

Discovering User Attribute Stylistic Differences via Paraphrasing

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Motivation

User attribute prediction from text is successful:

- ▶ **Age** (Rao et al. 2010 ACL)
- ▶ **Gender** (Burger et al. 2011 EMNLP)
- ▶ **Location** (Eisenstein et al. 2010 EMNLP)
- ▶ **Personality** (Schwartz et al. 2013 PLoS One)
- ▶ **Impact** (Lampos et al. 2014 EACL)
- ▶ **Political Orientation** (Volkova et al. 2014 ACL)
- ▶ **Mental Illness** (Coppersmith et al. 2014 ACL)
- ▶ **Occupation** (Preoțiuc-Pietro et al. 2015 ACL)
- ▶ **Income** (Preoțiuc-Pietro et al. 2015 PLoS One)

Motivation

User attribute prediction from text is useful:

- ▶ **Sentiment analysis** (Volkova et al. 2013 EMNLP)
- ▶ **Text classification** (Hovy 2015 ACL)
- ▶ **Audience profiling** (Yang et al. 2015 EMNLP)
- ▶ **Marketing**
- ▶ **Embedding to downstream tasks (e.g. controlling for demographic factors)**
- ▶ **Social science research**

However...

Most text prediction methods uncover **topical** differences

Not useful for many practical applications that adapt to traits:

- ▶ machine translation (Mirkin et al. 2015 EMNLP)
- ▶ agents (e.g. customer service, tutoring)
- ▶ controlling for gender or racial bias



Stylistic differences

We need to be aware of **style** differences, rather than topical

One type of stylistic difference is **phrase choice**

Text-to-text Translation

Female or Male?

@USER A teeny tiny cute coffee shop (and a cheap fry-up style cafe). I'm intrigued...

@USER A small tiny clever coffee shop (and a cheap fry-up style cafe). I'm intrigued...

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Text-to-text Translation

Over 30 years old or under 25 years old?

RT @USER : how your body answers to workout over time URL

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We study three traits:

- ▶ Gender
male vs. female
67,337 Twitter users, 104M tweets
- ▶ Age
 ≥ 30 y.o. vs. < 25 y.o.
3,865 Twitter users, 690k tweets
- ▶ Occupational Class
low skill (5–9) vs. high skill (1–2)
3,909 Twitter users, 5M tweets

Paraphrasing

Paraphrases – alternative ways to convey the same information

Paraphrase Database (PPDB) 2.0 (Pavlick et al. 2015 ACL):

- ▶ 100M automatically derived paraphrase pairs
- ▶ annotated with type and confidence (we keep only 'equivalent' paraphrases with $>.2$ confidence)
- ▶ we use only 1–3 grams
- ▶ difference in a pair more than just change of stopwords or root form of word
- ▶ non-transitive relationship, we create clusters via transitive closure

Straightforward measure:

$$\text{Gender}(w) = \log\left(\frac{\text{Female}(w)}{\text{Male}(w)}\right) \quad (1)$$

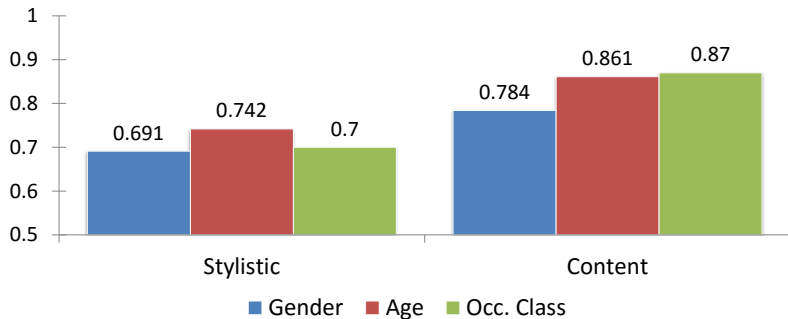
Within a paraphrase pair (w_1, w_2) , the difference $\text{Gender}(w_1) - \text{Gender}(w_2)$ is the stylistic distance

Examples

Female	≥ 30 y.o.	High Occ. Class
charming (-0.58)	delightful (-0.96)	gratifying (-0.33)
delightful (-0.49)	splendid (-0.55)	enjoyable (-0.30)
gratifying (0.03)	enjoyable (-0.46)	delightful (-0.17)
splendid (0.07)	gratifying (-0.04)	pleasant (-0.06)
good (0.12)	pleasant (0.01)	charming (-0.04)
pleasing (0.18)	charming (0.03)	splendid (-0.01)
nice (0.24)	pleasurable (0.13)	good (0.08)
pleasurable (0.24)	nice (0.53)	nice (0.17)
pleasant (0.33)	good (0.53)	pleasing (0.21)
enjoyable (0.38)	pleasing (0.80)	pleasurable (0.77)
Male	< 25 y.o.	Low Occ. Class

O - A Kendall $\tau = .51$, O - G $\tau = .2$, G - A $\tau = .06$

Prediction



ROC AUC, Naive Bayes, 80-20 training-testing

Which word is more likely to be used by a **female**?

Giggle – Laugh

Human Perception

Which word is more likely to be used by a **female**?

Giggle – Laugh

Which word is more likely to be used by an **older** person?

Impressive – Amazing

Human Perception

Which word is more likely to be used by an **older** person?

Impressive – **Amazing**

Which word is more likely to be used by a person of **higher occupational class** ?

Suggestions – Proposals

Human Perception

Which word is more likely to be used by a person of **higher occupational class** ?

Suggestions – Proposals

Human Perception

Which word is more likely to be used by a **female**?

Brutal – Fierce

Human Perception

Which word is more likely to be used by a **female**?

Brutal – **Fierce**

Which word is more likely to be used by an **older** person?

Defensive – Protective

Human Perception

Which word is more likely to be used by an **older** person?

Defensive – Protective

Human Perception

Which word is more likely to be used by a person of **higher occupational class** ?

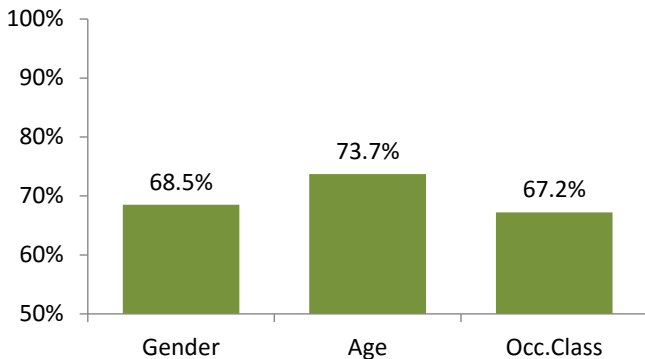
Humour – Wit

Human Perception

Which word is more likely to be used by a person of **higher occupational class** ?

Humour – Wit

Human Perception



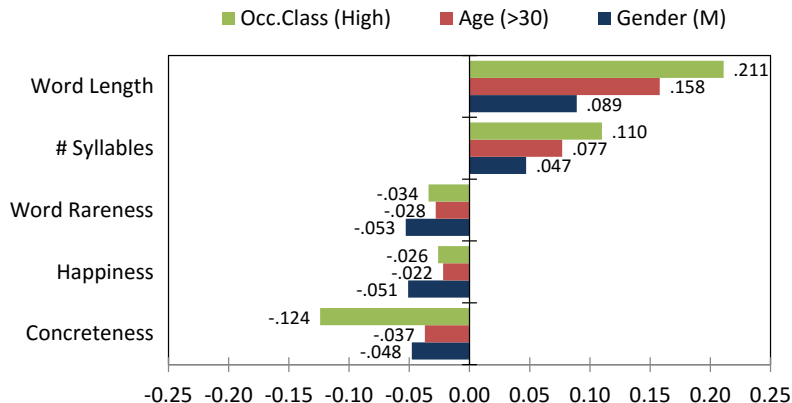
3 ratings / pair

Linguistic Theories

Study which attributes of words in a pair are preferred by one group:

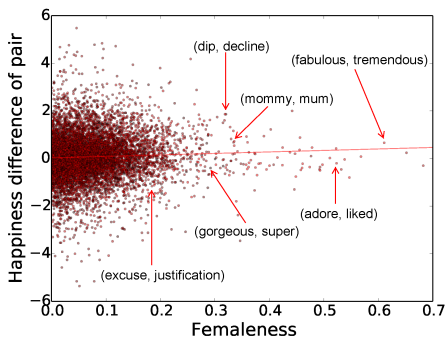
- ▶ Word Length in Characters
- ▶ Word Length in Syllables
Proxies for word complexity
- ▶ Word Rareness
Compared to a reference corpus of 400M tweets
Conflates lexical innovation, infrequent word usage, misspellings
- ▶ Perceived happiness
10k rated words: suicide (0.15) → bacon (0.70) → laughter (1)
- ▶ Concreteness
40k rated words: spirituality (1) → morning (3.44) → tiger (5)

Linguistic Theories



Correlation coefficients between paraphrase pair differences and user group usage

Gender and Perceived Happiness



Scatter plot and best fit line between paraphrase use differences and perceived word happiness

Each dot is a paraphrase pair

The first word is more used by females

Take Aways

Stylistic difference between user groups have important applicability

Paraphrase choice still contains valuable information (albeit less than topical)

Choices match human intuitions

Shed light on word usage

Co-Authors



Thank you!