# Model for Oregon

## Model for Oregon from march to june

```
X <- get_model_data(data, 'OR', as.Date('2020-06-30'))

p_delay <- get_delay_distribution()

nonzero_days <- which(X$total != 0)

stan_data <- list(N = nrow(X),
                  conv_gt = get_gt_convolution(nrow(X)),
                  length_delay = length(p_delay),
                  p_delay = p_delay,
                  exposures = exposures_from_total(X$total),
                  N_nonzero = length(nonzero_days),
                  nonzero_positives = X$positive[nonzero_days],
                  nonzero_days = nonzero_days

)


compiled_model <- stan_model('rt_model.stan')

fit_model <- sampling(compiled_model, data=stan_data, iter = 2000)
```

```
##
## SAMPLING FOR MODEL 'rt_model' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 0.002572 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take 25.72 seconds.
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 1: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 1: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 1: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 1: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 1: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 1: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 1: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 1: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 1: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 1: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 1: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1:
## Chain 1:  Elapsed Time: 138.271 seconds (Warm-up)
## Chain 1:                139.405 seconds (Sampling)
## Chain 1:                277.677 seconds (Total)
## Chain 1:
##
## SAMPLING FOR MODEL 'rt_model' NOW (CHAIN 2).
## Chain 2:
## Chain 2: Gradient evaluation took 0.001148 seconds
## Chain 2: 1000 transitions using 10 leapfrog steps per transition would take 11.48 seconds.
## Chain 2: Adjust your expectations accordingly!
## Chain 2:
## Chain 2:
## Chain 2: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 2: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 2: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 2: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 2: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 2: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 2: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 2: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 2: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 2: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 2: Iteration: 1800 / 2000 [ 90%]  (Sampling)
```

```
## Chain 2: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 2: 
## Chain 2:  Elapsed Time: 149.471 seconds (Warm-up)
## Chain 2:                146.47 seconds (Sampling)
## Chain 2:                295.942 seconds (Total)
## Chain 2: 
## 
## SAMPLING FOR MODEL 'rt_model' NOW (CHAIN 3).
## Chain 3: 
## Chain 3: Gradient evaluation took 0.001102 seconds
## Chain 3: 1000 transitions using 10 leapfrog steps per transition would take 11.02 seconds.
## Chain 3: Adjust your expectations accordingly!
## Chain 3: 
## Chain 3: 
## Chain 3: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 3: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 3: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 3: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 3: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 3: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 3: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 3: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 3: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 3: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 3: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 3: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 3: 
## Chain 3:  Elapsed Time: 141.898 seconds (Warm-up)
## Chain 3:                139.708 seconds (Sampling)
## Chain 3:                281.606 seconds (Total)
## Chain 3: 
## 
## SAMPLING FOR MODEL 'rt_model' NOW (CHAIN 4).
## Chain 4: 
## Chain 4: Gradient evaluation took 0.001104 seconds
## Chain 4: 1000 transitions using 10 leapfrog steps per transition would take 11.04 seconds.
## Chain 4: Adjust your expectations accordingly!
## Chain 4: 
## Chain 4: 
## Chain 4: Iteration:    1 / 2000 [  0%]  (Warmup)
## Chain 4: Iteration:  200 / 2000 [ 10%]  (Warmup)
## Chain 4: Iteration:  400 / 2000 [ 20%]  (Warmup)
## Chain 4: Iteration:  600 / 2000 [ 30%]  (Warmup)
## Chain 4: Iteration:  800 / 2000 [ 40%]  (Warmup)
## Chain 4: Iteration: 1000 / 2000 [ 50%]  (Warmup)
## Chain 4: Iteration: 1001 / 2000 [ 50%]  (Sampling)
## Chain 4: Iteration: 1200 / 2000 [ 60%]  (Sampling)
## Chain 4: Iteration: 1400 / 2000 [ 70%]  (Sampling)
## Chain 4: Iteration: 1600 / 2000 [ 80%]  (Sampling)
## Chain 4: Iteration: 1800 / 2000 [ 90%]  (Sampling)
## Chain 4: Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 4: 
## Chain 4:  Elapsed Time: 140.207 seconds (Warm-up)
## Chain 4:                141.118 seconds (Sampling)
## Chain 4:                281.325 seconds (Total)
## Chain 4: 
```

```r
print(fit_model, pars = 'r_t')
```

```
## Inference for Stan model: rt_model.
## 4 chains, each with iter=2000; warmup=1000; thin=1; 
## post-warmup draws per chain=1000, total post-warmup draws=4000.
## 
##          mean se_mean   sd 2.5%  25%  50%  75% 97.5% n_eff Rhat
## r_t[1]   1.74       0 0.20 1.38 1.60 1.73 1.87  2.16  3416    1
## r_t[2]   1.74       0 0.19 1.39 1.59 1.73 1.87  2.14  3450    1
## r_t[3]   1.73       0 0.19 1.40 1.60 1.72 1.85  2.13  3394    1
## r_t[4]   1.73       0 0.18 1.41 1.60 1.71 1.84  2.10  3360    1
## r_t[5]   1.72       0 0.17 1.41 1.60 1.71 1.83  2.06  3176    1
## r_t[6]   1.71       0 0.16 1.41 1.60 1.70 1.81  2.04  3097    1
## r_t[7]   1.70       0 0.15 1.41 1.59 1.69 1.80  2.01  3019    1
## r_t[8]   1.68       0 0.15 1.41 1.58 1.68 1.78  1.97  2907    1
```

```
## r_t[8]   1.68       0 0.15 1.41 1.58 1.68 1.78  1.97  2907     1
## r_t[9]   1.66       0 0.14 1.40 1.57 1.66 1.75  1.94  2993     1
## r_t[10]  1.64       0 0.13 1.40 1.55 1.64 1.73  1.91  3032     1
## r_t[11]  1.62       0 0.13 1.38 1.53 1.62 1.70  1.88  3125     1
## r_t[12]  1.60       0 0.12 1.36 1.51 1.59 1.68  1.84  3225     1
## r_t[13]  1.57       0 0.12 1.34 1.49 1.56 1.64  1.81  3336     1
## r_t[14]  1.53       0 0.11 1.32 1.46 1.53 1.61  1.77  3594     1
## r_t[15]  1.50       0 0.11 1.30 1.43 1.50 1.57  1.72  3600     1
## r_t[16]  1.46       0 0.10 1.27 1.39 1.46 1.53  1.68  3626     1
## r_t[17]  1.43       0 0.10 1.24 1.36 1.43 1.49  1.64  3750     1
## r_t[18]  1.39       0 0.10 1.21 1.32 1.39 1.46  1.59  4030     1
## r_t[19]  1.35       0 0.09 1.18 1.29 1.35 1.42  1.54  4182     1
## r_t[20]  1.32       0 0.09 1.15 1.25 1.31 1.37  1.50  4179     1
## r_t[21]  1.28       0 0.09 1.12 1.22 1.28 1.34  1.45  3724     1
## r_t[22]  1.24       0 0.08 1.09 1.19 1.24 1.30  1.41  3794     1
## r_t[23]  1.21       0 0.08 1.06 1.15 1.21 1.26  1.37  3842     1
## r_t[24]  1.18       0 0.08 1.03 1.12 1.17 1.23  1.33  4221     1
## r_t[25]  1.15       0 0.07 1.01 1.09 1.14 1.19  1.30  4031     1
## r_t[26]  1.12       0 0.07 0.98 1.07 1.11 1.16  1.26  4043     1
## r_t[27]  1.09       0 0.07 0.96 1.04 1.09 1.13  1.24  4123     1
## r_t[28]  1.07       0 0.07 0.93 1.02 1.06 1.11  1.20  4337     1
## r_t[29]  1.04       0 0.07 0.91 1.00 1.04 1.09  1.18  3884     1
## r_t[30]  1.02       0 0.07 0.90 0.98 1.02 1.06  1.15  3840     1
## r_t[31]  1.00       0 0.06 0.88 0.96 1.00 1.04  1.13  3638     1
## r_t[32]  0.98       0 0.06 0.87 0.94 0.98 1.03  1.11  3544     1
## r_t[33]  0.97       0 0.06 0.85 0.93 0.97 1.01  1.10  3344     1
## r_t[34]  0.95       0 0.06 0.84 0.91 0.95 0.99  1.08  3587     1
## r_t[35]  0.94       0 0.06 0.83 0.90 0.94 0.98  1.07  3832     1
## r_t[36]  0.93       0 0.06 0.82 0.89 0.93 0.97  1.05  3694     1
## r_t[37]  0.92       0 0.06 0.82 0.88 0.92 0.96  1.04  3739     1
## r_t[38]  0.91       0 0.06 0.81 0.88 0.91 0.95  1.03  3884     1
## r_t[39]  0.91       0 0.06 0.80 0.87 0.91 0.94  1.02  3966     1
## r_t[40]  0.90       0 0.06 0.80 0.86 0.90 0.94  1.01  3915     1
## r_t[41]  0.90       0 0.06 0.79 0.86 0.89 0.93  1.01  3833     1
## r_t[42]  0.89       0 0.06 0.79 0.85 0.89 0.93  1.01  3831     1
## r_t[43]  0.89       0 0.05 0.78 0.85 0.89 0.92  1.00  3874     1
## r_t[44]  0.88       0 0.05 0.78 0.85 0.88 0.92  1.00  4026     1
## r_t[45]  0.88       0 0.05 0.78 0.84 0.88 0.92  1.00  3908     1
## r_t[46]  0.88       0 0.06 0.78 0.84 0.88 0.91  0.99  3588     1
## r_t[47]  0.88       0 0.06 0.77 0.84 0.87 0.91  0.99  3511     1
## r_t[48]  0.87       0 0.06 0.77 0.84 0.87 0.91  0.99  3662     1
## r_t[49]  0.87       0 0.06 0.77 0.83 0.87 0.91  0.99  3711     1
## r_t[50]  0.87       0 0.06 0.77 0.83 0.87 0.91  0.99  3750     1
## r_t[51]  0.87       0 0.06 0.77 0.83 0.87 0.91  0.99  3648     1
## r_t[52]  0.87       0 0.06 0.76 0.83 0.87 0.91  0.98  3687     1
## r_t[53]  0.87       0 0.06 0.76 0.83 0.87 0.91  0.99  3547     1
## r_t[54]  0.87       0 0.06 0.77 0.83 0.87 0.91  0.99  3776     1
## r_t[55]  0.87       0 0.06 0.76 0.83 0.87 0.91  0.99  3893     1
## r_t[56]  0.87       0 0.06 0.76 0.83 0.87 0.91  0.99  3841     1
## r_t[57]  0.87       0 0.06 0.76 0.83 0.87 0.91  0.98  3773     1
## r_t[58]  0.87       0 0.06 0.76 0.83 0.87 0.91  0.98  3600     1
## r_t[59]  0.87       0 0.06 0.76 0.83 0.87 0.91  0.99  3759     1
## r_t[60]  0.87       0 0.06 0.77 0.84 0.87 0.91  0.99  3822     1
## r_t[61]  0.87       0 0.06 0.77 0.84 0.87 0.91  0.99  3608     1
## r_t[62]  0.88       0 0.06 0.77 0.84 0.88 0.91  1.00  3489     1
## r_t[63]  0.88       0 0.06 0.78 0.84 0.88 0.92  1.00  3452     1
## r_t[64]  0.89       0 0.06 0.78 0.85 0.89 0.92  1.00  3509     1
## r_t[65]  0.89       0 0.06 0.79 0.85 0.89 0.93  1.01  3368     1
## r_t[66]  0.90       0 0.06 0.79 0.86 0.90 0.94  1.02  3365     1
## r_t[67]  0.91       0 0.06 0.80 0.87 0.91 0.95  1.03  3383     1
## r_t[68]  0.92       0 0.06 0.81 0.88 0.92 0.96  1.04  3610     1
## r_t[69]  0.93       0 0.06 0.82 0.89 0.93 0.97  1.05  3589     1
## r_t[70]  0.95       0 0.06 0.83 0.90 0.94 0.98  1.07  3621     1
## r_t[71]  0.96       0 0.06 0.84 0.92 0.96 1.00  1.09  3563     1
## r_t[72]  0.98       0 0.06 0.86 0.93 0.97 1.02  1.11  3516     1
## r_t[73]  0.99       0 0.06 0.87 0.95 0.99 1.03  1.12  3132     1
## r_t[74]  1.01       0 0.06 0.89 0.96 1.01 1.05  1.14  3136     1
## r_t[75]  1.03       0 0.07 0.90 0.98 1.02 1.07  1.16  3270     1
## r_t[76]  1.04       0 0.07 0.91 1.00 1.04 1.09  1.18  3498     1
## r_t[77]  1.06       0 0.07 0.93 1.01 1.06 1.11  1.20  3570     1
## r_t[78]  1.08       0 0.07 0.95 1.03 1.08 1.13  1.22  3667     1
## r_t[79]  1.10       0 0.07 0.96 1.05 1.09 1.14  1.24  3410     1
## r_t[80]  1.11       0 0.07 0.98 1.07 1.11 1.16  1.26  3481     1
```

```
## r_t[81]  1.13       0 0.07 1.00 1.08 1.13 1.18  1.28  3450    1
## r_t[82]  1.15       0 0.07 1.01 1.10 1.15 1.19  1.30  3682    1
## r_t[83]  1.16       0 0.07 1.03 1.11 1.16 1.21  1.31  3798    1
## r_t[84]  1.18       0 0.08 1.04 1.13 1.18 1.23  1.33  3961    1
## r_t[85]  1.19       0 0.08 1.05 1.14 1.19 1.24  1.34  3841    1
## r_t[86]  1.20       0 0.08 1.06 1.15 1.20 1.26  1.36  3872    1
## r_t[87]  1.21       0 0.08 1.07 1.16 1.21 1.26  1.36  4051    1
## r_t[88]  1.22       0 0.08 1.07 1.17 1.22 1.27  1.38  3796    1
## r_t[89]  1.23       0 0.08 1.08 1.17 1.23 1.28  1.39  3836    1
## r_t[90]  1.23       0 0.08 1.08 1.18 1.23 1.28  1.39  3710    1
## r_t[91]  1.24       0 0.08 1.09 1.18 1.24 1.29  1.40  3583    1
## r_t[92]  1.24       0 0.08 1.09 1.18 1.24 1.29  1.40  3505    1
## r_t[93]  1.24       0 0.08 1.09 1.19 1.24 1.30  1.40  3539    1
## r_t[94]  1.24       0 0.08 1.08 1.19 1.24 1.29  1.40  3544    1
## r_t[95]  1.24       0 0.08 1.09 1.18 1.24 1.29  1.41  3653    1
## r_t[96]  1.24       0 0.08 1.08 1.18 1.24 1.29  1.41  3693    1
## r_t[97]  1.24       0 0.08 1.08 1.18 1.24 1.29  1.41  3601    1
## r_t[98]  1.24       0 0.08 1.08 1.18 1.23 1.29  1.41  3532    1
## r_t[99]  1.23       0 0.09 1.07 1.17 1.23 1.29  1.41  3554    1
## r_t[100] 1.23       0 0.09 1.07 1.17 1.23 1.29  1.41  3155    1
## r_t[101] 1.23       0 0.09 1.06 1.16 1.22 1.29  1.42  3001    1
## r_t[102] 1.22       0 0.09 1.05 1.16 1.22 1.28  1.42  2868    1
## r_t[103] 1.22       0 0.10 1.04 1.15 1.22 1.28  1.42  2793    1
## r_t[104] 1.22       0 0.10 1.03 1.15 1.21 1.28  1.42  2585    1
## r_t[105] 1.21       0 0.10 1.01 1.14 1.21 1.28  1.42  2424    1
## r_t[106] 1.21       0 0.11 1.00 1.14 1.20 1.28  1.43  2342    1
## r_t[107] 1.20       0 0.11 0.99 1.13 1.20 1.28  1.43  2306    1
## r_t[108] 1.20       0 0.12 0.97 1.12 1.20 1.28  1.45  2237    1
## r_t[109] 1.20       0 0.12 0.97 1.11 1.20 1.28  1.45  2131    1
## r_t[110] 1.20       0 0.13 0.96 1.11 1.19 1.28  1.46  2148    1
## r_t[111] 1.19       0 0.13 0.94 1.10 1.19 1.28  1.47  2106    1
## r_t[112] 1.19       0 0.14 0.93 1.09 1.19 1.28  1.48  2113    1
## r_t[113] 1.19       0 0.14 0.93 1.09 1.18 1.29  1.49  2116    1
## r_t[114] 1.19       0 0.15 0.92 1.09 1.18 1.29  1.50  2113    1
## r_t[115] 1.19       0 0.16 0.92 1.08 1.18 1.29  1.53  2075    1
## r_t[116] 1.19       0 0.16 0.91 1.08 1.18 1.30  1.54  2068    1
## r_t[117] 1.19       0 0.17 0.90 1.08 1.18 1.30  1.55  2038    1
## r_t[118] 1.19       0 0.17 0.89 1.07 1.18 1.30  1.57  2074    1
## r_t[119] 1.19       0 0.18 0.88 1.07 1.18 1.31  1.57  2110    1
## r_t[120] 1.20       0 0.19 0.88 1.07 1.18 1.31  1.61  2075    1
## r_t[121] 1.20       0 0.19 0.88 1.06 1.18 1.32  1.61  2086    1
## r_t[122] 1.20       0 0.19 0.86 1.06 1.18 1.32  1.61  2121    1
## r_t[123] 1.20       0 0.20 0.86 1.06 1.18 1.32  1.63  2168    1
## r_t[124] 1.20       0 0.20 0.85 1.06 1.18 1.32  1.65  2152    1
## r_t[125] 1.20       0 0.21 0.85 1.05 1.18 1.33  1.66  2138    1
## r_t[126] 1.20       0 0.22 0.84 1.05 1.18 1.34  1.68  2201    1
## 
## Samples were drawn using NUTS(diag_e) at Sun Oct 11 22:40:49 2020.
## For each parameter, n_eff is a crude measure of effective sample size,
## and Rhat is the potential scale reduction factor on split chains (at 
## convergence, Rhat=1).
```

```
print(fit_model, pars = 'mu')
```

```
## Inference for Stan model: rt_model.
## 4 chains, each with iter=2000; warmup=1000; thin=1; 
## post-warmup draws per chain=1000, total post-warmup draws=4000.
## 
##           mean se_mean    sd  2.5%   25%   50%   75%  97.5% n_eff Rhat
## mu[1]     4.63    0.02  1.20  2.77  3.78  4.47  5.30   7.43  3117    1
## mu[2]     5.35    0.02  1.31  3.31  4.41  5.17  6.10   8.41  3146    1
## mu[3]     6.31    0.03  1.46  3.99  5.26  6.11  7.15   9.73  3180    1
## mu[4]     7.04    0.03  1.52  4.60  5.95  6.84  7.90  10.57  3239    1
## mu[5]     7.94    0.03  1.60  5.33  6.78  7.75  8.85  11.57  3314    1
## mu[6]    10.07    0.03  1.79  7.12  8.78  9.87 11.11  14.07  3518    1
## mu[7]    12.57    0.03  1.98  9.24 11.16 12.37 13.76  16.94  3765    1
## mu[8]    14.07    0.03  2.10 10.53 12.58 13.87 15.35  18.69  3890    1
## mu[9]    15.57    0.03  2.20 11.77 14.01 15.37 16.92  20.36  4033    1
## mu[10]   17.21    0.04  2.31 13.21 15.57 17.02 18.65  22.25  4166    1
## mu[11]   18.99    0.04  2.44 14.81 17.27 18.79 20.53  24.37  4280    1
## mu[12]   20.88    0.04  2.58 16.45 19.04 20.69 22.52  26.56  4367    1
```

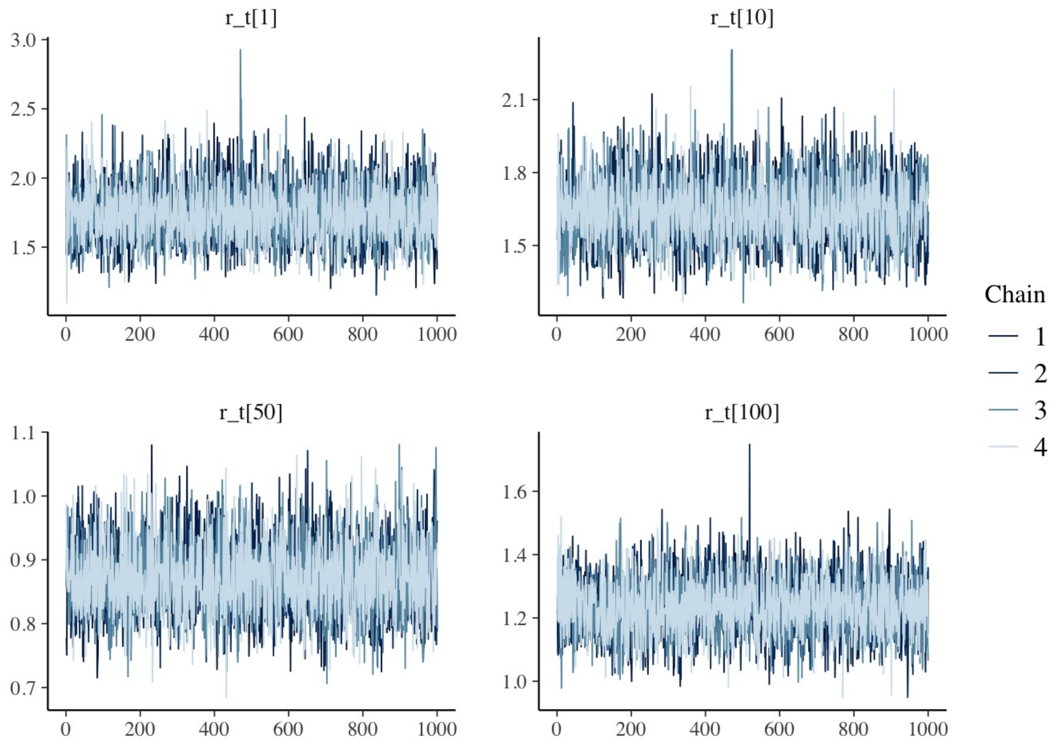
```
## mu[13]   24.97   0.04  2.89  19.93  22.95  24.80  26.83  31.08 4445    1
## mu[14]   27.12   0.05  3.05  21.75  24.98  26.95  29.03  33.48 4418    1
## mu[15]   29.31   0.05  3.22  23.58  27.04  29.14  31.31  35.99 4331    1
## mu[16]   85.47   0.14  9.06  69.64  79.03  84.91  91.19 104.39 4166    1
## mu[17]   55.03   0.09  5.75  44.80  51.00  54.71  58.66  67.05 4129    1
## mu[18]   44.29   0.07  4.58  36.02  41.11  44.00  47.13  54.09 4079    1
## mu[19]   46.94   0.08  4.81  38.24  43.55  46.64  49.95  57.05 4022    1
## mu[20]   57.25   0.09  5.83  46.72  53.15  56.90  60.96  69.44 3978    1
## mu[21]   44.13   0.07  4.47  36.03  40.96  43.89  47.04  53.57 3944    1
## mu[22]   45.87   0.07  4.63  37.53  42.58  45.63  48.86  55.87 3912    1
## mu[23]   97.61   0.16  9.83  79.86  90.57  97.11 103.94 118.89 3884    1
## mu[24]   61.26   0.10  6.16  50.36  56.89  60.95  65.14  74.52 3864    1
## mu[25]   50.06   0.08  5.03  41.03  46.46  49.85  53.26  60.81 3850    1
## mu[26]  146.79   0.24 14.73 120.36 136.30 146.22 156.31 178.36 3841    1
## mu[27]   56.83   0.09  5.70  46.62  52.82  56.55  60.48  69.15 3835    1
## mu[28]   58.96   0.10  5.91  48.34  54.85  58.65  62.72  71.70 3832    1
## mu[29]   76.80   0.12  7.70  62.96  71.48  76.31  81.65  93.49 3832    1
## mu[30]   53.35   0.09  5.35  43.82  49.69  53.05  56.73  64.86 3834    1
## mu[31]   79.35   0.13  7.97  65.07  73.84  79.00  84.26  96.09 3839    1
## mu[32]  125.50   0.20 12.63 102.80 116.79 125.01 133.32 151.89 3840    1
## mu[33]   67.12   0.11  6.76  55.04  62.44  66.76  71.37  81.20 3839    1
## mu[34]   60.67   0.10  6.12  49.64  56.47  60.35  64.58  73.47 3836    1
## mu[35]   52.01   0.08  5.25  42.54  48.39  51.73  55.41  63.09 3831    1
## mu[36]   75.84   0.12  7.67  62.02  70.51  75.36  80.85  91.71 3825    1
## mu[37]   65.19   0.11  6.60  53.37  60.61  64.79  69.54  78.93 3819    1
## mu[38]   58.59   0.10  5.94  47.77  54.50  58.32  62.50  71.02 3815    1
## mu[39]   66.44   0.11  6.73  54.19  61.71  66.10  70.84  80.52 3816    1
## mu[40]   48.24   0.08  4.88  39.33  44.83  47.97  51.36  58.60 3822    1
## mu[41]   47.66   0.08  4.82  39.01  44.23  47.39  50.72  57.90 3835    1
## mu[42]   46.39   0.08  4.68  38.06  43.08  46.09  49.35  56.33 3856    1
## mu[43]  117.90   0.19 11.83  96.92 109.50 117.20 125.43 142.84 3884    1
## mu[44]   62.67   0.10  6.26  51.56  58.29  62.27  66.70  76.14 3918    1
## mu[45]   76.20   0.12  7.56  62.80  70.95  75.77  81.01  92.41 3958    1
## mu[46]   62.70   0.10  6.18  51.71  58.43  62.32  66.60  75.92 4005    1
## mu[47]   86.23   0.13  8.44  70.89  80.42  85.74  91.50 104.36 4058    1
## mu[48]  120.44   0.18 11.63  99.08 112.46 119.86 127.75 144.55 4174    1
## mu[49]   56.00   0.08  5.38  46.07  52.30  55.68  59.32  66.90 4227    1
## mu[50]   75.09   0.11  7.18  61.89  70.14  74.72  79.60  89.66 4264    1
## mu[51]   68.64   0.10  6.56  56.58  64.12  68.31  72.77  81.96 4264    1
## mu[52]   65.51   0.10  6.24  54.11  61.21  65.13  69.44  78.30 4297    1
## mu[53]   46.73   0.07  4.45  38.67  43.67  46.45  49.54  55.97 4327    1
## mu[54]   63.89   0.09  6.09  53.07  59.72  63.50  67.71  76.52 4355    1
## mu[55]   80.82   0.12  7.72  67.12  75.50  80.38  85.66  96.95 4380    1
## mu[56]   76.65   0.11  7.35  63.49  71.67  76.22  81.20  91.93 4401    1
## mu[57]   67.31   0.10  6.49  55.78  62.93  66.94  71.30  81.18 4417    1
## mu[58]   56.62   0.08  5.50  46.83  52.88  56.27  59.95  68.27 4410    1
## mu[59]   30.84   0.05  3.02  25.45  28.77  30.63  32.66  37.20 4388    1
## mu[60]   58.77   0.09  5.80  48.41  54.78  58.41  62.27  71.06 4356    1
## mu[61]  170.73   0.26 17.18 140.61 158.50 169.40 181.13 206.81 4271    1
## mu[62]   28.17   0.04  2.86  23.13  26.15  27.95  29.92  34.19 4223    1
## mu[63]  140.12   0.22 14.40 115.03 130.14 138.85 148.91 170.67 4174    1
## mu[64]   67.91   0.11  7.06  55.58  63.04  67.33  72.30  82.80 4124    1
## mu[65]   53.51   0.09  5.62  43.68  49.60  53.01  56.98  65.54 4074    1
## mu[66]   72.35   0.12  7.69  58.77  67.04  71.59  77.14  88.86 4022    1
## mu[67]   58.09   0.10  6.23  47.08  53.75  57.45  62.03  71.65 3970    1
## mu[68]   58.10   0.10  6.29  47.07  53.78  57.50  62.04  71.77 3915    1
## mu[69]   73.03   0.13  7.97  59.10  67.56  72.28  78.05  90.36 3858    1
## mu[70]   61.83   0.11  6.79  49.99  57.17  61.22  66.07  76.45 3793    1
## mu[71]   55.91   0.10  6.17  45.10  51.63  55.38  59.82  69.04 3714    1
## mu[72]   47.00   0.09  5.20  37.89  43.38  46.56  50.32  58.14 3638    1
## mu[73]   39.50   0.07  4.38  31.84  36.41  39.13  42.27  48.84 3565    1
## mu[74]   40.21   0.08  4.46  32.46  37.08  39.91  43.03  49.79 3497    1
## mu[75]   35.18   0.07  3.90  28.39  32.42  34.93  37.64  43.56 3434    1
## mu[76]   65.14   0.12  7.21  52.62  60.03  64.72  69.68  80.71 3373    1
## mu[77]   75.72   0.15  8.35  61.24  69.81  75.18  80.93  93.71 3315    1
## mu[78]  104.75   0.20 11.50  84.88  96.63 103.96 111.95 129.70 3261    1
## mu[79]   62.68   0.12  6.84  50.93  57.81  62.20  67.05  77.41 3211    1
## mu[80]   64.59   0.12  7.00  52.60  59.57  64.15  69.04  79.56 3168    1
## mu[81]   71.21   0.14  7.66  58.02  65.74  70.69  75.98  87.68 3133    1
## mu[82]   69.67   0.13  7.44  56.84  64.42  69.13  74.28  85.63 3107    1
## mu[83]   77.37   0.15  8.20  63.13  71.61  76.83  82.46  95.10 2935    1
## mu[84]  119.13   0.24 12.52  97.28 110.16 118.33 127.06 146.09 2838    1
## mu[85]   91.43   0.18  9.54  74.81  84.62  90.84  97.57 112.12 2777    1
```

```
## mu[86]   73.00    0.14   7.56  59.87  67.60  72.53  77.86   89.39  2731    1
## mu[87]   50.05    0.10   5.14  41.20  46.39  49.71  53.41   61.24  2705    1
## mu[88]  131.56    0.26  13.42 108.36 121.93 130.56 140.11  160.38  2696    1
## mu[89]  115.04    0.22  11.67  94.63 106.63 114.17 122.37  140.05  2710    1
## mu[90]  192.43    0.37  19.42 158.02 178.74 191.01 204.72  233.90  2768    1
## mu[91]  174.17    0.33  17.52 143.02 161.95 172.96 185.27  211.04  2866    1
## mu[92]  177.53    0.33  17.84 145.73 164.97 176.14 189.05  215.54  2997    1
## mu[93]  146.73    0.26  14.77 120.57 136.36 145.70 155.96  177.83  3163    1
## mu[94]  101.26    0.18  10.25  82.92  94.18 100.52 107.71  122.71  3385    1
## mu[95]  159.21    0.27  16.26 130.58 147.89 158.03 169.23  193.66  3740    1
## mu[96]  234.55    0.39  24.28 191.30 217.68 232.80 249.07  285.93  3931    1
## mu[97]  242.91    0.40  25.64 197.68 225.26 241.02 257.88  297.20  4104    1
## mu[98]  252.57    0.42  27.34 204.36 233.44 250.42 268.88  310.62  4182    1
## mu[99]   59.12    0.10   6.61  47.62  54.51  58.54  62.99   73.13  4193    1
## mu[100] 486.88    0.88  56.55 388.77 447.23 481.54 521.23  606.17  4129    1
## mu[101] 238.79    0.46  29.04 189.39 218.60 235.94 256.36  301.92  3993    1
## mu[102] 252.34    0.52  32.35 197.11 229.65 248.97 272.36  323.30  3800    1
## mu[103] 211.62    0.48  28.79 162.98 191.73 208.96 229.31  275.09  3574    1
## mu[104] 174.08    0.44  25.29 131.52 156.62 171.65 189.66  229.89  3340    1
## mu[105]  74.51    0.21  11.62  55.21  66.33  73.25  81.63  100.42  3115    1
## mu[106] 773.83    2.41 129.97 560.51 682.25 760.41 851.53 1064.06  2913    1
## mu[107] 246.30    0.85  44.70 173.65 214.85 241.76 272.51  344.23  2738    1
## mu[108] 563.76    2.18 110.77 385.09 486.20 551.82 626.49  811.66  2591    1
## mu[109] 201.69    0.87  42.96 132.84 171.84 196.96 225.63  297.66  2464    1
##
## Samples were drawn using NUTS(diag_e) at Sun Oct 11 22:40:49 2020.
## For each parameter, n_eff is a crude measure of effective sample size,
## and Rhat is the potential scale reduction factor on split chains (at
## convergence, Rhat=1).
```

## Trace plots

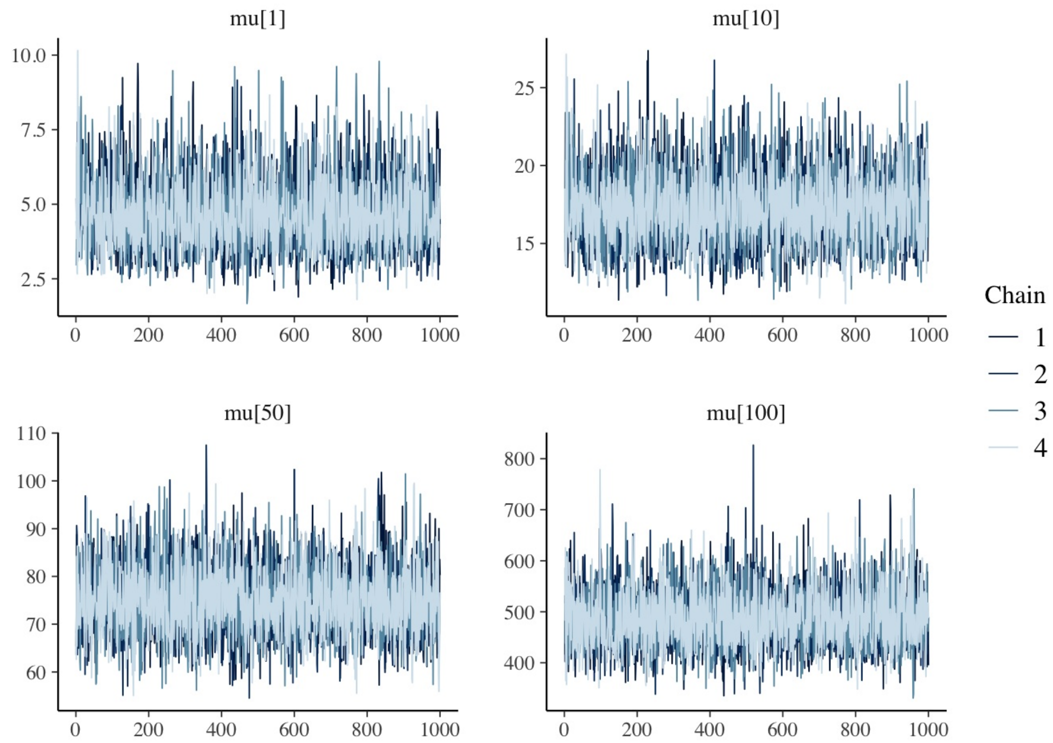
```
mcmc_trace(
  as.array(fit_model,pars = c('r_t[1]', 'r_t[10]', 'r_t[50]', 'r_t[100]')),
  np = nuts_params(fit_model)
)
```

```
## No divergences to plot.
```



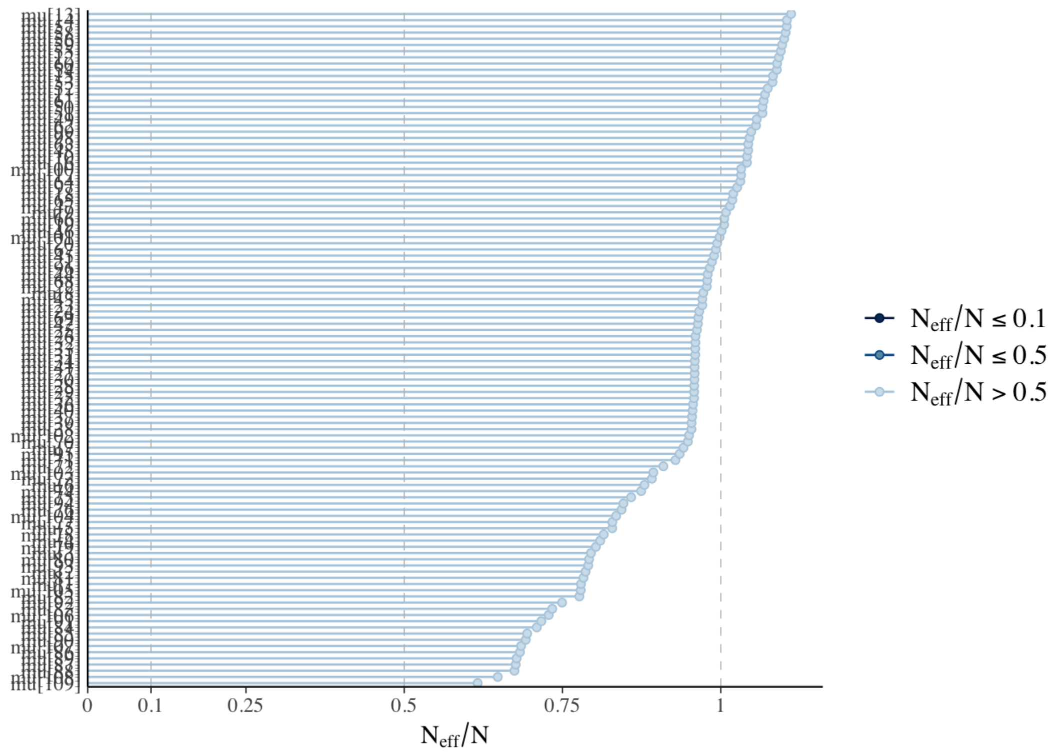
```
mcmc_trace(
  as.array(fit_model,pars = c('mu[1]','mu[10]', 'mu[50]', 'mu[100]' )),
  np = nuts_params(fit_model)
)
```

```
## No divergences to plot.
```

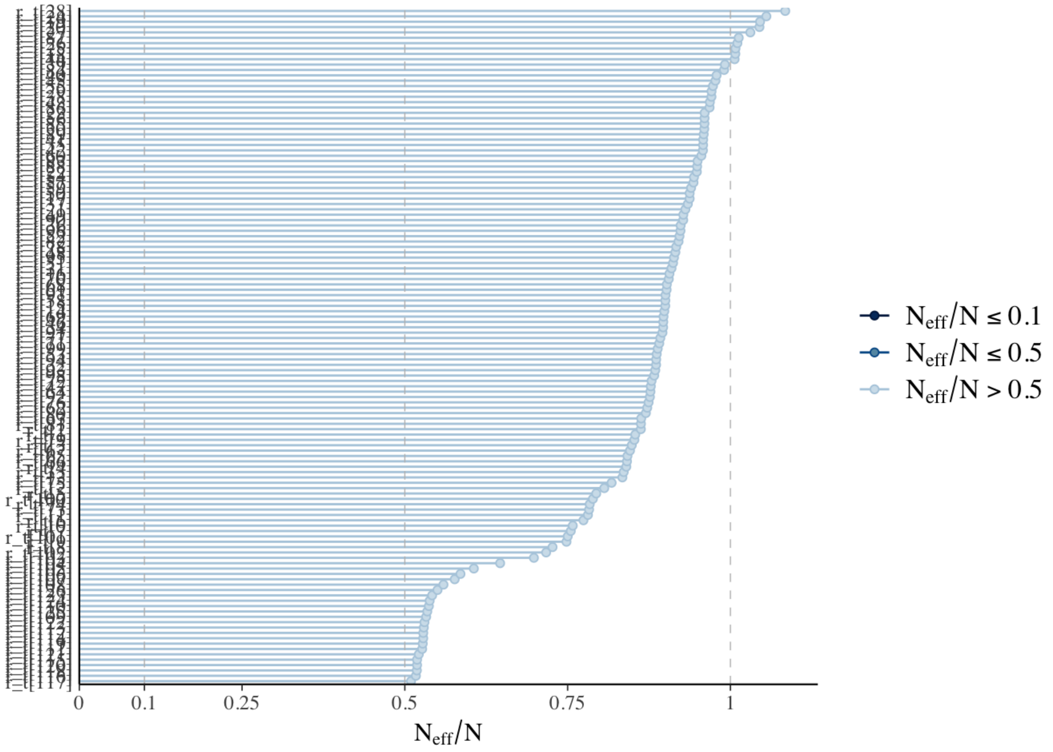



## Effective sample size

```
ratios1 <- neff_ratio(fit_model, pars = c('mu'))
mcmc_neff(ratios1) + yaxis_text(hjust = 1)
```

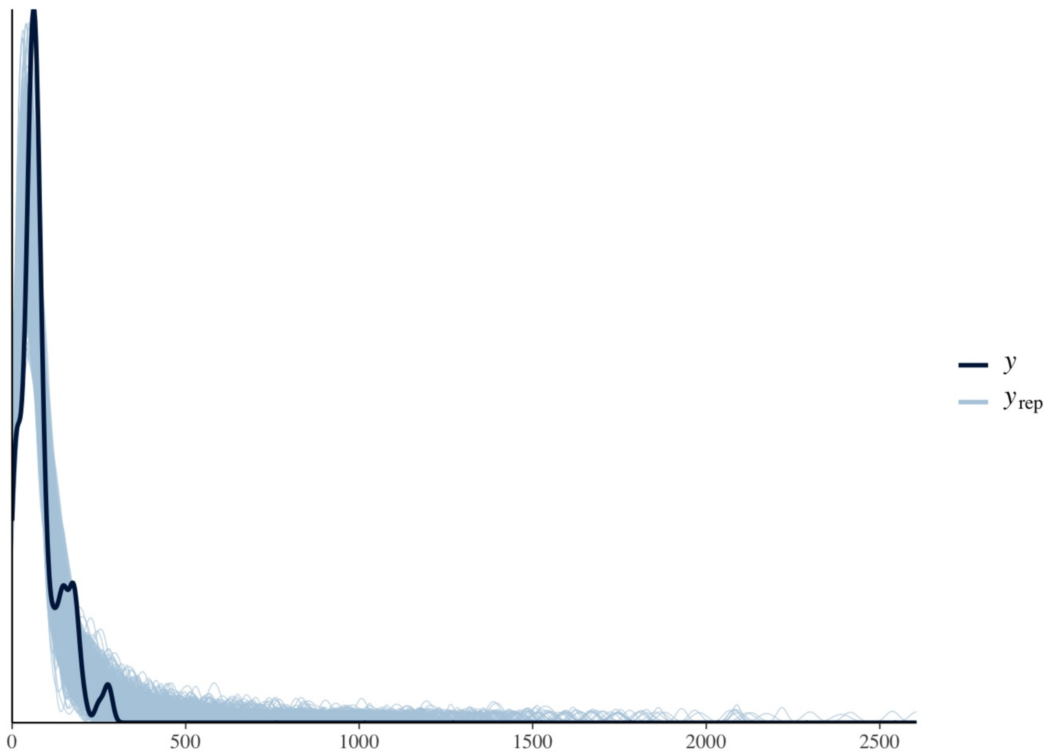



```
ratios2 <- neff_ratio(fit_model, pars = c('r_t'))
mcmc_neff(ratios2) + yaxis_text(hjust = 1)
```




## Density overlay

```
y_rep <- as.matrix(fit_model, pars = "y_rep")
ppc_dens_overlay(y = X$positive[nonzero_days], y_rep[1:1000, ])
```




## Resulting R_t curve

```
fit_summary <- summary(fit_model)

medians_rt <- fit_summary$summary[, '50%'][129: (129+125)]
min_rt_50_interval <- fit_summary$summary[, '25%'][129: (129+125)]
max_rt_50_interval <- fit_summary$summary[, '75%'][129: (129+125)]
min_rt_95_interval <- fit_summary$summary[, '2.5%'][129: (129+125)]
max_rt_95_interval <- fit_summary$summary[, '97.5%'][129: (129+125)]


ggplot(data = NULL, aes(x = X$date, y = medians_rt)) +
  geom_line() +
  xlab('Date') +
  ylab('') +
  ggtitle( 'OR r_t')+
  geom_hline(yintercept=1, linetype="dashed", color = "red") +
  geom_vline(xintercept = X$date[1]) +
  geom_ribbon(aes(ymin = min_rt_50_interval, ymax = max_rt_50_interval), alpha= 0.5, fill = 'darkred') +
  geom_ribbon(aes(ymin = min_rt_95_interval, ymax = max_rt_95_interval), alpha= 0.1, fill = 'darkred')
```