Job Shop Scheduling Optimization Project Documentation

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1. Project Overview

Objectives

- Solve Job Shop Scheduling Problem (JSP) using evolutionary algorithms
- Minimize makespan for JSPLIB benchmark instances
- Specifically analyze the ABZ5 benchmark instance

Research Context

- Problem Type: Combinatorial Optimization
- Benchmark Library: JSPLIB
- Specific Instance: ABZ5

2. Methodology

Algorithmic Approach

- Implemented Genetic Algorithm (GA)
- Key Algorithm Components:
  1. Population Initialization
     - Population Size: 10 individuals
     - Initial population randomly generated
  2. Fitness Evaluation

- Fitness Function: Sum of chromosome values

3. Selection Method

- Roulette Wheel Selection

- Probabilistic selection based on fitness scores

4. Crossover Mechanism

- Using NumPy for chromosome manipulation

- Crossover to generate new candidate solutions

Implementation Details

- Programming Language: Python

- Key Libraries:

  - NumPy for numerical operations

  - Random for population initialization

- Evolutionary Parameters:

  - Epochs: 100 generations

  - Crossover technique: Chromosome flattening and recombination

3. Data Preparation

- Data Source: ABZ5_cleaned.txt

- Data Initialization:

  - 10x10 matrix for initial data representation

  - Text file parsing for problem instance details

4 Challenges and Limitations

- Minimal fitness function complexity

- Limited exploration of solution space

- Placeholder evolutionary logic

- Small population size may limit solution diversity

5. Potential Improvements

- Implement more sophisticated fitness evaluation
- Increase population size
- Add mutation operators
- Implement advanced selection strategies
- More complex crossover techniques

6. Preliminary Results

- Full results analysis pending
- Current implementation provides framework for JSP optimization

7. Conclusions

- Demonstrated basic genetic algorithm approach to JSP
- Established foundational code for further optimization research

8. Next Steps

- Refine algorithm parameters
- Implement more robust evolutionary strategies
- Compare performance against other optimization techniques

9. References

- JSPLIB Benchmark Instances
- Genetic Algorithm literature in Combinatorial Optimization

1. J. Adams, E. Balas, D. Zawack. "The shifting bottleneck procedure for job shop scheduling.", Management Science, Vol. 34, Issue 3, pp. 391-401, 1988.

2. J.F. Muth, G.L. Thompson. "Industrial scheduling.", Englewood Cliffs, NJ, Prentice-Hall, 1963.
3. S. Lawrence. "Resource constrained project scheduling: an experimental investigation of heuristic scheduling techniques (Supplement).", Graduate School of Industrial Administration. Pittsburgh, Pennsylvania, Carnegie-Mellon University, 1984.
4. D. Applegate, W. Cook. "A computational study of job-shop scheduling.", ORSA Journal on Computer, Vol. 3, Isuue 2, pp. 149-156, 1991.
5. R.H. Storer, S.D. Wu, R. Vaccari. "New search spaces for sequencing problems with applications to job-shop scheduling.", Management Science Vol. 38, Issue 10, pp. 1495-1509, 1992.
6. T. Yamada, R. Nakano. "A genetic algorithm applicable to large-scale job-shop problems.", Proceedings of the Second international workshop on parallel problem solving from Nature (PPSN'2). Brussels (Belgium), pp. 281-290, 1992.
7. E. Taillard. "Benchmarks for basic scheduling problems", European Journal of Operational Research, Vol. 64, Issue 2, pp. 278-285, 1993.