

Table of Contents

Preface

Chapter 1. Information

Shannon's Theory of Communication

Measuring Information

The Discrete Case

The Continuous Case

Efficient Coding

Information and the Brain

Digital and Analog Signals

Appendix to Chapter 1

The information content of rare versus common events and signals.

Chapter 2. Bayesian Updating

Bayes' Theorem and Our Intuitions About Evidence

Using Bayes' Rule

Informative Priors

Parameter estimation

Summary

Chapter 3. Functions

Functions of One Argument

Composition and Decomposition of Functions

Functions of More than One Argument

Predicates and Relations as Functions

Properties and Relations

The Limits to Functional Decomposition

Functions can Map to Multi-Part Outputs

Mapping to Multiple-Element Outputs does Not Increase Expressive Power

Defining particular functions

Summary: Physical/Neurobiological Implications of Facts About Functions

Chapter 4. Representations

Some Simple Examples

Notation

The Algebraic Representation of Geometry

Chapter 5. Symbols

Physical Properties of Good Symbols

Symbol Taxonomy

Summary

Chapter 6. Procedures

Algorithms

Procedures, Computation, and Symbols

Coding and Procedures

Two Senses of Knowing

A Geometric Example

Chapter 7. Computation

Formalizing Procedures

The Turing Machine

Turing Machine for the Successor Successor Function

Turing Machines for f_{is_even}

Turing Machines for f_+

Minimal Memory Structure

General Purpose Computer

Summary

Chapter 8. Architectures

One-Dimensional Look-Up Tables (If-Then Implementation)

Adding State Memory: Finite State Machines

Adding Register Memory

Summary

Chapter 9. Data Structures

Finding Information in Memory

An Illustrative Example

Procedures and the Coding of Data Structures

The Structure of the Read-Only Biological Memory

Chapter 10. Computing with Neurons

Transducers and Conductors

Synapses and the Logic Gates

The Slowness of It All

The Time-Scale Problem

Synaptic Plasticity

Recurrent Loops in Which Activity Reverberates

Chapter 11. The Nature of Learning

Learning As Rewiring

Synaptic Plasticity and the Associative Theory of Learning

Why Associations Are Not Symbols

Distributed Coding

Learning As the Extraction and Preservation of Useful Information

Updating an Estimate of One's Location

Chapter 12. Learning Time and Space

Computational Accessibility

Learning the Time of Day

Learning Durations

Episodic Memory

Chapter 13. Modularity of Learning

Example 1: Path Integration

Example 2: Learning the Solar Ephemeris

Example 3: "Associative" Learning

Summary

Chapter 14. Dead Reckoning in a Neural Net

Reverberating Circuits as Read/Write Memory Mechanisms

Implementing Combinatorial Operations by Table-Look-Up

The Full Model

The Ontogeny of the Connections?

How Realistic is The Model?

Lessons to Be Drawn

Summary

Chapter 15 Neural Models of Interval Timing

Timing An Interval on First Encounter

Dworkin's Paradox

Neurally Inspired Models

The Deeper Problems

Chapter 16. Molecular Basis of Memory

Need to Separate Theory of Memory from Theory of Learning

The Coding Question

A Cautionary Tale

Why Not Synaptic Conductance?

A Molecular or SubMolecular Mechanism?

Bringing the Data to the Computational Machinery

Is It Universal?

References

Glossary

Subject Index