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Density based Spatial Clustering of Application with Noise (DBSCAN)

ε Epsilon - radius.

MinPts.

Epsilon Neighborhood N_ε
Set of all points within a distance 'ε'

Corepoint
$\geq$ minPts.

Border Point.
$0 <$ minpts.

Neither corepoint nor borderpoint

Noise point.

Corepoint: A point that has atleast 'minPoint' (including itself) points within it's epsilon neighbourhood. N_ε

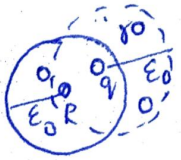
Directly Density Reachable.

A point q is directly density reachable from a point P if P is corepoint and $q \in N_\varepsilon$

Density Reachable:

Two points are directly reachable if there is a chain of DDR points that link these two points.

q is DDR to p



r is DR to P

r is DDR to q which in turn DDR to P

Border point:

have corepoint but not minimum minPts.

Point that is DDR but not a core point. (Points that does not have sufficient min points in its N_ε

Noise point: points that do not belong to any points N_ε

Noise points.

Problem I

$\varepsilon = 2$ min pt = 2

	x	y
A1	2	10
A2	2	5
A3	8	4
A4	5	8
A5	7	5
A6	6	4
A7	1	2
A8	4	9

Euclidean distance

A1 A3 (2,10) (8,4) $\sqrt{6^2+6^2} = \sqrt{72}$

A1 A4 (2,10) (5,8) $= \sqrt{3^2+2^2}$

A1 A5 (2,10) (7,5) $= \sqrt{5^2+5^2}$

A1 A6 (2,10) (6,4) $\sqrt{4^2+6^2}$

A1 A7 (2,10) (1,2) $= \sqrt{65}$

A1 A8 (2,10) (4,9) $= \sqrt{2^2+1^2} = \sqrt{5}$

A2 A3 (2,5) (8,4) $= \sqrt{6^2+1^2}$

A2 A4 (2,5) (5,8) $= \sqrt{3^2+3^2}$

A2 A5 (2,5) (7,5) $= \sqrt{5^2+0}$

A2 A6 (2,5) (6,4) $= \sqrt{4^2+1}$

A2 A7 (2,5) (1,2) $= \sqrt{1^2+3^2} =$

A2 A8 (2,5) (4,9) $= \sqrt{2^2+4^2}$

	A1	A2	A3	A4	A5	A6	A7	A8
A1	0	8.5	8.49	3.61	7.07	7.21	8.06	2.24
A2	5	0	6.08	4.24	5	4.12	3.16	4.47
A3	8.49	6.08	0	5	1.41	2	7.28	6.40
A4	3.61	4.24	5	0	3.61	4.12	7.21	1.41
A5	7.07	5	1.41	3.61	0	1.41	6.71	5

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	A1	A2	A3	A4	A5	A6	A7	A8
A1	7.21	4.12	2	4.12	1.41	0	5.39	5.39
A2	8.06	8.16	7.28	7.21	6.71	5.39	0	7.62
A3	2.24	4.47	6.40	1.41	5	5.39	7.62	0

$\varepsilon = 2$ | N_ε | A1 | A2 | A3, A5, A6 | A4, A8 | A3 A5 A6 | A3 A5 A6 | A7 | A4 A8

A3 A4	(8,4) (5,8)	$\sqrt{3^2+4^2}$	5
A3 A5	(8,4) (7,5)	$\sqrt{1+1}$	
A3 A6	(8,4) (6,4)	$=\sqrt{4}$	
A3 A7	(8,4) (1,2)	$\sqrt{49+4}$	
A3 A8	(8,4) (4,9)	$\sqrt{16+25}$	
A4 A5	(5,8) (7,5)	$\sqrt{4+9}$	
A4 A6	(5,8) (6,4)	$\sqrt{1+16}$	
A4 A7	(5,8) (1,2)	$=\sqrt{16+36}$	
A4 A8	(5,8) (4,9)	$=\sqrt{1+1}$	
A5 A6	(7,5) (6,4)	$=\sqrt{1+1}$	
A5 A7	(7,5) (1,2)	$=\sqrt{36+9}$	
A5 A8	(7,5) (4,9)	$=\sqrt{9+16}$	
A6 A7	(6,4) (1,2)	$\sqrt{5^2+2^2}$	
A6 A8	(6,4) (4,9)	$\sqrt{2^2+5^2}$	
A7 A8	(1,2) (4,9)	$\sqrt{7+7^2}$	

Core point A3, A4, A5, A6, A8

Border/Outlier: A1 A2 A7

A1 A2 A7 Outliers/Noise.

Cluster 1 A3, A5, A6

Cluster 2 A4, A8

Problem 2

A	(2, 10)
B	(2, 5)
C	(8, 4)
D	(5, 8)
E	(7, 5)
F	(6, 4)
G	(1, 2)
H	(4, 9)

AB	(2,10) (2,5)	$\sqrt{0+5^2}$	= 5
AC	(2,10) (8,4)	$\sqrt{6^2+6^2}$	8.49
AD	(2,10) (5,8)	$\sqrt{3^2+2^2}$	3.61
AE	(2,10) (7,5)	$\sqrt{5^2+5^2}$	7.07
AF	(2,10) (6,4)	$\sqrt{4^2+6^2}$	= $\sqrt{7.21}$
AG	(2,10) (1,2)	$\sqrt{1+64}$	8.06
AH	(2,10) (4,9)	$\sqrt{4+1}$	2.24
BC	(2,5) (8,4)	$\sqrt{36+1}$	6.08
BD	(2,5) (5,8)	$\sqrt{9+9}$	4.24
BE	(2,5) (7,5)	$\sqrt{25}$	5
BF	(2,5) (6,4)	$\sqrt{16+1}$	4.12
BG	(2,5) (1,2)	$\sqrt{1+9}$	3.16
BH	(2,5) (4,9)	$\sqrt{4+16}$	4.47

	A	B	C	D	E	F	G	H
A	0	5	8.49	3.61	7.07	7.21	8.06	2.24
B	5	0	6.08	4.24	5	4.12	3.16	4.47
C	8.49	6.08	0	5	1.41	2	7.28	6.4
D	3.61	4.24	5	0	3.61	4.12	7.21	1.41
E	7.07	5	1.41	3.61	0	1.41	6.71	5
F	7.21	4.12	2	4.12	1.41	0	5.39	5.39
G	8.06	3.16	7.28	7.21	6.71	5.39	0	7.62
H	2.24	4.47	6.4	1.41	5	5.39	7.62	0
	A, D, H	B, G	C, E, F	A, D, E, H		C, E, F	B, G	A, D, H

$\varepsilon = 4$

minPts 2

C, E, D, F

DE	(5,8)(7,5)	$\sqrt{22+22}$ 3.61
CD	(8,4)(5,8)	$= \sqrt{9+16} = 5$
CE	(8,4)(7,5)	$= \sqrt{2}$ 1.41
CF		
CG	(8,4)(6,4)	$= \sqrt{2^2} = 2$
CH	(8,4)(1,2)	$\sqrt{7^2+2^2} = 7.28$
	(8,4)(4,9)	$\sqrt{16+25}$ 6.4
DF	(5,8)(6,4)	$= \sqrt{1+4^2}$ 4.12
DG	(5,8)(1,2)	$= \sqrt{16+36}$ 7.21
DH	(5,8)(4,9)	$= \sqrt{1+1} = 1.41$
EF	(7,5)(6,4)	$= \sqrt{1+1} = 1.41$
EG	(7,5)(1,2)	$= \sqrt{36+9}$ 6.71
EH	(7,5)(4,9)	$= \sqrt{9+16} = 5$
FG	(6,4)(1,2)	$\sqrt{25+4} = 5.39$
FH	(6,4)(4,9)	$\sqrt{4+25}$ 5.39
GH	(1,2)(4,9)	$\sqrt{9+7^2}$ 7.62

Cluster 1 A, D, H

Cluster 2 C, E, F

Cluster 3 B, G

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Problem 2b $\epsilon = 3$ minPts = 3

	A	B	C	D	E	F	G	H
A	0	5	8.49	3.61	7.07	7.21	8.06	2.24
B	5	0	6.08	4.24	5	4.12	3.16	4.47
C	8.49	6.08	0	5	1.41	2	7.28	6.4
D	3.61	4.24	5	0	3.61	4.12	7.21	1.41
E	7.07	5	1.41	3.61	0	1.41	6.71	5
F	7.21	4.12	2	4.12	1.41	0	5.39	5.39
G	8.06	3.16	7.28	7.21	6.71	5.39	0	7.62
H	2.24	4.47	6.4	1.41	5	5.39	7.62	0
	A, H	B	C, E, F	D, H	C, E, F	C, E, F	G	A, D, H

$\epsilon = 3$

minPts = 3

Cluster 1 CEF

Cluster 2 ADH

Outlier B, G

Borderpoints A, D

Corepoints C, E, F