

Classical Information Theory

Basic Concepts and Mathematics

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Preface

In this lecture notes, I will try to establish a ground work for information theory, then would work of it's philosophy, and applications in mathematics and quantum physics. By reading this leacture note one would essentially learn information theory in it's complete form. This edition is updated until June 25, 2023. For any question or corrections please contact me Thisismeamir@outlook.com.

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1 Introduction to Information Theory

1.1 Some People and Some History

The concept of information, was hidden in Boltzmann view on entropy and statistical mechanics. Boltzmann earns the title of founding father, without doubt. Then it was mathematics that found the potential in the concept, gave it a formalism, which was sufficient enough to be used all over the science. Shannon proposed the basic definition which is still valid. Charles Babbage, Ada Lovelace, and Alan Turing, pioneered the idea of a computer and foundations of its mathematical description. Kurt Godel, though never talked about information explicitly, but it is undisputed by now that it is the key to understanding his Incompleteness Theorem.

In physics the idea was developed within theoreticians who recognized the correspondence between information theory and quantum mechanics. John Von Neumann brought the idea of Von-Neumann entropy. Leo Szilard reduced Maxwell's demon to its very essence, a single-bit decision, bringing out for the first time the equivalence of entropy and information. In a sense the theory of information was all along a key concept for our understandings of nature and physical theories.

1.2 Three Dimensions of Information

§ Syntactic Information: