Experimental Designs

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Abstract

The statistical design of experiments plays a vital role in experimentation in industry, medicine, agriculture, science and engineering. The need to obtain data which will give accurate and precise answers to research questions as economically as possible requires careful planning of experiments before they are run. Statistical methodology for designing experiments has a long history and classical methods continue to be successfully applied. However, as new technologies or business requirements lead to new types of experiment being conducted, research in the design of experiments continues and is currently experiencing an upsurge in activity.

The connection between design of experiments and linear statistical inference is old, with careful randomization providing a robust justification for linear models in many design structures and properties of estimators from linear theory providing the basis for optimal choices of designs. Many problems require computationally intensive optimizations and matrix methods provide the basis for this.

We encourage both invited and contributed papers in the design of experiments for the LinStat 2012 conference. There will be a stream of sessions on this theme, aiming to bring together international leaders in the field as well as early-career researchers to encourage the exchange of ideas and give participants a broad view of the subject. Papers related to any aspect of the design of experiments are encouraged, so that participants can get as broad a view as possible of the subject.

Some particular areas of research which are expected to feature are:

1. Block designs: the idea of blocking experimental units to improve the precision of treatment comparisons is widely used in practice. However, the extension to complex blocking structures continues to be an important area of research. Applications in genomics, proteomics and metabolomics have motivated recent work on optimal designs with very small block sizes, e.g. in experiments using microarrays. Related ideas for controlling variation, such as neighbour-balanced designs in agricultural experiments are increasingly popular and some of the same ideas can be used in experiments on social networks, in which neighbour relationships (or friendships) form less regular networks of experimental units.

2. Nonlinear design: the ideas generated from optimal design for linear models have been extended to cover various forms of nonlinear model. Although the basic theory is worked out, computational limitations mean that the application of nonlinear design is just starting. Experiments in pharmacokinetics and other areas of biological kinetics have motivated research on optimal design for nonlinear mixed models. However, as more is learned, the clearer it becomes that there are difficult problems to overcome and some of the current research will be presented at this conference. The advantages of pseudo-Bayesian design are well-recognised, but considerable research is still going on to find practicable ways of implementing these methods.
3. Factorial and response surface designs: increasing pressure on costs increases the importance of studying many factors in a single experiment and in industrial research the benefits of multifactorial experiments are widely recognised. Much current research focuses on designs which are useful when not all effects of interest can be studied. At one extreme, there has been an explosion of interest in supersaturated designs for screening very large numbers of factors. Research continues on how to analyse the data from such designs, while attention is turning to how to design follow-up experiments, or sequences of supersaturated designs. For more detailed study of processes, response surface methodology is widely used in practice. It has become increasingly recognised that many, perhaps most, industrial experiments have some factors whose levels are harder to set than others. This leads naturally to split-plot and other multi-stratum designs, and this is a topic of ongoing interest.
4. Experiments with discrete responses: most optimal design theory has been developed for linear models, or over-simplified generalized linear models. In most experiments, unit-to-unit variance must be allowed for and this requires the use of generalized linear mixed models and the design of experiments for such models has started to attract interest. Such data are often combined with complex factorial treatment designs and sometimes with multistratum structures and this is expected to become an area of active research in the near future.
5. Design for observational systems: Designing spatial sampling schemes and computer experiments are two types of application which have many similarities with design of experiments. They differ in that there is no concept of allocating and randomizing treatments to experimental units, but many of the same concepts of optimal design apply nonetheless. An explosion of research in such areas, and increasing realization that it is very similar to optimal design, will be reflected in the conference programme.

Submissions are encouraged in all of these areas of research, but also in others. The emphasis will be on methodological developments, but applied papers are also of interest.