Interpreting Averages

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Averages are measured in many circumstances for diagnostic, predictive, or surveillance purposes. Examples include: average stress along a beam, average speed along a section of highway, average alcohol consumption per month, average GDP over a large region, a student's average grade over 4 years of study. However, the average value of a variable reveals little about fluctuations of the variable along the path that is averaged. Extremes – stress concentrations, speeding violations, binge drinking, poverty and wealth, intellectual incompetence in particular topics – may be more significant than the average. The analyst who designs and employs the average can choose the path length for averaging, and the performance requirements for diagnosis, prediction or warning. This talk explores the choice of path length and performance requirements to achieve robustness against uncertainty when interpreting an average, in face of uncertain fluctuations of the averaged variable. Extremes are not observed, but robustness against those extremes enhances the ability to interpret the observed average despite the uncertainty. Two specific examples are developed: enforcing speed limits and statistical hypothesis testing. We present 4 generic propositions, based on info-gap decision theory, that establish necessary and sufficient conditions for robust dominance, and for sympathetic relations between robustness to pernicious uncertainty and opportuneness from propitious uncertainty.

Related paper:
Yakov Ben-Haim, 2022, Inferring extreme values from measured averages under deep uncertainty, ASME *Journal of Verification, Validation and Uncertainty Quantification*, June 2022, vol. 7, pp.021002-1 to 021002-12.