EXAM II Name:

Problem 1

Assume that two-dimensional space MxN contains 8 objects listed in Table T. Apply k-means (k=2) algorithm to cluster Y. Take objects y4, y8 as seeds.

Y	M	N
y1	1	2
y2	2	4
y3	6	2
y4	1	8
y5	2	6
y6	1	1
y7	4	2
y8	5	3

Table T

Solution:

Loop1

Y4	1	8
Y5	2	6
	3/2	14/2

seed1 = (1.5, 7)

Y8	5	3
Y1	1	2
Y2	2	4
Y3	6	2
Y6	1	1
Y7	4	2
	19/6	14/6

seed2 = (3+1/6, 2+2/6)

Loop2

	1.5	7
Y4	1	8
Y5	2	6

	3+1/6	2+2/6
Y1	1	2
Y2	2	4
Y3	6	2
Y6	1	1
Y7	4	2
Y8	5	3

The same clusters so algorithm stops.

Problem 2. Follow DEAR1 algorithm to extract action rules reclassifying objects from the class D0 to the class D1 hidden in table T. Attributes A, C are stable. Use LERS to find classification rules.

	A	B	C	D
x1	2	2	1	1
x2	1	1	1	1
x3	2	1	2	1
x4	2	3	1	0
x5	1	3	2	1
x6	1	2	2	0

Table T.

Solution:

Classification Rules:

D0* = {x4,x6} D1*= { x1,x2,x3,x5}
LOOP1
A1*= {x2,x5,x6} A2*= {x1,x3,x4} B1*={x2,x3}<D1* B2*= {x1,x6}
B3*={x4,x5} C1*={x1,x2,x4} C2*={x3,x5,x6}

LOOP2
A1.B2*={x6}<D0* A1.B3*= {x5}<D1* A1.C1*={x2}<D1*
A1.C2*={x5,x6} A2.B2*={x1}<D1* A2.B3*={x4}<D0* A2.C1*={x1,x4}
A2.C2*={x3}<D1* B2.C1*={x1}<D1* B2.C2*={x6}<D0*
B3.C1*={x4}<D0* B3.C2*={x5}<D1*

LOOP3
No results

RULES

A	**B**	**C**	**D**
	B1		D1
A1	B2		D0
A1	B3		D1
A1		C1	D1
A2	B2		D1
A2	B3		D0
A2		C2	D1
	B2	C1	D1
	B2	C2	D0
	B3	C1	D0
	B3	C2	D1

T(D1)

A	**B**	**C**
	B1	
A1	B3	
A1		C1
A2	B2	
A2		C2
	B2	C1
	B3	C2

T(D1, A?)

B	**C**
B1	
B2	C1
B3	C2

T(D1,A?,C?)

B
B1

T(D1,A?,C1)

B
B2

T(D1,A?,C2)

B
B3

T(D1,A1)

B	**C**
B3	
	C1

T(D1,A1,C?)

B
B3

T(D1,A1,C1)

B

T(D1,A2)

B	**C**
B2	
	C2

T(D1,A2,C?)

B
B2

T(D1,A2,C2)

B

T(D0)

A	B	C
A1	B2	
A2	B3	
	B2	C2
	B3	C1

T(D0,A?)

B	C
B2	C2
B3	C1

T(D0,A?,C1)

B
B3

T(D0,A?,C2)

B
B2

Let's stop right here and try to find action rules.

T(D1,A2,C?)

B
B2

Merging T(D0,A?,C1) with T(D1,A2,C?) we will get
A2*C1*(B3->B2) => (D0 -> D1)

Merging T(D0,A?,C2) with T(D1,A2,C?) we will get
A2*C2*(B2 -> B2) => (D0 -> D1)
(this kind of a rule is called a miracle)

Problem 3. Let S=(X, {a, b, c, d}) be a decision system, where all attributes are flexible. Attribute d is the decision attribute. Find action rules reclassifying objects from the class d1 to d2 using action reducts.

	a	b	c	d
x1	a3	b1	c3	d1
x2	a3	b2	c1	d2
x3	a1	b1	c1	d2
x4	a2	b1	c1	d1
x5	a2	b1	c3	d2
x6	a2	b2	c3	d2

System S

Solution:

	X2	X3	X5	X6
X1	b2, c1	a1, c1	a2	a2, b2
X4	a3, b2	a1	c3	b2, c3

Reducts:
R(x2)= (b2+c1)(a3+b2)= b2.a3 + b2 + c1.a3 + c1.b2 = b2 + c1.a3
R(x3)= a1
R(x5)= a2.c3
R(x6)= (a2+b2)(b2+c3)= a2.b2 + a2.c3 + b2 + b2.c3 = b2 + a2.c3

Reducts: {b2}, {c1,a3}, {a1}, {a2,c3}

Action Rules Schemas:
(b, ? -> b2) => (d1 -> d2) domain ={x1,x4}
(c, ? -> c1) ^ (a, ? -> a3) => (d1 -> d2) domain ={x1,x4}
(a, ? -> a1) => (d1 -> d2) domain ={x1,x4}
(a, ? -> a2) ^ (c, ? -> c3) => (d1 -> d2) domain ={x1,x4}

Rules Personalization:
Rule 1: (b, ? -> b2) => (d1 -> d2) domain ={x1,x4}
Extending by attribute a
a2*(b, b1 -> b2) => (d1 -> d2) domain ={x4}
a3*(b, b1 -> b2) => (d1 -> d2) domain ={x1}

Extending by attribute c
c1*(b, b1 -> b2) => (d1 -> d2) domain ={x4}
c3*(b, b1 -> b2) => (d1 -> d2) domain ={x1}

Rule 2: (c, ? -> c1) ^ (a, ? -> a3) => (d1 -> d2) domain ={x1,x4}
Extending by attribute b
b1*(c, ? -> c1) ^ (a, ? -> a3) => (d1 -> d2) domain = {x1,x4}
Personalization does not change the rule schema/domain

Rule 3:
(a, ? -> a1) => (d1 -> d2) domain ={x1,x4}
Extending by attribute b
b1*(a, ? -> a1) => (d1 -> d2) domain ={x1,x4}
does not change the domain
Extending by attribute c
c1*(a, a2 -> a1) => (d1 -> d2) domain ={x4}
c3*(a, a3 -> a1) => (d1 -> d2) domain ={x1}

Rule 4:
(a, ? -> a2) ^ (c, ? -> c3) => (d1 -> d2) domain ={x1,x4}
Extending by attribute b
b1*(a, ? -> a2) ^ (c, ? -> c3) => (d1 -> d2) domain ={x1,x4}
Personalization does not change the rule schema/domain

Problem 4. Find classification rules in a decision system T(d), where d is the decision attribute.

Car	Price	Mileage	Size	Accident	d
1	*	{mid}	{full}	*	excellent
2	{low}	*	{full}	{engine}	excellent
3	*	{high}	{compact}	*	poor
4	{high}	{low}	*	{doors}	good
5	*	*	{full}	{doors}	good
6	{low}	{high}	{compact}	*	poor

Decision System T(d)

Solution:
Tolerance classes
T(1)= {1,2,5}, T(2)={2,1}, T(3)={3,6}, T(4)={4,5}, T(5)={5,1,4} T(6)={6,3}

Car	Price	Mileage	Size	Accident	D
1	*	{mid}	{full}	*	excellent+ good
2	{low}	*	{full}	{engine}	excellent
3	*	{high}	{compact}	*	poor
4	{high}	{low}	*	{doors}	good
5	*	*	{full}	{doors}	excellent+ good
6	{low}	{high}	{compact}	*	poor

Discernibility matrix

	1	2	3	4	5	6
1	x					
2	NIL	x				
3	M, S	S	x			
4	M	P, A	M	x		
5	-	A	S	NIL	x	
6	M, S	S	-	P, M	S	x

Reduct = {P,M,S,A} because NIL is in the matrix

Object Reducts
R(1)=R(2)= NIL, R(3)= (M+S)SM=SM, R(4)=R(5)= NIL,
R(6)= (M+S)S(P+M)= S(P+M)= SP + SM

Car	Price	Mileage	Size	Accident	D
1	*	{mid}	{full}	*	excellent+ good
2	{low}	*	{full}	{engine}	excellent
3	*	{high}	{compact}	*	poor
4	{high}	{low}	*	{doors}	good
5	*	*	{full}	{doors}	excellent+ good
6	{low}	{high}	{compact}	*	poor

Rules
(S, compact) ^ (M, high) -> (D, poor) /row 3/
(S, compact) ^ (P, low) -> (D, poor) /row 6/
(S, compact) ^ (M, high) -> (D, poor) /row 6/

Final rules
(S, compact) ^ (M, high) -> (D, poor) sup = 2
(S, compact) ^ (P, low) -> (D, poor) sup=1