# covid_data_exploration

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## THEIR DATA

(This is just to figure out how the model works)

```
bav = read_tsv("data/onset_age_group_bav.csv", show_col_types = FALSE)
bav %>% group_by(date) %>% summarise(n=sum(onsets)) %>%
  filter(date<=ymd("2020-05-01"),
         date>=ymd("2020-02-15"))
```

```
## # A tibble: 77 x 2
##    date           n
##    <date>     <dbl>
##  1 2020-02-15     5
##  2 2020-02-16     4
##  3 2020-02-17     5
##  4 2020-02-18    10
##  5 2020-02-19     7
##  6 2020-02-20    12
##  7 2020-02-21    11
##  8 2020-02-22    16
##  9 2020-02-23    19
## 10 2020-02-24    24
## # i 67 more rows
```

```
bav_full = bav %>% group_by(date) %>%
  summarise(onsets=sum(onsets)) %>%
  right_join(tibble(date=seq(ymd("2020-02-24"), ymd("2020-05-15"), by = "1 day"))) %>%
  arrange(date) %>%
  mutate(onsets=replace_na(onsets,0))
```

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

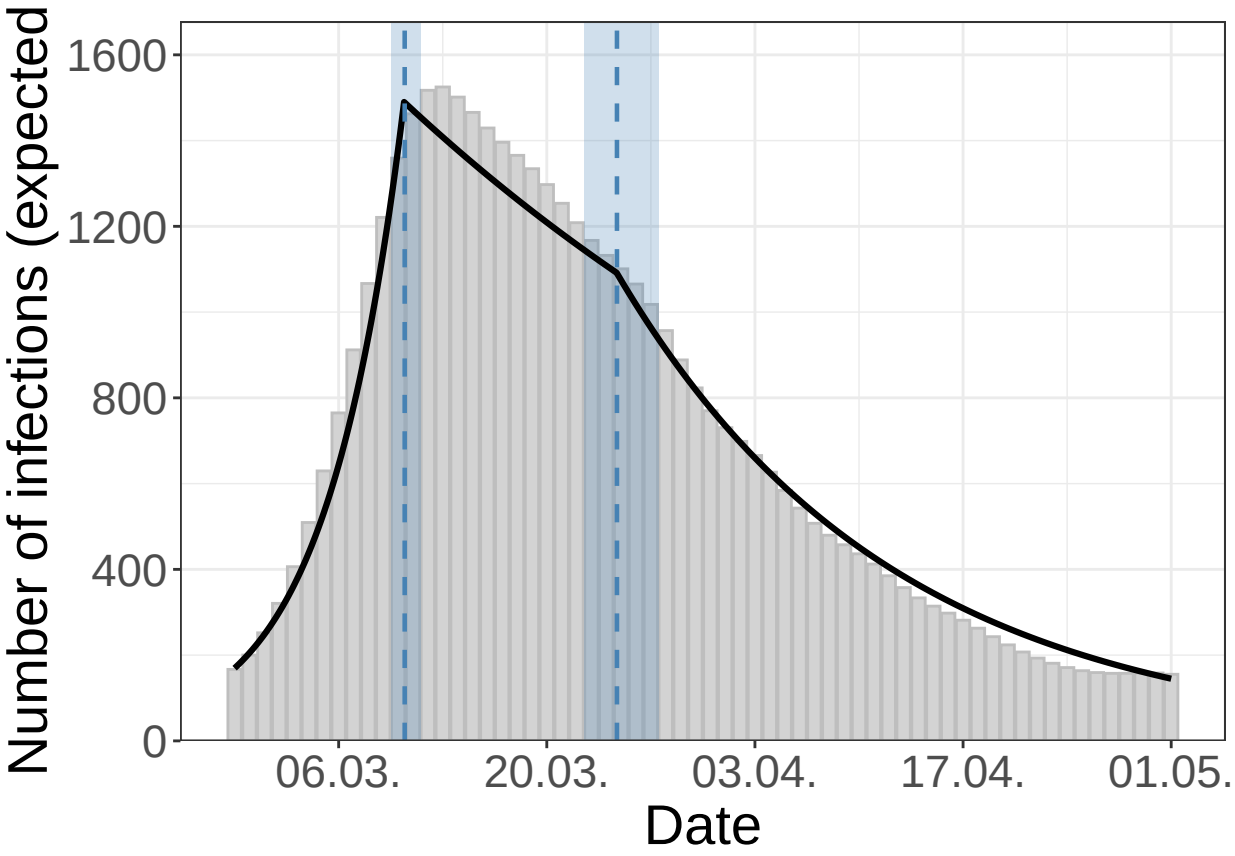
```
cp_res_bav_full = perform_cp_analysis(data = bav_full,
                                      type = "both",
                                      cp_max_onset = 6,
                                      cp_max_backpro = 6,
                                      save_disc_optim_results = T,
                                      use_disc_optim_results = T,
                                      name_disc =  "bav_full")
```

```
## [1] "perform analysis of backprojected infections"
## [1] "estimate change point models based on segmented package infections"

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
## i Please use `linewidth` instead.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.

## n bp:3

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:4

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:5

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:6

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## [1] "perform analysis of onsets"
## [1] "estimate change point models based on segmented package onset"

## Warning: Breakpoint estimate(s) outdistanced to allow finite estimates and
## st.errs

## Warning: Estimation failed. Too many breakpoints? Returning a glm fit..
```

```
cp_res_bav_full
```

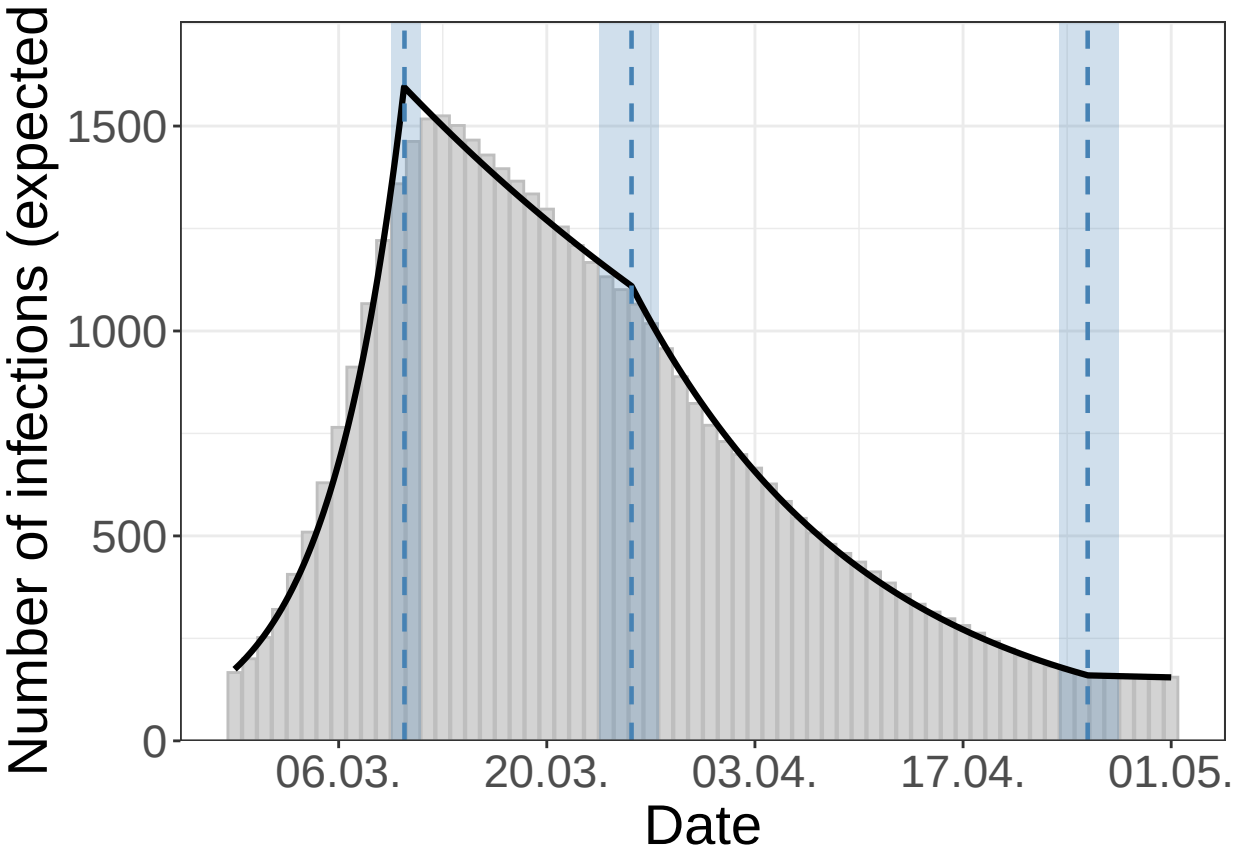
```
## $aic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -267.3049 -294.9154 -351.9020 -289.0836 -351.2372
##
## $bic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -250.0339 -273.3265 -325.9954 -258.8592 -316.6950
##
```

```
## $cp_segmented_list_backpro
## $cp_segmented_list_backpro$two_bp
## $cp_segmented_list_backpro$two_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 141.6525
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t      psi1.t      psi2.t
##  4.94205157  0.19068626 -0.21243962 -0.03237573  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.9554267
## Degrees of freedom: 64 total; 58 residual
## Residual standard error: 0.08792117
##
## $cp_segmented_list_backpro$two_bp$coef
## # A tibble: 3 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1       1.21   1.19   1.23
## 2       0.978  0.965  0.992
## 3       0.947  0.941  0.953
##
## $cp_segmented_list_backpro$two_bp$breakpoints
## # A tibble: 2 x 3
##   BP                BP_CI_lwr         BP_CI_upr
##   <chr>             <chr>             <chr>
## 1 12.4 (2020-03-10) 12.2 (2020-03-10) 12.7 (2020-03-11)
## 2 26.7 (2020-03-25) 25 (2020-03-23)   28.4 (2020-03-27)
##
## $cp_segmented_list_backpro$two_bp$plot
```



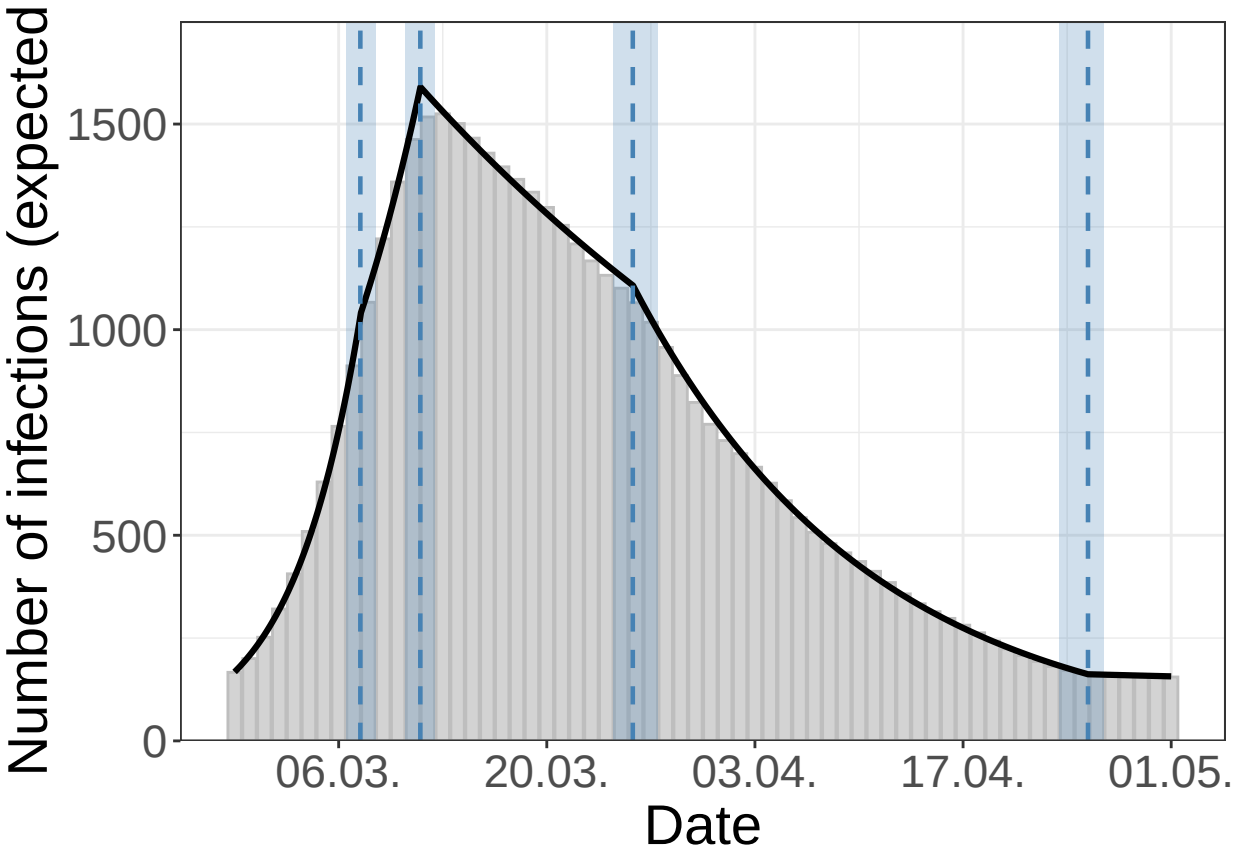

```
##
##
## $cp_segmented_list_backpro$three_bp
## $cp_segmented_list_backpro$three_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 157.4577
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t      psi1.t
##  4.96865648  0.19404944 -0.21777757 -0.03941969  0.05764209  0.00000000
##      psi2.t      psi3.t
##  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.8442745
## Degrees of freedom: 64 total; 56 residual
## Residual standard error: 0.03819028
##
## $cp_segmented_list_backpro$three_bp$coef
## # A tibble: 4 x 3
##   mult_factor CI_lwr CI_upr
```

```
##          <dbl>  <dbl>  <dbl>
## 1        1.21   1.20   1.23
## 2        0.977  0.969  0.984
## 3        0.939  0.935  0.942
## 4        0.995  0.978  1.01
##
## $cp_segmented_list_backpro$three_bp$breakpoints
## # A tibble: 3 x 3
##   BP                 BP_CI_lwr          BP_CI_upr
##   <chr>              <chr>              <chr>
## 1 12.4 (2020-03-10) 12.2 (2020-03-10) 12.6 (2020-03-11)
## 2 27.7 (2020-03-26) 26.5 (2020-03-24) 28.9 (2020-03-27)
## 3 58.4 (2020-04-25) 57.6 (2020-04-24) 59.2 (2020-04-27)
##
## $cp_segmented_list_backpro$three_bp$plot
```



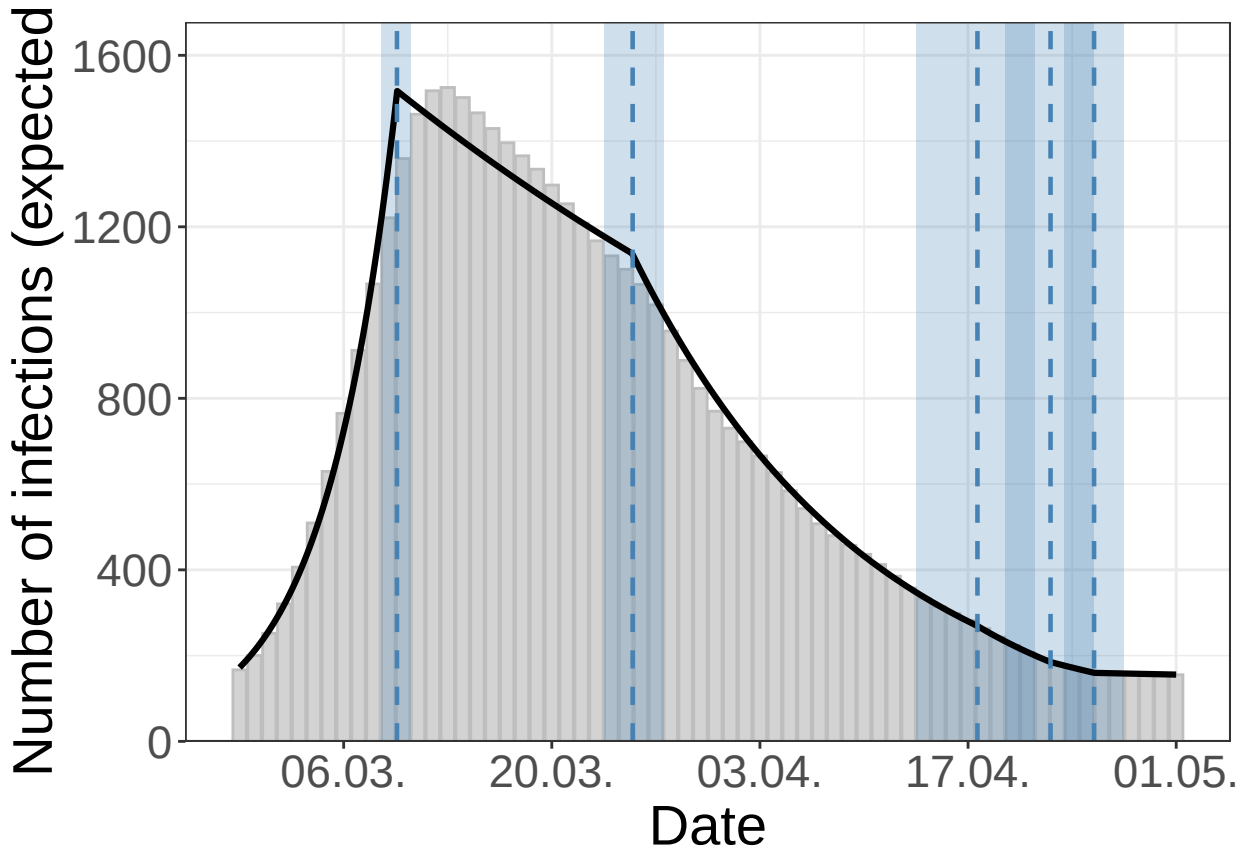

```
##
##
## $cp_segmented_list_backpro$four_bp
## $cp_segmented_list_backpro$four_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 187.951
##
```

```
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t        U4.t
##  4.90647085  0.21492526 -0.10909212 -0.13113979 -0.03750130  0.05708457
##      psi1.t      psi2.t      psi3.t      psi4.t
##  0.00000000  0.00000000  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.7441734
## Degrees of freedom: 64 total; 54 residual
## Residual standard error: 0.01909193
##
## $cp_segmented_list_backpro$four_bp$coef
## # A tibble: 5 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1       1.24   1.23   1.25
## 2       1.11   1.10   1.13
## 3       0.975  0.971  0.979
## 4       0.939  0.938  0.941
## 5       0.994  0.985  1.00
##
## $cp_segmented_list_backpro$four_bp$breakpoints
## # A tibble: 4 x 3
##   BP                BP_CI_lwr         BP_CI_upr
##   <chr>             <chr>             <chr>
## 1 9.5 (2020-03-07)  9.2 (2020-03-07)  9.8 (2020-03-08)
## 2 13.5 (2020-03-11) 13.3 (2020-03-11) 13.7 (2020-03-12)
## 3 27.8 (2020-03-26) 27 (2020-03-25)   28.6 (2020-03-27)
## 4 58.4 (2020-04-25) 57.9 (2020-04-24) 58.9 (2020-04-26)
##
## $cp_segmented_list_backpro$four_bp$plot
```



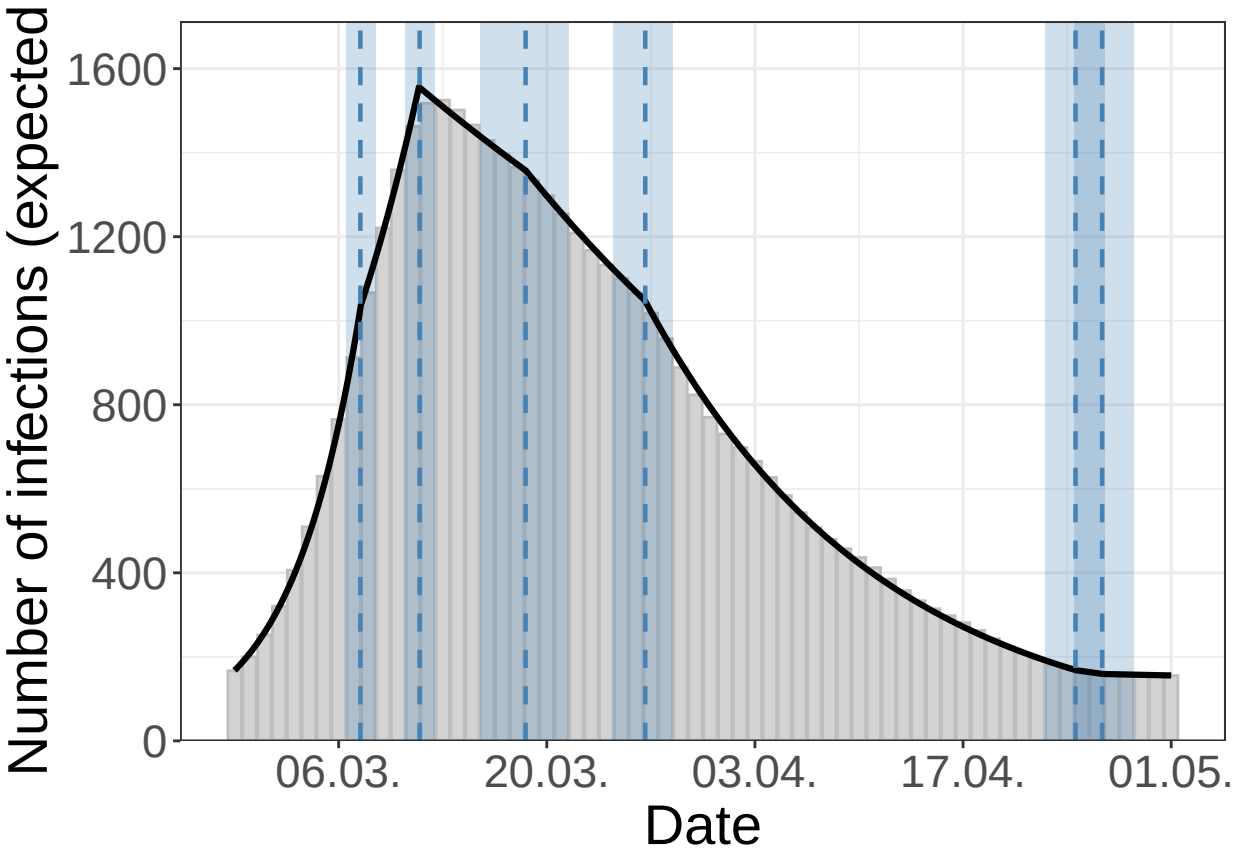

```
##
##
## $cp_segmented_list_backpro$five_bp
## $cp_segmented_list_backpro$five_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 158.5418
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t        U4.t
##  4.94281654  0.20530405 -0.22349214 -0.04386587 -0.01430536  0.02645417
##        U5.t      psi1.t      psi2.t      psi3.t      psi4.t      psi5.t
##  0.04528273  0.00000000  0.00000000  0.00000000  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.8083502
## Degrees of freedom: 64 total; 52 residual
## Residual standard error: 0.03423191
##
## $cp_segmented_list_backpro$five_bp$coef
## # A tibble: 6 x 3
##   mult_factor CI_lwr CI_upr
```

```
##          <dbl>  <dbl>  <dbl>
## 1        1.23   1.22   1.24
## 2        0.982  0.976  0.988
## 3        0.940  0.936  0.944
## 4        0.926  0.908  0.945
## 5        0.951  0.922  0.982
## 6        0.995  0.978  1.01
##
## $cp_segmented_list_backpro$five_bp$breakpoints
## # A tibble: 5 x 3
##   BP                 BP_CI_lwr          BP_CI_upr
##   <chr>              <chr>              <chr>
## 1 11.6 (2020-03-10) 11.4 (2020-03-09) 11.8 (2020-03-10)
## 2 27.4 (2020-03-25) 26.4 (2020-03-24) 28.5 (2020-03-27)
## 3 50.6 (2020-04-18) 47.3 (2020-04-14) 54 (2020-04-21)
## 4 55.5 (2020-04-23) 53.6 (2020-04-20) 57.5 (2020-04-25)
## 5 58.5 (2020-04-25) 57.3 (2020-04-24) 59.6 (2020-04-27)
##
## $cp_segmented_list_backpro$five_bp$plot
```




```
##
##
## $cp_segmented_list_backpro$six_bp
## $cp_segmented_list_backpro$six_bp$segmented_model
## Generalized least squares fit by maximum likelihood
```

```
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 191.6186
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t        U4.t
##  4.90687873  0.21455299 -0.11071876 -0.12286805 -0.01324697 -0.03081894
##        U5.t        U6.t      psi1.t      psi2.t      psi3.t      psi4.t
##  0.03278144  0.02543399  0.00000000  0.00000000  0.00000000  0.00000000
##      psi5.t      psi6.t
##  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##      Phi
## 0.748088
## Degrees of freedom: 64 total; 50 residual
## Residual standard error: 0.01814591
##
## $cp_segmented_list_backpro$six_bp$coef
## # A tibble: 7 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1       1.24   1.23   1.25
## 2       1.11   1.09   1.13
## 3       0.981  0.973  0.990
## 4       0.968  0.961  0.975
## 5       0.939  0.937  0.941
## 6       0.970  0.943  0.998
## 7       0.995  0.983  1.01
##
## $cp_segmented_list_backpro$six_bp$breakpoints
## # A tibble: 6 x 3
##   BP                BP_CI_lwr         BP_CI_upr
##   <chr>             <chr>             <chr>
## 1 9.5 (2020-03-07)  9.2 (2020-03-07)  9.7 (2020-03-08)
## 2 13.4 (2020-03-11) 13.2 (2020-03-11) 13.7 (2020-03-12)
## 3 20.6 (2020-03-19) 18.3 (2020-03-16) 22.9 (2020-03-21)
## 4 28.6 (2020-03-27) 27.7 (2020-03-25) 29.6 (2020-03-28)
## 5 57.6 (2020-04-25) 56.6 (2020-04-23) 58.6 (2020-04-26)
## 6 59.4 (2020-04-26) 58 (2020-04-25)   60.7 (2020-04-28)
##
## $cp_segmented_list_backpro$six_bp$plot
```




```
##
##
##
## $aic_onset
##   two_bp three_bp  four_bp  five_bp   six_bp
##       NA       NA       NA       NA       NA
##
## $bic_onset
##   two_bp three_bp  four_bp  five_bp   six_bp
##       NA       NA       NA       NA       NA
##
## $cp_segmented_list_onset
## $cp_segmented_list_onset$two_bp
## $cp_segmented_list_onset$two_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$two_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$two_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$two_bp$plot
## [1] NA
##
##
```

```
## $cp_segmented_list_onset$three_bp
## $cp_segmented_list_onset$three_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$three_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$three_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$three_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$four_bp
## $cp_segmented_list_onset$four_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$four_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$four_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$four_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$five_bp
## $cp_segmented_list_onset$five_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$five_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$five_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$five_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$six_bp
## $cp_segmented_list_onset$six_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$six_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$six_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$six_bp$plot
## [1] NA
```

Number of breakpoints chosen based on:

```
cp_res_bav_full['bic_backpro']
```

```
## $bic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -250.0339 -273.3265 -325.9954 -258.8592 -316.6950
```

## OUR DATA

### Overall model

For K = 2,. . . ,6 breakpoints, run model on entire data.

Data prep:

```
data <- read_csv("age_group_data.csv", show_col_types = FALSE)

data_full = data %>% group_by(date) %>%
  summarise(onsets=sum(onsets)) %>%
  right_join(tibble(date=seq(ymd("2020-02-24"), ymd("2020-05-15"), by = "1 day"))) %>%
  arrange(date) %>%
  mutate(onsets=replace_na(onsets,0))
```

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

```
data_full
```

```
## # A tibble: 82 x 2
##    date       onsets
##    <date>      <dbl>
##  1 2020-02-24      0
##  2 2020-02-25      1
##  3 2020-02-26      1
##  4 2020-02-27      1
##  5 2020-02-28      2
##  6 2020-02-29      2
##  7 2020-03-01      6
##  8 2020-03-02      8
##  9 2020-03-03      7
## 10 2020-03-04      8
## # i 72 more rows
```

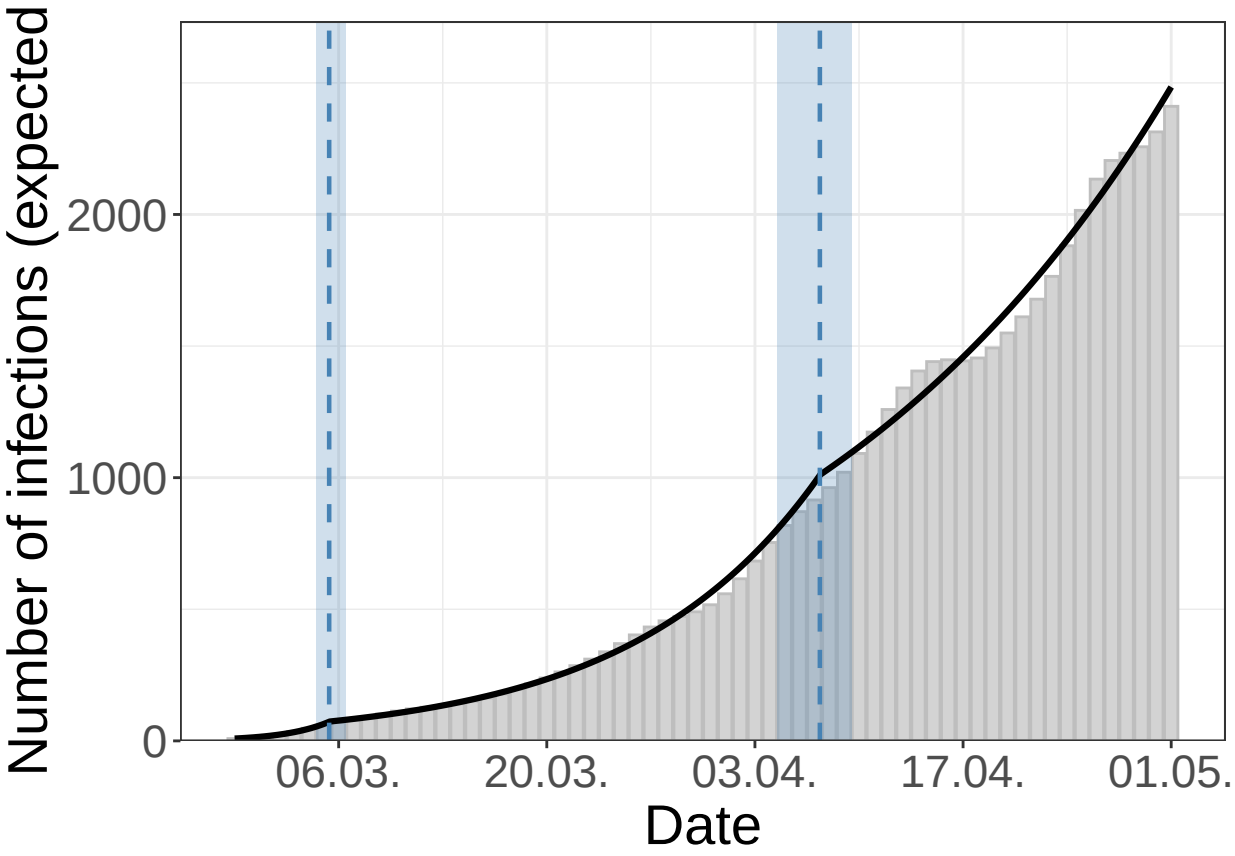
```
cp_res_full = perform_cp_analysis(data = data_full,
                                  type = "both",
                                  cp_max_onset = 6,
                                  cp_max_backpro = 6,
                                  save_disc_optim_results = T,
                                  use_disc_optim_results = T,
                                  name_disc =  "bav_full")
```

```
## [1] "perform analysis of backprojected infections"
## [1] "estimate change point models based on segmented package infections"

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:3

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:4

## n bp:5

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:6

## Warning: max number of iterations (1009) attained
## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## [1] "perform analysis of onsets"
## [1] "estimate change point models based on segmented package onset"

## Warning: Breakpoint estimate(s) outdistanced to allow finite estimates and
## st.errs

## Warning: Estimation failed. Too many breakpoints? Returning a glm fit..
```

```
cp_res_full
```

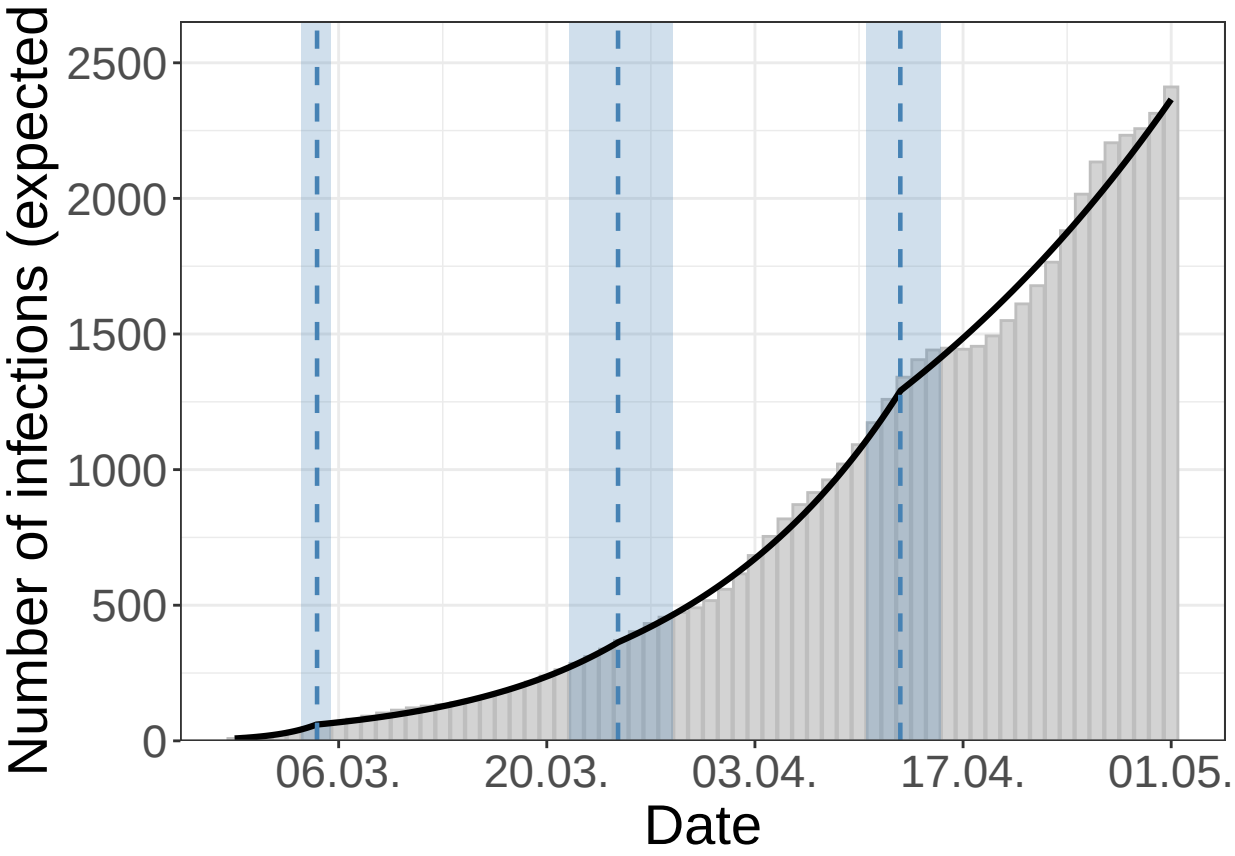
```
## $aic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -255.0048 -265.7934        NA -282.7931 -280.8597
##
## $bic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -237.7337 -244.2045        NA -252.5687 -246.3175
##
## $cp_segmented_list_backpro
## $cp_segmented_list_backpro$two_bp
## $cp_segmented_list_backpro$two_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 135.5024
##
```

```
## Coefficients:
## (Intercept)           t        U1.t        U2.t      psi1.t      psi2.t
##  1.84631888  0.33127075 -0.25182652 -0.04137833  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.7854752
## Degrees of freedom: 64 total; 58 residual
## Residual standard error: 0.04670809
##
## $cp_segmented_list_backpro$two_bp$coef
## # A tibble: 3 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1        1.39   1.37   1.42
## 2        1.08   1.08   1.09
## 3        1.04   1.03   1.04
##
## $cp_segmented_list_backpro$two_bp$breakpoints
## # A tibble: 2 x 3
##   BP                 BP_CI_lwr          BP_CI_upr
##   <chr>              <chr>              <chr>
## 1 7.4 (2020-03-05)  7.1 (2020-03-05)  7.6 (2020-03-06)
## 2 40.4 (2020-04-07) 38.9 (2020-04-05) 41.8 (2020-04-09)
##
## $cp_segmented_list_backpro$two_bp$plot
```



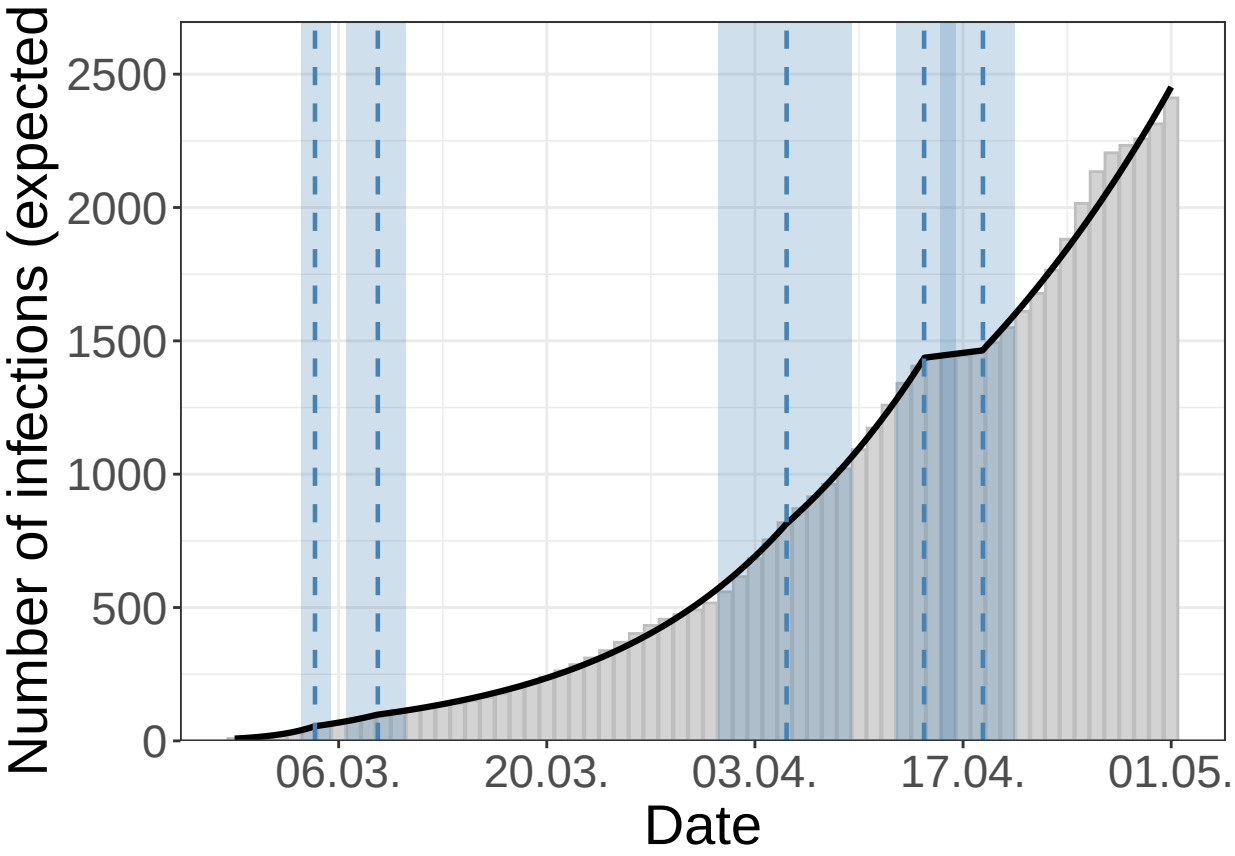

```
##
##
## $cp_segmented_list_backpro$three_bp
## $cp_segmented_list_backpro$three_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 142.8967
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t      psi1.t
##  1.82311578  0.34902237 -0.26014599 -0.02215706 -0.03347714  0.00000000
##      psi2.t      psi3.t
##  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.8409657
## Degrees of freedom: 64 total; 56 residual
## Residual standard error: 0.04749537
##
## $cp_segmented_list_backpro$three_bp$coef
## # A tibble: 4 x 3
##   mult_factor CI_lwr CI_upr
```

```
##         <dbl>  <dbl>  <dbl>
## 1        1.42   1.39   1.45
## 2        1.09   1.09   1.10
## 3        1.07   1.06   1.08
## 4        1.03   1.03   1.04
##
## $cp_segmented_list_backpro$three_bp$breakpoints
## # A tibble: 3 x 3
##   BP                 BP_CI_lwr          BP_CI_upr
##   <chr>              <chr>              <chr>
## 1 6.5 (2020-03-05)  6.3 (2020-03-04)  6.8 (2020-03-05)
## 2 26.8 (2020-03-25) 24.2 (2020-03-22) 29.4 (2020-03-28)
## 3 45.8 (2020-04-13) 44.1 (2020-04-11) 47.5 (2020-04-15)
##
## $cp_segmented_list_backpro$three_bp$plot
```



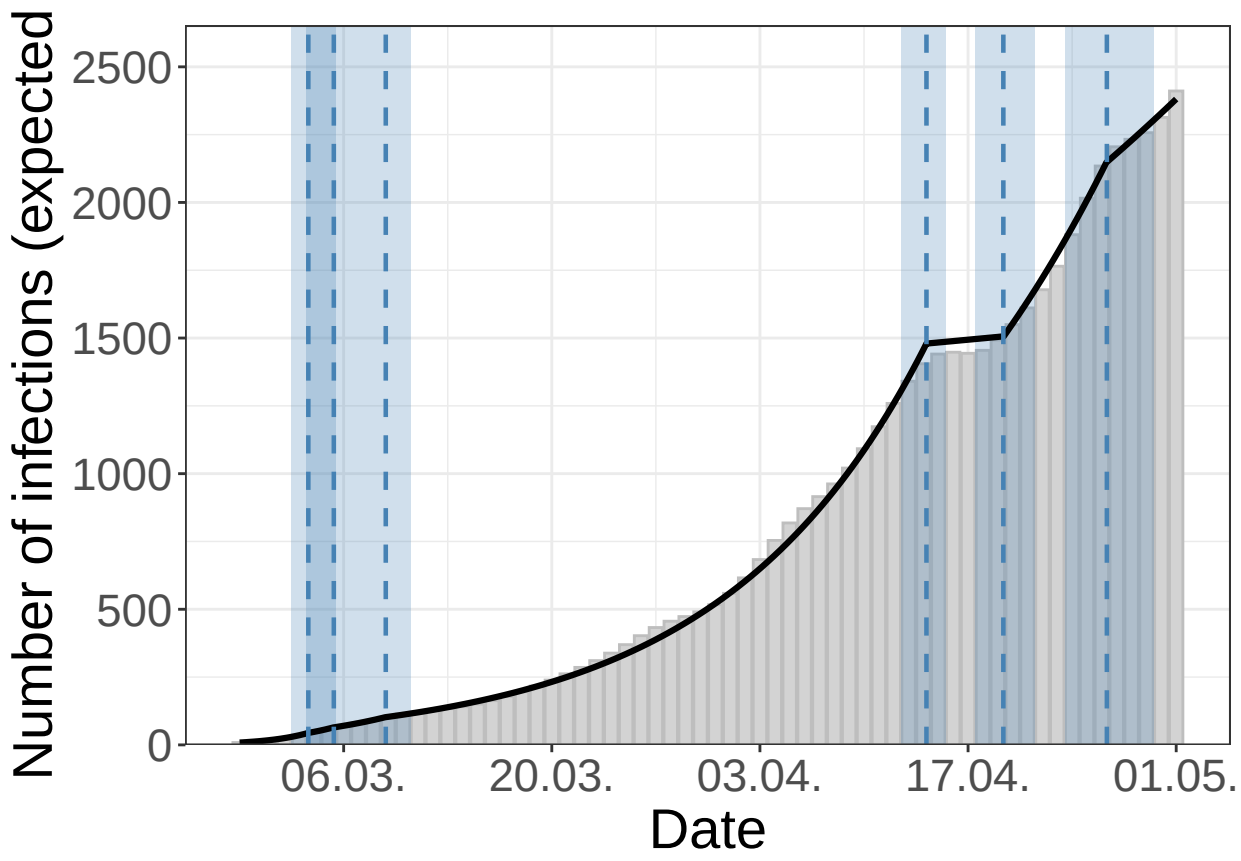

```
##
##
## $cp_segmented_list_backpro$four_bp
## $cp_segmented_list_backpro$four_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_backpro$four_bp$coef
## [1] NA
##
```

```
## $cp_segmented_list_backpro$four_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_backpro$four_bp$plot
## [1] NA
##
##
## $cp_segmented_list_backpro$five_bp
## $cp_segmented_list_backpro$five_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 155.3965
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t        U4.t
##  1.80471379  0.34392667 -0.20556104 -0.06150252 -0.01562969 -0.05641156
##        U5.t      psi1.t      psi2.t      psi3.t      psi4.t      psi5.t
##  0.03577898  0.00000000  0.00000000  0.00000000  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.7803081
## Degrees of freedom: 64 total; 52 residual
## Residual standard error: 0.03387859
##
## $cp_segmented_list_backpro$five_bp$coef
## # A tibble: 6 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1        1.41  1.39    1.44
## 2        1.15  1.12    1.18
## 3        1.08  1.08    1.08
## 4        1.06  1.05    1.08
## 5        1.00  0.980   1.03
## 6        1.04  1.03    1.05
##
## $cp_segmented_list_backpro$five_bp$breakpoints
## # A tibble: 5 x 3
##   BP                BP_CI_lwr         BP_CI_upr
##   <chr>             <chr>             <chr>
## 1 6.4 (2020-03-04)  6.1 (2020-03-04)  6.7 (2020-03-05)
## 2 10.6 (2020-03-09) 9.8 (2020-03-07)  11.5 (2020-03-10)
## 3 38.1 (2020-04-05) 34.8 (2020-04-01) 41.4 (2020-04-09)
## 4 47.4 (2020-04-14) 46.4 (2020-04-13) 48.3 (2020-04-16)
## 5 51.3 (2020-04-18) 49.9 (2020-04-16) 52.8 (2020-04-20)
##
## $cp_segmented_list_backpro$five_bp$plot
```




```
##
##
## $cp_segmented_list_backpro$six_bp
## $cp_segmented_list_backpro$six_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 156.4298
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t        U4.t
##  1.79938452  0.35386316 -0.12958326 -0.09201617 -0.05879360 -0.07003404
##        U5.t        U6.t      psi1.t      psi2.t      psi3.t      psi4.t
##  0.04794847 -0.02937807  0.00000000  0.00000000  0.00000000  0.00000000
##      psi5.t      psi6.t
##  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.8624587
## Degrees of freedom: 64 total; 50 residual
## Residual standard error: 0.04105561
##
## $cp_segmented_list_backpro$six_bp$coef
```

```
## # A tibble: 7 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1        1.42  1.39    1.46
## 2        1.25  1.19    1.31
## 3        1.14  1.10    1.18
## 4        1.08  1.07    1.08
## 5        1.00  0.982   1.03
## 6        1.05  1.04    1.07
## 7        1.02  1.00    1.04
##
## $cp_segmented_list_backpro$six_bp$breakpoints
## # A tibble: 6 x 3
##   BP                 BP_CI_lwr          BP_CI_upr
##   <chr>              <chr>              <chr>
## 1 5.6 (2020-03-04)  5.2 (2020-03-03)  6 (2020-03-05)
## 2 7.3 (2020-03-05)  6.7 (2020-03-04)  8 (2020-03-06)
## 3 10.8 (2020-03-09) 9.9 (2020-03-07)  11.8 (2020-03-10)
## 4 47.2 (2020-04-14) 46.4 (2020-04-13) 48 (2020-04-15)
## 5 52.4 (2020-04-19) 51.3 (2020-04-18) 53.4 (2020-04-21)
## 6 59.3 (2020-04-26) 57.6 (2020-04-24) 61.1 (2020-04-29)
##
## $cp_segmented_list_backpro$six_bp$plot
```




```
##
```

```
##
##
## $aic_onset
##   two_bp three_bp  four_bp  five_bp   six_bp
##       NA       NA       NA       NA       NA
##
## $bic_onset
##   two_bp three_bp  four_bp  five_bp   six_bp
##       NA       NA       NA       NA       NA
##
## $cp_segmented_list_onset
## $cp_segmented_list_onset$two_bp
## $cp_segmented_list_onset$two_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$two_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$two_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$two_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$three_bp
## $cp_segmented_list_onset$three_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$three_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$three_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$three_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$four_bp
## $cp_segmented_list_onset$four_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$four_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$four_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$four_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$five_bp
```

```
## $cp_segmented_list_onset$five_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$five_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$five_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$five_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$six_bp
## $cp_segmented_list_onset$six_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$six_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$six_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$six_bp$plot
## [1] NA
```

BIC:

```
cp_res_full['bic_backpro']
```

```
## $bic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -237.7337 -244.2045        NA -252.5687 -246.3175
```

- model doesn't converge for K=4?
- optimal nr of breakpoints is K=5

### Models per age group

```
# Split data:
data_014 = data %>% dplyr::filter(age_group=="0-14") %>%
  group_by(date) %>%
  summarise(onsets=sum(onsets)) %>%
  right_join(tibble(date=seq(ymd("2020-02-24"), ymd("2020-05-15"), by = "1 day"))) %>%
  arrange(date) %>%
  mutate(onsets=replace_na(onsets,0))
```

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

```
data_1559 = data %>% dplyr::filter(age_group=="15-59") %>%
  group_by(date) %>%
  summarise(onsets=sum(onsets)) %>%
  right_join(tibble(date=seq(ymd("2020-02-24"), ymd("2020-05-15"), by = "1 day"))) %>%
  arrange(date) %>%
  mutate(onsets=replace_na(onsets,0))
```

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

```
data_6079 = data %>% dplyr::filter(age_group=="60-79") %>%
  group_by(date) %>%
  summarise(onsets=sum(onsets)) %>%
  right_join(tibble(date=seq(ymd("2020-02-24"), ymd("2020-05-15"), by = "1 day"))) %>%
  arrange(date) %>%
  mutate(onsets=replace_na(onsets,0))
```

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

```
data_80 = data %>% dplyr::filter(age_group=="80+") %>%
  group_by(date) %>%
  summarise(onsets=sum(onsets)) %>%
  right_join(tibble(date=seq(ymd("2020-02-24"), ymd("2020-05-15"), by = "1 day"))) %>%
  arrange(date) %>%
  mutate(onsets=replace_na(onsets,0))
```

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

```
# Run model for each:
cp_res_014 = perform_cp_analysis(data = data_014,
                                 type = "backpro",
                                 cp_max_onset = 6,
                                 cp_max_backpro = 6,
                                 save_disc_optim_results = T,
                                 use_disc_optim_results = T,
                                 name_disc =  "bav_014")
```

```
## [1] "perform analysis of backprojected infections"
## [1] "estimate change point models based on segmented package infections"
```

```
## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)
```

```
## n bp:3
```

```
## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)
```

```
## n bp:4
```

```
## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:5

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:6

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)
```

```
res_014_selected_backpro = cp_res_014$cp_segmented_list_backpro[[which.min(cp_res_014$bic_backpro)]]
```

```
cp_res_1559 = perform_cp_analysis(data = data_1559,
                                  type = "backpro",
                                  cp_max_onset = 6,
                                  cp_max_backpro = 6,
                                  save_disc_optim_results = T,
                                  use_disc_optim_results = T,
                                  name_disc =  "bav_1559")
```

```
## [1] "perform analysis of backprojected infections"
## [1] "estimate change point models based on segmented package infections"

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:3

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:4

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:5

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:6

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)
```

```
res_1559_selected_backpro = cp_res_1559$cp_segmented_list_backpro[[which.min(cp_res_1559$bic_backpro)]]
```

```
cp_res_6079 = perform_cp_analysis(data = data_6079,
                                  type = "backpro",
                                  cp_max_onset = 6,
                                  cp_max_backpro = 6,
                                  save_disc_optim_results = T,
                                  use_disc_optim_results = T,
                                  name_disc =  "bav_6079")
```

```
## [1] "perform analysis of backprojected infections"
## [1] "estimate change point models based on segmented package infections"
```

```
## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)
```

```
## n bp:3
```

```
## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)
```

```
## n bp:4
```

```
## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)
```

```
## n bp:5
```

```
## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)
```

```
## n bp:6
```

```
## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)
```

```
res_6079_selected_backpro = cp_res_6079$cp_segmented_list_backpro[[which.min(cp_res_6079$bic_backpro)]]
```

```
cp_res_80 = perform_cp_analysis(data = data_80,
                                type = "backpro",
                                cp_max_onset = 6,
                                cp_max_backpro = 6,
                                save_disc_optim_results = T,
                                use_disc_optim_results = T,
                                name_disc =  "bav_80")
```

```
## [1] "perform analysis of backprojected infections"
## [1] "estimate change point models based on segmented package infections"
```

```
## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:3

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:4

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:5

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:6

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)
```

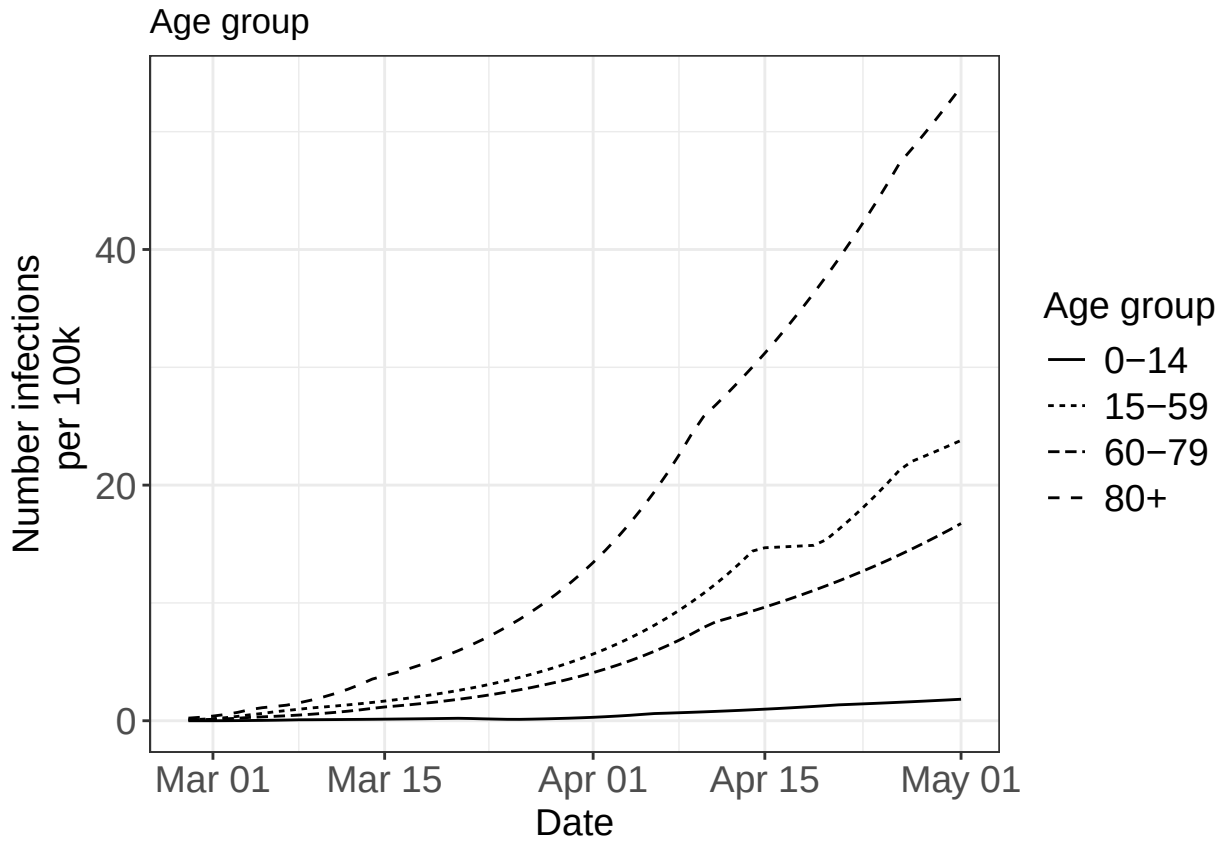
```
res_80_selected_backpro = cp_res_6079$cp_segmented_list_backpro[[which.min(cp_res_80$bic_backpro)]]
```

```
##### CHANGE THIS TO OUR DATA!!!
age_bav = read.csv("data/age_dist_bav.csv")
age_bav_group = age_bav %>% mutate(age_group=cut(Age, c(-1,14,59,79,120), labels = c("0-14", "15-59", "
  group_by(age_group) %>%
  summarise(n=sum(Num_191231))


# Plot:
plot_age_group = res_014_selected_backpro$segmented_model$model %>%
  dplyr::select(t, logbackpro) %>%
  mutate(age_group="0-14") %>%
  cbind(pred=res_014_selected_backpro$segmented_model$fitted) %>%
  rbind(res_1559_selected_backpro$segmented_model$model %>%
          dplyr::select(t, logbackpro) %>%
          mutate(age_group="15-59") %>%
          cbind(pred=res_1559_selected_backpro$segmented_model$fitted)) %>%
  rbind(res_6079_selected_backpro$segmented_model$model %>%
          dplyr::select(t, logbackpro) %>%
          mutate(age_group="60-79") %>%
          cbind(pred=res_6079_selected_backpro$segmented_model$fitted)) %>%
  rbind(res_80_selected_backpro$segmented_model$model %>%
          dplyr::select(t, logbackpro) %>%
          mutate(age_group="80+") %>%
          cbind(pred=res_80_selected_backpro$segmented_model$fitted)) %>%
  mutate(t=ymd("2020-02-27")+t) %>%
  right_join(age_bav_group) %>%
```

```
  mutate(pred_per_100k = (exp(pred)/n)*100000) %>%
  ggplot() +
  #geom_line(aes(t, exp(logbackpro), col=age_group), lty=2) +
  geom_line(aes(t, pred_per_100k, lty=age_group)) +
  ylab("Number infections\n per 100k") + xlab("Date") +
  theme(
    axis.text=element_text(size = rel(1.3)),
    axis.title=element_text(size = rel(1.3)),
    legend.text = element_text(size = rel(1.3)),
    legend.title =element_text(size = rel(1.3)))+
  guides(lty=guide_legend(title="Age group"))
```

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

```
plot_age_group + ggtitle("Age group") + theme()
```




```
### this is to plto everything:
# theme = theme(
#   axis.text=element_text(size = rel(1.3)),
#   axis.title=element_text(size = rel(1.3)),
#   legend.text = element_text(size = rel(1.3)),
#   legend.title =element_text(size = rel(1.3)))
# ggpubr::ggarrange(cp_res_full$cp_segmented_list_backpro[[which.min(cp_res_full$bic_backpro)]]$plot +
#                     ggtitle("Overall") + theme + ylab("Number infections"),
#                   plot_age_group + ggtitle("Age group") + theme, labels = "AUTO")
```

**Models for 3 cities**

```
data_mty <- read_csv("age_group_data_mty.csv", show_col_types = FALSE)

data_mty_full = data_mty %>% group_by(date) %>%
  summarise(onsets=sum(onsets)) %>%
  right_join(tibble(date=seq(ymd("2020-02-24"), ymd("2020-05-15"), by = "1 day"))) %>%
  arrange(date) %>%
  mutate(onsets=replace_na(onsets,0))
```

**Mty:**

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

```
data_mty_full
```

```
## # A tibble: 82 x 2
##    date       onsets
##    <date>      <dbl>
##  1 2020-02-24      0
##  2 2020-02-25      0
##  3 2020-02-26      0
##  4 2020-02-27      0
##  5 2020-02-28      0
##  6 2020-02-29      0
##  7 2020-03-01      0
##  8 2020-03-02      1
##  9 2020-03-03      0
## 10 2020-03-04      1
## # i 72 more rows
```

```
cp_res_mty = perform_cp_analysis(data = data_mty_full,
                                 type = "both",
                                 cp_max_onset = 6,
                                 cp_max_backpro = 6,
                                 save_disc_optim_results = T,
                                 use_disc_optim_results = T,
                                 name_disc =  "bav_full")
```

```
## [1] "perform analysis of backprojected infections"
## [1] "estimate change point models based on segmented package infections"
```

```
## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)
```

```
## n bp:3
```

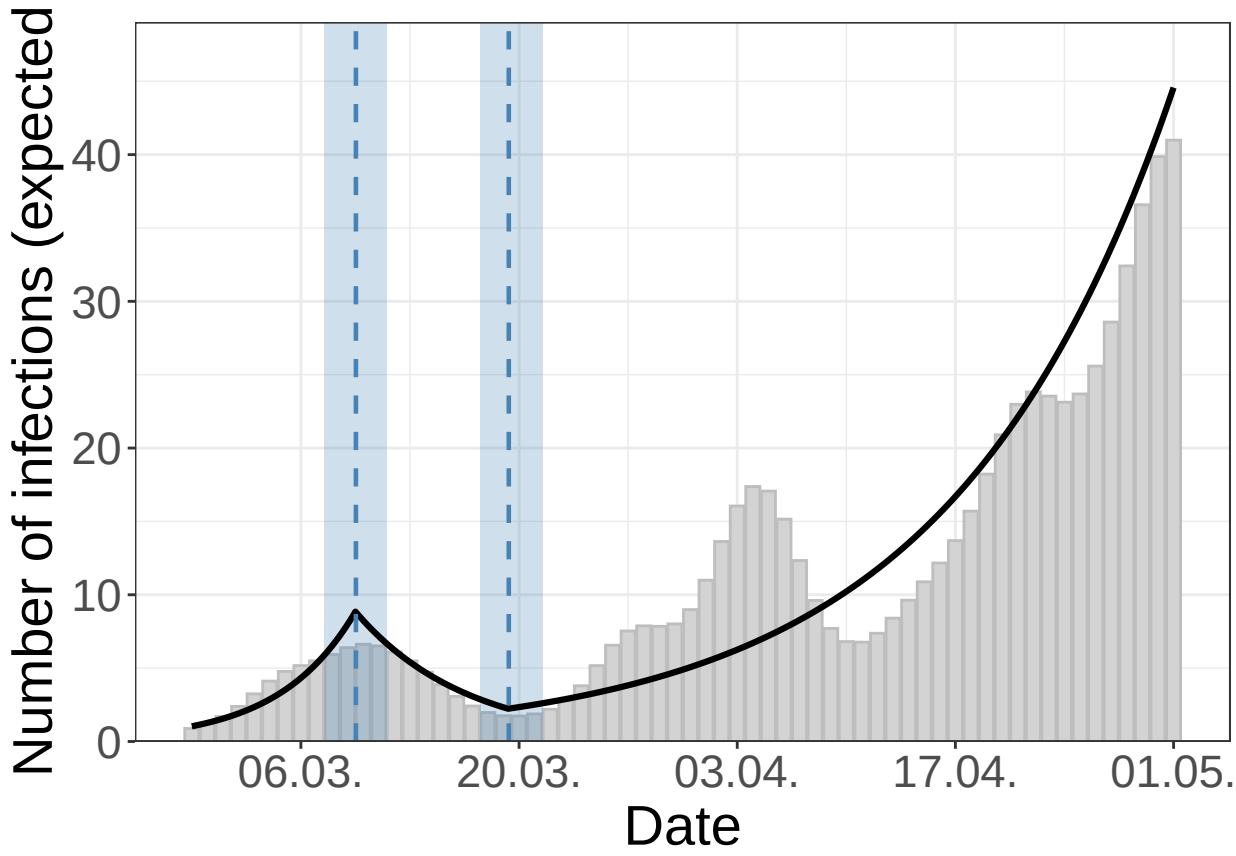
```
## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)
```

```
## n bp:4

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:5

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:6

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## [1] "perform analysis of onsets"
## [1] "estimate change point models based on segmented package onset"

## Warning: Breakpoint estimate(s) outdistanced to allow finite estimates and
## st.errs

## Warning: Estimation failed. Too many breakpoints? Returning a glm fit..
```

```
cp_res_mty
```

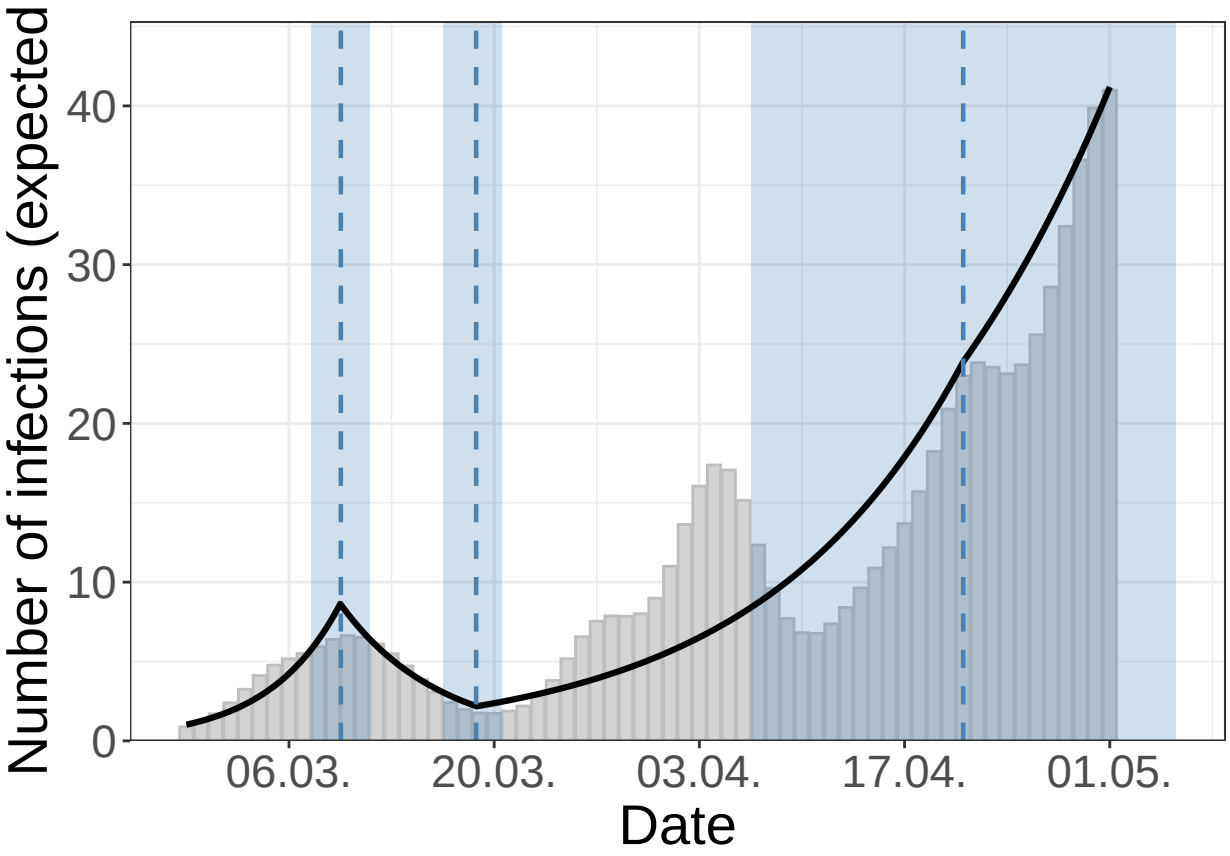
```
## $aic_backpro
##     two_bp   three_bp    four_bp    five_bp     six_bp
##  -79.61465  -75.56340 -123.18098 -125.39457 -124.82478
##
## $bic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -62.34359 -53.97457 -97.27438 -95.17020 -90.28265
##
## $cp_segmented_list_backpro
## $cp_segmented_list_backpro$two_bp
## $cp_segmented_list_backpro$two_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 47.80733
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t      psi1.t      psi2.t
##  -0.1698601   0.2043616  -0.3449300   0.2106927   0.0000000   0.0000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.9442699
## Degrees of freedom: 64 total; 58 residual
```

```
## Residual standard error: 0.3422836
##
## $cp_segmented_list_backpro$two_bp$coef
## # A tibble: 3 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1       1.23   1.15   1.31
## 2       0.869  0.809  0.933
## 3       1.07   1.05   1.10
##
## $cp_segmented_list_backpro$two_bp$breakpoints
## # A tibble: 2 x 3
##   BP                 BP_CI_lwr          BP_CI_upr
##   <chr>              <chr>              <chr>
## 1 11.5 (2020-03-10) 10.8 (2020-03-08) 12.2 (2020-03-11)
## 2 21.3 (2020-03-19) 20.2 (2020-03-18) 22.5 (2020-03-21)
##
## $cp_segmented_list_backpro$two_bp$plot
```



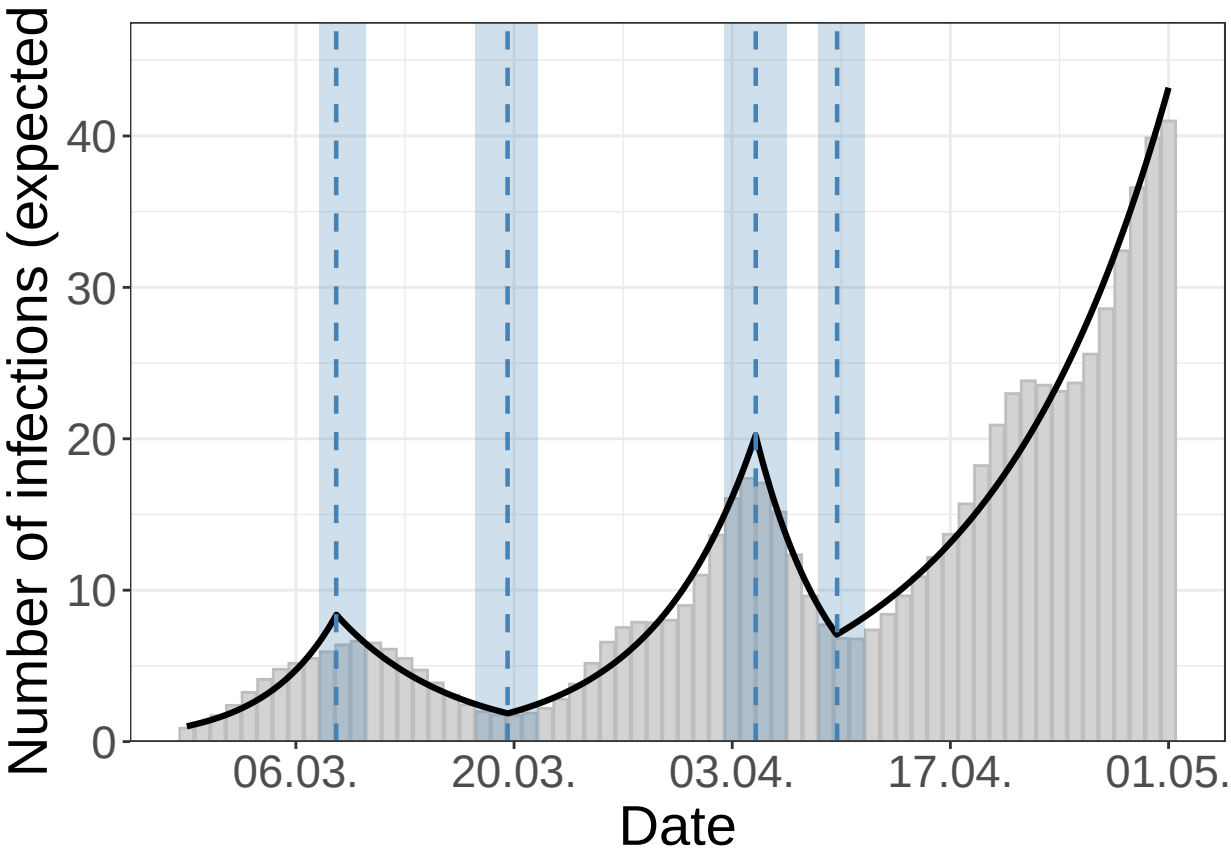

```
##
##
## $cp_segmented_list_backpro$three_bp
## $cp_segmented_list_backpro$three_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
```

```
##   Data: NULL
##   Log-likelihood: 47.7817
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t      psi1.t
## -0.18342861  0.20337243 -0.35139746  0.22014579 -0.01760988  0.00000000
##      psi2.t      psi3.t
##  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.9417637
## Degrees of freedom: 64 total; 56 residual
## Residual standard error: 0.3352994
##
## $cp_segmented_list_backpro$three_bp$coef
## # A tibble: 4 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1       1.23   1.15   1.31
## 2       0.862  0.798  0.932
## 3       1.07   1.04   1.11
## 4       1.06   0.987  1.13
##
## $cp_segmented_list_backpro$three_bp$breakpoints
## # A tibble: 3 x 3
##   BP                BP_CI_lwr         BP_CI_upr
##   <chr>             <chr>             <chr>
## 1 11.5 (2020-03-10) 10.8 (2020-03-08) 12.2 (2020-03-11)
## 2 20.8 (2020-03-19) 19.6 (2020-03-17) 21.9 (2020-03-20)
## 3 54 (2020-04-21)   40.1 (2020-04-07) 67.9 (2020-05-05)
##
## $cp_segmented_list_backpro$three_bp$plot
```



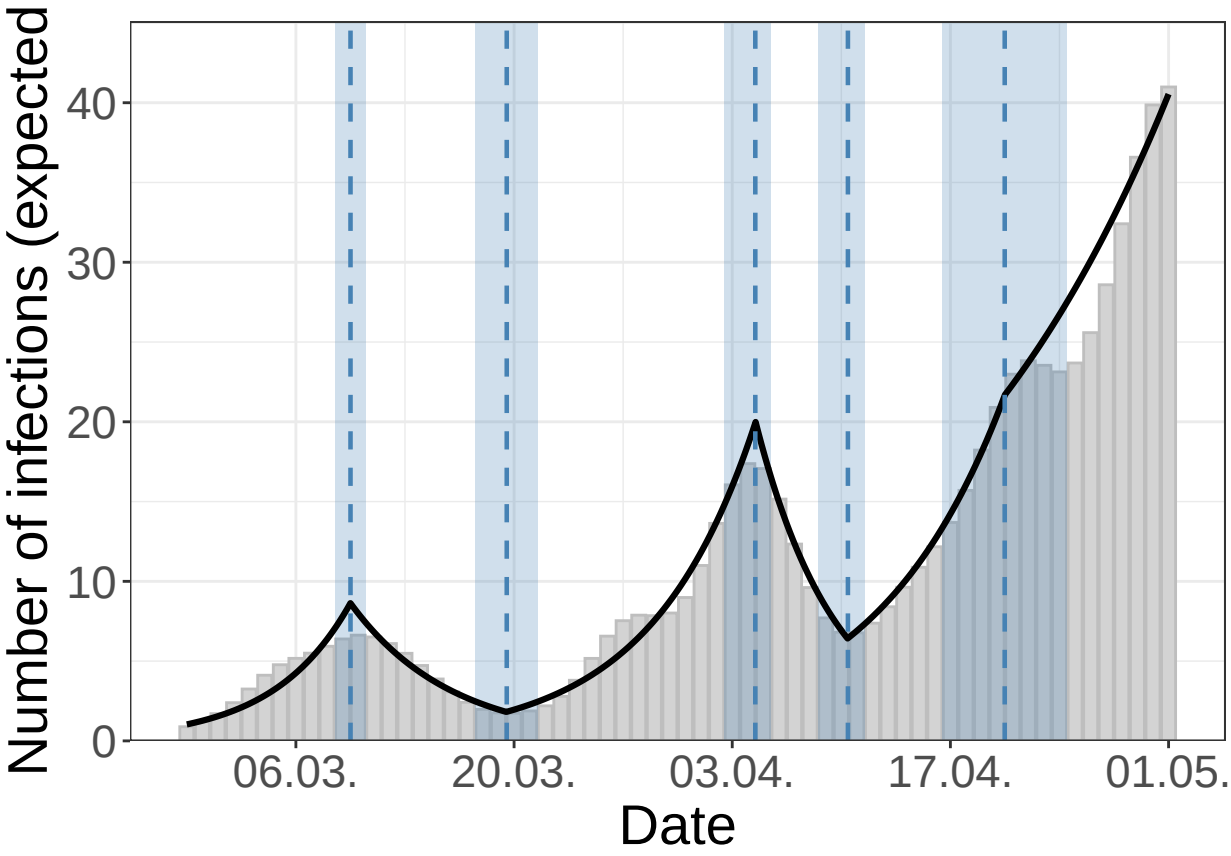

```
##
##
## $cp_segmented_list_backpro$four_bp
## $cp_segmented_list_backpro$four_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 73.59049
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t        U4.t
##  -0.2061657   0.2199805  -0.3566326   0.2866259  -0.3521503   0.2871425
##      psi1.t      psi2.t      psi3.t      psi4.t
##   0.0000000   0.0000000   0.0000000   0.0000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.8294578
## Degrees of freedom: 64 total; 54 residual
## Residual standard error: 0.1359439
##
## $cp_segmented_list_backpro$four_bp$coef
## # A tibble: 5 x 3
##   mult_factor CI_lwr CI_upr
```

```
##          <dbl>  <dbl>  <dbl>
## 1        1.25   1.20   1.30
## 2        0.872  0.840  0.905
## 3        1.16   1.13   1.19
## 4        0.817  0.759  0.879
## 5        1.09   1.07   1.11
##
## $cp_segmented_list_backpro$four_bp$breakpoints
## # A tibble: 4 x 3
##   BP                 BP_CI_lwr          BP_CI_upr
##   <chr>              <chr>              <chr>
## 1 10.6 (2020-03-09) 10.1 (2020-03-08) 11.1 (2020-03-10)
## 2 21.6 (2020-03-20) 21 (2020-03-18)   22.2 (2020-03-21)
## 3 37.5 (2020-04-05) 37 (2020-04-03)   38 (2020-04-06)
## 4 42.7 (2020-04-10) 42.1 (2020-04-09) 43.4 (2020-04-11)
##
## $cp_segmented_list_backpro$four_bp$plot
```



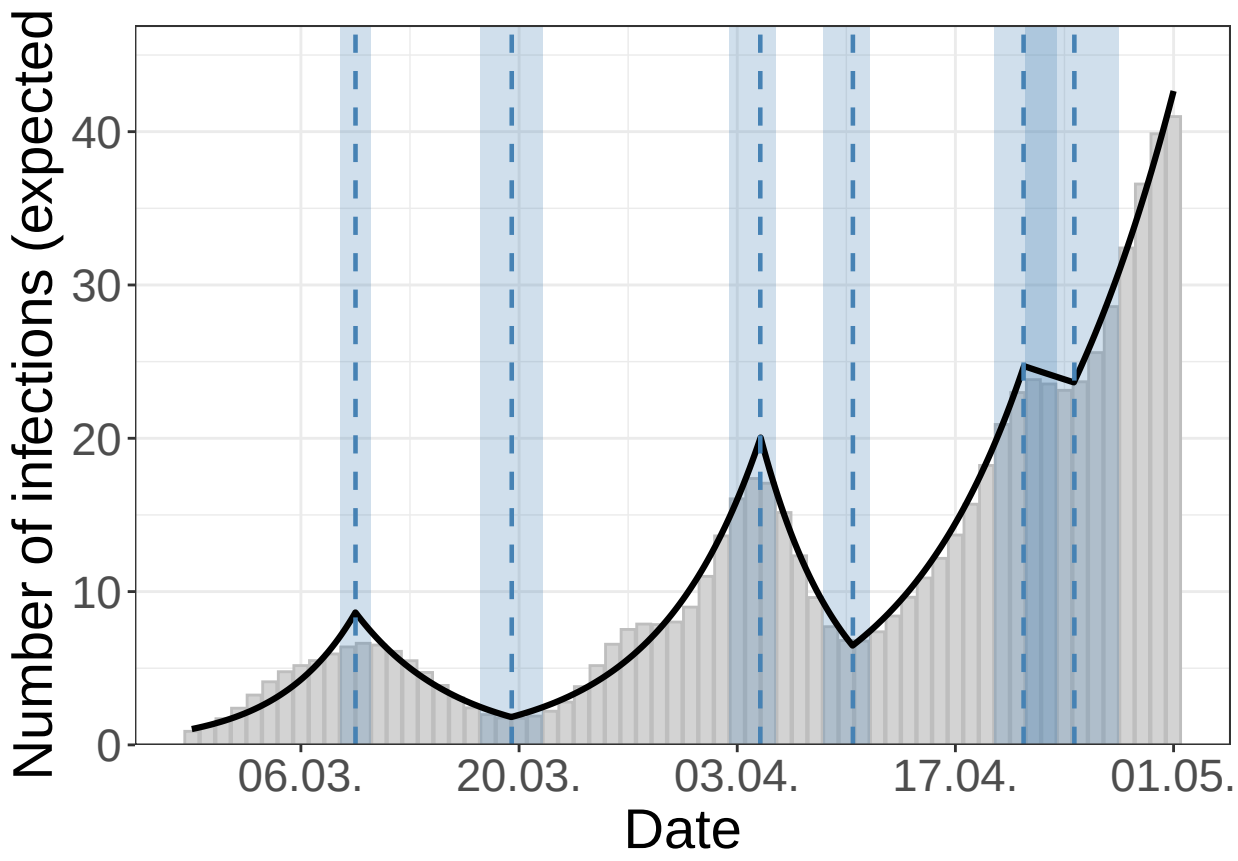

```
##
##
## $cp_segmented_list_backpro$five_bp
## $cp_segmented_list_backpro$five_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
```

```
##   Log-likelihood: 76.69728
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t        U4.t
## -0.17079882  0.20229017 -0.35819246  0.30581694 -0.34248447  0.31317569
##        U5.t      psi1.t      psi2.t      psi3.t      psi4.t      psi5.t
## -0.06106346  0.00000000  0.00000000  0.00000000  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.8367754
## Degrees of freedom: 64 total; 52 residual
## Residual standard error: 0.1320682
##
## $cp_segmented_list_backpro$five_bp$coef
## # A tibble: 6 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1       1.22   1.18   1.27
## 2       0.856  0.822  0.891
## 3       1.16   1.13   1.19
## 4       0.825  0.775  0.878
## 5       1.13   1.08   1.17
## 6       1.06   1.02   1.10
##
## $cp_segmented_list_backpro$five_bp$breakpoints
## # A tibble: 5 x 3
##   BP                BP_CI_lwr         BP_CI_upr
##   <chr>             <chr>             <chr>
## 1 11.5 (2020-03-10) 11 (2020-03-09)   12 (2020-03-10)
## 2 21.5 (2020-03-20) 21 (2020-03-18)   22.1 (2020-03-21)
## 3 37.5 (2020-04-04) 37 (2020-04-03)   38 (2020-04-05)
## 4 43.4 (2020-04-10) 42.9 (2020-04-09) 44 (2020-04-11)
## 5 53.5 (2020-04-20) 50.7 (2020-04-17) 56.3 (2020-04-24)
##
## $cp_segmented_list_backpro$five_bp$plot
```




```
##
##
## $cp_segmented_list_backpro$six_bp
## $cp_segmented_list_backpro$six_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 78.41239
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t        U4.t
##  -0.1702509   0.2023060  -0.3582936   0.3061008  -0.3416440   0.3132521
##        U5.t        U6.t      psi1.t      psi2.t      psi3.t      psi4.t
##  -0.1354418   0.1058944   0.0000000   0.0000000   0.0000000   0.0000000
##      psi5.t      psi6.t
##   0.0000000   0.0000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.8352393
## Degrees of freedom: 64 total; 50 residual
## Residual standard error: 0.1280374
##
## $cp_segmented_list_backpro$six_bp$coef
```

```
## # A tibble: 7 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1       1.22   1.18   1.27
## 2       0.856  0.822  0.890
## 3       1.16   1.13   1.19
## 4       0.826  0.776  0.878
## 5       1.13   1.09   1.17
## 6       0.986  0.882  1.10
## 7       1.10   1.04   1.16
##
## $cp_segmented_list_backpro$six_bp$breakpoints
## # A tibble: 6 x 3
##   BP                 BP_CI_lwr          BP_CI_upr
##   <chr>              <chr>              <chr>
## 1 11.5 (2020-03-10) 11 (2020-03-09)    12 (2020-03-10)
## 2 21.5 (2020-03-20) 21 (2020-03-18)    22.1 (2020-03-21)
## 3 37.5 (2020-04-04) 37 (2020-04-03)    38 (2020-04-05)
## 4 43.4 (2020-04-10) 42.9 (2020-04-09) 44 (2020-04-11)
## 5 54.4 (2020-04-21) 53 (2020-04-20)    55.7 (2020-04-23)
## 6 57.6 (2020-04-25) 55.9 (2020-04-22) 59.4 (2020-04-27)
##
## $cp_segmented_list_backpro$six_bp$plot
```




```
##
```

```
##
##
## $aic_onset
##   two_bp three_bp  four_bp  five_bp   six_bp
##       NA       NA       NA       NA       NA
##
## $bic_onset
##   two_bp three_bp  four_bp  five_bp   six_bp
##       NA       NA       NA       NA       NA
##
## $cp_segmented_list_onset
## $cp_segmented_list_onset$two_bp
## $cp_segmented_list_onset$two_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$two_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$two_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$two_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$three_bp
## $cp_segmented_list_onset$three_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$three_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$three_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$three_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$four_bp
## $cp_segmented_list_onset$four_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$four_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$four_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$four_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$five_bp
```

```
## $cp_segmented_list_onset$five_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$five_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$five_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$five_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$six_bp
## $cp_segmented_list_onset$six_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$six_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$six_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$six_bp$plot
## [1] NA
```

```
cp_res_mty['bic_backpro']
```

```
## $bic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -62.34359 -53.97457 -97.27438 -95.17020 -90.28265
```

```
data_jal <- read_csv("age_group_data_jal.csv", show_col_types = FALSE)

data_jal_full = data_jal %>% group_by(date) %>%
  summarise(onsets=sum(onsets)) %>%
  right_join(tibble(date=seq(ymd("2020-02-24"), ymd("2020-05-15"), by = "1 day"))) %>%
  arrange(date) %>%
  mutate(onsets=replace_na(onsets,0))
```

**Jal:**

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

```
data_jal_full
```

```
## # A tibble: 82 x 2
##    date       onsets
##    <date>      <dbl>
```

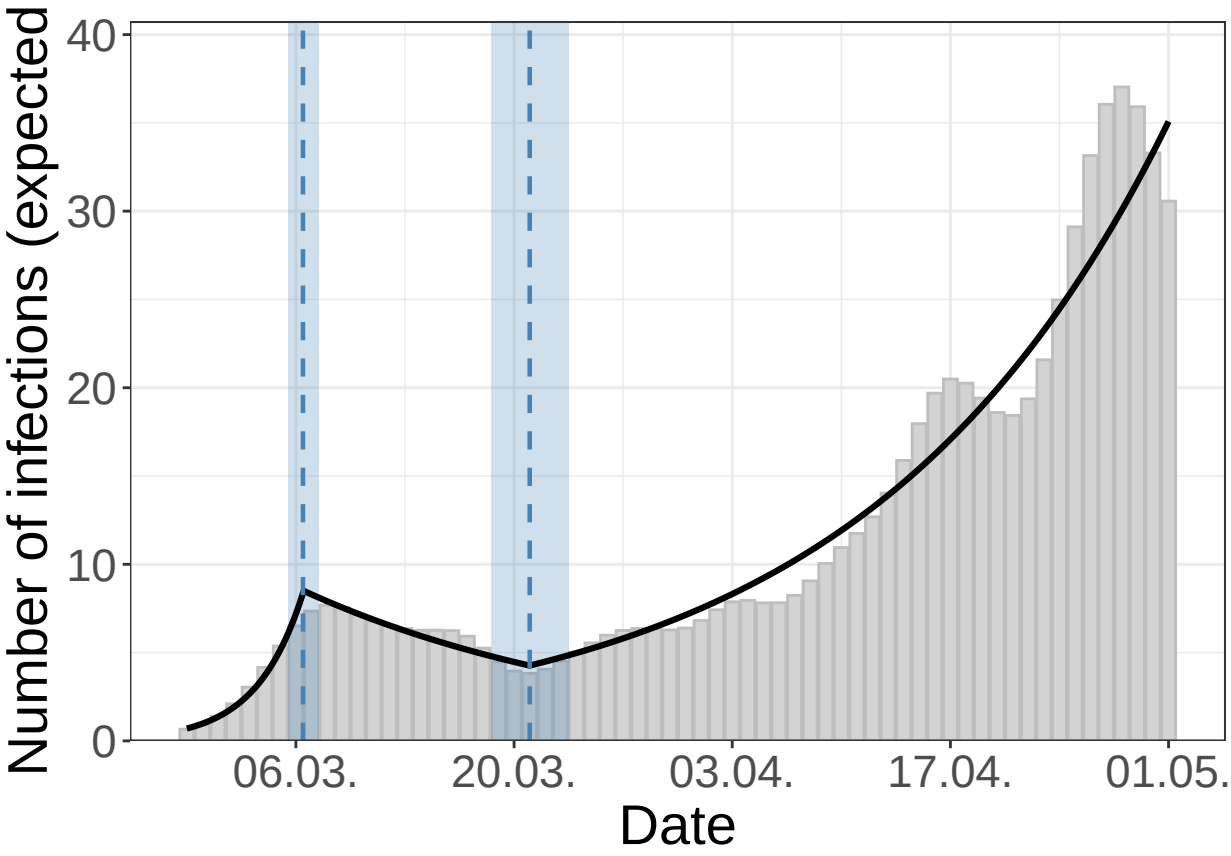
```
##  1 2020-02-24      0
##  2 2020-02-25      0
##  3 2020-02-26      0
##  4 2020-02-27      0
##  5 2020-02-28      0
##  6 2020-02-29      0
##  7 2020-03-01      2
##  8 2020-03-02      0
##  9 2020-03-03      0
## 10 2020-03-04      1
## # i 72 more rows
```

```
cp_res_jal = perform_cp_analysis(data = data_jal_full,
                                 type = "both",
                                 cp_max_onset = 6,
                                 cp_max_backpro = 6,
                                 save_disc_optim_results = T,
                                 use_disc_optim_results = T,
                                 name_disc =  "bav_full")
```

```
## [1] "perform analysis of backprojected infections"
## [1] "estimate change point models based on segmented package infections"

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:3

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:4

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:5

## n bp:6

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## [1] "perform analysis of onsets"
## [1] "estimate change point models based on segmented package onset"

## Warning: Breakpoint estimate(s) outdistanced to allow finite estimates and
## st.errs

## Warning: Breakpoint estimate(s) outdistanced to allow finite estimates and
## st.errs

## Warning: Estimation failed. Too many breakpoints? Returning a glm fit..
```

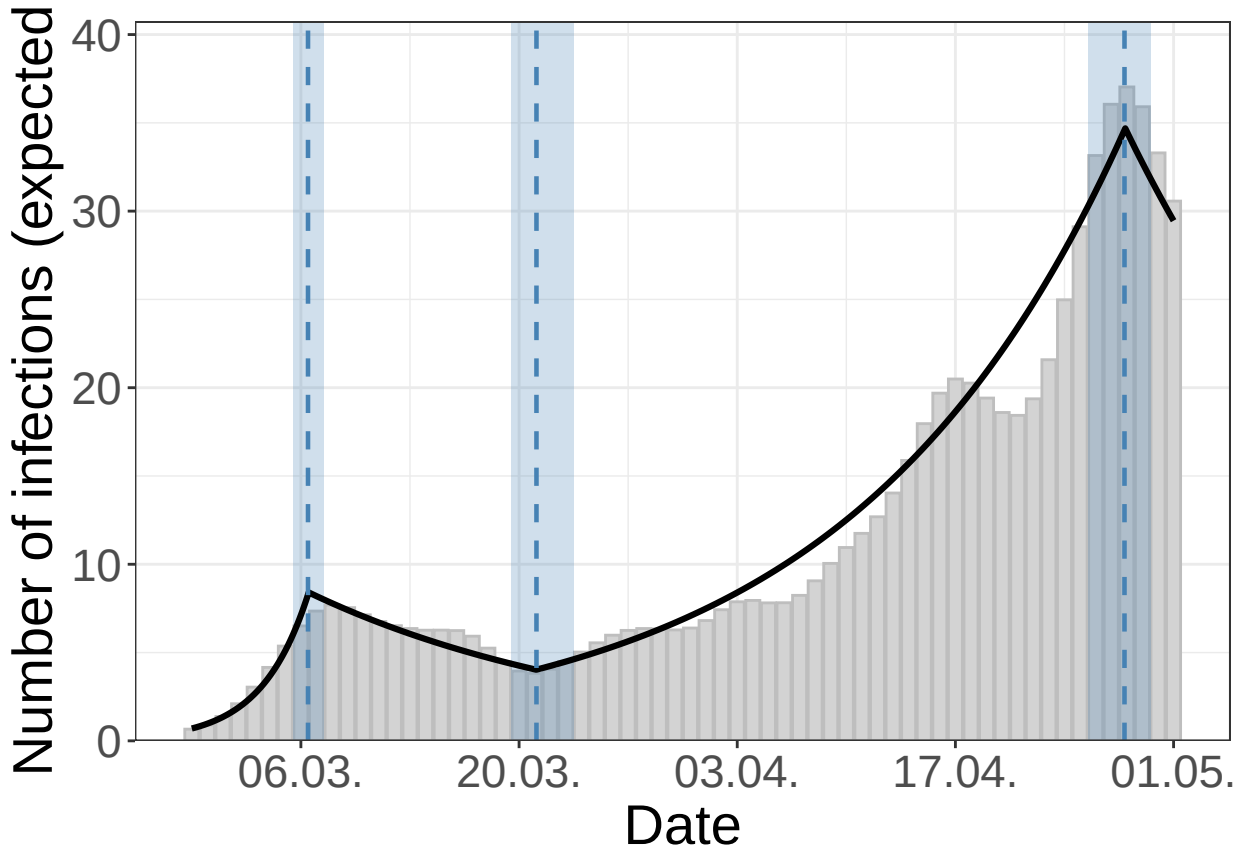
```
cp_res_jal
```

```
## $aic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -165.1317 -173.2456 -172.8548        NA -199.5337
##
## $bic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -147.8607 -151.6568 -146.9482        NA -164.9916
##
## $cp_segmented_list_backpro
## $cp_segmented_list_backpro$two_bp
## $cp_segmented_list_backpro$two_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 90.56587
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t      psi1.t      psi2.t
## -0.69092342  0.33301549 -0.38057085  0.09895613  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.8446957
## Degrees of freedom: 64 total; 58 residual
## Residual standard error: 0.1087429
##
## $cp_segmented_list_backpro$two_bp$coef
## # A tibble: 3 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1       1.40   1.34   1.45
## 2       0.954  0.934  0.973
## 3       1.05   1.05   1.06
##
## $cp_segmented_list_backpro$two_bp$breakpoints
## # A tibble: 2 x 3
##   BP               BP_CI_lwr         BP_CI_upr
##   <chr>            <chr>             <chr>
## 1 8.5 (2020-03-06) 8.1 (2020-03-06)  8.8 (2020-03-07)
## 2 23 (2020-03-21)  21.8 (2020-03-19) 24.3 (2020-03-23)
##
## $cp_segmented_list_backpro$two_bp$plot
```



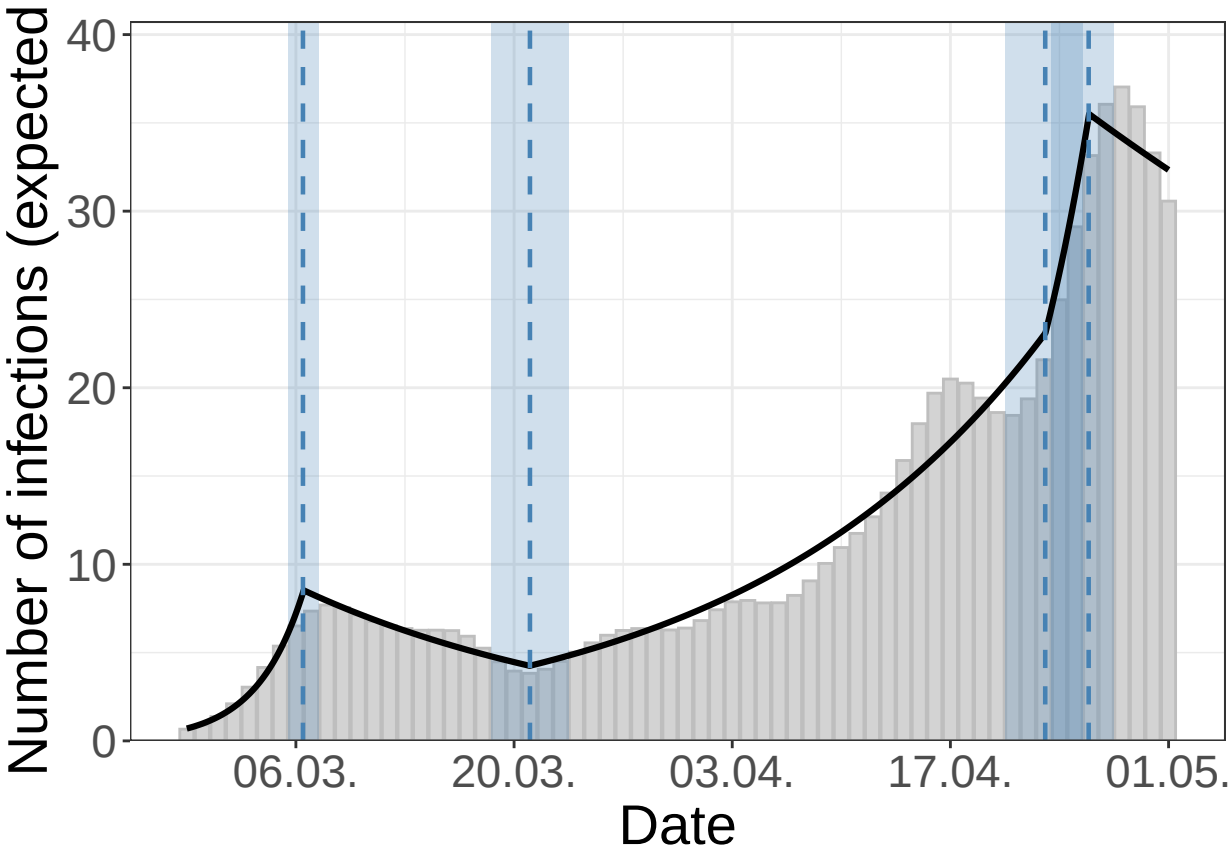

```
##
##
## $cp_segmented_list_backpro$three_bp
## $cp_segmented_list_backpro$three_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 96.62281
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t      psi1.t
##  -0.6906007   0.3317012  -0.3820689   0.1073232  -0.1097049   0.0000000
##      psi2.t      psi3.t
##   0.0000000   0.0000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.8693949
## Degrees of freedom: 64 total; 56 residual
## Residual standard error: 0.1070238
##
## $cp_segmented_list_backpro$three_bp$coef
## # A tibble: 4 x 3
##   mult_factor CI_lwr CI_upr
```

```
##          <dbl>  <dbl>  <dbl>
## 1        1.39   1.34   1.44
## 2        0.951  0.932  0.970
## 3        1.06   1.05   1.07
## 4        0.949  0.892  1.01
##
## $cp_segmented_list_backpro$three_bp$breakpoints
## # A tibble: 3 x 3
##   BP                 BP_CI_lwr          BP_CI_upr
##   <chr>              <chr>              <chr>
## 1 8.5 (2020-03-06)  8.1 (2020-03-06)  8.8 (2020-03-07)
## 2 23.1 (2020-03-21) 22 (2020-03-20)   24.2 (2020-03-23)
## 3 60.9 (2020-04-28) 59.8 (2020-04-26) 61.9 (2020-04-29)
##
## $cp_segmented_list_backpro$three_bp$plot
```



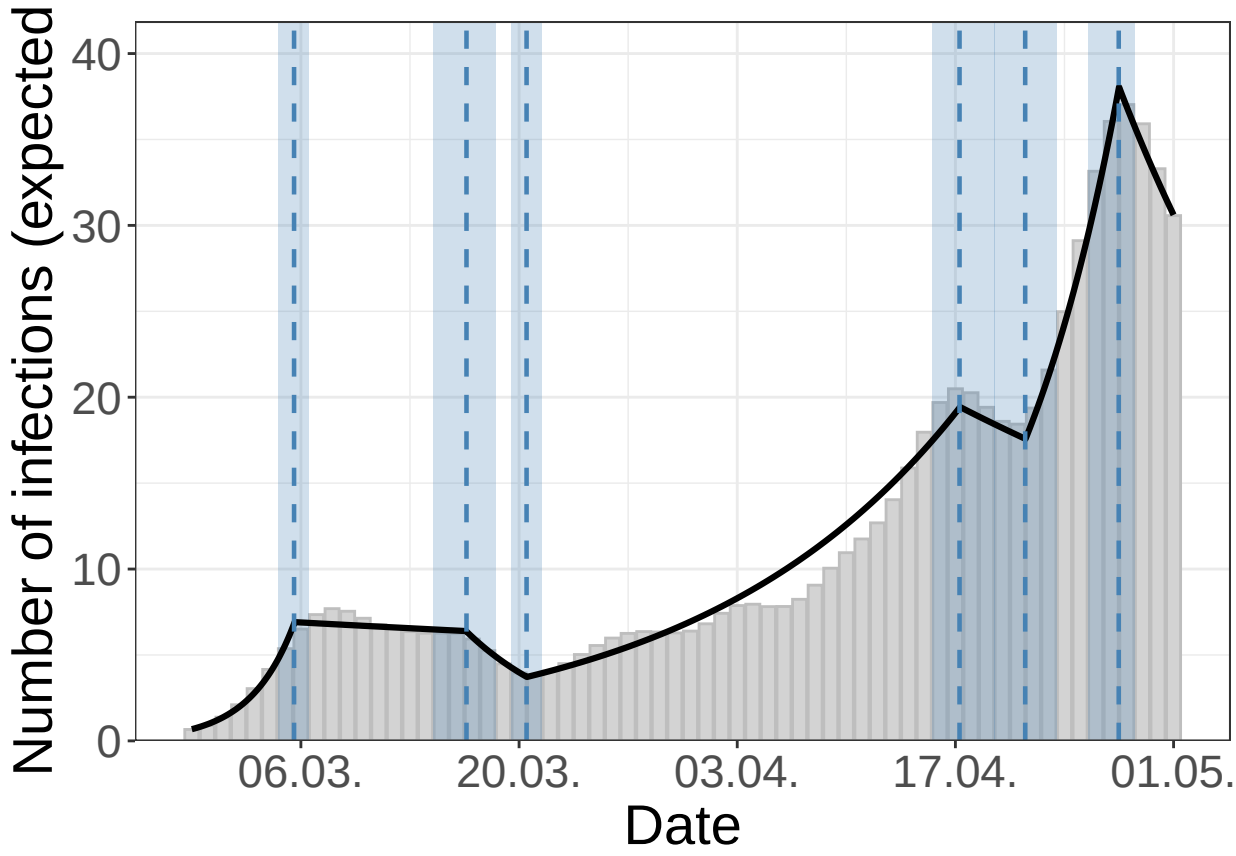

```
##
##
## $cp_segmented_list_backpro$four_bp
## $cp_segmented_list_backpro$four_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 98.4274
##
```

```
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t        U4.t
## -0.69170747  0.33350723 -0.38149094  0.09912108  0.10226400 -0.17170369
##      psi1.t      psi2.t      psi3.t      psi4.t
##  0.00000000  0.00000000  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##      Phi
## 0.831262
## Degrees of freedom: 64 total; 54 residual
## Residual standard error: 0.09265798
##
## $cp_segmented_list_backpro$four_bp$coef
## # A tibble: 5 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1       1.40   1.35   1.44
## 2       0.953  0.936  0.971
## 3       1.05   1.04   1.06
## 4       1.17   1.04   1.31
## 5       0.982  0.940  1.03
##
## $cp_segmented_list_backpro$four_bp$breakpoints
## # A tibble: 4 x 3
##   BP                BP_CI_lwr         BP_CI_upr
##   <chr>             <chr>             <chr>
## 1 8.5 (2020-03-06)  8.1 (2020-03-06)  8.8 (2020-03-07)
## 2 23 (2020-03-21)   21.9 (2020-03-19) 24.2 (2020-03-23)
## 3 56.1 (2020-04-23) 54.5 (2020-04-21) 57.7 (2020-04-25)
## 4 58.9 (2020-04-26) 57.9 (2020-04-24) 59.8 (2020-04-27)
##
## $cp_segmented_list_backpro$four_bp$plot
```




```
##
##
## $cp_segmented_list_backpro$five_bp
## $cp_segmented_list_backpro$five_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_backpro$five_bp$coef
## [1] NA
##
## $cp_segmented_list_backpro$five_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_backpro$five_bp$plot
## [1] NA
##
##
## $cp_segmented_list_backpro$six_bp
## $cp_segmented_list_backpro$six_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 115.7668
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t        U4.t
## -0.73713087  0.35135523 -0.35848228 -0.13163166  0.19822309 -0.08335885
```

```
##        U5.t        U6.t      psi1.t      psi2.t      psi3.t      psi4.t
##  0.15267017 -0.19095820  0.00000000  0.00000000  0.00000000  0.00000000
##      psi5.t      psi6.t
##  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.8815618
## Degrees of freedom: 64 total; 50 residual
## Residual standard error: 0.08300178
##
## $cp_segmented_list_backpro$six_bp$coef
## # A tibble: 7 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1       1.42   1.38   1.47
## 2       0.993  0.971  1.02
## 3       0.870  0.829  0.914
## 4       1.06   1.05   1.07
## 5       0.976  0.930  1.03
## 6       1.14   1.10   1.18
## 7       0.940  0.894  0.988
##
## $cp_segmented_list_backpro$six_bp$breakpoints
## # A tibble: 6 x 3
##   BP                BP_CI_lwr         BP_CI_upr
##   <chr>             <chr>             <chr>
## 1 7.6 (2020-03-06)  7.3 (2020-03-05)  7.8 (2020-03-06)
## 2 18.6 (2020-03-17) 17.9 (2020-03-15) 19.4 (2020-03-18)
## 3 22.5 (2020-03-20) 22 (2020-03-20)   23 (2020-03-21)
## 4 50.3 (2020-04-17) 49.1 (2020-04-16) 51.5 (2020-04-19)
## 5 54.5 (2020-04-21) 53.8 (2020-04-20) 55.1 (2020-04-23)
## 6 60.5 (2020-04-27) 60 (2020-04-26)   61 (2020-04-28)
##
## $cp_segmented_list_backpro$six_bp$plot
```




```
##
##
##
## $aic_onset
##   two_bp three_bp  four_bp  five_bp   six_bp
##       NA       NA       NA       NA       NA
##
## $bic_onset
##   two_bp three_bp  four_bp  five_bp   six_bp
##       NA       NA       NA       NA       NA
##
## $cp_segmented_list_onset
## $cp_segmented_list_onset$two_bp
## $cp_segmented_list_onset$two_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$two_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$two_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$two_bp$plot
## [1] NA
##
##
```

```
## $cp_segmented_list_onset$three_bp
## $cp_segmented_list_onset$three_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$three_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$three_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$three_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$four_bp
## $cp_segmented_list_onset$four_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$four_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$four_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$four_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$five_bp
## $cp_segmented_list_onset$five_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$five_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$five_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$five_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$six_bp
## $cp_segmented_list_onset$six_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$six_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$six_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$six_bp$plot
## [1] NA
```

```
cp_res_jal['bic_backpro']
```

```
## $bic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -147.8607 -151.6568 -146.9482        NA -164.9916
```

```
data_mx <- read_csv("age_group_data_mx.csv", show_col_types = FALSE)

data_mx_full = data_mx %>% group_by(date) %>%
  summarise(onsets=sum(onsets)) %>%
  right_join(tibble(date=seq(ymd("2020-02-24"), ymd("2020-05-15"), by = "1 day"))) %>%
  arrange(date) %>%
  mutate(onsets=replace_na(onsets,0))
```

**Mx:**

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

```
data_mx_full
```

```
## # A tibble: 82 x 2
##    date       onsets
##    <date>      <dbl>
##  1 2020-02-24      0
##  2 2020-02-25      0
##  3 2020-02-26      1
##  4 2020-02-27      0
##  5 2020-02-28      2
##  6 2020-02-29      2
##  7 2020-03-01      2
##  8 2020-03-02      4
##  9 2020-03-03      5
## 10 2020-03-04      5
## # i 72 more rows
```

```
cp_res_mx = perform_cp_analysis(data = data_mx_full,
                                type = "both",
                                cp_max_onset = 6,
                                cp_max_backpro = 6,
                                save_disc_optim_results = T,
                                use_disc_optim_results = T,
                                name_disc =  "bav_full")
```

```
## [1] "perform analysis of backprojected infections"
## [1] "estimate change point models based on segmented package infections"
```

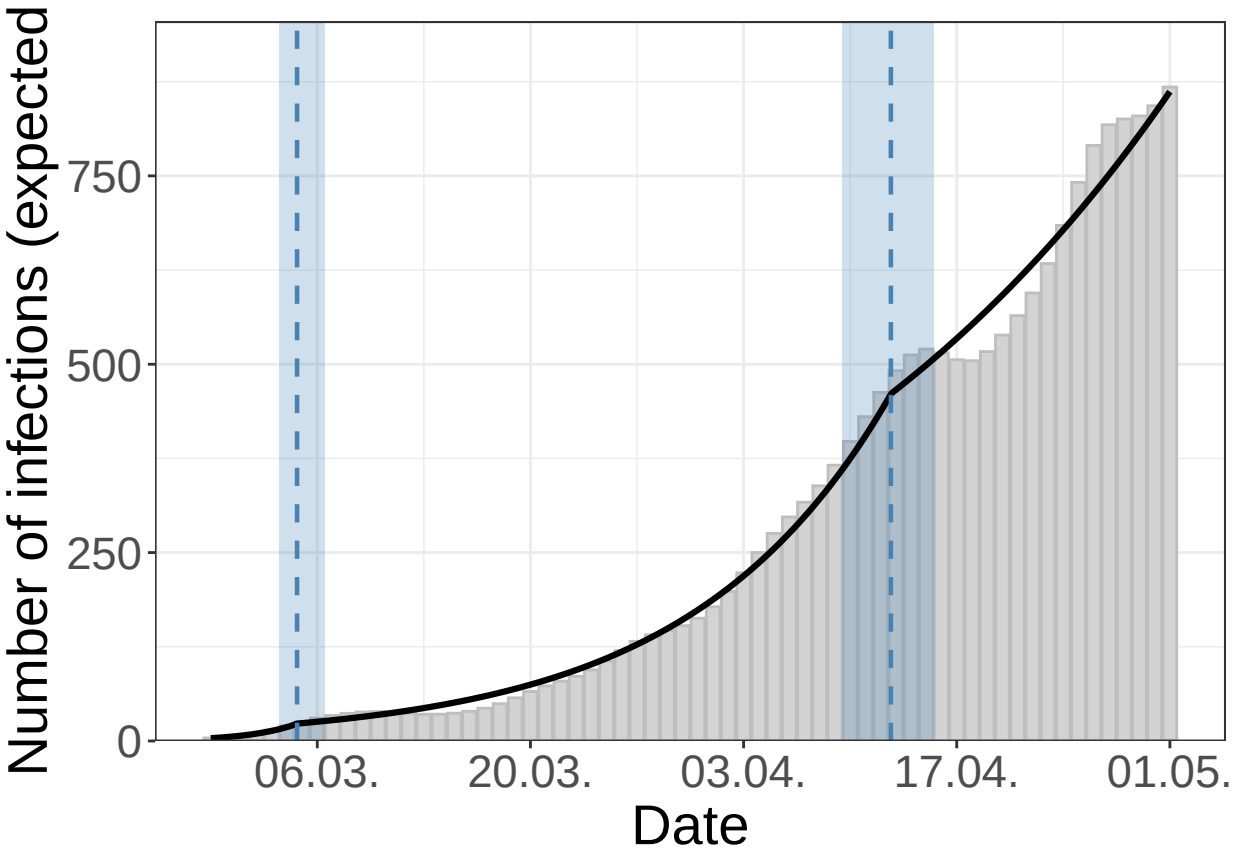
```
## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)
```

```
## n bp:3

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:4

## n bp:5

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## n bp:6

## Warning: The returned fit is OK, but not of class 'segmented'.
##  If interested, call explicitly the segmented methods (plot.segmented, confint.segmented,..)

## [1] "perform analysis of onsets"
## [1] "estimate change point models based on segmented package onset"
```

```
cp_res_mx
```

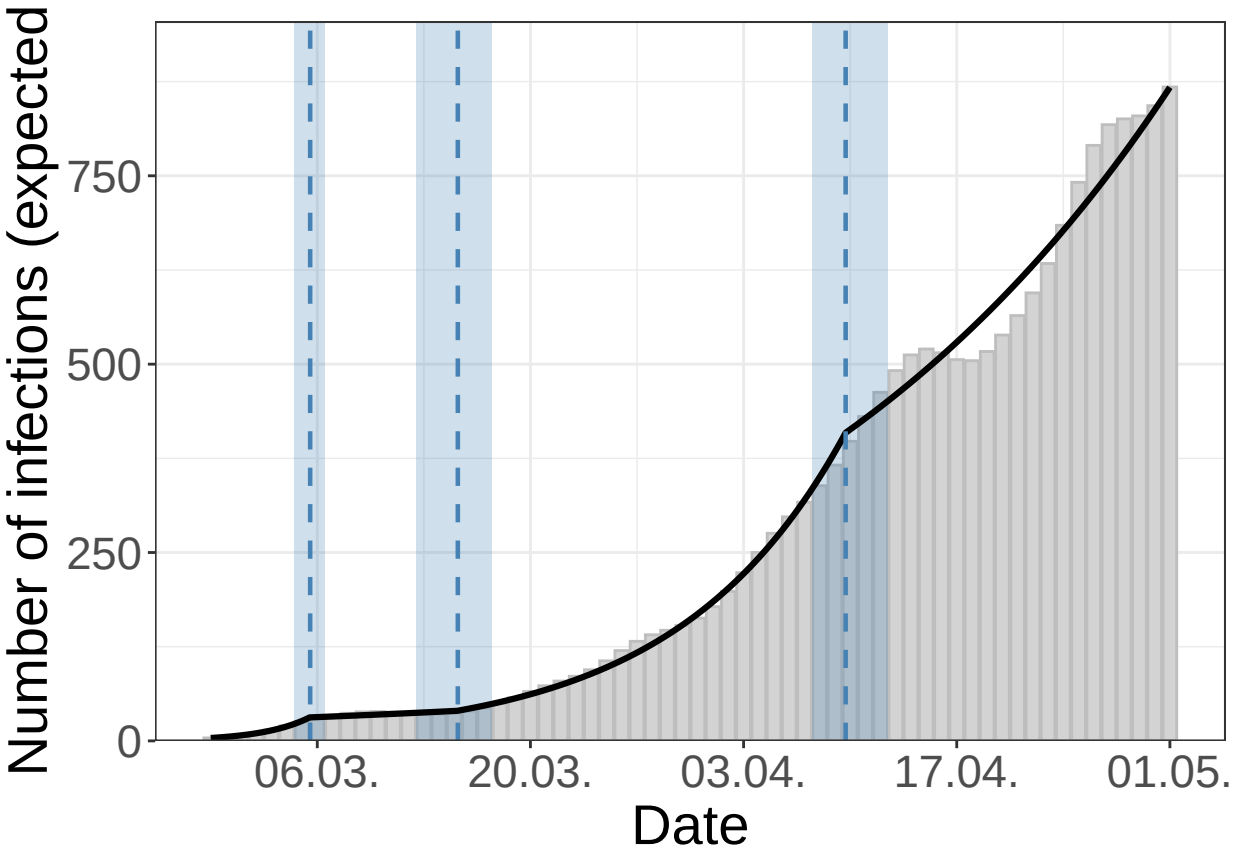
```
## $aic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -194.2620 -211.9086        NA -216.6260 -229.1375
##
## $bic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -176.9909 -190.3198        NA -186.4016 -194.5954
##
## $cp_segmented_list_backpro
## $cp_segmented_list_backpro$two_bp
## $cp_segmented_list_backpro$two_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 105.131
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t      psi1.t      psi2.t
##  0.98812938  0.32113609 -0.24436490 -0.04260396  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.9119296
## Degrees of freedom: 64 total; 58 residual
## Residual standard error: 0.112503
##
## $cp_segmented_list_backpro$two_bp$coef
## # A tibble: 3 x 3
```

```
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1        1.38   1.32   1.44
## 2        1.08   1.07   1.09
## 3        1.03   1.02   1.05
##
## $cp_segmented_list_backpro$two_bp$breakpoints
## # A tibble: 2 x 3
##   BP                 BP_CI_lwr          BP_CI_upr
##   <chr>              <chr>              <chr>
## 1 6.7 (2020-03-05)  6.3 (2020-03-04)  7.1 (2020-03-06)
## 2 45.7 (2020-04-13) 43.4 (2020-04-10) 48 (2020-04-15)
##
## $cp_segmented_list_backpro$two_bp$plot
```



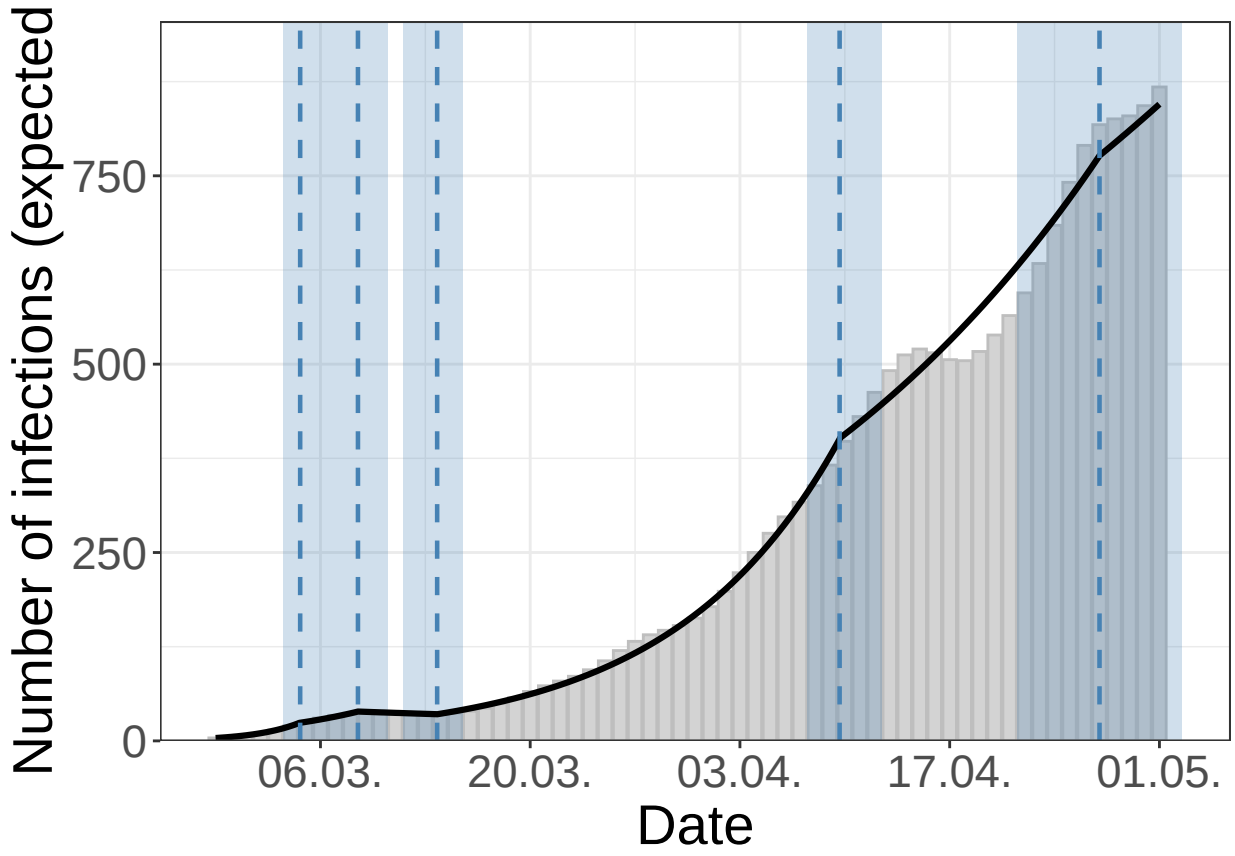

```
##
##
## $cp_segmented_list_backpro$three_bp
## $cp_segmented_list_backpro$three_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 115.9543
##
## Coefficients:
```

```
## (Intercept)           t        U1.t        U2.t        U3.t      psi1.t
##  1.02871204  0.32138714 -0.29586729  0.06573025 -0.05594473  0.00000000
##      psi2.t      psi3.t
##  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##      Phi
## 0.784237
## Degrees of freedom: 64 total; 56 residual
## Residual standard error: 0.06323544
##
## $cp_segmented_list_backpro$three_bp$coef
## # A tibble: 4 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1        1.38   1.34   1.42
## 2        1.03   1.01   1.05
## 3        1.10   1.09   1.10
## 4        1.04   1.03   1.04
##
## $cp_segmented_list_backpro$three_bp$breakpoints
## # A tibble: 3 x 3
##   BP                BP_CI_lwr         BP_CI_upr
##   <chr>             <chr>             <chr>
## 1 7.5 (2020-03-06)  7.2 (2020-03-05)  7.8 (2020-03-06)
## 2 17.2 (2020-03-15) 15.9 (2020-03-13) 18.6 (2020-03-17)
## 3 42.7 (2020-04-10) 41.2 (2020-04-08) 44.2 (2020-04-12)
##
## $cp_segmented_list_backpro$three_bp$plot
```



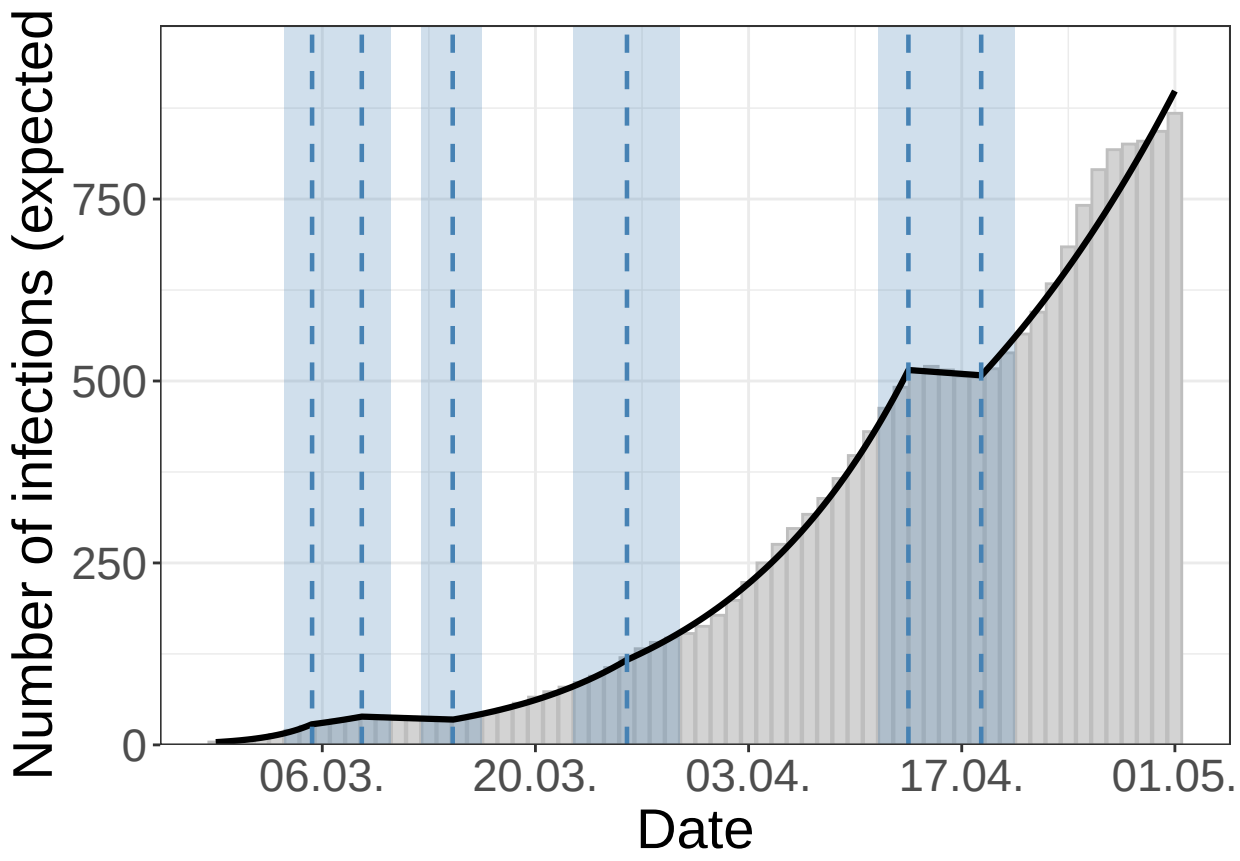

```
##
##
## $cp_segmented_list_backpro$four_bp
## $cp_segmented_list_backpro$four_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_backpro$four_bp$coef
## [1] NA
##
## $cp_segmented_list_backpro$four_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_backpro$four_bp$plot
## [1] NA
##
##
## $cp_segmented_list_backpro$five_bp
## $cp_segmented_list_backpro$five_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 122.313
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t        U4.t
##  1.00515217  0.32878473 -0.20420203 -0.14252945  0.10833138 -0.05235781
```

```
##        U5.t      psi1.t      psi2.t      psi3.t      psi4.t      psi5.t
## -0.01695447  0.00000000  0.00000000  0.00000000  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.7869505
## Degrees of freedom: 64 total; 52 residual
## Residual standard error: 0.05756942
##
## $cp_segmented_list_backpro$five_bp$coef
## # A tibble: 6 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1       1.39   1.35    1.43
## 2       1.13   1.09    1.18
## 3       0.982  0.949   1.02
## 4       1.09   1.09    1.10
## 5       1.04   1.03    1.05
## 6       1.02   0.986   1.06
##
## $cp_segmented_list_backpro$five_bp$breakpoints
## # A tibble: 5 x 3
##   BP                BP_CI_lwr         BP_CI_upr
##   <chr>             <chr>             <chr>
## 1 6.6 (2020-03-05)  6.2 (2020-03-04)  7.1 (2020-03-06)
## 2 10.5 (2020-03-09) 9.9 (2020-03-07)  11.1 (2020-03-10)
## 3 15.8 (2020-03-14) 15 (2020-03-12)   16.6 (2020-03-15)
## 4 42.7 (2020-04-10) 41.1 (2020-04-08) 44.2 (2020-04-12)
## 5 60 (2020-04-27)   55.1 (2020-04-22) 64.9 (2020-05-02)
##
## $cp_segmented_list_backpro$five_bp$plot
```




```
##
##
## $cp_segmented_list_backpro$six_bp
## $cp_segmented_list_backpro$six_bp$segmented_model
## Generalized least squares fit by maximum likelihood
##   Model: NULL
##   Data: NULL
##   Log-likelihood: 130.5687
##
## Coefficients:
## (Intercept)           t        U1.t        U2.t        U3.t        U4.t
##  1.00170970  0.32038317 -0.22377015 -0.11489169  0.12442117 -0.02588894
##        U5.t        U6.t      psi1.t      psi2.t      psi3.t      psi4.t
## -0.08323028  0.04790722  0.00000000  0.00000000  0.00000000  0.00000000
##      psi5.t      psi6.t
##  0.00000000  0.00000000
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.6276025
## Degrees of freedom: 64 total; 50 residual
## Residual standard error: 0.04025005
##
## $cp_segmented_list_backpro$six_bp$coef
```

```
## # A tibble: 7 x 3
##   mult_factor CI_lwr CI_upr
##         <dbl>  <dbl>  <dbl>
## 1       1.38   1.35    1.41
## 2       1.10   1.05    1.16
## 3       0.982  0.959   1.01
## 4       1.11   1.10    1.12
## 5       1.08   1.08    1.09
## 6       0.997  0.970   1.03
## 7       1.05   1.04    1.06
##
## $cp_segmented_list_backpro$six_bp$breakpoints
## # A tibble: 6 x 3
##   BP                 BP_CI_lwr          BP_CI_upr
##   <chr>              <chr>              <chr>
## 1 7.3 (2020-03-05)  6.9 (2020-03-04)  7.7 (2020-03-06)
## 2 10.6 (2020-03-09) 9.8 (2020-03-07)  11.4 (2020-03-10)
## 3 16.6 (2020-03-15) 15.9 (2020-03-13) 17.2 (2020-03-16)
## 4 28 (2020-03-26)   25.2 (2020-03-23) 30.8 (2020-03-29)
## 5 46.5 (2020-04-13) 45.5 (2020-04-12) 47.5 (2020-04-15)
## 6 51.3 (2020-04-18) 49.6 (2020-04-16) 52.9 (2020-04-20)
##
## $cp_segmented_list_backpro$six_bp$plot
```




```
##
```

```
##
##
## $aic_onset
##   two_bp three_bp  four_bp  five_bp   six_bp
##       NA       NA       NA       NA       NA
##
## $bic_onset
##   two_bp three_bp  four_bp  five_bp   six_bp
##       NA       NA       NA       NA       NA
##
## $cp_segmented_list_onset
## $cp_segmented_list_onset$two_bp
## $cp_segmented_list_onset$two_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$two_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$two_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$two_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$three_bp
## $cp_segmented_list_onset$three_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$three_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$three_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$three_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$four_bp
## $cp_segmented_list_onset$four_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$four_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$four_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$four_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$five_bp
```

```
## $cp_segmented_list_onset$five_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$five_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$five_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$five_bp$plot
## [1] NA
##
##
## $cp_segmented_list_onset$six_bp
## $cp_segmented_list_onset$six_bp$segmented_model
## [1] NA
##
## $cp_segmented_list_onset$six_bp$coef
## [1] NA
##
## $cp_segmented_list_onset$six_bp$breakpoints
## [1] NA
##
## $cp_segmented_list_onset$six_bp$plot
## [1] NA
```

```
cp_res_mx['bic_backpro']
```

```
## $bic_backpro
##    two_bp  three_bp   four_bp   five_bp    six_bp
## -176.9909 -190.3198        NA -186.4016 -194.5954
```