1.6 Legalese

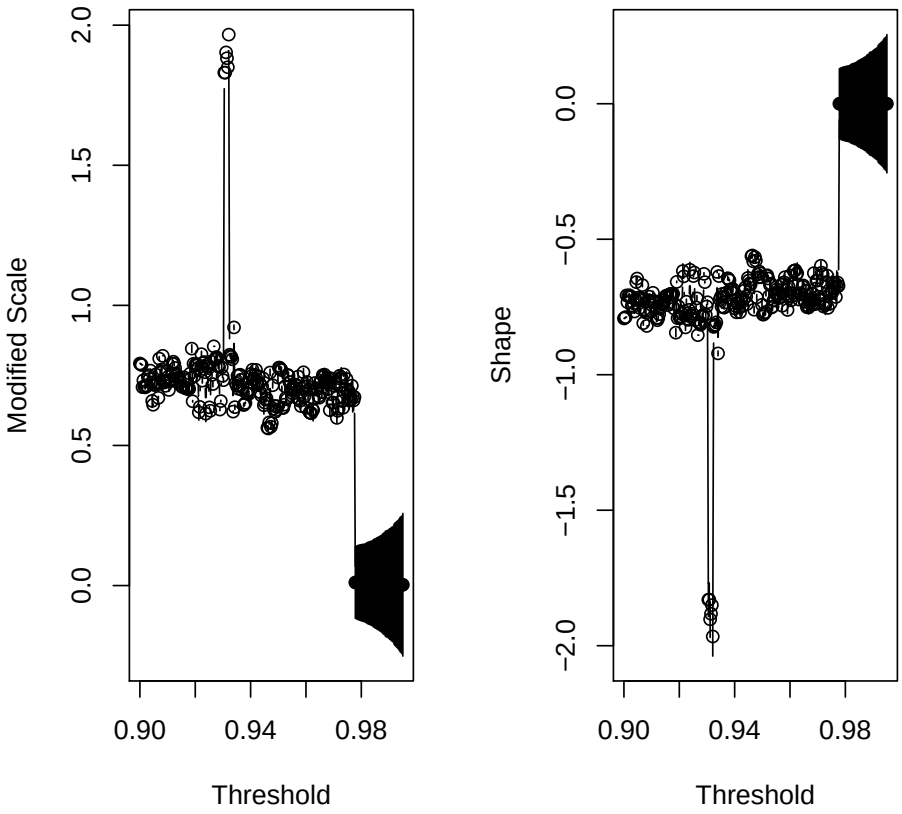
This program is free software; you can redistribute it and/or modify it under the terms of the GNU

$z \leq$

5. Two raFdom variables (with unit Fréchet margins) are perfectly depeFdeFt if*A*

3.2 Threshold Selection

The location for the GPD or equivalently the threshold is a particular parameter as must often it is not


Modified Scale
0.0
0.5
1.0
1.5
2.0
0.90
0.94
0.98
Threshold
Shape
−2.0
−1.5
−1.0
−0.5
0.0
0.90
0.94
0.98
Threshold

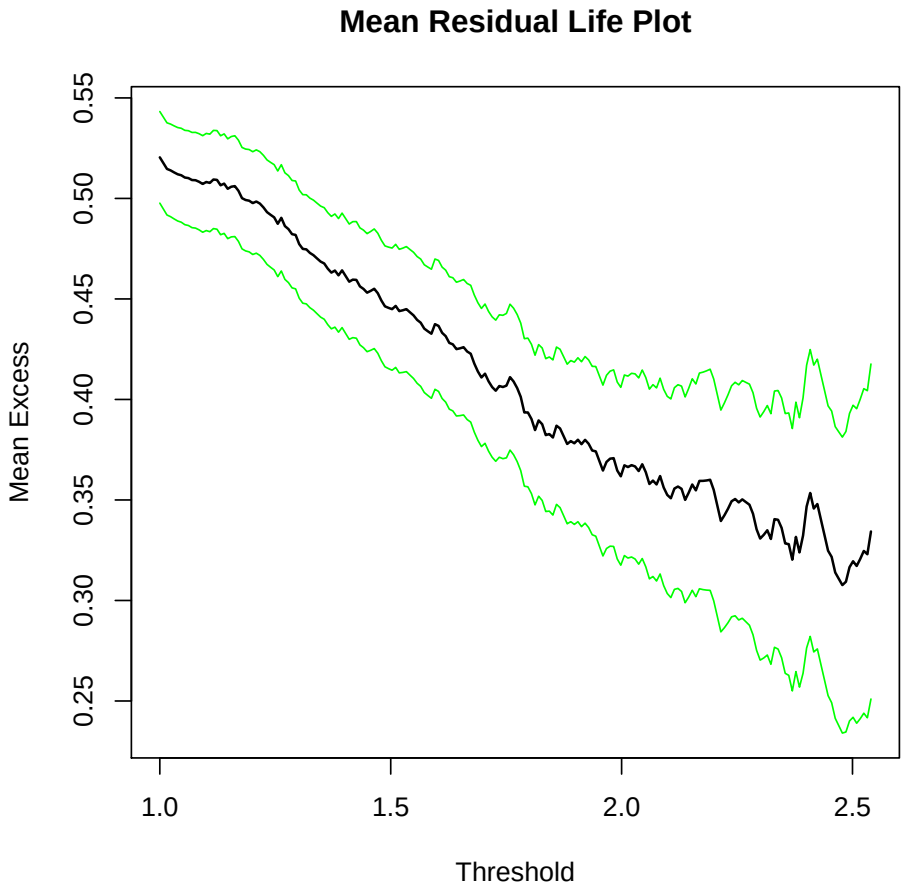


Figure 2: The threshold selection using the mrlplot function

The quantity $E[X - \mu_1 | X > \mu_1]$ is linear in μ_1. Or, $E[X - \mu_1 | X > \mu_1]$ is simply the mean of excesses above the threshold μ_1

3.2.3 L-Moments plot: *lmomplot*

L-moments are summary statistics for probability distributions and data samples. They are analogous to ordinary moments – they provide measures of location, (i)1(on)eeersion, skewness, kurtosis, and other aeeects of the shaee of probability distributions or data samples – but are computed from linear combinations of the ordered data values (hence the prefix L).

For the GPD, the following relation holds:

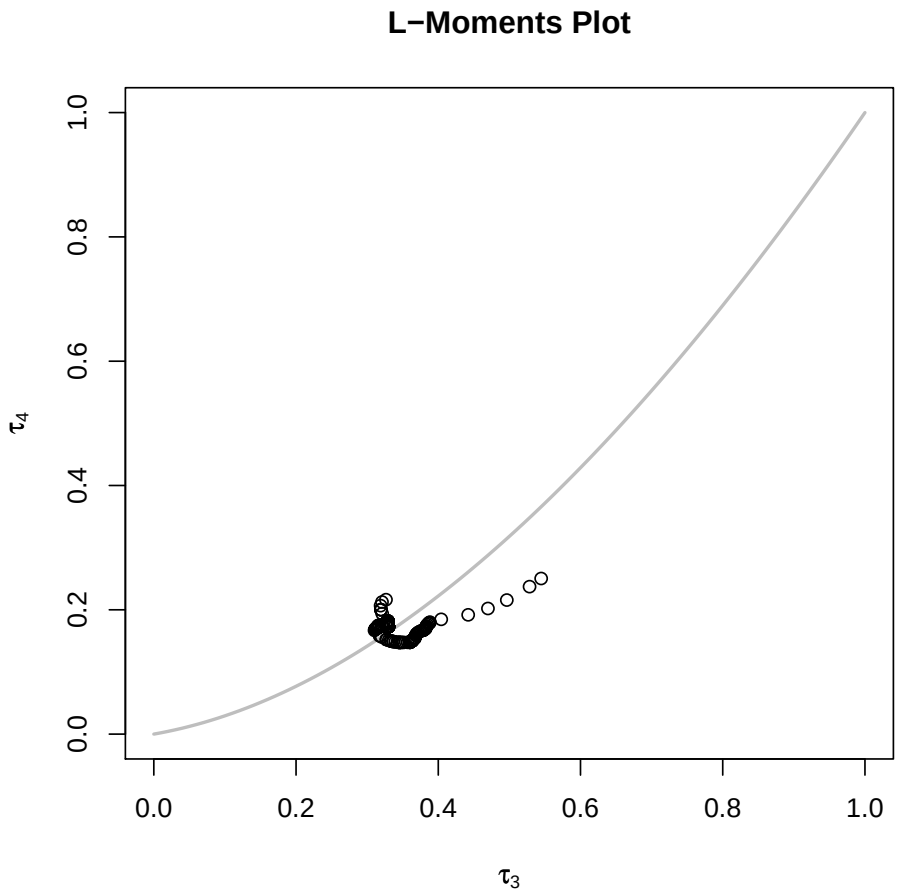


Figure 3: fig: The threshold selection using the lmomplot function

3.3 Fitting the GPD

3.3.1 The univariate case

The main function to fit the GPD is called **fitgpd**. This is a generic function which can fit the GPD according several estimators. There are currently 7 estimators available: method of moments `moments`, maximum likelihood `mle`

```
Standard Error Type: observed

Standard Errors
 scale
0.2083

Asymptotic Variance Covariance
       scale
scale  0.04337

Optimization Information
  Convergence: successful
  Function Evaluations: 6
  Gradient Evaluations: 1
```

```
Threshold Call: c(1, 2)
Number Above: 500
Proportion Above: 1

Estimates
   scale     shape
 0.29500  -0.02758

Standard Error Type: observed

Standard Errors
  scale    shape
0.01912  0.04692

Asymptotic Variance Covariance
        scale       shape
scale   0.0003654  -0.0006651
shape  -0.0006651   0.0022010

Optimization Information
  Convergence: successful
  Function Evaluations: 45
  Gradient Evaluations: 11
```

scale1 shape1 scale2 shape2 alpha

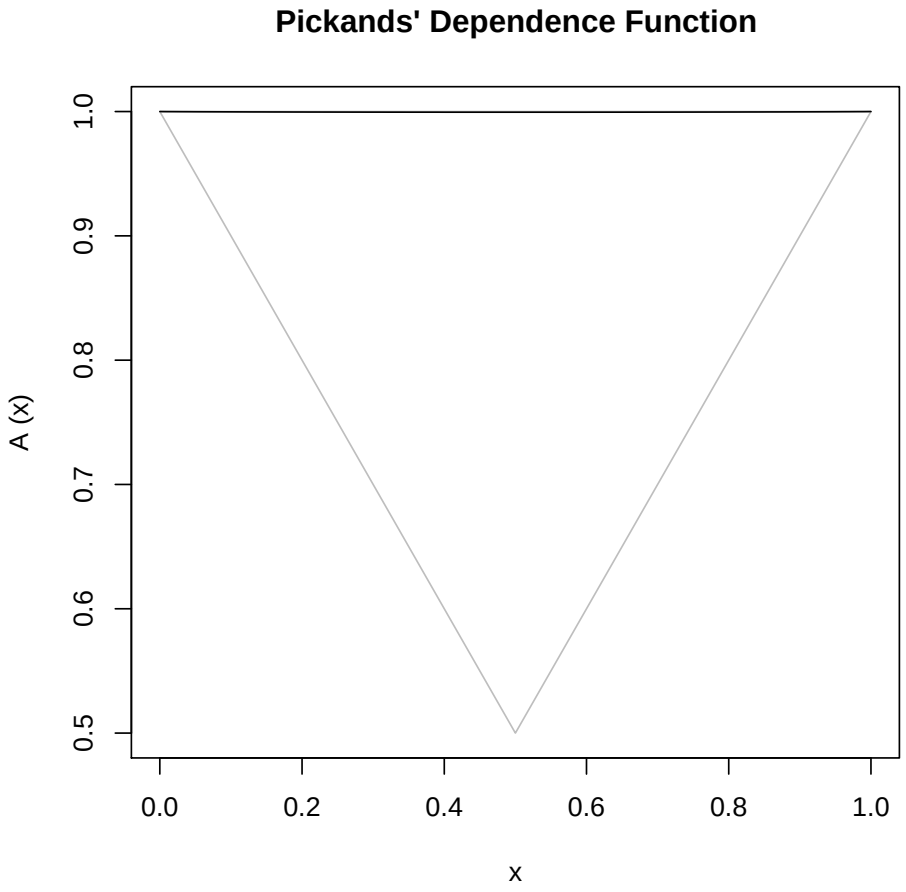


Figure 5: The Pickands' dependence function

```
Optimization Information
        Convergence: successful
        Function Evaluations: 6
        Gradient Evaluations: 1
```

```
> x <- rgpd(200, 1, 2, 0.25)
> mle <- fitgpd(x, 1, method = "mle")
> mom <- fitgpd(x, 1, method = "moments")
> pwmb <- fitgpd(x, 1, method = "pwmb")
> pwmu <- fitgpd(x, 1, method = "pwmu")
> gpd.fiscale(mle, conf = 0.9)

conf.inf.scale conf.sup.scale
      1.400080       2.103698

> gpd.fiscale(mom, conf = 0.9)

conf.inf.scale conf.sup.scale
           NaN            NaN

> gpd.fiscale(pwmu, conf = 0.9)

conf.inf.scale conf.sup.scale
      1.399238       2.099229

> gpd.fiscale(pwmb, conf = 0.9)

conf.inf.scale conf.sup.scale
      1.410214       2.111391
```

```
If there is some troubles try to put vert.lines = FALSE or change
 the range...
conf.inf conf.sup
1.431818 2.122727

If there is some troubles try to put vert.lines = FALSE or change
 the range...
 conf.inf  conf.sup
0.2454545 0.5424242
```

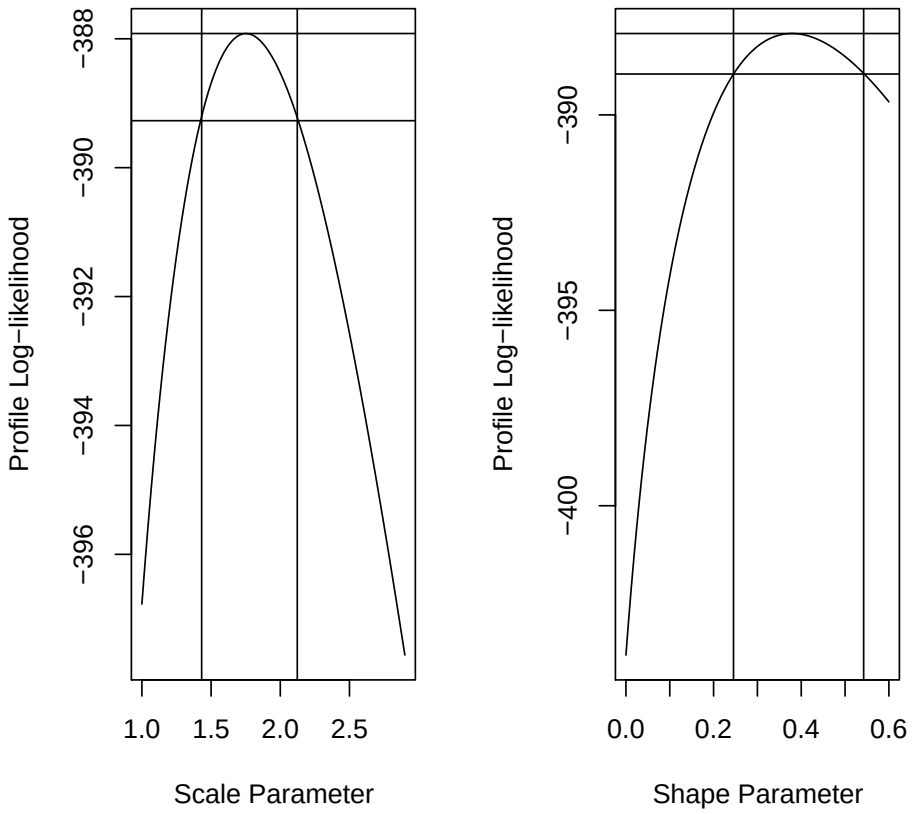
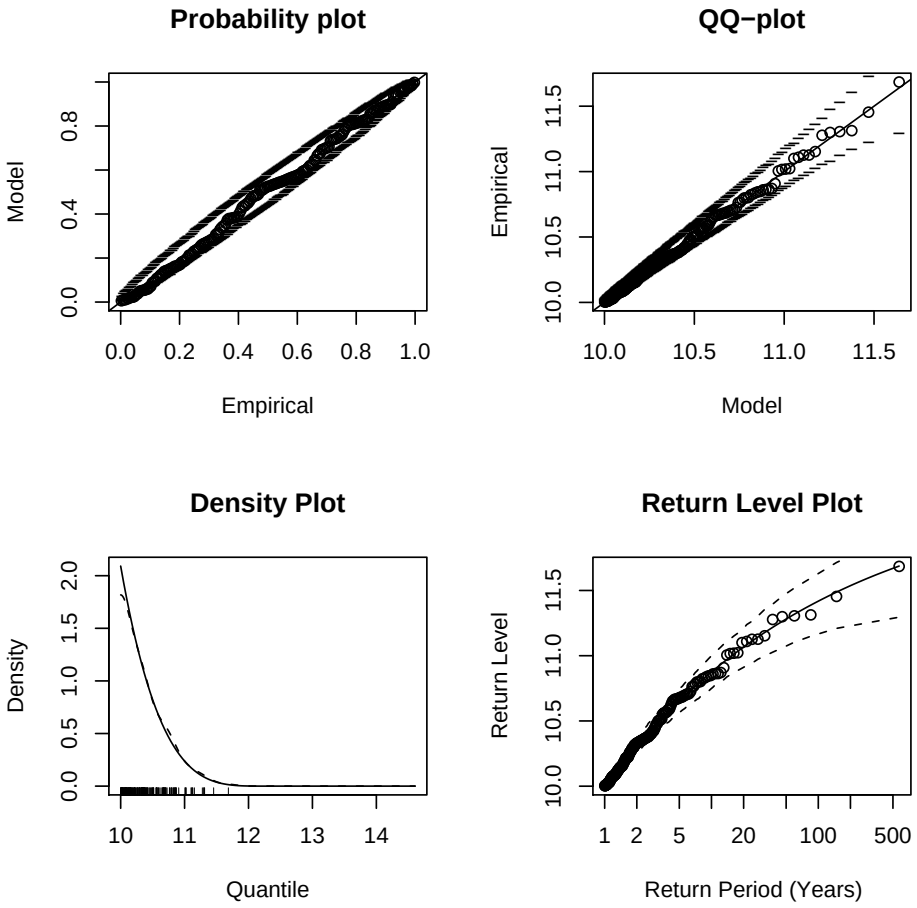
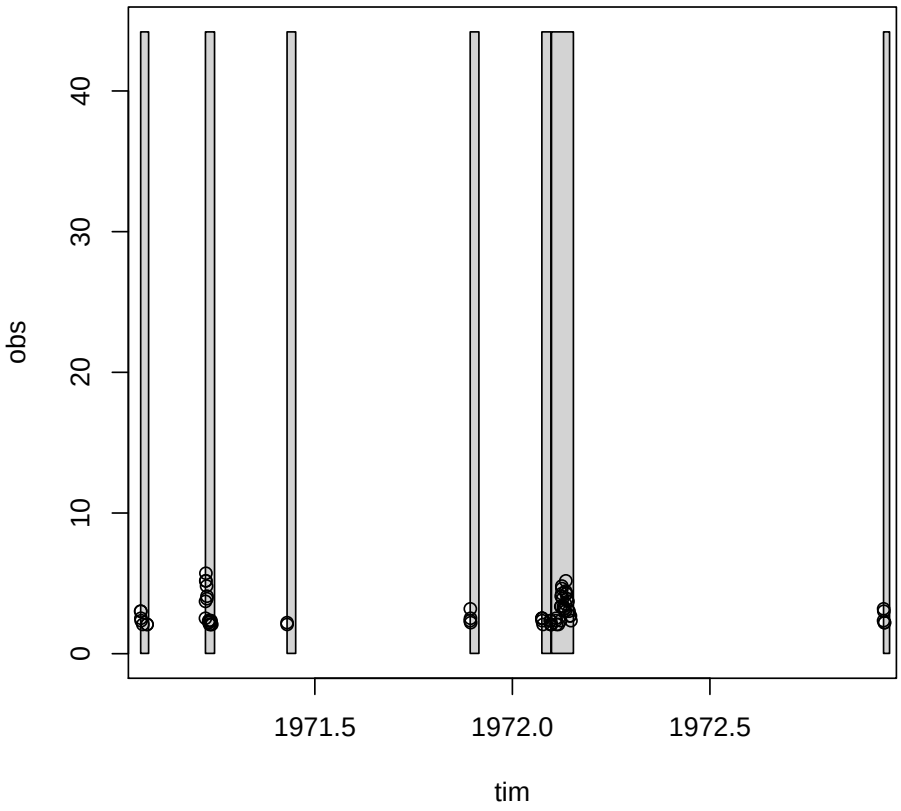
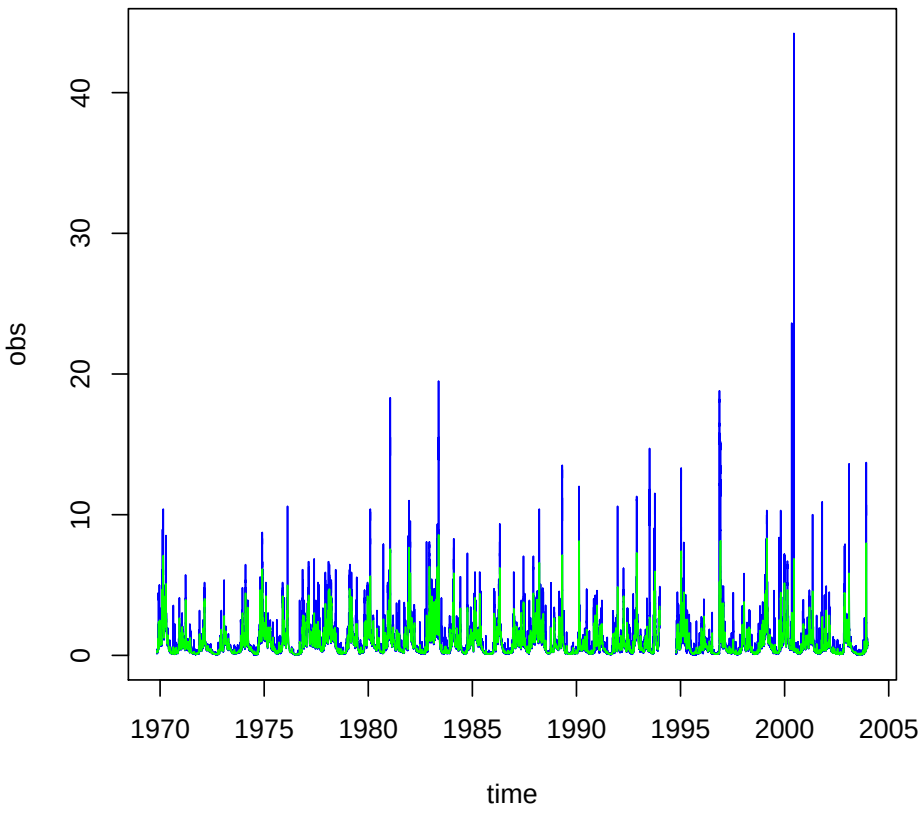


Figure 6: The profile log-likelihood confidence intervals

conf.inf conf.sup


Probability plot
Model
Empirical
0.0
0.2
0.4
0.6
0.8
1.0
QQ−plot
Empirical
Model
10.0
10.5
11.0
11.5
Density Plot
Density
Quantile
0.0
0.5
1.0
1.5
2.0
10
11
12
13
14
Return Level Plot
Return Level
Return Period (Years)
1
2
5
20
100
500


obs
0
10
20
30
40
1971.5
1972.0
1972.5
tim


obs
0
10
20
30
40
1970
1975
1980
1985
1990
1995
2000
2005
time

```
     time           obs        
Min.   :1970   Min.   : 0.022  
1st Qu.:1981   1st Qu.: 0.236  
```

The result of function fitgpd gives the name of the estimator, if a varying threshold was used, the threshold value, the number and the proportion of observations above the threshold, parameter estimates, standard error estimates and type, the asymptotic variance-covariance matrix and convergence diagnostic.

Figure 12 shows graphic diagnostics for the fitted model. It can be seen that the fitted model "mle" seems to be appropriate. Suppose we want to know the return level associated to the 100-year return period.

```
> rp2prob(retper = 100, npy = npy)

       npy retper      prob
1 1.707897    100 0.9941448

> prob <- rp2prob(retper = 100, npy = npy)[, "prob"]
> qgpd(prob, loc = 6, scale = mle$param["scale"], shape = mle$param["shape"])

   scale
36.44331
```

To take into account uncertainties, Figure 13 depicts the profile confidence interval for the quantile associated to the 100-year return period.

```
> gpd.pfrl(mle, prob, range = c(25, 100), nrang = 200)

If there is some troubles try to put vert.lines = FALSE or change
 the range...
conf.inf conf.sup
25.56533 90.76633
```

Sometimes it is necessary to know the estimated return period of a specified events. Lets do it with the larger events in "events1".