Review of the book

"The Theory of Information and Coding"

by Robert J. McEliece
Cambridge University Press, 2002

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# 1  Summary of the review

In this review I present "The Theory of Information and Coding" by Robert J. McEliece. This is a milestone book in design theory, and covers all the basic notions of the theory of information and coding. The second edition features many significant changes, that mirror the extensive development in the field during almost thirty years.

# 2  Summary of the book

The theory of information and coding is principally due to the foundational work of Claude Shannon (1948). It is a very vast subject, born to deal with one of the most important issues of modern society: communication. The theory, hence, has its roots in engineering, extending from there in many other areas of science such as mathematics and informatics.
This book is a self-contained introduction to the theory of information and coding, written in parallel to the author's lectures on the subject during 1972-1976, at California Institute of Technology. It is thus a very complete work that covers all the basics, intended both for specialists and non-specialists.
It is divided into two parts, preceded by a short introduction.

## 2.1  Introduction

This short section is, as advised by the author, essential for the understanding of the remainder of the book. It provides an overview of the topics that will be treated in the following chapters and serves as a starting point for the learning process.

## 2.2  Part I

Part I is dedicated mainly to Shannon's original work, and results. Fundamental concepts are presented here, such as entropy and mutual information (Chapter 1), discrete memoryless channels (Chapter 2) and sources (Chapter 3), and the special case of the Gaussian channel and source (Chapter 4). The section culminates in Chapter 5, where all the material of the previous chapters is put together to obtain the central result in information theory: the source-channel coding theory. The last chapter features a short survey that summarizes some of the important results already presented, in particular Shannon's channel coding theorem and his source coding theorem.

## 2.3   Part II

Part II, which is dedicated fully to coding theory, is where the most relevant changes to the first edition are performed. Chapter 7 is a general introduction to linear codes, providing the reader with all the basic tools such as generator and parity-check matrices, syndrome decoding and so on. What was Chapter 8 in the original book has then been expanded and revised, thus forming two distinct chapters: the first about cyclic codes in general (Chapter 8) and the second with more emphasis on BCH, and especially Reed-Solomon codes (Chapter 9), including the appropriate decoding algorithms and practical applications. The next chapters (10, 11 and 12) have been accordingly re-numbered from the previous edition. These chapters are partially, if not completely, independent from the preceding ones, presenting, respectively, convolutional codes, variable-length source coding, and a second survey similar to that of Chapter 6 for Part I.

## 2.4   Appendices

Four appendices are added at the end of the book. Appendix A provides a quick survey of Probability Theory: as remarked by the author, this is very helpful for a full understanding of Part I. Appendix B is a quite technical discussion on convex functions and Jensen's inequality. Appendix C is purely mathematical, and resumes a few results in the theory of finite fields, necessary for Part II (in particular Chapter 9). Finally, Appendix D describes an algorithm for path enumeration in directed graphs.

# 3   Style of the book

The style of the book is not very reader-friendly: the results and notions are presented almost without pause, with a tight succession of formulas, theorems and figures. The language is technical at times, and more than a few details and proofs are left as exercises. These are numerous, grouped at the end of each chapter (although examples are provided throughout the chapters); it is a good idea to at least read through them.

# 4   Would you recommend the book?

The author succeeds in presenting a self-contained introduction to the theory of information and coding. For the reasons described above, the book can end up being hard to grasp for a non-specialist, in absence of further explanation (as was the case originally, when presented alongside the author's lectures on the subject). It remains a very complete book, which I would recommend to any interested reader with at least a small background on the subject.

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