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Testing Accuracy, Additivity, and Sufficiency of Human Use of Probability Density Information in a Visuo-Cognitive Task

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Abstract

We tested three fundamental properties of Bayesian Decision Theory: accuracy, additivity, and sufficiency. In Experiment 1, observers were shown a sample of dots from a bivariate Gaussian and estimate the probability that an additional sample would fall into specified regions. There were three types of regions: symmetric around the mean (S), the upper and lower halves of the symmetric region (SU and SL). In Experiment 2, the same observers were asked to maximize the expected rewards based on jointly sufficient statistics for given the sample (herein, mean and covariance of a Gaussian). In Experiment 1, We found that the observers estimates of symmetric region $P[S]$ were close to accurate. However, they showed a highly patterned super-additivity: the sum of $P[SU] + P[SL] \gtrsim P[S]$. In Experiment 2, the observers violated sufficiency by assigning too much weight to a feature of the sample rather than jointly sufficient statistics.