

distributional observations on sentiment analysis

jussi karlgren

Gavagai and KTH

october 2017

Jussi Karlgren

- ▶ visitor here at Stanford 2017-18

Jussi Karlgren

- ▶ visitor here at Stanford 2017-18
- ▶ distributional semantics at scale

Jussi Karlgren

- ▶ visitor here at Stanford 2017-18
- ▶ distributional semantics at scale
- ▶ stylistics and genre (mostly in text, but working to change that)

Jussi Karlgren

- ▶ visitor here at Stanford 2017-18
- ▶ distributional semantics at scale
- ▶ stylistics and genre (mostly in text, but working to change that)
- ▶ many other things

Jussi Karlgren

- ▶ visitor here at Stanford 2017-18
- ▶ distributional semantics at scale
- ▶ stylistics and genre (mostly in text, but working to change that)
- ▶ many other things
- ▶ mostly at Gavagai

Jussi Karlgren

- ▶ visitor here at Stanford 2017-18
- ▶ distributional semantics at scale
- ▶ stylistics and genre (mostly in text, but working to change that)
- ▶ many other things
- ▶ mostly at Gavagai
- ▶ but also as adjoint professor at KTH Royal Institute of Technology

What we do at Gavagai

- ▶ media monitoring

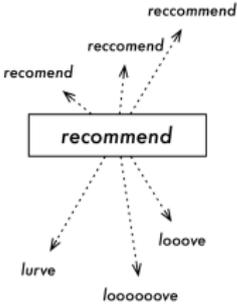
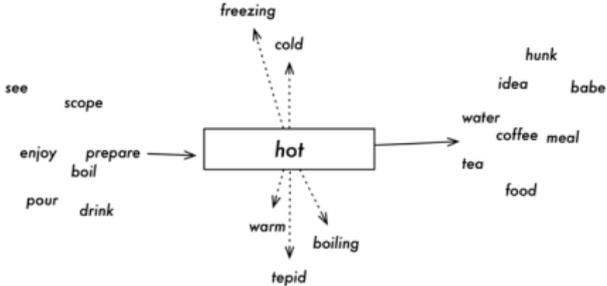
What we do at Gavagai

- ▶ media monitoring
- ▶ questionnaire processing

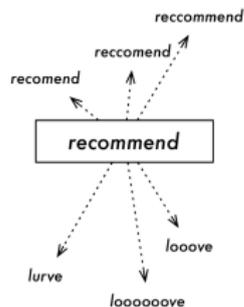
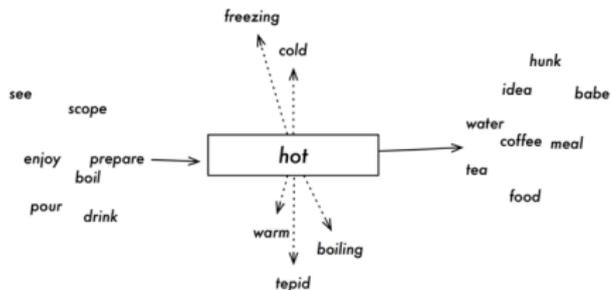
What we do at Gavagai

- ▶ media monitoring
- ▶ questionnaire processing
- ▶ Gavagai living lexicon

learning a lexicon: Gavagai living lexicon



learning a lexicon: Gavagai living lexicon



<http://lexicon.gavagai.se>

Our distributional implementation

Random Indexing

-
- ▶ Pentti Kanerva, Jan Kristoferson, and Anders Holst. 2000. Random Indexing of Text Samples for Latent Semantic Analysis. CogSci.
 - ▶ Magnus Sahlgren, Anders Holst, and Pentti Kanerva. 2008. Permutations as a Means to Encode Order in Word Space. CogSci.

semantic base technology

semantic base technology

- ▶ is this an example of that?

semantic base technology

- ▶ is this an example of that?
- ▶ are these two the same?

semantic base technology

- ▶ is this an example of that?
- ▶ are these two the same?
- ▶ has this changed? how?

semantic base technology

- ▶ is this an example of that?
- ▶ are these two the same?
- ▶ has this changed? how?
- ▶ what is the relation of this and that?

semantic base technology

- ▶ is this an example of that?
- ▶ are these two the same?
- ▶ has this changed? how?
- ▶ what is the relation of this and that?
- ▶ is this a new way of saying that?

semantic base technology

- ▶ is this an example of that?
- ▶ are these two the same?
- ▶ has this changed? how?
- ▶ what is the relation of this and that?
- ▶ is this a new way of saying that?
- ▶ are these or those more like this?

semantic base technology

- ▶ is this an example of that?
- ▶ are these two the same?
- ▶ has this changed? how?
- ▶ what is the relation of this and that?
- ▶ is this a new way of saying that?
- ▶ are these or those more like this?
- ▶ is this typical or strange?

semantic base technology

- ▶ is this an example of that?
- ▶ are these two the same?
- ▶ has this changed? how?
- ▶ what is the relation of this and that?
- ▶ is this a new way of saying that?
- ▶ are these or those more like this?
- ▶ is this typical or strange?
- ▶ can we trust this?

semantic base technology

- ▶ is this an example of that?
- ▶ are these two the same?
- ▶ has this changed? how?
- ▶ what is the relation of this and that?
- ▶ is this a new way of saying that?
- ▶ are these or those more like this?
- ▶ is this typical or strange?
- ▶ can we trust this?
- ▶ does the author believe this to be true?

semantic base technology

Meaningful application

Semantic layer

Crunch layer

Distributed processing
architecture

Database technology or similar

Data stream

semantic base technology

Meaningful application

Semantic layer

Crunch layer

Distributed processing
architecture

Database technology or similar

Data stream

is this an example of that?
are these two the same?
has this changed? how?
what is the relation of this and that?
is this a new way of saying that?
are these or those more like this?
is this typical or strange?
can we trust this?
does the author believe this to be true?

bridge between theory and use cases

three levels of sophistication for large scale text analysis

bridge between theory and use cases

three levels of sophistication for large scale text analysis

1. what are they talking about?

bridge between theory and use cases

three levels of sophistication for large scale text analysis

1. what are they talking about?
2. how are they talking about it?

bridge between theory and use cases

three levels of sophistication for large scale text analysis

1. what are they talking about?
2. how are they talking about it?
3. what are they saying about it?

implementational challenge

use distributional models for items beyond the
immediately topical and referential

implementational challenge

use distributional models for items beyond the immediately topical and referential

- ▶ enrich representation beyond token by token analysis

implementational challenge

use distributional models for items beyond the immediately topical and referential

- ▶ enrich representation beyond token by token analysis
- ▶ broaden scope to utterances

understanding distributional semantics

- ▶ many see distributional semantics as something given, as something naïve, and something with little theory

("viel data und wenig theorie")

understanding distributional semantics

- ▶ many see distributional semantics as something given, as something naïve, and something with little theory

("viel data und wenig theorie")

- ▶ i am looking for features with both signal and explanatory power to deploy in distributional frameworks

this year's project

this year's project

- ▶ event space ("how are they talking about it?")

this year's project

- ▶ event space ("how are they talking about it?")
- ▶ using random indexing-like models

this year's project

- ▶ event space ("how are they talking about it?")
- ▶ using random indexing-like models
- ▶ enriching the representation which currently is topical and referential

this year's project

- ▶ event space ("how are they talking about it?")
- ▶ using random indexing-like models
- ▶ enriching the representation which currently is topical and referential
- ▶ to event qualities and to situational features

this year's project

- ▶ event space ("how are they talking about it?")
- ▶ using random indexing-like models
- ▶ enriching the representation which currently is topical and referential
- ▶ to event qualities and to situational features i have a great collection of hurricane tweets

right now

right now

- ▶ sentiment analysis

right now

- ▶ sentiment analysis
- ▶ mostly lexical

right now

- ▶ sentiment analysis
- ▶ mostly lexical
- ▶ adjectives prototypically most interesting

sentiment analysis

attitude is a non-conventionalised aspect of
language use

sentiment analysis

attitude is a non-conventionalised aspect of
language use
... and therefore interesting as an object of study ...

sentiment analysis

attitude is a non-conventionalised aspect of
language use
... and therefore interesting as an object of study ...
... and potentially quite useful in commercial
application!

sentiment analysis can be difficult!

- ▶ And the sound quality - my God!
- ▶ Raymond left no room for error on his recordings and it shows.
- ▶ Definitely one of the better tracks on the album.
- ▶ Wow, could have been a expansion pack.
- ▶ I loved The Spy Who Came In From The Cold but the movie is a bit dated in a way the book never will be.
- ▶ Meat is more environmentally friendly than seafood.
- ▶ I am unsure about the feasibility of this knitting pattern.
- ▶ I love the Samsung B2710 but I would not recommend it to my colleagues.
- ▶ I don't know if I should call her up ? I liked her when I met her last weekend.
- ▶ This is true.

sentiment analysis in the media

Possibly the most offensive misrepresentation I've seen

So @ChrisWarcraft is speaking my law class on Thursday.
I was excited, but after #GamerGate, I am now holy-
mother-of-all-creation excited

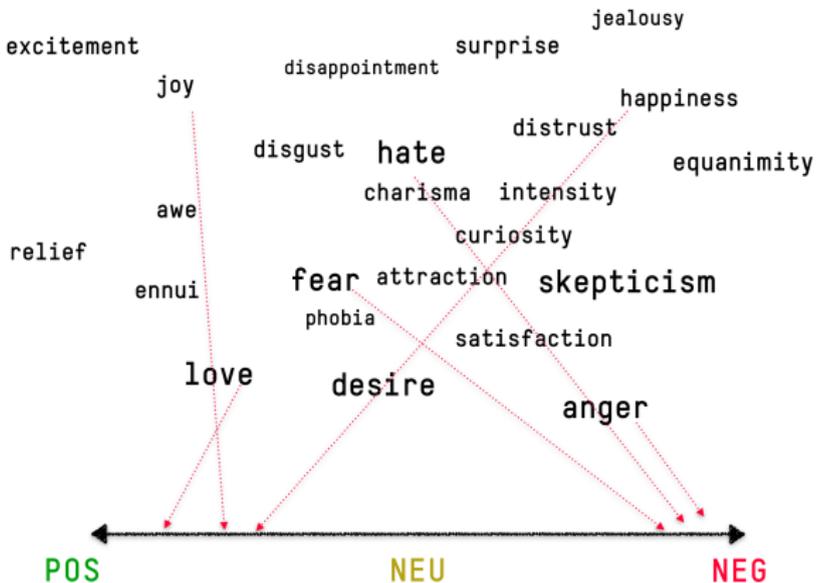
sentiment analysis? 10%
coverage wrt to POS-NEG

piece on #GamerGate
to think up a whole

Oh man I love to done spiked armor with nipples and
fight for love and honor. Thanks for the compliment
#GamerGate

multi-dimensional
tonality: > 50% coverage

sentiment analysis is overly simplistic!



requirements for practical tonality analysis

requirements for practical tonality analysis

- ▶ inspectable and editable

requirements for practical tonality analysis

- ▶ inspectable and editable
- ▶ transparent

requirements for practical tonality analysis

- ▶ inspectable and editable
- ▶ transparent
- ▶ tailorable without manual drudgery

requirements for practical tonality analysis

- ▶ inspectable and editable
- ▶ transparent
- ▶ tailorable without manual drudgery
- ▶ (meaning no training sets to speak of)

requirements for practical tonality analysis

- ▶ inspectable and editable
- ▶ transparent
- ▶ tailorable without manual drudgery
- ▶ (meaning no training sets to speak of)
- ▶ versatile ("give me N docs negative to new year's promises in lithuanian")

requirements for practical tonality analysis

- ▶ inspectable and editable
- ▶ transparent
- ▶ tailorable without manual drudgery
- ▶ (meaning no training sets to speak of)
- ▶ versatile ("give me N docs negative to new year's promises in lithuanian")
- ▶ timely and topic-relevant (cf. "decadent")

requirements for practical tonality analysis

- ▶ inspectable and editable
- ▶ transparent
- ▶ tailorable without manual drudgery
- ▶ (meaning no training sets to speak of)
- ▶ versatile ("give me N docs negative to new year's promises in lithuanian")
- ▶ timely and topic-relevant (cf. "decadent")
- ▶ relevant to some task at hand (which means it is only a component in something useful)

the "decadent" case

"decadent" is included in several lists of negative terms, but how is decadent used?

the "decadent" case

"decadent" is included in several lists of negative terms, but how is decadent used?

- ▶ ... Eating one is good. Eating two is great. Eating three is decadent, and awesome on an empty stomach. Eat four and you start to feel sick. ...

the "decadent" case

"decadent" is included in several lists of negative terms, but how is decadent used?

- ▶ ... Eating one is good. Eating two is great. Eating three is decadent, and awesome on an empty stomach. Eat four and you start to feel sick. ...
- ▶ Love this amazing fusion dessert. Sounds exotic and looks soooo decadent. ...

the “decadent” case

“decadent” is included in several lists of negative terms, but how is decadent used?

- ▶ ... Eating one is good. Eating two is great. Eating three is decadent, and awesome on an empty stomach. Eat four and you start to feel sick. ...
- ▶ Love this amazing fusion dessert. Sounds exotic and looks soooo decadent. ...
- ▶ A tailored take on the label’s romantic aesthetic, Elie Saab’s crepe jumpsuit is a decadent choice for evening events

the "decadent" case

"decadent" is included in several lists of negative terms, but how is decadent used?

- ▶ ... Eating one is good. Eating two is great. Eating three is decadent, and awesome on an empty stomach. Eat four and you start to feel sick. ...
- ▶ Love this amazing fusion dessert. Sounds exotic and looks soooo decadent. ...
- ▶ A tailored take on the label's romantic aesthetic, Elie Saab's crepe jumpsuit is a decadent choice for evening events
- ▶ So let's all raise a glass and hope we get many more decades of this decadent local staple

the "decadent" case

"decadent" is included in several lists of negative terms, but how is decadent used?

- ▶ ... Eating one is good. Eating two is great. Eating three is decadent, and awesome on an empty stomach. Eat four and you start to feel sick. ...
- ▶ Love this amazing fusion dessert. Sounds exotic and looks soooo decadent. ...
- ▶ A tailored take on the label's romantic aesthetic, Elie Saab's crepe jumpsuit is a decadent choice for evening events
- ▶ So let's all raise a glass and hope we get many more decades of this decadent local staple
- ▶ Dense and wickedly chocolatey, the decadent dessert is best shared for greater enjoyment.

the “decadent” case

“decadent” is included in several lists of negative terms, but how is decadent used?

- ▶ ... Eating one is good. Eating two is great. Eating three is decadent, and awesome on an empty stomach. Eat four and you start to feel sick. ...
- ▶ Love this amazing fusion dessert. Sounds exotic and looks soooo decadent. ...
- ▶ A tailored take on the label’s romantic aesthetic, Elie Saab’s crepe jumpsuit is a decadent choice for evening events
- ▶ So let’s all raise a glass and hope we get many more decades of this decadent local staple
- ▶ Dense and wickedly chocolatey, the decadent dessert is best shared for greater enjoyment.
- ▶ I’m surrounded by soft, glowing candles while enjoying a glass of rich red wine and a box of decadent dark chocolate

the “decadent” case

“decadent” is included in several lists of negative terms, but how is decadent used?

- ▶ ... Eating one is good. Eating two is great. Eating three is decadent, and awesome on an empty stomach. Eat four and you start to feel sick. ...
- ▶ Love this amazing fusion dessert. Sounds exotic and looks soooo decadent. ...
- ▶ A tailored take on the label’s romantic aesthetic, Elie Saab’s crepe jumpsuit is a decadent choice for evening events
- ▶ So let’s all raise a glass and hope we get many more decades of this decadent local staple
- ▶ Dense and wickedly chocolatey, the decadent dessert is best shared for greater enjoyment.
- ▶ I’m surrounded by soft, glowing candles while enjoying a glass of rich red wine and a box of decadent dark chocolate
- ▶ If you’re feeling decadent, put a pinch of crumbled bacon or a couple of sun-dried tomatoes in an egg white omelet

the "decadent" case

"decadent" is included in several lists of negative terms, but how is decadent used?

- ▶ ... Eating one is good. Eating two is great. Eating three is decadent, and awesome on an empty stomach. Eat four and you start to feel sick. ...
- ▶ Love this amazing fusion dessert. Sounds exotic and looks soooo decadent. ...
- ▶ A tailored take on the label's romantic aesthetic, Elie Saab's crepe jumpsuit is a decadent choice for evening events
- ▶ So let's all raise a glass and hope we get many more decades of this decadent local staple
- ▶ Dense and wickedly chocolatey, the decadent dessert is best shared for greater enjoyment.
- ▶ I'm surrounded by soft, glowing candles while enjoying a glass of rich red wine and a box of decadent dark chocolate
- ▶ If you're feeling decadent, put a pinch of crumbled bacon or a couple of sun-dried tomatoes in an egg white omelet
- ▶ Come join us for some more decadent daytime disco and house partying

the “decadent” case

“decadent” is included in several lists of negative terms, but how is decadent used?

- ▶ ... Eating one is good. Eating two is great. Eating three is decadent, and awesome on an empty stomach. Eat four and you start to feel sick. ...
- ▶ Love this amazing fusion dessert. Sounds exotic and looks soooo decadent. ...
- ▶ A tailored take on the label’s romantic aesthetic, Elie Saab’s crepe jumpsuit is a decadent choice for evening events
- ▶ So let’s all raise a glass and hope we get many more decades of this decadent local staple
- ▶ Dense and wickedly chocolatey, the decadent dessert is best shared for greater enjoyment.
- ▶ I’m surrounded by soft, glowing candles while enjoying a glass of rich red wine and a box of decadent dark chocolate
- ▶ If you’re feeling decadent, put a pinch of crumbled bacon or a couple of sun-dried tomatoes in an egg white omelet
- ▶ Come join us for some more decadent daytime disco and house partying
- ▶ ...

current models

how do they work in practice?

current models

how do they work in practice?

simply.

experiments

1. constructions: "but"
2. negations: skip, flip, or custom?
3. comparatives
4. pivoted weighting

descriptive stats

58 215 919 words of text with utterances selected
because they make use one of the adjectives found in
one standard sentiment analysis word list

let us be linguists for a while

we know things about language and about adjectives.
no need to reinvent everything.

Paradis, Carita, and Caroline Willners. 2006. "Antonymy and negation—The boundedness hypothesis." *Journal of pragmatics*.

Ferenc Kiefer. 1978. "Adjectives and presuppositions." *Theoretical linguistics*.

|---large--+-----everyday-----+-----small---|

|-----ill-----0

healthy^

--better-->

<--worse---

|---bad-----+---everyday-----+-----good-----|

~~~~

outstanding

--better-->

<--worse---

|---bad-----+---everyday-----+-----good-----|

~~~~

outstanding

|----not good-----|?

why is this interesting for practical reasons?

"Christina Aguilera is better than Whitney Houston in her prime..."

tells us rather little about either.

"Entertainment more disposable than Hanna-Barbera's half-hour cartoons ever were.

tells us both are "disposable"

gradation

1. This is very good.
2. ?This is very excellent.
3. *This is very okay.
4. *This is quite great.
5. This is very bad.
6. ?This is very awful.
7. ?This is very so-so.
8. *This is somewhat perfect.

amplifiers: some synonyms of "very"?

<http://lexicon.gavagai.se/lookup/en/very>

exceedingly extraordinarily exceptionally supremely so much more unbelievably amazingly
ridiculously insanely absurdly astoundingly sooo sooooo soooo surprisingly remarkably darned
darn soooooo wonderfully fantastically sooooooo astonishingly undeniably i'm super unbearably
oh-so scarily i'm real impossibly admittedly stupidly awfully inordinately hugely enormously
immensely tremendously phenomenally doubly

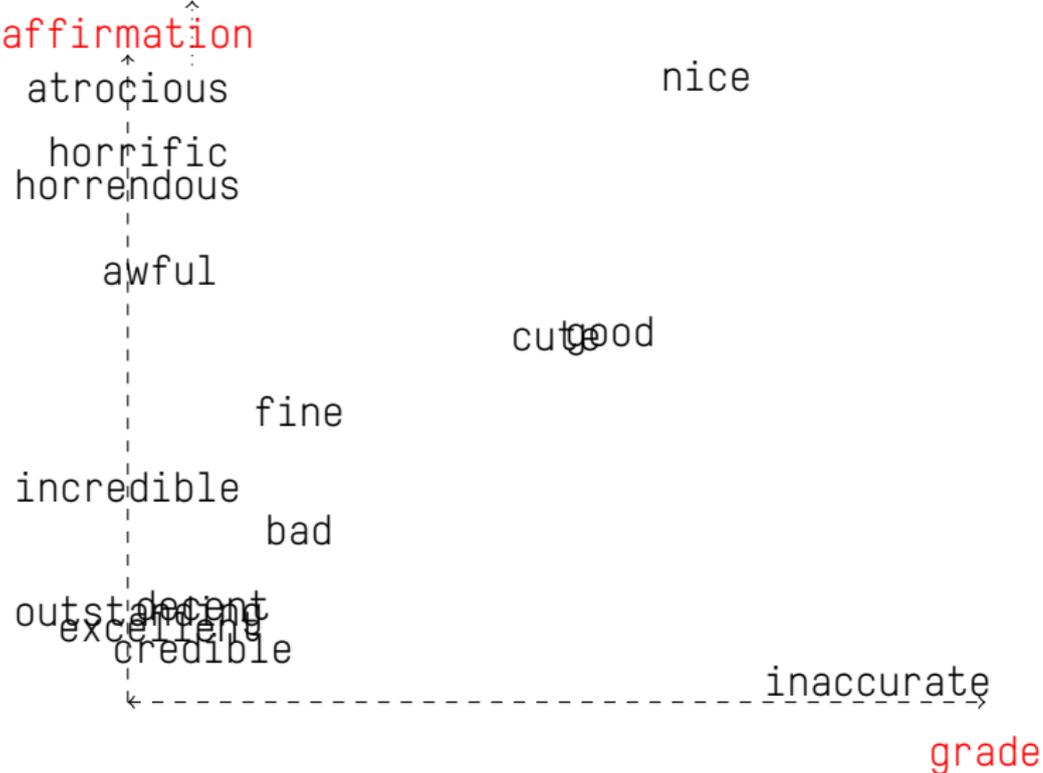
three types of amplifier

grade	affirmation	surprise
awfully	absolutely	amazingly
completely	definitely	exceptionally
entirely	famously	dramatically
enormously	genuinely	drastically
exceedingly	doubtlessly	surprisingly
excessively	immaculately	extraordinarily
extremely	truly	emphatically
entirely	overly	fantastically
intensely	perfectly	insanely
greatly	really	phenomenally
highly	severely	remarkably
hugely	surely	ridiculously
immensely	undoubtedly	strikingly
particularly	thoroughly	unusually
radically		wildly
significantly		wonderfully
strongly		horribly
substantially		incredibly
utterly		terribly
totally		
vastly		
very		

gradation split

1. This is very good
2. This is very bad
3. This is *very excellent
4. This is truly good
5. This is truly bad
6. This is truly excellent
7. This is surprisingly good
8. This is surprisingly bad
9. This is surprisingly excellent

adjs amplified by grade vs affirmation



is this of any practical use?

can we predict the intensity and type of adjective
from what modifiers they tend to take?

potential for more informed distributional
semantics

negation

flip, skip, or custom?

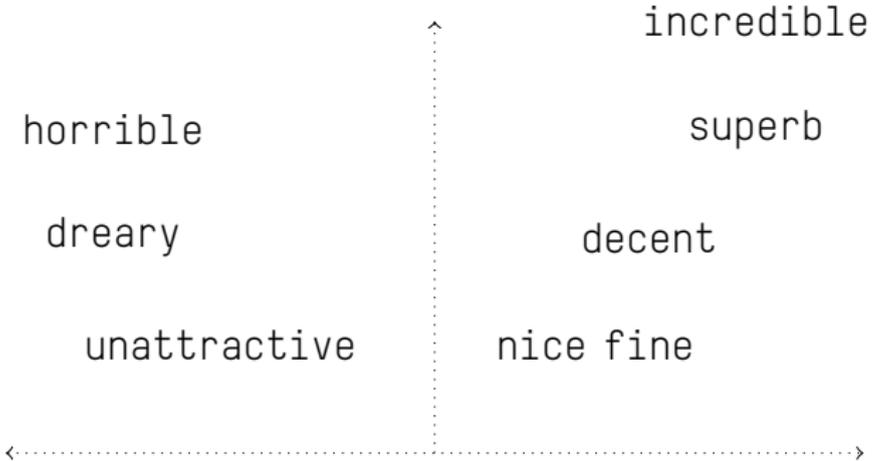
amplification vs negation

amplification

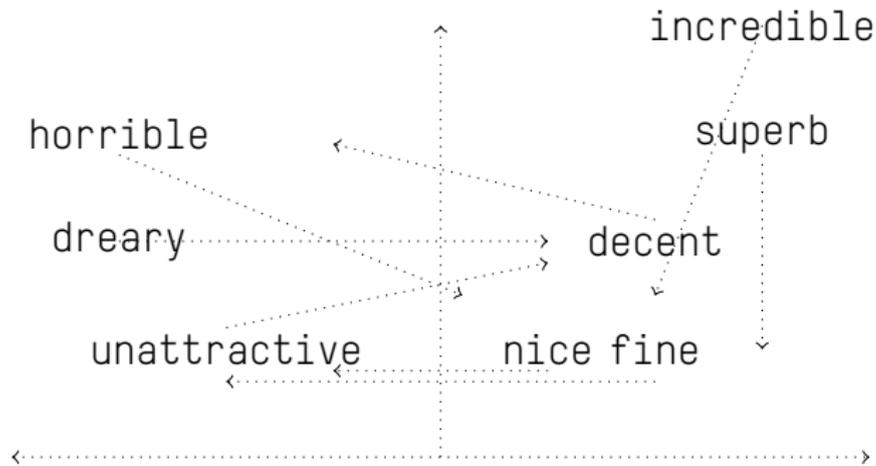


negation

Intensity-polarity plane



Intensity-polarity plane, with negation



native speakers, please discuss!

what is being negated?

1. polarity
2. intensity
3. markedness or normality

practical usefulness?

if adjectives can be identified by type, the effect of negating them can be algorithmised rather than using the skip theory of semantic operators

constructions

Ana von Klopp. 1994. "But and negation." *Nordic journal of linguistics* 17:1.

constructions

- ▶ first candidate construction: *A BUT B*

Ana von Klopp. 1994. "But and negation." *Nordic journal of linguistics* 17:1.

constructions

- ▶ first candidate construction: *A BUT B*
- ▶ *A* and *B* have (somewhat) opposite argumentative directions (but may have same nominal polar orientation)

Ana von Klopp. 1994. "But and negation." *Nordic journal of linguistics* 17:1.

constructions

- ▶ first candidate construction: *A* BUT *B*
- ▶ *A* and *B* have (somewhat) opposite argumentative directions (but may have same nominal polar orientation)
- ▶ *B* is a stronger argument than *A*

Ana von Klopp. 1994. "But and negation." *Nordic journal of linguistics* 17:1.

constructions

- ▶ first candidate construction: *A BUT B*
- ▶ *A* and *B* have (somewhat) opposite argumentative directions (but may have same nominal polar orientation)
- ▶ *B* is a stronger argument than *A*
- ▶ → "everything before but" rule ?

Ana von Klopp. 1994. "But and negation." *Nordic journal of linguistics* 17:1.

examples of but use

The music isn't bad, but it isn't good.

Some animations are quite bad, like people standing up or rolling out of the way, but the overall looks very good.

Control: I can't say they're bad; in fact they're pretty easy to use, if only you could carry more things, but they're really good!

So far, so good, I'm as excited as anyone who has played the previous, Itakagi is my man, too bad he is leaving Tecmo but maybe its a good thing since I doubt he will stop making games...

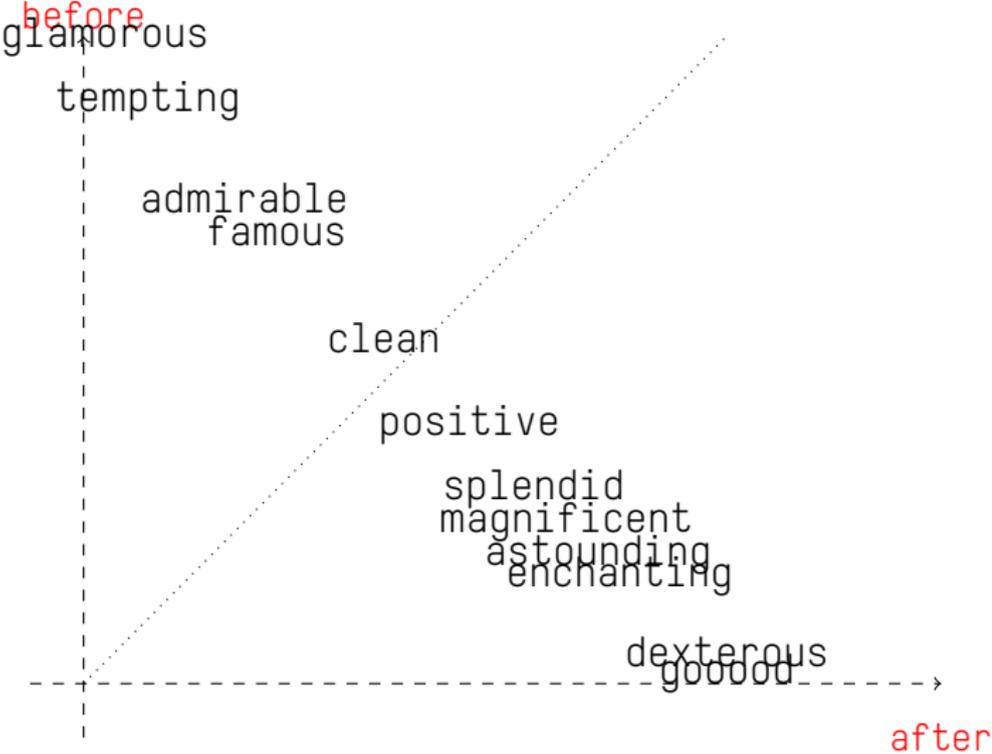
adjs often vs before resp after but

frail – capable

sexy – strong

great – difficult

adjs often vs before resp after but



comparing to gold standards

	Set	Size	Positive	Negative	Other
1	RepLab	62 886	36 548	8 618	17 599
2	T & McD	3 564	923	1 320	1 321
3	Stanford	11 855	4 963	4 650	2 242

Enrique Amigó et al. 2013. Proc of CLEF.

Oscar Täckström and Ryan McDonald. 2011. Proc ECIR.

Richard Socher et al. 2013. Proc EMNLP

Bing Liu, Minqing Hu, and Junsheng Cheng. 2005. Proc WWW.

bounded results

	Greedy		Conservative	
	Recall	Precision	Recall	Precision
	RepLab			
Positive	43.9	64.6	36.1	68.8
Negative	46.2	27.0	36.4	29.7
	T & McD			
Positive	76.6	33.9	53.8	43.9
Negative	55.6	42.6	25.5	56.3
	Stanford			
Positive	80.8	53.2	45.9	64.7
Negative	68.8	48.3	15.8	63.6

conservative: polar lexical items of only one orientation in text

greedy: some polar lexical items in text, never mind if others are there

baseline: majority vote

Set	Micro		Macro		Positive		Negative	
	p	r	p	r	p	r	p	r
RepLab	52.4	38.3	48.2	40.1	68.1	37.2	28.4	42.9
T & McD	44.2	55.7	44.3	56.9	40.4	63.7	48.3	50.1
Stanford	58.4	60.9	58.7	60.9	63.5	60.4	53.9	61.5

State of the art is around 81%; best pushing 90% using tightly trained classifiers. (Not applicable to industrial problems.)

incidence of but

RepLab	Incidence of "But"			No polar terms
	Pos & Neg	Pos only	Neg only	
All	74	98	65	91
Positive	34	61	22	46
Negative	18	13	19	9
T & McD	Pos & Neg	Pos only	Neg only	No polar terms
All	194	168	83	93
Positive	36	50	2	8
Negative	55	39	39	39
Stanford	Pos & Neg	Pos only	Neg only	No polar terms
All	588	398	219	138
Positive	220	206	40	46
Negative	209	94	120	52

results: "everything before but"

"everything before but":

Set	Micro		Macro		Positive		Negative	
	p	r	p	r	p	r	p	r
RepLab	52.7	37.9	48.4	39.6	68.3	36.9	28.5	42.3
T & McD	44.8	54.5	44.9	55.8	41.4	62.7	48.5	48.8
Stanford	59.4	60.1	59.8	60.1	65.2	59.6	54.4	60.8

baseline:

Set	Micro		Macro		Positive		Negative	
	p	r	p	r	p	r	p	r
RepLab	52.4	38.3	48.2	40.1	68.1	37.2	28.4	42.9
T & McD	44.2	55.7	44.3	56.9	40.4	63.7	48.3	50.1
Stanford	58.4	60.9	58.7	60.9	63.5	60.4	53.9	61.5

back to target question

back to target question

- ▶ "how are they talking about it?"

back to target question

- ▶ "how are they talking about it?"
- ▶ link to event representation: aspectual features of attitude

back to target question

- ▶ "how are they talking about it?"
- ▶ link to event representation: aspectual features of attitude
- ▶ represent using notions such as markedness and anomaly

take home

take home

1. simple methods are truly verily in use out there

take home

1. simple methods are truly verily in use out there
2. how are they talking about it comes before what are they saying

take home

1. simple methods are truly verily in use out there
2. how are they talking about it comes before what are they saying
3. linguistics could help

take home

1. simple methods are truly verily in use out there
2. how are they talking about it comes before what are they saying
3. linguistics could help
4. ... primarily by better feature palette

take home

1. simple methods are truly verily in use out there
2. how are they talking about it comes before what are they saying
3. linguistics could help
4. ... primarily by better feature palette
5. before experimentation: investigate if there is signal

take home

1. simple methods are truly verily in use out there
2. how are they talking about it comes before what are they saying
3. linguistics could help
4. ... primarily by better feature palette
5. before experimentation: investigate if there is signal
6. informed distributional models are a way to do so

take home

1. simple methods are truly verily in use out there
2. how are they talking about it comes before what are they saying
3. linguistics could help
4. ... primarily by better feature palette
5. before experimentation: investigate if there is signal
6. informed distributional models are a way to do so
7. markedness and anomaly might be useful