Directional Statistics with the Spherical Normal Distribution

A well-known problem in directional statistics - the study of data distributed on the unit sphere - is that current models disregard the curvature of the underlying sample space. This ensures computationally efficiency, but can influence results. To investigate this, we develop efficient inference techniques for data distributed by the curvature-aware spherical normal distribution. We derive closed-form expressions for the normalization constant when the distribution is isotropic, and a fast and accurate approximation for the anisotropic case on the two-sphere. We further develop approximate posterior inference techniques for the mean and concentration of the distribution, and propose a fast sampling algorithm for simulating the distribution. Combined, this provides the tools needed for practical inference on the unit sphere in a manner that respects the curvature of the underlying sample space.

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