Please carefully read and follow the general instructions regarding exercises. Failing to meet the requirements might lead to penalties. https://elearn.uef.fi/mod/page/view.php?id=293750

If you suspect that something is wrong with some exercise question, please contact the lecturer.

If you face persistent issues while working on an exercise, do ask for help, e.g. during a course meeting or by contacting the lecturer via email.

Consider the dataset consisting of 16 data points shown in Figure 1.

id	v_B	v_D
(1)	0.282	0.562
(2)	0.295	0.593
(3)	0.323	0.467
(4)	0.377	0.655
(5)	0.418	0.626
(6)	0.106	0.539
(7)	0.119	0.426
(8)	0.198	0.301
(9)	0.196	0.503
(10)	0.331	0.586
(11)	0.053	0.820
(12)	0.099	0.874
(13)	0.119	0.884
(14)	0.113	0.793
(15)	0.137	0.866
(16)	0.165	0.850

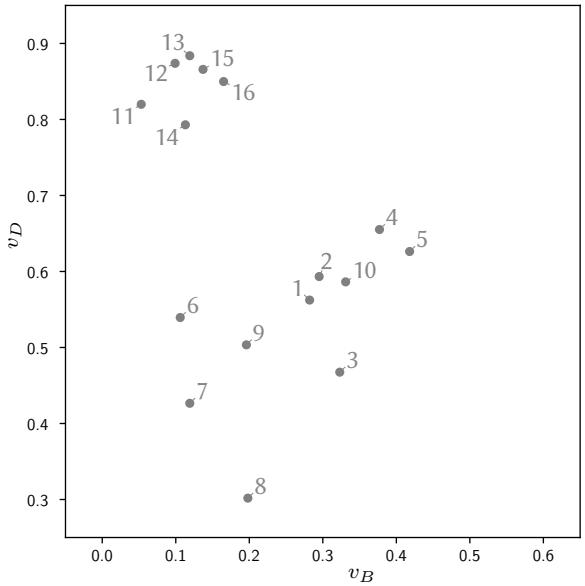

Figure 1: Dataset, as a list of data points (left) and as a plot (right)

The corresponding matrix of ℓ_2 pairwise distances is shown in Table 1.

Table 1: Matrix of pairwise distances between the data points

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1)	0	0.034	0.103	0.133	0.150	0.177	0.212	0.274	0.104	0.055	0.345	0.362	0.361	0.286	0.337	0.311
(2)	0.034	0	0.129	0.103	0.127	0.197	0.243	0.308	0.134	0.037	0.332	0.343	0.340	0.270	0.315	0.288
(3)	0.103	0.129	0	0.196	0.185	0.229	0.208	0.208	0.132	0.119	0.444	0.465	0.464	0.388	0.440	0.414
(4)	0.133	0.103	0.196	0	0.050	0.295	0.345	0.397	0.236	0.083	0.364	0.354	0.345	0.298	0.320	0.288
(5)	0.150	0.127	0.185	0.050	0	0.324	0.360	0.392	0.254	0.096	0.413	0.404	0.395	0.348	0.370	0.338
(6)	0.177	0.197	0.229	0.295	0.324	0	0.114	0.255	0.097	0.230	0.286	0.335	0.345	0.254	0.328	0.317
(7)	0.212	0.243	0.208	0.345	0.360	0.114	0	0.148	0.109	0.266	0.399	0.448	0.458	0.367	0.440	0.426
(8)	0.274	0.308	0.208	0.397	0.392	0.255	0.148	0	0.202	0.315	0.539	0.581	0.588	0.499	0.568	0.550
(9)	0.104	0.134	0.132	0.236	0.254	0.097	0.109	0.202	0	0.158	0.348	0.383	0.389	0.302	0.368	0.348
(10)	0.055	0.037	0.119	0.083	0.096	0.230	0.266	0.315	0.158	0	0.363	0.370	0.366	0.301	0.341	0.312
(11)	0.345	0.332	0.444	0.364	0.413	0.286	0.399	0.539	0.348	0.363	0	0.071	0.092	0.066	0.096	0.116
(12)	0.362	0.343	0.465	0.354	0.404	0.335	0.448	0.581	0.383	0.370	0.071	0	0.022	0.082	0.039	0.070
(13)	0.361	0.340	0.464	0.345	0.395	0.345	0.458	0.588	0.389	0.366	0.092	0.022	0	0.091	0.025	0.057
(14)	0.286	0.270	0.388	0.298	0.348	0.254	0.367	0.499	0.302	0.301	0.066	0.082	0.091	0	0.077	0.077
(15)	0.337	0.315	0.440	0.320	0.370	0.328	0.440	0.568	0.368	0.341	0.096	0.039	0.025	0.077	0	0.032
(16)	0.311	0.288	0.414	0.288	0.338	0.317	0.426	0.550	0.348	0.312	0.116	0.070	0.057	0.077	0.032	0

Problem 1 (k-means algorithm).

a) Run the k-means algorithm with $k = 3$ to cluster the dataset.
As initial centers, use the values shown in Table 2.

Table 2: Initial centers for the the k-means algorithm with $k = 3$

	v_B	v_D
$\boldsymbol{r}^{(1)}$	0.230	0.560
$\boldsymbol{r}^{(2)}$	0.150	0.740
$\boldsymbol{r}^{(3)}$	0.120	0.860

Show intermediate steps, i.e. the successive computations of centers, distances and assignments.

Problem 2 (DBSCAN algorithm).

a) Run the DBSCAN algorithm with $\epsilon = 0.14$ and $\tau = 5$ to cluster the dataset.
Show intermediate steps, i.e. partitioning the data points into three categories, etc.

```
### Data matrix
## id, vB, vD
1, 0.282, 0.562
2, 0.295, 0.593
3, 0.323, 0.467
4, 0.377, 0.655
5, 0.418, 0.626
6, 0.106, 0.539
7, 0.119, 0.426
8, 0.198, 0.301
9, 0.196, 0.503
10, 0.331, 0.586
11, 0.053, 0.820
12, 0.099, 0.874
13, 0.119, 0.884
14, 0.113, 0.793
15, 0.137, 0.866
16, 0.165, 0.850
```