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Universal Uncertainty Relations[1]

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Uncertainty relations are a distinctive characteristic of quantum theory that imposes intrinsic limitations on the precision with which physical properties can be simultaneously determined. The modern work on uncertainty relations employs entropic measures to quantify the lack of knowledge associated with measuring non-commuting observables. However, I will show here that there is no fundamental reason for using entropies as quantifiers; in fact, any functional relation that characterizes the uncertainty of the measurement outcomes can be used to define an uncertainty relation. Starting from a simple assumption that any measure of uncertainty is non-decreasing under mere relabeling of the measurement outcomes, I will show that Schur-concave functions are the most general uncertainty quantifiers. I will then introduce a novel fine-grained uncertainty relation written in terms of a majorization relation, which generates an infinite family of distinct scalar uncertainty relations via the application of arbitrary measures of uncertainty. This infinite family of uncertainty relations includes all the known entropic uncertainty relations, but is not limited to them. In this sense, the relation is universally valid and captures the essence of the uncertainty principle in quantum theory. This talk is based on a joint work with Shmuel Friedland and Vlad Gheorghiu.

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