

Contents

1	Prologue: What This Book Is About	1
1.1	Part I: The Basic Model	1
1.1.1	Adaptive vs. Non-adaptive Search	2
1.1.2	Q -ary Search with Lies	3
1.1.3	Half-Lies, Erasures and Other Types of Errors	4
1.1.4	Heuristics	4
1.2	Part II: More Models and Applications	4
1.2.1	Erasure Errors, Delays and Time-outs	5
1.2.2	Group Testing	5
1.2.3	Memory Faults and Resilient Search	5
1.2.4	A Model of Learning	6
1.3	Bibliographic Notes	6
 Part I The Ulam-Rényi Game and Its Variants		
2	Fault-Tolerant Search à la Ulam-Rényi	9
2.1	Introduction	9
2.1.1	The Binary Ulam-Rényi Game	10
2.2	The Volume Bound	12
2.3	Borderline States Satisfying the Volume Bound with Equality	17
2.4	The Solution of the 20 Question Game with Lies	21
2.5	Asymptotics for the Ulam-Rényi Problem	23
2.6	Heuristics for the Ulam-Rényi Problem	24
2.6.1	Experimental Validation of the Heuristics	27
2.7	Bibliographic Notes	28
2.8	Exercises	29
3	Adaptive vs. Non-adaptive Search	31
3.1	Coding in a Channel with Noiseless Feedback	31
3.2	No Feedback Equals Error-Correcting Codes	32

3.3	Elements of the Theory of Error-Correcting Codes	33
3.3.1	Linear and Hamming Codes.....	35
3.3.2	MDS Codes and the Reed-Solomon Codes.....	36
3.3.3	Bounds on Codes	38
3.4	Fault-Tolerant q -ary Search and Minimum Feedback	40
3.4.1	Fault-Tolerant q -ary search.....	42
3.4.2	Perfect Strategies and Least Adaptiveness: $M = q^m$	44
3.4.3	Arbitrary Cardinality of the Search Space: Least Adaptive Quasi-perfect Strategies	51
3.5	Some Finite Exact Results for the q -ary Adaptive Ulam-Rényi game	56
3.6	Bibliographic Notes.....	62
3.7	Exercises.....	63
4	Weighted Errors over a General Channel.....	65
4.1	Introduction	65
4.2	Two-Batch Search with Weighted Lies	65
4.3	The Lower Bound: The Winning Strategy	68
4.3.1	The First Batch of Questions	68
4.3.2	The Second Batch of Questions	70
4.4	The Upper Bound	71
4.5	Other Noise Models: Unidirectional Errors.....	74
4.6	Bibliographic Notes.....	75
4.7	Exercises.....	76
5	Variations on a Theme of Ulam and Rényi: More Types of Questions and Lies	77
5.1	Comparison-Based Search: The Multiple-Interval Queries	77
5.2	Query Optimal Multi-interval Search with $k = O(e^2)$	78
5.2.1	The Case of Two Lies: A Canonical Representation of States and 2-Interval Queries	87
5.2.2	About Comparison Questions	89
5.3	Linearly Bounded Number of Lies	90
5.4	Prefix-Bounded Numbers of Lies	96
5.5	Bibliographic Notes.....	97
5.6	Exercises.....	97
 Part II Other Models		
6	Delays and Time Outs	101
6.1	Search with Fixed Batches of Questions and Variable Delay in Answers	102
6.2	Search with Variable Batches and Delays.....	115
6.3	Lost Answers and Delays	122
6.3.1	Extensions and Generalizations	127
6.3.2	The Proof of Proposition 6.1	129

6.3.3	Broadcast with Latency vs. Search with Delay	133
6.4	Bibliographic Notes	136
6.5	Exercises	137
7	Group Testing	139
7.1	Group Testing with Subset Tests	140
7.1.1	The (p, v, n) -SUPER-SELECTOR	141
7.1.2	Approximate Group Testing	143
7.1.3	Bounds on the Size of a (p, v, n) -SUPER-SELECTOR	144
7.2	Interval Group Testing	147
7.2.1	Non-adaptive Fault-Tolerant Interval Group Testing	149
7.2.2	Two-Stage Fault-Tolerant Interval Group Testing	151
7.3	Some Typical Applications of Group Testing in Computational Biology	169
7.4	Bibliographic Notes	171
7.5	Exercises	172
8	Resilient Search	175
8.1	The Definition of the Problem and a Lower Bound	175
8.2	Randomized Resilient Search	177
8.3	Optimal Deterministic Resilient Search	179
8.3.1	The Verification Procedure	181
8.4	Bibliographic Notes	183
8.5	Exercises	184
9	A Model for Learning	185
9.1	Computational Learning	185
9.2	Predicting from Expert Advice	186
9.3	Learning in Noisy Environments	188
9.3.1	Rényi's Probabilistic Example	188
9.3.2	Learning with Negative Reinforcement	188
9.3.3	Supervised Learning for Online Prediction	192
9.4	Bibliographic Notes	197
9.5	Exercises	198
	Bibliography	199

Fault-Tolerant Search Algorithms

Reliable Computation with Unreliable Information

Cicalese, F.

2013, XV, 207 p. 14 illus., Hardcover

ISBN: 978-3-642-17326-4