Report on the Effectiveness of Constructive and Perturbation Heuristic in Local Search Optimization Problem

CSE318 Artificial Intelligence

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I. Problem Statement

We were to design an exam timetable of students using local search, given all the ids of the courses taken by each student. In the end, we had to output a day-wise plan of exam scheduling of the courses. Two exams for the same student cannot be scheduled on the same day If two exams of the same student are set close to one another, a penalty amount will be incurred.

The primary goal is to minimize the number of timeslots needed for the problem. The secondary goal is to minimize the penalty amount of your scheduling.

II. Result

Epochs = 3000 for all experiments.

1. Linear Penalty

1.1 With Largest Degree Heuristic

Benchmark Data	Known Best Solution		Scheme -1 Largest-Degree + Kempe + PairSwap			
			Timeslots	Penalty		
	Timeslots	Penalty		After Largest Degree	After Kempe	After Pairwise
CAR-S-91	35		37	7.44	4.97	4.35
CAR-F-92	32		33	6.17	4.35	3.74
KFU-S-93	20		21	28.87	14.39	12.21
TRE-S-92	23		24	9.64	7.05	6.33
YOR-F-83	21		22	39.11	31.27	29.97

2. Exponential Penalty

2.1 With Largest Degree Heuristic

Benchmark Data	Known Best Solution		Scheme -1 Largest-Degree + Kempe + PairSwap			
			Timeslots	Penalty		
	Timeslots	Penalty		After Largest Degree	After Kempe	After Pairwise
CAR-S-91	35	4.42	37	11.62	7.57	6.31
CAR-F-92	32	3.74	33	9.50	7.28	5.90
KFU-S-93	20	12.96	21	46.28	25.85	21.24
TRE-S-92	23	7.75	24	14.87	11.58	10.10
YOR-F-83	21	34.84	22	61.88	46.35	44.11

2.2 With Saturation Degree Heuristic

Benchmark Data	Known Best Solution		Scheme -1 Largest-Degree + Kempe + PairSwap			
			Timeslots	Penalty		
	Timeslots	Penalty		After Saturation Degree	After Kempe	After Pairwise
CAR-S-91	35	4.42	**30**	12.01	9.40	8.70
CAR-F-92	32	3.74	**31**	9.80	7.41	6.33
KFU-S-93	20	12.96	21	37.61	17.65	15.59
TRE-S-92	23	7.75	**21**	15.89	13.20	12.13
YOR-F-83	21	34.84	23	65.24	46.80	44.15

2.3 With Largest Enrollment Heuristic

Benchmark Data	Known Best Solution		Scheme -1 Largest-Degree + Kempe + PairSwap			
			Timeslots	Penalty		
	Timeslots	Penalty		After Largest Enrollment	After Kempe	After Pairwise
CAR-S-91	35	4.42	36	13.78	7.31	6.31
CAR-F-92	32	3.74	35	10.70	6.16	5.14
KFU-S-93	20	12.96	21	54.50	18.49	16.26
TRE-S-92	23	7.75	**22**	16.33	12.44	11.16
YOR-F-83	21	34.84	25	63.28	39.53	34.88

2.4 With Random Ordering Heuristic

Benchmark Data	Known Best Solution		Scheme -1 Largest-Degree + Kempe + PairSwap			
			Timeslots	Penalty		
	Timeslots	Penalty		After Random Ordering	After Kempe	After Pairwise
CAR-S-91	35	4.42	46	9.68	5.78	4.61
CAR-F-92	32	3.74	41	8.30	4.84	3.97
KFU-S-93	20	12.96	25	36.79	16.32	13.63
TRE-S-92	23	7.75	27	12.75	10.33	8.40
YOR-F-83	21	34.84	26	49.22	35.92	30.57

III. Observations

- The DSatur Algorithm has performed the best on the primary goal of reducing the number of timeslots, while Random Ordering has performed the worst.
- Random Ordering has performed the best when it came to the secondary objective of reducing the penalty, coming quite close to the Known Best Penalty Scores.
- This verifies that there is an inverse relation between the number of timeslots and the penalty, since with more timeslots courses can be more spaced out and hence incur a smaller penalty.