CONTENTS

Chapter 1

	INTRODUCTION	1
1.1	Networks and shortest paths	1
1.2	Algorithms	2
1.3	How to evaluate an algorithm	3
1.4	The organization of the monograph	3

Chapter 2

FINDING THE SHORTEST DISTANCES FROM A FIXED NODE TO ALL OTHER NODES IN N-NODE NON-NEGATIVE DISTANCE NETWORKS 6

2.1	Introduction	6
2.2	Notation	8
2.3	Algorithm 2.3	9
2.4	Justification of Algorithm 2.3	11
2.5.	The efficiency of Algorithm 2.3	11
2.6	An empirical study on the efficiency of Algorithm 2.3 on a computer	15
2.7	Applications of Algorithm 2.3	. 16
2.1A	Appendix 2.1 A "matrix" algorithm for finding all shortest paths from a fixed node in a non-negative distance network	17
2.2A	Appendix 2.2 FORTRAN IV computer programs for Algorithm 2.3 and Dijkstra's algorithm as suggested by Dreyfus	20

Chapter 3

	FINDING THE SHORTEST DISTANCES BETWEEN ALL PAIRS OF NODES IN	
	NON-NEGATIVE DISTANCE NETWORKS	23
3.1	Introduction	23
3.2	Algorithm 3.2	24
3.3	Floyd's and Hoffman and Winograd's algorithms	26
3.4	Dantzig's algorithm and its improvement by Tabourier	33

3.5	Algorithm 3.5	37
3.6	Algorithm 3.6	41
3.7	Algorithm 3.7	43
3.1A	Appendix 3.1 FORTRAN IV computer programs for Algorithm 3.2 Algorithm 3.3.1 (Floyd), and Algorithm 3.3.2	49

Chapter 4

	FINDING ALL SHORTEST DISTANCES FROM A FIXED NODE IN GENERAL NETWORKS	52
4.1	Introduction	52
4.2	Algorithm 4.2	53
4.2.1	Notation	53
4.2.2	Algorithm 4.2	54
4.2.3	Proof of Algorithm 4.2	55
4.2.4	The efficiency of Algorithm 4.2	56
4.2.5	A "matrix" algorithm of Algorithm 4.2	57
4.3	Algorithm 4.3	61
4.3.1	Notation	61
4.3.2	Algorithm 4.3	62
4.3.3	Proof of Algorithm 4.3	63
4.3.4	A five node example	66
4.3.5	Efficiency of Algorithm 4.3	67
4.3.6	Comparison of Algorithms	68

Chapter 5

	FINDING THE SHORTEST DISTANCES BETWEEN ALL PAIRS OF NODES IN GENERAL NETWORKS	72
5.1	Introduction	72
5.2	Algorithm 5.2	73
5.3	Algorithm 5.3	76
5.4	Comparison of the efficiencies of different algorithms for finding all shortest distances in general networks	80

Chapter 6

	EFFICIENCIES OF ALGORITHMS FOR DETECTING THE EXISTENCE OF NEGATIVE CYCLES IN GENERAL NETWORKS	82
6.1	Introduction	82
6.2	The computational bounds of different algorithms for detecting the existence of negative cycles in general networks	82
6.3	An empirical study	85
6.4	Conclusions based on the empirical study	88

Chapter 7

	FINDING THE SHORTEST DISTANCES BETWEEN ALL PAIRS OF NODES IN NON-CIRCULAR SPARSE NETWORKS BY DECOMPOSITION ALGORITHMS	90
7.1	Introduction	90
7.2	Decomposition algorithms for finding all shortest distances in the first type of linearly overlapping network	92
7.2.1	Algorithm 7.2.1 for finding all key shortest distance submatrices in the first type of linearly overlapping sparse network.	93
7.2.2	Algorithm 7.2.2 for finding all non-key shortest distance submatrices in the first type of linearly overlapping sparse network	97
7.3	Decomposition algorithm for finding all shortest distances in the second type of linearly overlapping sparse network	9 9
7.3.1	Algorithm 7.3.1 for finding all key shortest distance submatrices in the second type of linearly overlapping sparse network	100
7.3.2	Algorithm 7.3.2 for finding all non-key shortest distance submatrices in the second type of linearly overlapping sparse network	104
7.4	Algorithm 7.4 for finding all shortest distances in star-shaped sparse networks.	106
7.5	Decomposition algorithms for finding all shortest distances in non-circular sparse networks	109
7.5.1	Algorithm 7.5.1 for finding all key shortest distance submatrices in non-circular sparse networks	110
7.5.2	Algorithm 7.5.2 for finding all non-key distance submatrices in non-circular sparse networks.	113
7.5.3	The efficiency of Algorithms 7.5.1 and 7.5.2	114
7.6	Extension	115

Chapter 8

	FINDING THE SHORTEST DISTANCES BETWEEN ALL PAIRS OF NODES IN CIRCULAR SPARSE NETWORKS BY DECOMPOSITION ALGORITHMS	117
8.1	Introduction	117
8.2	Decomposition algorithms for finding all shortest distances in donut-shaped sparse networks.	118
8.2.1	Algorithm 8.2.1 (a node-elimination approach)	120
8.2.2	Algorithm 8.2.2 (an arc-elimination approach)	123
8.3	Algorithm 8.3 for finding all shortest distances in a first-degree circular sparse network.	126
8.4	Decomposition algorithm for finding all shortest distances in a wheel-shaped sparse network	127
8.4.1	Algorithm 8.4.1 (a node-elimination approach)	129
8.4.2	Algorithm 8.4.2 (an arc-elimination approach)	131
8.4.3	Algorithm 8.4.3 (an arc-node-elimination approach)	133
8.5	Algorithm 8.5 for finding all shortest distances in second-degree circular sparse networks	135
8.6	Decomposition algorithms for finding all shortest distances in an n-degree circular sparse network	137

Chapter 9

FINDING THE K SHORTEST LOOPLESS PATHS BETWEEN A PAIR OF NODES IN A NETWORK 141

9.1	Algorithm 9.1 for finding the K shortest loopless paths between a pair of nodes in general networks	141
9.2	Algorithm 9.2 for finding the K shortest loopless paths between a pair of nodes in non-negative distance networks	146

BIBLIOGRAPHY

149