C3-W8-SecondExam-PeerReview

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$$S(D) = -K \sum_{i=1}^{k} \lambda_i \log_2 \lambda_I \tag{3.3.1}$$

where λ_i are eigenvalues of the operator D and K is an arbitrary constant.

Formula (3.3.1) is usually converted to a more compressed form

$$S(D) = -K \operatorname{Tr} \eta(D) \tag{3.3.2}$$

where Tr A is the trace of an operator (matrix) A and η is the continuous real function defined by the following formula

$$\eta(t) = t \log_2 t$$

Quantum entropy is one of the basic concepts of the mathematical formalism of quantum mechanics developed by von Neumann (1932). However, quantum entropy was not related to information for a long time. Only the advent of quantum computation (in its theoretical form) connected quantum entropy and information. Although von Neumann apparently did not see an intimate connection between his entropy formula and the similar Shannon information entropy, many years later an information theoretical reinterpretation of quantum entropy has become common. For instance, it is demonstrated that the von Neumann entropy describes the capacity of a quantum communication channel much in the same way as information entropy describes the capacity of a quantum communication channel (cf. Section 3.2).

There were many generalizations of the von Neumann's approach to quantum information measurement (cf., for example, (Hu and Ye, 2006)).

Classical information theory developed by Nyquist, Hartley, Shannon and their followers usually abstracts completely from the physical nature of the carriers of information. This is sensible because information can be converted easily and essentially without loss between different carriers, such as magnetized patches on a disk, currents in a wire, electromagnetic waves, and printed symbols. However, this convertibility no longer holds for microscopic particles that are described by quantum theory. As a result, the quantum level of information processing demands new tools and new understanding.

A natural way to understand the underlying unity between physical (i.e., thermodynamic or quantum) entropy and information entropy is as

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