Evolutionary Computing in Advanced Manufacturing

Edited by
Manoj Tiwari
Dept. of Industrial Engineering and Management, Indian Institute of Technology, Kharagpur, India

and
Jenny A. Harding
Wolfson School of Mechanical and Manufacturing Engineering, Loughborough University, UK
Contents

Preface xiii
List of Contributors xvii

1. Production Planning Using Genetic Algorithm 1
   S.K. Kumar and M.K. Tiwari
   1.1 Introduction 1
   1.2 Production Planning Models 2
      1.2.1 Mathematical Model 3
   1.3 Genetic Algorithm 9
      1.3.1 Procedure of Genetic Algorithm (GA) 10
   1.4 Implementation of GA 15
      1.4.2 Parameter Tuning 16
   1.5 Summary 18
   Further Reading 18

2. Process Planning through Ant Colony Optimization 19
   Puneet Bhardwaj and M.K. Tiwari
   2.1 Introduction 19
   2.2 Ant Colony Optimization (ACO) 25
      2.2.1 Problem Description 27
      2.2.2 Case Problem 28
      2.2.3 Results 31
   References 33

3. Introducing a Hybrid Genetic Algorithm for Integration of Set Up and Process Planning 37
   S.H. Chung and F.T.S. Chan
   3.1 Introduction 38
   3.2 Process Planning 38
   3.3 Machine Set-up Time 39
      3.3.1 Optimization Methodology:
         Genetic Algorithms (GA) 41
   3.4 Chromosome Representation 43
   3.5 Fitness Value Evaluation 44
   3.6 Selection Operation 45
   3.7 Crossover Operations 47
CONTENTS

3.8 Mutation Operations (k-opt exchange) 47
3.9 Conclusion 48
References 48

4. Design for Supply Chain with Product
Development Issues Using Cellular Particle
Swarm Optimization (CPSO) Technique 51
Vikas Kumar and F.T.S. Chan
4.1 Introduction 52
4.2 Problem Formulation 55
  4.2.1 Notations 56
  4.2.2 Simulated Problem 60
  4.2.3 Particle Swarm Algorithm (PSO) 63
  4.2.4 Cellular Particle Swarm Optimization
     (CPSO) Algorithm 67
  4.2.5 CPSO-outer Algorithm 69
4.3 Computational Analysis and Result 71
4.4 Conclusions 74
References 75

5. Genetic Algorithms with Chromosome
Differentiation (GACD) Based Approach
for Process Plan Selection Problems 77
Nishikant Mishra and Vikas Kumar
5.1 Introduction 77
5.2 Problem Formulation 80
5.3 Genetic Algorithm with Chromosome
Differentiation 81
  5.3.1 Overview of GA 81
  5.3.2 Genetic Algorithm Incorporating
     Chromosome Differentiation 82
  5.3.3 Description of GA with Chromosome
     Differentiation 82
5.4 GACD Based Solution Methodology to
Process Plan Selection Problem 86
  5.4.1 Selection of GACD's Parameter 90
5.5 Numerical Experiments 90
5.6 Conclusions 92
References 92
6. Operation Allocation in Flexible Manufacturing System Using Immune Algorithm 95

Mayank K. Pandey

6.1 Introduction 96
6.2 Machine Loading Problem 100
   6.2.1 Problem Formulation 103
6.3 Solution Methodology 106
   6.3.1 Introduction to Immune System and Analogy to Immune Algorithm 106
   6.3.2 Modified Immune Algorithm Used to Solve Machine Loading Problem (Prakash et al. 2008) 108
   6.3.3 Fast Clonal Algorithm (Khilwani et al., 2008) 113
6.4 Implementing Immune Algorithm for Machine Loading Problem 113
6.5 Computational Result 114
6.6 Conclusion 117
References 119

7. Tool Selection in FMS A Hybrid SA-Tabu Algorithm Based Approach 123

Nitesh Khilwani, J/A. Harding and Nishikant Mishra

7.1 Introduction 124
7.2 Literature Survey 125
7.3 Problem Formulation 127
7.4 Background on SA-Tabu Heuristic 130
   7.4.1 Simulated Annealing 130
   7.4.2 Tabu Search 131
   7.4.3 Simulated Annealing-Tabu 133
7.5 Implementation of Tabu-Simulated Annealing 133
   7.5.1 Notations Used in SA-Tabu Heuristic 133
   7.5.2 Steps of the Hybrid SA-Tabu Heuristic 134
   7.5.3 Representation 135
   7.5.4 Search Parameters 136
7.6 Test Cases 139
7.7 Conclusion 144
References 148
8. Integrating AGVs and Production Planning with Memetic Particle Swarm Optimization

Sri Krishna Kumar, M.K. Tiwari and J. Harding

8.1 Introduction

8.1.1 Production and AGVs Scheduling
8.1.2 AGVs Routing

8.2 Literature Review

8.3 Mathematical Model

8.3.1 Problem Statement
8.3.2 Mathematical Programming Model

8.4 PSO and EMPSO

8.5 Example

8.6 Recombination (Local Search)

8.7 Summary

References

9. Simulation-Based Aircraft Assembly Planning Using a Self-Guided Ant Colony Algorithm

Sai Srinivas Nageshwaraniyer, Nurcin Celik, Young-Jun Son and Roberto Lu

9.1 Introduction

9.2 Background and Literature Survey

9.2.1 Assembly Planning in Aircraft Manufacturing
9.2.2 Self-Guided Ant Colony Algorithm

9.3 Specifications of the Considered Aircraft Assembly

9.4 Proposed Simulation-Based Assembly Planning Framework

9.4.1 Overview of the Proposed Framework
9.4.2 Mathematical Formulation
9.4.3 Details of Self Guided Ant Colony Algorithm (SGAC)

9.5 Experiment and Results

9.5.1 Effect of Rework on the Total Lead Time
9.5.2 Effect of Size of the Order on the Average Utilization of Workstations

9.6 Conclusion and Future Work

References
12.3 Problem Description 263
  12.3.1 Problem Statement 264
  12.3.2 Formulation of the Model 265
12.4 Evolutionary Solution Approaches 268
  12.4.1 Solution Encoding 269
  12.4.2 Genetic Algorithm with Integer Programming (GAIP) 269
  12.4.3 Pure Probability Based Heuristic Approach 271
  12.4.4 Extension to Independent Demand for Each Product 272
12.5 Example Problem - Results and Discussions 272
  12.5.1 Example 272
  12.5.2 Results and Discussions 273
  12.5.3 Results and Analysis Using GAIP 273
  12.5.4 The Solution Quality of PHA and Comparison with the GAIP Approach 275
  12.5.5 Results When Demand of Each Product is Represented as a Probability Distribution 280
12.6 Conclusion and Recommendations for Future Research 283
References 285

13. A Hybrid Particle Swarm and Ant Colony Optimizer for Multi-attribute Partnership Selection in Virtual Enterprises 289
  S.H. Niu, S.K. Ong and A.Y.C. Nee 289
13.1 Introduction 289
13.2 Literature Review 292
13.3 Partner Selection Problem Formation 294
  13.3.1 Fundamental Variables Discussion 294
  13.3.2 Partner Selection Problem Description 295
13.4 Solution Methodology 297
  13.4.1 Particle Swarm Optimization 297
  13.4.2 Ant Colony Optimization 299
  13.4.3 Hybrid PSO-ACO 300
  13.4.4 Weights of the Criteria and the Qualitative Variables 303
13.5 Experimental Analysis 308
  13.5.1 Determine the Weights of the Main Criteria and Sub-Criteria 309
13.5.2 Evaluation of Qualitative Attributes 313
13.5.3 Evaluation of the Quantitative Aspects of the Enterprise 316
13.5.4 Results 316
13.6 Conclusion 319
Nomenclature 320
References 324

Index 327