Extreme Risk Analysis

Course title – Intitulé du cours	Extreme Risk Analysis
Level / Semester – Niveau /semestre	M2 / second semester
School – Composante	Ecole d'Economie de Toulouse
Teacher – Enseignant responsable	Gilles Stupfler
Other teacher(s) – Autre(s) enseignant(s)	Abdelaati Daouia (practicals)
Other teacher(s) – Autre(s) enseignant(s)	
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Other teacher(s) – Autre(s) enseignant(s)	
Lecture Hours – Volume Horaire CM	18
TA Hours – Volume horaire TD	
TP Hours – Volume horaire TP	
Course Language – Langue du cours	English / Anglais
TA and/or TP Language – Langue des TD et/ou TP	English / Anglais

Teaching staff contacts – Coordonnées de l'équipe pédagogique :

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Course Objectives – Objectifs du cours :

The objective of a statistical analysis is often to estimate or infer a "central" parameter. This is the case in regression analysis, in survival analysis or in clustering. This kind of methodology uses well-known and common results such as the law of large numbers or the central limit theorem, and common families of distributions such as Gaussian distributions, or the exponential family. A typical analysis in this framework will use all the available data.

There are many applications however where the objective is not to estimate a central parameter of a distribution. In actuarial science, a company may want to estimate its ruin probability at a 10-year horizon, or maybe even at a longer horizon. In finance, it is important to have an idea of the large losses typically incurred during a financial crisis. In environmental science, politicians and town planners need to have reliable estimates of flood heights, wind speeds, and extreme temperatures during rare climate events happening once every 1,000 years on average, possibly even less often. To solve such problems, it is not reasonable to use purely parametric models and classical techniques based on collecting a large sample representing the random phenomenon of interest.

The goal of this course is to give an overview of Extreme Value Theory, which is the statistical framework relevant to such applications, in the context of risk assessment. The module starts by a discussion of why extreme value theory is indeed needed on two samples of real data, and a description of the classical models used in extreme value analysis. We then show how to estimate

extreme parameters of a given distribution, first in the case of heavy-tailed distributions, then in the most general case. The methods are illustrated on real data relevant to risk analysis.

Prerequisites – Pré requis :

Basic notions of probability theory (weak convergence, convergence in probability) and statistical inference (maximum likelihood estimation, moment estimation). Basic knowledge of R.

Practical information about the sessions – Modalités pratiques de gestion du cours :

Students are expected to attend and actively participate in all lectures.

Grading system – Modalités d'évaluation :

The final grade consists of the following parts:

- A final exam (50%)
- A short report following group work on an applied statistical problem (50%)

Bibliography/references – Bibliographie/références :

Beirlant, J., Goegebeur, Y., Segers, J., Teugels, J. (2004). Statistics of Extremes: Theory and Applications, John Wiley & Sons, Chichester.

Coles, S. (2001). An Introduction to Statistical Modeling of Extreme Values, Springer-Verlag, London.

Embrechts, P., Klüppelberg, C., Mikosch, T. (1997). Modelling Extremal Events for Insurance and Finance, Springer-Verlag, Berlin.

Grimshaw, S.D. (1993). Computing maximum likelihood estimates for the Generalized Pareto distribution, Technometrics 35(2): 185-191.

Hosking, J.R.M., Wallis, J.R. (1987). Parameter and quantile estimation for the generalized Pareto distribution, Technometrics 29(3): 339-349.

Resnick, S.I. (2007). Heavy-Tail Phenomena: Probabilistic and Statistical Modeling, Springer, New York.

Weissman, I. (1978). Estimation of parameters and large quantiles based on the k largest observations, Journal of the American Statistical Association 73(364): 812-815.

Session planning – Planification des séances :

Session 1 (three hours of methodology, plus three hours of practicals): Why extreme value theory? GEV and GP models.

Session 2 (three hours of methodology, plus three hours of practicals): Heavy-tailed models.

Session 3 (three hours of methodology, plus three hours of practicals): The general case.

Distance learning – Enseignement à distance :

Distance learning can be provided when necessary by implementing, for example: / En cas de nécessité, un enseignement à distance sera assuré en mobilisant, par exemple :

- Interactive virtual classrooms / Classe en ligne interactive
- Remote (online) tutorials (classes) / TP/TD à distance
- Email support