**Operations Research**

**Metaheuristic Assignment**

Due Date: Dec. 13, 2019, 5pm

This work is **optional**! It will count the 5% in your final grade if you work for it.

Please zip your files including eg. MS Word, Excel (or csv, txt), **Python code** file or other files, with the file name: **OR_HW_ID_NAME.zip**, and upload your homework to MOODLE by due.

**The last digit of your student ID is (1) EVEN for Traveling Salesman Problem; (2) ODD for Single-Machine Scheduling Problem.**

**(學號末位數為偶數做旅行推銷員、奇數做單機排程問題)**

***Programming Questions (100%)***

Please use *Python* (**MUST use it, other language is not allowed**) to answer the following questions. Provide your code and justify your answer. Show all your work in detail including specific algorithm and parameter design. You should hand in *one ZIP fold (EVEN for Traveling Salesman Problem by Simulated Annealing and ODD for scheduling problem by Tabu)*. The result should include ***approximate optimal solution (i.e., traveling sequence, job sequence), fitness function value, running time.*** For the parameter settings (eg. temperature, cooling rate, tabu size, etc.), please give a simple ***trial-and-error*** adjustment of parameters.

**Traveling Salesman Problem (學號末位數為偶數)**

Please answer following TSP problem. The objective function is to minimize the total distance.

Data Source: **GR17** is a set of 17 cities, from TSPLIB.

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 633 | 257 | 91 | 412 | 150 | 80 | 134 | 259 | 505 | 353 | 324 | 70 | 211 | 268 | 246 | 121 |
| 633 | 0 | 390 | 661 | 227 | 488 | 572 | 530 | 555 | 289 | 282 | 638 | 567 | 466 | 420 | 745 | 518 |
| 257 | 390 | 0 | 228 | 169 | 112 | 196 | 154 | 372 | 262 | 110 | 437 | 191 | 74 | 53 | 472 | 142 |
| 91 | 661 | 228 | 0 | 383 | 120 | 77 | 105 | 175 | 476 | 324 | 240 | 27 | 182 | 239 | 237 | 84 |
| 412 | 227 | 169 | 383 | 0 | 267 | 351 | 309 | 338 | 196 | 61 | 421 | 346 | 243 | 199 | 528 | 297 |
| 150 | 488 | 112 | 120 | 267 | 0 | 63 | 34 | 264 | 360 | 208 | 329 | 83 | 105 | 123 | 364 | 35 |
| 80 | 572 | 196 | 77 | 351 | 63 | 0 | 29 | 232 | 444 | 292 | 297 | 47 | 150 | 207 | 332 | 29 |
| 134 | 530 | 154 | 105 | 309 | 34 | 29 | 0 | 249 | 402 | 250 | 314 | 68 | 108 | 165 | 349 | 36 |
| 259 | 555 | 372 | 175 | 338 | 264 | 232 | 249 | 0 | 495 | 352 | 95 | 189 | 326 | 383 | 202 | 236 |
| 505 | 289 | 262 | 476 | 196 | 360 | 444 | 402 | 495 | 0 | 154 | 578 | 439 | 336 | 240 | 685 | 390 |
| 353 | 282 | 110 | 324 | 61 | 208 | 292 | 250 | 352 | 154 | 0 | 435 | 287 | 184 | 140 | 542 | 238 |
| 324 | 638 | 437 | 240 | 421 | 329 | 297 | 314 | 95 | 578 | 435 | 0 | 254 | 391 | 448 | 157 | 301 |
| 70 | 567 | 191 | 27 | 346 | 83 | 47 | 68 | 189 | 439 | 287 | 254 | 0 | 145 | 202 | 289 | 55 |
| 211 | 466 | 74 | 182 | 243 | 105 | 150 | 108 | 326 | 336 | 184 | 391 | 145 | 0 | 57 | 426 | 96 |
| 268 | 420 | 53 | 239 | 199 | 123 | 207 | 165 | 383 | 240 | 140 | 448 | 202 | 57 | 0 | 483 | 153 |
| 246 | 745 | 472 | 237 | 528 | 364 | 332 | 349 | 202 | 685 | 542 | 157 | 289 | 426 | 483 | 0 | 336 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 121 | 518 | 142 | 84 | 297 | 35 | 29 | 36 | 236 | 390 | 238 | 301 | 55 | 96 | 153 | 336 | 0 | |

Please use Simulated Annealing (SA) algorithm to solve the problem and provide the total distance. Show your parameter design (i.e. temperature, cooling rate) and the result.

**Single-Machine Scheduling Problem (學號末位數為奇數)**

Please answer following single-machine total weighted tardiness problem. The objective function is to minimize the total weighted tardiness.

| Jobs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Processing Time | 10 | 10 | 13 | 4 | 9 | 4 | 8 | 15 | 7 | 1 | 9 | 3 | 15 | 9 | 11 | 6 | 5 | 14 | 18 | 3 |
| Due Date | 50 | 38 | 49 | 12 | 20 | 105 | 73 | 45 | 6 | 64 | 15 | 6 | 92 | 43 | 78 | 21 | 15 | 50 | 150 | 99 |
| Weights | 10 | 5 | 1 | 5 | 10 | 1 | 5 | 10 | 5 | 1 | 5 | 10 | 10 | 5 | 1 | 10 | 5 | 5 | 1 | 5 |

Please use Tabu Search (TS) algorithm to solve the problem and provide the total weighted tardiness. Show your parameter design (i.e. tabu list size) and the result.

***Note***

1. Show all your work in detail. **Innovative** idea is encouraged.
2. If your answer refers to any external source, please "must" give an academic citation. Any "**plagiarism**" is not allowed.