**Master 2 internship 2019-2020 EDF R&D/Inria Grenoble Rhône-Alpes**

# Quantification of the performance of extreme quantile Bayesian estimators - Application to environmental data

EDF : Anne Dutfoy (anne.dutfoy@edf.fr)

Inria Grenoble Rhône-Alpes :

Stéphane Girard (stephane.girard@inria.fr, http://mistis.inrialpes.fr/people/girard/)

Julyan Arbel (julyan.arbel@inria.fr, https://www.julyanarbel.com/)

Location: Inria Grenoble Rhône-Alpes, 655 Avenue de l'Europe, 38330 Montbonnot-Saint-Martin

Duration: 6 months

Stipend: ~1000 euros/mois

## 1. Context

EDF R&D has developed a methodology for analysing extreme values. This methodology is used to carry out numerous statistical studies of extreme values based on meteorological variables (temperature, flow, wind speed, etc.). They are carried out by several R&D departments, such as the LNHE for hydraulic variables (flow rates, swell, etc.) and MFEE for temperature and wind processing. The PERICLES department provides support through its expertise in probabilistic and statistical modelling, within a univariate and multivariate framework.

These studies are used to dimension EDF structures (nuclear power plants, hydraulic dams...) to meteorological aggressions, such as floods, storms, drought due to climate change... They consist, from a law of extreme values based on data, in determining the extreme quantiles of centennial, millennial or even decamillennial return periods or in calculating probabilities of exceeding the extreme threshold.

The extreme quantiles, with a return period of 100 years or more, depend on the extreme value model used. They also depend on the number of data available to estimate extreme value models and their quality (outliers, missing values in the series of measurements, etc.). It is therefore important to be able to quantify these sensitivities and determine confidence intervals in order to make decision-making more robust.

## 2. Description

The objective of the internship is to study the applicability of theoretical results establishing the convergence of extreme quantile Bayesian estimators (see for example "Extreme value theory, an introduction", L. de Haan & A. Ferreira, Springer, 2006, for a description of non-Bayesian extreme quantile estimators).

These results are established in the non-Bayesian setting for sample sizes tending towards infinity and under certain technical assumptions. We wish to compare these asymptotic results with the reality of finite sample sizes on simulated data. In particular, the accuracy of asymptotic biases, variances and confidence intervals will need to be quantified in practice.

These methods will be applied to a real case of measurements of environmental variables for which PERICLES has the time series: chronic flow, temperature, instantaneous wind speed.

The deliverables of the internship will be a thesis describing the proposed methods as well as R scripts to implement them. These scripts should be commented on in order to facilitate their use by EDF engineers.

## 3. Possibility to continue with a Ph.D.

This work would be ideally continued in a PhD. on the quantification of the credibility limits of extrapolation of Bayesian extreme value models. A first PhD. was carried out by Clément ALBERT, who proposed a quantification of the extrapolation error in the case where the data belong to the Gumbel or Fréchet attraction domain. Further work is needed to address the general case where the domain of attraction of the law underlying the data is not known in advance.

In addition, these extrapolation errors should be combined with parametric estimation errors to allow the analyst, depending on the error she/he sets, to see how far she/he can extrapolate the estimated extreme value model.

## 4. Student profile

- Master 2, specialising in applied mathematics / statistics.

- Knowledge of the univariate theory of extreme values is desirable.

- Knowledge of the R software is required.

- Interest in research, in particular for a Ph.D. continuation.