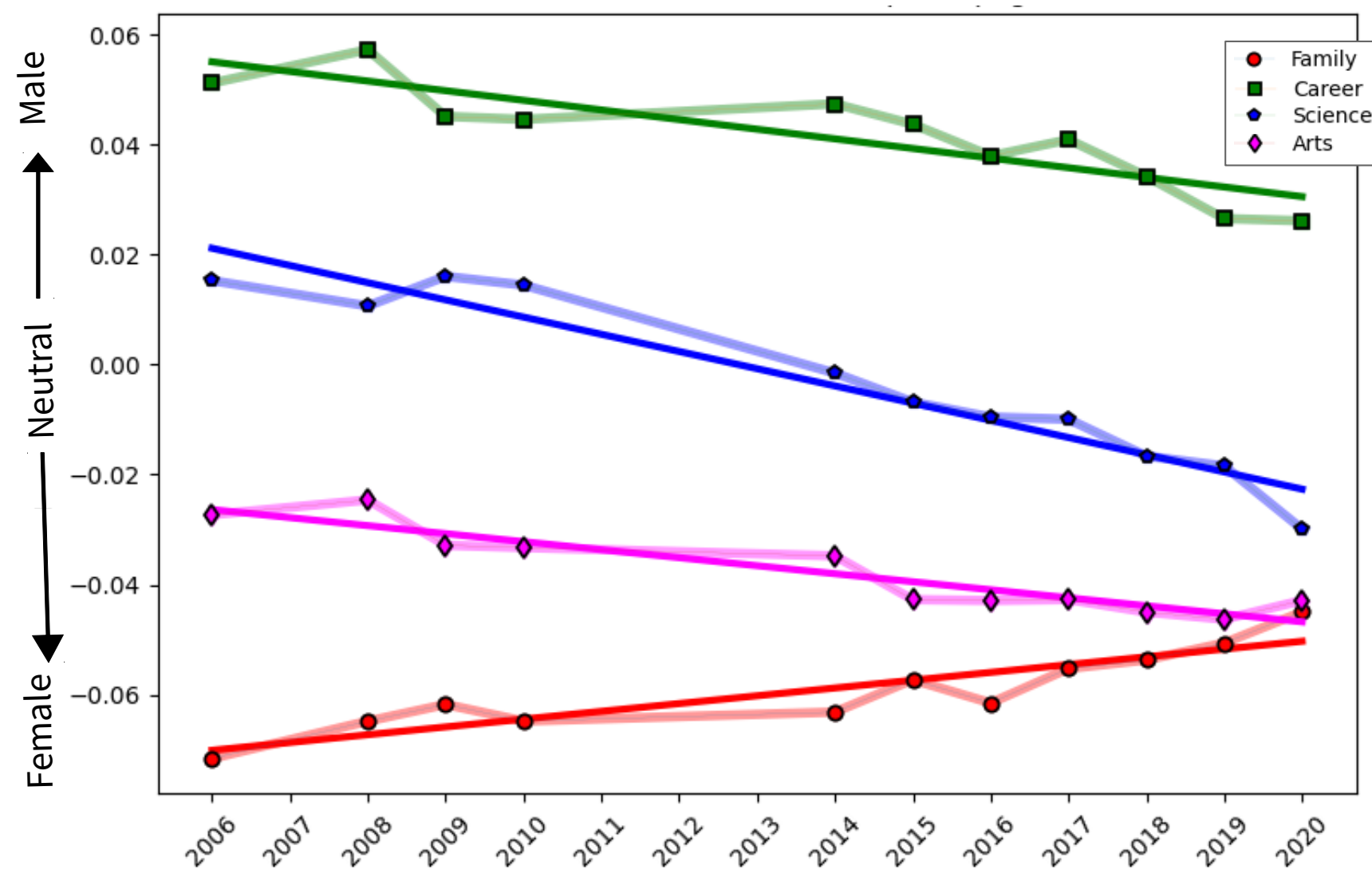


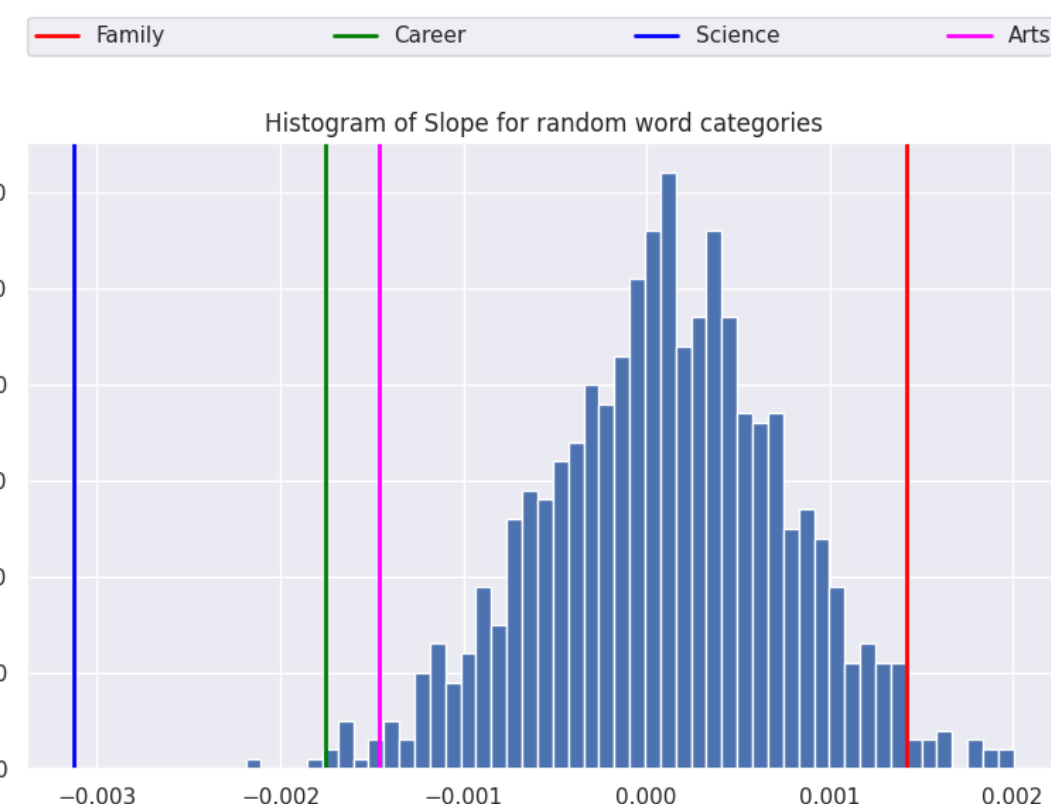
bias over time



significance

Independent samples test using random category sets:

Category	p-value
Career	0.0027
Arts	0.0095
Science	$5.60 \cdot 10^{-7}$
Family	0.0230



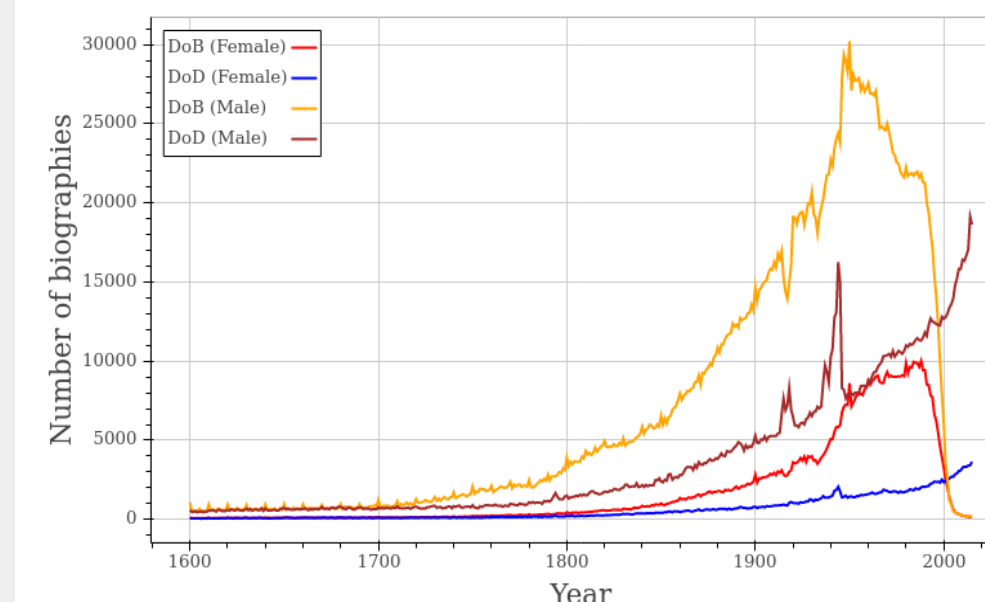
background

Word embeddings are an important tool for natural language processing. These are regularly created using unsupervised learning with word2vec from a large corpus of text which contains a gender bias. Certain words have a stronger association with male words than female words or the other way around.

Research to literature from 1800 to 2000 shows that this stereotypical gender bias has decreased over time. If this trend has continued in more recent years, this would mean that training algorithms on more recent data instead could already decrease gender bias without altering the word embeddings.

biographies

Amount of biographies by date of birth



computation

For every category c we formally define the bias using category set C , male set M and female set F as:

$$bias(C, F, M) = mean_{c \in C}(assoc(c, M) - assoc(c, F))$$
 where $assoc(w, A) = mean_{a \in A}(\cos(\vec{w}, \vec{a}))$

Categories

Career	Executive, management, professional, corporation, salary, office, business, career
Family	Home, parents, children, family, cousins, marriage, wedding, relatives
Arts	Poetry, art, dance, literature, novel, symphony, drama, sculpture, Shakespeare
Science	Science, technology, physics, chemistry, Einstein, NASA, experiment, astronomy
Female	She, her, woman, female, girl, daughter, sister, mother, aunt, lady
Male	He, his, man, male, boy, son, brother, father, uncle, gentleman

conclusion

There is a significant decrease in the gender bias for the stereotypical biases of the categories Family and Career. The words for Arts and Science are however already biased towards female and increasing.

To understand what causes the changes in the male and female association, we look at the biographies in Wikipedia. This shows that the change can partly be explained by the increased percentage of female biographies. increasing this is also what Wikipedia has been focusing on to reduce the gender gap. However, the majority of biographies is still by far male. The traditionally female biases arts and family must therefore be caused by how people are represented. Another possible reason can be found in the fact that male is sometimes seen as the default gender and that in female biographies more words like female and woman are used to specify the gender.