

Vectors, Translations, and Meaning

Extension Sheet

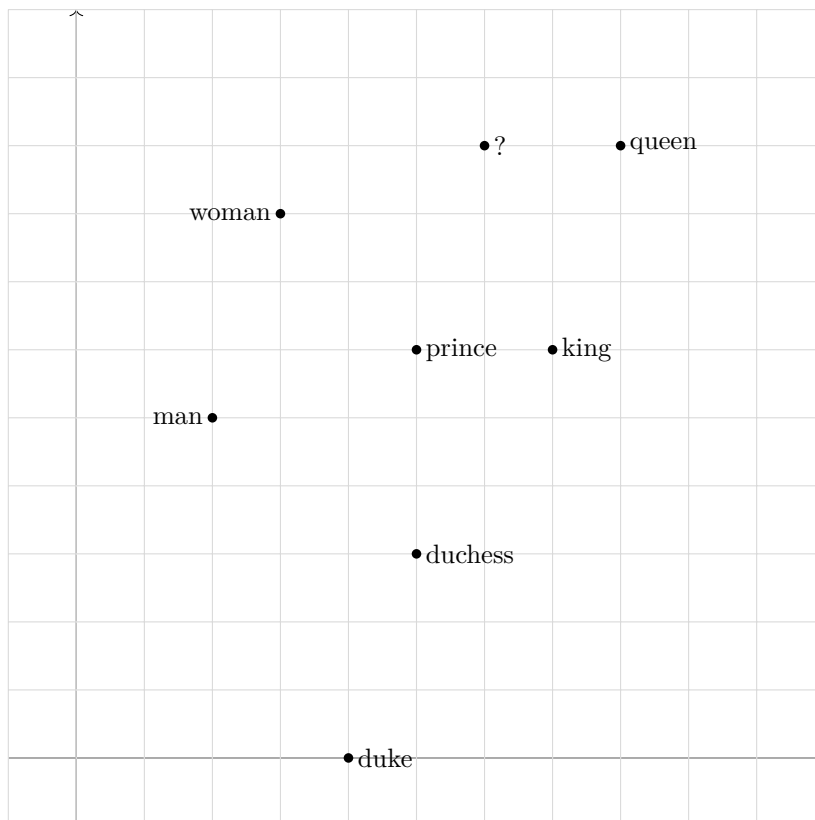
1 Vector translation review

Point $A = (2, 3)$ is translated by $\mathbf{t} = \begin{pmatrix} 4 \\ 1 \end{pmatrix}$. Find the destination.

Apply the same translation to $B = (-1, 5)$.

2 Word embeddings

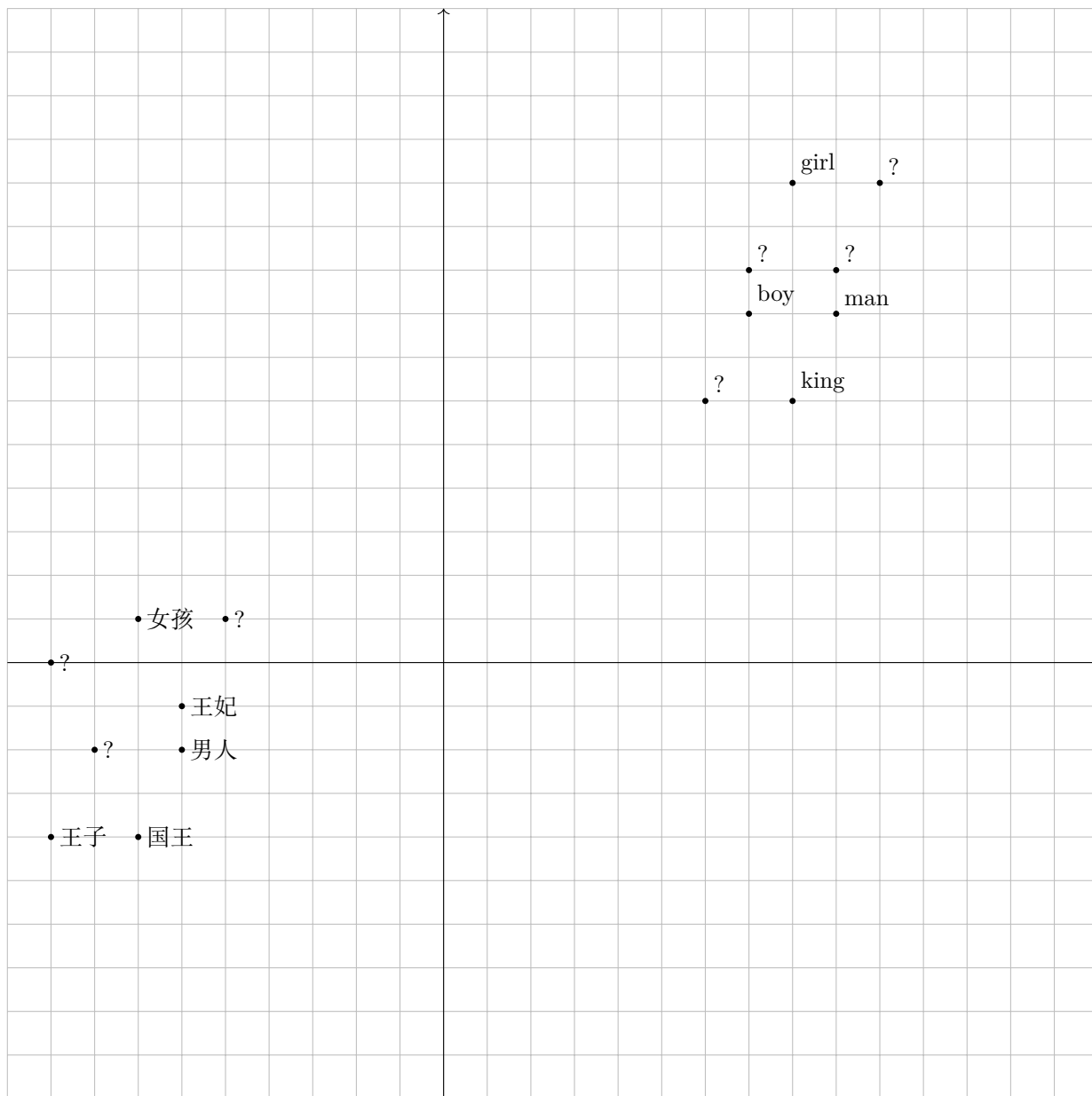
AI models take words and assign them coordinates (x, y) , so that the words can be processed by algorithms - this is called a **word embedding**. Below is an example of this for 8 words:



1. Compute the vector $\overrightarrow{\text{king} - \text{queen}}$.
2. Compute the vector $\overrightarrow{\text{duke} - \text{duchess}}$.
3. What do you think the translation $\begin{pmatrix} 1 \\ 3 \end{pmatrix}$ represents in our word vector embedding?
4. Consider $\overrightarrow{\text{man} - \text{woman}}$, does that match up with your answer to the previous question?
5. What word is missing at the question mark ?

3 Translating English to Chinese

Machine translation is a field of AI that deals with translating text between two different languages, below is an incomplete grid and translation table:



Translation table (incomplete)

English	English coords	Chinese	Chinese coords
man	(9,8)	男人	(-6,-2)
woman	(10,11)	女人	(-5,1)
boy		男孩	
		女孩	(-7,1)
	(8,6)		
		王妃	
prince		王子	
princess	(7,9)	公主	(-9,0)

Tasks

1. Use the given coordinates and table to compute the translation vector $\mathbf{t}$ from English to Chinese.
2. Fill in the missing values in the table and coordinate grid
3. (Challenge) What do you think the vector $\begin{pmatrix} -2 \\ 0 \end{pmatrix}$ means in the context of this word-vector embedding?
4. (Challenge) The bottom row of the table does not follow the pattern, why do you think this is? (hint - consider the Chinese characters)