GENETIC ALGORITHMS FOR ACTIVITY SCHEDULING

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OUTLINE

1. Introduction
2. Formal Definition of the Algorithm
3. Analysis of the Algorithm
4. Applications
5. Conclusion

INTRODUCTION

- Activity Scheduling is a problem
- Evident in professional organizations in universities
- Complex problem

REVIEW OF RELATED LITERATURE

- Genetic Algorithms[4,5]
- Scheduling single set of exams for single set of students[1]
- Hashmap chromosome (timeslots to classes)[3]
- Two ply chromosome[2]

1 Corne, D., Fang, H.L. & Mellish, C. (1993). Solving the Modular Exam Scheduling Problem with Genetic Algorithms. Technical Report 622, Department of Artificial Intelligence, University of Edinburgh.
2 Omara, F.A. & Arafa, M.M. (2010). Genetic algorithms for task scheduling problem, Journal of Parallel and Distributed Computing, 70(1), 13-22, ISSN 0743-7315.
3 Jankovic, M. (2008). Making a Class Schedule Using a Genetic Algorithm. Retrieved July 4, 2016, from Code Project: http://www.codeproject.com/Articles/23111/Making-a-Class- Schedule-Using-a-Genetic-Algorithm
4 Mitchell, T. (1997). Machine learning. McGraw-Hill.
5 Russell, S. & Norvig, P. (2010). Artificial Intelligence: A Modern Approach, 3rd Ed. New Jersey: Prentice-Hall.

RESEARCH GAP

- None of the studies deal with a scheduling problem with tasks with target groups and venues with simple temporal constraints

RESEARCH PROBLEM

- Can a genetic algorithm effectively generate schedules with the previously mentioned constraints?

FORMAL DEFINITION OF THE ALGORITHM

Genetic Algorithm

- Uses the concept of evolutionary genetics
- Answers come from sexual reproduction of previous candidates
- Can search complex problem spaces
- Can be programmed to run in parallel

GENETIC ALGORITHM

- Main components:
  - Fitness
  - Chromosomes
    - Crossover
    - Mutation

FITNESS

How desirable a solution is

e.g. n-queens problem

Fitness is reciprocal of number of queens attacking each other.

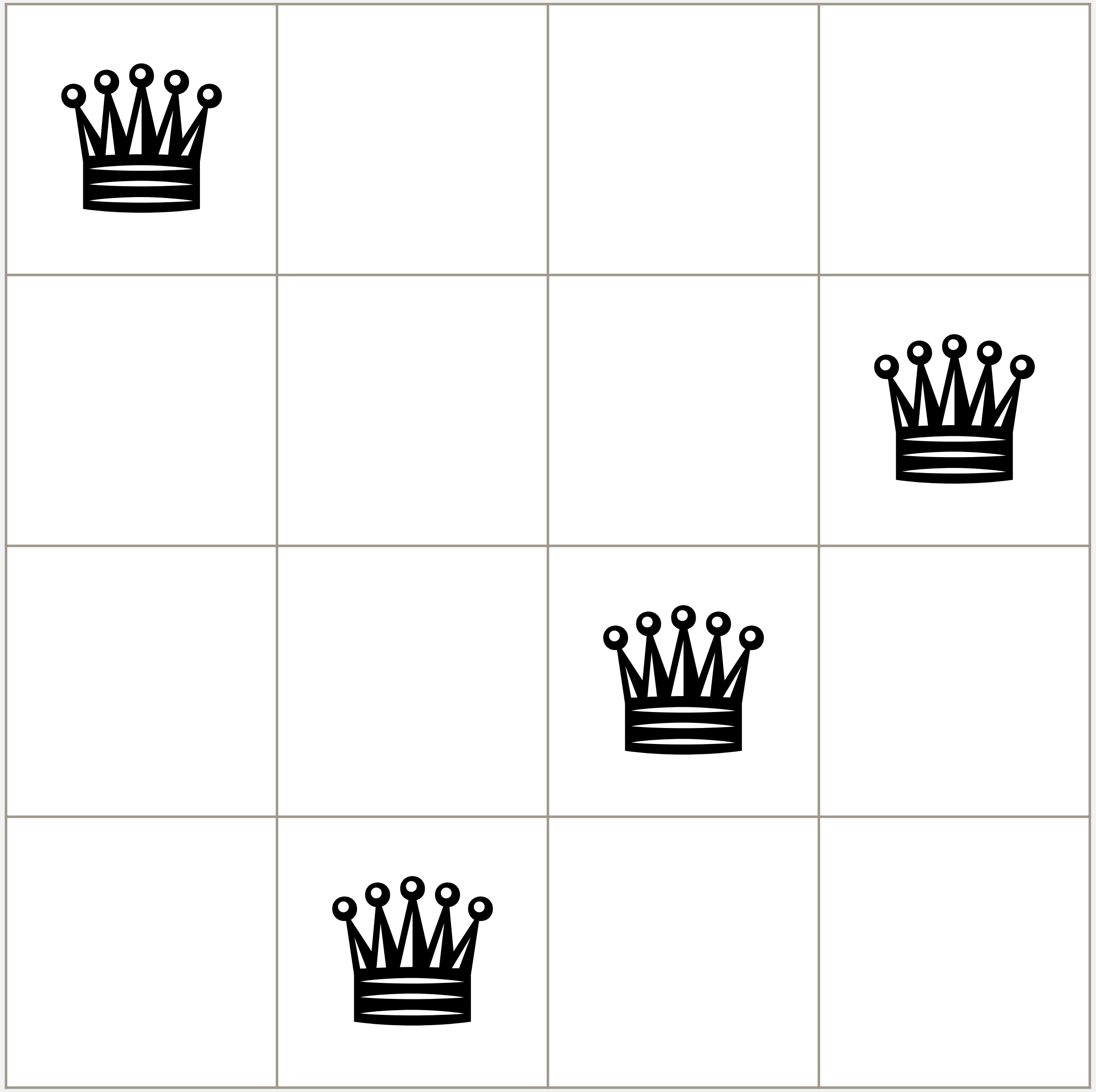
CHROMOSOME

Encoding of a solution

Must have clear distinct parts e.g. bits, hashmap

e.g. n-queens problem

a chromosome could look like the row of each queen on each column (1 4 3 2)



CHROMOSOME

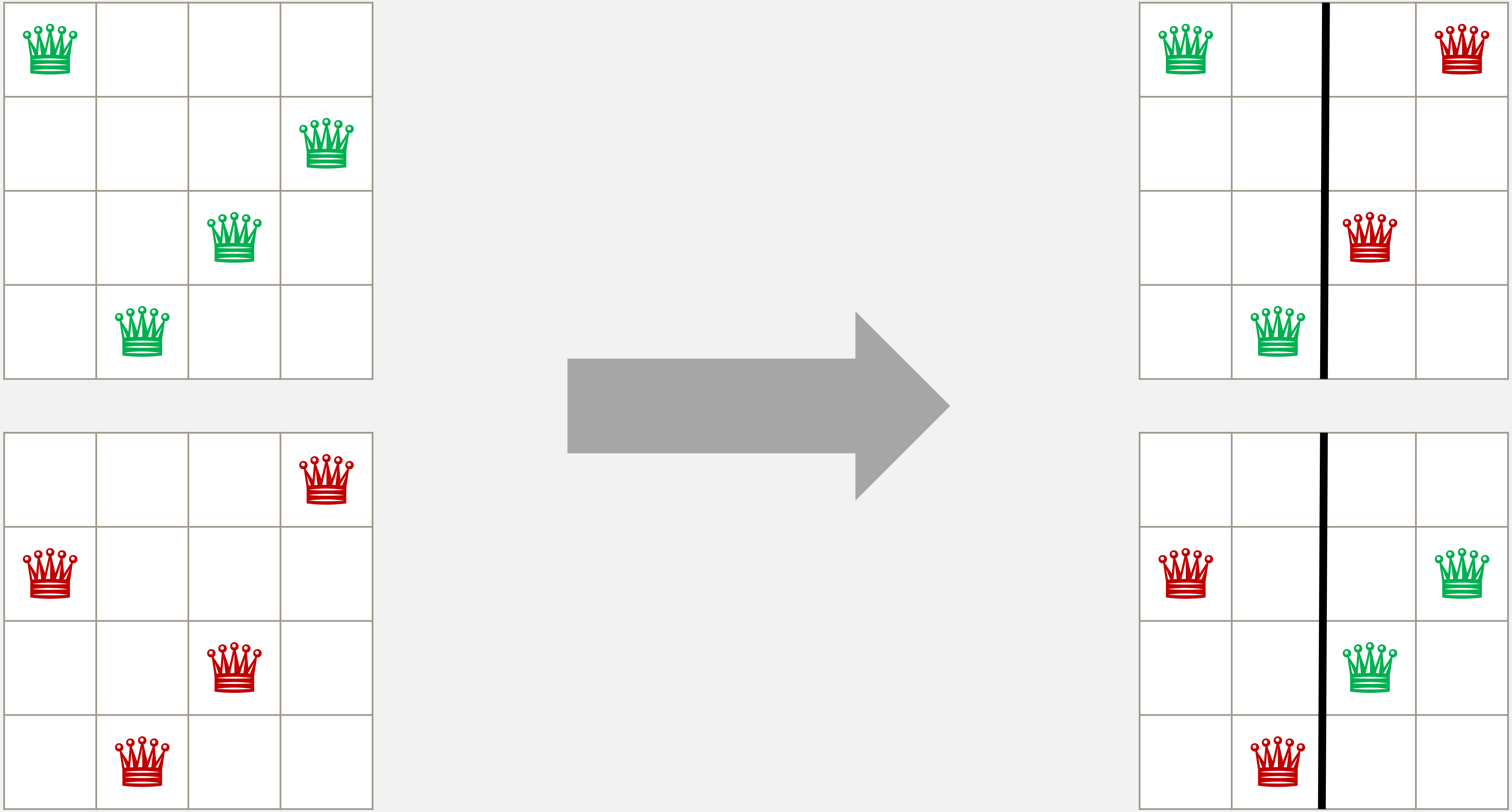
Crossover: breeding of solutions

- Crossover point

e.g. n-queens problem

breed n-queens solutions 4 1 3 2 and 2 4 3 1

result in 4 1 3 1 and 2 4 3 2



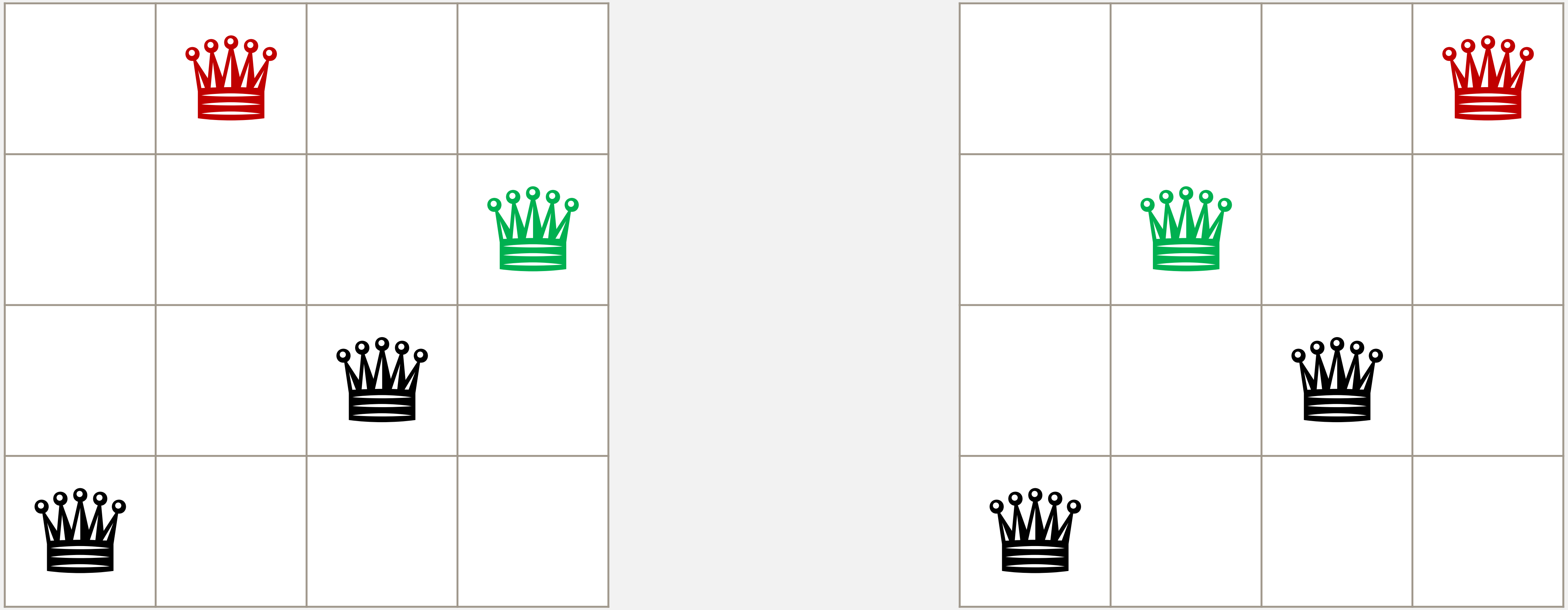
CHROMOSOME

Mutation: introducing randomness to a solution

e.g. n-queens problem

mutate n-queens solution by randomly swapping two queens

4 1 3 2 can mutate to 4 2 3 1



THE ALGORITHM

```
population = randomize population

while !termination condition
      Create new empty population
      Carry over elite clones from old population
      Breed the remainder of the population
      Mutate random members of the population
      Get best chromosome
```

THE ALGORITHM

- Termination Conditions
  - Until a fitness threshold is reached
  - Until a fixed number of generations is reached
  - Until the best solution has remained unchanged for a fixed amount of generations

CHROMOSOME SELECTION

- Roulette Wheel
- $\frac{c_{fitness}}{\sum_{x \in population} x_{fitness}}$
- E.g. Fitness = [1,10,33,6] -> probabilities = [2%,20%,66%,12%]
- Tournament Selection
- Rank Selection

ANALYSIS

- Commonly used for optimization problems
- Usually used for complex problems e.g. NP-class of problems
- GA’s prefer certain schemata
  - E.g. n-queens solution that follow the 1 4 * * schemata are better than those with a 4 * 4 * schemata
- Crowding

VS. NEURAL NETWORKS

- Neural Networks move from one hypothesis to another slowly
- GA may move quickly from one hypothesis to another

APPLICATION (ACTIVITY SCHEDULING)

- **Fitness** = 1 / (punishment + 1)
- **Punishment** = sum of all conflicts
  - For each date and time conflict regardless of target group, add 2 punishment points.
  - For each date and time conflict with intersecting target groups, add 7 punishment points.
  - For each date and time conflict with same venue, add 10 punishment points.
  - For each pair of activities where one activity takes place after the other on the same day, add 3 punishment points.
- Punishment stacks up

CHROMOSOME DESIGN

	Chromosome 1	Chromosome 2
Act 1	08/12/16 14:00:00	08/19/16 13:00:00
Act 2	09/01/16 12:30:00	09/08/16 12:45:00
Act 3	08/15/16 08:00:00	09/01/16 10:45:00
Act 4	09/03/16 11:30:00	09/05/16 12:00:00

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CHROMOSOME DESIGN

Mutation

- For each activity, with probability 0.7, randomize the schedule of that activity
- Choose a random date
- Choose a random timeslot

CHROMOSOME DESIGN

Algorithm Parameters

- Population Size: 50
- Fitness Threshold: 0.14
- Elitism Rate: 0.2
- Mutation Rate: 0.4
- Roulette Wheel Selection
- 1000 iterations

RESULTS AND ANALYSIS

- Satisfactory
- Threshold allowed few acceptable
- GOSM for LSCS as test script
- Performed well with 22 activities

CONCLUSION

- Genetic Algorithm performs well in this context
- Implementation of the data model, algorithm, and system were successful
- It is recommended to add more capabilities and constraints to the data model to better represent real life situations in scheduling

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Thank you!