Contents

Part I: Biological Computing and Optimization							
1	Bio-inspired Computing						
2	2 Combinatorial Optimization						
Pa	rt II:	Ant Algorithms					
3	Intr	oduction	31				
	3.1	Multi-agent Systems	32				
	3.2	Ant Programming Approach to Combinatorial					
		Optimization	33				
	3.3	Solving Optimization Problems Using Bio-inspired					
		Algorithms	41				
	3.4	Mathematical Analysis of ACO: Hyper-Cube Model	42				
	3.5	\mathcal{NP} -hard Problems Addressed	43				
4	Loc	al Guided Ant Search	57				
_	4.1	Inner-Reinforced Local Search.	58				
	4.2	Solving the Traveling Salesman Problem Using					
		Inner-Reinforced Local Search	59				
	4.3	Solving the Generalized Traveling Salesman Problem with					
		Reinforcing ACS	66				
	4.4	Solving the Railway Traveling Salesman Problem with					
		Reinforcing ACS	72				
5	Sen	sitivity: A Metaheuristic Model	81				
	5.1	Heterogeneous Sensitive Ants	82				
	5.2	Sensitive Ants	85				

X	Contents

8 Pa	8.1 8.2 8.3	Probl Solvin Solvin Solvin Mode Solvin Mode	ing the Dynamic Railway Traveling Salesman item	134 138 143 144 149
	7.4 Age 8.1 8.2 8.3	Probl Solvin Ent-Ba Solvin Solvin Mode Solvin Mode	ng the Dynamic Large Drilling Problem	134 138 143 144
8	7.4 Age 8.1 8.2	Probl Solvin Solvin Solvin Mode Solvin	lem	134 138 143 144
8	7.4 Age 8.1 8.2	Probl Solvin Ent-Ba Solvin Solvin Mode	ng the Dynamic Large Drilling Problem	134 138 143 144
8	7.4 Age 8.1	Probl Solvin e nt-B a Solvin	ng the Dynamic Large Drilling Problem	134 138 143
8	7.4	Probl Solvii	lem	134 138
		Probl	lem	134
	7 ')	متعملين	ag the Dymanie Bailway Traveling Salagnan	
	7.2	Probl	ng the Dynamic Generalized Vehicle Routing	130
	7.1	Solvii Probl	ng the Dynamic Generalized Traveling Salesman	
7	Ant	-Base	ed Algorithms for Dynamic Problems	125
Pa	rt IV	: Ap	oplications with Bio-inspired Algorithms	
	6.3		ning Sensitive Stigmergic Agents	
6	Stig 6.1 6.2	Stigm	ic Collaborative Agents nergic Agents tive Stigmergic Agents	107
Pa	rt III	: Bi	o-inspired Multi-agent Systems	
		0.0.1	Robots	100
	5.3		Solving the Emear Ordering Problem	99
		5.2.3	with Sensitive Ants	89 95
		5.2.2	with Sensitive AntsSolving the Generalized Vehicle Routing Problem	00
			111 C 111 A 1	86