Preface

Algebraic statistics is a rapidly developing field, where ideas from statistics and algebra blend and foster new directions for research. Statistics has long been relying on classical asymptotic theory as a basis for statistical inferences. This classical basis is still very powerful and useful. However, when the validity of asymptotic theory is in doubt, statisticians rely more and more on various computational methods. Similarly, algebra has long been considered as one of the purest fields of mathematics, far apart from practical computations. However due mainly to the development of Gröbner basis technology, algebra is now becoming a field, where computations for practical applications are feasible.

These two trends meet in the field of algebraic statistics. On one hand algebraic algorithms are now essential for some practical statistical computations, such as Markov chain Monte Carlo tests for discrete exponential families. On the other hand algebraic structures and computational needs of statistical models provide new challenging problems to algebraists. Some algebraic structures are naturally motivated from statistical modeling, but not necessarily from pure mathematical considerations. Furthermore statistical models needed in practice often challenge the current state of the art in algebraic algorithms.

Algebraic statistics has two origins. One origin is the work by Pistone and Wynn in 1996 on the use of Gröbner bases for studying confounding relations in factorial designs of experiments. Another origin is the work by Diaconis and Sturmfels in 1998 on the use of Gröbner bases for constructing connected Markov chain for performing conditional tests of discrete exponential family. These two works opened up the whole new field of algebraic statistics. In Japan some statisticians, including my group, started working in this field around 2000. Also some very prominent algebraists in Japan, in particular the group led by Takayuki Hibi, started working on algebraic problems posed by statistical models. Therefore also in Japan we have very fruitful collaborations between statisticians and algebraists.

In view of these developments, in December of 2008 we organized a workshop "Computational Algebraic Statistics, Theories and Applications (CASTA2008)" in

Kyoto as a satellite meeting to ISAC2008, the Joint Meeting of the 4th World Conference of the International Association for Statistical Computing and the 6th Conference of the Asian Regional Section of the IASC. Nearly 60 researchers joined the workshop with more than 30 talks covering various aspects of algebraic statistics and other uses of computational methods to statistics.

This special issue of the *Annals of Institute of Statistical Mathematics* is primarily based on research results presented in CASTA2008. It contains 11 articles on various aspects of algebraic statistics. We are very happy to have contributions by two pioneers of algebraic statistics mentioned above. The articles of this issue well reflect the current research on algebraic statistics. We hope these articles in a special issue influence further developments of the field.

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