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Non-standard boundary behaviour arising in binary mixture problems

Consider a binary mixture model of the form , where is standard normal and is a completely specified heavy-tailed distribution with the same support. Gaussianity of reflects a reduction of the raw data to a set of pivotal test statistics at each site (e.g. an energy level in a particle physics context). For a sample of independent and identically distributed values , the maximum likelihood estimator
is asymptotically normal provided that is an interior point. This paper investigates the large-sample behaviour for boundary points, which is entirely different and strikingly asymmetric for and . On the right boundary, well known results on boundary parameter problems are recovered, giving
. On the left boundary (which corresponds to no new physics)
, where indexes the domain of attraction of the density ratio when . For , which is the most important case in practice, the tail behaviour of governs the properties of the maximum likelihood estimator and related statistics. Most notably, conditional on the event
, the likelihood ratio statistic has a conditional null limit distribution that is not the usual
. In the talk I will omit technical details and focus on the conceptual points with a view to ascertaining whether the formulation is reasonable in a particle physics context.
This is joint work with Peter McCullagh and Daniel Xiang at the University of Chicago.

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