Zürcher Hochschule
für Angewandte Wissenschaften
School of
Engineering
IAMP Institut für Angewandte
Mathematik und Physik

# Lecture 3: Exercise Solutions

MSE Algorithms - Metaheuristics

# Solutions: Manual Local Search

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## Task 1: Manual Local Searches

| 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 |

Best move policy

First improving move policy

# Solutions: 2-opt and 3-opt moves for TSP

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## Task 2: 2-opt and 3-opt moves for TSP

a) c1-c2-c5-c6-c3-c4-c7-c8-c1.

b) c1-c2-c4-c3-c6-c5-c7-c8-c1.

c) c1-c2-c6-c5-c4-c3-c7-c8-c1.

# Solutions: Greedy for Knapsack Problem

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**Task 3: Greedy for Knapsack Problem**

a) Let n = W and $v_1 = 2$, $w_1 = W$, $v_2 = v_3 \ldots = v_n = 1$, $w_2 = w_3 = \ldots = w_n = 1$.
Then Naive Greedy takes item 1 with value 2, whereas a better solution would be to take all other items with value n-1.

b) Worst case for Smarter Greedy: Let $v_1 = 2$, $w_1 = 1$, $v_2 = W$ and $w_2 = W$. Then Smarter Greedy takes item 1, but item 2 would be much better.

c) Potential Neighbourhoods:
- Flip one bit $x_i$ , if result is a valid solution.
- Exchange one item with another, if result is a valid solution.

# Solutions: Knapsack with SA

## Task 4: Knapsack Problem with Simulated Annealing

Optimal Solution for Instance Knapsack_P08:

- Value = 13549094
- Items: 1 1 0 1 1 1 0 0 0 1 1 0 1 0 0 1 0 0 0 0 0 1 1 1

Source: http://people.sc.fsu.edu/~jburkardt/datasets/knapsack_01/knapsack_01.html

# Solutions: Solving TSP with SA

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Will be updated periodically until end of lecture