

# COMP9444 Neural Networks and Deep Learning

## Term 2, 2020

### Solutions to Exercise 6: Word Vectors

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#### 1. Consider the sentence

"two flowers grew tall on two tall towers"

- a. Write the co-occurrence matrix  $X$  for this sentence, using a 4-word context window (i.e. two context words on either side of the central word)

	flowers	grew	on	tall	towers	two
flowers	0	1	0	1	0	1
grew	1	0	1	1	0	1
on	0	1	0	2	0	1
tall	1	1	2	0	1	2
towers	0	0	0	1	0	1
two	1	1	1	2	1	0

- b. Use `torch.svd()` to compute the singular value decomposition of this matrix  $X = USV^T$

```
import torch

M = torch.Tensor(
    [[0,1,0,1,0,1],
     [1,0,1,1,0,1],
     [0,1,0,2,0,1],
     [1,1,2,0,1,2],
     [0,0,0,1,0,1],
     [1,1,1,2,1,0]])

U, S, V = torch.svd(M)

torch.set_printoptions(precision=2)

print(U)
print(S)
print(V)

tensor([[ -0.30,  0.24,  0.38, -0.36,  0.41,  0.64],
        [ -0.37, -0.11, -0.03,  0.80,  0.47,  0.04],
        [ -0.41,  0.53,  0.29, -0.12,  0.08, -0.67],
        [ -0.56, -0.74,  0.16, -0.27, -0.13, -0.14],
        [ -0.22,  0.19,  0.37,  0.36, -0.75,  0.29],
        [ -0.50,  0.25, -0.78, -0.13, -0.17,  0.17]])
tensor([4.83, 2.53, 1.70, 1.10, 0.40, 0.11])
```

```
tensor([[ -0.30,  -0.24,  -0.38,   0.36,   0.41,   0.64],
        [ -0.37,   0.11,   0.03,  -0.80,   0.47,   0.04],
        [ -0.41,  -0.53,  -0.29,   0.12,   0.08,  -0.67],
        [ -0.56,   0.74,  -0.16,   0.27,  -0.13,  -0.14],
        [ -0.22,  -0.19,  -0.37,  -0.36,  -0.75,   0.29],
        [ -0.50,  -0.25,   0.78,   0.13,  -0.17,   0.17]])
```

(Note: replacing  $U$  and  $V$  with  $-U$  and  $-V$  would preserve  $X = USV^T$ )

- c. Extract a word representation from the first two columns of  $U$  and use `matplotlib` to plot the words on a 2-dimensional graph.

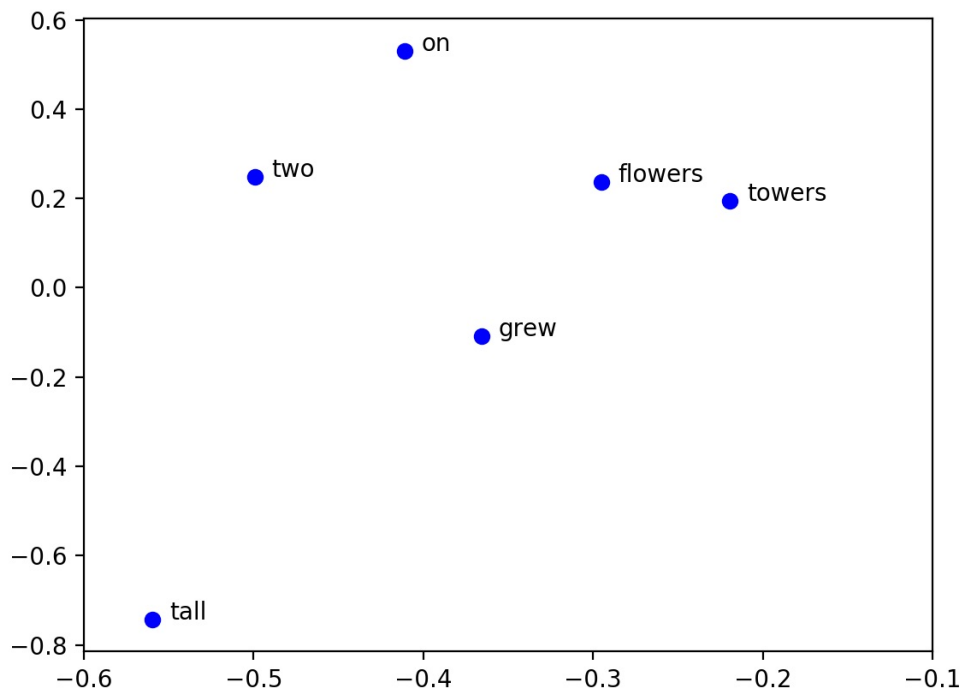
```
import matplotlib.pyplot as plt

Lex = ['flowers', 'grew', 'on', 'tall', 'towers', 'two']

plt.scatter(U[:,0], U[:,1], c='B')
plt.xlim([-0.6, -0.1])

for a in range(U.size()[0]):
    plt.text(0.01+U[a,0], U[a,1], Lex[a])

plt.savefig('vectors.png')
plt.show()
```



(Note: the image may be rotated, depending on the sign of  $U$ )