Natural Language Processing (NLP)

for

Computational Social Science

Cristian Danescu-Niculescu-Mizil
and
Lillian Lee

http://www.cs.cornell.edu/courses/cs6742/2015fa

Datasets:
http://www.cs.cornell.edu/home/llee/data/index.html
http://www.cs.cornell.edu/~cristian/Data_Media_Talks_News.html

Natural Language Processing

Computational Social Science

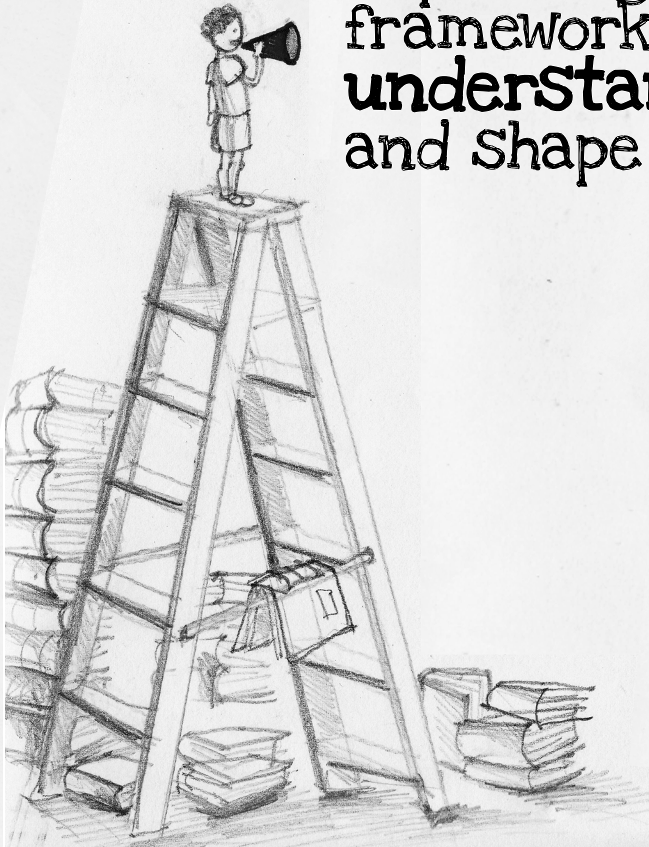
Why do people do what they do (when other people are involved)?

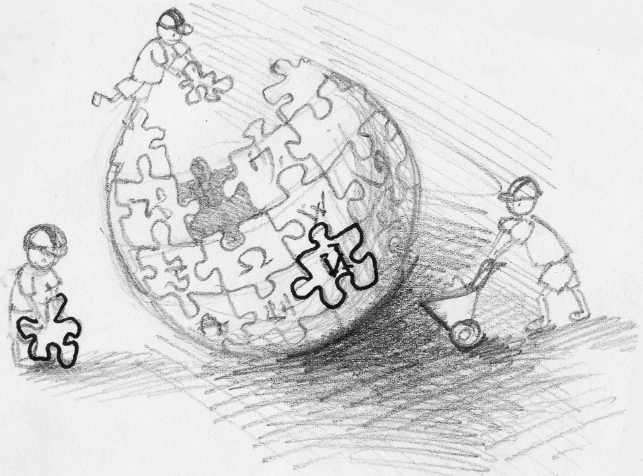
NLP: a great way to find out!

Why NLP for CSS?

Much of online human activity leaves digital traces that are recorded in **natural-language format**.

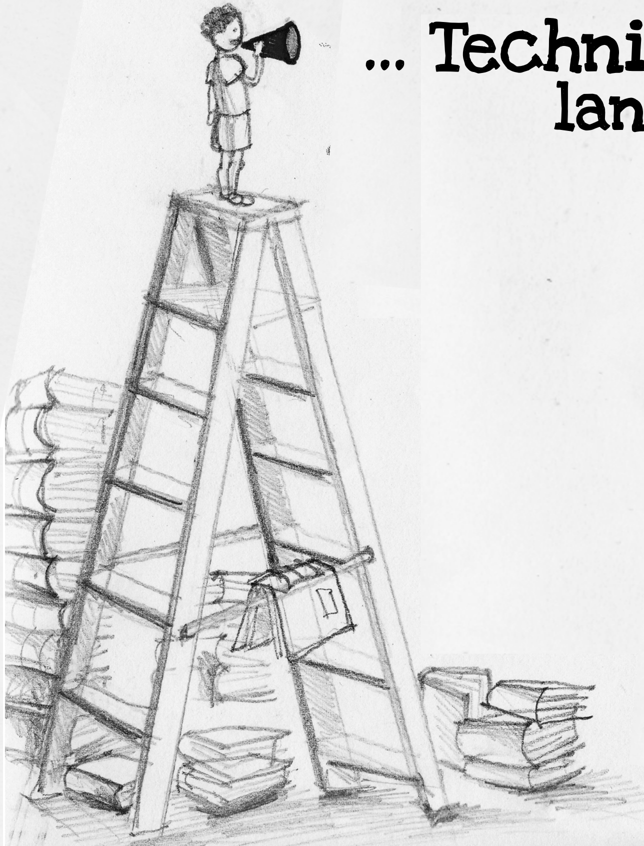
Exploiting these resources under a computational framework can bring **a phase transition in our understanding of human social behavior** and shape the future of social-media systems.



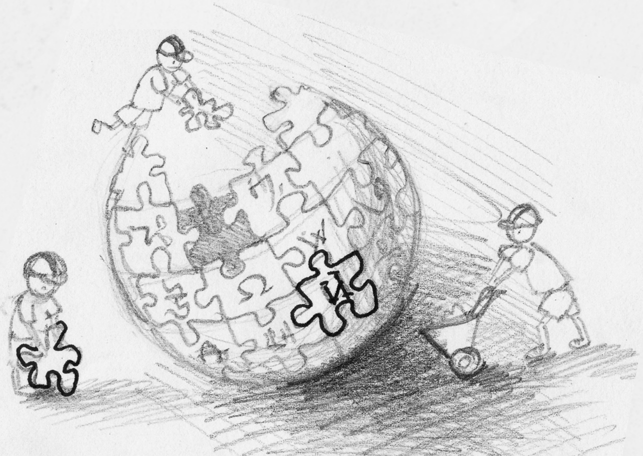


TODAY:

... Research questions
persuasion, linguistic change, framing



... Techniques
language models, Bayesian feature analysis



...Research practices
controls, feasibility, data inspection

The social effects of linguistic subtleties

The social effects of linguistic subtleties

"Motivating voter turnout" (Bryan et al., 2011)

The Social effects of linguistic subtleties

"Motivating voter turnout" (Bryan et al., 2011)

"How important it is to you to be a voter?"

"How important it is to you to vote?"

The Social effects of linguistic subtleties

"Motivating voter turnout" (Bryan et al., 2011)

"How important it is to you to be a voter?" (identity)

"How important it is to you to vote?" (action)

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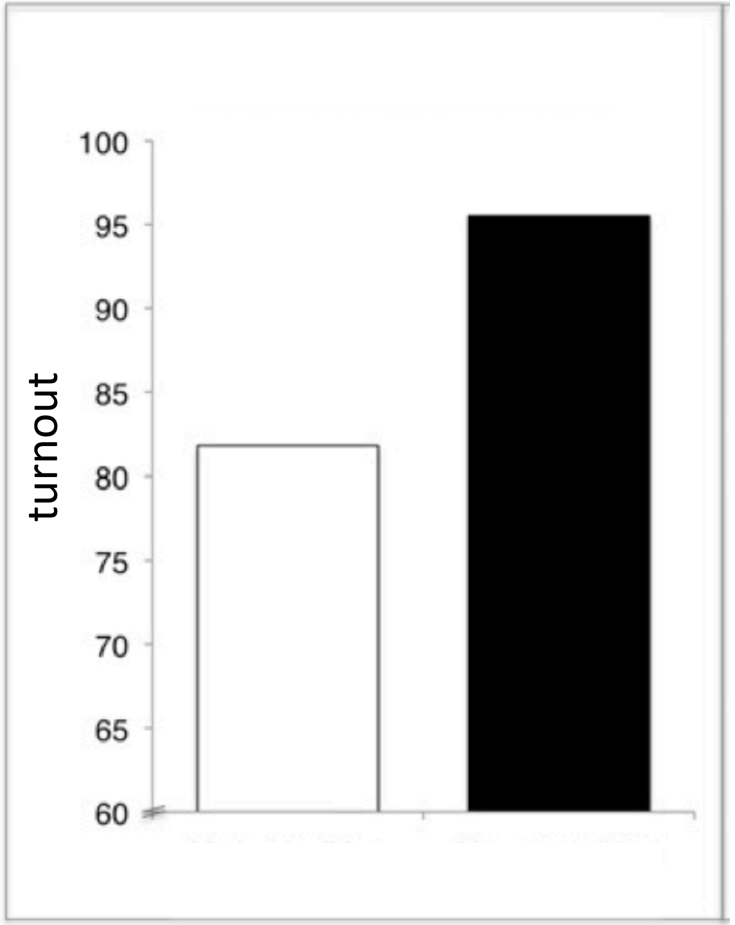

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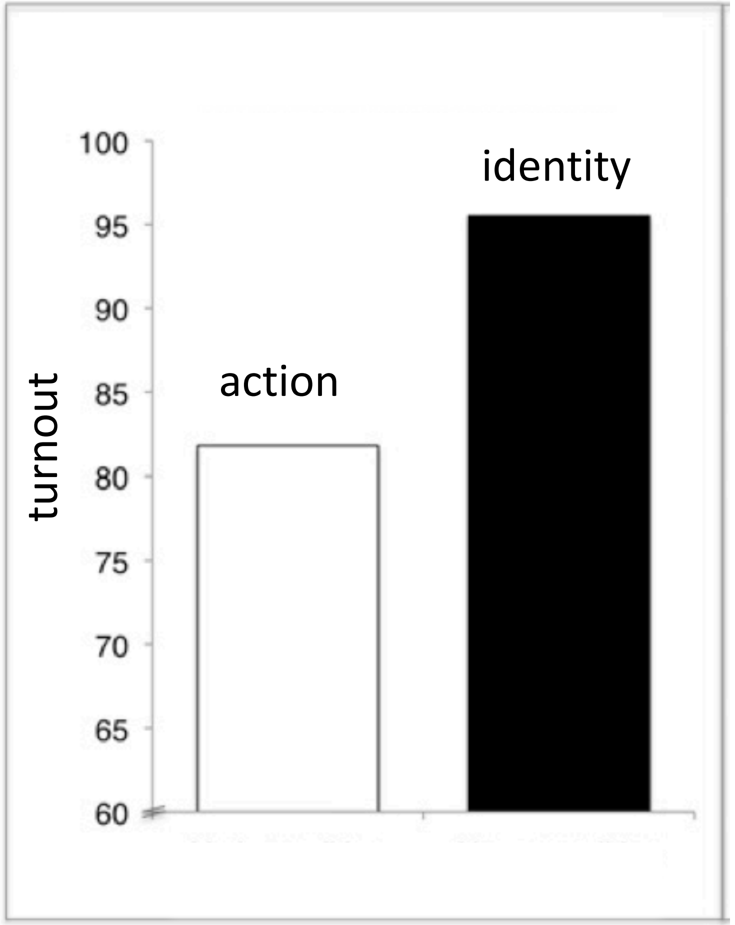

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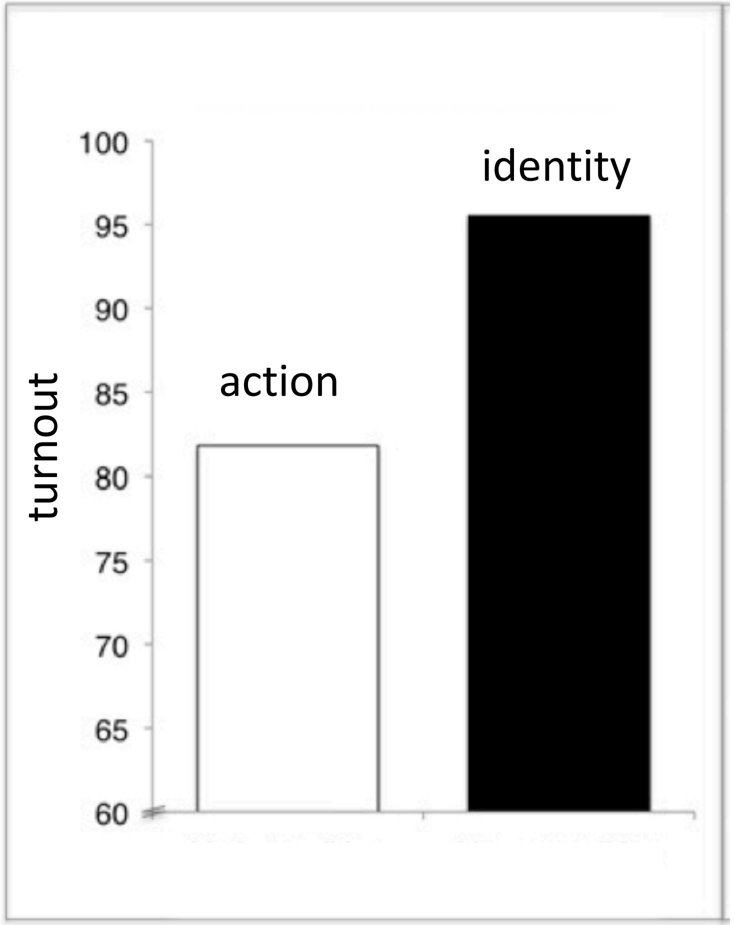

How things are said
(vs what is said)

The Social effects of linguistic subtleties

"The role of placebic information" (Langer et al., 1978)

"I have 5 pages. May I use the xerox machine?"

The social effects of linguistic subtleties

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"I have 5 pages. May I use the xerox machine?"

"I have 5 pages. May I use the xerox machine,

because I need to make copies?"

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The Social effects of linguistic subtleties

"The role of placebic information" (Langer et al., 1978)

"I have 5 pages. May I use the xerox machine?"	60% agreed
"I have 5 pages. May I use the xerox machine, because I need to make copies?"	93% agreed

The social effects of linguistic subtleties

"The role of placebic information" (Langer et al., 1978)

"I have 5 pages. May I use the xerox machine?"	60% agreed
"I have 5 pages. May I use the xerox machine, because I need to make copies?"	93% agreed
"I have 5 pages. May I use the xerox machine, because I am in a rush?"	94% agreed

The Social effects of linguistic subtleties

Today's data → opportunity to discover and better understand social effects

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A classification problem?

Example: (How) do male and female describe things differently?

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A classification problem?

Example: (How) do male and female describe things differently?

Gender classification

The social effects of linguistic subtleties

Today's data → opportunity to discover and better understand social effects

A classification problem?

Example: (How) do male and female describe things differently?

Gender classification

Issue: Gender-topic confound (Argamon et al. 2003, Sarawgi et al. 2011)

"Finance" trends male,
but what about females who talk about finance?

The social effects of linguistic subtleties

Today's data → opportunity to discover and better understand social effects

Challenges:

- ★ maintaining the controlled, hypothesis-driven nature of traditional studies
    - › sense (and luck) to find the right data

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"I have 20 pages. May I use the xerox machine, because I need to make copies?"	~~93% agreed~~ 24% agreed
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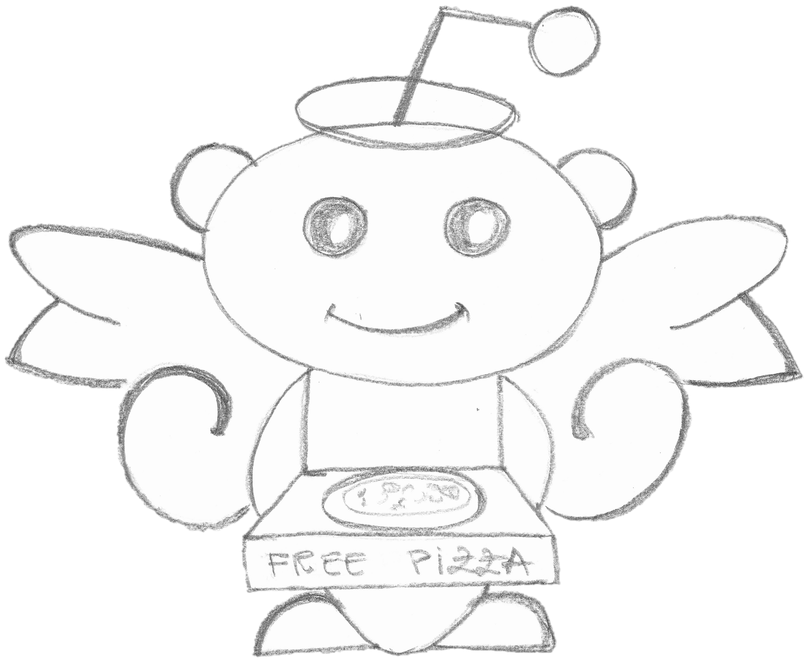
"How to ask for a favor" (Althoff et al., 2013)

20,000 requests for ... pizza



(Althoff et al., 2013)

65 ▲ 0

[Request] I have gotten pizza before from this subreddit, but it's Easter, and I'm stuck at school because finals for me start tomorrow, and I'm broke.

submitted 3 days ago by silentsly

comment share

66 ▲ 4

[Request] I've been working on my first computer for 6 hours, only to find my GPU was DOA. Can someone hit me up with some pizza please?

submitted 3 days ago by bigbootypanda

4 comments share

68 ▲ 1

[Request] Spooky podcasts go great with pizza! (California)

submitted 3 days ago by posolutelyabsotively

comment share

69 ▲ 23

[REQUEST] I know this is a long shot. But I've come to the end of college and have drained my funds for it 100% I am currently waiting on an email from said college that will basically determine my future. I have never been so stressed or scared. Pizza would be a comfort. Promise to pay it forward.

submitted 3 days ago by mrshansgruber

3 comments share

(Althoff et al., 2013)

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Challenges:

★ maintaining the controlled, hypothesis-driven nature of traditional studies

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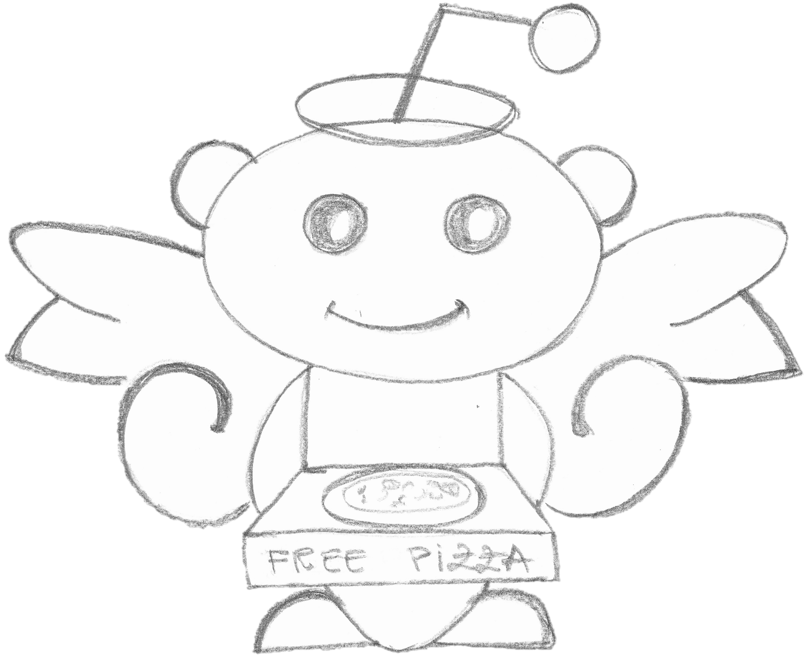
Language choices can increase success rate from 9% to 57%



The Social effects of linguistic Subtleties

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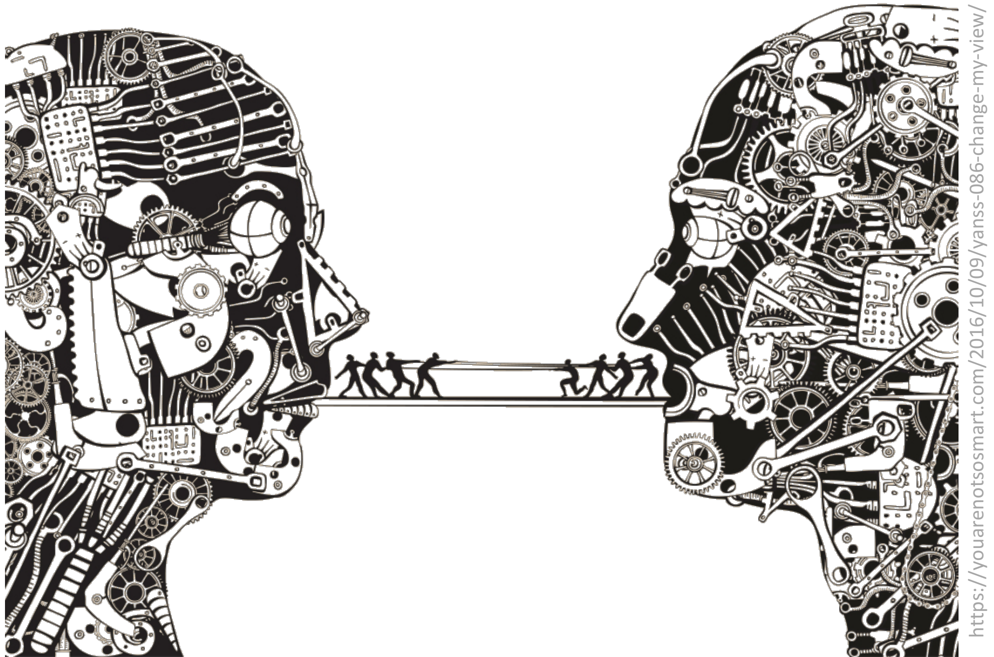
"Winning arguments" (Tan et al., 2016)

20,000 persuasion "contests"



Example persuasion attempts in ChangeMyView

Original post, by "blue" user

CMV: the Tontine should be legalized and made a common retirement strategy.

[Reference URL omitted] Basically, today we have a huge problem with retirement [...+73 words]
A tontine for retirement looks like [...+56 words] The yearly sum is divided evenly for all the surviving participants [...+25 words]. The key advantages as I see it are:
*We don't need actuaries [...+29 words...]
*Management fees can be quite low [...+22 words]
* [Another reason]
* [Another reason]
But CMV. Are there major risks I am not forseeing? [+2 more questions]

Δ

A tontine is a pretty crappy retirement vehicle for most people. It pays out the least when you need the most, and the most when you need the least.

People's income needs in retirement generally fall as they age. [...+35 words]
[URL]

Very interesting. I'll give a Δ because I didn't have any idea that was true and changes my idea of how the tontine should work. That said, I don't think it's unsolvable [...+44 words]

[DeltaBot] Confirmed: 1 delta awarded to [red]

Then your back to needing actuaries, to predict [...+11 words]

Depends how exact you need to be [...+33 words]

The Social Security system is basically one giant Tontine [...+13 words] So it's already legal.

I'd imagine the tontine as a secondary system to social security though, one that is optional for people to do, not mandatory like social security. [...+11 words]

There are some key differences though. First, Social Security is defined by the government [...+36 words]

And a tontine would be defined by your bank [...+79 words]

...

...

...

...

...

...

...

...

(Tan et al., 2016)

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Challenges:

- maintaining the controlled, hypothesis-driven nature of traditional studies
  - sense (and luck) to find the right data
  - taming wild data: art to setting up the right comparisons

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  - › sense (and luck) to find the right data
  - › taming wild data: art to setting up the right comparisons
- ★ need to develop/adapt computational tools

Case study: catchy language

(Some) people craft (some) political and ad slogans, news items, song lyrics, etc. to achieve cultural penetration.

A depressing possibility: does content actually matter, on average?

➢ Maybe not: Salganik, Dodds, Watts “MusicLab” paper, *Science* 2006

http://veridian-dynamics.org;
By Source, Fair use, https://en.wikipedia.org/w/index.php?curid=28611555

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Movie quotes: massively, permanently viral

"FRANKLY, MY DEAR, I DON'T GIVE A DAMN" TOPS AFI'S LIST OF 100 GREATEST MOVIE QUOTES OF ALL TIME

OTHER WINNERS INCLUDE:

THE GODFATHER, ***"I'M GOING TO MAKE HIM AN OFFER HE CAN'T REFUSE"***

THE WIZARD OF OZ, ***"TOTO, I'VE GOT A FEELING WE'RE NOT IN KANSAS ANYMORE"***

AND CASABLANCA, ***"HERE'S LOOKING AT YOU, KID"***

AFI's 100 YEARS 100 "Movie Quotes"

AFI'S 100 Years...100 Movie Quotes: America's Greatest Quips, Comebacks and Catchphrases

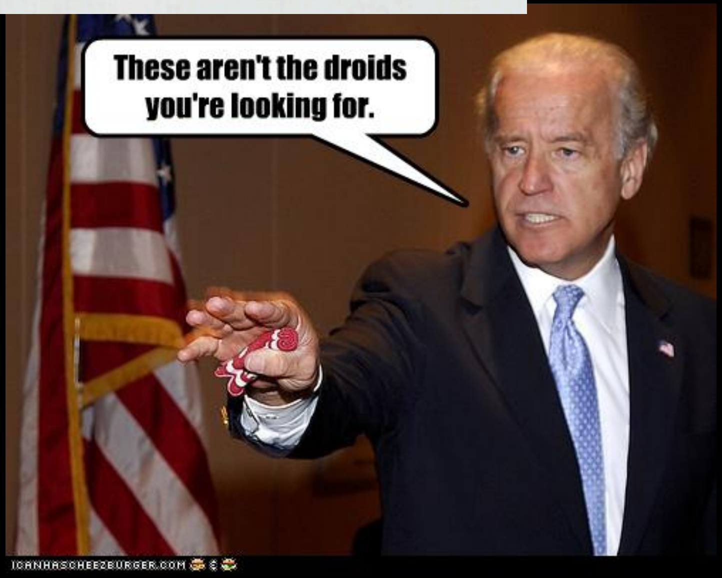
LOS ANGELES, June 22, 2005 — The American Film Institute revealed the top movie quotes of all time in **AFI's 100 Years...100 Movie Quotes**, a three-hour special television event on CBS hosted by actor and action star Pierce Brosnan with commentary from many of Hollywood's most celebrated actors and filmmakers. A jury of 1,500 film artists, critics and historians selected "Frankly, my dear, I don't give a damn," spoken by Clark Gable in the celebrated Civil War epic, GONE WITH THE WIND as the most memorable movie quote of all time.

http://www.afi.com/100years/quotes.aspx

Research question: Does phrasing affect memorability?

Obi-Wan: You don't need to see his identification.
Stormtrooper: [ditto]
Obi-Wan: These aren't the droids you're looking for.
Stormtrooper: [ditto]
Obi-Wan: He can go about his business.
Stormtrooper: [ditto]
Obi-Wan: Move along.
Stormtrooper: [ditto]

http://www.blu-ray.com/movies/screenshot.php?movieid=14903&position=6



http://mikiedaniel.files.wordpress.com/2011/09/troopers.jpg
http://ic.pics.livejournal.com/ievil_spock_47i/11608842/245440/245440_original.jpg
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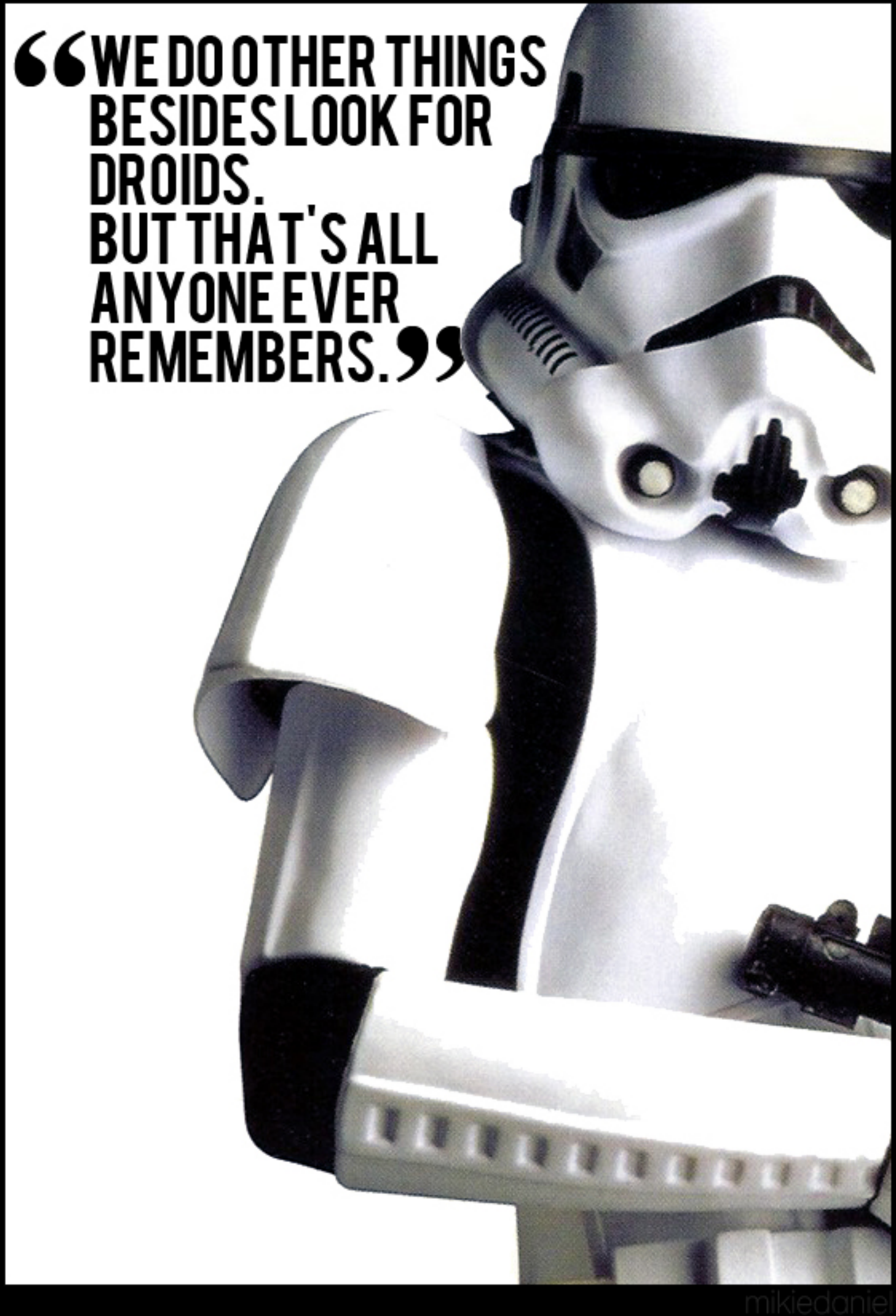

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Data: Movie scripts
with memorability labels (IMDB)

RQ: Does phrasing affect memorability?

Possible prediction setting:

memorable quotes vs. all the rest

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RQ: Does phrasing affect memorability?

Possible prediction setting:

- memorable quotes vs. all the rest
  - confounds:
    - memorable movies (e.g., Star Wars)
    - memorable characters (e.g., Obi-Wan)
    - memorable positions (e.g., last line of a movie)
    - length (shorter are easier to remember)

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Controlled setting

Match each memorable quote with a non-memorable quote

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RQ: Does phrasing affect memorability?

Controlled setting

Match each memorable quote with a non-memorable quote
- from the same character
- same place in the movie
- same length

... to focus on the effect of phrasing

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Gain intuition: Look at the data

Research question: Does phrasing affect memorability?

First quote	Second quote
Half a million dollars will always be missed	I know the type, trust me on this.

Gain intuition: Look at the data

Research question: Does phrasing affect memorability?

First quote	Second quote
Half a million dollars will always be missed	I know the type, trust me on this.
I think it's time to try some unsafe velocities.	No cold feet, or any other parts of our anatomy.

Gain intuition: Look at the data

Research question: Does phrasing affect memorability?

First quote	Second quote
Half a million dollars will always be missed	I know the type, trust me on this.
I think it’s time to try some unsafe velocities.	No cold feet, or any other parts of our anatomy.
A little advice about feelings kiddo; don’t expect it always to tickle.	I mean there’s someone besides your mother you’ve got to forgive.

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A little advice about feelings kiddo; don't expect it always to tickle.	I mean there's someone besides your mother you've got to forgive.

Humans: 72-78%

50%

100%

Impossible
(no phrasing effects,
bad labels, etc.)

interesting
task

trivial

Gain intuition: Look at the data

Hypothesis: Surprising combinations of words are memorable

Hypothesis: surprising language is memorable

Technique:

measure surprisingness using language models

Toolkits: KenLM, MIT LM Toolkit, SRILM

Creative part:

A) Where to train the language model
i.e., "surprising with respect to what?"

B) How to represent the language?

Hypothesis: surprising language is memorable

Technique:

measure surprisingness using language models

Toolkits: KenLM, MIT LM Toolkit, SRILM

Creative part:

A) Where to train the language model
i.e., "surprising with respect to what?"

B) How to represent the language?

Here:

A) Train on fiction that pre-dates the movies (to avoid contamination)

Hypothesis: surprising language is memorable

Technique:

measure surprisingness using language models

Toolkits: KenLM, MIT LM Toolkit, SRILM

Creative part:

A) Where to train the language model
i.e., "surprising with respect to what?"

B) How to represent the language?

Here:

B) represent language as sequence of words
→ surprising combinations of words are more memorable
e.g., "I see dead people."

Hypothesis: surprising language is memorable

Technique:

measure surprisingness using language models

Toolkits: KenLM, MIT LM Toolkit, SRILM

Creative part:

A) Where to train the language model
i.e., "surprising with respect to what?"

B) How to represent the language?

Here:

B) represent language as sequence of parts of speech
→ common syntax is more memorable

e.g., "You're gonna need a bigger boat" vs. "You're gonna need a boat that is bigger"

Fitness and difussion of cultural content (memes)

"Meme-tracking" Leskovec, Backstrom, Kleinberg. 2009

"Memes online" Simmons, Adamic, Adar. 2011

"What's in a name" Himabindu, McAuley, Leskovec. 2013

"QUOTUS" Niculae, Suen, Zhang, Danescu-Niculescu-Mizil, Leskovec. 2015

Another quick LM case study: gender bias in sports journalism

[Fu et al. 2016]

Inspired by covertheathlete.com

Hypothesis: questions to female players are less about the game

Hypothesis: questions to female players are less about the game

Technique:

measure surprisingness using language models

Hypothesis (rewritten in terms of surprise):

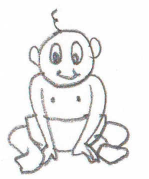
questions to female players are more surprising wrt game language

Creative part:

Where to train the language model?

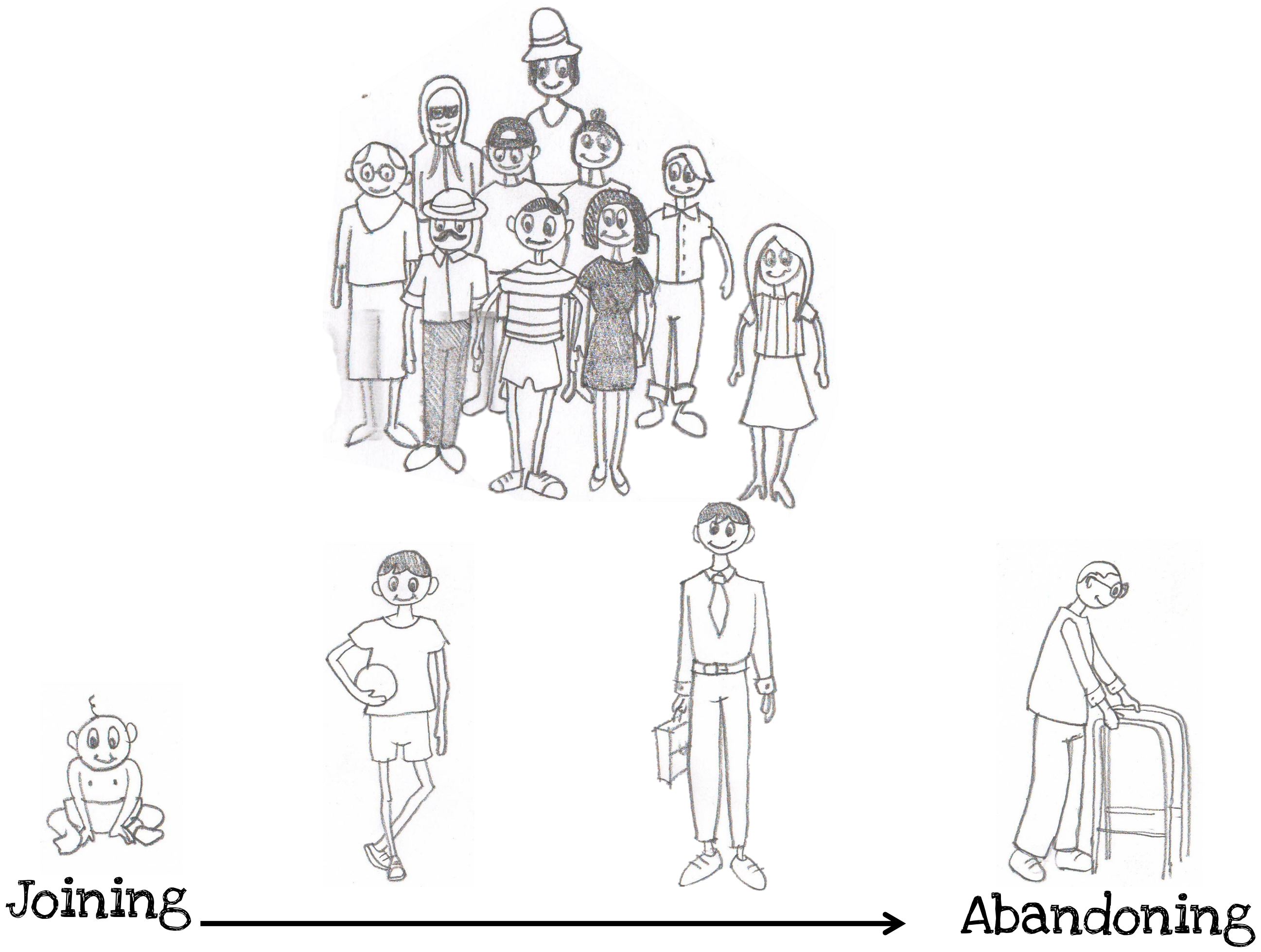
→ play-by-play game commentary

Language (models) capturing user-community dynamics



Joining

Language (models) capturing user-community dynamics



Main intuition: linguistic change

Language norms

- build collective identity
- foster individual expression

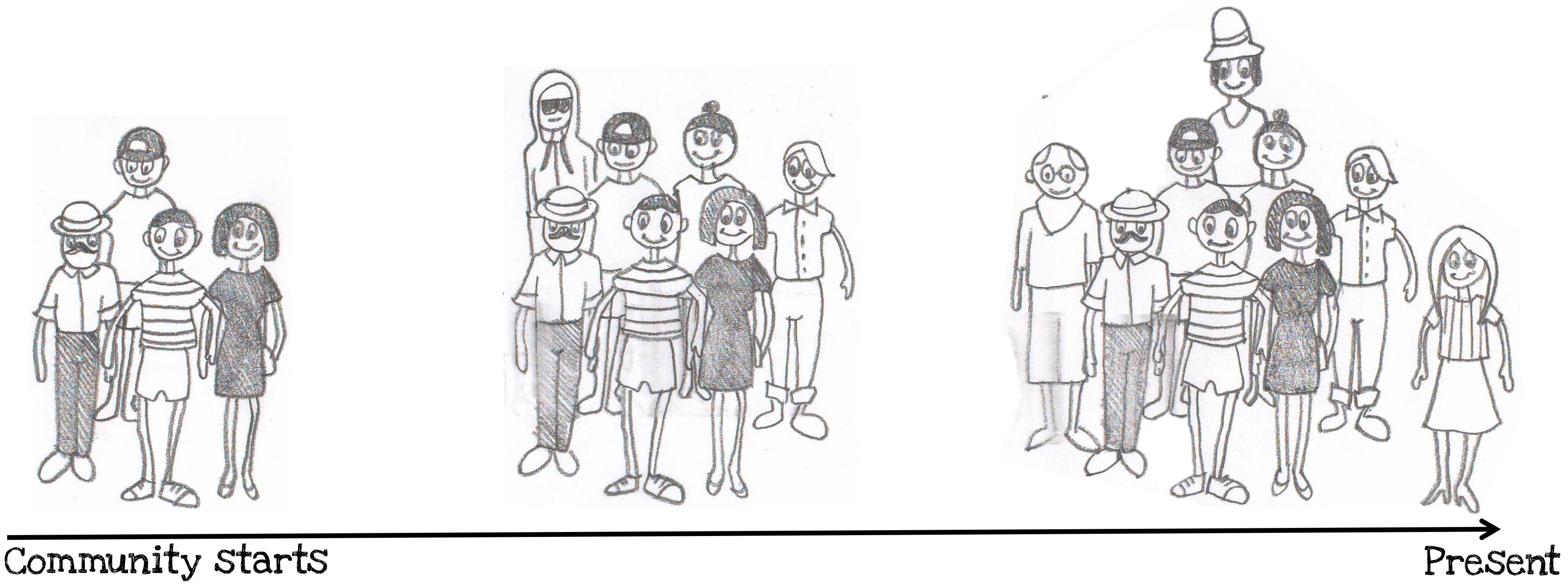
Linguistic change allows us to capture

- relation between members and their community

"No country for old members" (Danescu-Niculescu-Mizil et al., 2013)

Longitudinal data

Complete linguistic record of **three** online communities:



ratebeer

Beeradvocate

BREASTCANCER.ORG

Main intuition: linguistic change

Intuition check:

- Norms form online: Language becomes less surprising over time

Main intuition: linguistic change

Intuition check:

Norms form online: Language becomes less surprising over time

Main intuition: linguistic change

Intuition check:

Norms form online: Language becomes less surprising over time

Main intuition: linguistic change

Intuition check:
Norms form online: Language becomes less surprising over time

Entropy:

$$H(\vec{\theta}) = \sum_i \theta_i \log \frac{1}{\theta_i}, \qquad \theta_i = P(string_i)$$

Main intuition: linguistic change

Intuition check:

Norms form online: Language becomes less **surprising** over time

Entropy:

$$H(\vec{\theta}) = \sum_i \theta_i \log \frac{1}{\theta_i} , \qquad \theta_i = P(string_i)$$

surprise to see string

Main intuition: linguistic change

Intuition check:

Norms form online: Language becomes less surprising over time

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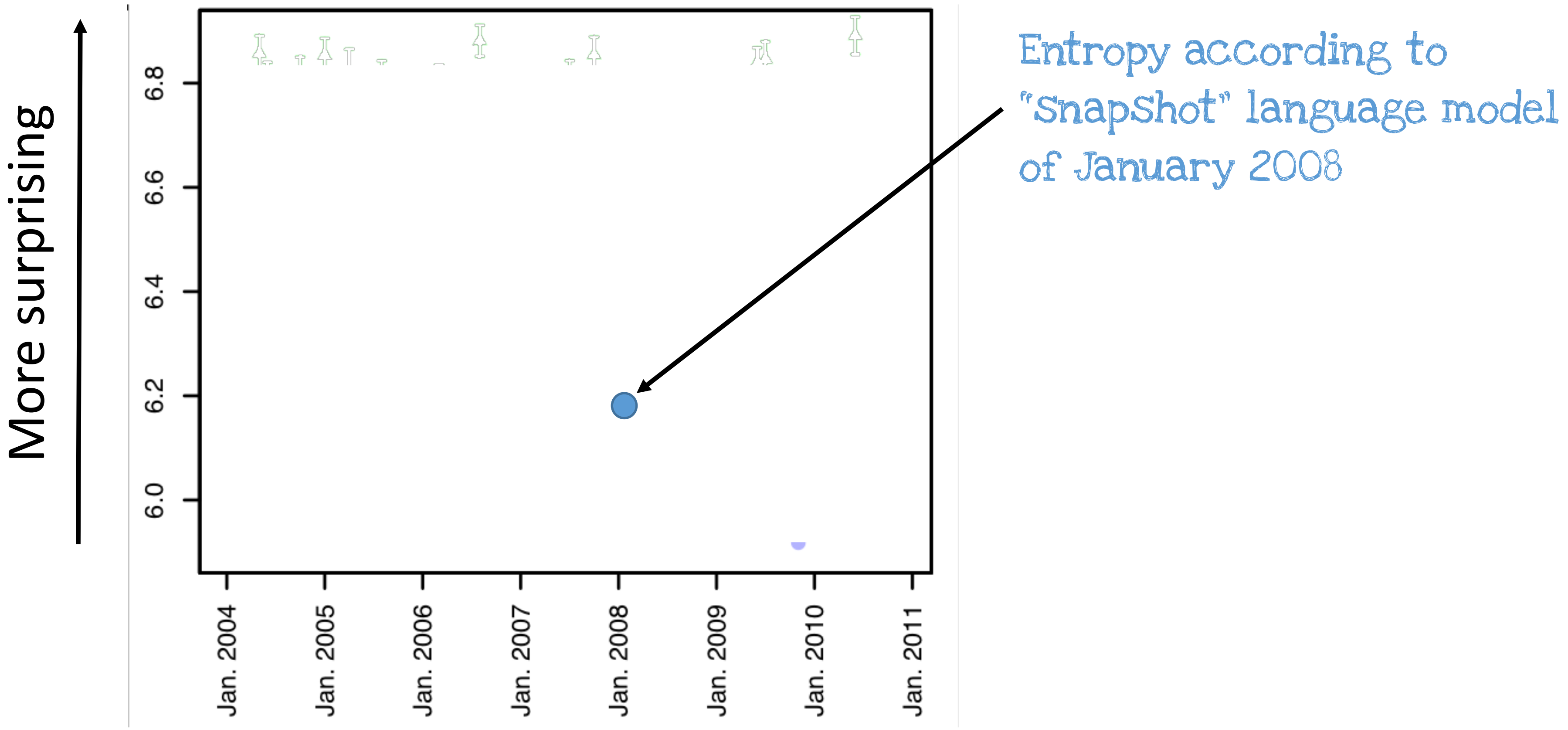

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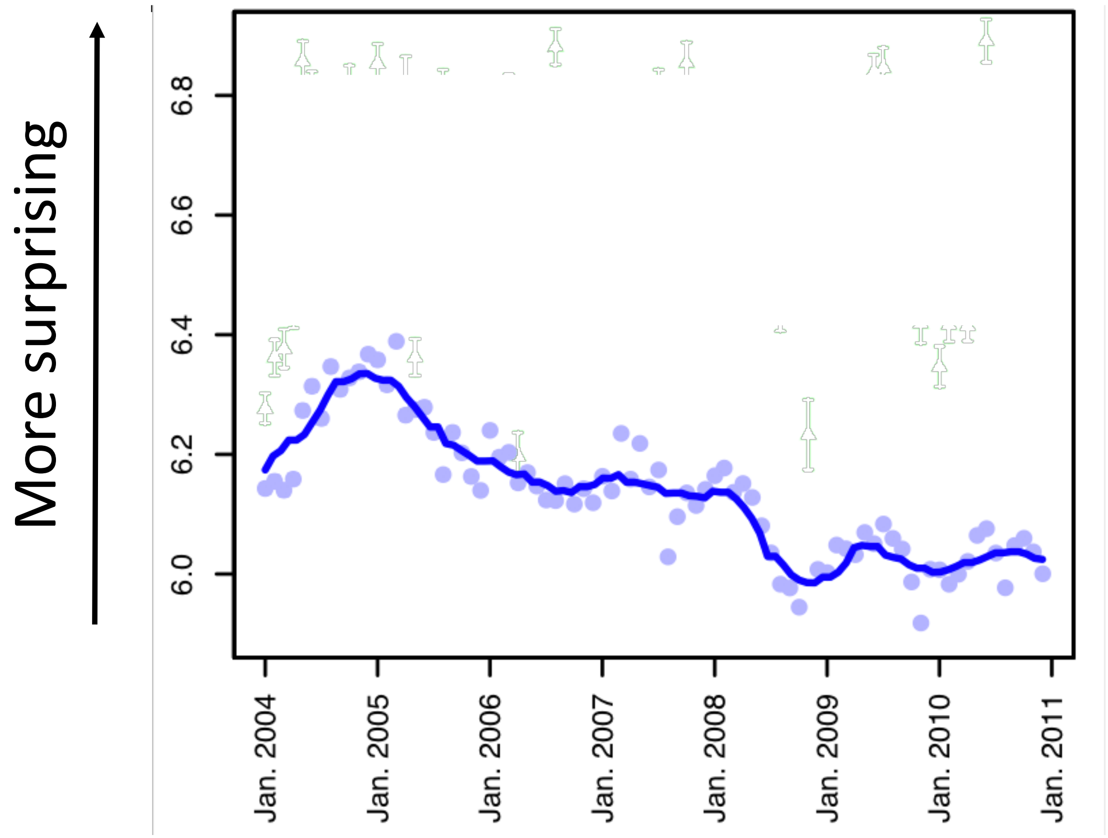

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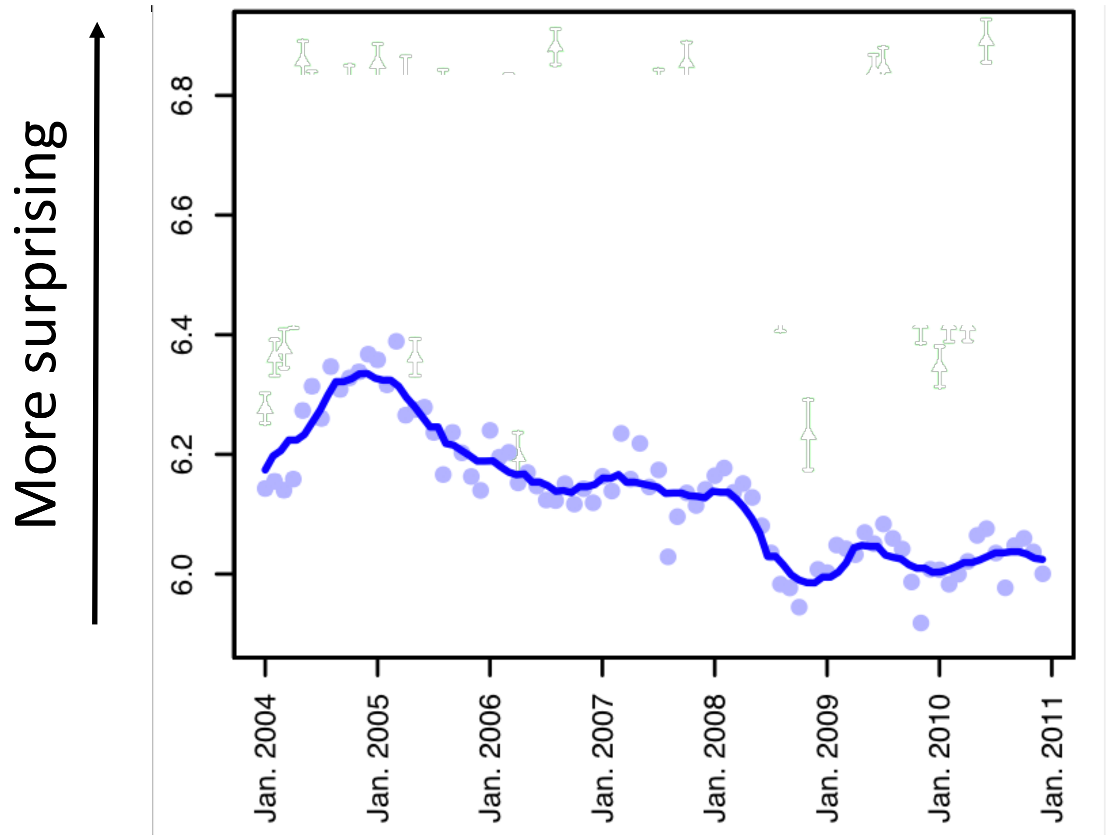

Alternative explanation

Main intuition: linguistic change

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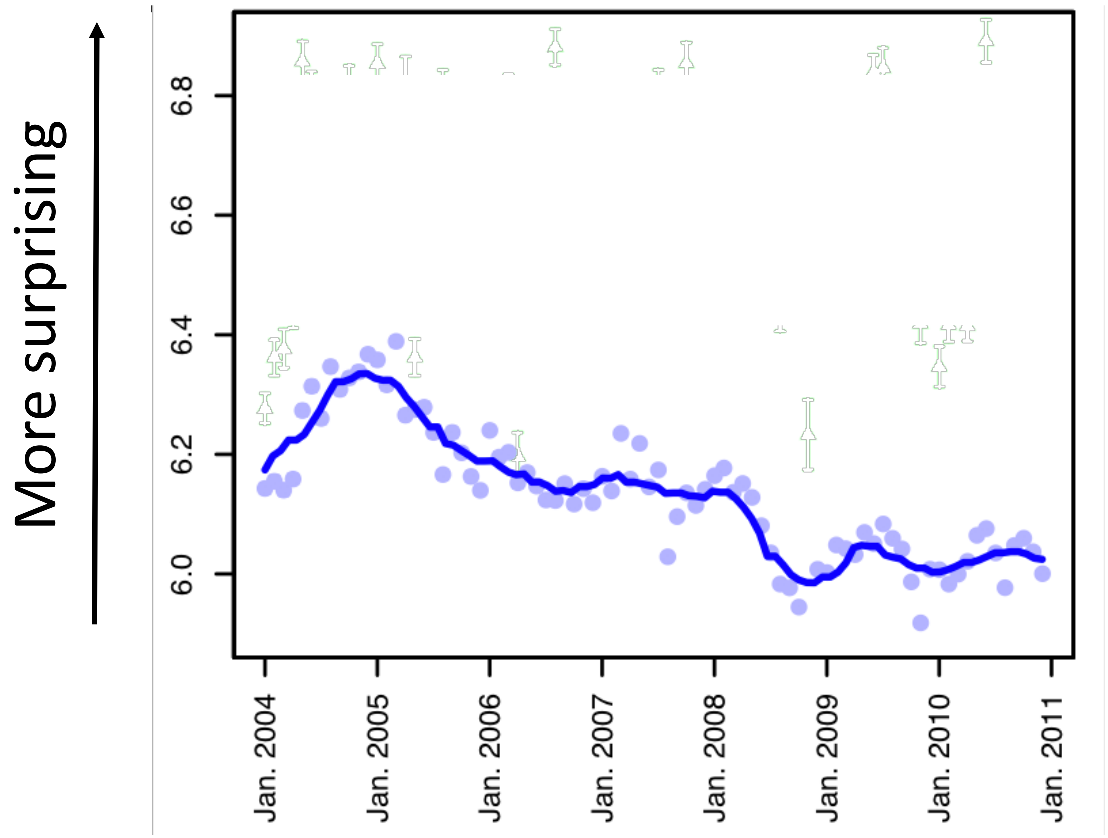
Entropy: expected surprise in a language



Alternative explanation

as community size grows,
LM is more informed,
so harder to surprise

Main intuition: linguistic change

Intuition check:

Norms take time to learn: Newcomers start farther away

Main intuition: linguistic change

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Cross-Entropy: expected surprise given a "known" language

Main intuition: linguistic change

Intuition check:

Norms take time to learn: Newcomers start farther away

Cross-Entropy: expected surprise given a "known" language

$$H(\vec{\theta}, \vec{\varphi}) = \sum_i \varphi_i \log \frac{1}{\theta_i},$$

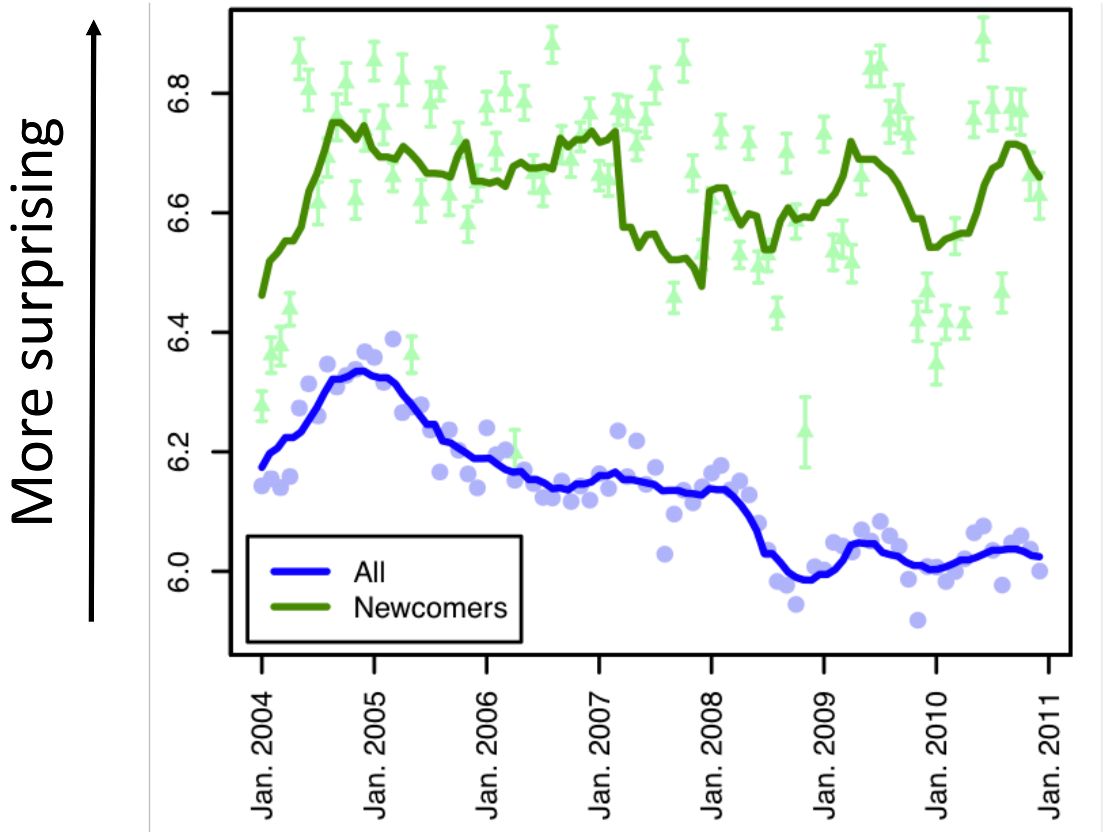
$$\theta_i = P(string_i \text{ in "known" language})$$

$$\varphi_i = P(string_i \text{ in "new" language})$$

Main intuition: linguistic change

Intuition check:
Norms take time to learn: Newcomers start farther away

Cross-Entropy: expected surprise given a "known" language



Main intuition: linguistic change

Main results: "No country for old members" (Danescu-Niculescu-Mizil et al., 2013)

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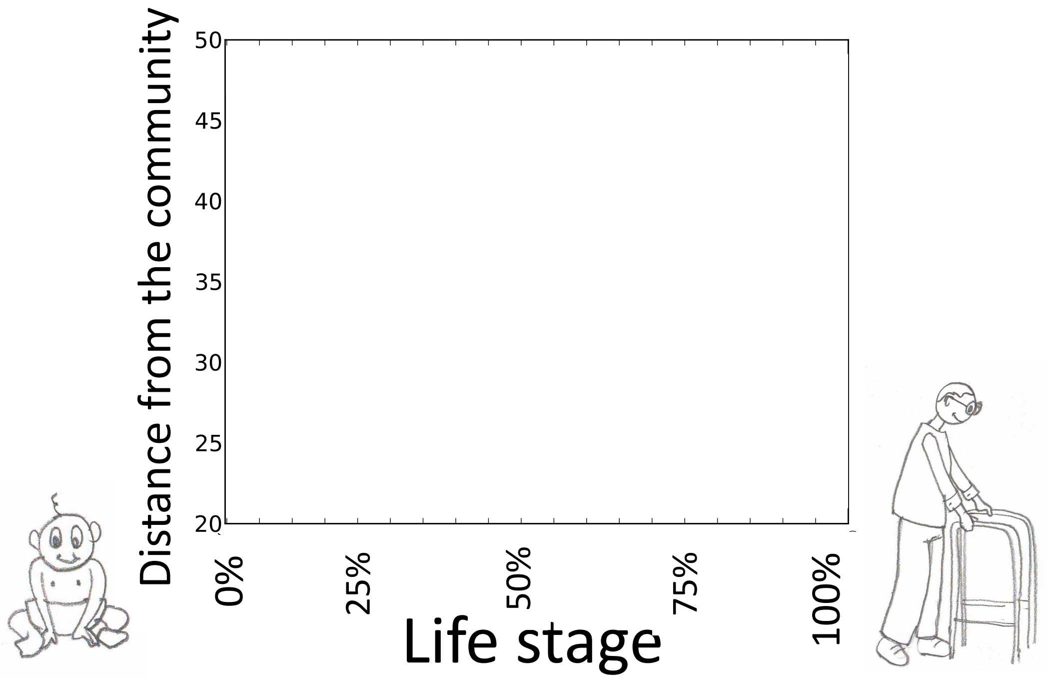
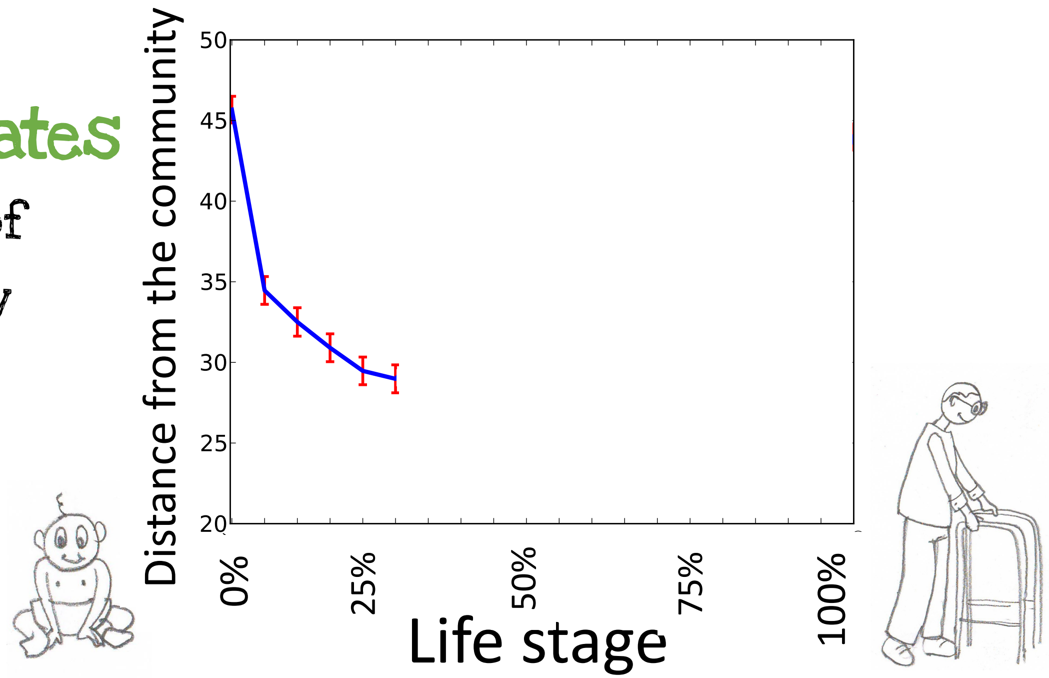


Main intuition: linguistic change

Main results: "No country for old members" (Danescu-Niculescu-Mizil et al., 2013)

Stage 1:

user **assimilates** the language of the community



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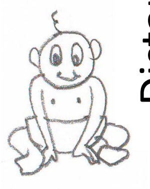
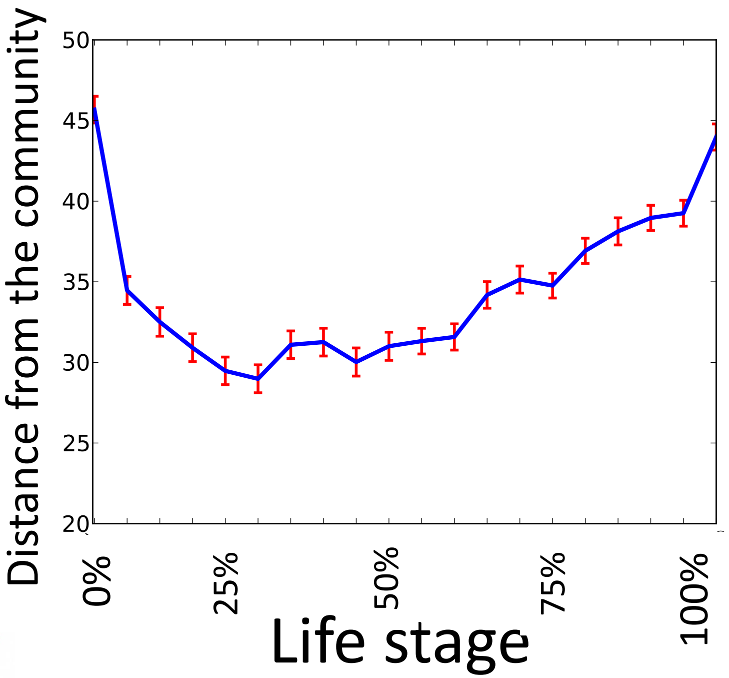
Stage 1:

user assimilates the language of the community





Stage 2:

user's language distances itself from that of the community

Language change and Social dynamics

Other cool work (links & more on website):

"Social Dynamics of Language Change."
Goel, Soni, Goyal, Paparrizos, Wallach, Diaz, Eisenstein. 2016

Regional dialects - Eisenstein. 2014

Geographic variation - Kulkarni, Perozzi, Skiena. 2016

Semantic Change - Hamilton, Jurafsky, Leskovec. 2016

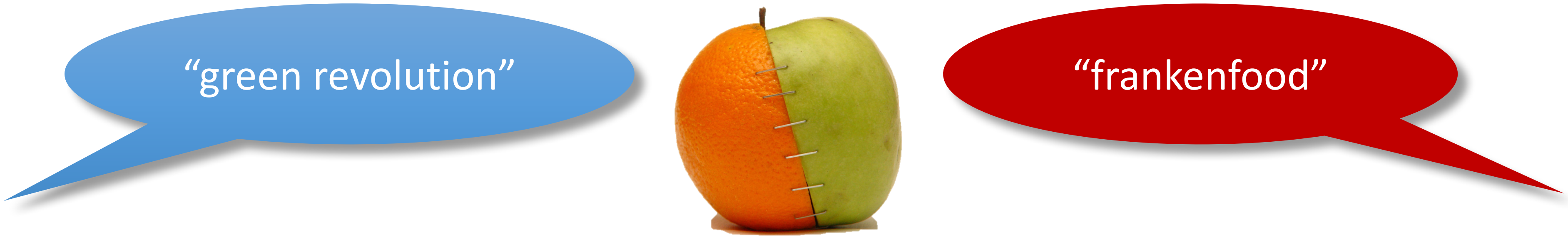
What makes two "languages" different?

Issues analyzed in Kleinberg (2004, *Data Stream Management* 2015)

Presentation/figures follow Monroe, Colaresi and Quinn, *Political Analysis* (2008)

Persuasion: *frame* competition

Example: public discussion of GMOs in food



http://www.ourbreathingplanet.com/control-the-world-through-genetically-modified-food/

The *framing* of an argument emphasizes certain principles or perspectives.

“One of the most important concepts in the study of public opinion”
James Druckman (2001)

“*CL” framing work includes: Eunsol Choi, Chenhao Tan, Lillian Lee, Cristian Danescu-Niculescu-Mizil, Jennifer Spindel (2012); Viet-An Nguyen, Jordan Boyd-Graber, Philip Resnik (2013); Eric Baumer, Elisha Elovic, Ying Qin, Francesca Polletta, Geri Gay (2015); Oren Tsur, Dan Calacci, David Lazer (2015); Dallas Card, Justin Gross, Amber Boydstun, and Noah Smith (2016).

Example: 106th U.S. Senate speeches on abortion

Frames we might expect from Democrats:

… women’s rights …
… privacy …

Frames we might expect from Republicans:

… unborn children …
… murder …

Assume a joint vocabulary of terms v_i .

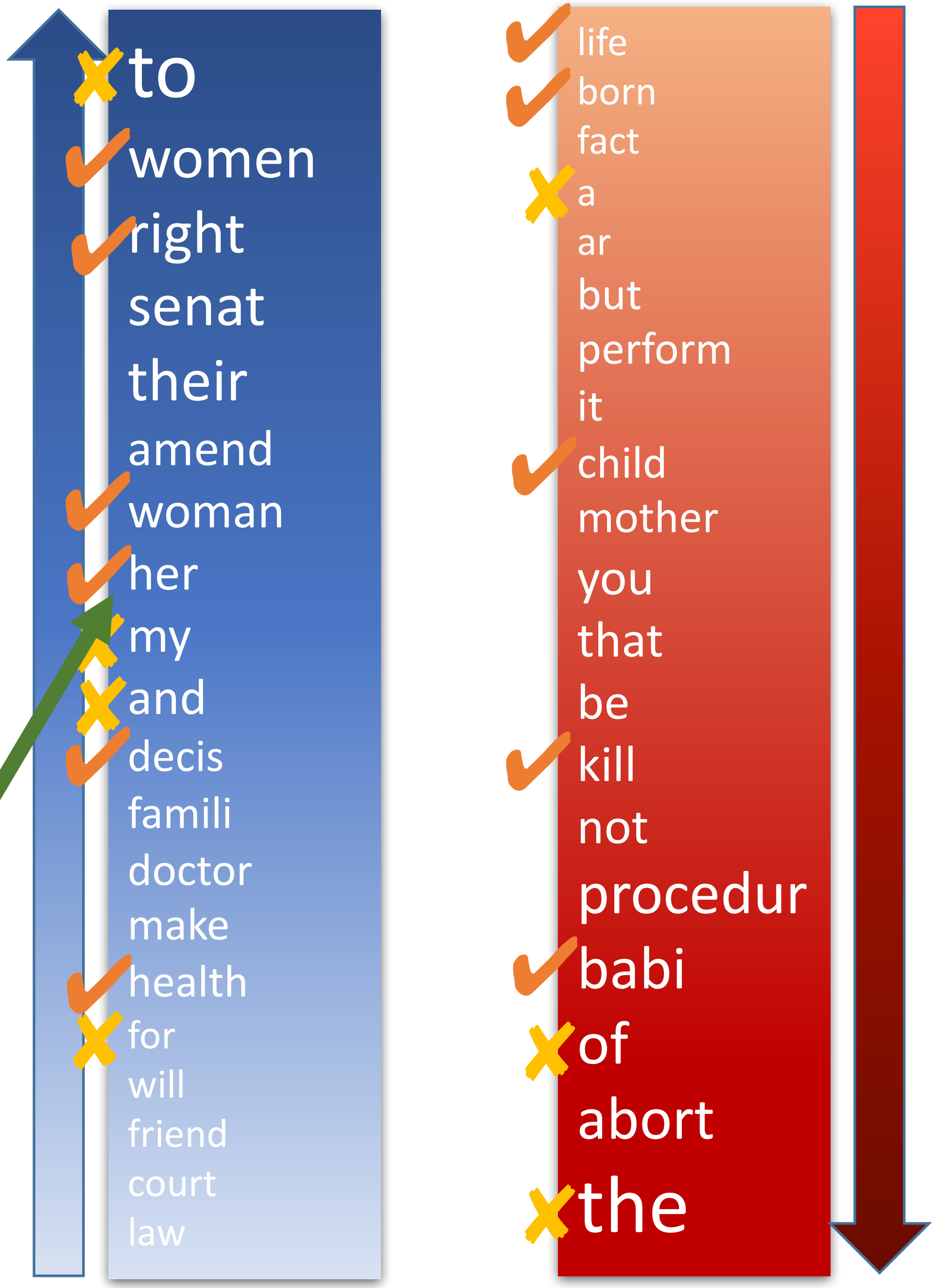
$p(v_i)$ and p(v_i) : relative frequency of v_i in the blue and red samples

Ranking using $P(x|class)$

Top and bottom 20 words according to

$$p(v_i) - p(v_i)$$

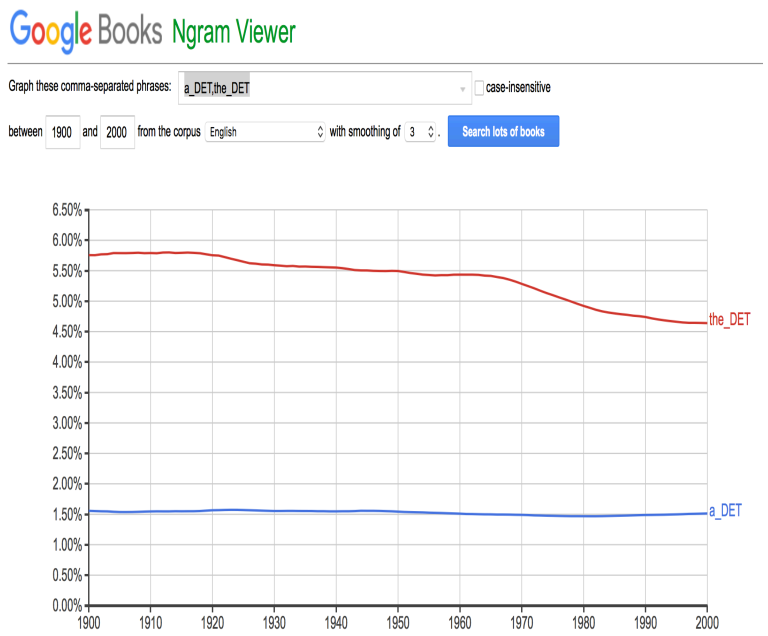
important, but would be lost with stopword filtering



Aside: “stopword removal” not recommended

- Very-frequent terms have been proving “increasingly” useful, e.g., for stylistic or psychological cues

- “a” vs “the” is surprising

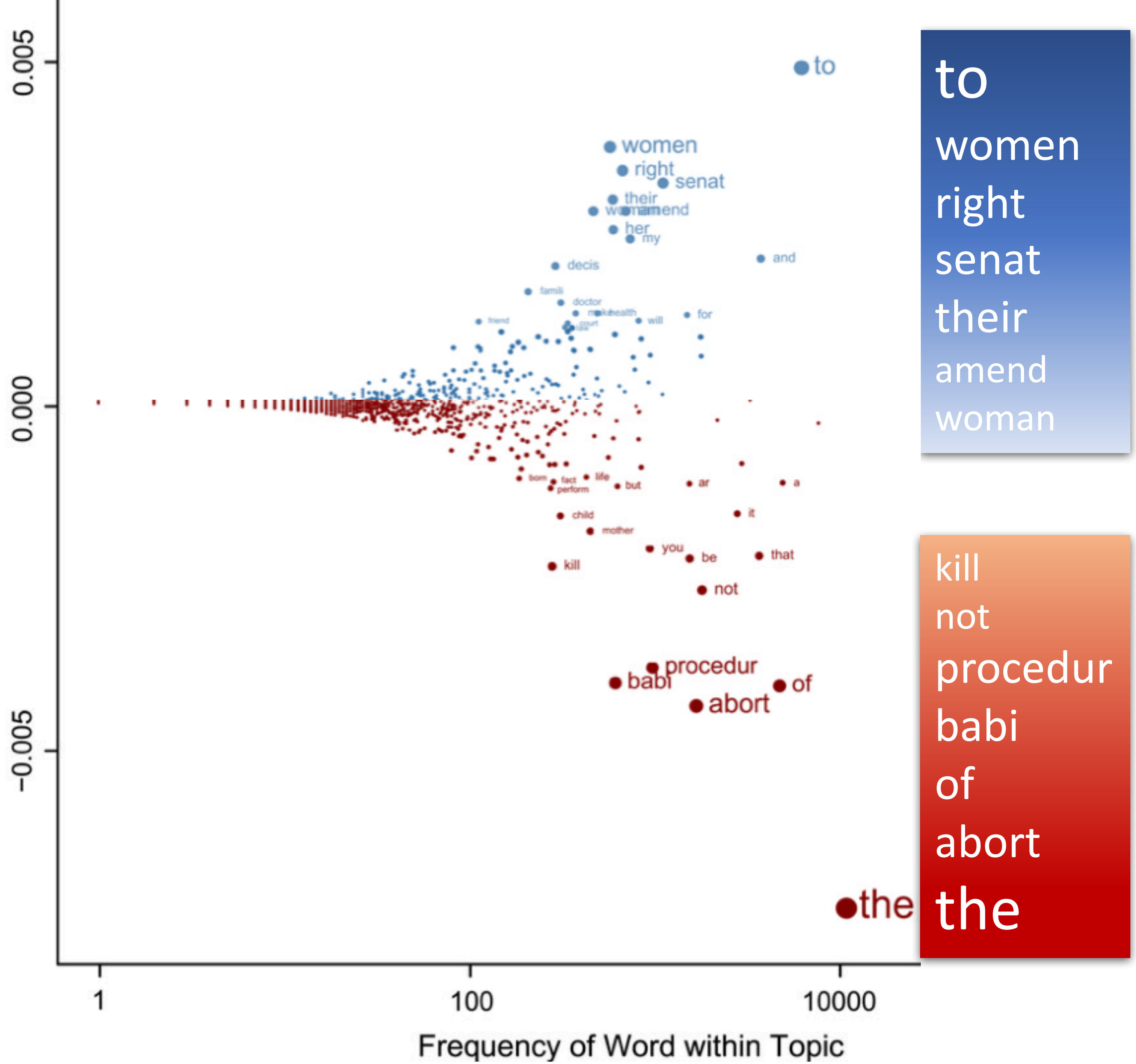


[for years LL assumed this was a bug, but see Language Log, Jan 3 2016]

$P(x|class)$ vs. count

$p(v_i) - p(v_i)$ favors big counts, i.e., v_i towards the righthand side of this plot

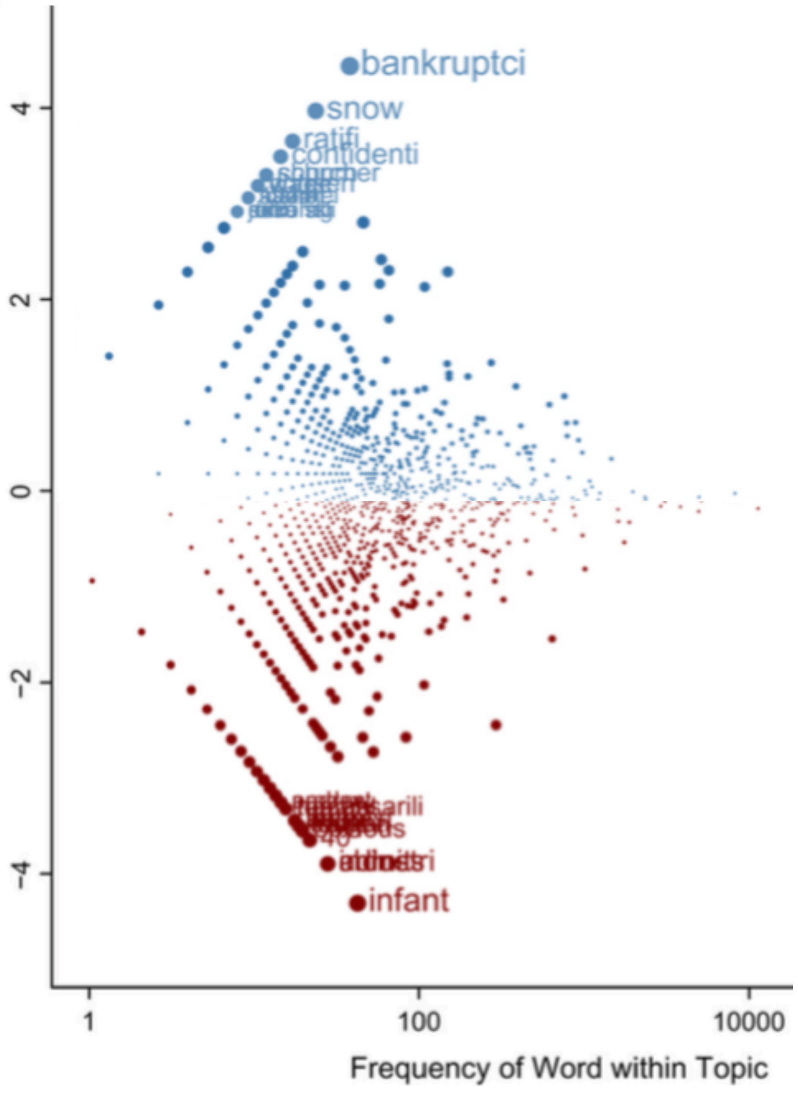
(can't have a large difference between two small differences)



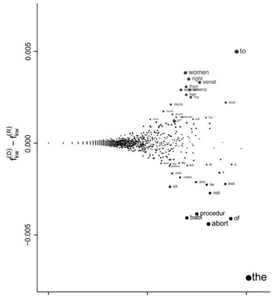
Ranking by log odds-ratio

$$\log \frac{p(v_i)/(1 - p(v_i))}{p(v_i)/(1 - p(v_i))}$$

bankruptc	tonight
snow	necessarili
ratifi	martin
confidenti	peter
church	leg
schumer	harvest
chosen	frist
voter	bright
wage	anim
1974	trade
attach	taught
attornie	dayton
idaho	obvious
sadli	40
coverag	industri
d	chines
juri	admit
mikulsi	infant

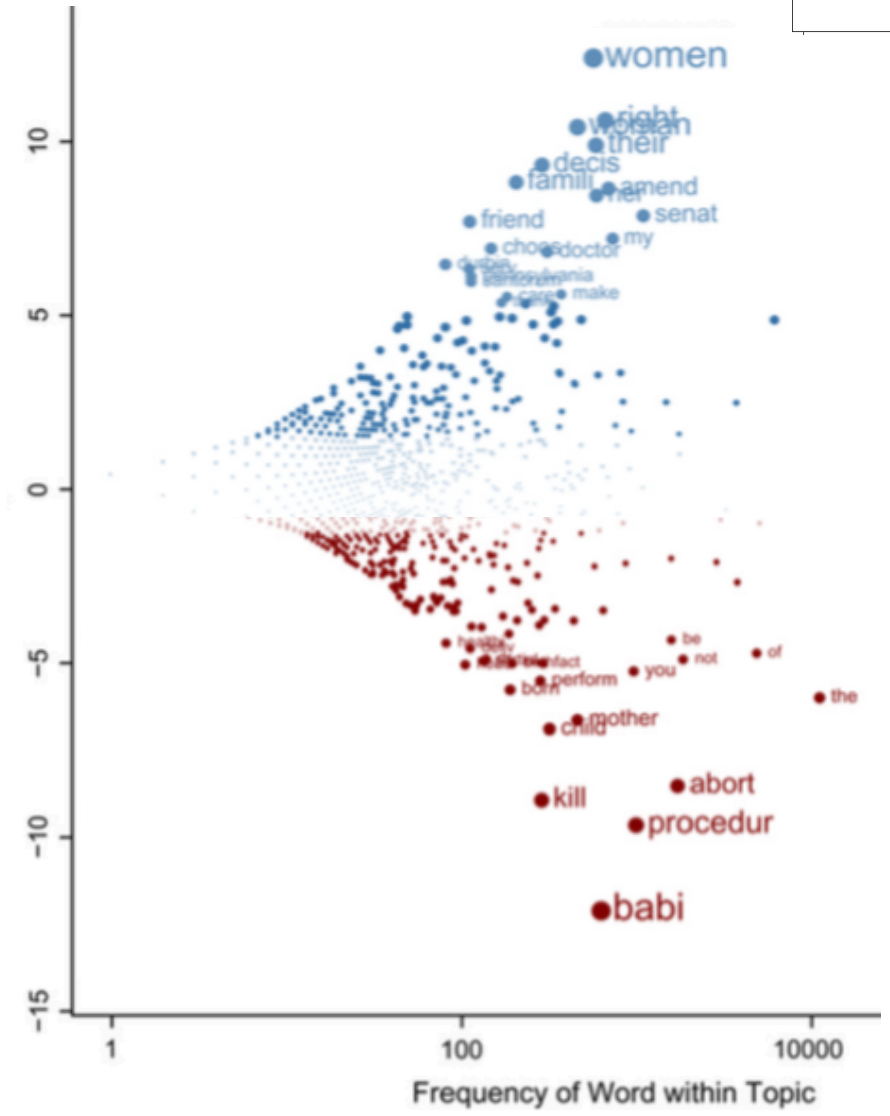


Ranking by z-score of log odds-ratio, with model of variance (uniform prior)



women
right
woman
their
decis
famili
amend
her
senat
friend
my
choos
doctor
durbin
serv
pennsylvania
santorum

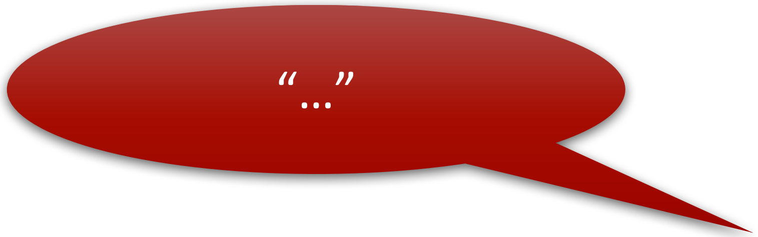
of
dr
not
partial
fact
birth
head
you
perform
born
the
mother
child
abort
kill
procedur
babi



Additional applications: Differentiating the language of ….

- successful vs. unsuccessful persuaders
- low-status vs. high-status people …
- males vs females
- *your experimental condition A vs. your experimental condition B!!*

Also good for sanity-checking your data…



Drawing to a close

[The Duchess said,] `You’re thinking about something, my dear, and that makes you forget to talk. I can't tell you just now what the moral of that is, but I shall remember it in a bit.’

`Perhaps it hasn't one,' Alice ventured to remark.

`Tut, tut, child!' said the Duchess. `Everything's got a moral, if only you can find it.'

http://upload.wikimedia.org/wikipedia/commons/5/56/Alice_par_John_Tenniel_32.png

Morals you *shouldn't* conclude (we only had two hours together…)

- ~~"More sophisticated NLP isn't used (or doesn't work) for computational social science."~~
  - example: topic models for differentiating language samples (Blei, Ng, Jordan 2003)
  - example: syntactic correlates of gender differences (Sarawgi, Gajulapalli and Choi 2011)
  - example: discourse modeling of conversational flow

- ~~"We now know all the interesting problems and work there are in computational social science."~~
  - not even close! (And that's not even counting ethics, fairness, and bias questions...)

Pointers to resources

This tutorial was based on our Cornell course
"Natural Language Processing and Social Interaction".

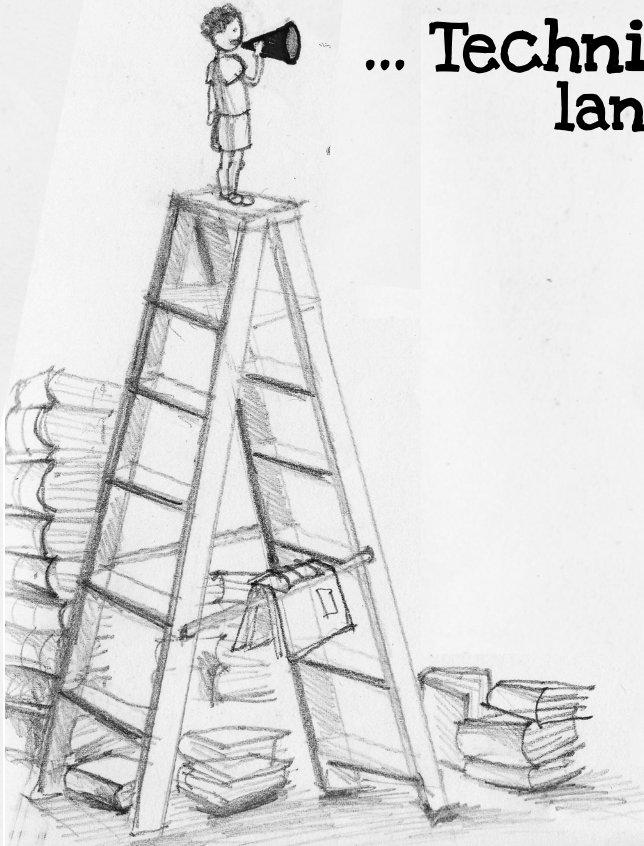
For links to papers, conferences, datasets, toolkits, research ideas:
http://www.cs.cornell.edu/courses/cs6742/ - most recent run (5 so far)

Add one of {2011fa,2013fa,2014fa,2015fa,2016fa} to URL to get that semester;
http://www.cs.cornell.edu/courses/cs6742/2014fa has scanned lecture notes

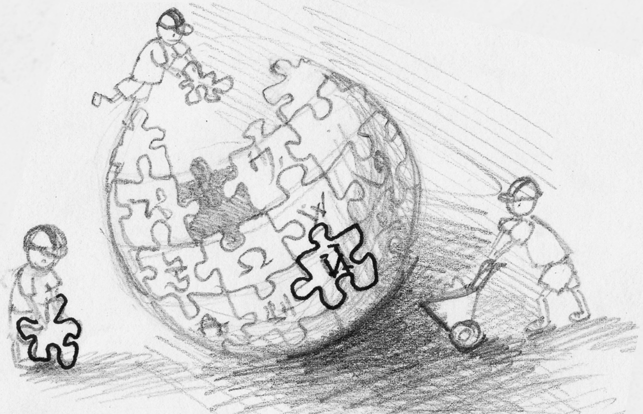
More datasets:
http://www.cs.cornell.edu/home/llee/data/index.html
http://www.cs.cornell.edu/~cristian/Data_Media_Talks_News.html

TODAY:

... Research questions
persuasion, linguistic change, framing



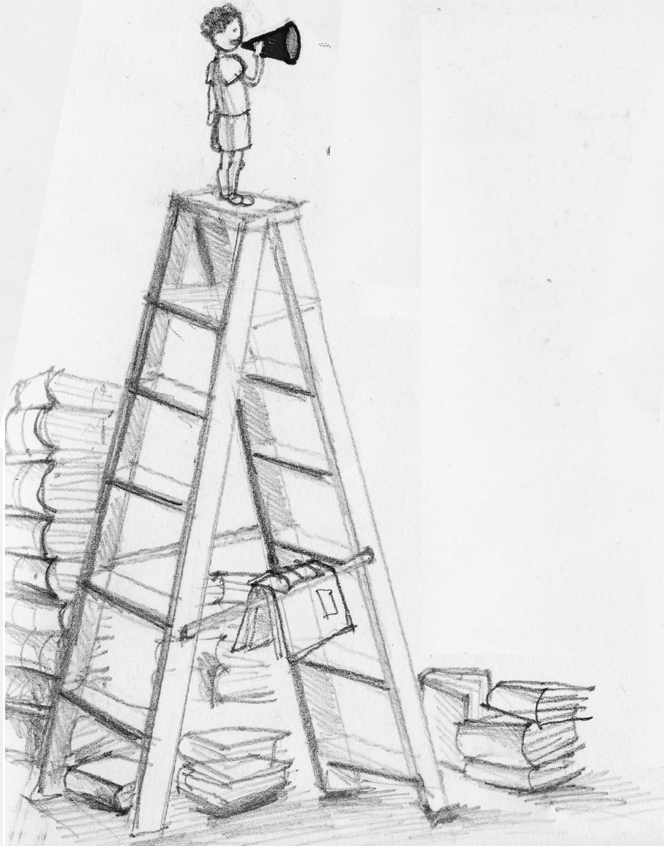
... Techniques
language models, Bayesian feature analysis

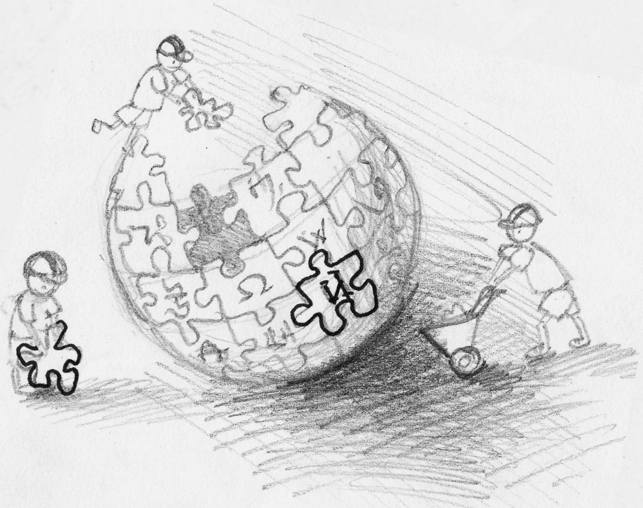


...Research practices
controls, feasibility, data inspection

LOOKING FORWARD:

Deeper interplay between
natural language processing
and
how people use and are affected by language
is a huge opportunity for all concerned.





I think this is the beginning of a beautiful friendship.

Thanks!