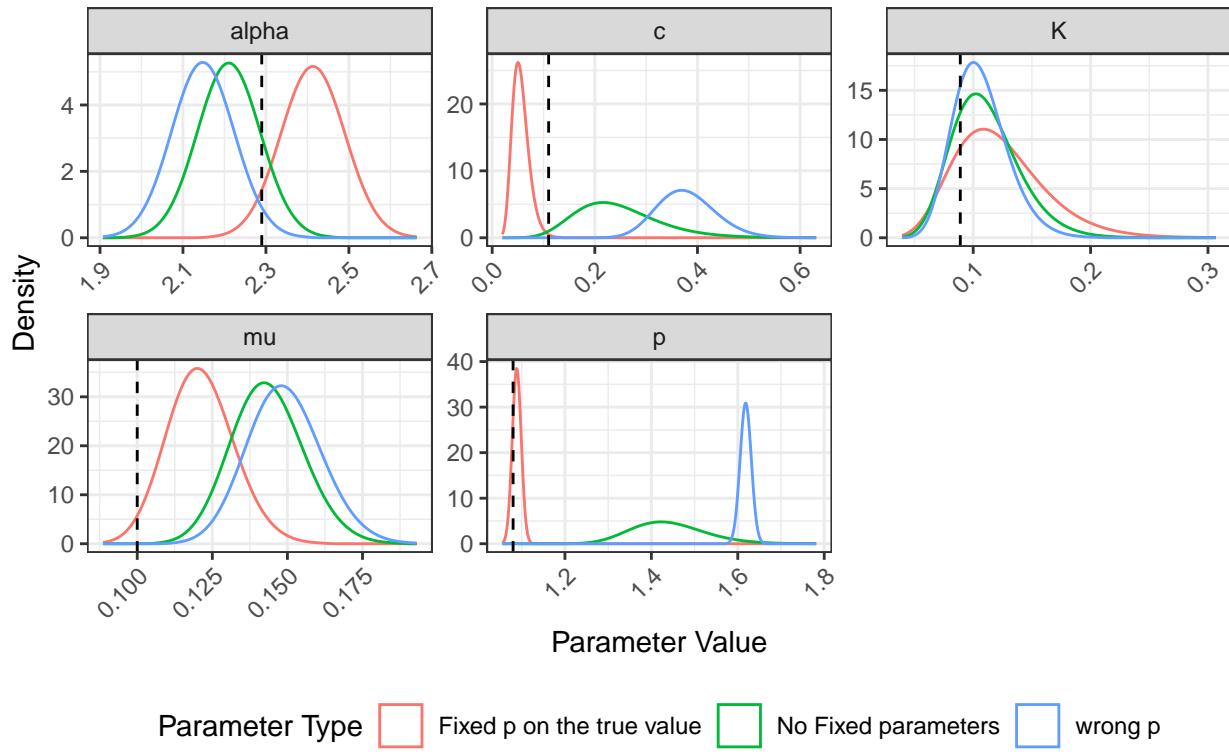
```
posterior_wrong_p$post.df$cat.used <- "wrong p"

# Merge posterior distribution data frames for plotting
bind_post_df <- rbind(all_params.post$post.df, posterior_fixed_p$post.df,
                      posterior_wrong_p$post.df)

# Plot the posterior density distributions
ggplot(bind_post_df, aes(x = x, color = cat.used)) +
  geom_density(alpha = 0.5, fill = NA) +
  facet_wrap(~param, scales = "free") +
  xlab("Parameter Value") +
  ylab("Density") +
  geom_vline(data = df.true.param, aes(xintercept = x), linetype = "dashed",
             color = "black") +
  theme_minimal() +
  labs(
    title = "Posterior Density Distribution without Fixed Parameters, Fixed p,
    and Incorrect p",
    color = "Parameter Type",
    linetype = "Line Type"
  ) +
  theme_bw() +
  theme(
    axis.text.x = element_text(angle = 45, hjust = 1),
    legend.position = "bottom",
    plot.title = element_text(size = 12, hjust = 0.5)
  )
```

Posterior Density Distribution without Fixed Parameters, Fixed p, and Incorrect p

Parameter Type ☐ Fixed p on the true value ☐ No Fixed parameters ☐ wrong p

#validate the correlation of parameters through Pearson heatmap

```r
# set.seed
set.seed(1)

# set bru
bru.opt.list <- list(
  bru_verbose = 3,
  bru_max_iter = 70,
  bru_initial = th.init
)


set.seed(1)

# fit model
all_params.fit <- Temporal.ETAS(
  total.data = group_3_4_major_events[[1]],
  M0 = M0,
  T1 = T1,
  T2 = T2,
  link.functions = link.f,
  coef.t. = 1,
  delta.t. = 0.1,
  N.max. = 5,
  bru.opt = bru.opt.list
```

```
)
```

Start creating grid...
Finished creating grid, time 0.4838421

iinla: Evaluate component inputs

iinla: Evaluate component linearisations

iinla: Evaluate component simplifications

iinla: Evaluate predictor linearisation

iinla: Construct inla stack

iinla: Model initialisation completed

iinla: Iteration 1 [max:70]

iinla: Step rescaling: 61.8%, Contract (norm0 = 306.6, norm1 = 373.6, norm01 = 270.8)

iinla: Step rescaling: 26.71%, Approx Optimisation (norm0 = 72.07, norm1 = 218.6, norm01 = 270.8)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Iteration 2 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 384.6, norm1 = 290.2, norm01 = 240.8)

iinla: Step rescaling: 100%, Overstep (norm0 = 219, norm1 = 121.5, norm01 = 240.8)

iinla: Step rescaling: 80.55%, Approx Optimisation (norm0 = 176, norm1 = 106.5, norm01 = 240.8)

iinla: Evaluate component linearisations

iinla: Evaluate predictor linearisation

iinla: Max deviation from previous: 351% of SD, and line search is active [stop if: <10% and line se

iinla: Iteration 3 [max:70]

iinla: Step rescaling: 162%, Expand (norm0 = 226.7, norm1 = 79.57, norm01 = 148.1)

iinla: Step rescaling: 100%, Overstep (norm0 = 143.3, norm1 = 7.732, norm01 = 148.1)

iinla: Step rescaling: 103.2%, Approx Optimisation (norm0 = 147.6, norm1 = 6.353, norm01 = 148.1)

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 148% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 4 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 96.66, norm1 = 29.34, norm01 = 70.36)

## iinla: Step rescaling: 100%, Overstep (norm0 = 63.53, norm1 = 9.274, norm01 = 70.36)

## iinla: Step rescaling: 109.7%, Approx Optimisation (norm0 = 69.04, norm1 = 7.338, norm01 = 70.36)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 162% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 5 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 67.82, norm1 = 21.92, norm01 = 46.48)

## iinla: Step rescaling: 100%, Overstep (norm0 = 43.59, norm1 = 3.775, norm01 = 46.48)

## iinla: Step rescaling: 106.5%, Approx Optimisation (norm0 = 46.23, norm1 = 2.678, norm01 = 46.48)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 92.2% of SD, and line search is active [stop if: <10% and line s

## iinla: Iteration 6 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 47.52, norm1 = 16.51, norm01 = 31.3)

## iinla: Step rescaling: 100%, Overstep (norm0 = 30.1, norm1 = 1.878, norm01 = 31.3)

## iinla: Step rescaling: 103.7%, Approx Optimisation (norm0 = 31.18, norm1 = 1.531, norm01 = 31.3)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 89.1% of SD, and line search is active [stop if: <10% and line s
```

```
## iinla: Iteration 7 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 35.51, norm1 = 12.87, norm01 = 22.81)

## iinla: Step rescaling: 100%, Overstep (norm0 = 22.27, norm1 = 1.111, norm01 = 22.81)

## iinla: Step rescaling: 102.1%, Approx Optimisation (norm0 = 22.74, norm1 = 1.009, norm01 = 22.81)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 77.5% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 8 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 27.1, norm1 = 10.07, norm01 = 17.12)

## iinla: Step rescaling: 100%, Overstep (norm0 = 16.89, norm1 = 0.6846, norm01 = 17.12)

## iinla: Step rescaling: 101.2%, Approx Optimisation (norm0 = 17.08, norm1 = 0.6567, norm01 = 17.12)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 60.8% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 9 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 20.9, norm1 = 7.885, norm01 = 13.06)

## iinla: Step rescaling: 100%, Overstep (norm0 = 12.97, norm1 = 0.4158, norm01 = 13.06)

## iinla: Step rescaling: 100.6%, Approx Optimisation (norm0 = 13.04, norm1 = 0.4094, norm01 = 13.06)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 45.9% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 10 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 16.26, norm1 = 6.189, norm01 = 10.1)

## iinla: Step rescaling: 100%, Overstep (norm0 = 10.07, norm1 = 0.2483, norm01 = 10.1)
```

```
## iinla: Step rescaling: 100.2%, Approx Optimisation (norm0 = 10.09, norm1 = 0.2475, norm01 = 10.1)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 34.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 11 [max:70]

## iinla: Step rescaling: 162%, Expand (norm0 = 12.75, norm1 = 4.874, norm01 = 7.882)

## iinla: Step rescaling: 100%, Overstep (norm0 = 7.878, norm1 = 0.1467, norm01 = 7.882)

## iinla: Step rescaling: 99.99%, Approx Optimisation (norm0 = 7.878, norm1 = 0.1467, norm01 = 7.882)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 25.5% of SD, and line search is inactive [stop if: <10% and line

## iinla: Iteration 12 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 6.2, norm1 = 0.08582, norm01 = 6.201)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 19% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 13 [max:70]

## iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 4.91, norm1 = 0.04977, norm01 = 4.911)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 14.2% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 14 [max:70]

## iinla: Step rescaling: 99.83%, Approx Optimisation (norm0 = 3.91, norm1 = 0.0287, norm01 = 3.911)

## iinla: Evaluate component linearisations
```

```
## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 10.7% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 15 [max:70]

## iinla: Step rescaling: 99.84%, Approx Optimisation (norm0 = 3.13, norm1 = 0.01649, norm01 = 3.13)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 8.14% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 16 [max:70]

## iinla: Step rescaling: 99.85%, Approx Optimisation (norm0 = 2.517, norm1 = 0.009459, norm01 = 2.517)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 6.62% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 17 [max:70]

## iinla: Step rescaling: 99.88%, Approx Optimisation (norm0 = 2.033, norm1 = 0.005424, norm01 = 2.033)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 5.39% of SD, and line search is active [stop if: <10% and line se

## iinla: Iteration 18 [max:70]

## iinla: Step rescaling: 99.9%, Approx Optimisation (norm0 = 1.649, norm1 = 0.003114, norm01 = 1.649)

## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 4.4% of SD, and line search is active [stop if: <10% and line sea

## iinla: Iteration 19 [max:70]

## iinla: Step rescaling: 99.91%, Approx Optimisation (norm0 = 1.343, norm1 = 0.001792, norm01 = 1.343)
```

```
## iinla: Evaluate component linearisations

## iinla: Evaluate predictor linearisation

## iinla: Max deviation from previous: 3.59% of SD, and line search is inactive [stop if: <10% and line

## iinla: Convergence criterion met, running final INLA integration with known theta mode.

## iinla: Iteration 20 [max:70]
```

```r
# set seed
set.seed(1)

# get posterior
all_params.post <- get_posterior_param(input.list = list(
  model.fit = all_params.fit,
  link.functions = link.f
))

# set seed
set.seed(1)

#use link.f
link.f <- list(
  mu = \(x) gamma_t(x, 0.3, 0.6),
  K = \(x) unif_t(x, 0, 10),
  alpha = \(x) unif_t(x, 0, 5),
  c_ = \(x) unif_t(x, 0, 10),
  p = \(x) unif_t(x, 1, 10)
)

# set seed
set.seed(1)

# let  yb be the sample set
yb <- post_sampling(
  input.list = list(
    model.fit = all_params.fit,
    link.functions = link.f
  ),
  n.samp = 1000,
  max.batch = 1000,
  ncore = 1
)
```

```
## Warning: The `ncore` argument of `post_sampling()` is deprecated as of ETAS.inlabru
## 1.1.1.9001.
## i Please use future::plan(future::multisession, workers = ncore) in your code
##   instead.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```

```
# set seed
set.seed(1)

# calculate peason matrix
pearson_matrix <- cor(yb, method = "pearson")

# calculate spearman matrix
#spearman_matrix <- cor(yb, method = "spearman")

# load knitr
library(knitr)
# install lattice and load it
if (!require("lattice")) install.packages("lattice", dependencies = TRUE)
```

```
##      lattice
```

```
library(lattice)

# calculate pearson matrix
cor_matrix <- cor(yb[, c("K", "alpha", "c", "p","mu")], method = "pearson")

#transform data
cor_df <- expand.grid(Variable1 = colnames(cor_matrix),
                      Variable2 = colnames(cor_matrix))
cor_df$Correlation <- as.vector(cor_matrix)
```

```
# plot heatmap by levelplot
levelplot(Correlation ~ Variable1 * Variable2, data = cor_df,
          scales = list(x = list(rot = 0)),
          col.regions = colorRampPalette(c("blue", "white", "red")),
          main = "Heatmap of Pearson correlation coefficient matrix")
```

Heatmap of Pearson correlation coefficient matrix