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On the information-theoretic structure of distributed measurements

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The internal structure of a measuring device, which depends on what its components are and how they are organized, determines how it categorizes its inputs. This paper presents a geometric approach to studying the internal structure of measurements performed by distributed systems such as probabilistic cellular automata. It constructs the quale, a family of sections of a suitably defined presheaf, whose elements correspond to the measurements performed by all subsystems of a distributed system. Using the quale we quantify (i) the information generated by a measurement; (ii) the extent to which a measurement is context-dependent; and (iii) whether a measurement is decomposable into independent submeasurements, which turns out to be equivalent to context-dependence. Finally, we show that only indecomposable measurements are more informative than the sum of their submeasurements.

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