Zürcher Hochschule
für Angewandte Wissenschaften

School of
Engineering
IAMP Institut für Angewandte
Mathematik und Physik

Lecture 4: Exercises

MSE Algorithms - Metaheuristics

Exercises

*** Relevant for Exam**

*** Task 1: Manual Tabu Search**

An integer function [–7, 7] x [-6, 7] → [–10, 754] is explicitly given in the table below. A Tabu Search is used to find the minimum of this function. The neighbourhood consists of increasing or decreasing the value of one variable by 1. The tabu condition forbids to **change back** a variable that has been **changed** at most *t* iterations before. In every iteration the best possible move is taken, even if it increases the function value. The search stops if no allowed move exists or if 25 iterations have been performed.

a) Start a tabu search with t=3 at (x, y) = (–7, 7).

b) Start a tabu search with t=1 at (x, y) = (–7, –6).

y\x	–7	–6	–5	–4	–3	–2	–1	0	1	2	3	4	5	6	7
-6	248	216	210	222	230	234	256	304	336	372	428	495	585	650	754
-5	193	175	157	166	174	181	215	249	295	329	382	454	539	597	707
-4	138	144	126	116	124	150	184	194	250	305	361	425	480	566	646
-3	123	89	85	97	105	109	129	179	209	246	302	368	458	525	627
-2	92	58	70	70	78	94	98	148	168	223	282	339	413	510	582
-1	68	34	46	46	54	70	74	124	144	199	258	315	388	486	558
0	51	17	14	25	33	38	57	107	136	174	230	296	386	454	555
1	18	25	5	-4	3	29	65	74	131	185	240	305	361	445	527
2	27	6	-10	0	8	13	46	83	126	160	213	284	371	429	539
3	33	0	-3	7	15	20	39	89	118	156	212	278	368	436	537
4	33	12	-4	6	14	19	52	89	132	166	219	290	377	435	545
5	30	37	17	7	15	41	77	86	143	197	252	317	373	457	539
6	69	35	32	43	51	56	75	125	154	192	248	314	404	472	573
7	92	58	70	70	78	94	98	148	168	223	282	339	412	510	582

Exercises

*** Task 2: Tabu Search on Knapsack Problem**

$$\text{Maximize } 11x_1 + 10x_2 + 9x_3 + 12x_4 + 10x_5 + 6x_6 + 7x_7 + 5x_8 + 3x_9 + 8x_{10}$$

$$\text{subject to } 33x_1 + 27x_2 + 16x_3 + 14x_4 + 29x_5 + 30x_6 + 31x_7 + 33x_8 + 14x_9 + 18x_{10} \leq 100$$

$$x_i = \{0,1\},\ i = 1, \ldots, 10$$

Initial solution : (0, 0, 0, 0, 0, 0, 0, 0, 0, 0) revenue : 0

Move : flip a bit $x_i \leftarrow 1 - x_i$

Tabu condition : don't flip the same bit for 3 (complete) iterations

Tabu list : iteration AFTER which a bit can be flipped again

Initial tabu list : (0, 0, 0, 0, 0, 0, 0, 0, 0, 0)

Iteration	Variable flipped	Current solution	Reve-nue	Vol.	Tabu list

Greedy Strategy : insert the object with maximum value that fits (breaking ties by choosing the object weighing less). If no further object can be inserted, remove the object with minimal value (breaking ties by choosing the heavier object). Compute the 10 first iterations.

Exercises

*** Task 3: Neighbourhood Analysis for CVRP**

Analyse the properties properties

- Size of Neighbourhood
- Connectivity
- Run time complexity for one move

for the following neighbourhoods for the Capacitated Vehicle Routing Problem (CVRP):

a) Neighborhood description: Select customer X randomly -- Select destination tour randomly -- Select insertion position for X in destination tour randomly.
b) Neighborhood description: Select customer X randomly -- Select destination tour randomly -- Select best insertion position for X in destination tour.