Annals of the Institute of Statistical Mathematics (2023) 75:159–200
https://doi.org/10.1007/s10463-022-00842-6

Flexible asymmetric multivariate distributions based on two-piece univariate distributions

Jonas Baillien[1] · **Irène Gijbels**[1] · **Anneleen Verhasselt**[2]

Received: 26 July 2021 / Revised: 11 March 2022 / Accepted: 24 May 2022 /
Published online: 2 August 2022

Abstract
Classical symmetric distributions like the Gaussian are widely used. However, in reality data often display a lack of symmetry. Multiple distributions, grouped under the name "skewed distributions", have been developed to specifically cope with asymmetric data. In this paper, we present a broad family of flexible multivariate skewed distributions for which statistical inference is a feasible task. The studied family of multivariate skewed distributions is derived by taking affine combinations of independent univariate distributions. These are members of a flexible family of univariate asymmetric distributions and are an important basis for achieving statistical inference. Besides basic properties of the proposed distributions, also statistical inference based on a maximum likelihood approach is presented. We show that under mild conditions, weak consistency and asymptotic normality of the maximum likelihood estimators hold. These results are supported by a simulation study confirming the developed theoretical results, and some data examples to illustrate practical applicability.

Keywords Affine combination · Maximum likelihood estimation · Multivariate skew distribution

✉ Irène Gijbels
irene.gijbels@kuleuven.be

[1] Department of Mathematics and Leuven Statistics Research Center (LStat), KU Leuven, Celestijnenlaan 200B, Box 2400, 3001 Leuven (Heverlee), Belgium

[2] Center for Statistics, Data Science Institute, Hasselt University, Agoralaan-Building D, 3590 Diepenbeek, Belgium