Stan_Mechbayes

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```
library(outbreaks)
library(tidyverse)
```

```
## -- Attaching packages --------------------------------- tidyverse 1.3.0 --
```

```
## v ggplot2 3.3.0     v purrr   0.3.4
## v tibble  3.0.1     v dplyr   0.8.5
## v tidyr   1.1.0     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.5.0
```

```
## -- Conflicts ------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
head(influenza_england_1978_school)
```

```
##         date in_bed convalescent
## 1 1978-01-22      3            0
## 2 1978-01-23      8            0
## 3 1978-01-24     26            0
## 4 1978-01-25     76            0
## 5 1978-01-26    225            9
## 6 1978-01-27    298           17
```

```
library(rstan)
```

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

```
## rstan (Version 2.19.3, GitRev: 2e1f913d3ca3)
```

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

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

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

```
library(gridExtra)
```

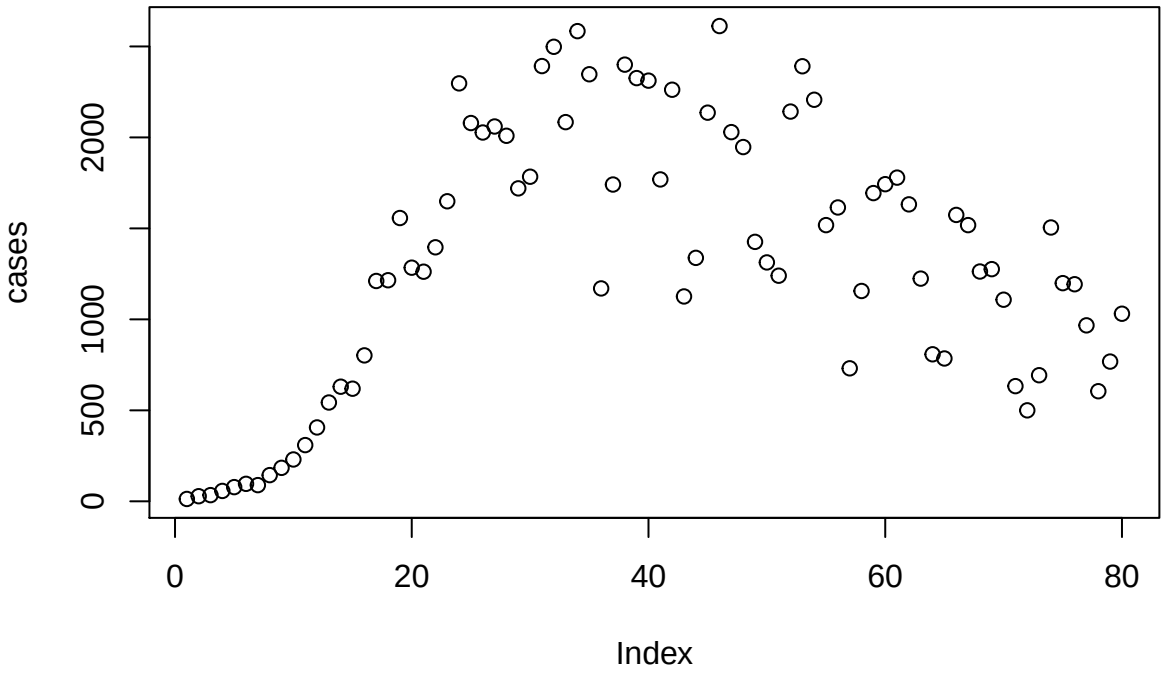
```
##
## Attaching package: 'gridExtra'
```

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

```
##
##     combine
```

```
rstan_options (auto_write = TRUE)
options (mc.cores = parallel::detectCores ())
set.seed(3) # for reproductibility
```

```
cases <- read.csv("/Users/gcgibson/turth-deaths.csv")  # Number of students in bed
cases <- tail(cases[cases$location_name =="US",]$value,80)
# time series of cases
#cases <- influenza_england_1978_school$in_bed  # Number of students in bed

# total count
N <- 300e6;

# times
n_days <- length(cases)
t <- c(1,2)
t0 = 0
#t <- t[-1]

#initial conditions
i0 <- 100*cases[1]
s0 <- N - i0
r0 <- 0
d0 <- 0
y0 = c(S = s0, E= 4*i0, I = i0, R = r0,D1 = 4*cases[1],D2=cases[1])

# data for Stan
data_sir <- list(n_days = n_days, y0 = y0, t0 = t0, ts = t, N = N, cases = cases,L=0.)
plot(cases)
```




```
# number of MCMC steps
```

```
library(rstan)
model <- stan_model("stan-mech-bayes.stan")
```

```
## Warning in readLines(file, warn = TRUE): incomplete final line found on '/Users/
## gcgibson/jags-seir/stan-mech-bayes.stan'
```

```
## recompiling to avoid crashing R session
```

```
## Trying to compile a simple C file
```

```
## Running /Library/Frameworks/R.framework/Resources/bin/R CMD SHLIB foo.c
## clang -mmacosx-version-min=10.13 -I"/Library/Frameworks/R.framework/Resources/include" -DNDEBUG   -I
## In file included from <built-in>:1:
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/StanHeaders/incl
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/inclu
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/inclu
## /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include/Eigen/src/Core/util/
## namespace Eigen {
## ^
## /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include/Eigen/src/Core/util/
## namespace Eigen {
##                 ^
##                 ;
## In file included from <built-in>:1:
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/StanHeaders/incl
## In file included from /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/inclu
## /Library/Frameworks/R.framework/Versions/4.0/Resources/library/RcppEigen/include/Eigen/Core:96:10: fa
## #include <complex>
##          ^~~~~~~~~
## 3 errors generated.
## make: *** [foo.o] Error 1
```

```
fit_sir_negbin <- sampling(model,
                data = data_sir,
                chains = 1,
                iter=1000,
                warmup=500)
```

```
##
## SAMPLING FOR MODEL 'stan-mech-bayes' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 0.025682 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 256.82 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:   1 / 1000 [  0%]  (Warmup)
## Chain 1: Iteration: 100 / 1000 [ 10%]  (Warmup)
## Chain 1: Iteration: 200 / 1000 [ 20%]  (Warmup)
## Chain 1: Iteration: 300 / 1000 [ 30%]  (Warmup)
## Chain 1: Iteration: 400 / 1000 [ 40%]  (Warmup)
## Chain 1: Iteration: 500 / 1000 [ 50%]  (Warmup)
## Chain 1: Iteration: 501 / 1000 [ 50%]  (Sampling)
## Chain 1: Iteration: 600 / 1000 [ 60%]  (Sampling)
## Chain 1: Iteration: 700 / 1000 [ 70%]  (Sampling)
## Chain 1: Iteration: 800 / 1000 [ 80%]  (Sampling)
```

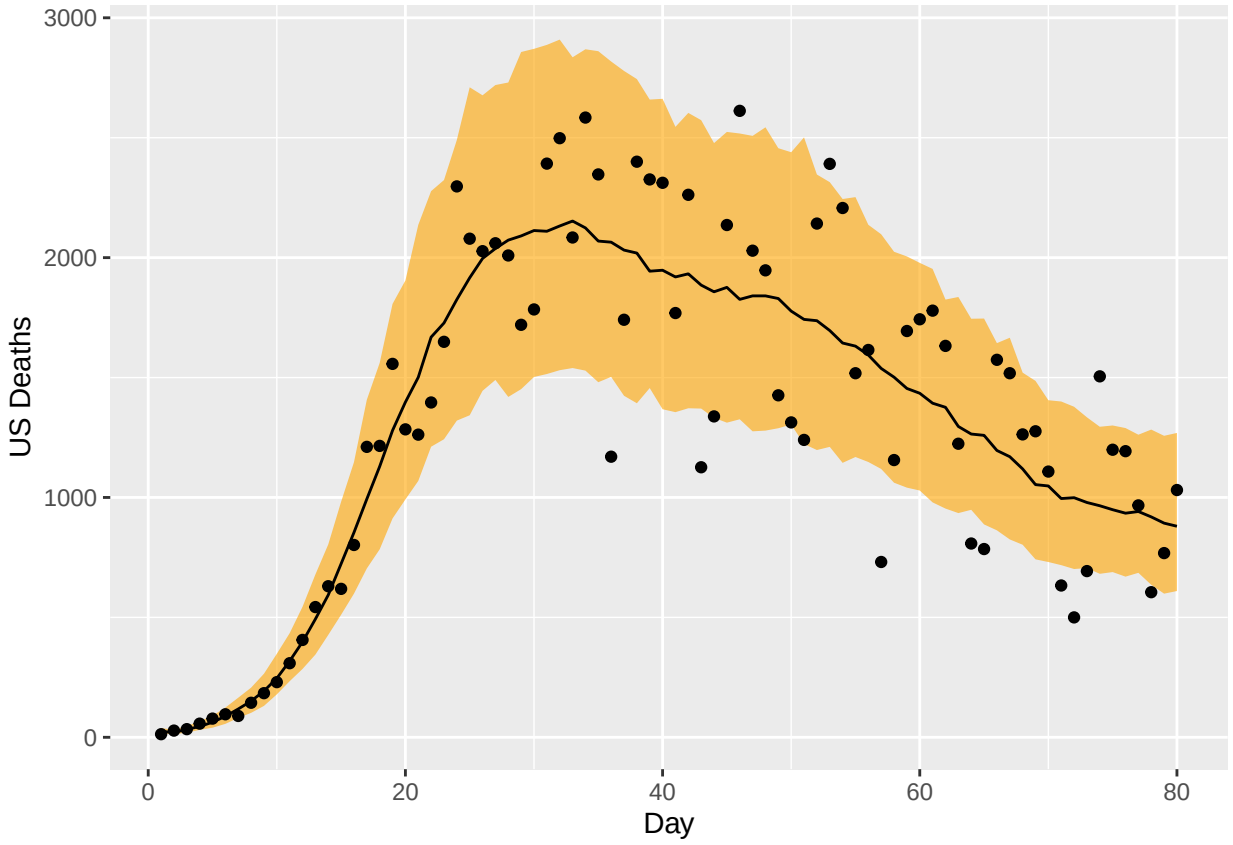
```
## Chain 1: Iteration: 900 / 1000 [ 90%]  (Sampling)
## Chain 1: Iteration: 1000 / 1000 [100%]  (Sampling)
## Chain 1:
## Chain 1:  Elapsed Time: 2803.79 seconds (Warm-up)
## Chain 1:                872.854 seconds (Sampling)
## Chain 1:                3676.64 seconds (Total)
## Chain 1:
```

```
## Warning in validityMethod(object): The following variables have undefined
## values: tmp[3,1],The following variables have undefined values: tmp[4,1],The
## following variables have undefined values: tmp[5,1],The following variables
## have undefined values: tmp[6,1],The following variables have undefined values:
## tmp[7,1],The following variables have undefined values: tmp[8,1],The following
## variables have undefined values: tmp[9,1],The following variables have undefined
## values: tmp[10,1],The following variables have undefined values: tmp[11,1],The
## following variables have undefined values: tmp[12,1],The following variables
## have undefined values: tmp[13,1],The following variables have undefined
## values: tmp[14,1],The following variables have undefined values: tmp[15,1],The
## following variables have undefined values: tmp[16,1],The following variables
## have undefined values: tmp[17,1],The following variables have undefined
## values: tmp[18,1],The following variables have undefined values: tmp[19,1],The
## following variables have undefined values: tmp[20,1],The following variables
## have undefined values: tmp[21,1],The following variables have undefined
## values: tmp[22,1],The following variables have undefined values: tmp[23,1],The
## following variables have undefined values: tmp[24,1],The following variables
## have undefined values: tmp[25,1],The following variables have undefined
## values: tmp[26,1],The following variables have undefined values: tmp[27,1],The
## following variables have undefined values: tmp[28,1],The following variables
## have undefined values: tmp[29,1],The following variables have undefined
## values: tmp[30,1],The following variables have undefined values: tmp[31,1],The
## following variables have undefined values: tmp[32,1],The following variables
## have undefined values: tmp[33,1],The following variables have undefined
## values: tmp[34,1],The following variables have undefined values: tmp[35,1],The
## following variables have undefined values: tmp[36,1],The following variables
## have undefined values: tmp[37,1],The following variables have undefined
## values: tmp[38,1],The following variables have undefined values: tmp[39,1],The
## following variables have undefined values: tmp[40,1],The following variables
## have undefined values: tmp[41,1],The following variables have undefined
## values: tmp[42,1],The following variables have undefined values: tmp[43,1],The
## following variables have undefined values: tmp[44,1],The following variables
## have undefined values: tmp[45,1],The following variables have undefined
## values: tmp[46,1],The following variables have undefined values: tmp[47,1],The
## following variables have undefined values: tmp[48,1],The following variables
## have undefined values: tmp[49,1],The following variables have undefined
## values: tmp[50,1],The following variables have undefined values: tmp[51,1],The
## following variables have undefined values: tmp[52,1],The following variables
## have undefined values: tmp[53,1],The following variables have undefined
## values: tmp[54,1],The following variables have undefined values: tmp[55,1],The
## following variables have undefined values: tmp[56,1],The following variables
## have undefined values: tmp[57,1],The following variables have undefined
## values: tmp[58,1],The following variables have undefined values: tmp[59,1],The
## following variables have undefined values: tmp[60,1],The following variables
## have undefined values: tmp[61,1],The following variables have undefined
## values: tmp[62,1],The following variables have undefined values: tmp[63,1],The
```

```
## following variables have undefined values: tmp[64,1],The following variables
## have undefined values: tmp[65,1],The following variables have undefined
## values: tmp[66,1],The following variables have undefined values: tmp[67,1],The
## following variables have undefined values: tmp[68,1],The following variables
## have undefined values: tmp[69,1],The following variables have undefined
## values: tmp[70,1],The following variables have undefined values: tmp[71,1],The
## following variables have undefined values: tmp[72,1],The following variables
## have undefined values: tmp[73,1],The following variables have undefined
## values: tmp[74,1],The following variables have undefined values: tmp[75,1],The
## following variables have undefined values: tmp[76,1],The following variables
## have undefined values: tmp[77,1],The following variables have undefined
## values: tmp[78,1],The following variables have undefined values: tmp[79,1],The
## following variables have undefined values: tmp[80,1],The following variables
## have undefined values: tmp[3,2],The following variables have undefined values:
## tmp[4,2],The following variables have undefined values: tmp[5,2],The following
## variables have undefined values: tmp[6,2],The following variables have undefined
## values: tmp[7,2],The following variables have undefined values: tmp[8,2],The
## following variables have undefined values: tmp[9,2],The following variables
## have undefined values: tmp[10,2],The following variables have undefined
## values: tmp[11,2],The following variables have undefined values: tmp[12,2],The
## following variables have undefined values: tmp[13,2],The following variables
## have undefined values: tmp[14,2],The following variables have undefined
## values: tmp[15,2],The following variables have undefined values: tmp[16,2],The
## following variables have undefined values: tmp[17,2],The following variables
## have undefined values: tmp[18,2],The following variables have undefined
## values: tmp[19,2],The following variables have undefined values: tmp[20,2],The
## following variables have undefined values: tmp[21,2],The following variables
## have undefined values: tmp[22,2],The following variables have undefined
## values: tmp[23,2],The following variables have undefined values: tmp[24,2],The
## following variables have undefined values: tmp[25,2],The following variables
## have undefined values: tmp[26,2],The following variables have undefined
## values: tmp[27,2],The following variables have undefined values: tmp[28,2],The
## following variables have undefined values: tmp[29,2],The following variables
## have undefined values: tmp[30,2],The following variables have undefined
## values: tmp[31,2],The following variables have undefined values: tmp[32,2],The
## following variables have undefined values: tmp[33,2],The following variables
## have undefined values: tmp[34,2],The following variables have undefined
## values: tmp[35,2],The following variables have undefined values: tmp[36,2],The
## following variables have undefined values: tmp[37,2],The following variables
## have undefined values: tmp[38,2],The following variables have undefined
## values: tmp[39,2],The following variables have undefined values: tmp[40,2],The
## following variables have undefined values: tmp[41,2],The following variables
## have undefined values: tmp[42,2],The following variables have undefined
## values: tmp[43,2],The following variables have undefined values: tmp[44,2],The
## following variables have undefined values: tmp[45,2],The following variables
## have undefined values: tmp[46,2],The following variables have undefined
## values: tmp[47,2],The following variables have undefined values: tmp[48,2],The
## following variables have undefined values: tmp[49,2],The following variables
## have undefined values: tmp[50,2],The following variables have undefined
## values: tmp[51,2],The following variables have undefined values: tmp[52,2],The
## following variables have undefined values: tmp[53,2],The following variables
## have undefined values: tmp[54,2],The following variables have undefined
## values: tmp[55,2],The following variables have undefined values: tmp[56,2],The
## following variables have undefined values: tmp[57,2],The following variables
```

```
## have undefined values: tmp[58,2],The following variables have undefined
## values: tmp[59,2],The following variables have undefined values: tmp[60,2],The
## following variables have undefined values: tmp[61,2],The following variables
## have undefined values: tmp[62,2],The following variables have undefined values:
## tmp[63,2],The following variables have undefined values: tmp[64,2],The following
## variables have undefined values: tmp[65,2],The following variables ha

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

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

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

```r
smr_pred <- cbind(as.data.frame(summary(
  fit_sir_negbin, pars = "pred_cases", probs = c(0.05, 0.5, 0.95))$summary), t, cases)
colnames(smr_pred) <- make.names(colnames(smr_pred)) # to remove % in the col names

ggplot(smr_pred, mapping = aes(x = 1:n_days)) +
 geom_ribbon(aes(ymin = X5., ymax = X95.), fill = "orange", alpha = 0.6) +
  geom_line(mapping = aes(x = 1:n_days, y = X50.)) +
  geom_point(mapping = aes(y = cases)) +
  labs(x = "Day", y = "US Deaths")
```



```r
smr_pred <- cbind(as.data.frame(summary(
  fit_sir_negbin, pars = "pred_cases", probs = c(0.10, 0.5, 0.90))$summary), t, cases)
colnames(smr_pred) <- make.names(colnames(smr_pred)) # to remove % in the col names

ggplot(smr_pred, mapping = aes(x = 1:n_days)) +
 geom_ribbon(aes(ymin = cumsum(X10.), ymax = cumsum(X90.)), fill = "orange", alpha = 0.6) +
  geom_line(mapping = aes(x = 1:n_days, y = cumsum(X50.))) +
  geom_point(mapping = aes(y = cumsum(cases))) +
  labs(x = "Day", y = "US Deaths")
```