Exercise 1

Machine Learning in Graphics & Vision

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1 Task 1

(a) The complexity of the method in subtask (a) is $O(d * n^2)$ where d is the dimension of the feature vector and n is the number of examples. Plot of the results is in figure 1a.

Code in `problem_1_1_a_b.py`.

(b) A single vector has to be compared with
30 FPS $*120$ s $= 3,600$ frames $= 3,600 * 20,000 = 7.2 * 10^7$(or $3,600N$) vectors
in one video, and each one of these has to be compared with all of the vectors from another video (i.e. $7.2 * 10^7$(or $3,600N$) vectors as well).
There are therefore $128 * 7.2^2 * 10^{14}$(or $128 * (3,600N)^2$) comparisons. Assuming that the machine can compute $3 * 10^9$ comparisons in a second, it would take $221,184,000$ s ≈ 7.0137 years (or $0.55296N^2$ seconds) to find all matchings of the vectors between two different 2 minute long videos (30 FPS) using `exhaustive_search`.

Code in `problem_1_1_a_b.py`. Plot of the results is in figure 1b.

(c) Query times in both, exhaustive and KDTree, search grow linearly as the number of dimensions increases. However, KDTree is for datasets with more dimensional vectors up to more than 20 times faster. This implies that another variable, the number of vectors in the dataset, is the source of this difference.

Code in `problem_1_1_c.py`. Plot of the results is in figure 1c

2 Task 2

(a) Code in `problem_1_2_a.py`. Top-K accuracy for K between 1 and 10 as expected grows with K and is in the range between 0.8 and 0.97 as can be seen in figure 2.

(b) Code in `problem_1_2_b.py`.

Obtained results:

```
Precision (with "Pullover" (2) as positive):  0.8333333333333334
Precision (with "Shirt" (6) as positive):     0.780952380952381
-----------------------------------------------------------------
Recall (with "Pullover" (2) as positive):  0.7653061224489796
Recall (with "Shirt" (6) as positive):     0.845360824742268
```

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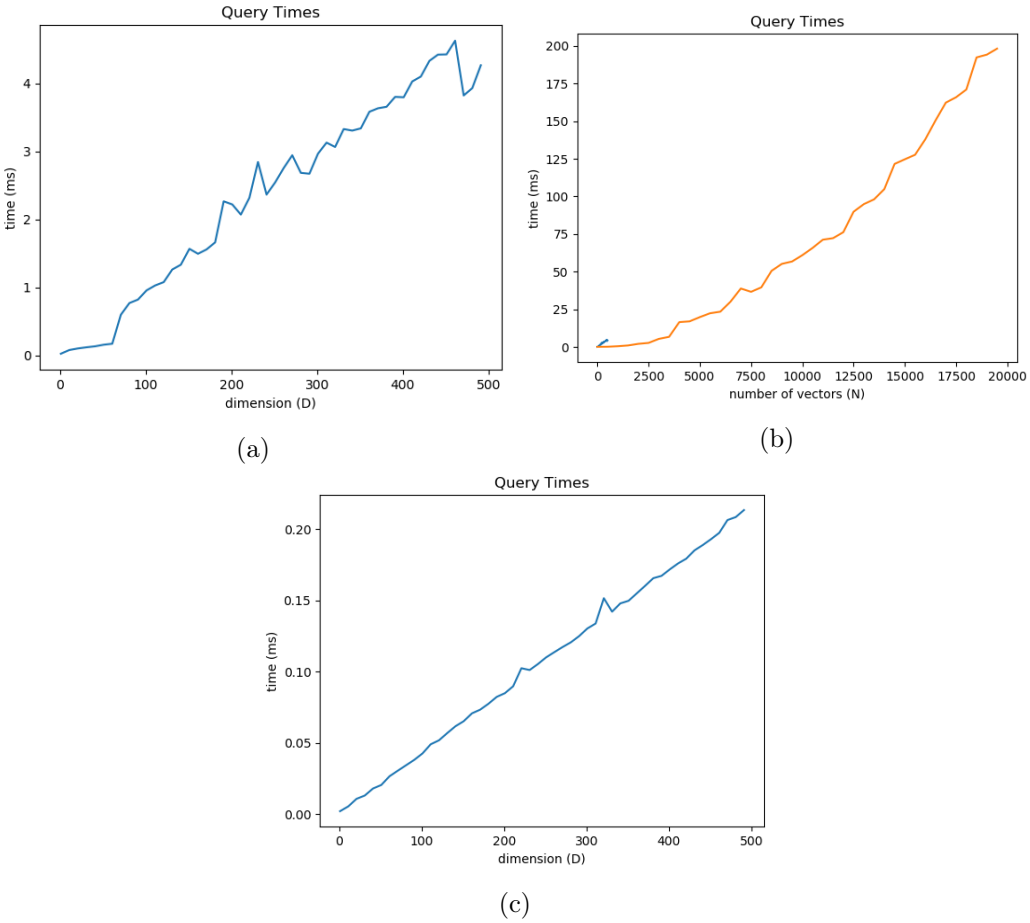

(a) (b)

(c)

Figure 1: Plot of results from task 1

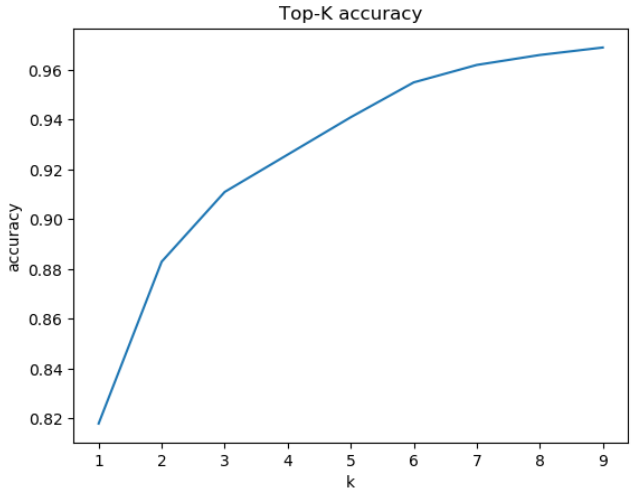

Figure 2: Top-K accuracy for $K = 1, 2, \ldots, 10$ using the KD-tree from task 2.a)