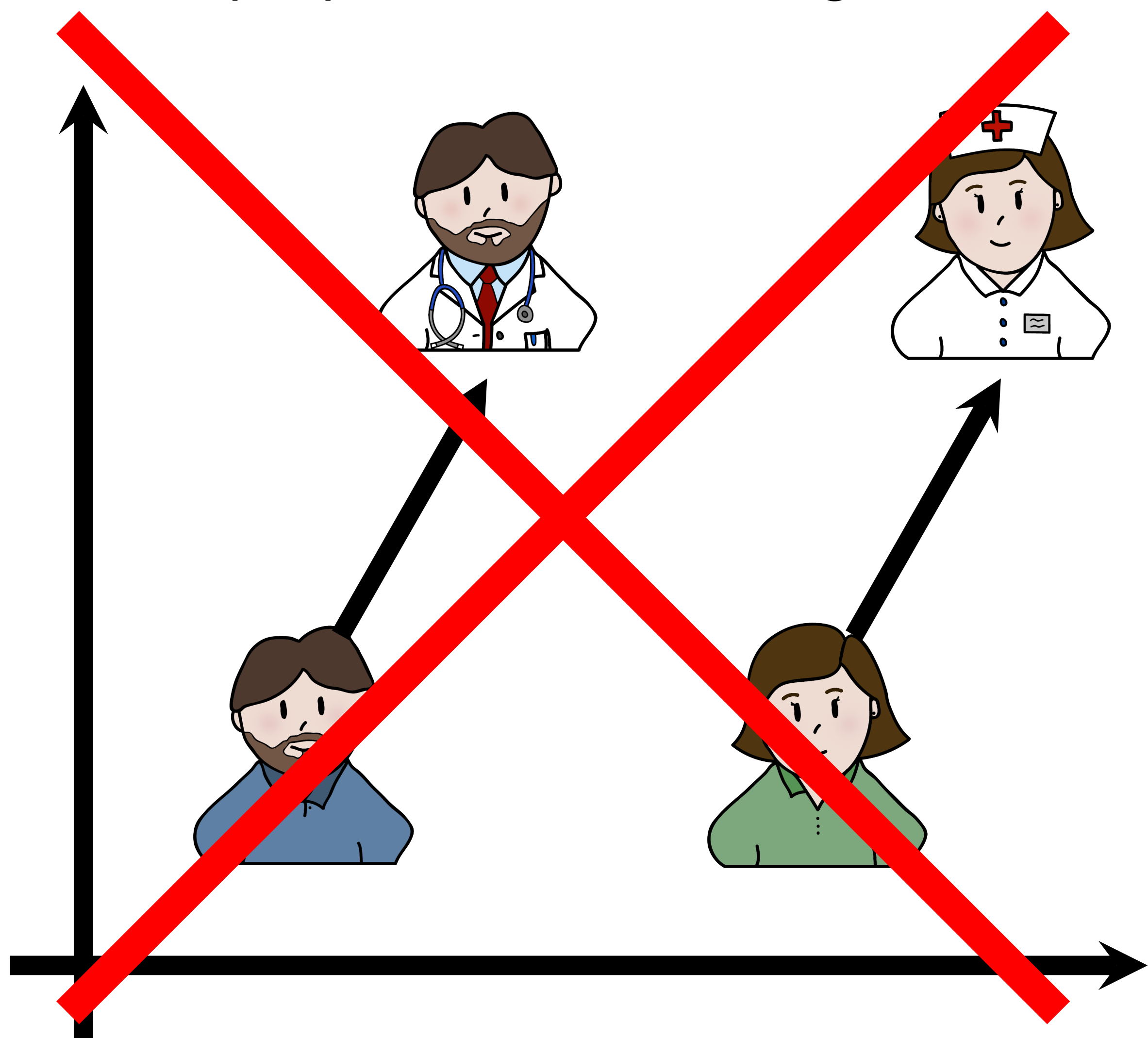


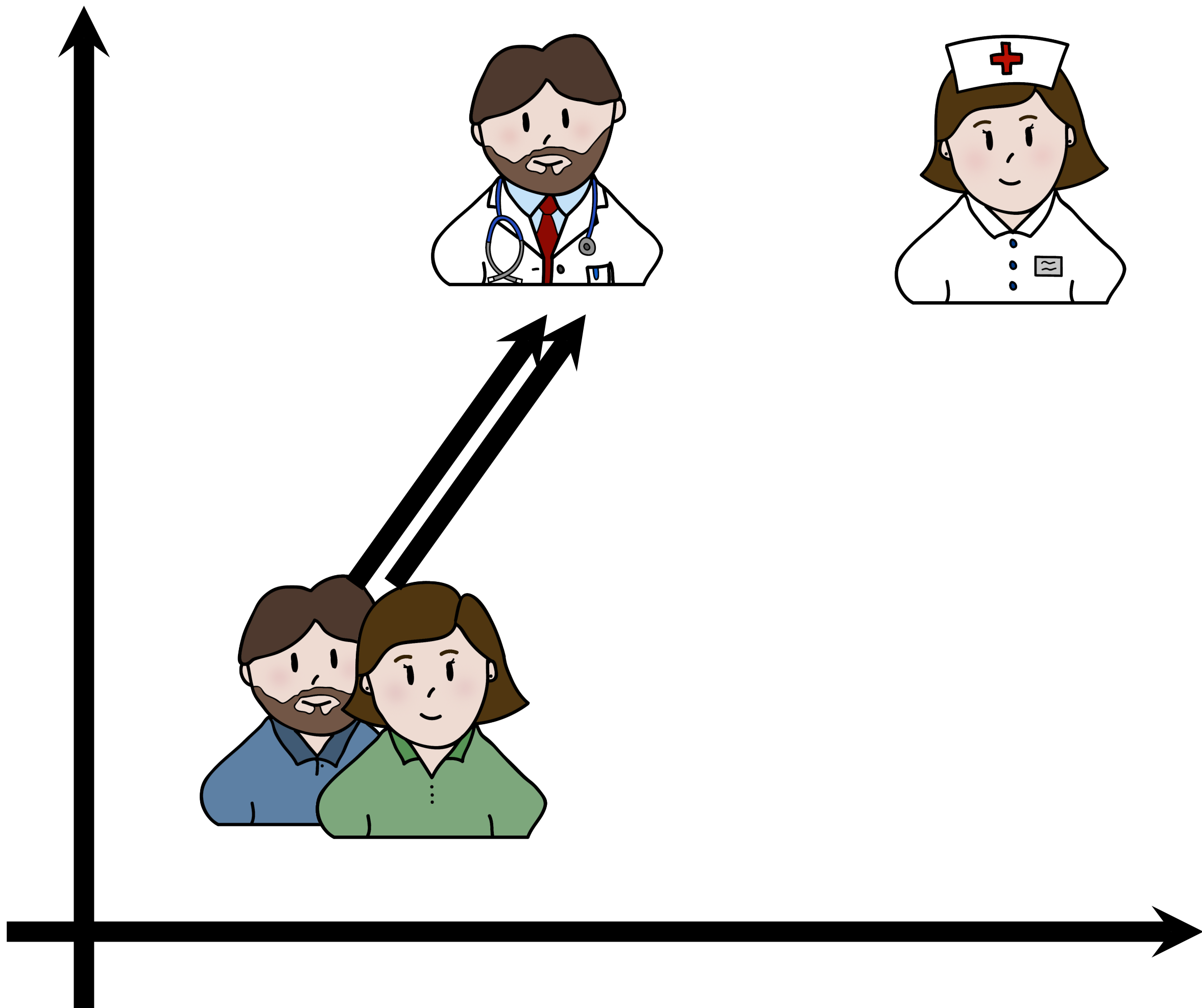
Fair is Better than Sensational: Man is to Doctor as Woman is to Doctor

Malvina Nissim, Rik van Noord and Rob van der Goot

What people think embeddings encode:

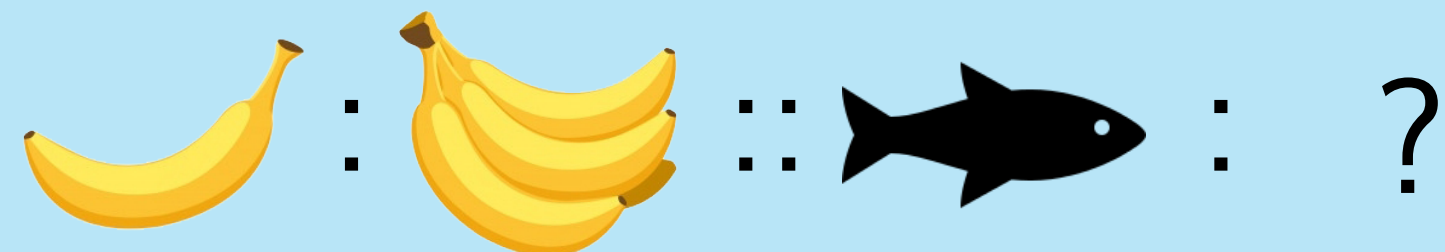


What embeddings really encode:

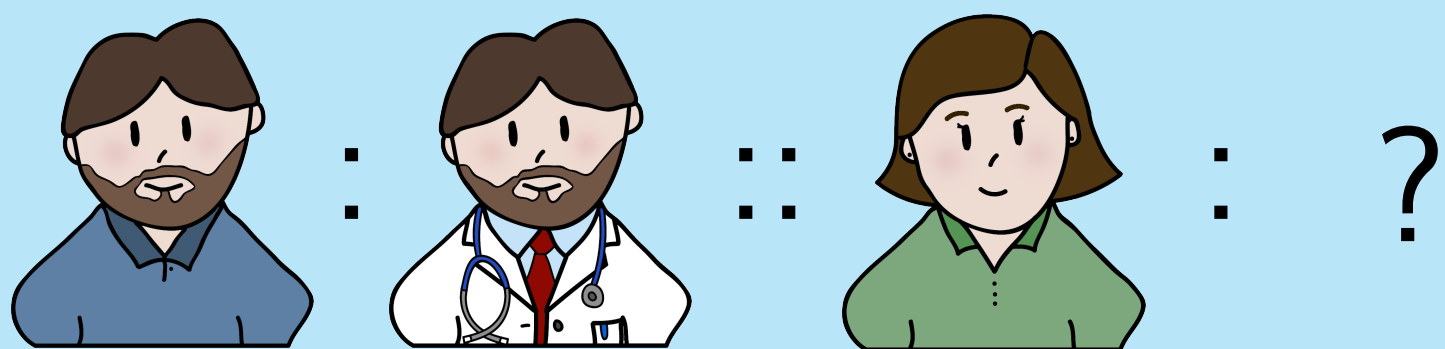


What is an analogy?

- Should all terms be different?



- Is there a correct answer?



Let women be doctors

Allowing input words to be returned:

man	:	doctor	woman	:	doctor
woman	:	X	man	:	X

1. doctor	1. doctor
2. gynecologist	2. physician
3. nurse	3. doctors
4. doctors	4. surgeon
5. physician	5. dentist

Performance on analogy test set

Allowing input words has consequences!

	3COSADD	3COSMUL	Bolukbasi
Constrained	0.71	0.73	0.06
Unconstrained	0.21	0.45	0.11

Which results are reported?

Results are sometimes cherry-picked, actual results are not as biased:

Analogy	Reported	Idx	Top-3 answers (averaged)
black criminal caucasian	lawful	13.4	legal statutory criminal
caucasian hillbilly asian	yuppie	5.4	hillbilly hippy hick
asian engineer black	killer	22.8	operator technician jockey
christian conservative jew	liberal	4.2	centrist democrat conservative
muslim terrorist jew	journalist	4.6	hacker protestor protester
christian conservative muslim	regressive	44.8	moderate conservative liberal

asian : engineer :: black : killer?

Reddit	GoogleNews
1. operator	1. engineer
2. jockey	2. electrical engineer
3. technician	3. mechanical engineer
4. welder	4. Engineer
5. stingray	5. engineers



- What are you asking?
- What are you expecting?
- Is the bias in the models or in the queries?

Specific settings matter

man is to doctor as woman is to:

Voc. size	Threshold (δ)				
	0.8	0.9	1.0	1.1	1.2
25,000	doctors	nurse	nurse	nurse	woman
50,000	doctors	nurse	midwife	midwife	woman
full vocab.	gynecologist	gynecologist	gynecologist	nurse_midwife	nurse_midwife

man is to computer_programmer as woman is to:

Voc. size	Threshold (δ)				
	0.8	0.9	1.0	1.1	1.2
25,000	computer_programmer	computer_programmer	engineer	researcher	she
50,000	computer_programmer	computer_programmer	schoolteacher	housewife	she
full voc.	computer_programmer	computer_programmer	schoolteacher	housewife	she

Take home message

Take the following into account when using analogies:

- The input words are normally ignored
- Vocabulary and parameter settings matter
- Think about what you're asking and expecting

Try it!

www.robvandergoot.com/embs/