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1. [ZM] Exercises 14.4, Q3

δ	B	C	D	E
A	(1)	3	2	4
B		3	2	3
C			1	3
D				5

δ	C	D	E
AB	3	2	3.5
C		(1)	3
D			5

$d(AB,C) = \alpha_A \cdot d(A,C) + \alpha_B \cdot d(B,C) = \frac{1}{2} * 3 + \frac{1}{2} * 3 = 3$

$d(AB,D) = \alpha_A \cdot d(A,D) + \alpha_B \cdot d(B,D) = \frac{1}{2} * 2 + \frac{1}{2} * 2 = 2$

$d(AB,E) = \alpha_A \cdot d(A,E) + \alpha_B \cdot d(B,E) = \frac{1}{2} * 4 + \frac{1}{2} * 3 = 3.5$

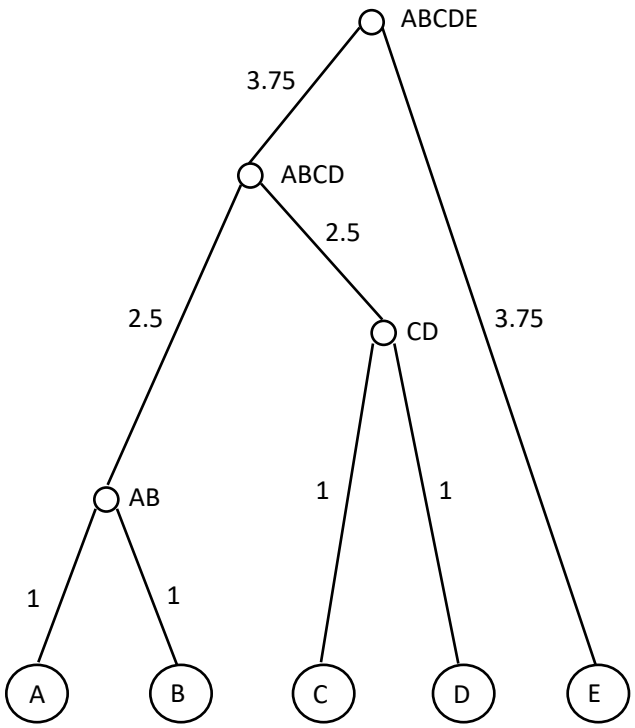
δ	CD	E
AB	(2.5)	3.5
CD		4

$d(AB,CD) = \alpha_A \cdot d(AB,C) + \alpha_B \cdot d(AB,D) = \frac{1}{2} * 3 + \frac{1}{2} * 2 = 2.5$

$d(CD,E) = \alpha_A \cdot d(C,E) + \alpha_B \cdot d(D,E) = \frac{1}{2} * 3 + \frac{1}{2} * 5 = 4$

δ	E
ABCD	(3.75)

$d(ABCD,E) = \alpha_A \cdot d(AB,E) + \alpha_B \cdot d(CD,E) = \frac{1}{2} * 3.5 + \frac{1}{2} * 4 = 3.75$



2. [ZM] Exercises 15.5, Q1

(a) a, b, c, d, e, f, g, h, i, j, k, n, o, p, q, r, s, t, v, w

(b) Yes

(c) Yes, i -> **e** -> **b** -> **c** -> **f** -> **g** -> **j** -> **n** -> o

(d) No, density reachability is an asymmetric relationship.
X is density reachable from y implies that y is a core point, but x may not be a core point. So y may not be density reachable from x. Hence, density reachable is not a symmetric relationship.

(e) Yes, the intermediate points are **t** and **w**.
That is: l – **t** – **w** – x

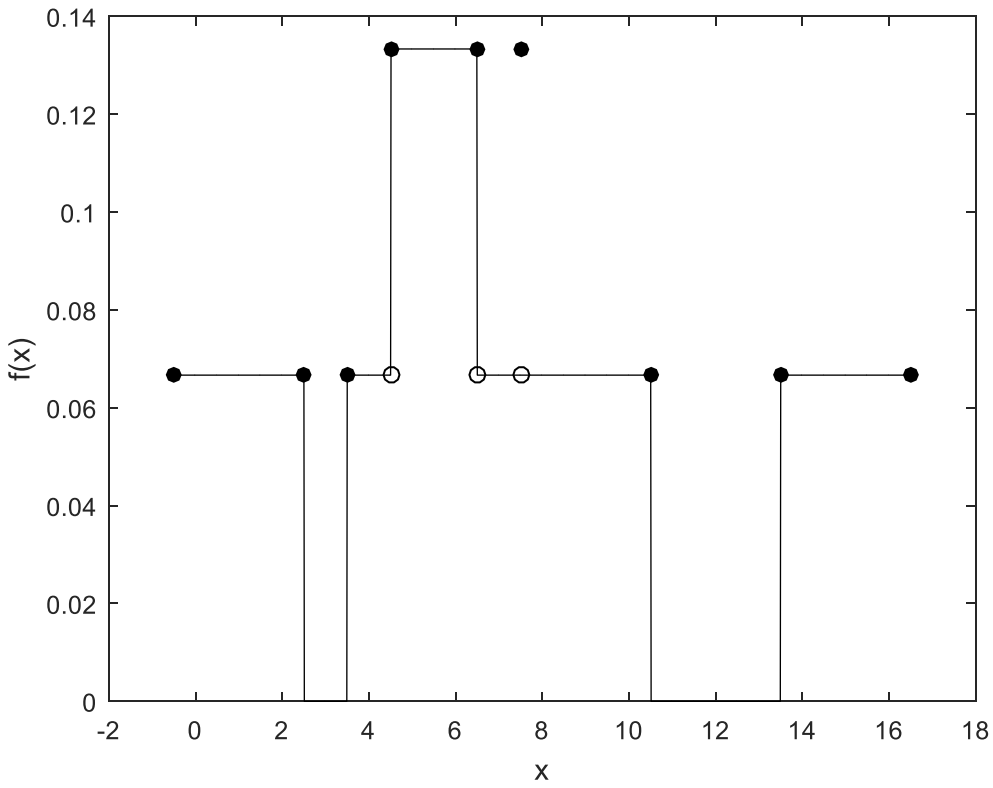
(f) Yes

(g) Density-based cluster 1: a, d, h, k, p, q, r, s, t, l, v, w, x
Density-based cluster 2: b, c, e, f, g, i, j, n, m, o, u
There are no noise points.

3. Using the 1-dimensional discrete kernel from [ZM] eq. (15.2), with width h = 3, draw the kernel density estimate based on the points {1, 5, 6, 9, 15}. Draw the estimate as a piecewise constant function paying close attention to the endpoints.

In MATLAB,

```
>> x=-0.5:0.01:16.5;
>>
y=1/15*(x>=-0.5&x<=2.5|x>=3.5&x<=4.5|x>=6.5&x<=10.5|x>=13.5&x<=16.5)+2/15*(x>4.5&x<6.5);
>> plot(x,y,'k');
>> hold on;
>> scatter(-0.5,1/15,'k','filled');
>> scatter(2.5,1/15,'k','filled');
>> scatter(3.5,1/15,'k','filled');
>> scatter(4.5,1/15,'k');
>> scatter(4.5,2/15,'k','filled');
>> scatter(6.5,2/15,'k','filled');
>> scatter(6.5,1/15,'k');
>> scatter(7.5,1/15,'k');
>> scatter(7.5,2/15,'k','filled');
>> scatter(10.5,1/15,'k','filled');
>> scatter(13.5,1/15,'k','filled');
>> scatter(16.5,1/15,'k','filled');
>> xlabel('x');
>> ylabel('f(x)');
```


0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
f(x)
-2
0
2
4
6
8
10
12
14
16
18
x