Postdoc proposal

Title: Bayesian nonparametric estimation of extreme risk measures.

Expected starting date: October 2017

Environment: Inria Grenoble Rhône-Alpes

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Keywords: Extreme-value analysis, nonparametric statistics, Bayesian statistics, graphical models.

Detailed subject:

Extreme-value theory is a branch of statistics dealing with the extreme deviations from the bulk of probability distributions. More specifically, it focuses on the limiting distributions for the minimum or the maximum of a large collection of random observations from the same arbitrary (unknown) distribution. In extreme-value statistics, the main problems are the estimation of the tail index and extreme quantiles associated to a random variable of interest X. The tail index drives the distribution tail heaviness of the considered random variable distribution. We refer to [1,2] for a general account on extreme-value statistics.

In a risk analysis perspective, the extreme quantile associated with X is referred to as the Value at Risk and has been extensively studied [3]. Recently, many efforts have been done to define alternative extreme risk measures based either on expectiles, Lp quantiles, or extensions of the Expected Shortfall, see for instance [4,5]. However, since these methods are extreme-value based, their applicability is restricted to large sample sizes.

The goal of this project is to contribute to the development of Bayesian nonparametric methods for the estimation of extreme risk measures. We propose to investigate how introducing prior information on the distribution of X can improve the estimation of extreme risk measures on small samples. Two directions will be investigated.
The first one tackles theoretical developments such as posterior consistency of parameters estimation. More specifically, the recent contribution [6] provides conditions for consistent estimation of the tail index for heavy tailed distributions (characterized by a positive tail index). This leaves unexplored the two other domains of attraction characterized by a zero tail index and a negative tail index. The Gumbel domain of attraction (zero tail index) is very broad, including Gaussian, log Gaussian, gamma, Weibull, exponential. Thus, conditions of consistent estimation of the Weibull-tail index in this class are of the utmost interest, and will be the subject of a first direction.
The second direction, more methodological, will explore extreme risk measures estimation from a Bayesian nonparametric viewpoint. Quantile estimation is quite natural in this framework, see for instance [7]. However, extreme quantile estimation and alternative extreme risk measures as mentioned above have not been the object of many developments. This innovative direction is promising as providing prior information to the model may allow for a sharpening of the estimators (variance reduction).

Conditions for applicants:

We look for candidates strongly motivated by challenging research with application to real world data. The applicant should have strong background in mathematics and probability/statistics. The required knowledge includes ideally Bayesian methods and extreme-value analysis. Programming skills with C/C++, Matlab, Python or R are desired.

References:

[1] P. Embrechts, C. Kluppelberg, T. Mikosch. (1997). *Modelling extremal events*, Springer.
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[3] A. Daouia, L. Gardes, S. Girard. (2013). On kernel smoothing for extremal quantile regression,*Bernoulli*, 19, 2557--2589.
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[5] A. Daouia, S. Girard, G. Stupfler. (2016). Estimation of Tail Risk based on Extreme Expectiles, https://hal.archives-ouvertes.fr/hal-01142130
[6] C. Li, L. Lizhen, and D. B. Dunson. (2015). On Posterior Consistency of Tail Index for Bayesian Kernel Mixture Models, a*rXiv preprint* arXiv:1511.02775.
[7] G. Kon Kam King, J. Arbel, and I. Prünster. (2016). A Bayesian nonparametric approach to ecological risk assessment, https://hal.archives-ouvertes.fr/hal-01405593