Are Gaussian data all you need?

We consider the problem of generalized linear estimation on Gaussian mixture data with labels given by a single-index model. Our first result is a sharp asymptotic expression for the test and training errors in the high-dimensional regime. Motivated by the recent stream of results on the Gaussian universality of the test and training errors in generalized linear estimation, we ask ourselves the question: "when is a single Gaussian enough to characterize the error?". Our formulas allow us to give sharp answers to this question, both in the positive and negative directions.

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