

Table of Contents

Introduction	ix
Chapter 1. Context	1
1.1. Embedded systems	2
1.1.1. Main components of embedded systems . .	3
1.2. Memory management for decreasing power consumption, performance and area in embedded systems	4
1.3. State of the art in optimization techniques for memory management and data assignment . .	8
1.3.1. Software optimization	9
1.3.2. Hardware optimization	11
1.3.3. Data binding	16
1.3.3.1. Memory partitioning problem for low energy	17
1.3.3.2. Constraints on memory bank capacities and number of accesses to variables . .	18
1.3.3.3. Using external memory	19
1.4. Operations research and electronics	21
1.4.1. Main challenges in applying operations research to electronics	23

Chapter 2. Unconstrained Memory Allocation Problem	27
2.1. Introduction	28
2.2. An ILP formulation for the unconstrained memory allocation problem	31
2.3. Memory allocation and the chromatic number	32
2.3.1. Bounds on the chromatic number	33
2.4. An illustrative example	35
2.5. Three new upper bounds on the chromatic number	38
2.6. Theoretical assessment of three upper bounds	45
2.7. Computational assessment of three upper bounds	49
2.8. Conclusion	53
Chapter 3. Memory Allocation Problem With Constraint on the Number of Memory Banks	57
3.1. Introduction	58
3.2. An ILP formulation for the memory allocation problem with constraint on the number of memory banks	61
3.3. An illustrative example	64
3.4. Proposed metaheuristics	65
3.4.1. A tabu search procedure	66
3.4.2. A memetic algorithm	69
3.5. Computational results and discussion	71
3.5.1. Instances	72
3.5.2. Implementation	72
3.5.3. Results	73
3.5.4. Discussion	75
3.6. Conclusion	75

Chapter 4. General Memory

Allocation Problem	77
4.1. Introduction	78
4.2. ILP formulation for the general memory allocation problem	80
4.3. An illustrative example	84
4.4. Proposed metaheuristics	85
4.4.1. Generating initial solutions	86
4.4.1.1. Random initial solutions	86
4.4.1.2. Greedy initial solutions	86
4.4.2. A tabu search procedure	89
4.4.3. Exploration of neighborhoods	91
4.4.4. A variable neighborhood search hybridized with a tabu search	93
4.5. Computational results and discussion	94
4.5.1. Instances used	95
4.5.2. Implementation	95
4.5.3. Results	96
4.5.4. Discussion	97
4.5.5. Assessing TabuMemex	101
4.6. Statistical analysis	105
4.6.1. <i>Post hoc</i> paired comparisons	106
4.7. Conclusion	107

Chapter 5. Dynamic Memory

Allocation Problem	109
5.1. Introduction	110
5.2. ILP formulation for dynamic memory allocation problem	113
5.3. An illustrative example	116
5.4. Iterative metaheuristic approaches	119
5.4.1. Long-term approach	119
5.4.2. Short-term approach	122
5.5. Computational results and discussion	123
5.5.1. Results	124

5.5.2. Discussion	125
5.6. Statistical analysis	128
5.6.1. <i>Post hoc</i> paired comparisons	129
5.7. Conclusion	130
Chapter 6. MemExplorer: Cases Studies	131
6.1. The design flow	131
6.1.1. Architecture used	131
6.1.2. MemExplorer design flow	132
6.1.3. Memory conflict graph	134
6.2. Example of MemExplorer utilization	139
Chapter 7. General Conclusions and Future Work	147
7.1. Summary of the memory allocation problem versions	147
7.2. Intensification and diversification	149
7.2.1. Metaheuristics for memory allocation problem with constraint on the number of memory banks	149
7.2.1.1. Tabu-Allocation	149
7.2.1.2. Evo-Allocation	151
7.2.2. Metaheuristic for general memory allocation problem	151
7.2.3. Approaches for dynamic memory allocation problem	152
7.3. Conclusions	152
7.4. Future work	154
7.4.1. Theoretical perspectives	154
7.4.2. Practical perspectives	156
Bibliography	159
Index	181