

**Department of Applied Statistics,
Johannes-Kepler-University of Linz, Austria
PHD STUDENTSHIPS**

Project title:**Designs for Spatial Random Fields: Copulas****Project area:****Statistics; in particular optimum design of experiments, copula modelling****Supervisor(s):****Prof. Werner G. Müller (JKU) and Dr. Luc Pronzato (CNRS)****Start date:****March 2012 or later****Project details:**

The project addresses the problem of defining *efficient designs* (location of observations points, sensors, etc.) *for observation of spatial fields* within a statistical framework. While our objectives cover numerous industrial and scientific applications, the work of the project stays at a fundamental level, with the aim of identifying appropriate modeling frameworks for distinct specific instances of the spatial observation problem, as well as expedite algorithms to compute associated efficient designs. To demonstrate the relevance of the results obtained, and in cooperation with external collaborators of the institutions involved, the project also compares the techniques developed to existing state-of-the-art approaches in a small number of real problems.

In terms of modeling, the field will be considered as being the superposition of a deterministic component and a realization of a (spatially correlated) stochastic process. Compared to more classical (parametric) approaches, it has the important added values of flexibility and reduced sensitivity with respect to the choice of the parametric families on which the field is described. The prediction at unsampled locations is then obtained (explicitly) by kriging (Kriging, 1951), a method that is now rather standard in spatial statistics, including applications to computer (i.e., simulated) experiments since the pioneering work of Sacks et al. (1989). Although this prediction technique is now rather usual, we intend to improve current results in the particular direction of investigation of an alternative modeling framework for dependence structures, based on copulas.

In spatial applications (like, e.g., hydrology, cf. Bardossy and Li, 2008) modeling dependencies by traditional covariance functions is often of limited use. Then stochastic dependence can easily and elegantly modeled by so-called copulas (see Nelsen, 2006), parameterized functions that allow the connection of arbitrary marginal distributions. These have been utilized in optimal experimental designs before e.g. in (Denman *et al.*, 2010). The task will be to review current work on the use of copulas for field observation/prediction, with the goal of establishing associated relevant performance criteria, that enable to study the impact of the process dependency parameters on the geometry of the corresponding optimal designs.

Recently copulas have been successfully established for modelling deviations from the Gaussian assumptions including specific generalizations of the random fields dependence

structure (see Bárdossy and Li, 2008 and Kazianka and Pilz, 2010). There they model dependencies in an high-dimensional, potentially infinite space, which makes it unfeasible for design questions. By breaking it down to model local neighbourhoods one can simplify to low-dimensional, ideally bivariate copulas. Then copula parameter estimation can be treated similarly to covariance parameter estimation and its impact on design can be investigated. We will also research the impact of the choice of the copula or the marginal models respectively.

Suitable candidates: The successful candidate should have excellent knowledge in mathematics and statistics, ideally from the fields of optimal design or copulas, and very good computer programming skills, preferably in R. A Masters degree in Statistics or a related field or a respective degree expected latest in September 2012 (in the latter case finishing Masters research could be partially funded within the project as well).

Funding details: The studentship is funded by the FWF (Austrian Science Grant Agency) in the framework of a joint ANR-research project with the University of Nice/CNRS (France). It covers a standardized salary of € 33,620 (before taxes) per annum and is available to candidates of all nationalities.

The student will be expected to visit the University of Nice (for up to three months over the three year period). The visits will be financially supported by the grant.

Information about the Department of Applied Statistics: The IFAS (Institut für Angewandte Statistik) offers the longest standing German language full curriculum in Statistics. Its staff consists of active researchers in various fields in statistics. The department is hosted in the newly opened Science Park 2 building together with the Mathematics departments and in close proximity to the Campus. For more details visit <http://www.jku.at/ifas/content>

Contact: Informal enquiries can be made by email to Werner Müller werner.mueller@jku.at

How to apply: There will be an official announcement on the JKU Mitteilungsblatt (in German) on http://www3.jku.at/mtb/content/index_ger.html (international applicants please contact Werner Müller +4373224686802 beforehand).

Application deadline: Deadline for applications is 28th January 2012.