Modeling extreme values with a GEV mixture probability distributions

Application to a rain data in australia

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2023-10-26

```r
# library(xfun)
```

```r
path <- ".."
```

```r
xfun::in_dir(dir = path, expr = source("./src/generate_gev_sample.R"))
xfun::in_dir(dir = path, expr = source("./src/calculate_gev_inverse_cdf.R"))
xfun::in_dir(dir = path, expr = source("./src/estimate_gev_mixture_model_parameters.R"))
xfun::in_dir(dir = path, expr = source("./src/predict_gev_mixture_model_parameters.R"))
xfun::in_dir(dir = path, expr = source("./src/plot_gev_mixture_model_pdf.R"))
xfun::in_dir(dir = path, expr = source("./src/plot_gev_mixture_model_cdf.R"))
xfun::in_dir(dir = path, expr = source("./src/estimate_gev_mixture_model_quantile.R"))
xfun::in_dir(dir = path, expr = source("./src/estimate_gev_mixture_model_pdf.R"))
xfun::in_dir(dir = path, expr = source("./src/estimate_gev_mixture_model_cdf.R"))
xfun::in_dir(dir = path, expr = source("./src/estimate_gev_mixture_model_sample.R"))
```

```r
library(readr)
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ----------------------- tidyverse 2.0.0 --
## v dplyr     1.1.2     v purrr     1.0.2
## v forcats   1.0.0     v stringr   1.5.0
## v ggplot2   3.4.2     v tibble    3.2.1
## v lubridate 1.9.2     v tidyr     1.3.0
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```r
library(DataExplorer)
#library(tibble)
#library(explore)
```

```r
weatherAUS <- xfun::in_dir(dir = path, expr = read_csv("./applications/weatherAUS.csv"))
```

```
## Rows: 235699 Columns: 24
## -- Column specification -------------------------------------------------------
## Delimiter: ","
## chr   (6): Location, WindGustDir, WindDir9am, WindDir3pm, RainToday, RainTom...
## dbl  (17): MinTemp, MaxTemp, Rainfall, Evaporation, Sunshine, WindGustSpeed,...
## date  (1): Date
##
```

```
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
# View(weatherAUS)
```

```r
#str(weatherAUS)
```

```r
names(weatherAUS)
```

```
##  [1] "Date"          "Location"      "MinTemp"       "MaxTemp"
##  [5] "Rainfall"      "Evaporation"   "Sunshine"      "WindGustDir"
##  [9] "WindGustSpeed" "WindDir9am"    "WindDir3pm"    "WindSpeed9am"
## [13] "WindSpeed3pm"  "Humidity9am"   "Humidity3pm"   "Pressure9am"
## [17] "Pressure3pm"   "Cloud9am"      "Cloud3pm"      "Temp9am"
## [21] "Temp3pm"       "RainToday"     "RISK_MM"       "RainTomorrow"
```

```r
head(weatherAUS)
```

```
## # A tibble: 6 x 24
##   Date       Location MinTemp MaxTemp Rainfall Evaporation Sunshine WindGustDir
##   <date>     <chr>      <dbl>   <dbl>    <dbl>       <dbl>    <dbl> <chr>
## 1 2008-12-01 Albury      13.4    22.9      0.6          NA       NA W
## 2 2008-12-02 Albury       7.4    25.1      0            NA       NA WNW
## 3 2008-12-03 Albury      12.9    25.7      0            NA       NA WSW
## 4 2008-12-04 Albury       9.2    28        0            NA       NA NE
## 5 2008-12-05 Albury      17.5    32.3      1            NA       NA W
## 6 2008-12-06 Albury      14.6    29.7      0.2          NA       NA WNW
## # i 16 more variables: WindGustSpeed <dbl>, WindDir9am <chr>, WindDir3pm <chr>,
## #   WindSpeed9am <dbl>, WindSpeed3pm <dbl>, Humidity9am <dbl>,
## #   Humidity3pm <dbl>, Pressure9am <dbl>, Pressure3pm <dbl>, Cloud9am <dbl>,
## #   Cloud3pm <dbl>, Temp9am <dbl>, Temp3pm <dbl>, RainToday <chr>,
## #   RISK_MM <dbl>, RainTomorrow <chr>
```

```r
tail(weatherAUS)
```
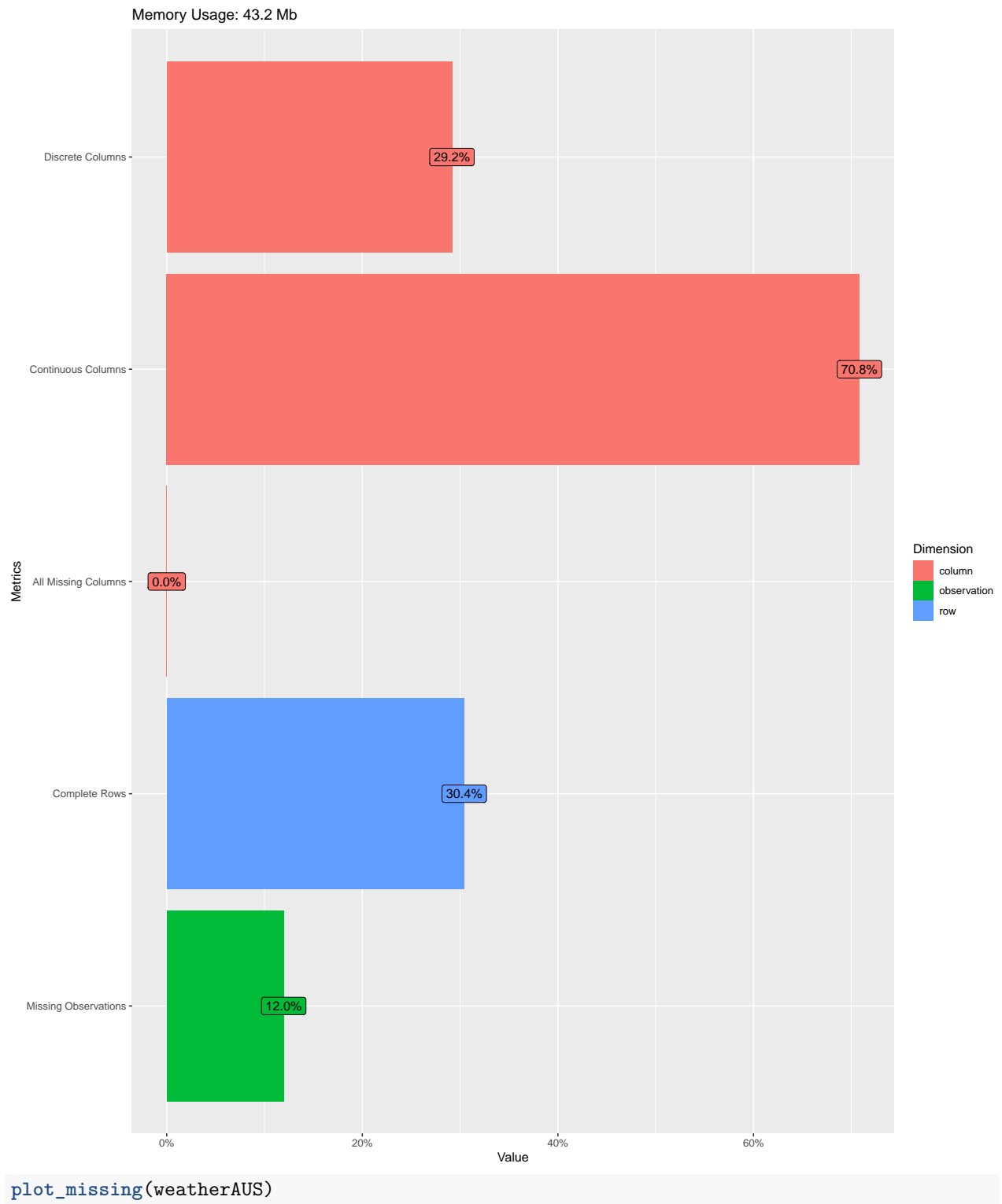
```
## # A tibble: 6 x 24
##   Date       Location MinTemp MaxTemp Rainfall Evaporation Sunshine WindGustDir
##   <date>     <chr>      <dbl>   <dbl>    <dbl>       <dbl>    <dbl> <chr>
## 1 2023-09-24 Uluru       14.1    34        0            NA       NA S
## 2 2023-09-25 Uluru       15.5    33.8      0            NA       NA ENE
## 3 2023-09-26 Uluru       15      34.1      0            NA       NA SSE
## 4 2023-09-27 Uluru       18.8    33        0            NA       NA SE
## 5 2023-09-28 Uluru       19.6    33.6      0            NA       NA E
## 6 2023-09-29 Uluru       17.2    34.2      0            NA       NA ENE
## # i 16 more variables: WindGustSpeed <dbl>, WindDir9am <chr>, WindDir3pm <chr>,
## #   WindSpeed9am <dbl>, WindSpeed3pm <dbl>, Humidity9am <dbl>,
## #   Humidity3pm <dbl>, Pressure9am <dbl>, Pressure3pm <dbl>, Cloud9am <dbl>,
## #   Cloud3pm <dbl>, Temp9am <dbl>, Temp3pm <dbl>, RainToday <chr>,
## #   RISK_MM <dbl>, RainTomorrow <chr>
```
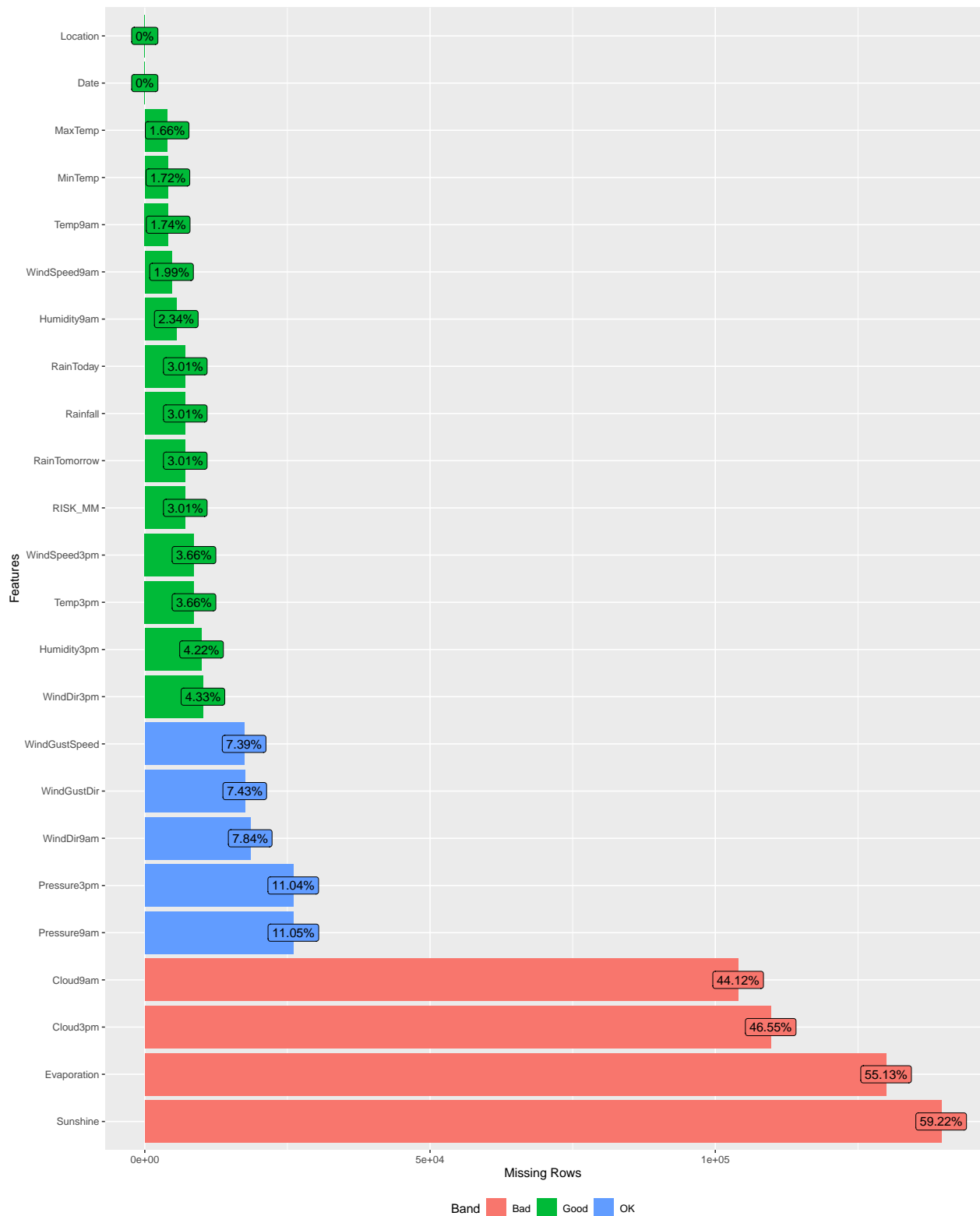
```r
# plot_str(weatherAUS)
```

```r
# introduce(weatherAUS)
```

```r
plot_intro(weatherAUS)
```

```
plot_missing(weatherAUS)
```
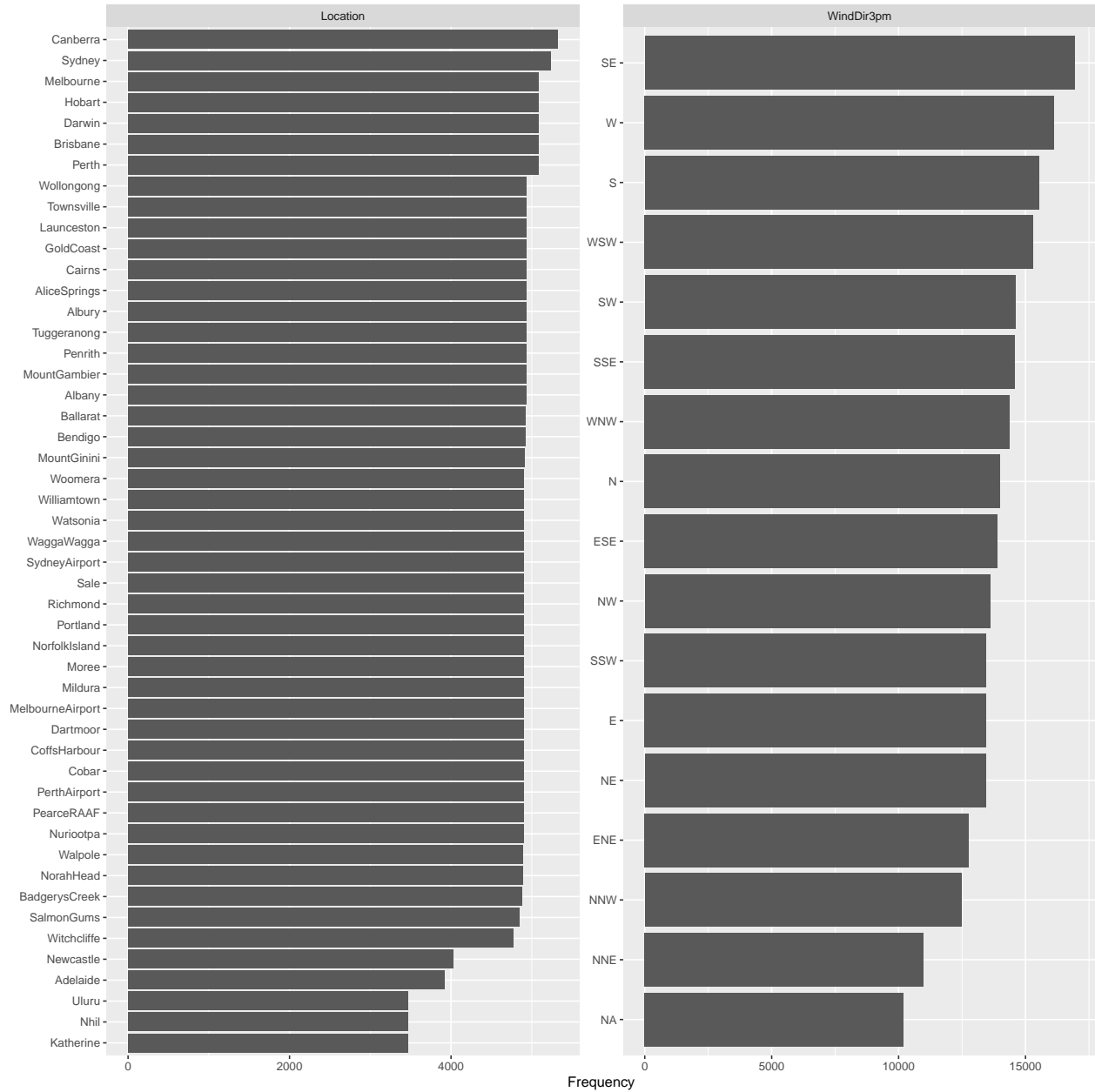
```
final_data <- drop_columns(weatherAUS, c("Date", "RISK_MM", "Cloud9am", "Cloud3pm", "Evaporation", "Suns
                                          "WindGustSpeed", "WindDir9am", "Pressure9am", "Pressure3pm", "
```

```
# names(final_data)
```
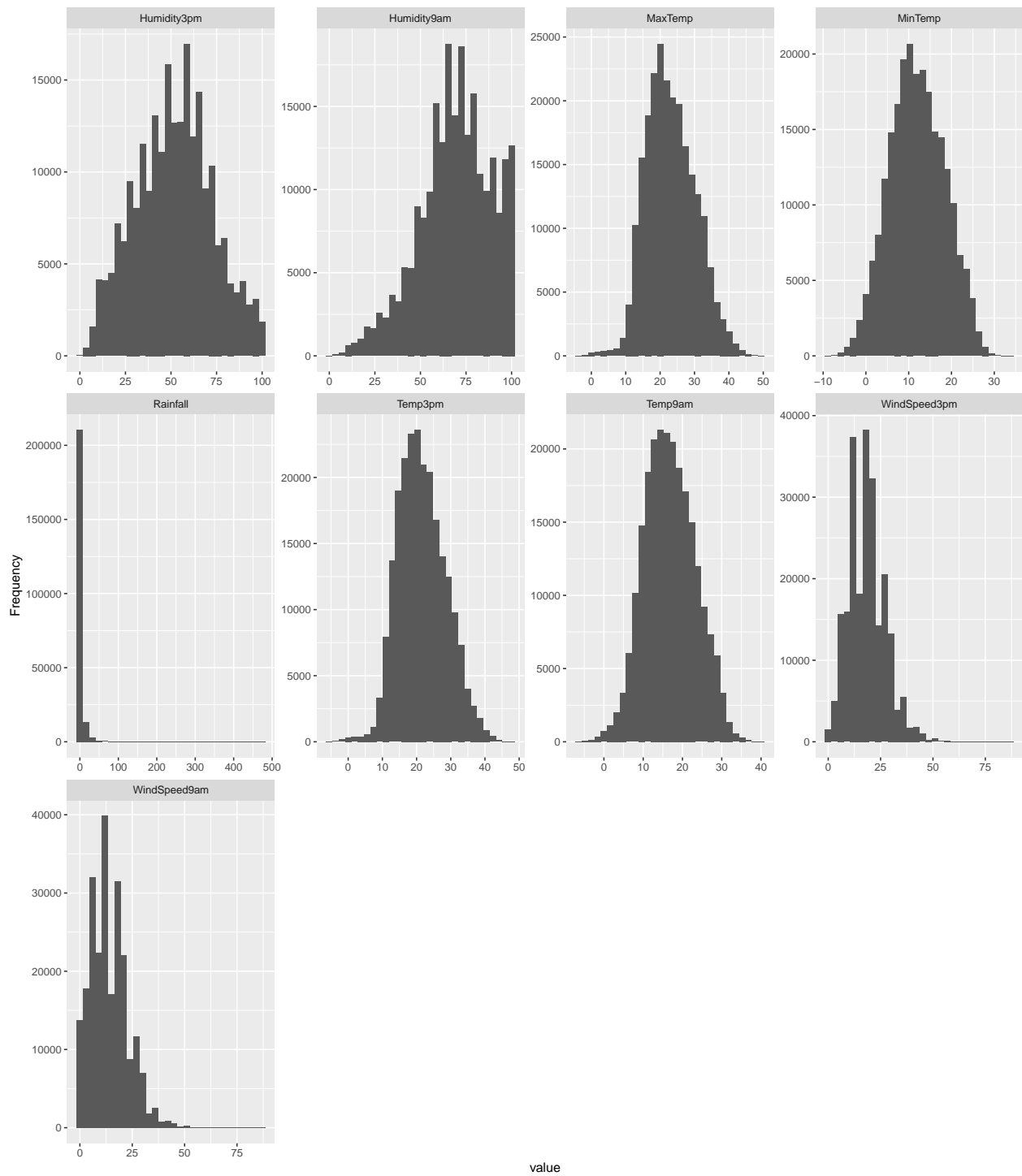
```
# View(final_data)
```

```
# profile_missing(final_data)
```
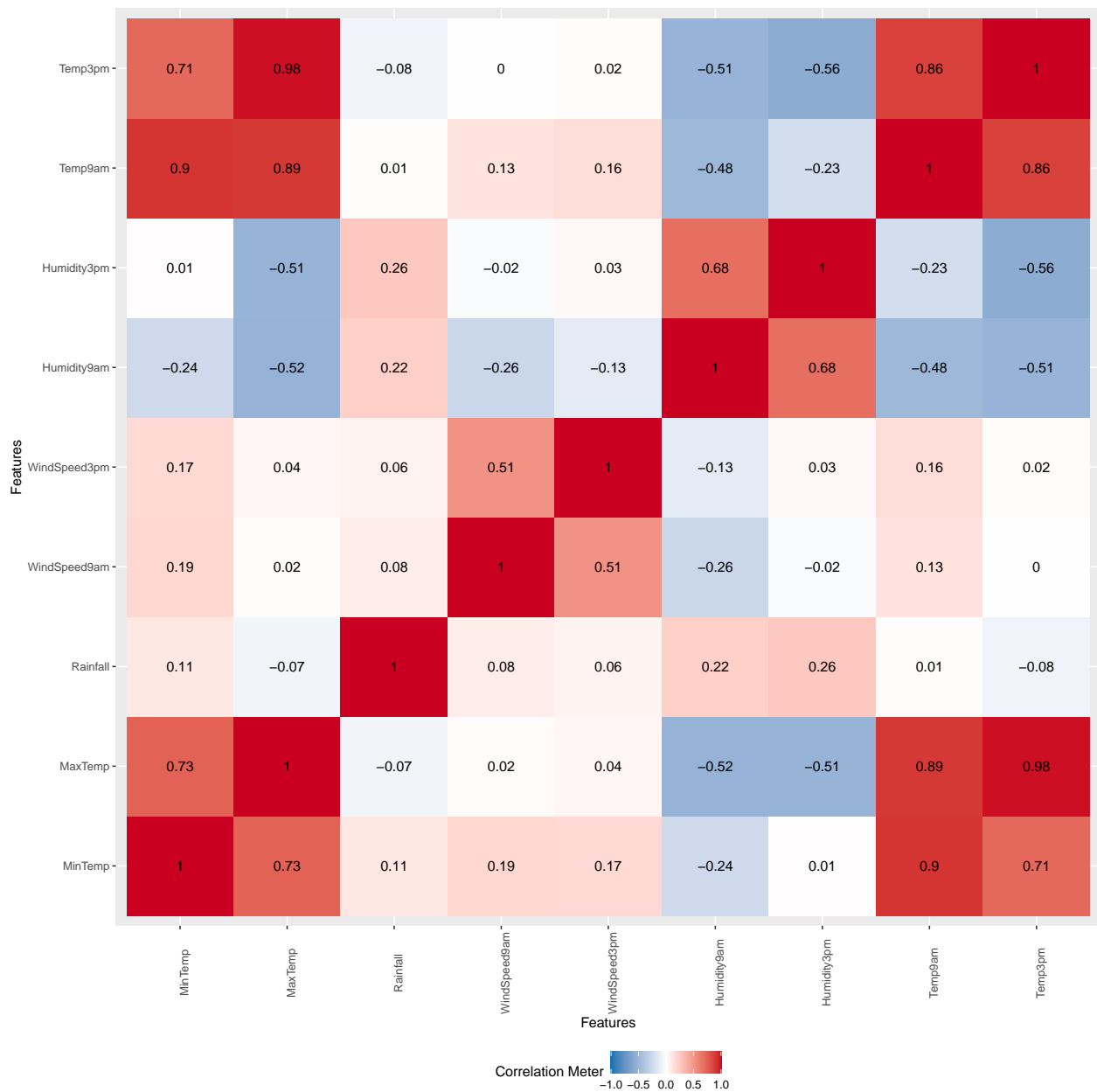
```
plot_bar(final_data)
```



```
plot_histogram(final_data)
```

```
plot_correlation(na.omit(final_data), type = "c")
```

Features	MinTemp	MaxTemp	Rainfall	WindSpeed9am	WindSpeed3pm	Humidity9am	Humidity3pm	Temp9am	Temp3pm
Temp3pm	0.71	0.98	−0.08	0	0.02	−0.51	−0.56	0.86	1
Temp9am	0.9	0.89	0.01	0.13	0.16	−0.48	−0.23	1	0.86
Humidity3pm	0.01	−0.51	0.26	−0.02	0.03	0.68	1	−0.23	−0.56
Humidity9am	−0.24	−0.52	0.22	−0.26	−0.13	1	0.68	−0.48	−0.51
WindSpeed3pm	0.17	0.04	0.06	0.51	1	−0.13	0.03	0.16	0.02
WindSpeed9am	0.19	0.02	0.08	1	0.51	−0.26	−0.02	0.13	0
Rainfall	0.11	−0.07	1	0.08	0.06	0.22	0.26	0.01	−0.08
MaxTemp	0.73	1	−0.07	0.02	0.04	−0.52	−0.51	0.89	0.98
MinTemp	1	0.73	0.11	0.19	0.17	−0.24	0.01	0.9	0.71

Correlation Meter −1.0 −0.5 0.0 0.5 1.0

```r
plot_scatterplot(final_data[, c("MinTemp", "MaxTemp", "Rainfall", "WindSpeed9am", "WindSpeed3pm", "Hu
                                "Humidity3pm", "Temp9am", "Temp3pm")],
                 by = "Rainfall",
                 sampled_rows = 3000L)
```

Warning: Removed 1122 rows containing missing values (`geom_point()`).
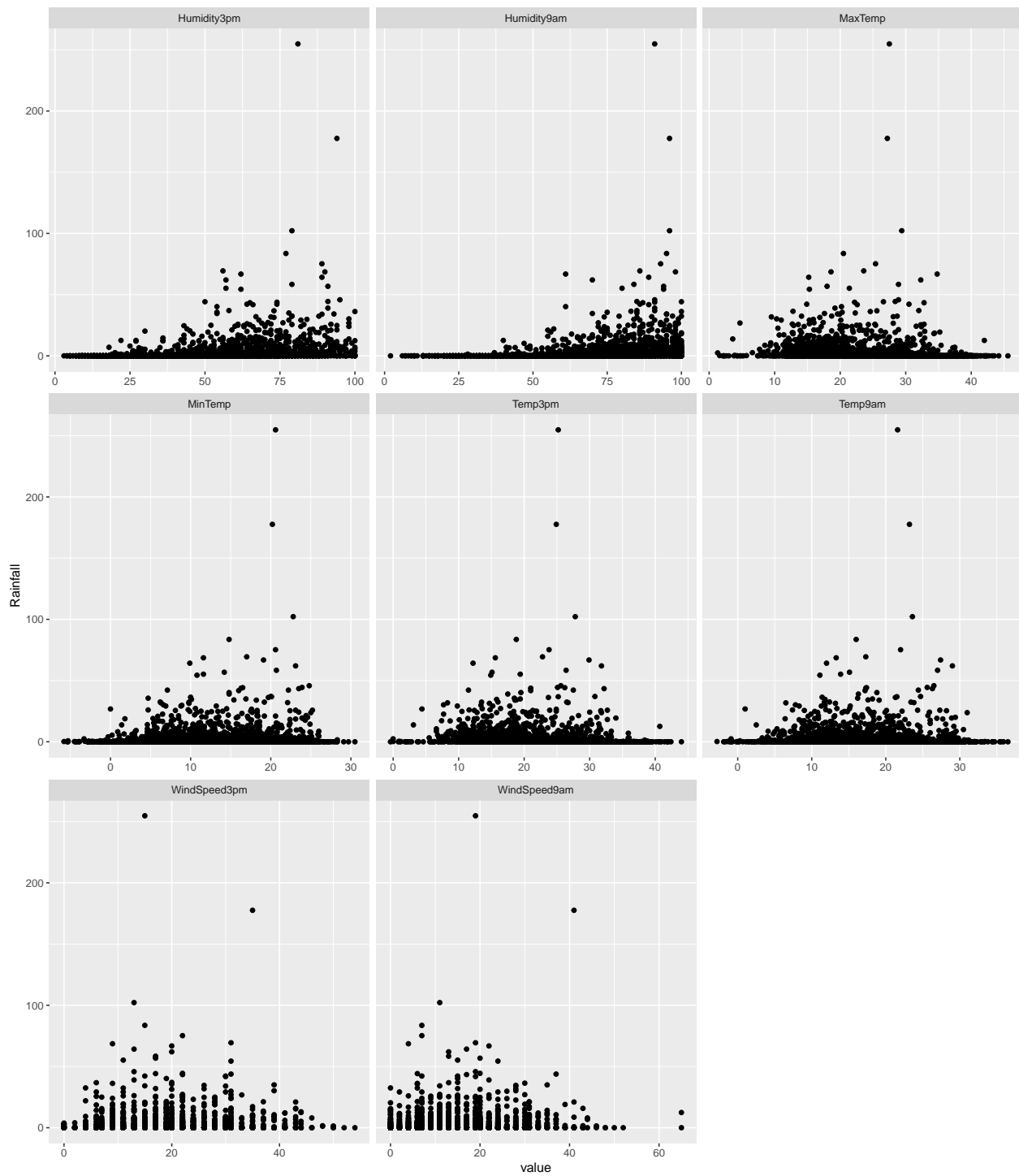
```r
final_data_clean <- na.omit(final_data)

summary(final_data_clean)
```

```
##    Location            MinTemp            MaxTemp           Rainfall
##  Length:215553      Min.   :-8.70000   Min.   :-3.70000   Min.   : 0.000000
##  Class :character   1st Qu.: 7.40000   1st Qu.:17.90000   1st Qu.: 0.000000
##  Mode  :character   Median :11.80000   Median :22.60000   Median : 0.000000
```

```
##                          Mean    :12.02255   Mean    :23.20927   Mean    :  2.296852
##                          3rd Qu.:16.70000   3rd Qu.:28.20000   3rd Qu.:  0.600000
##                          Max.    :33.90000   Max.    :48.90000   Max.    :474.000000
##     WindDir3pm         WindSpeed9am        WindSpeed3pm        Humidity9am
##   Length:215553      Min.    : 0.00000   Min.    : 2.00000   Min.    :  0.00000
##   Class :character   1st Qu.: 7.00000   1st Qu.:13.00000   1st Qu.: 57.00000
##   Mode  :character   Median :13.00000   Median :19.00000   Median : 70.00000
##                      Mean    :14.09672   Mean    :18.69989   Mean    : 68.78909
##                      3rd Qu.:19.00000   3rd Qu.:24.00000   3rd Qu.: 83.00000
##                      Max.    :87.00000   Max.    :87.00000   Max.    :100.00000
##     Humidity3pm         Temp9am             Temp3pm
##   Min.    :  0.00000   Min.    :-6.20000   Min.    :-5.10000
##   1st Qu.: 36.00000   1st Qu.:12.10000   1st Qu.:16.60000
##   Median : 52.00000   Median :16.60000   Median :21.10000
##   Mean    : 51.23395   Mean    :16.86624   Mean    :21.69488
##   3rd Qu.: 66.00000   3rd Qu.:21.40000   3rd Qu.:26.40000
##   Max.    :100.00000   Max.    :40.20000   Max.    :48.20000
```

```r
# View(final_data_clean)
```

```r
x <- final_data_clean$Rainfall
x <- x[!is.na(x)]
n <- length(x)

n
```
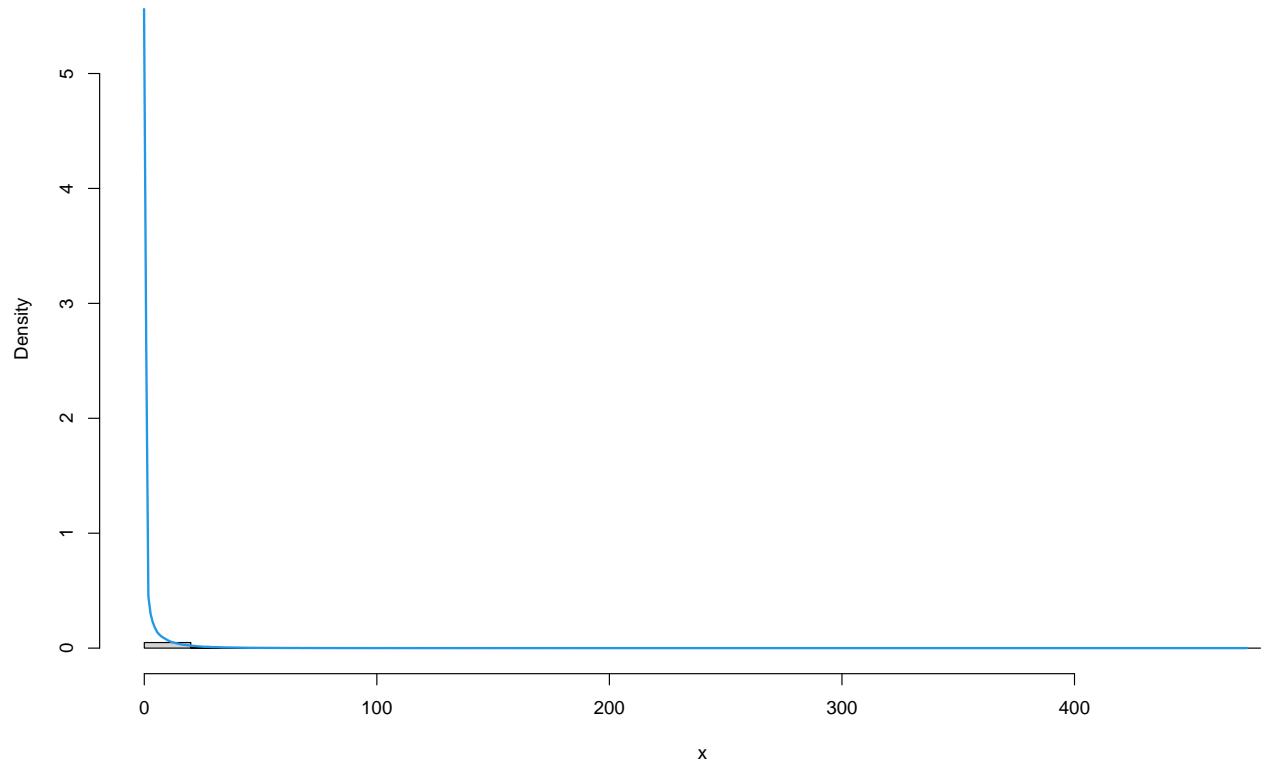
```
## [1] 215553
```
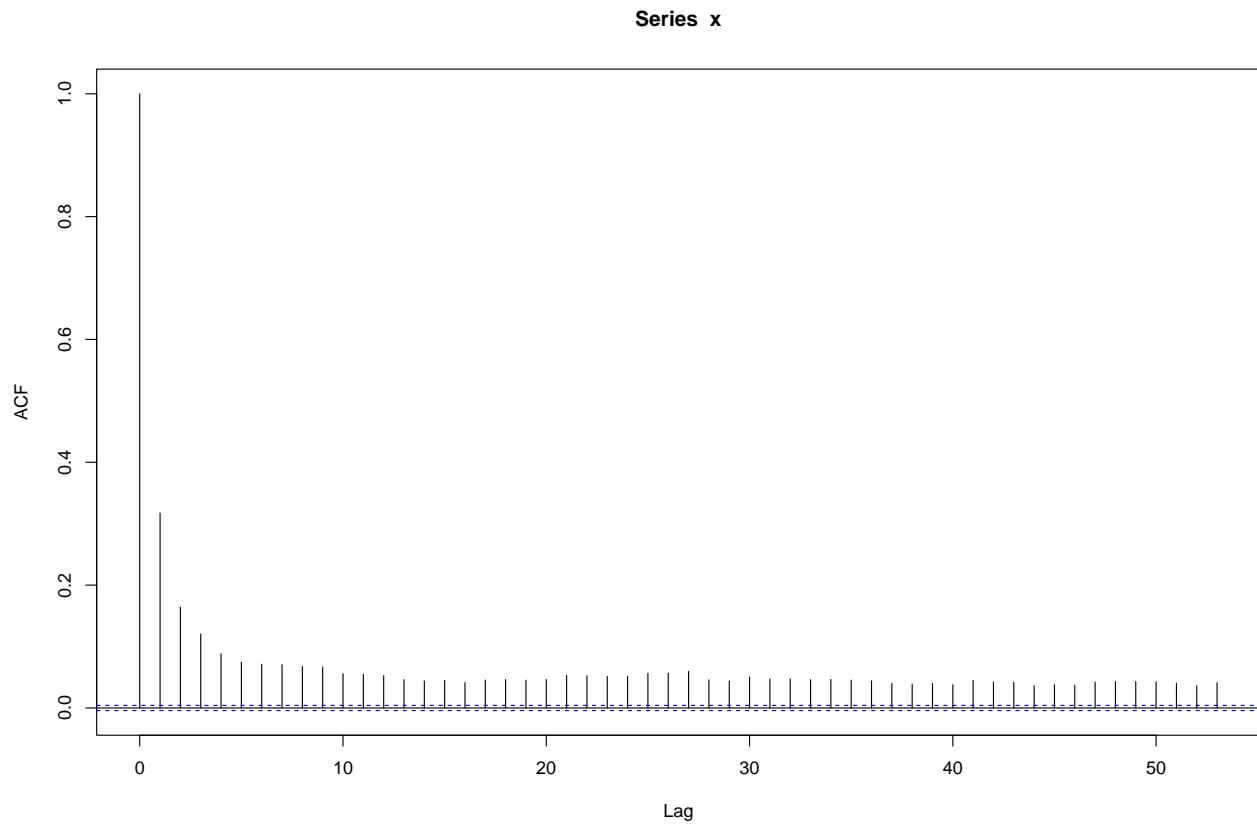
```r
# Histogram of all data
```

```r
dens_x <- density(x)
hist(x, prob = TRUE, ylim = range(dens_x$y))
lines(dens_x, lwd = 2, col = 4)
```

Histogram of x


```
# Autocorrelation function of all data
```

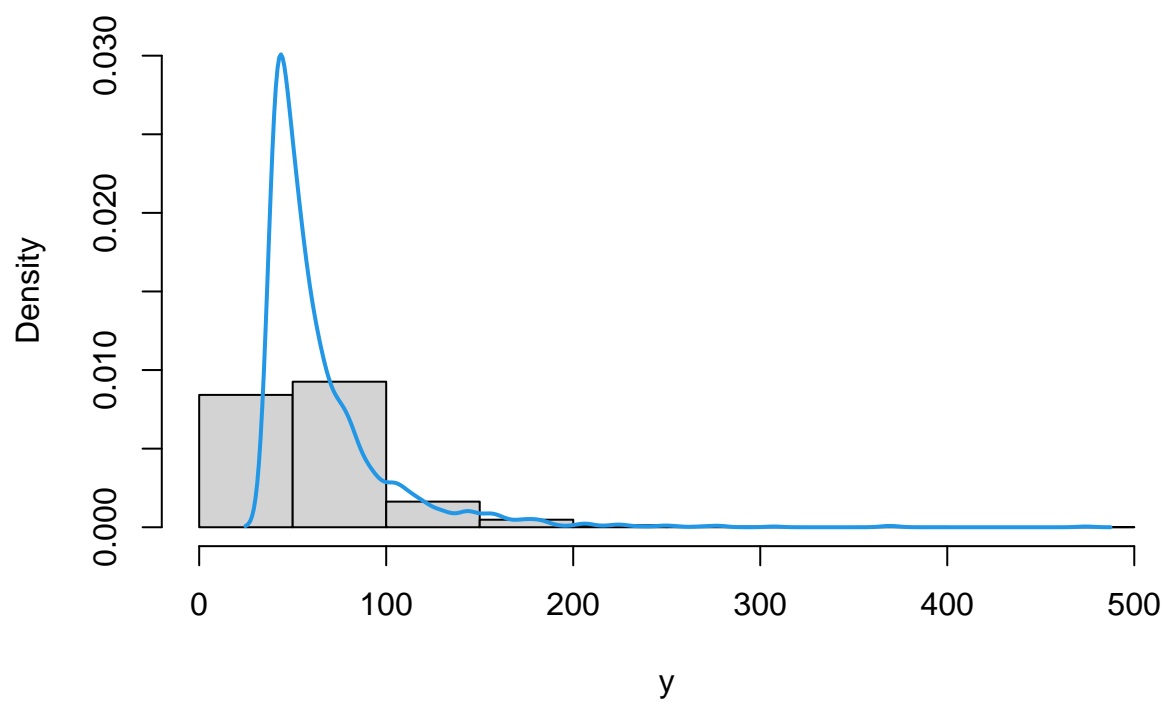```
acf(x)
```

**Series x**



```r
# Histogram of the largest data
```

```r
nlargest <- 2000
y <- extract_nlargest_sample(x, n = nlargest)
dens_y <- density(y)
hist(y, prob = TRUE, ylim = range(dens_y$y))
lines(density(y), lwd = 2, col = 4)
```
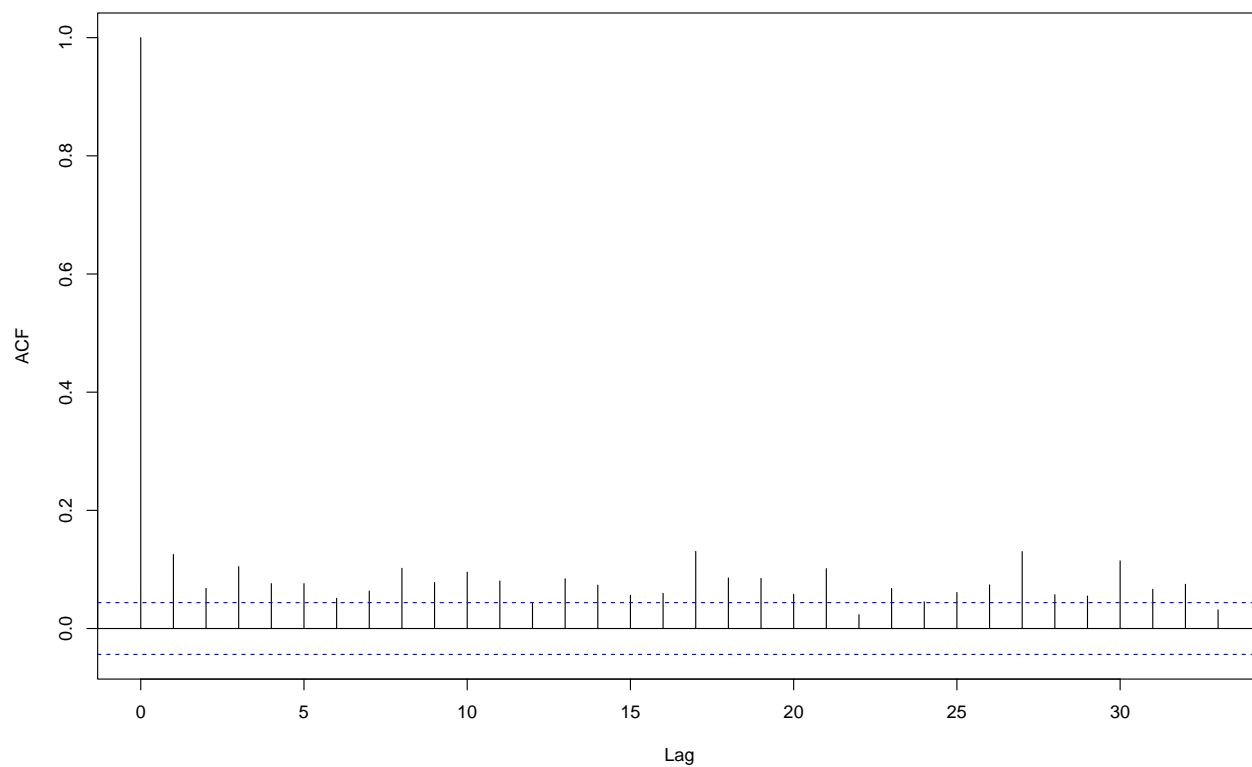
Histogram of y


```
# Autocorrelation function of the largest data
```

```
acf(y)
```

Series y

```r
# Estimation of gev mixture models

gev_mixture_model <- suppressWarnings(estimate_gev_mixture_model_parameters(x = x,
                                                block_sizes = 10:40,
                                                minimum_nblocks = 50,
                                                threshold = NULL,
                                                nlargest = nlargest,
                                                confidence_level = 0.95,
                                                use_extremal_index = TRUE,
                                                use_lower_threshold = FALSE
                                                maximum_iterations = 1500,
                                                log_mv = TRUE,
                                                log_pw = TRUE,
                                                trace = FALSE,
                                                method = "MLE"))
```

```
##   Successful convergence.
##   Successful convergence.
```

```r
gev_mixture_model$extremal_indexes
```

```
##            10           11           12           13           14           15
## 0.7655912339 0.7655912339 0.7672438642 0.7787652117 0.7030676139 0.7076676640
##            16           17           18           19           20           21
## 0.6884932418 0.7209353967 0.7076676640 0.7076676640 0.7311913344 0.7076676640
##            22           23           24           25           26           27
## 0.7182467915 0.7182467915 0.7043010586 0.7182467915 0.7311913344 0.7076676640
##            28           29           30           31           32           33
## 0.7030676139 0.6802117785 0.6802117785 0.7213707006 0.6842277034 0.6842277034
##            34           35           36           37           38           39
## 0.6842277034 0.7076676640 0.6802117785 0.7076676640 0.6842277034 0.7043010586
##            40
## 0.7182467915
```

```r
gev_mixture_model$normalized_gev_parameters_object
```

```
##         loc_star   scale_star    shape_star
## 10 37.797981972 19.47977524 0.2275104110
## 11 33.603888363 21.72508213 0.1976419188
## 12 32.633458778 22.46123009 0.1863640437
## 13 29.934754158 22.43684272 0.1883819411
## 14 34.826896819 20.18514534 0.2166037020
## 15 33.532196102 20.91663779 0.2049076826
## 16 27.924504835 23.68825918 0.1765002541
## 17 26.030672549 23.82801141 0.1664179724
## 18 27.876769235 23.03114130 0.1772251020
## 19 20.800697561 25.49437029 0.1627105751
## 20 32.356836774 20.37901750 0.2136887659
## 21 23.072959494 23.36476885 0.1800647387
## 22 33.159943115 19.94280692 0.2130867466
## 23 34.688172688 18.31912171 0.2437894521
## 24 20.121570612 23.10009474 0.1881131931
## 25 29.284641863 19.48071402 0.2263842496
## 26 31.362741707 18.36473886 0.2366107662
## 27 15.742200546 23.86434302 0.1749203262
## 28 16.402282544 22.72637099 0.1959221759
```

13

```
## 29 33.705751177 16.97782446 0.2610976979
## 30 28.571179721 19.29249307 0.2322812028
## 31 18.680085888 23.66037675 0.1868496031
## 32 37.502068406 14.62847536 0.2963519092
## 33 36.009159479 15.84649064 0.2757753204
## 34 38.579242559 14.69547899 0.2874461524
## 35 -3.398984840 29.19353381 0.1444171729
## 36 20.243646858 21.30528354 0.2119759427
## 37 -7.919674709 28.22577413 0.1564092275
## 38 33.169648607 16.30050120 0.2677258108
## 39 -4.285517601 28.17136840 0.1548151584
## 40  4.462116025 25.16311000 0.1797776607
```

gev_mixture_model**$**full_normalized_gev_parameters_object

```
##           loc_star  scale_star   shape_star
## 10  32.749743014 18.33124832 0.2275104110
## 11  27.951481518 20.60792959 0.1976419188
## 12  26.826878994 21.37909240 0.1863640437
## 13  24.454600724 21.40448077 0.1883819411
## 14  27.980183826 18.70212196 0.2166037020
## 15  26.549905820 19.48591287 0.2049076826
## 16  19.367813597 22.17800100 0.1765002541
## 17  18.442484635 22.56520056 0.1664179724
## 18  20.152148708 21.66214464 0.1772251020
## 19  12.228638851 24.09960568 0.1627105751
## 20  26.185316075 19.06023286 0.2136887659
## 21  15.240247413 21.95437359 0.1800647387
## 22  26.787365481 18.58489508 0.2130867466
## 23  28.863722932 16.89918230 0.2437894521
## 24  12.285067500 21.62594512 0.1881131931
## 25  23.073238945 18.07455023 0.2263842496
## 26  25.820905687 17.05348080 0.2366107662
## 27   7.734967364 22.46371518 0.1749203262
## 28   8.665803725 21.21062323 0.1959221759
## 29  27.481692365 15.35273703 0.2610976979
## 30  21.459812459 17.64065613 0.2322812028
## 31  11.183620556 22.25966518 0.1868496031
## 32  32.251821213 13.07255458 0.2963519092
## 33  30.299915257 14.27202199 0.2757753204
## 34  33.296192566 13.17688660 0.2874461524
## 35 -13.245644490 27.77150706 0.1444171729
## 36  12.360004056 19.63414092 0.2119759427
## 37 -17.420372365 26.73977735 0.1564092275
## 38  27.288009675 14.72583465 0.2677258108
## 39 -13.897783504 26.68324394 0.1548151584
## 40  -3.622528510 23.70967152 0.1797776607
```

gev_mixture_model**$**automatic_weights_pw_shape

```
##              10            11            12            13            14
## 0.000000000e+00 0.000000000e+00 0.000000000e+00 0.000000000e+00 0.000000000e+00
##              15            16            17            18            19
## 0.000000000e+00 4.054248254e-02 1.058835986e-01 3.584492447e-02 1.299104324e-01
##              20            21            22            23            24
```

```
## 0.000000000e+00 1.744181214e-02 0.000000000e+00 0.000000000e+00 0.000000000e+00
##              25              26              27              28              29
## 0.000000000e+00 0.000000000e+00 5.078166203e-02 0.000000000e+00 0.000000000e+00
##              30              31              32              33              34
## 0.000000000e+00 0.000000000e+00 0.000000000e+00 0.000000000e+00 0.000000000e+00
##              35              36              37              38              39
## 2.484658237e-01 0.000000000e+00 1.707480469e-01 3.388131789e-21 1.810788793e-01
##              40
## 1.930233794e-02
```

`gev_mixture_model$automatic_weights_pw_scale`

```
##              10              11              12              13
##   0.000000000e+00  0.000000000e+00  0.000000000e+00  0.000000000e+00
##              14              15              16              17
##   0.000000000e+00  0.000000000e+00  0.000000000e+00  0.000000000e+00
##              18              19              20              21
##   0.000000000e+00  0.000000000e+00  0.000000000e+00  0.000000000e+00
##              22              23              24              25
##   6.938893904e-18  0.000000000e+00  0.000000000e+00  0.000000000e+00
##              26              27              28              29
##   0.000000000e+00  0.000000000e+00  0.000000000e+00 -6.938893904e-18
##              30              31              32              33
##   6.938893904e-18  0.000000000e+00  0.000000000e+00  6.938893904e-18
##              34              35              36              37
##   0.000000000e+00  1.000000000e+00  0.000000000e+00  8.326672685e-16
##              38              39              40
##   0.000000000e+00  0.000000000e+00  0.000000000e+00
```

`gev_mixture_model$automatic_weights_pw_loc`

```
##              10              11              12              13
## -4.857225733e-16  0.000000000e+00  0.000000000e+00  0.000000000e+00
##              14              15              16              17
##   0.000000000e+00  0.000000000e+00  0.000000000e+00  0.000000000e+00
##              18              19              20              21
##   0.000000000e+00  0.000000000e+00  0.000000000e+00 -6.938893904e-18
##              22              23              24              25
##   0.000000000e+00  0.000000000e+00  0.000000000e+00  0.000000000e+00
##              26              27              28              29
##   0.000000000e+00  6.938893904e-18  1.734723476e-17  0.000000000e+00
##              30              31              32              33
##   0.000000000e+00  6.938893904e-18  0.000000000e+00  0.000000000e+00
##              34              35              36              37
##   1.000000000e+00  0.000000000e+00  6.938893904e-18  5.551115123e-17
##              38              39              40
##   0.000000000e+00  0.000000000e+00 -5.204170428e-18
```

`gev_mixture_model$weighted_normalized_gev_parameters_object[3, ]`

```
##                     loc_star   scale_star    shape_star
## automatic_weights 38.57924256 29.19353381 0.1583837005
```

`gev_mixture_model$automatic_weights_mw`

```
##              10              11              12              13
##   1.000000000e+00  0.000000000e+00 -1.387778781e-17  0.000000000e+00
```

```
##                14               15               16               17
##  0.000000000e+00  0.000000000e+00  0.000000000e+00  0.000000000e+00
##                18               19               20               21
##  0.000000000e+00  0.000000000e+00  0.000000000e+00  0.000000000e+00
##                22               23               24               25
##  0.000000000e+00  0.000000000e+00  0.000000000e+00  0.000000000e+00
##                26               27               28               29
##  0.000000000e+00  6.938893904e-18  0.000000000e+00  0.000000000e+00
##                30               31               32               33
##  0.000000000e+00  0.000000000e+00  0.000000000e+00  0.000000000e+00
##                34               35               36               37
##  0.000000000e+00  0.000000000e+00  1.387778781e-17  1.387778781e-17
##                38               39               40
##  0.000000000e+00  6.938893904e-18  1.387778781e-17
```
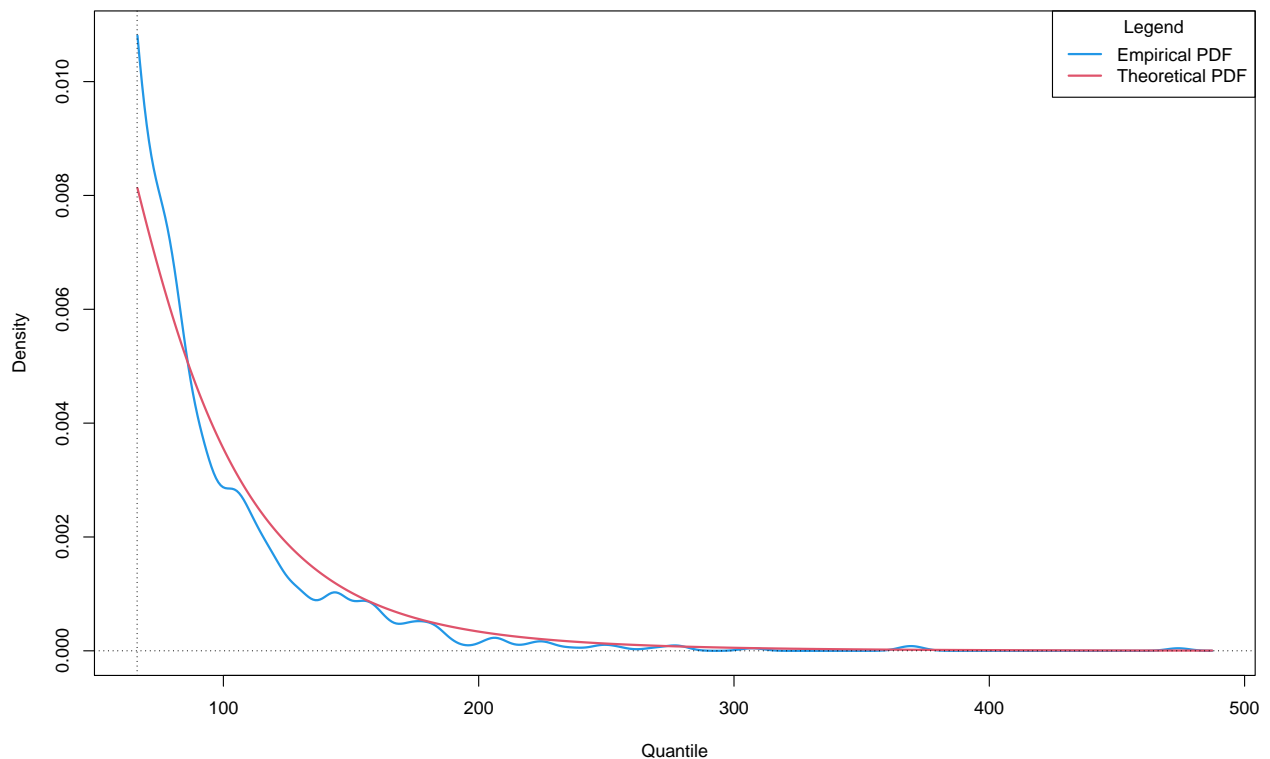
```
# Model diagnostics
```

```
## GEV mixture model with respect to parameters
```

```
plot_gev_mixture_model_pdf(gev_mixture_model,
                           type = "automatic_weights",
                           model_wise = FALSE,
                           zoom = TRUE,
                           xlab = "Quantile",
                           ylab = "Density",
                           main = "Probability Density Function (PDF) Plot")
```

Probability Density Function (PDF) Plot : automatic_weights – model_wise = FALSE : zoom = TRUE
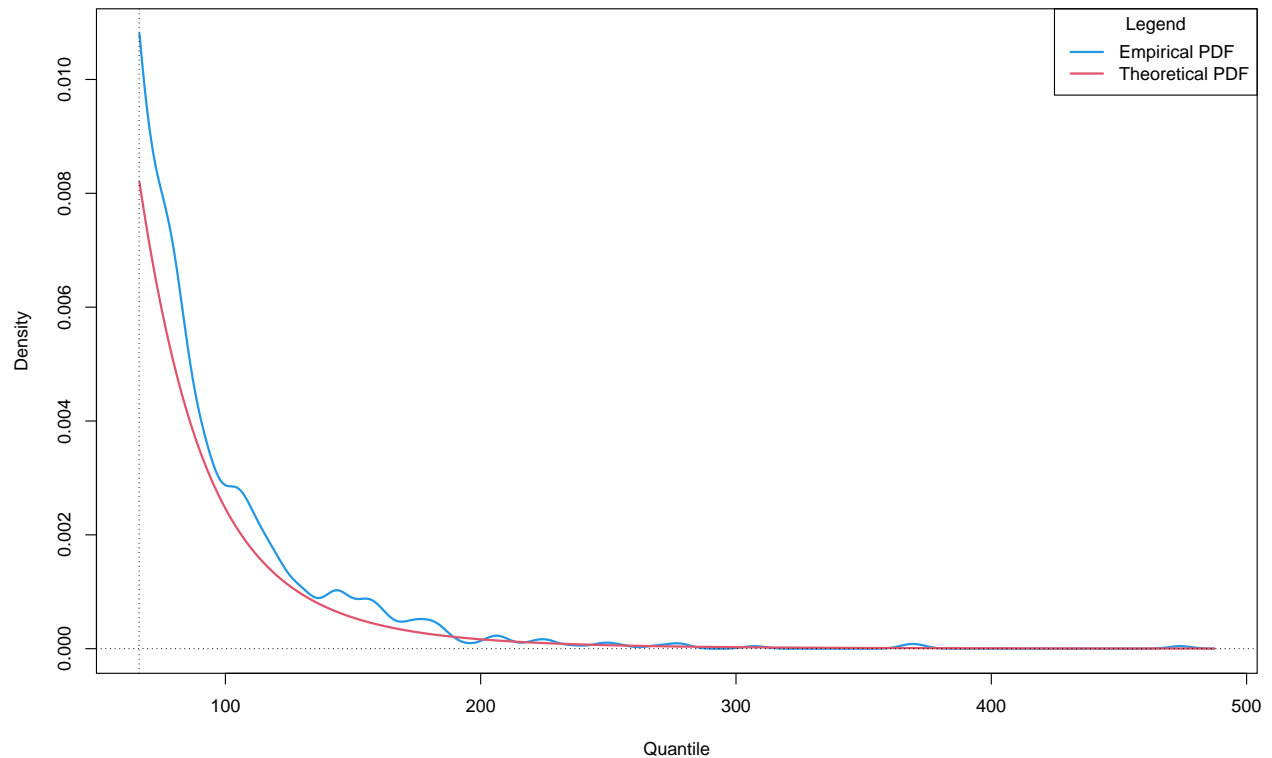


```
## GEV mixture model with respect to distribution functions
```

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```
plot_gev_mixture_model_pdf(gev_mixture_model,
                           type = "automatic_weights",
                           model_wise = TRUE,
                           zoom = TRUE,
                           xlab = "Quantile",
                           ylab = "Density",
                           main = "Probability Density Function (PDF) Plot")
```

Probability Density Function (PDF) Plot : automatic_weights – model_wise = TRUE : zoom = TRUE


```
# Estimation of an extreme quantile
```

```
estimator_types <- c("automatic_weights_mw",
                     "pessimistic_weights_mw",
                     "identic_weights_mw",
                     "automatic_weights_pw",
                     "pessimistic_weights_pw",
                     "identic_weights_pw",
                     "model_wise",
                     "parameter_wise",
                     "empirical")
```

```
alpha <- 10^(-6)
```

```
## Quantile from GEV mixture model with respect to parameters
```

```
rl_pw <- estimate_gev_mixture_model_quantile(gev_mixture_model,
                                             alpha = alpha,
                                             confidence_level = 0.95,
                                             do.ci = TRUE,
                                             estimator_type = estimator_types[4])
```

```
rl_pw
```

```
## [1] 1249.82882
## Quantile from GEV mixture model with respect to distribution functions
```

```
rl_mw <- estimate_gev_mixture_model_quantile(gev_mixture_model,
                                             alpha = alpha,
                                             confidence_level = 0.95,
                                             do.ci = TRUE,
                                             estimator_type = estimator_types[1])
```

```
rl_mw
```

```
## [1] 1428.167306
## Quantiles from equivalent estimated distributions in GEV mixture model with respect to parameters
```

```
est_rl_pw <- suppressWarnings(estimate_gev_mixture_model_quantile(gev_mixture_model,
                                                                 alpha = alpha,
                                                                 confidence_level = 0.95,
                                                                 do.ci = TRUE,
                                                                 estimator_type = estimator_types[8]))
```

```
est_rl_pw
```

```
##              lower    quantile        upper
## 10   -155.6726378 1429.283247 3014.239133
## 11   -110.3212209 1228.203560 2566.728340
## 12   -118.3549837 1152.250699 2422.856382
## 13   -128.9187408 1172.965119 2474.848978
## 14   -397.1680557 1318.648428 3034.464912
## 15   -292.8909869 1236.386676 2765.664339
## 16   -246.2418851 1093.030303 2432.302491
## 17   -145.5645457 1020.812966 2187.190478
## 18   -235.5142697 1076.593695 2388.701661
## 19   -289.9110146 1048.576807 2387.064628
## 20   -629.5209075 1304.324378 3238.169664
## 21   -402.8660147 1111.031580 2624.929174
## 22   -687.0131546 1269.332135 3225.677425
## 23  -1144.3209939 1523.125365 4190.571725
## 24   -591.5853722 1168.451956 2928.489284
## 25  -1021.4122989 1384.462969 3790.338236
## 26  -1036.2720962 1436.643054 3909.558204
## 27   -482.6647309 1081.181415 2645.027560
## 28   -801.8752444 1225.362742 3252.600727
## 29  -1828.0642259 1621.254794 5070.573815
## 30  -1468.3372539 1420.776964 4309.891182
## 31  -1093.5779050 1214.454694 3522.487294
## 32  -2897.7051267 1934.456317 6766.617761
## 33  -2516.5358103 1736.074136 5988.684082
## 34  -2474.4889439 1793.844616 6062.178176
## 35   -636.6356341 1015.377182 2667.389998
## 36  -1516.0977035 1339.122697 4194.343098
## 37   -827.2326486 1069.269853 2965.772354
```

```
## 38 -2375.1769881 1655.443214 5686.063416
## 39  -800.8994359 1062.380449 2925.660334
## 40 -1134.1665055 1176.154783 3486.476072
```

Comparison of estimated quantiles

```r
est_rl_pw_range <- range(as.matrix(est_rl_pw))
```

Quantiles from equivalent estimated GEV distributions in GEV mixture model respect to distribution f

```r
est_rl_mw <- suppressWarnings(estimate_gev_mixture_model_quantile(gev_mixture_model,
                                                  alpha = alpha,
                                                  confidence_level = 0.95,
                                                  do.ci = TRUE,
                                                  estimator_type = estimator_types[7]))

est_rl_mw
```

```
##              lower    quantile      upper
## 10  -155.6726378 1429.283247 3014.239133
## 27  -482.6647309 1081.181415 2645.027560
## 36 -1516.0977035 1339.122697 4194.343098
## 37  -827.2326486 1069.269853 2965.772354
## 39  -800.8994359 1062.380449 2925.660334
## 40 -1134.1665055 1176.154783 3486.476072
```

```r
est_rl_mw_range <- range(as.matrix(est_rl_mw))

est_rl_mw_range
```

```
## [1] -1516.097703  4194.343098
```

```r
matplot(x = rownames(est_rl_pw),
        y = est_rl_pw,
        xlab = "block size",
        ylab = "quantile",
        main = "Estimates of a quantile",
        ylim = range(c(est_rl_pw_range, rl_pw)),
        cex = 1,
        cex.lab = 1,
        cex.axis = 1,
        type = "l",
        lty = c("dotted", "solid", "dotted"),
        lwd = c(2,2,2),
        col = c(3, 1, 3))

abline(h = rl_mw, col = 7, lwd = 2)
abline(h = rl_pw, col = 6, lwd = 2)
abline(h = est_rl_pw_range, col = 6, lty = "dotted", lwd = 2)
abline(h = est_rl_mw_range, col = 7, lty = "dotted", lwd = 2)
```

Estimates of a quantile
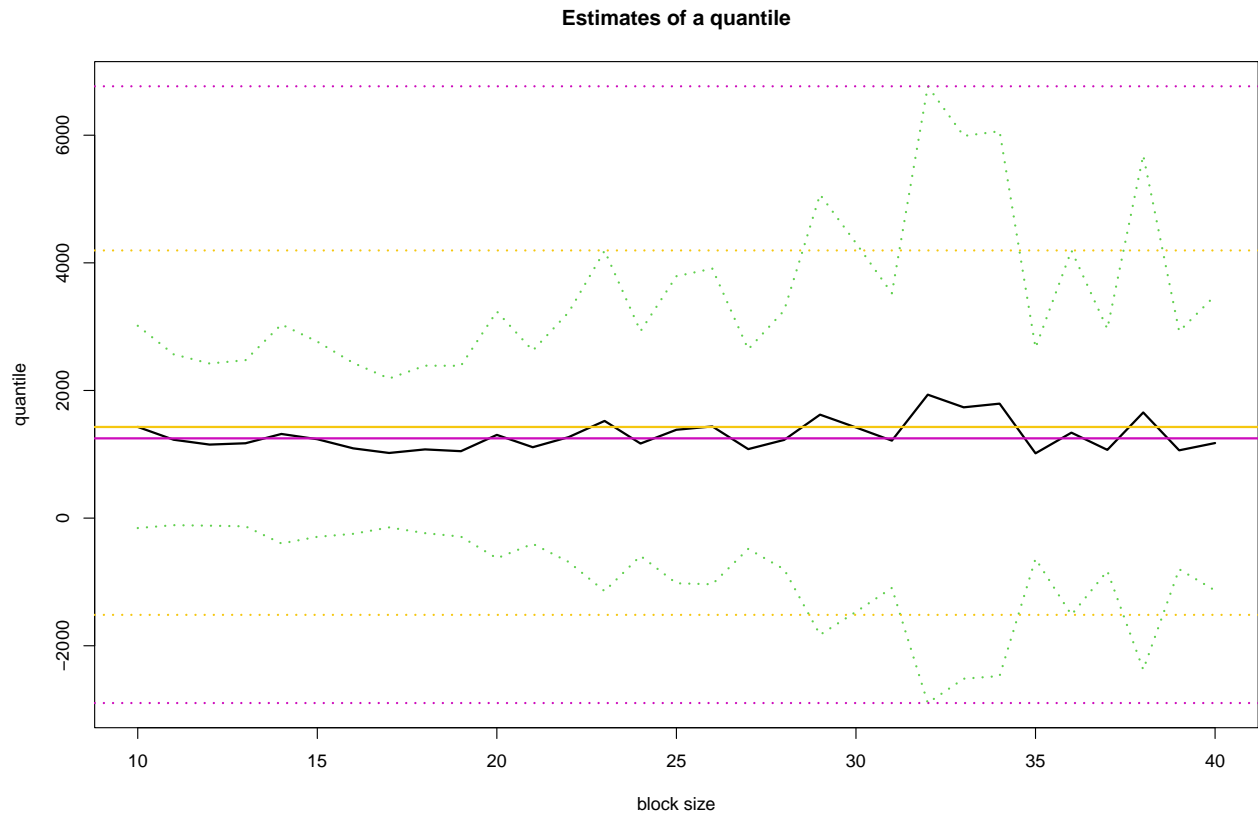

```
# Legend:
# yellow: Quantile from GEV mixture model with respect to distribution functions
# pink: Quantile from GEV mixture model with respect to parameters
```