



Année Académique:

2025/2026

Domaine:

Mathématiques et Informatique

Filière:

Informatique

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intelligence artificielle et sciences des données

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Master 1

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Semestre 2

Matière

Techniques d’optimisation

Enseignant:

SILEM Abdelheq

Section/Groupe

SECTION 1 / GROUPE 3

PV des notes CC par matière (Enseignant)

#	Matricule	Nom	Prénom	Note CC	Note corrigée	Signature
1	222234038704			18.0		
2	212234092814			17.0		
3	222234041510			17.25		
4	222234038609			18.0		
5	222234045908			17.25		
6	222234017120			17.0		
7	222234020105			18.0		
8	222234026608			18.0		
9	212234083906			18.0		
10	222234037804			18.0		
11	222234041607			18.0		
12	222234067902			0.0		
13	222234006619			18.0		
14	212134006285			18.0		
15	222234018506			17.0		
16	191934005273			10.7		
17	222234006320			18.0		
18	222234006914			0.0		
19	222234342109			17.0		
20	222234045008			17.25		
21	222234017716			17.25		
22	9696409028			0.0		
23	222234029117			17.0		
24	222234053301			18.0		
25	222234053314			0.0		
26	212134007719			16.2		
27	222234045212			18.0		
28	212234092307			0.0		
29	212234093310			0.0		
30	212134002814			17.0		
31	222234059113			18.0		
32	212234092910			18.0		
33	222234006302			0.0		
34	222234030003			17.0		
35	222234067602			0.0		



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#	Matricule	Nom	Prénom	Note CC	Note corrigée	Signature
1	222234009915			18.0		
2	202034004249			17.25		
3	08084001902			18.0		
4	182234084003			18.0		
5	222234007218			18.0		
6	212134005321			17.0		
7	222234089609			17.25		
8	222234007206			18.0		
9	162134014167			18.0		
10	212234083911			18.0		
11	222234018703			17.25		
12	2495250742			17.0		
13	222234041015			17.25		
14	0101407320			0.0		
15	212134004339			17.25		
16	222234046307			17.25		
17	212134004586			17.0		
18	212234090107			18.0		
19	212134004793			18.0		
20	222234028908			18.0		
21	222234055015			17.25		
22	222234021517			17.25		
23	222234036516			17.0		
24	222234061804			18.0		
25	222234007020			18.0		
26	222234027210			18.0		
27	222234041312			17.0		
28	222234037407			18.0		
29	222234007304			18.0		
30	222234005414			0.0		
31	222234008014			17.25		
32	222234021414			18.0		
33	2495253034			18.0		
34	222234010314			17.25		



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#	Matricule	Nom	Prénom	Note CC	Note corrigée	Signature
1	222234018413			17.25		
2	222234009308			18.0		
3	2301402953			12.25		
4	212134010237			15.3		
5	0101474160			13.0		
6	212134001017			18.0		
7	222234005910			17.25		
8	0202467738			13.3		
9	212234085606			17.0		
10	222234019518			0.0		
11	222234053712			17.5		
12	222234008617			18.0		
13	222234006104			18.0		
14	191934003928			0.0		
15	222234007216			18.0		
16	222234020201			19.5		
17	9898434402			10.3		
18	222234016714			18.0		
19	222234005715			18.0		
20	222234020901			0.0		
21	222234017816			18.0		
22	222234021004			17.0		
23	222234016708			18.0		
24	222234019104			18.0		
25	212134012725			18.0		
26	222234297114			0.0		
27	222234053606			18.0		
28	222234030109			0.0		
29	222234017111			18.0		
30	222234042410			17.25		
31	222234038101			18.0		
32	212234092107			18.0		

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Section/GroupeSECTION 1

PV des notes des examens par matière (Enseignant)

#	Matricule	Nom	Prénom	Note Examen	Note corrigée	Signature
1	222234038704			9.0		
2	212234092814			14.25		
3	222234009915			15.0		
4	222234041510			15.0		
5	222234038609			12.75		
6	222234018413			10.0		
7	222234045908			14.25		
8	202034004249			12.75		
9	222234017120			10.75		
10	08084001902			4.5		
11	222234009308			12.75		
12	222234020105			14.5		
13	222234026608			15.5		
14	212234083906			13.0		
15	222234037804			15.75		
16	222234041607			9.5		
17	222234067902			0.0		
18	222234006619			15.75		
19	182234084003			7.25		
20	222234007218			14.25		
21	212134005321			13.75		
22	212134006285			12.25		
23	222234089609			9.25		
24	222234007206			12.5		
25	222234018506			14.75		
26	212134001017			12.0		
27	222234006320			15.75		
28	222234006914			0.0		
29	162134014167			16.75		
30	222234005910			15.5		
31	212234083911			9.0		
32	212234085606			13.5		
33	222234342109			17.0		
34	222234018703			9.0		
35	222234019518			0.0		
36	222234045008			15.75		
37	222234017716			18.25		
38	2495250742			16.75		
39	222234041015			17.75		
40	222234053712			14.25		
41	222234008617			9.75		
42	0101407320			0.0		
43	9696409028			0.0		
44	222234029117			12.75		
45	212134004339			14.75		
46	222234053301			5.0		
47	222234046307			11.0		
48	222234006104			16.5		
49	191934003928			0.0		
50	212134004586			18.5		
51	222234053314			0.0		
52	222234007216			16.25		
53	222234020201			17.0		
54	212234090107			19.25		
55	222234045212			7.25		
56	212134004793			12.25		
57	222234028908			13.5		
58	222234016714			17.25		
59	222234055015			16.5		
60	222234005715			15.25		
61	222234021517			7.75		
62	222234036516			15.75		
63	212234092307			0.0		
64	222234061804			15.25		
65	222234020901			0.0		
66	222234017816			14.0		
67	222234007020			10.25		
68	222234027210			10.0		
69	222234021004			16.75		
70	212234093310			0.0		
71	212134002814			15.25		
72	222234016708			13.25		
73	222234019104			15.25		
74	222234041312			12.75		
75	222234059113			13.0		
76	212234092910			12.5		

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#	Matricule	Nom	Prénom	Note Examen	Note corrigée	Signature
77	222234006302			0.0		
78	222234037407			13.0		
79	222234007304			15.25		
80	212134012725			13.5		
81	222234297114			0.0		
82	222234005414			0.0		
83	222234053606			15.0		
84	222234030003			11.25		
85	222234030109			0.0		
86	222234008014			14.25		
87	222234017111			17.75		
88	222234021414			8.5		
89	222234067602			0.0		
90	222234042410			14.25		
91	222234038101			17.75		
92	212234092107			15.5		
93	2495253034			9.5		
94	222234010314			8.75		



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1	222234038704			15.0		
2	212234092814			15.0		
3	222234041510			15.0		
4	222234038609			14.5		
5	222234045908			14.5		
6	222234017120			14.0		
7	222234020105			14.5		
8	222234026608			15.0		
9	212234083906			15.0		
10	222234037804			15.0		
11	222234041607			15.0		
12	222234067902			0.0		
13	222234006619			15.0		
14	212134006285			15.0		
15	222234018506			15.0		
16	191934005273			10.7		
17	222234006320			15.0		
18	222234006914			0.0		
19	222234342109			13.5		
20	222234045008			14.0		
21	222234017716			14.5		
22	9696409028			0.0		
23	222234029117			14.5		
24	222234053301			14.0		
25	222234053314			0.0		
26	212134007719			16.2		
27	222234045212			15.0		
28	212234092307			0.0		
29	212234093310			0.0		
30	212134002814			14.5		
31	222234059113			14.5		
32	212234092910			15.0		
33	222234006302			0.0		
34	222234030003			15.0		
35	222234067602			0.0		

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5	222234007218			15.0		
6	212134005321			14.0		
7	222234089609			14.5		
8	222234007206			15.0		
9	162134014167			14.5		
10	212234083911			15.0		
11	222234018703			15.0		
12	2495250742			14.0		
13	222234041015			14.5		
14	0101407320			0.0		
15	212134004339			14.0		
16	222234046307			15.0		
17	212134004586			14.0		
18	212234090107			15.0		
19	212134004793			14.5		
20	222234028908			14.0		
21	222234055015			15.0		
22	222234021517			14.0		
23	222234036516			14.5		
24	222234061804			15.0		
25	222234007020			14.5		
26	222234027210			15.0		
27	222234041312			14.5		
28	222234037407			14.5		
29	222234007304			15.0		
30	222234005414			0.0		
31	222234008014			14.5		
32	222234021414			14.5		
33	2495253034			13.5		
34	222234010314			15.0		



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2	222234009308			15.0		
3	2301402953			12.25		
4	212134010237			15.3		
5	0101474160			13.0		
6	212134001017			14.5		
7	222234005910			15.0		
8	0202467738			13.3		
9	212234085606			15.0		
10	222234019518			0.0		
11	222234053712			15.0		
12	222234008617			15.0		
13	222234006104			15.0		
14	191934003928			0.0		
15	222234007216			15.0		
16	222234020201			15.0		
17	9898434402			10.3		
18	222234016714			15.0		
19	222234005715			15.0		
20	222234020901			0.0		
21	222234017816			15.0		
22	222234021004			14.5		
23	222234016708			15.0		
24	222234019104			15.0		
25	212134012725			13.0		
26	222234297114			0.0		
27	222234053606			15.0		
28	222234030109			0.0		
29	222234017111			15.0		
30	222234042410			15.0		
31	222234038101			15.0		
32	212234092107			14.0		

Exam correction

Questions (3 points)

Choose the correct answer from the following statements:

1. In a multi-objective optimization problem, the goal is to:
C. Optimize multiple, often conflicting, objectives (01 point)
2. Genetic Algorithm is:
C. A meta-heuristic inspired by natural selection (01 point)
3. The objective function in an optimization problem represents:
B. The variable to be maximized or minimized (01 point)

Correction of Exercise 1 (6 points) Particle Swarm Optimization (PSO)

Using the PSO algorithm, we want to minimize:

$$f(x) = x^2 + 2x + 1$$

Given:

- Number of particles: 3
- Dimension: 1D
- Inertia weight: $w=0.6$
- Cognitive coefficient: $c1=1.2$
- Social coefficient: $c2=1.2$
- Random values:
 - Iteration 1: $r1=0.4$, $r2=0.5$
 - Iteration 2: $r1=0.7$, $r2=0.3$

Initial positions and velocities:

Particle	$x(0)$	$v(0)$
P1	3	0
P2	-2	0
P3	1	0

Tasks:

1. Compute the initial fitness of each particle.

Particle P1

16 (0.5 point)

Particle P2

1 (0.5 point)

Particle P3

4 (0.5 point)

2. Determine the initial pBest and gBest.

Initially:

- **pBest1= 3 (0.25 points)**
- **pBest2= -2 (0.25 points)**
- **pBest3= 1 (0.25 points)**

The smallest fitness is obtained by P2.

gBest= -2 (0.25 points)

3. Perform tow iterations of the PSO algorithm. and 4. Compute the new positions and velocities.

Iteration 1

Particle P1

v1 = -3 (0.25 points)

New position:

x1= 0 (0.25 points)

Particle P2

v2= 0 (0.25 points)

x2= -2 (0.25 points)

Particle P3

v3=-1.8 (0.25 points)

New position:

$x_3 = -0.8$ (0.25 points)

Best particle:

$gBest = -0.8$ (0.25 points)

Iteration 2

Particle P1

$v_1 = -2.088$ (0.25 points)

New position:

$x_1 = -2.088$ (0.25 points)

Particle P2

$v_2 = 0.432$ (0.25 points)

New position:

$x_2 = -1.568$ (0.25 points)

Particle P3

$v_3 = -1.08$ (0.25 points)

New position:

$x_3 = -1.88$ (0.25 points)

4. Determine the new $gBest$.

Final global best:

$gBest = -1.568$ (0.25 points)

Exercise 2 (5 points) Genetic Algorithm (GA)

A mobile edge computing system has 5 computational tasks.
Each task can be:

- Executed locally (0)
- Offloaded to a Fog UAV (1)

Each solution is represented by a binary chromosome of length 5.

Example:

- 10110 → Tasks 1, 3, and 4 are offloaded.

Initial population:

Chromosome	Fitness
10101	18
11100	12
01011	20
00110	15

Tasks:

1. Select the two best chromosomes using selection function. (The two following solutions are correct) (01 point).

- In the case of Minimization:

Chromosome Fitness	
11100	12
00110	15

- In the case of Maximization:

Chromosome Fitness	
01011	20
10101	18

2. Apply one-point crossover between the selected chromosomes at position 3. (The two following solutions are correct) (01 point).

- In the case of Minimization:

Crossover point = 3

Parent 1:

111 | 00 or 11 | 100 (The two solutions are correct)

Parent 2:

001 | 10 or 00 | 110 (The two solutions are correct)

Offspring:

Child 1 = 11110 or Child 1 = 11100 (The tow solutions are correct)

Child 2 = 00100 or Child 2 = 00110 (The tow solutions are correct)

- In the case of Maximization:

Crossover point = 3

Parent 1:

010 | 11 or 01 | 011 (The tow solutions are correct)

Parent 2:

101 | 01 or 10 | 101 (The tow solutions are correct)

Offspring:

Child 1 = 01001 or Child 1 = 01111 (The tow solutions are correct)

Child 2 = 10111 or Child 2 = 10001 (The tow solutions are correct)

3. Apply mutation on the second bit of the first offspring. (The tow following solutions are correct) (01 point).

- In the case of Minimization:

1. Mutate the second bit of Child 1:

Before mutation: 11110

After mutation: 10110 or 11110 (The tow solutions are correct)

Or

2. Mutate the second bit of Child 1:

Before mutation: 11100

After mutation: 10100 or 11100 (The tow solutions are correct)

- In the case of Maximization:

3. Mutate the second bit of Child 1:

Before mutation: 01001

After mutation: 00001 or 10001 or 00101 (The three solutions are correct)

Or

4. Mutate the second bit of Child 1:

Before mutation: 01111

After mutation: 00111 or 10111 or 01111 (The three solutions are correct)

4. Compute the new population. (01 point).

- In the case of Minimization:

11100

00110

10110 or 11110 or 10100 or 11100 (All these solutions are correct)

00100 or 00110 (All these solutions are correct)

- In the case of Maximization:

01011

10101

00001 or 10001 or 00101 or 00111 or 10111 or 01111 (All these solutions are correct)

10111 or 10001 (All these solutions are correct)

5. Explain the role of crossover and mutation in GA. (01 point).

- Crossover combines information from two parents to generate new solutions.
- Mutation introduces diversity and helps avoid local optima.

Exercise 3 (6 points) Ant Colony Optimization (ACO)

A delivery drone must travel from node A to node D.
The graph contains the following paths:

Path	Distance
A-B	2
A-C	4
B-D	3
C-D	2
B-C	1

Initial pheromone value on all paths:

$$\tau_{ij} = 1$$

Parameters:

- $\alpha = 1$
- $\beta = 2$
- Evaporation rate: $\rho = 0.5$

Visibility is defined as:

$$\eta_{ij} = \frac{1}{d_{ij}}$$

Tasks:

1. Compute the visibility values for all paths **(1.25 points)**.

Path	Distance	Visibility
A-B	2	0.5
A-C	4	0.25
B-D	3	0.333
C-D	2	0.5
B-C	1	1

2. Calculate the probability of choosing path A-B and A-C from node A.

Probability equation: **(0.25 point)**

$$P_{ij} = \frac{(\tau_{ij})^\alpha (\eta_{ij})^\beta}{\sum (\tau_{ik})^\alpha (\eta_{ik})^\beta}$$

Since all pheromones are equal to 1:

For A-B:

$$(1)(0.5)^2=0.25 \quad (0.25 \text{ point})$$

For A-C:

$$(1)(0.25)^2=0.0625 \quad (0.25 \text{ point})$$

Total:

$$0.25+0.0625=0.3125 \quad (0.25 \text{ point})$$

Probability of A-B:

$$P(A-B)=0.25/0.3125=0.8 \quad (0.25 \text{ point})$$

Probability of A-C:

$$P(A-C)=0.0625/0.3125=0.2 \quad (0.25 \text{ point})$$

3. Determine which path is more attractive.

The most attractive path is: A-B, because it has the highest probability (0.5 point).

4. Assume an ant chooses the route A-B-D.

5. Update the pheromone values after evaporation and pheromone deposition.

The ant chooses: A-B-D

Total distance:

$$L=2+3=5 \quad (0.5 \text{ point})$$

Evaporation formula: (0.25 point)

$$\tau^{new} = (1 - \rho)\tau$$

Since:

$$\rho=0.5$$

After evaporation:

$\tau=0.5$ (0.5 point)

Deposited pheromone: (0.25 point)

$$\Delta\tau = \frac{1}{L} = \frac{1}{5} = 0.2$$

Updated pheromone values: (1.25 point)

Path	New pheromone
A-B	0.7
B-D	0.7
A-C	0.5
C-D	0.5
B-C	0.5