

## Finding Minimum Entropy Codes

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To determine whether a particular sensory event is a reliable predictor of reward or punishment it is necessary to know the prior probability of that event. If the variables of a sensory representation normally occur independently of each other, then it is possible to derive the prior probability of any logical function of the variables from the prior probabilities of the individual variables, without any additional knowledge; hence such a representation enormously enlarges the scope of definable events that can be searched for reliable predictors. Finding a Minimum Entropy Code is a possible method of forming such a representation, and methods for doing this are explored in this paper. The main results are (1) to show how to find such a code when the probabilities of the input states form a geometric progression, as is shown to be nearly true for keyboard characters in normal text; (2) to show how a Minimum Entropy Code can be approximated by repeatedly recoding pairs, triples, etc. of an original 7-bit code for keyboard characters; (3) to prove that in some cases enlarging the capacity of the output channel can lower the entropy.

### 1 Reasons for Minimum Entropy Coding

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When any combination of sensory stimuli — a sensory event — occurs the brain needs to know whether it is an expected, common, usual event, or an unexpected, rare, unusual event. It is evident that the brain works this out for itself because animals make startle or alerting responses to unusual stimuli, and the following explanation of the need to attend to the unusual is also fairly obvious. One of the brain's most important jobs is to find predictive or causal relationships between the sensory events that impinge on it, the motor actions it takes, and the rewards and punishments these lead to. Now unexpected rewards and punishments are somewhat unusual, and for an animal with good knowledge of its environment they are presumably very unusual, so it follows that the sensory events it is seeking as new but reliable predictors are themselves somewhat or very unusual. For the purpose of learning something new the vast majority of sensory events can be ignored, but it is necessary to

