

## Article

# Asymptotic Expansions for Symmetric Statistics with Degenerate Kernels

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**Abstract:** Asymptotic expansions for U-statistics and V-statistics with degenerate kernels are investigated, respectively, and the remainder term  $O(n^{1-p/2})$ , for some  $p \geq 4$ , is shown in both cases. From the results, it is obtained that asymptotic expansions for the Cramér–von Mises statistics of the uniform distribution  $U(0, 1)$  hold with the remainder term  $O(n^{1-p/2})$  for any  $p \geq 4$ . The scheme of the proof is based on three steps. The first one is the almost sure convergence in a Fourier series expansion of the kernel function  $u(x, y)$ . The key condition for the convergence is the nuclearity of a linear operator  $T_u$  defined by the kernel function. The second one is a representation of U-statistics or V-statistics by single sums of Hilbert space valued random variables. The third one is to apply asymptotic expansions for single sums of Hilbert space valued random variables.

**Keywords:** U-statistics; V-statistics; asymptotic expansion; integral kernel; nuclearity

**MSC:** 60B12; 60P05; 62G20



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## 1. Introduction

Asymptotic expansions for symmetric statistics are studied by many people. See, e.g., Callaert–Janssen–Veraverbeke (1980) [1], Withers (1988) [2], Masono (2004) [3], and so on. They treat U-statistics with non-degenerate kernels. On the other hand, Bentkus–Götze (1999) [4] and Zubayraev (2011) [5] obtained optimal bounds in asymptotic expansions for U-statistics with degenerate kernels. They treat the following modified U-statistics,

$$W_n = \frac{1}{n^2} \sum_{1 \leq i < j \leq n} \phi(\xi_i, \xi_j) + \frac{1}{n} \sum_{1 \leq i \leq n} \phi_1(\xi_i), \quad (1)$$

where  $\phi(\cdot, \cdot)$  is a symmetric function,  $\phi_1(\cdot)$  is a measurable function and  $\{\xi_i\}$  are i.i.d. random variables.  $W_n$  coincides with V-statistics when

$$\phi_1(x) = \frac{1}{2} \phi(x, x). \quad (2)$$

If  $\phi_1(x) = 0$  for any  $x$ , then  $W_n$  coincides with U-statistics. They obtained asymptotic expansions with remainder  $O(n^{-1})$  for the distribution function of  $W_n$ . In this paper, we investigate asymptotic expansions for the simple U-statistics and the V-statistics with degree two defined by

$$U_n = \frac{2}{n^2} \sum_{1 \leq i < j \leq n} u(\xi_i, \xi_j), \quad V_n = \frac{1}{n^2} \sum_{1 \leq i, j \leq n} u(\xi_i, \xi_j), \quad (3)$$

respectively. We obtain asymptotic expansions with remainder  $O(n^{1-p/2})$  for some  $p \geq 4$  for the distribution function of  $U_n$  or  $V_n$  under some assumptions for  $\{\xi_i\}$  and  $u(x, y)$ . Our scheme of the proof is based on three steps. The first one is the almost sure convergence

# Expansions And Asymptotics For Statistics Expansions And Asymptotics For Statistics

**Christopher G. Small**



## **Expansions And Asymptotics For Statistics Expansions And Asymptotics For Statistics:**

Expansions and Asymptotics for Statistics Christopher G. Small, 2010-05-07 Asymptotic methods provide important tools for approximating and analysing functions that arise in probability and statistics Moreover the conclusions of asymptotic analysis often supplement the conclusions obtained by numerical methods Providing a broad toolkit of analytical methods **Expansions and Asymptotics for Statistics** shows how asymptotic **Asymptotic Expansions for General Statistical Models** Johann Pfanzagl, 2013-11-27 0 1 The aim of the book Our Contributions to a General Asymptotic Statistical Theory Springer Lecture Notes in Statistics Vol 13 1982 called Vol I in the following suggest to describe the local structure of a general family of probability measures by its tangent space and the local behavior of a functional  $K_k$  by its gradient Starting from these basic concepts asymptotic envelope power functions for tests and asymptotic bounds for the concentration of estimators are obtained and heuristic procedures are suggested for the construction of test and estimator sequences attaining these bounds In the present volume these asymptotic investigations are carried one step further From approximations by limit distributions to approximations by Edgeworth expansions 1 2 adding one term of order  $n$  to the limit distribution As in Vol I the investigation is general in the sense of dealing with arbitrary families of probability measures and arbitrary functionals The investigation is special in the sense that it is restricted to statistical procedures based on independent identically distributed observations 2 Moreover it is special in the sense that its concern are regular models i e families of probability measures and functionals which are subject to certain general conditions like differentiability Irregular models are certainly of mathematical interest Since they are hardly of any practical relevance it appears justifiable to exclude them at this stage of the investigation Asymptotic Theory of Testing Statistical Hypotheses Vladimir E.

Bening, 2011-08-30 The series is devoted to the publication of high level monographs and surveys which cover the whole spectrum of probability and statistics The books of the series are addressed to both experts and advanced students

Asymptotic Statistics Manfred Denker, Rabi Bhattacharya, 2012-12-06 These notes are based on lectures presented during the seminar on Asymptotic Statistics held at SchloB Reisenburg Gunzburg May 29 June 5 1988 They consist of two parts the theory of asymptotic expansions in statistics and probabilistic aspects of the asymptotic distribution theory in nonparametric statistics Our intention is to provide a comprehensive presentation of these two subjects leading from elementary facts to the advanced theory and recent results Prospects for further research are also included We would like to thank all participants for their stimulating discussions and their interest in the subjects which made lecturing very pleasant Special thanks are due H Zimmer for her excellent typing We would also like to take this opportunity to express our thanks to the Gesellschaft fur mathematische Forschung and to the Deutsche Mathematiker Vereinigung especially to Professor G Fischer for the opportunity to present these lectures and to the Birkhauser Verlag for the publication of these lecture notes R Bhattacharya M Denker Part I Asymptotic Expansions in Statistics Rabi Bhattacharya 11 sect 1 CRAMER EDGEWORTH EXPANSIONS Let

$Q$  be a probability measure on  $\mathbb{R}^k$   $\mathcal{B}$  denoting the Borel sigmafield on  $\mathbb{R}$  Assume that the  $s$  th absolute moment of  $Q$  is finite  $\int |x|^s Q(dx) < \infty$

**State of the Art in Probability and Statistics** Mathisca de Gunst, Chris Klaassen, A. W. van der Vaart, 2001

**Probability Theory and Extreme Value Theory** Madan Lal Puri, 2011-07-11 No detailed description available for Probability Theory and Extreme Value Theory

**Asymptotic Expansion of a Partition Function Related to the Sinh-model** Gaëtan Borot, Alice Guionnet, Karol K. Kozłowski, 2016-12-08 This book elaborates on the asymptotic behaviour when  $N$  is large of certain  $N$  dimensional integrals which typically occur in random matrices or in 1 dimensional quantum integrable models solvable by the quantum separation of variables The introduction presents the underpinning motivations for this problem a historical overview and a summary of the strategy which is applicable in greater generality The core aims at proving an expansion up to  $o(1)$  for the logarithm of the partition function of the sinh model This is achieved by a combination of potential theory and large deviation theory so as to grasp the leading asymptotics described by an equilibrium measure the Riemann Hilbert approach to truncated Wiener Hopf in order to analyse the equilibrium measure the Schwinger Dyson equations and the bootstrap method to finally obtain an expansion of correlation functions and the one of the partition function This book is addressed to researchers working in random matrices statistical physics or integrable systems or interested in recent developments of asymptotic analysis in those fields

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**Higher Order Asymptotics** J. K. Ghosh, 1994

**Inference, Asymptotics, and Applications** Nancy Reid, Torben Martinussen, 2017-03-10 This book showcases the innovative research of Professor Skovgaard by providing in one place a selection of his most important and influential papers Introductions by colleagues set in context the highlights key achievements and impact of each work This book provides a survey of the field of asymptotic theory and inference as it was being pushed forward during an exceptionally fruitful time It provides students and researchers with an overview of many aspects of the field

**International Encyclopedia of Statistical Science** Miodrag Lovric, 2025-06-19 The International Encyclopedia of Statistical Science stands as a monumental effort to enrich statistics education globally particularly in regions facing

educational challenges By amalgamating the expertise of over 700 authors from 110 countries including Nobel Laureates and presidents of statistical societies it offers an unparalleled resource for readers worldwide This encyclopedia is not just a collection of entries it is a concerted effort to revive statistics as a vibrant critical field of study and application Providing a comprehensive and accessible account of statistical terms methods and applications it enables readers to gain a quick insight into the subject regardless of their background This work serves to refresh and expand the knowledge of researchers managers and practitioners highlighting the relevance and applicability of statistics across various fields from economics and business to healthcare and public policy Furthermore it aims to inspire students by demonstrating the significance of statistics in solving real world problems thus encouraging a new generation to explore and contribute to the field

**Asymptotic Statistics** Reinhard Höpfner, 2014-01-31 This textbook is devoted to the general asymptotic theory of statistical experiments Local asymptotics for statistical models in the sense of local asymptotic mixed normality or local asymptotic quadraticity make up the core of the book Numerous examples deal with classical independent and identically distributed models and with stochastic processes The book can be read in different ways according to possibly different mathematical preferences of the reader One reader may focus on the statistical theory and thus on the chapters about Gaussian shift models mixed normal and quadratic models and on local asymptotics where the limit model is a Gaussian shift or a mixed normal or a quadratic experiment LAN LAMN LAQ Another reader may prefer an introduction to stochastic process models where given statistical results apply and thus concentrate on subsections or chapters on likelihood ratio processes and some diffusion type models where LAN LAMN or LAQ occurs Finally readers might put together both aspects The book is suitable for graduate students starting to work in statistics of stochastic processes as well as for researchers interested in a precise introduction to this area

**Small Sample Asymptotics** Christopher A. Field, Elvezio Ronchetti, 1990

**Asymptotic Expansions for Infinite Weighted Convolutions of Heavy Tail Distributions and Applications** Philippe Barbe, William P. McCormick, 2009 January 2009 volume 197 number 922 Fourth of five numbers [Current Index to Statistics, Applications, Methods and Theory](#), 1994 The Current Index to Statistics CIS is a bibliographic index of publications in statistics probability and related fields

*Selected Works of Peter J. Bickel* Jianqing Fan, Ya'acov Ritov, C.F. Jeff Wu, 2012-11-28 This volume presents selections of Peter J Bickel's major papers along with comments on their novelty and impact on the subsequent development of statistics as a discipline Each of the eight parts concerns a particular area of research and provides new commentary by experts in the area The parts range from Rank Based Nonparametrics to Function Estimation and Bootstrap Resampling Peter's amazing career encompasses the majority of statistical developments in the last half century or about half of the entire history of the systematic development of statistics This volume shares insights on these exciting statistical developments with future generations of statisticians The compilation of supporting material about Peter's life and work help readers understand the environment under which his research was conducted The material

will also inspire readers in their own research based pursuits This volume includes new photos of Peter Bickel his biography publication list and a list of his students These give the reader a more complete picture of Peter Bickel as a teacher a friend a colleague and a family man     *Symbolic Computation for Statistical Inference* David F. Andrews,James E. H. Stafford,2000

Over recent years developments in statistical computing have freed statisticians from the burden of calculation and have made possible new methods of analysis that previously would have been too difficult or time consuming Up till now these developments have been primarily in numerical computation and graphical display but equal steps forward are now being made in the area of symbolic computing or in other words the use of computer languages and procedures to manipulate expressions This allows researchers to compute an algebraic expression rather than evaluate the expression numerically over a given range This book summarizes a decade of research into the use of symbolic computation applied to statistical inference problems It shows the considerable potential of the subject to automate statistical calculation leaving researchers free to concentrate on new concepts Starting with the development of algorithms applied to standard undergraduate problems the book then goes on to develop increasingly more powerful tools Later chapters then discuss the application of these algorithms to different areas of statistical methodology     **Asymptotic Statistics** A. W. van der Vaart,2000-06-19 This book is an introduction to the field of asymptotic statistics The treatment is both practical and mathematically rigorous In addition to most of the standard topics of an asymptotics course including likelihood inference M estimation the theory of asymptotic efficiency U statistics and rank procedures the book also presents recent research topics such as semiparametric models the bootstrap and empirical processes and their applications The topics are organized from the central idea of approximation by limit experiments which gives the book one of its unifying themes This entails mainly the local approximation of the classical i i d set up with smooth parameters by location experiments involving a single normally distributed observation Thus even the standard subjects of asymptotic statistics are presented in a novel way Suitable as a graduate or Master s level statistics text this book will also give researchers an overview of research in asymptotic statistics

*Proceedings of the Seventh Conference on Probability Theory* Marius Iosifescu,Şerban Grigorescu,Tiberiu Postelnicu,2020-05-18 No detailed description available for Proceedings of the Seventh Conference on Probability Theory

**The First Erich L. Lehmann Symposium** Javier Rojo,Víctor Pérez-Abreu,Institute of Mathematical Statistics,2004

The book delves into Expansions And Asymptotics For Statistics Expansions And Asymptotics For Statistics. Expansions And Asymptotics For Statistics Expansions And Asymptotics For Statistics is a crucial topic that must be grasped by everyone, ranging from students and scholars to the general public. The book will furnish comprehensive and in-depth insights into Expansions And Asymptotics For Statistics Expansions And Asymptotics For Statistics, encompassing both the fundamentals and more intricate discussions.

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