Modeling extreme values with a GEV mixture probability distributions

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```
# library(xfun)
```

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

```
xfun::in_dir(dir = path, expr = source("./src/estimate_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/generate_gev_sample.R"))
xfun::in_dir(dir = path, expr = source("./src/plot_normalized_gev_mixture_model_pdf.R"))
xfun::in_dir(dir = path, expr = source("./src/calculate_gev_inverse_cdf.R"))
xfun::in_dir(dir = path, expr = source("./src/calculate_gev_mixture_model_inverse_cdf.R"))
xfun::in_dir(dir = path, expr = source("./src/calculate_gev_mixture_model_cdf.R"))
```

```
n <- 10000

nlargest <- 1000

#x <- generate_gev_sample(n = n, loc = 1, scale = 0.5, shape = 0.1)
x <- rnorm(n = n)

gev_mixture_model <- estimate_gev_mixture_model_parameters(x,
                                                           nsloc = NULL,
                                                           std.err = FALSE,
                                                           block_sizes = NULL,
                                                           minimum_nblocks = 50,
                                                           nlargest = nlargest,
                                                           confidence_level = 0.95,
                                                           log_mv = TRUE,
                                                           log_pw = TRUE,
                                                           trace = TRUE)
```

```
## iter:  0  f-value:  0.0505359515007515  pgrad:  0.101149234734501
## iter:  10  f-value:  0.00534040409581967  pgrad:  0.00442642253408549
## iter:  20  f-value:  0.00533081955369182  pgrad:  0.0042940534383582
## iter:  30  f-value:  0.00532217450006063  pgrad:  0.00417114700081273
## iter:  40  f-value:  0.00531433581631507  pgrad:  0.00405701375887361
## iter:  50  f-value:  0.00530718886984858  pgrad:  0.00395101391365511
## iter:  60  f-value:  0.00530063490329457  pgrad:  0.00385255368931487
## iter:  70  f-value:  0.00529458878498478  pgrad:  0.00376108195033377
## iter:  80  f-value:  0.00528897703027827  pgrad:  0.00367763577870467
## iter:  90  f-value:  0.00528373566435172  pgrad:  0.00360142026936735
## iter:  100  f-value:  0.00527880930687614  pgrad:  0.0035306087309672
## iter:  110  f-value:  0.00527415005729837  pgrad:  0.00346479910734851
```

```
## iter:  120  f-value:  0.00526971631905492  pgrad:  0.00340361794098809
## iter:  130  f-value:  0.00526547182595749  pgrad:  0.00334671815445589
## iter:  140  f-value:  0.00526138478769187  pgrad:  0.00329377696734975
## iter:  150  f-value:  0.00525742713256752  pgrad:  0.00324449393139234
## iter:  160  f-value:  0.00525357382698981  pgrad:  0.00319858906507922
## iter:  170  f-value:  0.00524980225153951  pgrad:  0.00315580106697372
## iter:  180  f-value:  0.00524609161278055  pgrad:  0.00311588558298209
## iter:  190  f-value:  0.00524242236754251  pgrad:  0.00309331813755376
## iter:  200  f-value:  0.00523877563166331  pgrad:  0.00308047072546721
## iter:  210  f-value:  0.00523513253666957  pgrad:  0.00307608521436201
## iter:  220  f-value:  0.00523147348316482  pgrad:  0.00307485798216412
## iter:  230  f-value:  0.00522777721424143  pgrad:  0.00307671318245595
## iter:  240  f-value:  0.00522428922470796  pgrad:  0.00307047950782929
## iter:  250  f-value:  0.00522108668459153  pgrad:  0.00305696045868179
## iter:  260  f-value:  0.00521808057491913  pgrad:  0.00303304418144708
## iter:  270  f-value:  0.00521511648969907  pgrad:  0.00301031657670734
## iter:  280  f-value:  0.00521217943559004  pgrad:  0.00298865970563625
## iter:  290  f-value:  0.00520926087462356  pgrad:  0.00296800895176896
## iter:  300  f-value:  0.00520635233962657  pgrad:  0.00295062916580014
## iter:  310  f-value:  0.00520344526718737  pgrad:  0.00286102425850299
## iter:  320  f-value:  0.00520053080629305  pgrad:  0.00240885623594329
## iter:  330  f-value:  0.00519759959096451  pgrad:  0.00208524384937031
## iter:  340  f-value:  0.00519464146030109  pgrad:  0.00203213726939705
## iter:  350  f-value:  0.00519164663188265  pgrad:  0.0019778161616791
## iter:  360  f-value:  0.00518862873277846  pgrad:  0.00192513397882133
## iter:  370  f-value:  0.00518555004115919  pgrad:  0.00186922802358641
## iter:  380  f-value:  0.00518362679430436  pgrad:  0.00182378678310981
## iter:  390  f-value:  0.00518162670297451  pgrad:  0.00177771148164684
## iter:  400  f-value:  0.00517944152198602  pgrad:  0.00172658146758368
## iter:  410  f-value:  0.00517703704185677  pgrad:  0.00167235311392574
## iter:  420  f-value:  0.00517621309897831  pgrad:  0.00167465150998036
## iter:  430  f-value:  0.00517541175315977  pgrad:  0.0016768544798023
## iter:  440  f-value:  0.00517462631178082  pgrad:  0.00167898005569122
## iter:  450  f-value:  0.00517385563818498  pgrad:  0.00167555002306991
## iter:  460  f-value:  0.0051730986630999  pgrad:  0.00166806760131095
## iter:  470  f-value:  0.00517235437990793  pgrad:  0.00166046210271673
## iter:  480  f-value:  0.00517162184018819  pgrad:  0.00165273577047984
## iter:  490  f-value:  0.00517090014950969  pgrad:  0.00164489067105574
## iter:  500  f-value:  0.00517018846345587  pgrad:  0.00163692869247185
## iter:  510  f-value:  0.005169485983861  pgrad:  0.00162885154202441
## iter:  520  f-value:  0.00516880365223475  pgrad:  0.0016243166737701
## iter:  530  f-value:  0.00516814939936479  pgrad:  0.00162562098975332
## iter:  540  f-value:  0.00516750280433067  pgrad:  0.00162687780583005
## iter:  550  f-value:  0.00516686321792289  pgrad:  0.0016280886611619
## iter:  560  f-value:  0.00516623002352884  pgrad:  0.00162925504404945
## iter:  570  f-value:  0.00516560263434814  pgrad:  0.00163037839351662
## iter:  580  f-value:  0.00516498049072146  pgrad:  0.00163146010083665
## iter:  590  f-value:  0.00516436305755831  pgrad:  0.00163250151099895
## iter:  600  f-value:  0.0051637498218486  pgrad:  0.00163350392411953
## iter:  610  f-value:  0.00516314029024282  pgrad:  0.00163446859679376
## iter:  620  f-value:  0.00516253398668484  pgrad:  0.00163539674339327
## iter:  630  f-value:  0.00516193045008136  pgrad:  0.00163628953730676
## iter:  640  f-value:  0.00516132923199044  pgrad:  0.00163714811212378
## iter:  650  f-value:  0.00516072989430995  pgrad:  0.00163797356276271
```

```
## iter:  660  f-value:  0.00516013200694671  pgrad:  0.00163876694654061
## iter:  670  f-value:  0.0051595351454426  pgrad:  0.00163952928418469
## iter:  680  f-value:  0.00515893888853392  pgrad:  0.00164026156078283
## iter:  690  f-value:  0.00515834281561477  pgrad:  0.001640964726672
## iter:  700  f-value:  0.00515774650407265  pgrad:  0.00164163969826026
## iter:  710  f-value:  0.00515714952645845  pgrad:  0.00164228735877897
## iter:  720  f-value:  0.00515655144744722  pgrad:  0.00164290855896014
## iter:  730  f-value:  0.00515595182053778  pgrad:  0.00164350411763238
## iter:  740  f-value:  0.00515535018442957  pgrad:  0.00164407482222718
## iter:  750  f-value:  0.00515474605900162  pgrad:  0.00164462142918537
## iter:  760  f-value:  0.00515413894080396  pgrad:  0.00164514466425121
## iter:  770  f-value:  0.00515352829795005  pgrad:  0.00164564522263704
## iter:  780  f-value:  0.00515291356427307  pgrad:  0.00164612376903846
## iter:  790  f-value:  0.00515229413257482  pgrad:  0.00164658093747355
## iter:  800  f-value:  0.00515166934675218  pgrad:  0.00164701733091223
## iter:  810  f-value:  0.00515103849252673  pgrad:  0.0016474335206526
## iter:  820  f-value:  0.00515040078642663  pgrad:  0.00164783004538752
## iter:  830  f-value:  0.00514975536256552  pgrad:  0.00164820740988766
## iter:  840  f-value:  0.00514910125662121  pgrad:  0.00164856608320307
## iter:  850  f-value:  0.00514843738622406  pgrad:  0.00164890649625202
## iter:  860  f-value:  0.00514776252669237  pgrad:  0.00164922903862026
## iter:  870  f-value:  0.0051470752806704  pgrad:  0.0016495340543267
## iter:  880  f-value:  0.00514637403967287  pgrad:  0.00164982183621688
## iter:  890  f-value:  0.00514565693473469  pgrad:  0.00165009261850479
## iter:  900  f-value:  0.00514492177216012  pgrad:  0.00165034656677152
## iter:  910  f-value:  0.00514416594853282  pgrad:  0.00165058376440422
## iter:  920  f-value:  0.00514338633627607  pgrad:  0.00165080419394683
## iter:  930  f-value:  0.00514257912644618  pgrad:  0.00165100771100252
## iter:  940  f-value:  0.00514173960779467  pgrad:  0.00165119400693947
## iter:  950  f-value:  0.0051408618480057  pgrad:  0.0016513625542406
## iter:  960  f-value:  0.00513993821949037  pgrad:  0.0016515125239784
## iter:  970  f-value:  0.00513895866790612  pgrad:  0.00165164265660993
## iter:  980  f-value:  0.0051379095335048  pgrad:  0.00165175105059234
## iter:  990  f-value:  0.00513677154733512  pgrad:  0.00165183479720753
## iter:  1000  f-value:  0.00513551618620669  pgrad:  0.00165188930468518
## iter:  1010  f-value:  0.00513409842988483  pgrad:  0.00165190692918924
## iter:  1020  f-value:  0.00513244051987199  pgrad:  0.0016518738368782
## iter:  1030  f-value:  0.00513038845809928  pgrad:  0.00165176137629348
## iter:  1040  f-value:  0.00512755545253067  pgrad:  0.00165149396206483
## iter:  1050  f-value:  0.00512223170974517  pgrad:  0.00165071275027621
## iter:  1060  f-value:  0.0050722135396527  pgrad:  0.00153688588587395
## iter:  1070  f-value:  0.00498040289307016  pgrad:  0.0015059289727858
## iter:  1080  f-value:  0.00497789600209743  pgrad:  0.00150528621503317
## iter:  1090  f-value:  0.00497509363154979  pgrad:  0.00150454660720484
## iter:  1100  f-value:  0.00497195710313166  pgrad:  0.00150369651995
## iter:  1110  f-value:  0.00496845158887787  pgrad:  0.00150272336182991
## iter:  1120  f-value:  0.00496455189970882  pgrad:  0.00150161758291774
## iter:  1130  f-value:  0.00496024899676726  pgrad:  0.00150037497740144
## iter:  1140  f-value:  0.00495598370390834  pgrad:  0.00139465415401362
## iter:  1150  f-value:  0.00495552932800196  pgrad:  0.0013912580547116
## iter:  1160  f-value:  0.00495507636862722  pgrad:  0.00138787594027139
## iter:  1170  f-value:  0.00495462481223693  pgrad:  0.0013845077598703
## iter:  1180  f-value:  0.0049541746437017  pgrad:  0.00138115345030143
## iter:  1190  f-value:  0.00495372584799774  pgrad:  0.00137781294860394
```

```
## iter:  1200  f-value:  0.0049532784102056  pgrad:  0.00137448619206026
## iter:  1210  f-value:  0.00495283231550877  pgrad:  0.00137117311819532
## iter:  1220  f-value:  0.00495238754919263  pgrad:  0.00136787366477498
## iter:  1230  f-value:  0.00495194409664336  pgrad:  0.00136458776980504
## iter:  1240  f-value:  0.00495150194334652  pgrad:  0.00136131537152931
## iter:  1250  f-value:  0.00495106107488594  pgrad:  0.00135805640842901
## iter:  1260  f-value:  0.0049506214769427  pgrad:  0.00135481081922036
## iter:  1270  f-value:  0.00495018313529368  pgrad:  0.00135157854285431
## iter:  1280  f-value:  0.00494974603581064  pgrad:  0.0013483595185142
## iter:  1290  f-value:  0.00494931016445891  pgrad:  0.00134515368561551
## iter:  1300  f-value:  0.00494887550729624  pgrad:  0.00134196098380278
## iter:  1310  f-value:  0.00494844205047176  pgrad:  0.00133878135295087
## iter:  1320  f-value:  0.00494800978022463  pgrad:  0.00133561473316048
## iter:  1330  f-value:  0.00494757868288308  pgrad:  0.00133246106475921
## iter:  1340  f-value:  0.0049471487448632  pgrad:  0.00132932028829952
## iter:  1350  f-value:  0.00494671995266777  pgrad:  0.00132619234455657
## iter:  1360  f-value:  0.00494629229288515  pgrad:  0.0013230771745279
## iter:  1370  f-value:  0.00494586575218818  pgrad:  0.00131997471943135
## iter:  1380  f-value:  0.00494544031733296  pgrad:  0.00131688492070441
## iter:  1390  f-value:  0.00494501597515788  pgrad:  0.00131380772000186
## iter:  1400  f-value:  0.00494459271258233  pgrad:  0.00131074305919576
## iter:  1410  f-value:  0.00494417051660568  pgrad:  0.00130769088037243
## iter:  1420  f-value:  0.0049437493743062  pgrad:  0.00130465112583276
## iter:  1430  f-value:  0.00494332927283978  pgrad:  0.00130162373808936
## iter:  1440  f-value:  0.00494291019943907  pgrad:  0.00129860865986636
## iter:  1450  f-value:  0.00494249214141219  pgrad:  0.0012956058340972
## iter:  1460  f-value:  0.00494207508614161  pgrad:  0.00129261520392389
## iter:  1470  f-value:  0.00494165902108316  pgrad:  0.00128963671269526
## iter:  1480  f-value:  0.00494124393376495  pgrad:  0.00128667030396559
## iter:  1490  f-value:  0.00494082981178612  pgrad:  0.00128371592149329
## iter:  1500  f-value:  0.00494041664281582  pgrad:  0.00128077350923962
## iter:  0  f-value:  0.0505359515007515  pgrad:  0.101149234734501
## iter:  10  f-value:  0.00525973399499331  pgrad:  0.00324156981941174
## iter:  20  f-value:  0.00516798669465785  pgrad:  0.00162925486184574
## iter:  30  f-value:  0.00510813922398548  pgrad:  0.00164881893147967
## iter:  40  f-value:  0.004901677558209  pgrad:  6.84516335150431e-05
## iter:  50  f-value:  0.00490157985428414  pgrad:  5.91414820838576e-05
## iter:  60  f-value:  0.00490145338590297  pgrad:  5.35158066647945e-05
## iter:  70  f-value:  0.00490117312841144  pgrad:  5.60357291984337e-05
## iter:  80  f-value:  0.00489760454900854  pgrad:  5.44193770870005e-05
## iter:  90  f-value:  0.00489342471753832  pgrad:  5.15162144931192e-05
## iter:  100  f-value:  0.00488871361980362  pgrad:  4.753721976547e-05
## iter:  110  f-value:  0.00488630193737675  pgrad:  4.62484077674574e-05
## iter:  120  f-value:  0.00488144275676627  pgrad:  4.31478381736072e-05
## iter:  130  f-value:  0.00487995139615439  pgrad:  4.1094801050745e-05
## iter:  140  f-value:  0.00487657929278081  pgrad:  3.7685567985335e-05
## iter:  150  f-value:  0.00487456849820206  pgrad:  3.58464683034576e-05
## iter:  160  f-value:  0.00487267659359383  pgrad:  3.39098627479828e-05
## iter:  170  f-value:  0.00486744301394989  pgrad:  9.1708205506108e-05
## iter:  180  f-value:  0.00486734101601277  pgrad:  7.80824088470189e-05
## iter:  190  f-value:  0.004867269703972  pgrad:  6.68176290352929e-05
## iter:  200  f-value:  0.00486721876982048  pgrad:  5.74579964318922e-05
## iter:  210  f-value:  0.00486718123118787  pgrad:  4.96252247711437e-05
## iter:  220  f-value:  0.00486715226818909  pgrad:  4.30035651335509e-05
```

```
## iter:  230  f-value:  0.00486712838325975  pgrad:  3.7327670680154e-05
## iter:  240  f-value:  0.00486710668068938  pgrad:  3.23733378662233e-05
## iter:  250  f-value:  0.00486708388596327  pgrad:  2.79524360445316e-05
## iter:  260  f-value:  0.00486705343255486  pgrad:  2.58078193072775e-05
## iter:  270  f-value:  0.00486697742557756  pgrad:  2.69749813881504e-05
## iter:  280  f-value:  0.00486549930588865  pgrad:  2.45532684768346e-05
## iter:  290  f-value:  0.00486512939700384  pgrad:  2.45956636939493e-05
## iter:  300  f-value:  0.00486431033757908  pgrad:  1.70783872322708e-05
## iter:  310  f-value:  0.00486429529475748  pgrad:  1.61641802093188e-05
## iter:  320  f-value:  0.00486428181931731  pgrad:  1.52989107393697e-05
## iter:  330  f-value:  0.00486426974794591  pgrad:  1.44799591923414e-05
## iter:  340  f-value:  0.00486425893434674  pgrad:  1.37048461675143e-05
## iter:  350  f-value:  0.00486424924746667  pgrad:  1.29712249862246e-05
## iter:  360  f-value:  0.00486424056990762  pgrad:  1.22768745879354e-05
## iter:  370  f-value:  0.00486423279650381  pgrad:  1.16196928049636e-05
## iter:  380  f-value:  0.00486422583304703  pgrad:  1.09976899995423e-05
## iter:  390  f-value:  0.00486421959514515  pgrad:  1.04089830392576e-05
##   Successful convergence.
## iter:  0  f-value:  0.0481149892097352  pgrad:  0.2784381237911
## iter:  10  f-value:  0.00787614143309062  pgrad:  0.116964776868585
## iter:  20  f-value:  0.0070863637107185  pgrad:  0.107476665932912
## iter:  30  f-value:  0.0064222307576543  pgrad:  0.0987501708052742
## iter:  40  f-value:  0.00586329868551856  pgrad:  0.0907231316778454
## iter:  50  f-value:  0.00539255486445498  pgrad:  0.0833386248986351
## iter:  60  f-value:  0.0049958172393309  pgrad:  0.0767182477716283
## iter:  70  f-value:  0.00466124464025136  pgrad:  0.0707136252815708
## iter:  80  f-value:  0.00437893641197953  pgrad:  0.0651977182073056
## iter:  90  f-value:  0.00414060361177533  pgrad:  0.0601295568241136
## iter:  100  f-value:  0.00393929861849279  pgrad:  0.0554717939905564
## iter:  110  f-value:  0.00376919194223926  pgrad:  0.0511903561253655
## iter:  120  f-value:  0.00362538749597952  pgrad:  0.0472541284462045
## iter:  130  f-value:  0.00350376965054212  pgrad:  0.0436346804869036
## iter:  140  f-value:  0.00340087603264305  pgrad:  0.0403060143688445
## iter:  150  f-value:  0.00331379173233254  pgrad:  0.037244343668169
## iter:  160  f-value:  0.00324006113825053  pgrad:  0.0344278922630286
## iter:  170  f-value:  0.00317761430361757  pgrad:  0.031836714521905
## iter:  180  f-value:  0.00312470543955522  pgrad:  0.0294525335775101
## iter:  190  f-value:  0.00307986140456589  pgrad:  0.0272585935850855
## iter:  200  f-value:  0.00304183854764696  pgrad:  0.0252395272155494
## iter:  210  f-value:  0.00300958652456895  pgrad:  0.0233812358688655
## iter:  220  f-value:  0.00298221791377506  pgrad:  0.0216707813206849
## iter:  230  f-value:  0.0029589826733235  pgrad:  0.0200962847997481
## iter:  240  f-value:  0.00293924667366696  pgrad:  0.0186468389593425
## iter:  250  f-value:  0.00292247362918912  pgrad:  0.0173124252314614
## iter:  260  f-value:  0.00290820987131641  pgrad:  0.016083838790618
## iter:  270  f-value:  0.00289607153479544  pgrad:  0.014952621718925
## iter:  280  f-value:  0.00288573373445481  pgrad:  0.013910995249727
## iter:  290  f-value:  0.00287692145325483  pgrad:  0.0129518260041986
## iter:  300  f-value:  0.00286940183708531  pgrad:  0.0120685299022834
## iter:  310  f-value:  0.00286297770118216  pgrad:  0.0112550689569061
## iter:  320  f-value:  0.00285748203538947  pgrad:  0.0105058861035647
## iter:  330  f-value:  0.00285277336430802  pgrad:  0.0098158693745525
## iter:  340  f-value:  0.00284873183214055  pgrad:  0.00918031609390377
## iter:  350  f-value:  0.00284525587888645  pgrad:  0.00859489964948866
```

```
## iter:  360  f-value:  0.00284225944172333  pgrad:  0.00805563865215936
## iter:  370  f-value:  0.00283966958012105  pgrad:  0.00755886987984648
## iter:  380  f-value:  0.00283742446772947  pgrad:  0.00710122066003838
## iter:  390  f-value:  0.0028354716937166  pgrad:  0.00667958770651615
## iter:  400  f-value:  0.00283376682453163  pgrad:  0.00629111421486007
## iter:  410  f-value:  0.00283227218307272  pgrad:  0.00593316948992922
## iter:  420  f-value:  0.00283095582113649  pgrad:  0.00560333261416292
## iter:  430  f-value:  0.00282979064002177  pgrad:  0.00529937353909461
## iter:  440  f-value:  0.0028287536543226  pgrad:  0.00501923909842124
## iter:  450  f-value:  0.00282782536115515  pgrad:  0.00476103845692587
## iter:  460  f-value:  0.00282698920991671  pgrad:  0.00452303026448875
## iter:  470  f-value:  0.0028262311489162  pgrad:  0.00430360973601174
## iter:  480  f-value:  0.00282553924442398  pgrad:  0.00410129927379209
## iter:  490  f-value:  0.00282490335449206  pgrad:  0.00391473706930501
## iter:  500  f-value:  0.00282431485264567  pgrad:  0.00374266808264173
## iter:  510  f-value:  0.00282376639440955  pgrad:  0.00358393570571747
## iter:  520  f-value:  0.00282325171549111  pgrad:  0.00343747333440662
## iter:  530  f-value:  0.00282276546262085  pgrad:  0.00330229751168674
## iter:  540  f-value:  0.00282230304760876  pgrad:  0.003177501117042
## iter:  550  f-value:  0.0028218605212703  pgrad:  0.00306224670693195
## iter:  560  f-value:  0.00282143446479461  pgrad:  0.00295576085814742
## iter:  570  f-value:  0.00282102189680421  pgrad:  0.00285732970559577
## iter:  580  f-value:  0.00282062018847276  pgrad:  0.0027662918212611
## iter:  590  f-value:  0.00282022698748081  pgrad:  0.00268203578125448
## iter:  600  f-value:  0.00281984015106901  pgrad:  0.00260399442713181
## iter:  610  f-value:  0.00281945767760308  pgrad:  0.00253164051860465
## iter:  620  f-value:  0.00281907763938718  pgrad:  0.00246448349538962
## iter:  630  f-value:  0.00281869811591269  pgrad:  0.00240206474972554
## iter:  640  f-value:  0.00281831710356044  pgrad:  0.00234395292924837
## iter:  650  f-value:  0.00281793242757365  pgrad:  0.00228974079497306
## iter:  660  f-value:  0.0028175416105895  pgrad:  0.00223903990328202
## iter:  670  f-value:  0.00281714169423026  pgrad:  0.00219147335767227
## iter:  680  f-value:  0.00281672898969712  pgrad:  0.00214667074625398
## iter:  690  f-value:  0.00281629866441828  pgrad:  0.00210425604964375
## iter:  700  f-value:  0.00281584408670019  pgrad:  0.00206383288533425
## iter:  710  f-value:  0.00281535565046277  pgrad:  0.00202496007519849
## iter:  720  f-value:  0.00281481850716964  pgrad:  0.00198710618091724
## iter:  730  f-value:  0.00281420772556534  pgrad:  0.00195517148405983
## iter:  740  f-value:  0.00281347622101796  pgrad:  0.00198929580779694
## iter:  750  f-value:  0.00281251712408516  pgrad:  0.0020243371873172
## iter:  760  f-value:  0.0028109860885247  pgrad:  0.0020628449104414
## iter:  770  f-value:  0.00280531274621176  pgrad:  0.00210777045918259
## iter:  780  f-value:  0.00276779633173924  pgrad:  0.00192893994903123
## iter:  790  f-value:  0.0027365858919531  pgrad:  0.00175336237933157
## iter:  800  f-value:  0.00271052742271386  pgrad:  0.00159338715579754
## iter:  810  f-value:  0.00268877823198235  pgrad:  0.0014476329094516
## iter:  820  f-value:  0.00267063090619495  pgrad:  0.00131483995638565
## iter:  830  f-value:  0.00265549218327764  pgrad:  0.00119385897688329
## iter:  840  f-value:  0.00264286501881968  pgrad:  0.00108364247588219
## iter:  850  f-value:  0.00263233331803757  pgrad:  0.000983235170799041
## iter:  860  f-value:  0.0026235490286437  pgrad:  0.000891766088418372
## iter:  870  f-value:  0.00261622124674553  pgrad:  0.000808441150756845
## iter:  880  f-value:  0.00261010696864396  pgrad:  0.000732536680330798
## iter:  890  f-value:  0.00260500333719697  pgrad:  0.000663393233575615
```

```
## iter:  900  f-value:  0.00260074110166616  pgrad:  0.000610467691660718
## iter:  910  f-value:  0.0025971791347568  pgrad:  0.000568691871299806
## iter:  920  f-value:  0.00259419980555755  pgrad:  0.000530609027852763
## iter:  930  f-value:  0.00259170509594217  pgrad:  0.000495893937892136
## iter:  940  f-value:  0.00258961339284065  pgrad:  0.000464249376788697
## iter:  950  f-value:  0.00258785674495699  pgrad:  0.000435404326886824
## iter:  960  f-value:  0.00258637859664439  pgrad:  0.000409111316149402
## iter:  970  f-value:  0.00258513190005081  pgrad:  0.000385145054954475
## iter:  980  f-value:  0.00258407751890354  pgrad:  0.000363298775105672
## iter:  990  f-value:  0.00258318290593115  pgrad:  0.000343384744828465
## iter:  1000  f-value:  0.00258242100450359  pgrad:  0.00032523152320868
## iter:  1010  f-value:  0.00258176932782444  pgrad:  0.000308683060304862
## iter:  1020  f-value:  0.00258120917879278  pgrad:  0.000293596426106019
## iter:  1030  f-value:  0.00258072502820831  pgrad:  0.000279841821735044
## iter:  1040  f-value:  0.00258030396872828  pgrad:  0.000267300335873036
## iter:  1050  f-value:  0.00257993527358282  pgrad:  0.000255864063660224
## iter:  1060  f-value:  0.00257961003447551  pgrad:  0.00024543463904754
## iter:  1070  f-value:  0.00257932084524132  pgrad:  0.000235921800397054
## iter:  1080  f-value:  0.00257906155308523  pgrad:  0.0002272438559663
## iter:  1090  f-value:  0.00257882704059682  pgrad:  0.000219325994359781
## iter:  1100  f-value:  0.00257861305217101  pgrad:  0.000212100233932852
## iter:  1110  f-value:  0.00257841603713233  pgrad:  0.000205504086693328
## iter:  1120  f-value:  0.00257823304330199  pgrad:  0.000199481087030676
## iter:  1130  f-value:  0.0025780615990661  pgrad:  0.000193979383698736
## iter:  1140  f-value:  0.00257789963586359  pgrad:  0.000188952001108661
## iter:  1150  f-value:  0.00257774540999785  pgrad:  0.00018435570344616
## iter:  1160  f-value:  0.00257759744180727  pgrad:  0.00018015087396385
## iter:  1170  f-value:  0.00257745447243948  pgrad:  0.000176301827954306
## iter:  1180  f-value:  0.00257731540021796  pgrad:  0.000172775520019389
## iter:  1190  f-value:  0.00257717926472917  pgrad:  0.000169541578403723
## iter:  1200  f-value:  0.00257704518478487  pgrad:  0.000166572255121122
## iter:  1210  f-value:  0.00257691234215174  pgrad:  0.000163842218149177
## iter:  1220  f-value:  0.00257677992710815  pgrad:  0.000161327591549035
## iter:  1230  f-value:  0.00257664712242618  pgrad:  0.000159006293375119
## iter:  1240  f-value:  0.00257651304781567  pgrad:  0.000156858173729998
## iter:  1250  f-value:  0.00257637664479867  pgrad:  0.000154863211013559
## iter:  1260  f-value:  0.00257623671362667  pgrad:  0.000153003027998991
## iter:  1270  f-value:  0.00257609159930598  pgrad:  0.000151258595853951
## iter:  1280  f-value:  0.00257593917277397  pgrad:  0.000149611283648335
## iter:  1290  f-value:  0.0025757762811598  pgrad:  0.000148040350233136
## iter:  1300  f-value:  0.00257559808224935  pgrad:  0.000146521677892475
## iter:  1310  f-value:  0.00257539635780951  pgrad:  0.000145023234957367
## iter:  1320  f-value:  0.00257515830470065  pgrad:  0.000143505969188329
## iter:  1330  f-value:  0.00257488494995302  pgrad:  0.000142044683307252
## iter:  1340  f-value:  0.002574650587545  pgrad:  0.000141070307562233
## iter:  1350  f-value:  0.00257446123681904  pgrad:  0.000140325897964602
## iter:  1360  f-value:  0.00257433569037607  pgrad:  0.000139820592170312
## iter:  1370  f-value:  0.00257410314455694  pgrad:  0.000139031255041652
## iter:  1380  f-value:  0.00257409823849141  pgrad:  0.0001390587793208
## iter:  1390  f-value:  0.00257404538634104  pgrad:  0.000138966510101923
##   Successful convergence.
```

```
names(gev_mixture_model)
```

```
##  [1] "data"
```

```
##  [2] "data_largest"
##  [3] "block_sizes"
##  [4] "equivalent_block_sizes"
##  [5] "rejected_block_sizes"
##  [6] "block_maxima_indexes_object"
##  [7] "gev_models_object"
##  [8] "extremal_indexes"
##  [9] "normalized_gev_parameters_object"
## [10] "weighted_normalized_gev_parameters_object"
## [11] "identic_weights_mw"
## [12] "pessimistic_weights_mw"
## [13] "pessimistic_weights_pw_shape"
## [14] "pessimistic_weights_pw_scale"
## [15] "pessimistic_weights_pw_loc"
## [16] "automatic_weights_mw"
## [17] "automatic_weights_mw_statistics"
## [18] "automatic_weights_pw_shape"
## [19] "automatic_weights_pw_scale"
## [20] "automatic_weights_pw_loc"
## [21] "automatic_weights_pw_statistics"
```

```
gev_mixture_model$block_sizes
```

```
##  [1]  9 10 11 12 13 14 15 16 17 18 19 20
```

```
gev_mixture_model$normalized_gev_parameters_object
```

```
##            loc_star        scale_star         shape_star
## 9  1.45031240747489 0.453295904282513 -0.129499522646265
## 10 1.45217886307157 0.470430879606973 -0.146346090530784
## 11 1.42750590343749 0.480761517460331 -0.149492305889059
## 12 1.54599338448194 0.429952573042360 -0.129786485217946
## 13 1.36582641027225 0.515300195576797 -0.162999666389887
## 14 1.56421546355518 0.401143523589144 -0.105811568835362
## 15 1.55489274331959 0.421455598503346 -0.124588851282045
## 16 1.51538903066186 0.430238254224637 -0.123616594318032
## 17 1.24885023362850 0.585206475333077 -0.191136501202314
## 18 1.50968177385212 0.445535340344140 -0.136720730490755
## 19 1.30493328749473 0.568426853284889 -0.190761324612201
## 20 1.28521537168452 0.573611929117186 -0.200157405792068
```

```
gev_mixture_model$weighted_normalized_gev_parameters_object
```

```
##                             loc_star        scale_star         shape_star
## identic_weights     1.43541623941122 0.481279920363783 -0.149243087267227
## pessimistic_weights 1.44636308346441 0.485132829123202 -0.148387349180774
## automatic_weights   1.39450741759067 0.479435162550496 -0.150452542370691
```

```
gev_mixture_model$automatic_weights_mw
```

```
##                  9                 10                 11                 12
## 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
##                 13                 14                 15                 16
## 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
##                 17                 18                 19                 20
## 0.0447381138097925 0.0000000000000000 0.0000000000000000 0.9552618861902075
```

```
gev_mixture_model$automatic_weights_mw_statistics
```

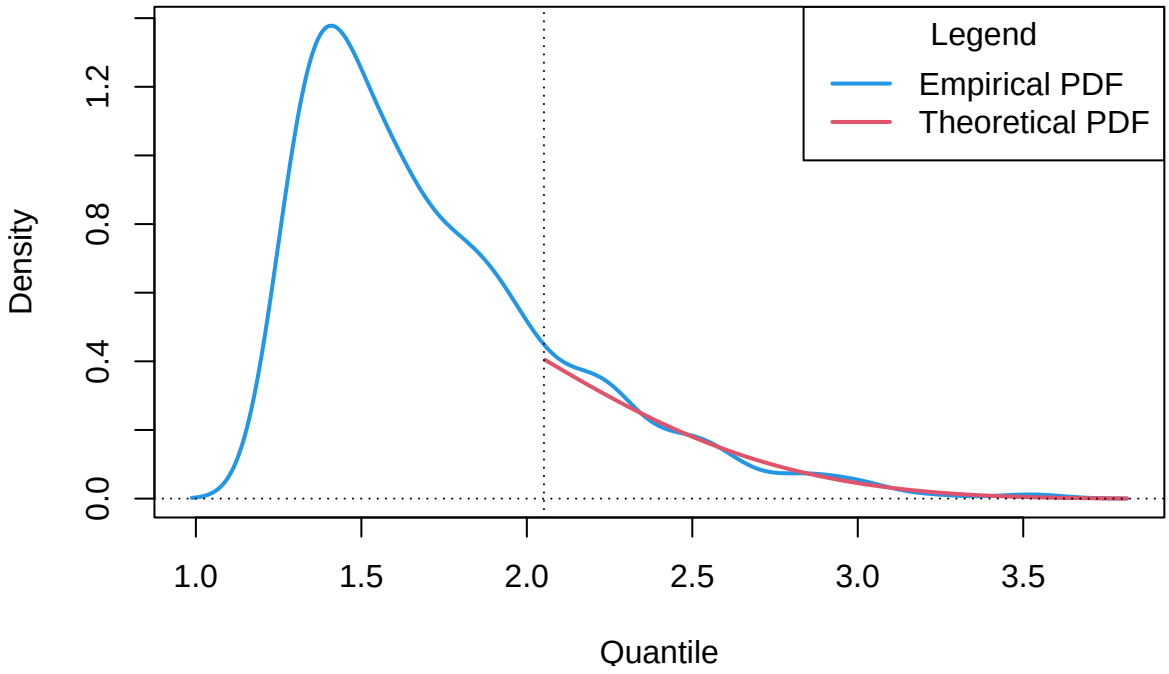
```
## $function_value
## [1] 0.00486421507614914
##
## $gradient_value
## [1] 9.96078950687984e-06
##
## $function_reduction
## [1] 0.0456717364246023
##
## $number_iterations
## [1] 1899
##
## $convergence
## [1] 0
##
## $message
## [1] "Successful convergence"
```

```
gev_mixture_model$automatic_weights_pw_statistics
```

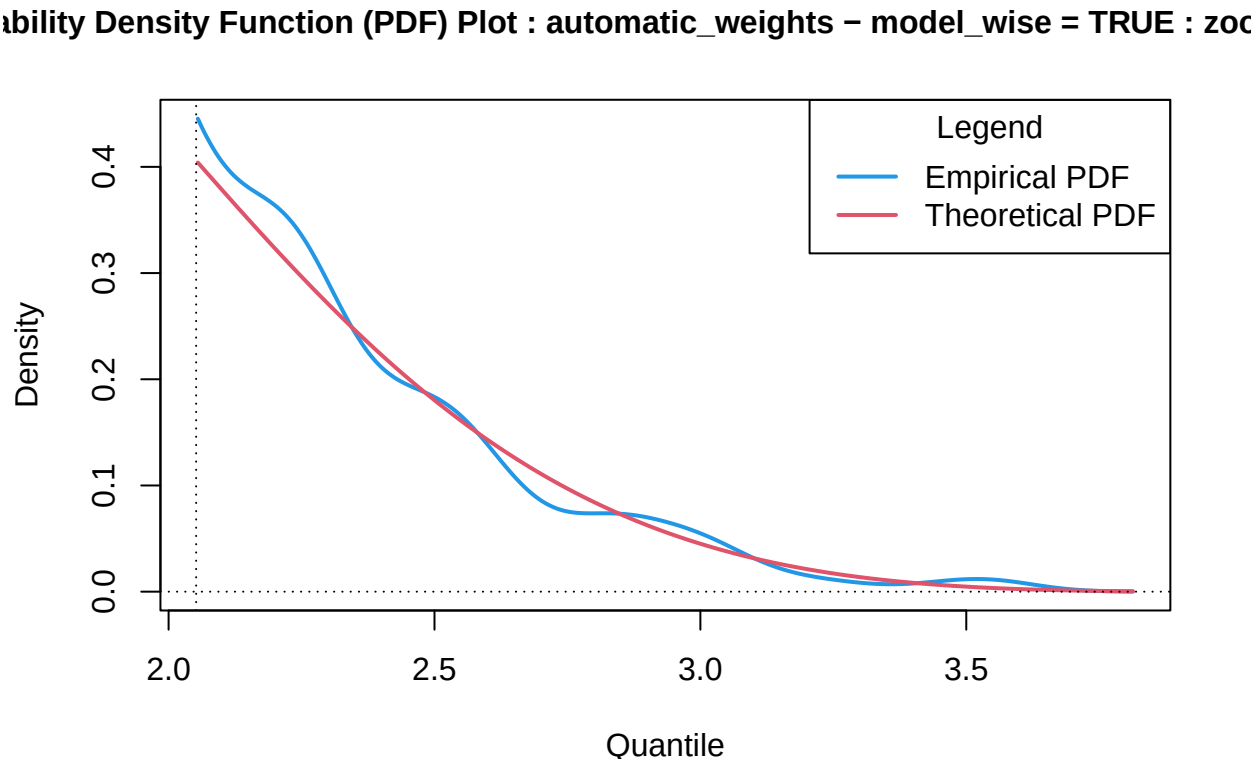
```
## $function_value
## [1] 0.00257370092636521
##
## $gradient_value
## [1] 0.000138751751335583
##
## $function_reduction
## [1] 0.04554128828337
##
## $number_iterations
## [1] 1395
##
## $convergence
## [1] 0
##
## $message
## [1] "Successful convergence"
```

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

bility Density Function (PDF) Plot : automatic_weights − model_wise = TRUE : zoo




```
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")
```




```
gev_mixture_model_parameters <- gev_mixture_model$normalized_gev_parameters_object

shapes <- gev_mixture_model_parameters$shape_star
scales <- gev_mixture_model_parameters$scale_star
locations <- gev_mixture_model_parameters$loc_star

weights <- gev_mixture_model$automatic_weights_mw


#
p <- 0.95

q_initial_guesses <- sapply(1:length(weights), function(j) calculate_gev_inverse_cdf(p = p,
                                                                                     loc = locations[j]
                                                                                     scale = scales[j],
                                                                                     shape = shapes[j]))

q_initial_guesses
```

```
##  [1] 2.56799226359907 2.58537662389256 2.58058336331817 2.60569341711567
##  [5] 2.57907187574268 2.58662621564676 2.60119213049330 2.58494078699782
##  [9] 2.57512484834392 2.59727483387717 2.59383009125445 2.56956910899392
```

```
range(q_initial_guesses)
```

```
## [1] 2.56799226359907 2.60569341711567
```

```
block_size <- max(gev_mixture_model$block_sizes)
y <- gev_mixture_model$data_largest
threshold <- find_threshold_associated_with_given_block_size(x = y, block_size = block_size)
```

```r
library(evd)

data <- y[y > threshold]

M3 <- fgev(data, prob = 0.95)

M3
```

```
##
## Call: fgev(x = data, prob = 0.95)
## Deviance: 7.37470023624205
##
## Estimates
##       quantile           scale           shape
## 2.085687188697  0.175296792923  0.323600711000
##
## Standard Errors
##        quantile            scale            shape
## 0.0110274232122  0.0133679456059  0.0865582736934
##
## Optimization Information
##   Convergence: successful
##   Function Evaluations: 53
##   Gradient Evaluations: 13
```

```r
M4 <- fgev(data)

M4
```

```
##
## Call: fgev(x = data)
## Deviance: 7.37470052122982
##
## Estimates
##            loc           scale           shape
## 2.247585533272  0.175300714509  0.323607979470
##
## Standard Errors
##             loc            scale            shape
## 0.0154999898013  0.0133666047976  0.0865643113784
##
## Optimization Information
##   Convergence: successful
##   Function Evaluations: 64
##   Gradient Evaluations: 14
```

```r
Fn <- ecdf(y)
```

```r
p <- seq(from = Fn(threshold), to = 0.999, length.out = 20)
p
```

```
##  [1] 0.810000000000000 0.819947368421053 0.829894736842105 0.839842105263158
##  [5] 0.849789473684211 0.859736842105263 0.869684210526316 0.879631578947368
##  [9] 0.889578947368421 0.899526315789474 0.909473684210526 0.919421052631579
## [13] 0.929368421052632 0.939315789473684 0.949263157894737 0.959210526315790
## [17] 0.969157894736842 0.979105263157895 0.989052631578947 0.999000000000000
```

```r
quantiles <- calculate_gev_mixture_model_inverse_cdf(p = p*0.1, locations, scales, shapes, weights, ite

quantiles
```

```
##  [1] 0.702710065015057 0.706068460970806 0.709399262395997 0.712703084135398
##  [5] 0.715980520476155 0.719232146069597 0.722458516801515 0.725660170614365
##  [9] 0.728837628284555 0.731991394157750 0.735121956844902 0.738229789881498
## [13] 0.741315352352368 0.744379089484176 0.747421433207612 0.750442802691124
## [17] 0.753443604847912 0.756424234817783 0.759385076425368 0.762326502616067
```

```r
probaility <- calculate_gev_mixture_model_cdf(q = quantiles, locations, scales, shapes, weights)

probaility
```

```
##  [1] 0.0810000000000001 0.0819947368421053 0.0829894736842106 0.0839842105263160
##  [5] 0.0849789473684211 0.0859736842105262 0.0869684210526314 0.0879631578947369
##  [9] 0.0889578947368423 0.0899526315789475 0.0909473684210527 0.0919421052631577
## [13] 0.0929368421052634 0.0939315789473685 0.0949263157894737 0.0959210526315789
## [17] 0.0969157894736843 0.0979105263157897 0.0989052631578947 0.0998999999999998
```

```r
qnorm(p = p)
```

```
##  [1] 0.877896295051229 0.915164528602127 0.953749363776187 0.993809152404018
##  [5] 1.035530880474656 1.079137770494556 1.124899606039293 1.173147048461917
##  [9] 1.224291969493252 1.278857138641972 1.337521001817481 1.401187889735764
## [13] 1.471103391861397 1.549055325021272 1.637750821650920 1.741597224503634
## [17] 1.868558884519282 2.035610588653305 2.292189044775085 3.090232306167813
```

```r
calculate_gev_inverse_cdf(p = p*0.1, loc = 2.52214, scale = 0.5222, shape = 0.1487)
```

```
##  [1] 2.07240111402595 2.07461859000665 2.07682156658709 2.07901036906413
##  [5] 2.08118531210465 2.08334670021583 2.08549482818949 2.08762998152202
##  [9] 2.08975243681178 2.09186246213513 2.09396031740268 2.09604625469687
## [13] 2.09812051859214 2.10018334645868 2.10223496875088 2.10427560928126
## [17] 2.10630548548089 2.10832480864699 2.11033378417856 2.11233261180067
```

```r
calculate_gev_inverse_cdf(p = p, loc = 1, scale = 0.5, shape = 0.1)
```

```
##  [1] 1.84250665857528 1.87747301769356 1.91442151021505 1.95360702475601
##  [5] 1.99533513649798 2.03997640966544 2.08798609207236 2.13993182907415
##  [9] 2.19653364471529 2.25872330790852 2.32773551861923 2.40525373584542
## [13] 2.49365508889916 2.59644744425962 2.71911227775053 2.87090635075032
## [17] 3.06931128767335 3.35374540241972 3.84874501696606 5.97581256378162
```