CSE-318 ARTIFICIAL INTELLIGENCE SESSIONAL

# EXAM SCHEDULING

# OFFLINE 3 (LOCAL SEARCH)

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## Introduction

The exam scheduling problem is a combinatorial optimization problem that aims to schedule a set of exams and with a given set of constraints. The problem can be modeled as a graph coloring problem, where each exam is represented by a vertex, and two vertices are connected if the corresponding exams have common students. The goal is to assign a time slot or a room to each exam, such that no two exams that have common students are assigned the same time slot.

## Methodology

In this assignment, a constructive heuristics approach is used to generate an initial solution to the exam scheduling problem. The approach uses four heuristics: DSatur, Largest Degree, Largest Enrollment, and Random Ordering. The heuristics aim to assign a color to the vertices in such a way that the number of conflicts (i.e., edges between vertices of the same color) is minimized.

To further improve the solution, a penalty function based on the exponential approach is used. The penalty is calculated when two courses of the same student fall in less than six days. The goal is to minimize the penalty while keeping the courses conflict free. To achieve this, local search techniques such as Kempe-chain interchange and pair swap heuristic are applied.

## Outputs on Benchmark Dataset

| Benchmark Data | Known Best Solution | | Scheme - 1 Largest Degree + Kempe + Pairswap | | | |
|---|---|---|---|---|---|---|
| | | | Time Slots | Penalty | | |
| | Time Slots | Penalty | | After Largest Degree | After Kempe | After Pairswap |
| CARF92 | 32 | 3.74 | 32 | 10.61 | 5.5 | 4.87 |
| CARS91 | 35 | 4.42 | 35 | 11.72 | 6.68 | 5.92 |
| KFU93 | 20 | 12.96 | 20 | 46.47 | 16.97 | 14.38 |
| TRE92 | 23 | 7.75 | 22 | 15.81 | 10.71 | 10.23 |
| YOR83 | 21 | 34.84 | 23 | 65.62 | 36.99 | 36.06 |

| Benchmark Data | Known Best Solution | | Scheme - 2 Saturation Degree + Kempe + Pairswap | | | |
|---|---|---|---|---|---|---|
| | | | Time Slots | Penalty | | |
| | Time Slots | Penalty | | After Saturation Degree | After Kempe | After Pairswap |
| CARF92 | 32 | 3.74 | 30 | 9.69 | 5.84 | 5.34 |
| CARS91 | 35 | 4.42 | 31 | 12.45 | 7.67 | 7 |
| KFU93 | 20 | 12.96 | 19 | 46.7 | 18.79 | 16.97 |
| TRE92 | 23 | 7.75 | 23 | 15.92 | 10.31 | 9.85 |
| YOR83 | 21 | 34.84 | 20 | 61.66 | 45.56 | 44.9 |

| Benchmark Data | Known Best Solution | | Scheme - 3 Largest Enrollment + Kempe + Pairswap | | | |
|---|---|---|---|---|---|---|
| | | | Time Slots | Penalty | | |
| | Time Slots | Penalty | | After Largest Enrollment | After Kempe | After Pairswap |
| CARF92 | 32 | 3.74 | 35 | 10.69 | 4.79 | 4.11 |
| CARS91 | 35 | 4.42 | 36 | 13.78 | 6.26 | 5.53 |
| KFU93 | 20 | 12.96 | 21 | 54.5 | 14.82 | 13.47 |
| TRE92 | 23 | 7.75 | 22 | 16.34 | 10.66 | 10.2 |
| YOR83 | 21 | 34.84 | 24 | 63.87 | 34.28 | 33.26 |

| Benchmark Data | Known Best Solution | | Scheme - 4<br>Random Ordering + Kempe + Pairswap | | | |
|---|---|---|---|---|---|---|
| | | | Time Slots | Penalty | | |
| | Time Slots | Penalty | | After Random Ordering | After Kempe | After Pairswap |
| CARF92 | 32 | 3.74 | 43 | 7.61 | 3.97 | 3.11 |
| CARS91 | 35 | 4.42 | 45 | 9.44 | 5.16 | 4.09 |
| KFU93 | 20 | 12.96 | 25 | 38.52 | 12.08 | 9.99 |
| TRE92 | 23 | 7.75 | 28 | 13.12 | 7.61 | 7.02 |
| YOR83 | 21 | 34.84 | 27 | 48.87 | 28.26 | 27.26 |

| Benchmark Data | Known Best Solution | | Scheme - 2 (Linear Penalty)<br>Saturation Degree + Kempe + Pairswap | | | |
|---|---|---|---|---|---|---|
| | | | Time Slots | Penalty | | |
| | Time Slots | Penalty | | After Saturation Degree | After Kempe | After Pairswap |
| CARF92 | 32 | 3.74 | 30 | 6.28 | 3.92 | 3.56 |
| CARS91 | 35 | 4.42 | 31 | 8.05 | 5.02 | 4.66 |
| KFU93 | 20 | 12.96 | 19 | 28.99 | 12.35 | 11.45 |
| TRE92 | 23 | 7.75 | 23 | 10.13 | 6.47 | 6.21 |
| YOR83 | 21 | 34.84 | 20 | 38.92 | 29.81 | 29.78 |

## Conclusion

It is observed that as the total number of time slots decreases, the penalty calculated by the exponential approach increases. This indicates that there is a trade-off between the number of time slots and the number of conflicts between exams of the same student. To balance this trade-off, local search techniques such as Kempe-chain interchange and pair swap heuristic were applied to further improve the solution and reduce the penalty.