Task Assignment

Maximum number of points: 25

Each student is requested implementing a command-line application in Java or Python to solve a given Knapsack using Genetic Algorithms (GA), Simulated Annealing (SA), Ant Colony Optimization (ACO) and Particle Swarm Optimization (PSO).

After finishing the project/implementation a complete **archive [student_id]_[student_name].zip** must be created and **uploaded to Vula latest until April 03rd 2020**.

Specification

Programming language and IDE	
Programming language	Oracle JDK/JRE 11.0.5 (LTS) **or** Python 3.8
Random Generator	
MersenneTwister (http://www.math.sci.hiroshima-u.ac.jp/~m-mat/MT/emt.html)	
Knapsack data instance [knapsack_instance.csv]	
Number of items	150
Search space	2^{150} = 1427247692705960000000000000000000000000
Maximum capacity	822
Maximum number of iterations	10000
Best-known optimum	997
Command-line	
General	Command-line arguments in any arrangements
-configuration [name].json	**Configuration** for each algorithm is stored in a **JSON-file.**
-search_best_configuration [ga | sa | aco | pso]	Search for the best configuration. Each default configuration will be loaded and evaluated. The best configuration with the highest solution quality will be stored in a **separate JSON-file**, e.g. ga_best.json.

Scores (maximum 25 points)

Genetic Algorithm (1st week) [10 points]	**Base** [2 points]; **One-point Crossover** (1PX) [1 point]; **Two-point Crossover** (2PX) [1.5 points]; **Roulette-Wheel Selection** (RWS) [2 points]; **Tournament-Selection (TS)** [1 point]; **Bit-Flip Mutation** (BFM) [0.5 point]; **Exchange Mutation** (EXM) [0.5 point]; **Inversion Mutation** (IVM) [0.5 point]; **Insertion Mutation** (ISM) [0.5 point]; **Displacement Mutation** (DPM) [0.5 point]
Simulated Annealing (2nd week) [5 points]	**Algorithm** [5 points]
Particle Swarm Optimization (3rd week) [5 points]	**Algorithm** [5 points]

A **generator** should be implemented which creates after each evaluation a **report** report_[algorithm]_yyyymmdd.txt. **5 points**

```
Evaluation | 2020-03-12 21:25
Configuration:  ga_default_11.json
                GA | #10000 | RWS | 2PX (0.7) | EXM (0.003)
=====================================================================
#     bweight    bvalue     squality   knapsack
---------------------------------------------------------------------
1         769       566       56.77%   [00000010000011100001100000...]
...
10000     822       997      100.00%   [00110010000011000000110000...]
---------------------------------------------------------------------
[Statistics]
Runtime          12322 ms

Convergence        #    bweight    bvalue    squality
                 2500      782       572      57.37%
                 5000      799       688      67.00%
                 7500      802       899      90.63%
                10000      822       997     100.00%

Plateau | Longest sequence 443-472 with improvement less average 3%.

=====================================================================
```

Genetic Algorithm

configuration	selection	crossover (ratio)	mutation (ratio)
ga_default_01	RWS	1PX (0.6)	BFM (0.003)
ga_default_02	RWS	1PX (0.7)	BFM (0.003)
ga_default_03	RWS	1PX (0.8)	BFM (0.003)
ga_default_04	RWS	1PX (0.7)	EXM (0.003)
ga_default_05	RWS	1PX (0.7)	IVM (0.003)
ga_default_06	RWS	1PX (0.7)	ISM (0.003)
ga_default_07	RWS	1PX (0.7)	DPM (0.003)
ga_default_08	RWS	2PX (0.6)	BFM (0.003)
ga_default_09	RWS	2PX (0.7)	BFM (0.003)
ga_default_10	RWS	2PX (0.8)	BFM (0.003)
ga_default_11	RWS	2PX (0.7)	EXM (0.003)
ga_default_12	RWS	2PX (0.7)	IVM (0.003)
ga_default_13	RWS	2PX (0.7)	ISM (0.003)
ga_default_14	RWS	2PX (0.7)	DPM (0.003)
ga_default_15	TS	1PX (0.6)	BFM (0.003)
ga_default_16	TS	1PX (0.7)	BFM (0.003)
ga_default_17	TS	1PX (0.8)	BFM (0.003)
ga_default_18	TS	1PX (0.7)	EXM (0.003)
ga_default_19	TS	1PX (0.7)	IVM (0.003)
ga_default_20	TS	1PX (0.7)	ISM (0.003)
ga_default_21	TS	1PX (0.7)	DPM (0.003)
ga_default_22	TS	2PX (0.6)	BFM (0.003)
ga_default_23	TS	2PX (0.7)	BFM (0.003)
ga_default_24	TS	2PX (0.8)	BFM (0.003)
ga_default_25	TS	2PX (0.7)	EXM (0.003)
ga_default_26	TS	2PX (0.7)	IVM (0.003)
ga_default_27	TS	2PX (0.7)	ISM (0.003)
ga_default_28	TS	2PX (0.7)	DPM (0.003)

Simulated Annealing

k = 1

configuration	T_0	cooling rate
sa_default_01	10000	0.5
sa_default_02	10000	0.6
sa_default_03	10000	0.7
sa_default_04	10000	0.8
sa_default_05	10000	0.9
sa_default_06	5000	0.5
sa_default_07	5000	0.6
sa_default_08	5000	0.7
sa_default_09	5000	0.8
sa_default_10	5000	0.9
sa_default_11	2500	0.5
sa_default_12	2500	0.6
sa_default_13	2500	0.7
sa_default_14	2500	0.8
sa_default_15	2500	0.9
sa_default_16	500	0.5
sa_default_17	500	0.6
sa_default_18	500	0.7
sa_default_19	500	0.8
sa_default_20	500	0.9
sa_default_21	100	0.5
sa_default_22	100	0.6
sa_default_23	100	0.7
sa_default_24	100	0.8
sa_default_25	100	0.9

Particle Swarm Optimization

configuration	#particles	minVelocity	maxVelocity	c1	c2	inertia
pso_default_01	100	4	4	0.5	0.5	1.00
pso_default_02	50	4	4	0.5	0.5	1.00
pso_default_03	25	4	4	0.5	0.5	1.00
pso_default_04	100	3	3	0.5	0.5	1.00
pso_default_05	100	2	2	0.5	0.5	1.00
pso_default_06	100	2	2	0.3	0.5	1.00
pso_default_07	100	2	2	0.4	0.5	1.00
psp_default_08	100	2	2	0.6	0.5	1.00
pso_default_09	100	2	2	0.5	0.3	1.00
pso_default_10	100	2	2	0.5	0.4	1.00
pso_default_11	100	2	2	0.5	0.6	1.00
pso_default_12	100	2	2	0.5	0.5	0.85
pso_default_13	100	2	2	0.3	0.5	0.85
pso_default_14	100	2	2	0.4	0.5	0.85
pso_default_15	100	2	2	0.6	0.5	0.85
pso_default_16	100	2	2	0.5	0.3	0.85
pso_default_17	100	2	2	0.5	0.4	0.85
pso_default_18	100	2	2	0.5	0.6	0.85
pso_default_19	100	2	2	0.5	0.5	1.15
pso_default_20	100	2	2	0.3	0.5	1.15
pso_default_21	100	2	2	0.4	0.5	1.15
pso_default_22	100	2	2	0.6	0.5	1.15
pso_default_23	100	2	2	0.5	0.3	1.15
pso_default_24	100	2	2	0.5	0.4	1.15
pso_default_25	100	2	2	0.5	0.6	1.15