Linear Data Chapter 2

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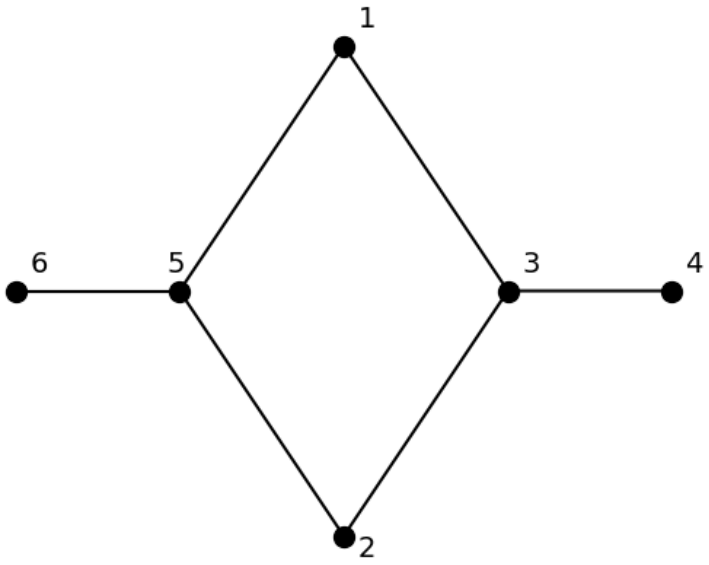
1. (a) What is numeration?
   Numeration translates data into numbers lets mathematics do the work of transformation.

   (b) Give an example of coding in the context of numeration.
   Many examples possible. In the lecture, we saw coding in the context of audio recordings of classrooms, where key words were assigned numbers and each student's response was assigned the numbers of the key words they remembers. We also saw one-hot encoding to aid in classification tasks, where each class in a set of n classes is assigned a different vector with ten entries, one being 1 and the others being 0s. Any other example of turning one type of data into some (other) sort of number is acceptable.

2. Suppose we wanted to understand on what type of device students watched lecture videos: phone, tablet, laptop, desktop. Devise a one-hot encoding scheme for this classification.
   One possible scheme:

$$\textit{phone} \Rightarrow \begin{pmatrix} 1 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \quad \textit{tablet} \Rightarrow \begin{pmatrix} 0 \\ 1 \\ 0 \\ 0 \end{pmatrix}, \quad \textit{laptop} \Rightarrow \begin{pmatrix} 0 \\ 0 \\ 1 \\ 0 \end{pmatrix}, \quad \textit{desktop} \Rightarrow \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \end{pmatrix}.$$

3. Consider the graph/network plotted below.



Explicitly give (i.e., write down all of the entries) the adjacency matrix $\mathbf{A}$ of the graph.

$$\mathbf{A} = \begin{pmatrix} 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{pmatrix}$$

4. Using Python/Jupyter or Matlab/Matlab Live Script, perform the following:

   - Generate three different random row vectors with 4 entries, $\vec{a}$, $\vec{b}$, and $\vec{c}$.
   - Set $\vec{d} = \vec{a} + \vec{b} + \vec{c}$.
   - Set $\vec{e} = \vec{b} + \vec{c} + \vec{a}$.
   - Test if $\vec{d}$ and $\vec{e}$ are the same up to uncertainty in floating point arithmetic. (Sometimes, but not always, they will be exactly the same, but you cannot count on that.)

In Matlab (with or without semicolons):

```
a=rand(1,4)
b=rand(1,4)
c=rand(1,4)
d=a+b+c
e=b+c+a
norm(d-e,Inf)<10e-15
```

In Python:

```
import numpy as np
a= np.random.rand(4)
b = np.random.rand(4)
c = np.random.rand(4)
d=a+b+c
e=b+c+a
np.allclose(d,e)
```