

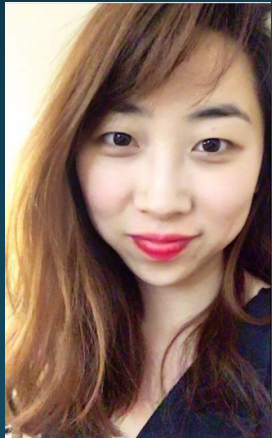
# Modeling and recognizing controversy

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 **Recurring Wilms tumors in the lung**  
"Emma has been in remission for almost 9 years now thanks to Dr. Issels' natural treatment. She just started high school and learning how to drive, my girl is 14 going on 40!!!"  
- Susan Banks, Emma's mother  
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International,  
indicating  
broad  
support

People willing to  
go on the  
record saying it  
works

Real clinics  
mean authentic

Longevity  
suggests  
reliability

# Concerns?

Quackwatch.com lists this as a "dubious treatment"

Successful!

Up to date, so

Skepdic.com says that the founder was "misguided in his beliefs and his treatment is 'ineffective.'"

Definitely scientific (but not outrageously so), so trustworthy

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- Susan Banks, Emma's mother

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Immunotherapy

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History

International, indicating broad support

Cancerresearchuk.org says "There is no scientific or medical research to support these claims."

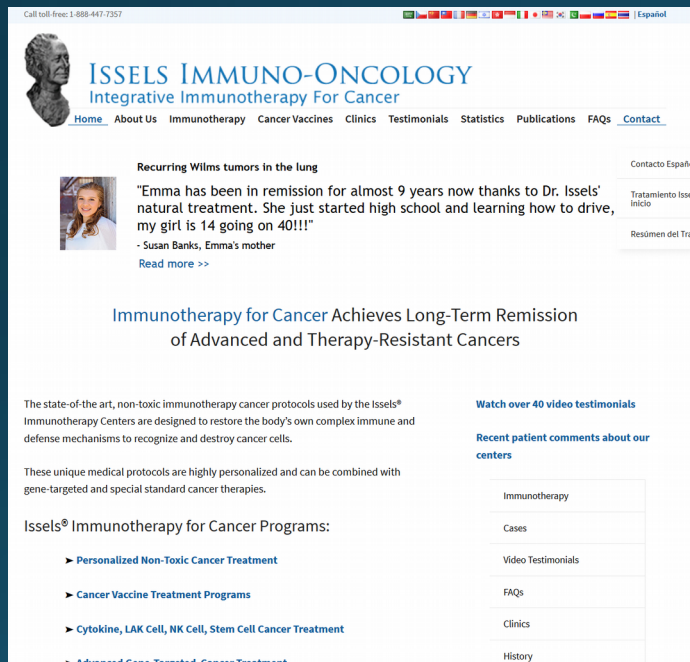
People willing to go on the record saying it works

Real clinics mean authentic

Longevity suggests reliability

# Can hidden controversy be found?

- Can we score the topic of a web page (or other document)?



???

$C = 0.8$

- How might we generate such a score?



# Scientific or experiential

## I'm Autistic, And Believe Me, It's A Lot Better Than Measles

Vaccines don't cause autism. But even if they did, is being like me really a

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- Gabe's Story
- The Autistic Child
- Temple Grandin
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## Autism-Vaccine Link: Evidence Doesn't Dispel Doubts

Many major medical groups say vaccines don't cause autism. Many parents say they do. So who's right?

By [Martin Downs, MPH](#)

WebMD Feature

Reviewed by [Louise Chang, MD](#)

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Would the fear of autism keep you from getting your child vaccinated?

- ☐ Yes  
☐ No

VOTE

> View Results



## Activist Post

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Thursday, September 12, 2013

## 22 Medical Studies That Show Vaccines Can Cause Autism

Arjun Walia  
Activist Post



Concerns regarding vaccinations continue to increase exponentially in light of all of the information and documentation that has surfaced over the past few years. As a result, corporate media has responded to alternative media, stating that the increase of persons who are choosing to opt out of vaccines and the recommended vaccine schedule is a result of 'fear mongering.'

This may not be too surprising as the corporate media is owned by the major vaccine manufacturers, and the major vaccine manufacturers are owned by corporate media(1)(2)(3)  
(4). Given this fact, it's easy to fathom the possibility that these institutions are desperately

# Moral or political

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NAF & Professionals

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7



# “Important” or “unimportant”



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It's about scoring great gains for all of us

LEARN MORE



Climate change may be the most important challenge we have ever faced. But together, we all are part of the solution.

ADAM ROGERS SCIENCE 02.26.15 10:28 PM

## THE SCIENCE OF WHY NO ONE AGREES ON THE COLOR OF THIS DRESS





# Long-term or ephemeral



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ADAM ROGERS SCIENCE 02.26.15 10:28 PM

## THE SCIENCE OF WHY NO ONE AGREES ON THE COLOR OF THIS DRESS



# Focus on disagreement for now

- Call this aspect of controversy: “contention”
- Are there multiple sides (stances)?
  - Need at least two for there to be disagreement
- How one-sided is the disagreement?
  - Does a 99/1 split mean contention? 70/30? 50/50?
- What is the population that has disagreement?
  - Size of population is an estimate of importance, perhaps?

# Computational model of contention

- $P(\text{contention} | \Omega, T)$ 
  - Measuring disagreement on a topic  $T$  within a population
- Pick two people from the population at random
- Do they disagree about the topic?
  - Do they hold conflicting positions (stances) on the topic?

$$P(\text{contention} | \Omega, T) = \frac{\sum_{p_1, p_2 \in \Omega} P(\text{conflict}_T(p_1, p_2))}{|\Omega|^2}$$

# Using polls to define conflict

- Opinion polls request which “stance” someone agrees with
  - Thinking about childhood diseases, such as measles, mumps, rubella and polio, do you think...
    - a) All children should be required to be vaccinated
    - b) Parents should be able to decide *not* to vaccinate their children
    - c) No answer
  - Do you think it is generally ... to eat foods grown with pesticides
    - a) Safe
    - b) Unsafe
    - c) No answer
- Someone holding opinion (a) conflicts with someone holding (b)
- Assume that (c) does not conflict with either (a) or (b)

*[Rainie and Funk, Appendix A, 2015]*



# Using polls to define conflict

- Do you think it is generally ... to eat foods grown with pesticides
  - a) Safe
  - b) Unsafe
  - c) No answer

- Consider the people that hold each stance

- Stance 1 = "Safe"
- Stance 2 = "Unsafe"

- Stance 0 = no opinion

$$P(\text{conflict}_T(p_1, p_2)) = \text{holds}(p_1, s_i^T) \cap \text{holds}(p_2, s_j^T) \cap i \neq j \cap i, j > 0$$



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# So...

$$P(\text{contention}|\Omega, T) = \frac{\sum_{p_1, p_2 \in \Omega} P(\text{conflict}_T(p_1, p_2))}{|\Omega|^2}$$

$$P(\text{contention}|\Omega, T) = \frac{\sum_{p_1, p_2 \in \Omega} \bigvee_{i \neq j, i, j > 0} \text{holds}(p_1, s_i^T) \wedge \text{holds}(p_2, s_j^T)}{|\Omega|^2}$$

- In opinion polls, we *know* who holds each stance
- Assume  $k$  stances and that they are mutually exclusive
- Let  $G_i$  be the group holding stance  $i$  ( $0 \leq i \leq k$ ), and we get:

$$P(\text{contention}|\Omega, T) = \frac{\sum_{i=2}^k \sum_{j=1}^{i-1} (2|G_i||G_j|)}{|\Omega|^2}$$



# Some notes

$$P(\text{contention}|\Omega, T) = \frac{\sum_{i=2}^k \sum_{j=1}^{i-1} (2|G_i||G_j|)}{|\Omega|^2}$$

- By construction, maximal if group sizes are the same
  - Greatest disagreement
- Maximum value depends on  $k$ , specifically  $(k-1)/k$ 
  - If  $k=2$  then maximum value is  $\frac{1}{2}$
  - If  $k=3$  then maximum value is  $\frac{2}{3}$  (and so on)
- To make comparable across topics, normalize to range  $[0,1]$  by:

$$\text{cscore}(\Omega, T) = \frac{k}{k-1} \cdot P(\text{contention}|\Omega, T)$$

- Hard to find examples with data *and* more than two stances
  - (So estimated probability is half of the reported score)
  - And score reduces to a product of ratios

$$2 \cdot 2 \frac{|G_1|}{|\Omega|} \frac{|G_2|}{|\Omega|}$$

# Does it work across topics?

	%G1	%G2	%G0	C-score
Safe to eat foods with pesticides? (1=Safe,2=unsafe)	28	69	3	77.3
Vaccinations (1=require, 2=parents decide)	68	30	2	85.0
Evolution (1=happened, 2=did not)	65	31	4	87.5
Climate warming (1=human caused, 2=natural causes, 3=not clear it is happening)	50	2=23 3=25	2	89.3

- Drawn from Pew Research poll data
- Polls are typically on contentious topics, so hard to find ones that are not...

# Across populations?

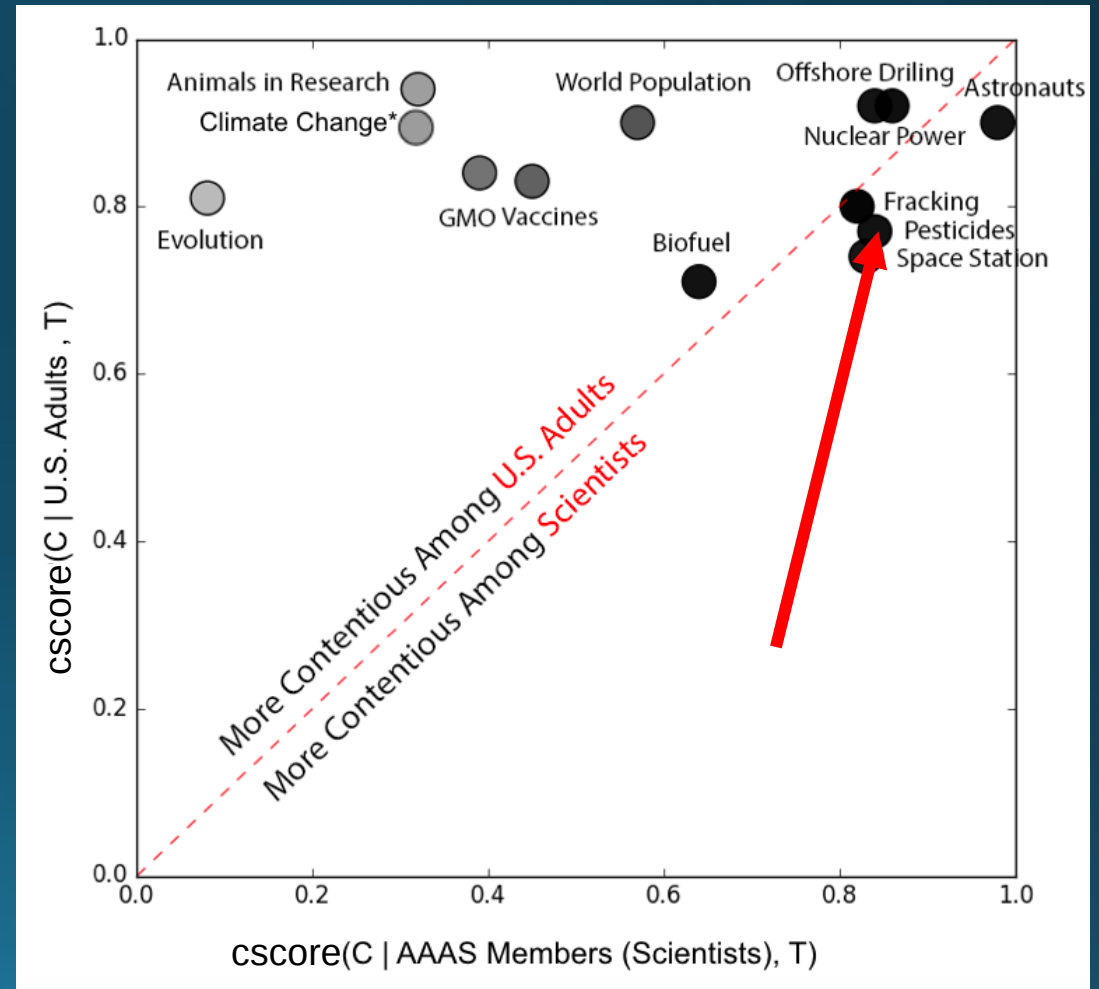
$$2 \cdot 2 \frac{|G_1|}{|\Omega|} \frac{|G_2|}{|\Omega|}$$

- Captured contention within “U.S. adults”
- Some additional polls were restricted to “active research scientists”

	US adults				Scientists			
	%G 1	%G 2	%G 0	C- score	%G 1	%G 2	%G 0	C- score
Safe to eat foods with pesticides? (1=Safe,2=unsafe)	28	69	3	77.3	71	28	1	79.5
Vaccinations (1=require, 2=parents decide)	68	30	2	85.0	87	13	1	45.2
Evolution (1=happened, 2=did not)	65	31	4	87.5	99	1	0	3.4
Climate warming (1=human caused, 2=natural causes, 3=not clear it is happening)	50	2=2 3 3=2 5	2	89.3	90	2=7 3=2	1	24.7

# Popular contention v. scientists

- Consider a range of topics, all of which are selected because of likely disagreement
- Calculate c-score for the two populations





# Across populations?

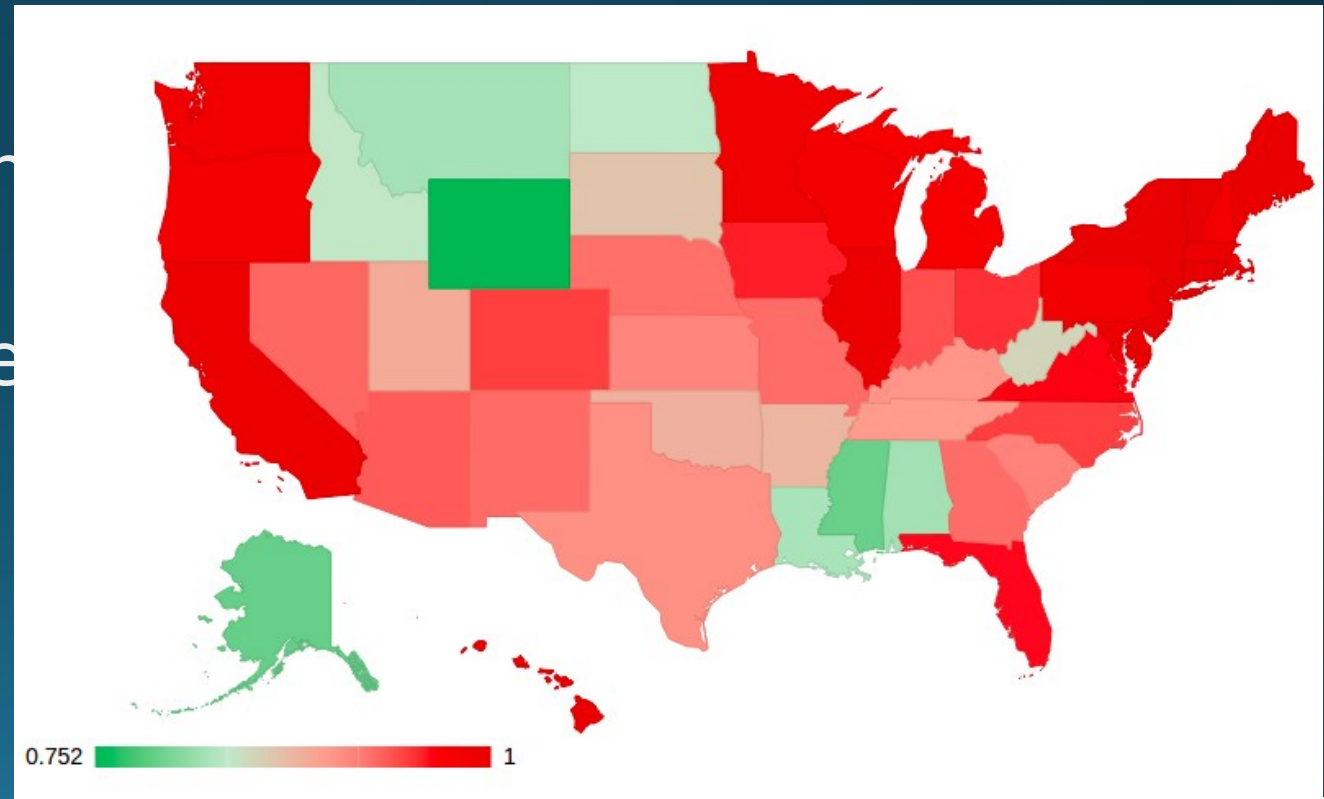
$$2 \cdot 2 \frac{|G_1|}{|\Omega|} \frac{|G_2|}{|\Omega|}$$

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- Some additional polls were restricted to “active research scientists”

	US adults				Scientists			
	%G 1	%G 2	%G 0	C- score	%G 1	%G 2	%G 0	C- score
Safe to eat foods with pesticides? (1=Safe,2=unsafe)	20	69	3	77.3	71	28	1	79.5
Vaccinations (1=require, 2=parents decide)	68	30	2	85.0	87	13	1	45.2
Evolution (1=happened, 2=did not)	65	31	4	87.5	99	1	0	3.4
Climate warming (1=human caused, 2=natural causes, 3=not clear it is happening)	50	2=2 3 3=2 5	2	89.3	90	2=7 3=2	1	24.7

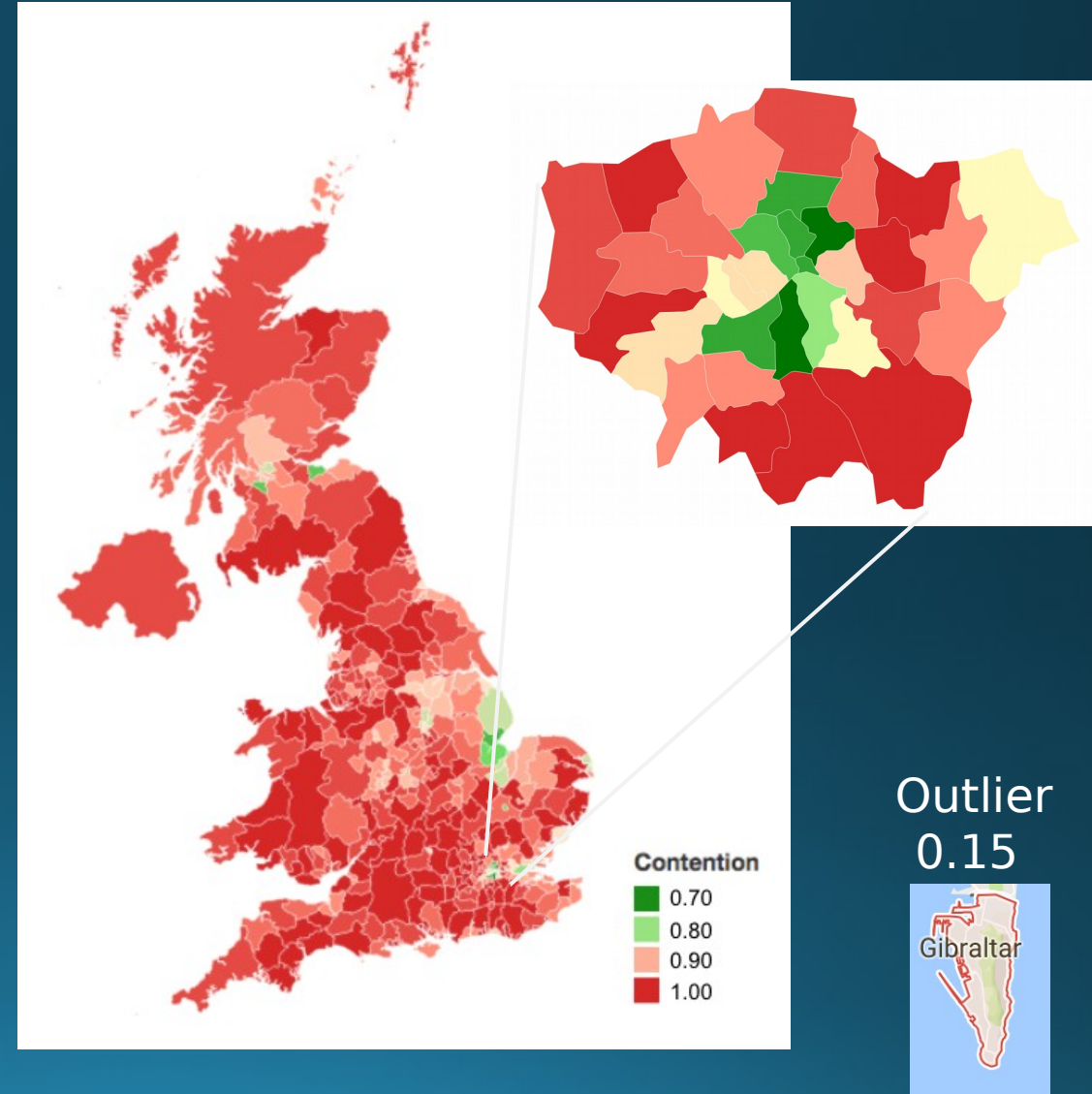
# Population by state

- “Do you support increased gun control”
- Answers collected by iSideWith.com, an on-line opinion gathering site
- Population of each state provides different  $\Omega$  for



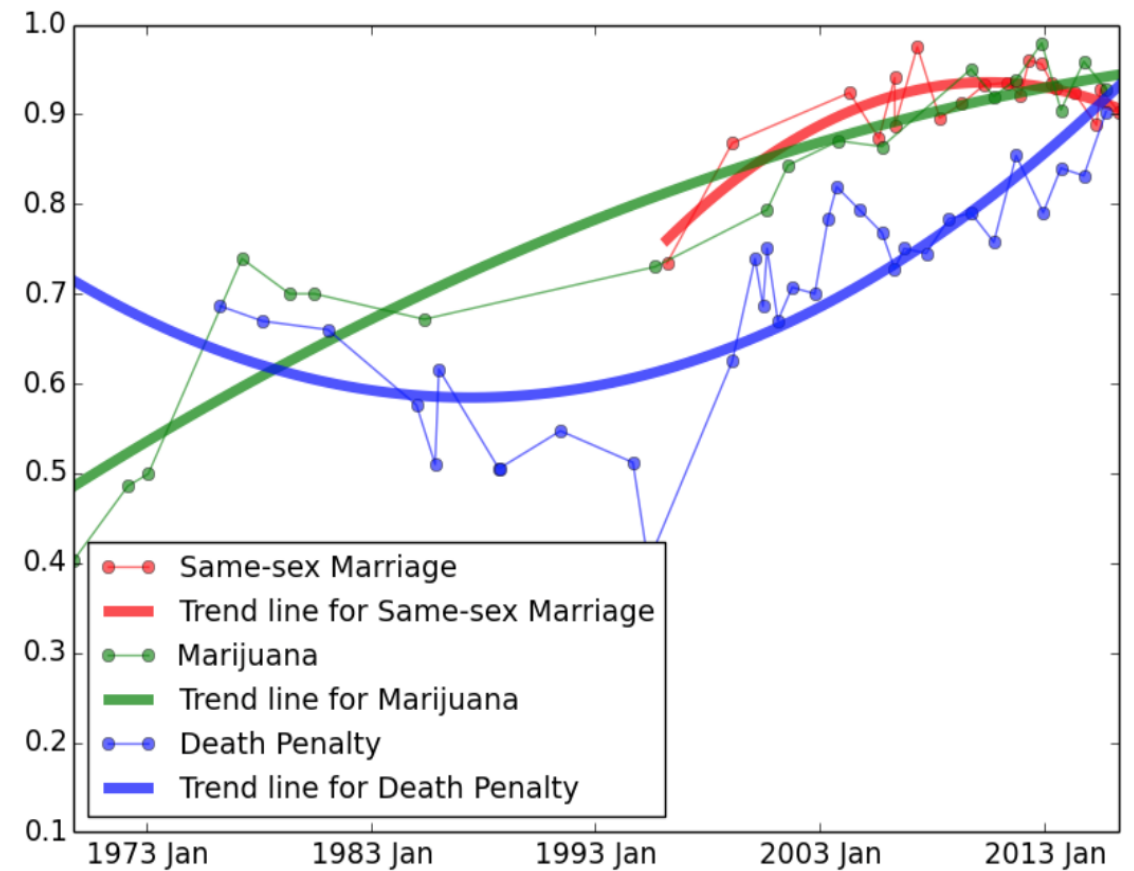
# Measuring contention by *votes*

- Should Britain leave the EU?
- Overall contention is 1.0
- When broken down by voting districts, more interesting patterns are visible



# Contention trends over time

- Similar issues have been polled repeatedly over the years (U.S. polls)
- Contention varies greatly, but there are some vague trends
- Some effects seem to be related to polarity shifts





# Polls provide limited coverage

- Polls provide good estimates of “stance group” sizes
- Coverage of topics is unfortunately sparse
  - Largely topics known to be contentious (or why poll?)
  - Somewhat rare snapshots, so not very dynamic
- Would like another source of topics
- One that covers more topics than polls do
- Perhaps one that covers all of human discourse...

# Wikipedia and controversy

- Wikipedia includes about 5.4 million articles (English)
- Each page discusses a topic
- Pages added quickly and most pages are regularly updated
- Can we adapt our model to Wikipedia?

$$P(\text{contention}|\Omega, T) = \frac{\sum_{p_1, p_2 \in \Omega} P(\text{conflict}_T(p_1, p_2))}{|\Omega|^2}$$

- Need a population  $\Omega$  and a way to recognize “conflict”

# Controversy within Wikipedia

- Fortunately, we're not alone
  - Several people have played with recognizing controversy there
- One successful measure from Yasseri et al (2012) is called "M"
  - Leverages the edit history of Wikipedia pages
  - Particularly individuals who undo each others work (mutual reverts)
  - Uses the total number of editors who ever reverted mutually
  - Attempts to address vandalism
  - Discards most frequent mutual revert: one pair does not mean controversy

# Wikipedia article

- **Climate change** is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (i.e., decades to millions of years). ... Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities have also been identified as significant causes of recent climate change, often referred to as global warming.

# Edited by editor X

- **Climate change** is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (i.e., decades to millions of years). ... Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities, **without any evidence whatsoever**, have also been identified as significant causes of recent climate change, often referred to as global warming.



# X's edit undone (reverted) by Y

- **Climate change** is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (i.e., decades to millions of years). ... Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities, ~~without any evidence whatsoever,~~ have also been identified as significant causes of recent climate change, often referred to as global warming.<sup>[1]</sup>

# Y's revert reverted by X

- **Climate change** is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (i.e., decades to millions of years). ... Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities, **without any evidence whatsoever**, have also been identified as significant causes of recent climate change, often referred to as global warming.<sup>[1]</sup>
- X and Y are *mutually reverting* each others edits: conflict

# C-score within Wikipedia

$$P(\textit{contention}|\Omega, T) = \frac{\sum_{p_1, p_2 \in \Omega} P(\textit{conflict}_T(p_1, p_2))}{|\Omega|^2}$$

# C-score within Wikipedia

$$P(\textit{contention} | E_T, T) = \frac{\sum_{p_1, p_2 \in E_T} P(\textit{conflict}_T(p_1, p_2))}{|E_T|^2}$$

- Population will be the set of editors
  - Will use editors of this page (topic); could be across entire Wikipedia

# C-score within Wikipedia

$$P(\text{contention} | E_T, T) = \frac{\sum_{(p_1, p_2) \in MR_T} P(\text{conflict}_T(p_1, p_2))}{|E_T|^2}$$

- Population will be the set of editors
  - Will use editors of this page (topic); could be across entire Wikipedia
- Conflict is recognized *only* by mutual reverts
  - Assume everything else is a friendly edit
  - That is, outside of  $MR_T$   $\text{conflict}() = 0$



# Estimating conflict within reverts

- Only interested in reverts who are not fixing vandalism (e.g., X?)
  - So each editor in pair should be “legitimate”
  - Legitimacy estimated by total number of edits they have done
    - “Reputation” factor [Sumi et al., 2011]

Bound by normalizing by maximum number (of edits of any editor)

$$PP(\text{contention} | E_T, T) = \frac{\sum_{(p_1, p_2) \in MR_T} \left( \frac{N_{p_1}^T}{N_{max}^T + 1} \right) \cdot \left( \frac{N_{p_2}^T}{N_{max}^T + 1} \right)}{|E_T|^2}$$

# Finding “contention” in Wikipedia

1. George W. Bush
2. Super Smash Bros. Brawl
3. Avatar: The Last Airbender
4. Chiropractic
5. List of scientists opposing the mainstream scientific assessment of global warming
6. Chronic fatigue syndrome
7. L. Ron Hubbard
8. List of World Wrestling Entertainment employees
9. Moldovans
10. International recognition of Kosovo
11. List of living supercentenarians
12. Transnistria
13. Islam
14. Global warming
15. 2009

# C v. M (Yasseri et al., 2012)

- Model-derived estimate

$$P(\text{contention} | E_T, T) = \frac{\sum_{(p_1, p_2) \in MR_T} \left( \frac{N_{p_1 p_1}}{N_{max} + 1} \right) \cdot \left( \frac{N_{p_2 p_2}}{N_{max} + 1} \right)}{|E_T|^2}$$

- Heuristically-derived estimate

$$M = |E_T| \cdot \sum_{(p_1, p_2) \in MR_T} \min(N_{p_1}, N_{p_2})$$

- Similar components, but min() rather than multiplication, removal of outlier, directly rather than indirectly related to  $E_T$ , ...

# Comparing: win some, lose some

Article	Cscore-rank	Mscore-rank
Avatar: The Last Airbender	3	82
List of scientists opposing the mainstream scientific assessment of global warming	5	235
L. Ron Hubbard	7	194
Antisemitism	19	396
Horcrux	33	466
Intelligent design	246	11
United States	411	6
Deaths in 2008	428	24
The Beatles	489	33

# Another experiment

- Considered a set of about 2K Wikipedia articles
  - Manually judged for contention
- Rank articles by several measures
- Area under ROC curve captures differences between measures

- M and c-score are comparable
- C-score accuracy drops slightly when considering smaller population (editors of page)

<i><b>Measure</b></i>	<b>AUC</b>
$P(\text{cont} \mid E_T, T)$	0.624
$P(\text{cont} \mid E_*, T)$	0.628
Original “M” score	0.630



# Wikipedia isn't lightning fast

- Polls provide sparse coverage of topics and long latency
  - Wikipedia provides “all” topics and less latency
  - Still requires that someone create/edit a page
- 
- Can we find yet another source of topics
  - One that covers more topics than polls do
  - One that responds more quickly than Wikipedia
  - Perhaps one that also covers all of human discourse...

# Twitter and controversy

- One or more hashtags represent a “topic”
- Hashtags created constantly
  - 100’s of millions of tweets on numerous topics every day
- Faster-moving, creating new operational challenges
- But can we adapt our model to Twitter?

$$P(\text{contention} | \Omega, T) = \frac{\sum_{p_1, p_2 \in \Omega} P(\text{conflict}_T(p_1, p_2))}{|\Omega|^2}$$

- Again, need a population  $\Omega$  and a way to recognize “conflict”

# Twitter, what is a topic?

- Define a topic by a set of related hashtags
  - Topic *seed* is a single hashtag or a set of hashtags
    - #voteleave, #betteroffout, #strongerin, #voteremain
- Find all tweets with those hashtags
- Extract other hashtags used
  - Pick top  $n$  and let that represent the topic's description
- All tweets using any of those hashtags are part of the topic
  - Can weight by confidence that tweet matches the “topic”

# Twitter, stances and population

- Need stances and sizes of groups aligned with each stance
- Cluster topic's hashtags
  - Standard IR methods with some adaptation to small sized text
  - People who tweet or retweet each stance are in that stance group
- Build classifier to estimate change tweet would have hashtag
- Cluster by retweet graph
  - Some evidence that stance groups do not mix
- Population can be all people who tweet on that topic
  - Or all people who tweet at all

# Does it work?

- Remember this?
- Collected hashtags and divided into stances
  - **Blue and black:** #blackandblue, #notwhiteandgold, #blackandbluedress, #negroyazul, ... (total of 49)
  - **White and gold:** #whiteandgold, #whiteandgoldteam, #thedressiswhiteandgold, #blancodorado, ... (total of 37)
- Consider estimated contention over

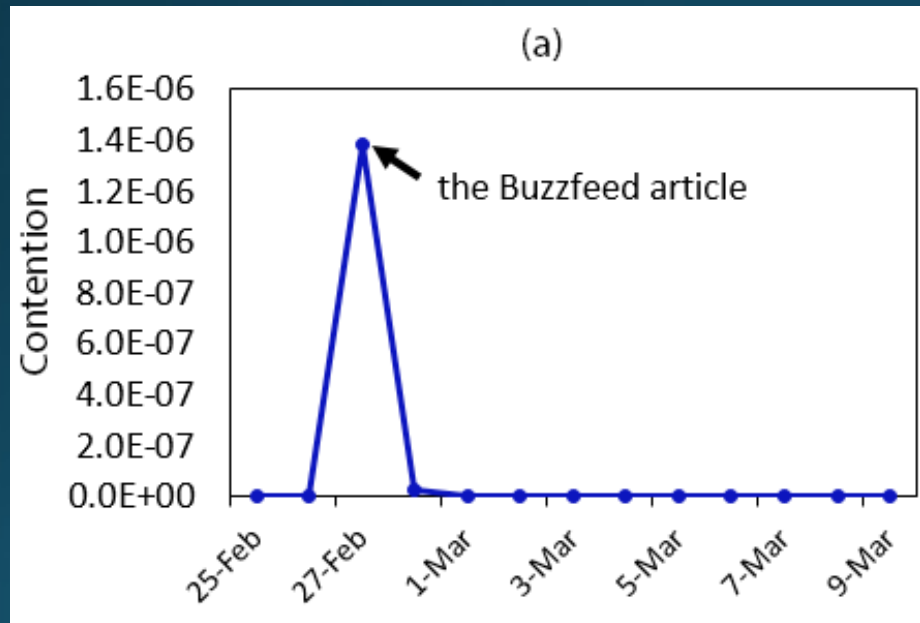




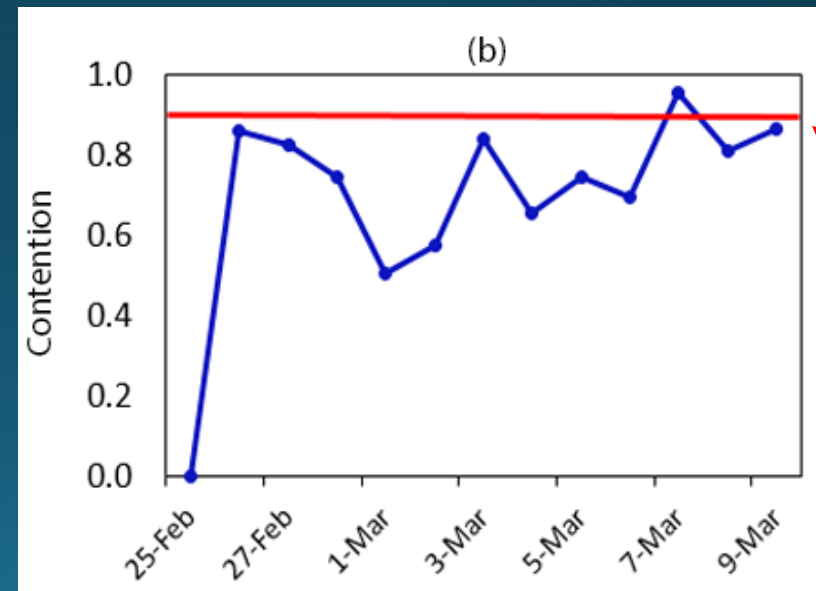
# “Dress” contention over time

- 408K tweets from 297K users, February 26 to March 9, 2015

$\Omega = \text{all Twitter}$



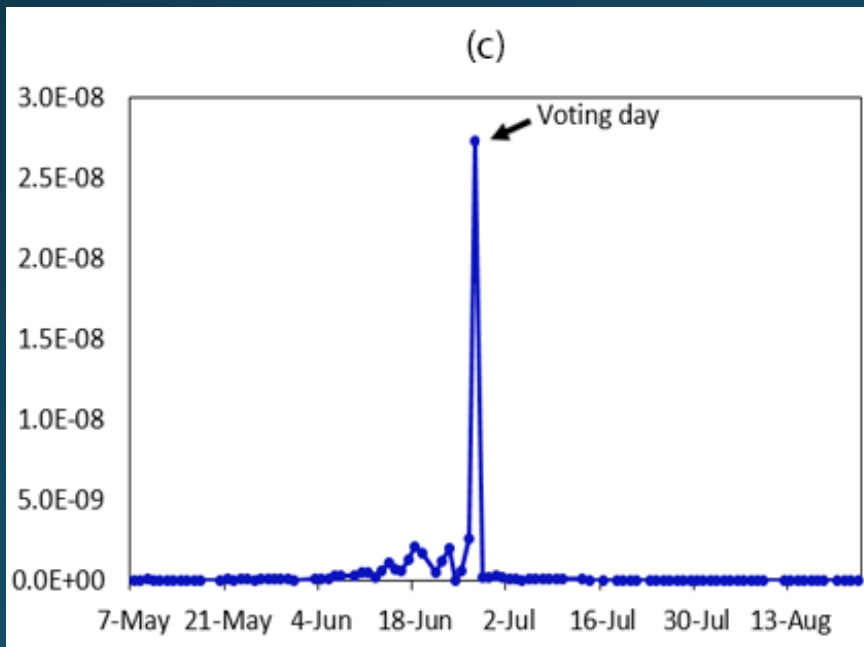
$\Omega = G_1 U$



# “Brexit” contention over time

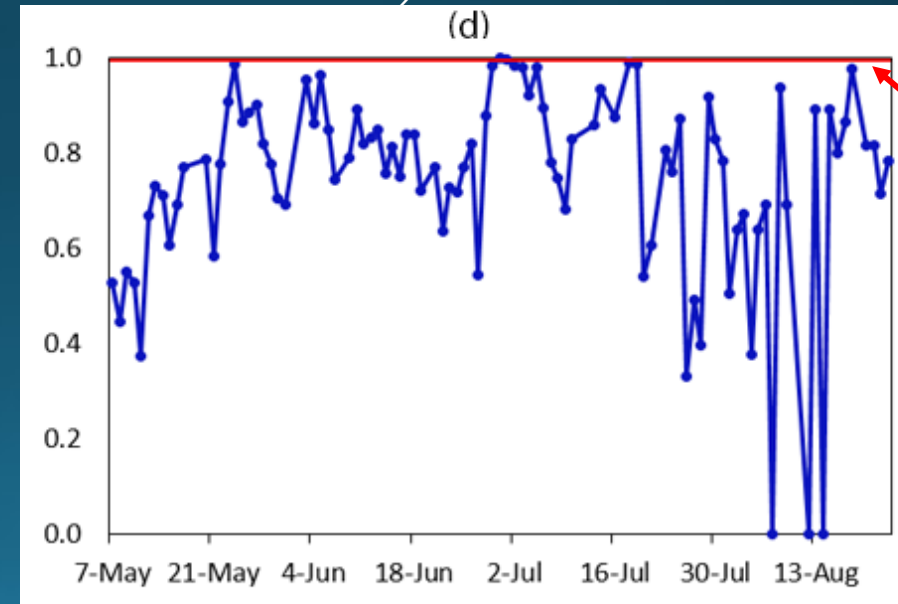
- 1.2M tweets from 604K users, May 7 to August 24, 2016

$\Omega = \text{all Twitter}$



$\Omega = G_1 U$

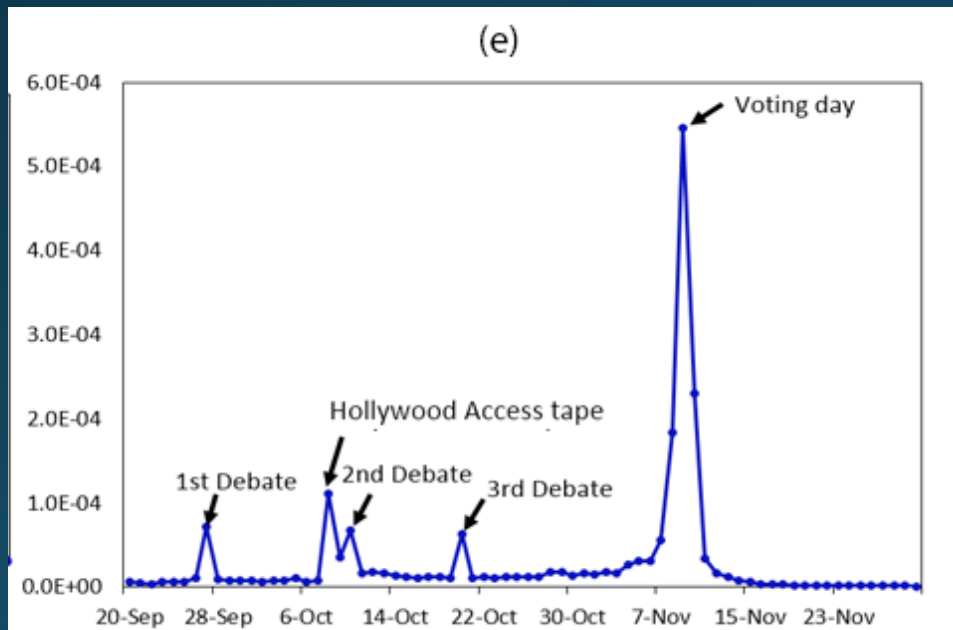
$G_2$



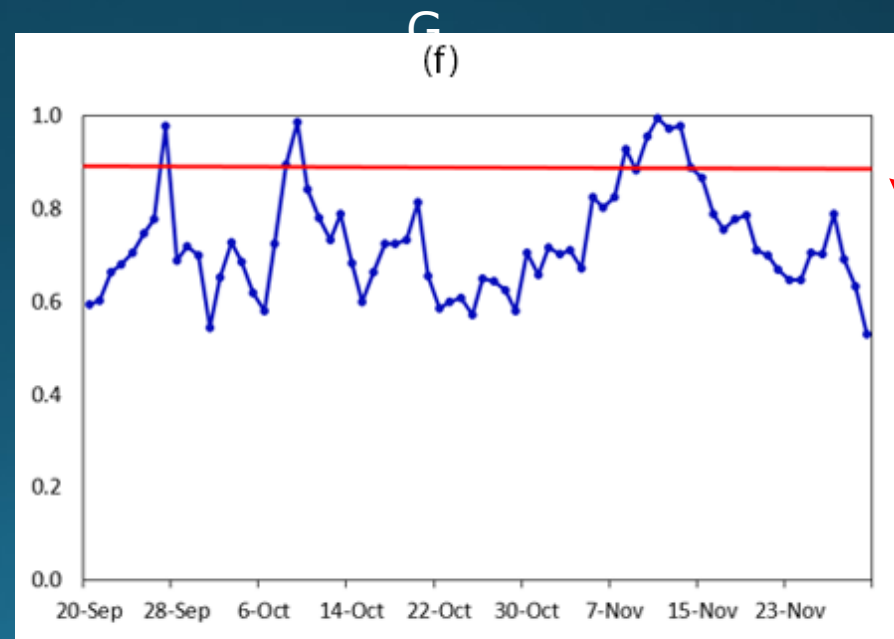
# U.S. election contention over time

- 87M tweets from 10M users, September 20 to November 30, 2016

$\Omega = \text{all Twitter}$



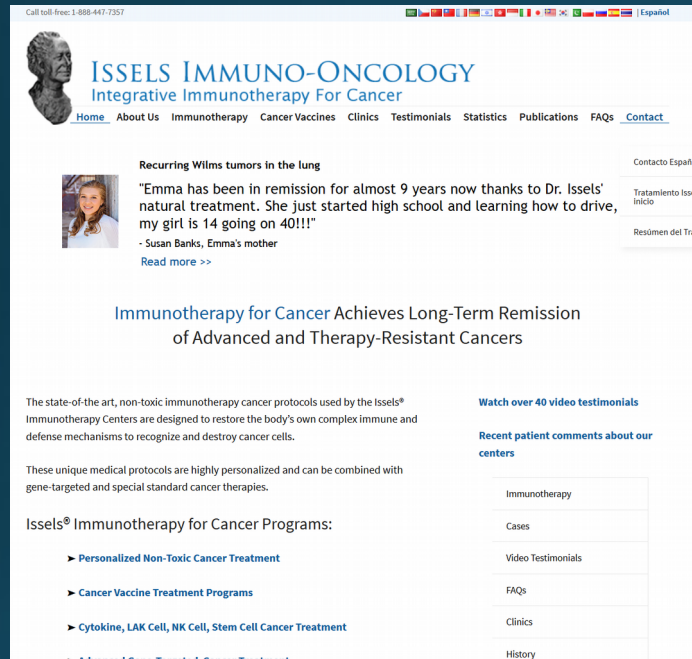
$\Omega = G_1 U$



# Modeling contention, summary

- Controversy has several dimensions
  - Importance, duration, conviction, polarity, ...
  - Focused on contention (disagreement) primarily
- Developed a model
- Showed it has explanatory power
  - Using poll data, where groups come from polling numbers
  - Using Twitter data, where groups come from those who tweet
  - Using Wikipedia edit data, where groups come from editors
- All that is nice, but...

# *This was the goal we started with*



??? →  $C = 0.8$

- Not on Twitter
  - Wikipedia article on topic is a stub
  - Probably not a poll question
  - Just have web site
- 
- But... suspect that “alterative” cancer therapies may be broadly described as contentious

# Could that be useful?

- Did some experiments within Wikipedia topics
  - Using some pages manually labeled for controversy
- Found that controversial topics are linked
- Found that similarity links exhibit same property
- Controversy exhibits “homophily”
  - In the same way that relevance does (cf. cluster hypothesis)
- (In Wikipedia, at least)

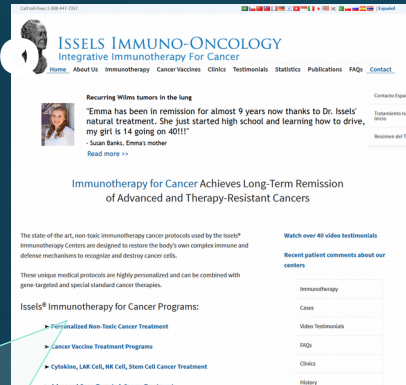


# Suggests a strategy

- To decide if a page is controversial (contentious)
- Find labeled instances that are similar to it
- Look at their contention labels
- Propagate label to starting page
- Find = search
- Labeled instances = Wikipedia, twitter, polls, ...

# kNN classification approach

Webpage to  
classify



Classification:  
Controversial

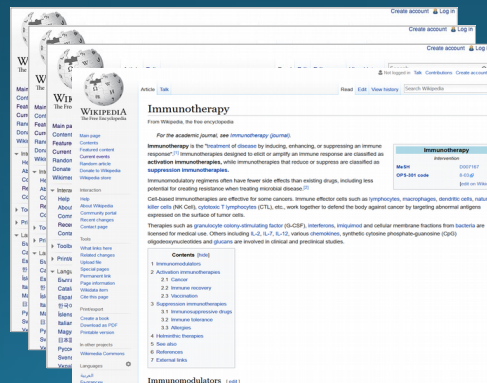
6.  
Vote

Controversial  
Noncontroversial  
Controversial

5.  
Threshold  
scores

1. Query Generation:  
cancer immunotherapy issels  
treatment cell patient advanced  
testimonials video lung

2. Query  
to  
Wikipedia



3.  
Score  
articles

0.0573  
0.0563  
0.973  
4  
C=0.8  
1171

# Experiments: data set

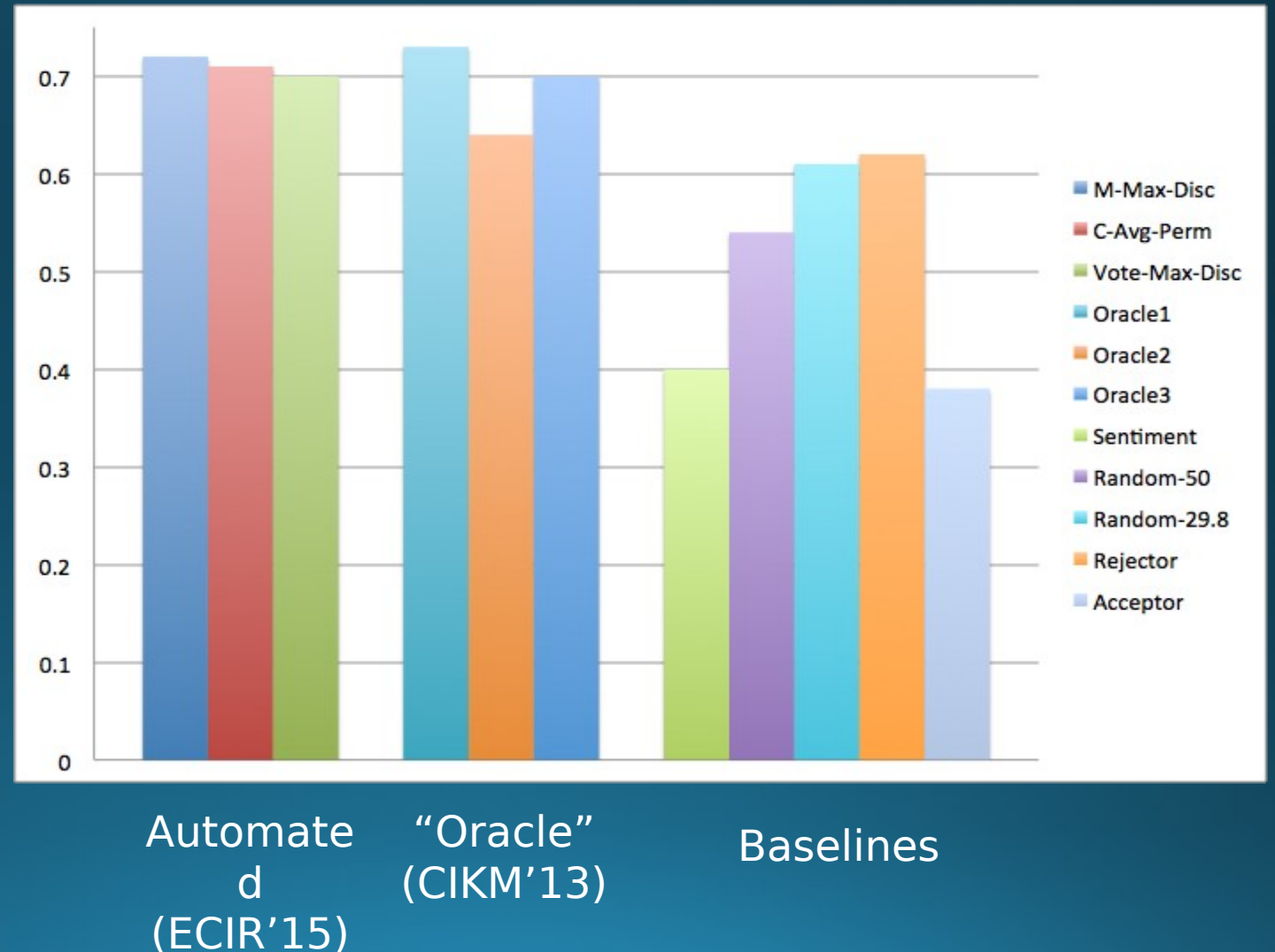
- Labeled small set of web pages
  - (Were more, but some were problematic so dropped here)
  - Selected to bias toward controversy
- Used a large set of Wikipedia articles as the labeled set
  - i.e., where the  $k$  NN's come from
  - Used automated scoring to label

Webpages		
Set	Pages	Controversial
Training	248	74 (29.8%)
Testing	129	49 (38.0%)

Wikipedia articles (labeled data)		
All Pages	Annotated	Controversial
8,755	1,761	282 (16.0%)

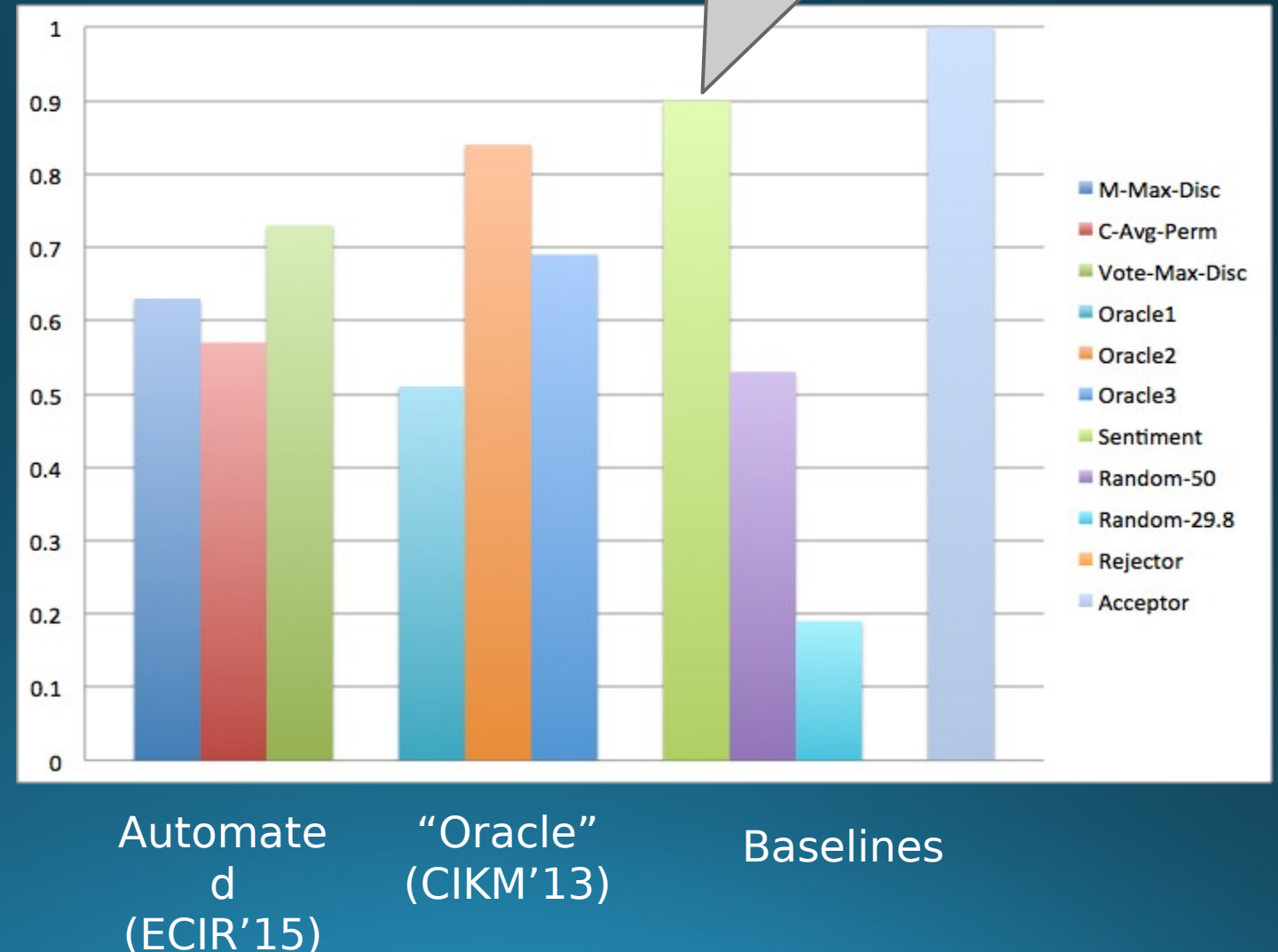
# Results, accuracy

- Generated labels work better than human annotations
  - More consistent
- Interesting baselines are not competitive



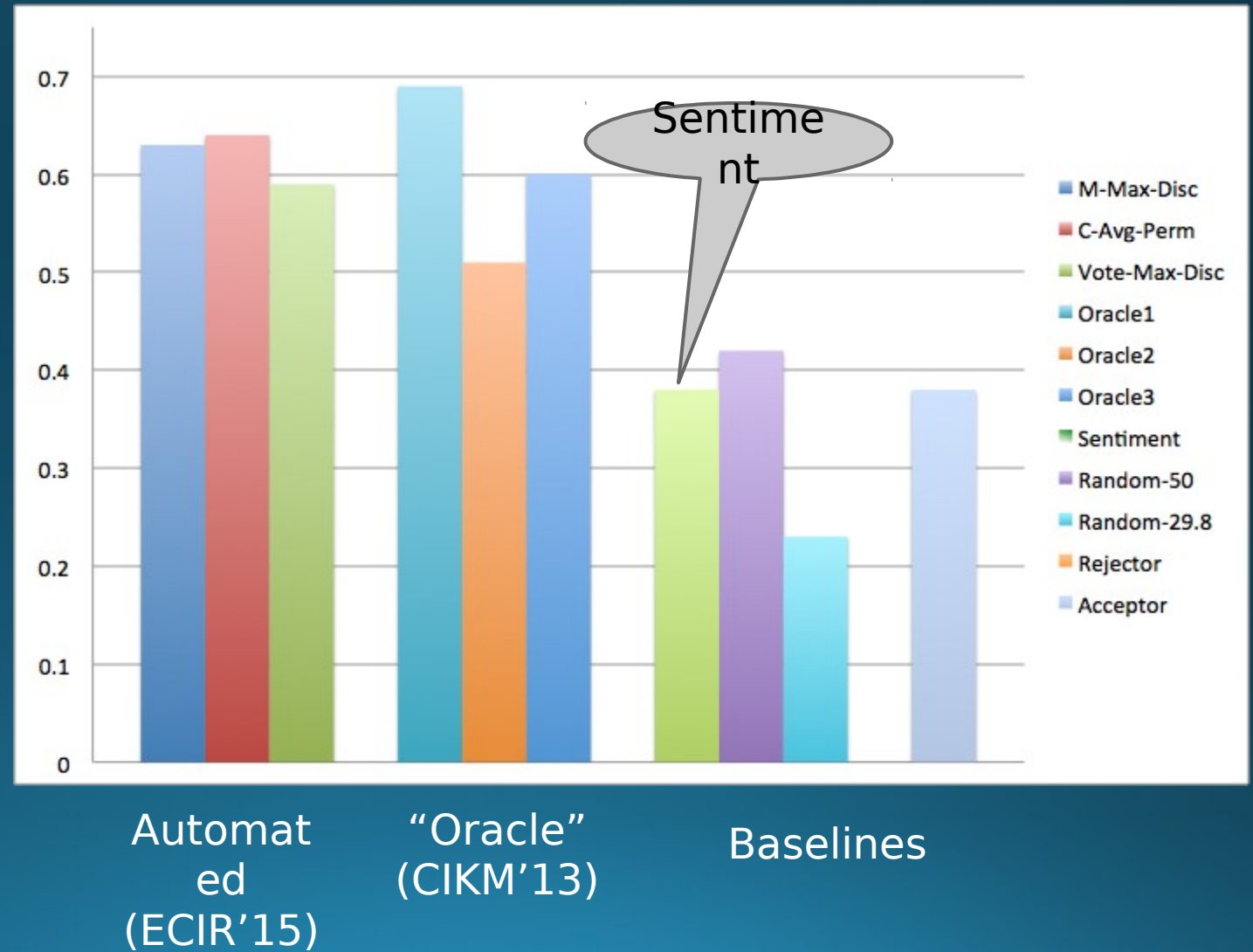
# Results, recall

- One human produced better recall
- Note very high recall for a sentiment based classifier



# Results, precision

- High-recall human had lower precision
- Automated labels fairly consistent here
- Baselines are poor precision



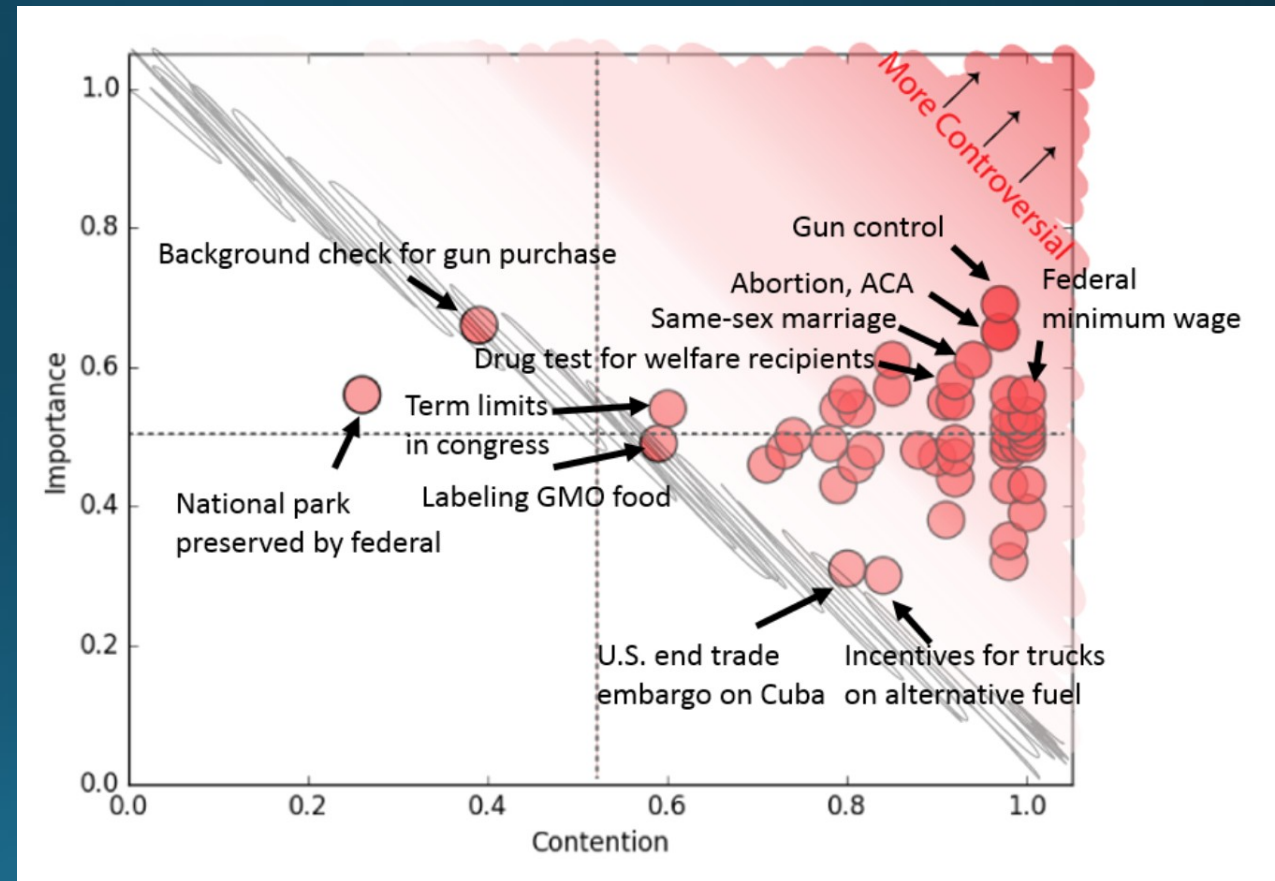


# Summary

- Controversy has several dimensions
- Developed a model and demonstrated explanatory power
- Claimed that contention / controversy “cluster”
  - There is empirical evidence, but it was only asserted
- Showed that a k-NN classifier works for this task
  - 60% precision at 70% recall

# Future: beyond contention

- Contention model is good and captures much of what we think of as “controversy”
- Capture “importance”?
  - Graph shows self-reported
  - Where would “the dress” be?
  - Proportion of population involved? Reporting in major media?
- Others: conviction, duration
- Speed of recognition, evolution
- Stance descriptions



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