Contents

Foreword **xv**

1 Introduction **1**
1.1 Motivation and Overview . . . 3
1.2 Problem Domain . . . 7
1.3 Contributions . . . 10
1.4 Publications . . . 11
1.5 Outline of the Thesis . . . 11

2 CBR Preliminaries and Related Work **13**
2.1 Case Based Reasoning . . . 13
2.2 CBR Applied to RoboCup . . . 16
2.2.1 Karol et al. . . . 16
2.2.2 Lin, Chen and Liu . . . 16
2.2.3 Berger and Lämmel . . . 17
2.2.4 Wendler et. al . . . 17
2.2.5 Marling et al. . . . 18
2.2.6 Ahmadi et al. . . . 19
2.2.7 Steffens . . . 19
2.3 Other Models Applied to RoboCup . . . 20
2.3.1 Learning from Observation or Imitation . . . 20
2.3.2 Reinforcement Learning . . . 21
2.3.3 Pattern Recognition . . . 22
2.3.4 Fuzzy Theory . . . 23
2.3.5 Planning . . . 24
2.3.6 Neural Networks . . . 25
2.3.7 Evolutionary Algorithms . . . 25
2.3.8 Other Approaches . . . 26
2.4 CBR Applied to Other Robotic-Related Domains . . . 27
2.5 Summary . . . 29

http://libros.csic.es

3 The Retrieval Step **33**
3.1 Case Definition . . . 33
3.1.1 Problem Description . . . 33
3.1.2 Solution Description . . . 35
3.1.3 Case Scope Representation . . . 37
3.1.4 Case Example . . . 38
3.2 Case Base Description . . . 39
3.3 Case Retrieval . . . 40
3.3.1 Similarity Measure . . . 41
3.3.2 Cost Measure . . . 45
3.3.3 Case Applicability Measure . . . 48
3.3.4 Case Filtering . . . 51
3.3.5 Experiments . . . 54
3.4 Conclusions and Future Work . . . 60

4 Case Reuse through a Multi-Robot System **63**
4.1 Robot Architecture . . . 63
4.1.1 Deliberative System . . . 65
4.1.2 Executive System . . . 66
4.2 Multi-Robot System and Case Reuse . . . 67
4.3 Conclusions and Future Work . . . 71

5 Learning the Scopes of Cases **73**
5.1 Scope Adaptation Algorithm . . . 74
5.1.1 When to Adjust the Values . . . 75
5.1.2 How to Adjust the Values . . . 76
5.1.3 Example . . . 79
5.2 Acquiring New Cases . . . 80
5.3 Experiments . . . 80
5.3.1 Simulation Experiments . . . 81
5.3.2 Real World Experiments . . . 83
5.4 Conclusions and Future Work . . . 90

6 Experimentation **93**
6.1 CBR System Settings . . . 94
6.2 Experiments Setup . . . 99
6.2.1 Robot's Behaviors . . . 99
6.2.2 The Scenarios . . . 100
6.2.3 Evaluation Measures . . . 102
6.3 Simulation Experiments . . . 102
6.3.1 The Simulator . . . 102
6.3.2 Simulation Results . . . 103
6.4 Real Robot Experiments . . . 108
6.4.1 The Robots . . . 108
6.4.2 Results . . . 110
6.5 A Trial Example . . . 117

http://libros.csic.es

6.6 Discussion and Future Work 129

7 Conclusions and Future Work **131**
7.1 Summary of the Contributions 131
7.2 Future Directions 133

Bibliography **137**

http://libros.csic.es