Effortless calculation of complex probability distributions using CharFunTool: Computational methods, tools and applications

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Abstract

This presentation is focused on the calculation of complex probability distributions using CharFunTool, a powerful toolbox for characteristic functions. We explore various applications in statistics, insurance, measurement, and metrology, demonstrating how CharFunTool simplifies and enhances both analytical and computational processes. Through selected examples, we showcase its utility in addressing real-world problems and improving accuracy across diverse fields. Attendees will gain practical insights into leveraging CharFunTool for efficient distribution analysis, making it an invaluable resource for researchers and practitioners alike.

Statistical inference often requires the computation of non-standard probability distributions for estimators or test statistics, which can be fully specified by their moments or characteristic functions. Standard asymptotic approximations and small sample approximations based on first moments and cumulants are commonly used but can be inadequate for specific situations. In such cases, more sophisticated approximations, such as near-exact distributions, can be employed. However, for a wide range of applications, numerical inversion of characteristic functions is a highly efficient and sufficient method.

In this talk, we illustrate the applicability of numerical inversion of characteristic functions through several examples, including the exact null and non-null distributions of selected tests in multivariate statistical analysis, the application of empirical characteristic functions, and the exact distribution of the bootstrap mean. We will also discuss practical experiences and potential issues associated with calculating the required characteristic functions and related exact distributions.

Keywords

Characteristic function, Numerical inversion, CharFunTool.