On coding by probability transformation

Author(s):
Sayir, Jossy

Publication Date:
1999

Permanent Link:
https://doi.org/10.3929/ethz-a-002093628

Diss. ETH No. 13099

On Coding by Probability Transformation

A dissertation submitted to the
SWISS FEDERAL INSTITUTE OF TECHNOLOGY
ZURICH

for the degree of
Doctor of Technical Sciences

presented by
JOSSY SAYIR
dipl. El.-Ing. ETH
born 8 June 1968
citizen of Zürich ZH

accepted on the recommendation of
Prof. Dr. James L. Massey, examiner
Prof. Dr. Frans M. J. Willems, co-examiner
Prof. Dr. Fritz Eggimann, co-examiner

1999

Abstract

An introduction to arithmetic source coding is given, showing how this technique transforms the output probability distribution of the source into an almost uniform probability distribution. A similar approach is investigated for block coding for noisy channels, leading to the definition of the (N, K) block coding capacity of a discrete memoryless channel. Arithmetic coding is modified for data transmission over noisy channels and a metric is developed for a sequential decoder to be used in conjunction with an arithmetic encoder.

Universal arithmetic source coding is investigated for a class of sources whose output distributions lie within a polytope of probability distributions. The properties of the optimal coding distribution over a polytope of distributions are derived. Gallager's redundancy-capacity theorem is presented. An iterated version of the Arimoto-Blahut algorithm is fomulated to compute the optimal coding distribution for a polytope with many vertices, or, alternatively, to compute the capacity of a discrete memoryless channel with a large input alphabet. The optimal coding distribution is computed for the polytope of all monotone non-increasing probability distributions with a given expected value.

Universal source coding with a source transformation is described. Two source transformers are investigated: the recency-rank calculator (also called the move-to-front list) and the competitive list transformer. It is shown that the steady-state output distribution of these transformers is monotone non-increasing when the transformers are applied to the output of a discrete memoryless source. A context-tree algorithm is formulated which uses competitive list transformers followed by a universal arithmetic source encoder. The performance of this algorithm is compared to the performance of other universal source coding algorithms.