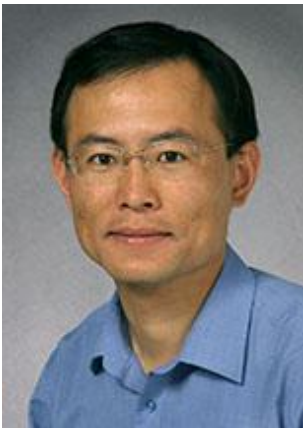


**Title:** The Essence and Limitation of Shannon Information Theory

**Abstract:** The three cornerstones of information theory (source-coding theorem, channel-coding theorem, and rate-distortion theorem) were all originally contributed by Shannon. These wouldn't have been possible without Shannon first finding a universal measure of information, i.e., the opposite of uncertainty, by introducing the concept of entropy, or simply bits. Only after that, Shannon could separate a communication task into two steps: source coding and channel coding. Today, the universality of bits and the effectiveness of Shannon's two-step framework have been well demonstrated by the success of the Internet, which can transport all kinds of information, but in fact, only bits are moving around. Another great contribution of Shannon was the probabilistic model he introduced for channels, which captured the real problem of channel uncertainty. Therefore, Shannon could build his theory completely upon probability theory, and by applying the law of large numbers, obtain the three cornerstone theorems. Once realizing the essence of Shannon's theory, we can easily see its limitation. Since the application of the law of large numbers requires long sequences, the three theorems only hold with long delays, which may be a critical issue for control purposes. The two-step framework of separating source and channel coding not only introduces delay, but also loses its optimality in the case of networks.



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