

ClaimBuster:

The Quest to Automate Fact-Checking

Chengkai Li

Associate Professor, Department of Computer Science and Engineering

Director, Innovative Database and Information Systems Research (IDIR) Laboratory

University of Texas at Arlington

Duke University, Feb. 8th, 2016



Confession/Disclaimer



- The talk is fairly non-technical.
- I am not politically savvy.



“Stupidest Statistics” and “Goofy Combinations”



<http://n.pr/1nQtb8F>

How I Got into Computational Journalism



Chris Paul had 16 points, 10 rebounds, 13 assists and five steals..... The only other active player to have such a game is Jason Kidd...

2009



How did they come up with that?

How I Got into Computational Journalism

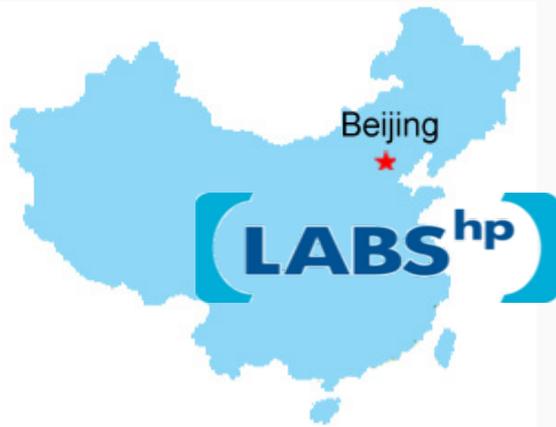


2010



I'm designing algorithms to find such facts.

It is a computational journalism problem.



#@%&!#!%

How I Got into Computational Journalism



2010-present

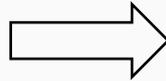
Collaboration between Duke, Google Research, Stanford, and UTA.
Collaboration with Chinese Academy of Sciences and HP Labs China.

- **Story-finding:** finding and monitoring number-based facts pertinent to real-world events. The facts are leads to news stories.
- **Fact-checking:** discovering and checking factual claims in political discourses, social media, and news.

Story-finding



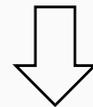
Finding and monitoring number-based facts pertinent to real-world events. The facts are leads to news stories.



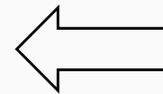
Real-world event (sports, transportation, crime, weather, finance, social media)

New tuple appended to database

id	player	day	month	season	team	opp_team	pts	ast	reb
t_1	Bogues	11	Feb.	1991-92	Hornets	Hawks	4	12	5
t_2	Seikaly	13	Feb.	1991-92	Heat	Hawks	24	5	15
t_3	Sherman	7	Dec.	1993-94	Celtics	Nets	13	13	5
t_4	Wesley	4	Feb.	1994-95	Celtics	Nets	2	5	2
t_5	Wesley	5	Feb.	1994-95	Celtics	Timberwolves	3	5	3
t_6	Strickland	3	Jan	1995-96	Blazers	Celtics	27	18	8
t_7	Wesley	25	Feb.	1995-96	Celtics	Nets	12	13	5



Find facts



Wesley had 12 points, 13 assists and 5 rebounds on February 25, 1996 to become the first player with a 12/13/5 (points/assists/rebounds) in February.

Generate factual claim

Story-finding

Many interesting facts in the real-world can be modeled as **skyline points**.

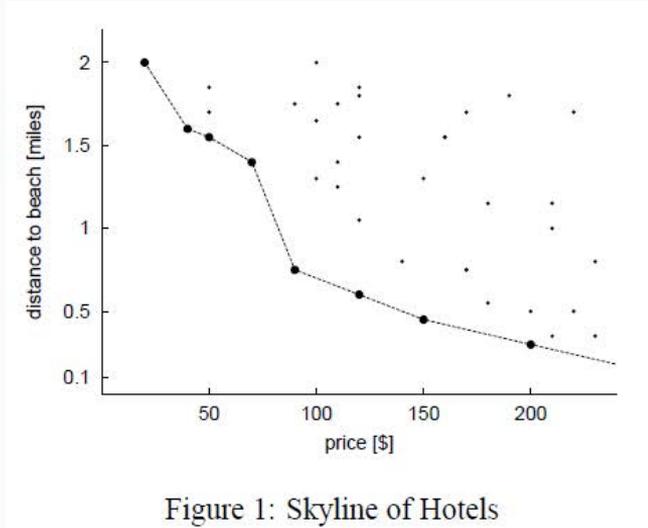


Figure 1: Skyline of Hotels



Figure 2: Skyline of Manhattan

Stephan Börzsönyi, Donald Kossmann, Konrad Stocker: The Skyline Operator. ICDE 2001: 421-430

Story-finding: Prominent Streaks



Long consecutive subsequence of high values in a sequence

- “This month the Chinese capital has experienced **10 days** with a maximum temperature in around **35 degrees** Celsius – the most for the month of July in a decade.” http://www.chinadaily.com.cn/china/2010-07/27/content_11055675.htm
- “The Nikkei 225 closed **below 10000** for the **12th consecutive week**, the longest such streak since June 2009.”
<http://www.bloomberg.com/news/articles/2010-08-06/japanese-stocks-fall-for-second-day-this-week-on-u-s-jobless-claims-yen>

Prominent Streak Discovery in Sequence Data. Xiao Jiang, Chengkai Li, Ping Luo, Min Wang, Yong Yu. KDD 2011, pages 1280-1288.

Discovering General Prominent Streaks in Sequence Data. Gensheng Zhang, Xiao Jiang, Ping Luo, Min Wang, Chengkai Li. ACM TKDD, 8(2):article 9, June 2014.

Story-finding: One-of-the-few Objects



Qualifying statements that can only be made for very few objects

- Chris Paul had 16 points, 10 rebounds, 13 assists and five steals The only other active player to have such a game is Jason Kidd. <http://espn.go.com/espn/elias?date=20080407>

On "One of the Few" Objects. You Wu, Pankaj K. Agarwal, Chengkai Li, Jun Yang, Cong Yu. KDD 2012, pages 1487-1495.

Story-finding: Situational Facts



Comparison contexts and spaces that make a given object stand out

- “The social world’s **most viral photo** ever generated **3.5 million likes, 170,000 comments and 460,000 shares** by Wednesday afternoon.”

<http://www.cnn.com/id/49728455>

Incremental Discovery of Prominent Situational Facts. Afroza Sultana, Naeemul Hassan, Chengkai Li, Jun Yang, Cong Yu. ICDE 2014, pages 112-123.

FactWatcher

idir.uta.edu/factwatcher

»LIVE UPDATE
[February 20, 1998] **Todd Fuller** had 1 assist, 3 steals and 1 block in the Golden State Warriors' defeat against the Denver Nuggets.

SEARCH

- Michael Adonis Jordan
- Michael Jordan**
- Michael Michael Jordan
- Michael Reggie Jordan
- Michael Thomas Jordan

4

3

1

2

1

5

3

2

MORE LIKE THIS

FACT TYPE

- SITUATIONAL FACT
- PROMINENT STREAK
- ONE-OF-THE-FEW

RANKING

- RECENTNESS
- INTERESTINGNESS
- POPULARITY

PLAYERS

TEAMS

SEASONS

- 1996-97 (9)
- 1994-95 (5)
- 1992-93 (1)
- +MORE
- LESS-

<https://vimeo.com/154356599>



Excellent Demo Award



Data In, Fact Out: Automated Monitoring of Facts by FactWatcher. Naeemul Hassan, Afroza Sultana, You Wu, Gensheng Zhang, Chengkai Li, Jun Yang, and Cong Yu. VLDB 2014, pages 1557-1560.
Demonstration description.

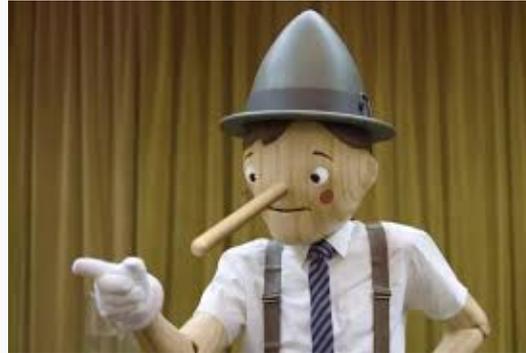
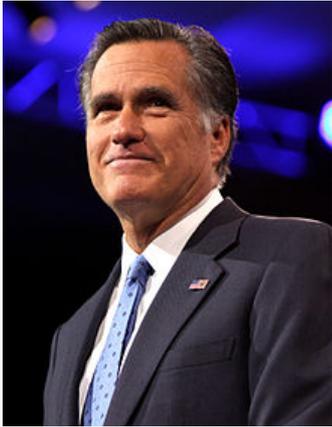


Fact-checking

People Make Claims All the Time



“... our Navy is smaller than it's been since 1917”, said Republican candidate Mitt Romney in third presidential debate in 2012.



http://en.wikipedia.org/wiki/Mitt_Romney

<http://www.thebrainchildgroup.com/>

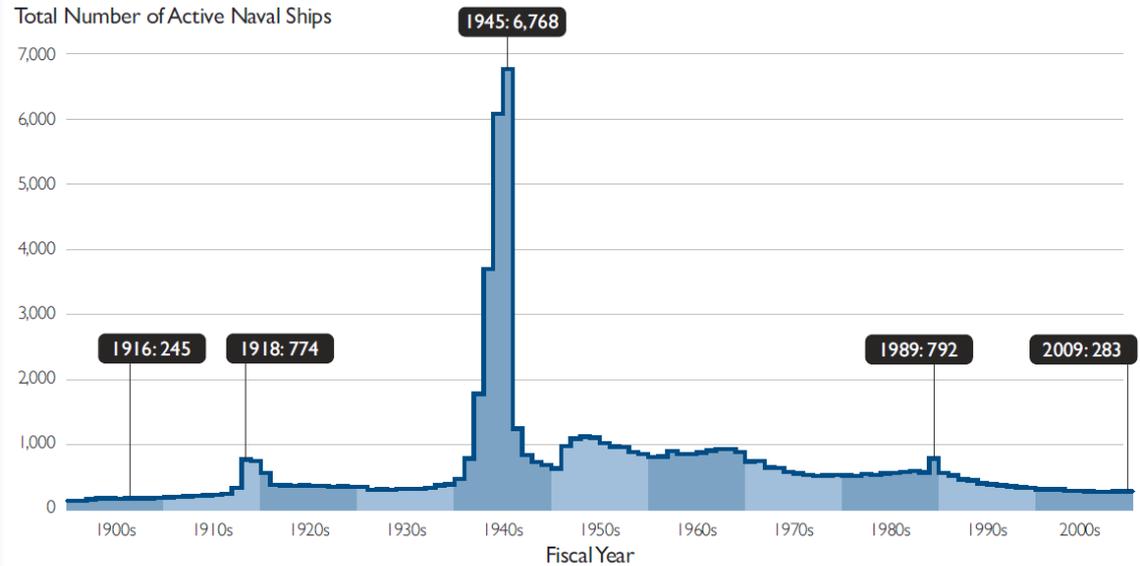
Fact-checking is not Easy



“... our Navy is smaller than it's been since 1917”, said Republican candidate Mitt Romney in third presidential debate in 2012.



U.S. Navy Has Smallest Number of Ships Since 1916



Source: U.S. Navy, Active Ship Force Levels, 2009, at <http://www.history.navy.mil/branches/org9-4.htm> (December 6, 2009).

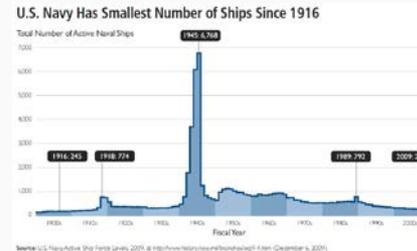
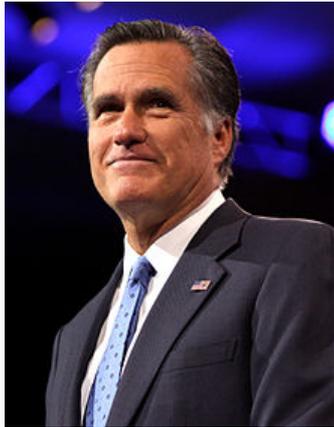
http://en.wikipedia.org/wiki/Mitt_Romney

http://s3.amazonaws.com/thf_media/2010/pdf/Military_chartbook.pdf

Fact-checking is not Easy



“... our Navy is smaller than it's been since 1917”, said Republican candidate Mitt Romney in third presidential debate in 2012.



VS



http://en.wikipedia.org/wiki/Mitt_Romney

http://s3.amazonaws.com/thf_media/2010/pdf/Military_chartbook.pdf

http://en.wikipedia.org/wiki/United_States_Navy

Existing Fact-checking Platforms



Journalists and reporters spend good amount of time on fact checking



The U.S. military is at risk of losing its "military superiority" because "our Navy is smaller than it's been since 1917. Our Air Force is smaller and older than any time since 1947."

— *Mitt Romney on Monday, January 16th, 2012 in a Republican presidential debate in Myrtle Beach, S.C.*



64 active fact-checking sites in 2015 (PolitiFact .com, FactCheckEU.org, FullFact.or , Factcheck .org CNN, Washington Post , New York Times, Poynter, American Press Institute, ...)

<http://reporterslab.org/snapshot-of-fact-checking-around-the-world-july-2015/>

Fact-Checking is Time-Consuming and Resource-Demanding



- Journalists spend hours going through documents to identify claims.
- Research on factual claims can take days (finding data sources, finding experts).
- Long gap from when a claim is made to when it is checked

“Total Physical and Mental Collapse”



☰ THE NEW YORKER 🔍


BOROWITZ REPORT
JANUARY 16, 2016

FACT CHECKER AT REPUBLICAN DEBATE HOSPITALIZED FOR EXHAUSTION

BY ANDY BOROWITZ



PolitiFact “Buffet” of Factual Claims



	A	B	C	D	E
1	Statement	Speaker	Date	Location/Source	Link
232	I haven't heard one (republican) say that they're in	o'malley	4/20/2015	morning edition	http://www.npr.org/blogs/its
233	concentrated wealth and capital have been put into	o'malley	4/20/2015	morning edition	http://www.npr.org/blogs/its
234	it is not true that regulation holds poor people down or	o'malley	4/20/2015	morning edition	http://www.npr.org/blogs/its
235	Every three weeks we bring online as much as solar	Obama	4/18/2015	Weekly address	https://www.whitehouse.gov
236	Our carbon pollution has fallen by 10 percent since	Obama	4/19/2015	Weekly address	https://www.whitehouse.gov
237	"Benghazi has had more hearings, more documents	Claire McCaskill	4/19/2015	ABC this week	http://thehill.com/policy/inte
238	With fast track trade " I would be receiving the same	Obama	4/17/2015	remarks joint press	https://www.whitehouse.gov
239	Loretta Lynch "has been now sitting there longer than	Obama	4/17/2015	remarks joint press	https://www.whitehouse.gov
240	I just counted 19 Republicans who are likely to run for	chris cillizza	4/20/2015	the twitters	https://twitter.com/TheFix/st
241	He [Rand Paul] wanted to cut all our defense	John McCain	4/20/2015	Fox News	https://www.youtube.com/w

2014 This is what they eat at PolitiFact.



Let me work on its automation.



CLAIMBUSTER

The Quest to Automate Fact-Checking

ClaimBuster for 2016



2016
Presidential
Debates

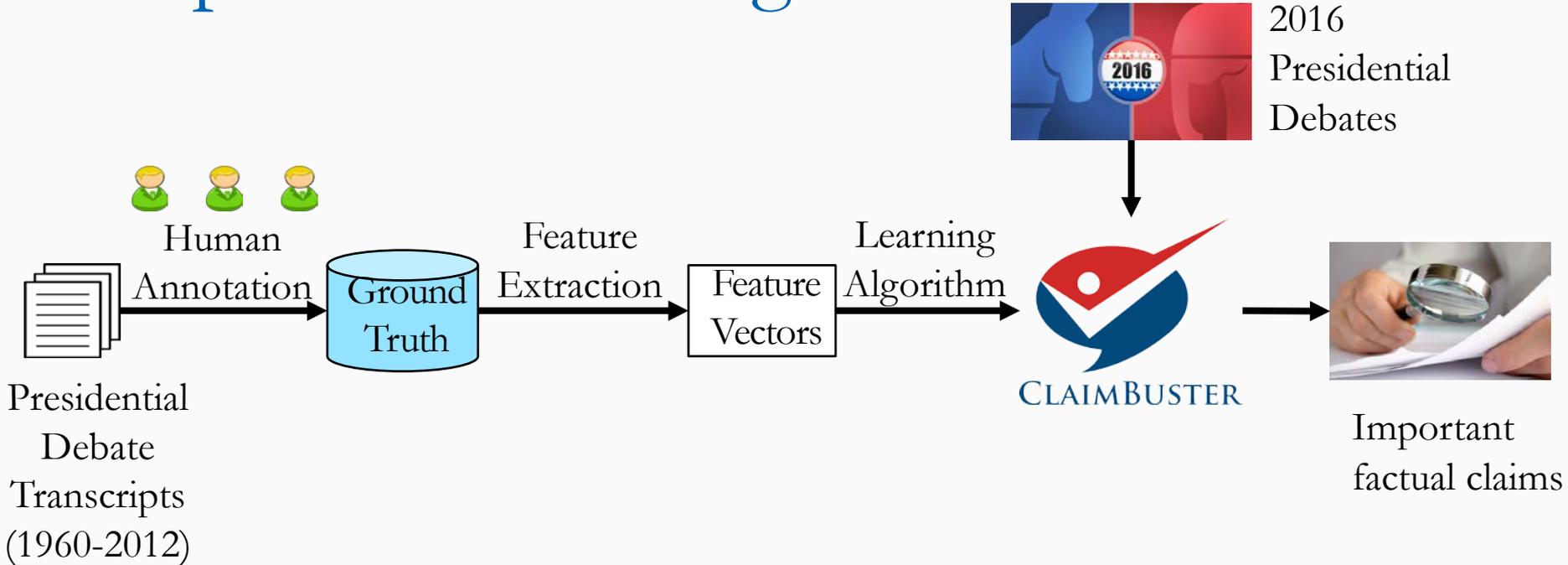


Factual claims
recommended
for checking



Journalists
investigate
the claims

Finding Important Factual Claims: A Supervised Learning Task



Dataset: Presidential Debate Transcripts

- Source: <http://www.debates.org/index.php?page=debate-transcripts>
- All 30 debates (11 general elections) in history: 1960, 1976—2012
- 20k sentences by presidential candidates: removed very short (< 5 words) sentences

3 Classes of Sentences



CFS: Important factual claims

“We spend less on the military today than at any time in our history.” “The President’s position on gay marriage has changed.” “More people are unemployed today than four years ago.”

UFS: Unimportant factual claims

“I was in Iowa yesterday.” “My mother enjoys cooking.” “I ran for President once before.”

NFS: No factual claims (just opinions, questions & declarations)

“Iran must not get nuclear weapons.” “7% unemployment is too high.” “My opponent is wishy-washy.” “I will be tough on crime.” “Why should we do that?” “Hello, New Hampshire!” “Our plan is to reduce tax rate by 10%.”



3 Classes of Sentences

If a sentence contains an opinion and an important factual claim, it shouldn't be labelled “No factual claims”.

“Unemployment rate is too high and in last four years it increased from 8% to 10%.”

Ranking and Classification Problems

Classification

Given a future sentence, find the class it belongs to.

Ranking

Rank sentences based on how likely they contain important factual claims.

Ground Truth Collection Website



OI: Wages are going up for the first time in a decade.

[More Context](#)

Will the general public be interested in knowing whether (part of) this sentence is true or false?

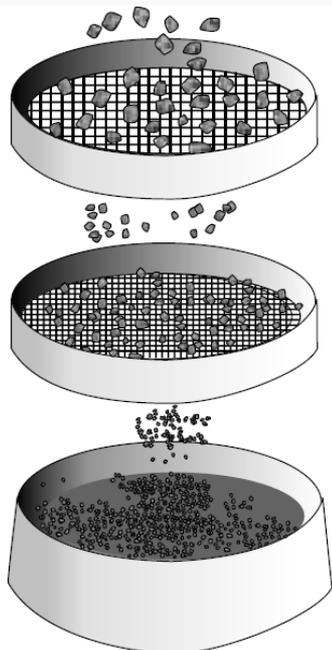
- There is **no** factual claim in this sentence.
- There is a factual claim but it is **unimportant**
- There is an **important** factual claim.

Submit

Skip this sentence

[Modify My Previous Responses](#)

Ground Truth Collection



329 coders

51925 labels

53 top-quality coders

26853 labels

53 top-quality coders

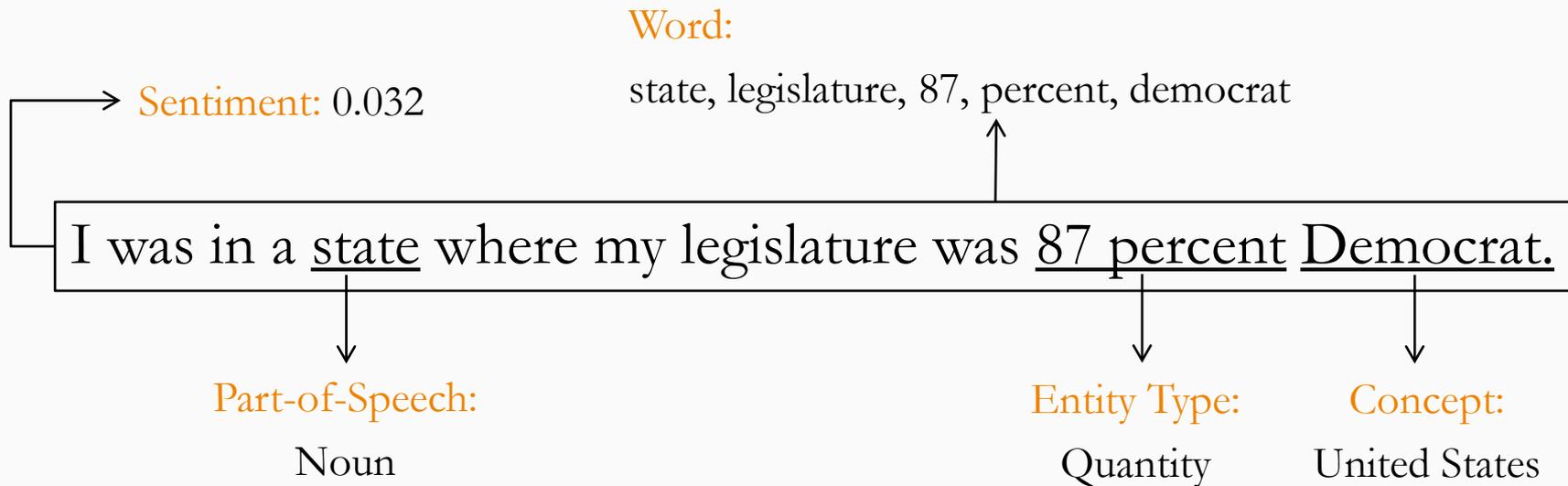
14652 labels in agreement

7326 admitted sentences

- 10 months (in 3 stages)
- ~\$3,000 paid
- 1032 screening sentences (by 3 experts) to detect spammers & low-quality coders

Class	Count
CFS	1561
UFS	418
NFS	5347

Feature Extraction



Sentiment: [-1.0 to 1.0]

Word: tf-idf scores of 6130 words (excluding rare words)

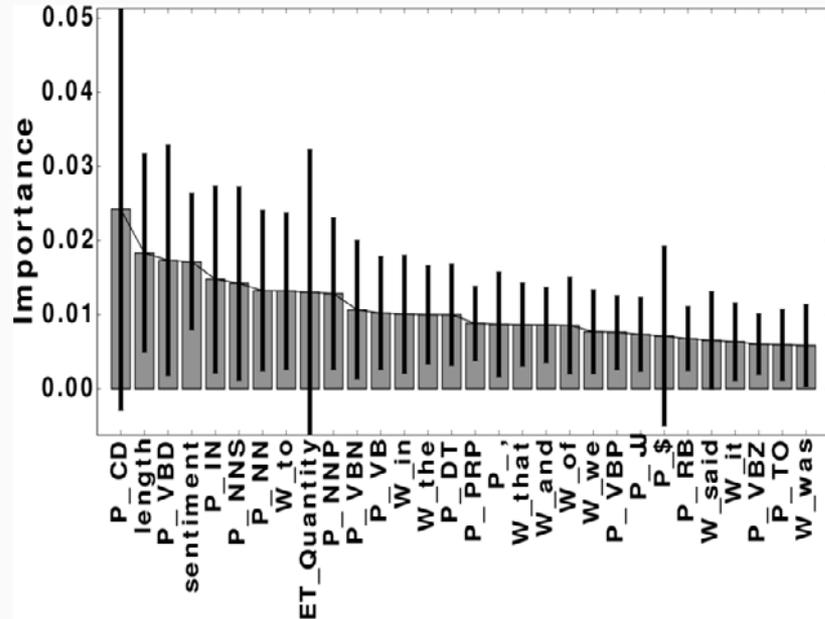
POS Tag: 43 tags

Entity Type: 26 types



Feature Importance

- 6201 features in total
- Used a Random Forest Classifier to calculate the importance of each feature.



Word	percent; people; jobs
POS Tag	noun; cardinal number; past tense; preposition
Entity Type	Quantity; Country; FieldTerminology; Person
Concept	United States Senate; Barack Obama
Sentiment	

Evaluation: Classification



- 4-fold cross validation
- Methods: Naive Bayes (NBC), Random Forest (RFC), Support Vector Machine (SVM)
- In general, SVM, using Word + POS, performed better than other combinations.

	Precision	Recall	F-measure
NFS	0.90	0.96	0.93
UFS	0.65	0.26	0.37
CFS	0.79	0.74	0.77

Evaluation: Ranking



- NBC, RFC, SVM all allow ranking.
- Accuracy of top-K sentences ranked by ClaimBuster, using the admitted sentences from top-coders as ground truth.
- ClaimBuster has a strong agreement with top-quality human coders on the check-worthiness of sentences.

K	P@K	NDCG@K
25	1	1
50	1	1
100	0.960	0.970
200	0.940	0.951
300	0.853	0.881
500	0.690	0.840

Case Study: Republican/Democratic Primary Debates in 2015



CNN Claim	Associated sentence(s) [From TextGrabber]	Score
1	Part of this iranian deal was lifting the international sanctions on general sulemani.	0.415
2	I would go on to add – >> you don't favor – >> i have never said that.	0.511
3	A majority of the candidates on this stage supported amnesty.	0.295
4	Timely the medicaid is growing at one of the lowest rates in the country.	0.534
4	We went from \$8 billion in the hole to \$5 million in the black.	0.773
5	And the mexican government is much smarter, much sharper, much more cunning and they send the bad ones over because they don't want to pay for them.	0.215
6	[Not found in the transcript]	N/A

Case Study: Republican/Democratic Primary Debates 2015-2016



For all debates, significant differences between ClaimBuster scores on Group 1 (sentences checked by professionals) and Group 2 (the rest)

Gop_2015_10_28_6PM_MT				
SOURCE	AVG(YES)	AVG(NO)	t-value	p-value
CNN	0.4930249153	0.2597790063	6.047489098	1.80E-09
PolitiFact	0.5325469223	0.2600943917	6.457431538	1.38E-10
Factcheck	0.5623478292	0.2600979023	6.429287356	1.66E-10
WashingtonPost	0.5341234143	0.2596289087	6.192084234	7.40E-10

Case Study: Republican/Democratic Primary Debates in 2015

- Ranked all 1393 sentences from the Aug. 6th debate
- Used the 59 claims in PolitiFact “buffet” as the ground truth

K	P@K	NDCG@K
10	0.4	0.441
20	0.45	0.456
30	0.367	0.401
40	0.325	0.368
50	0.3	0.346

More Details

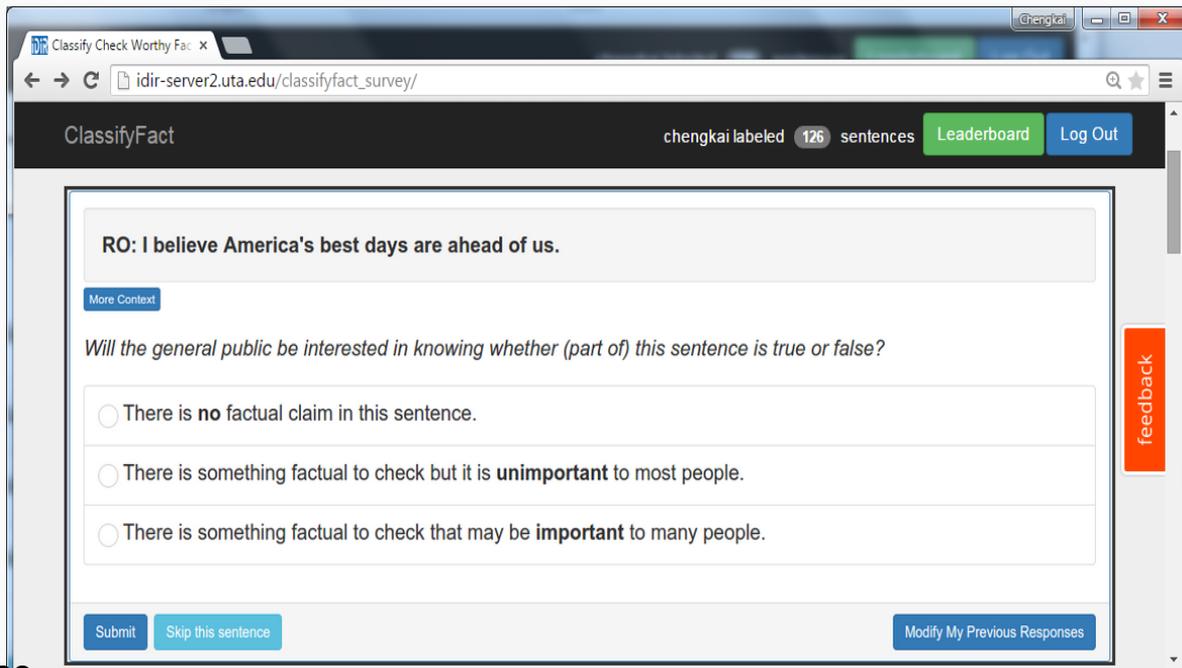


- [Detecting Check-worthy Factual Claims in Presidential Debates](#). Naeemul Hassan, Chengkai Li, Mark Tremayne. CIKM 2015, pages 1835-1838.
- [The Quest to Automate Fact-Checking](#). Naeemul Hassan, Bill Adair, James Hamilton, Chengkai Li, Mark Tremayne, Jun Yang and Cong Yu. 2015 Computation+Journalism Symposium.

You are Invited to Contribute



<http://bit.ly/claimbusters>



Live Coverage of Debates



- Extracted closed captions of debates on broadcast TV channels using TextGrabber
- Finding speaker identity using Twitter
- Tweeted important factual claims to <https://twitter.com/ClaimBusterTM>, live!



Claims Tweeted



Tweets [Follow](#)

 **ClaimBuster** 14 Nov
@ClaimBusterTM
(1/2) [#PolitiFactThis](#) [BERNIE SANDERS?]
We have the highest rate of childhood poverty, and we're the only country in the world --

 **ClaimBuster** 14 Nov
@ClaimBusterTM
(2/2) [#PolitiFactThis](#) virtually the only country that doesn't guarantee paid family and medical leave.

 **ClaimBuster** 14 Nov
@ClaimBusterTM
(1/2) [#PolitiFactThis](#) It wasn't the bill that I wanted, but yet it turned out to be one of the more significant pieces of





Demo

<http://idir.uta.edu/claimbuster>

ClaimBuster Press Acknowledgement

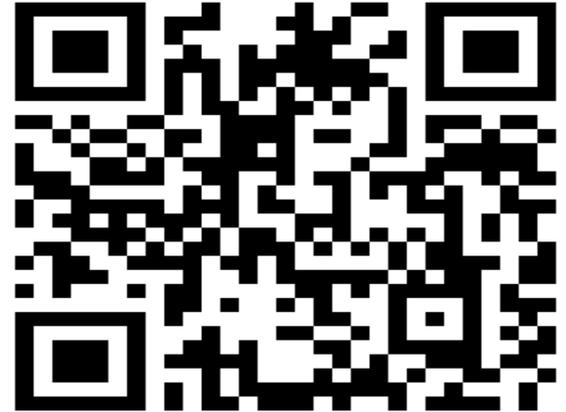
2016 Republican Party Presidential Debate. Sept. 16, 2015, 7 p.m.
 Venue: Ronald Reagan Presidential Library, Simi Valley, California. Broadcasted by: CNN.
 Speakers: Dana Bash, Jeb Bush, Ben Carson, Chris Christie, Ted Cruz, Carly Fiorina, Hugh Hewitt, Mike Huckabee, John Kasich, Rand Paul, Marco Rubio, Jake Tapper, Donald Trump, Scott Walker
 Transcript Source: <http://time.com/4037239/second-republican-debate-transcript-cnn/>

Chronological Order **Order by Score** Most Check-worthy 0.85 < 0.8 < 0.75 < 0.7 < 0.65 < 0.6 < 0.55 < 0.5 < 0.45 < 0.4 < 0.35 < 0.3 < 0.2 < 0.1 Least Check-worthy

0.45 The eleven leading Republican candidates for president are at their podiums.
 0.17 They are ready to face off, and if you've been watching this race, you know anything could happen over the next few hours.
 0.43 To viewers who are just joining us, welcome to the Air Force One Pavilion of the Ronald Reagan Presidential Library.
 0.29 Our thanks to the staff here and especially to former first lady Nancy Reagan for this impressive setting with Ronald Reagan's presidential plane as our backdrop.
 0.23 This debate is airing on CNN networks in the United States and around the world.
 0.30 It's also being broadcast on the Salem Radio Network.
 0.17 I know everyone is very eager to get started.
 0.23 But first, I want to explain the ground rules tonight.
 0.19 My name is Jake Tapper.
 0.19 I'll be the moderator.
 0.24 I will be joined in the questioning by Salem Radio Network talk show host Hugh Hewitt.
 0.44 He worked in the Reagan administration for six years.
 0.22 And by CNN's chief political correspondent Dana Bash.
 0.16 I will ask follow-up questions, I will attempt to guide the discussion.

Second 2016 GOP President...

0.24 Do they bear responsibility for this refugee crisis, and what would you have done when Bashar Assad crossed the line?





Fact-check your own text



2016 Democratic Party Presidential Debate. Jan. 17, 2016, 9 p.m. ET

Participants: Hillary Clinton, Bernard Sanders, Martin O'Malley
Moderators: Lester Holt, Andrea Mitchell



2016 Republican Party Presidential Debate. Jan. 14, 2016, 9 p.m. ET

Participants: Ted Cruz, John Kasich, Chris Christie, Jeb Bush, Marco Rubio, Ben Carson, Donald Trump
Moderators: Neil Cavuto, Maria Bartiromo



2016 Democratic Party Presidential Debate. Dec. 19, 2015, 8 p.m. ET

Participants: Hillary Clinton, Martin O'Malley, Bernard Sanders
Moderators: David Muir, Martha Raddatz, Josh McElveen



2016 Republican Party Presidential Debate. Dec. 15, 2015, 9 p.m. ET

Participants: Rand Paul, John Kasich, Chris Christie, Carly Fiorina, Jeb Bush, Marco Rubio, Ted Cruz, Ben Carson, Donald Trump
Moderators: Wolf Blitzer, Hugh Hewitt, Dana Bash



2016 Democratic Party Presidential Debate. Nov. 14, 2015, 8 p.m. CST

Tweets

Follow



Donna Brazile
@donnabrazile

6 Feb

More jobs created under President Obama in 12 months than 12 years under GOP presidents. That's a fact.

#GOPDebate twitter.com/steveattner/s...

Retweeted by ClaimBuster

Expand



ClaimBuster
@ClaimBusterTM

6 Feb

(3/3)#GOPDebate new hampshire, here again are david muir and martha raddatz.



ClaimBuster
@ClaimBusterTM

6 Feb

#GOPDebate 50 million is not going to do exactly what hillary clinton wants to have done, has advocated for.

Tweet to @ClaimBusterTM

2016 Republican Party Presidential Debate. Sept. 16, 2015, 7 p.m.

Venue: Ronald Reagan Presidential Library, Simi Valley, California. Broadcasted by: CNN.

Speakers: Dana Bash, Jeb Bush, Ben Carson, Chris Christie, Ted Cruz, Carly Fiorina, Hugh Hewitt, Mike Huckabee, John Kasich, Rand Paul, Marco Rubio, Jake Tapper, Donald Trump, Scott Walker

Transcript Source: <http://time.com/4037239/second-republican-debate-transcript-cnn/>

Most Check-worthy ≤1.0 ≤0.9 ≤0.8 ≤0.7 ≤0.6 ≤0.5 ≤0.4 ≤0.3 ≤0.2 ≤0.1 Least Check-worthy

Chronological Order

Order by Score

0.24 That's a fact.

0.33 And when the people of Iowa found that out, I went to No.

0.46 1 and you went down the tubes.

0.29 Governor Walker?

0.13 Jake, yeah, absolutely, I'll take this on, because this is an issue that's important in this race.

0.31 Just because he says it doesn't make it true.

0.19 The facts are the facts.

0.75 We balanced a \$3.6 billion budget deficit, we did it by cutting taxes - \$4.7 billion to help working families, family farmers, small business owners and senior citizens.

0.23 And it's about time people in America stand up and take note of this.

0.30 If you want someone that can actually take on the special interest of Washington, which you yourself said you were part of, using the system, we need somebody that will stand up and fight for average Americans to put them back in charge of their government.

0.16 I'm the one who is taking that on.

0.23 I'll do that as your next president.

0.17 Let's move on.

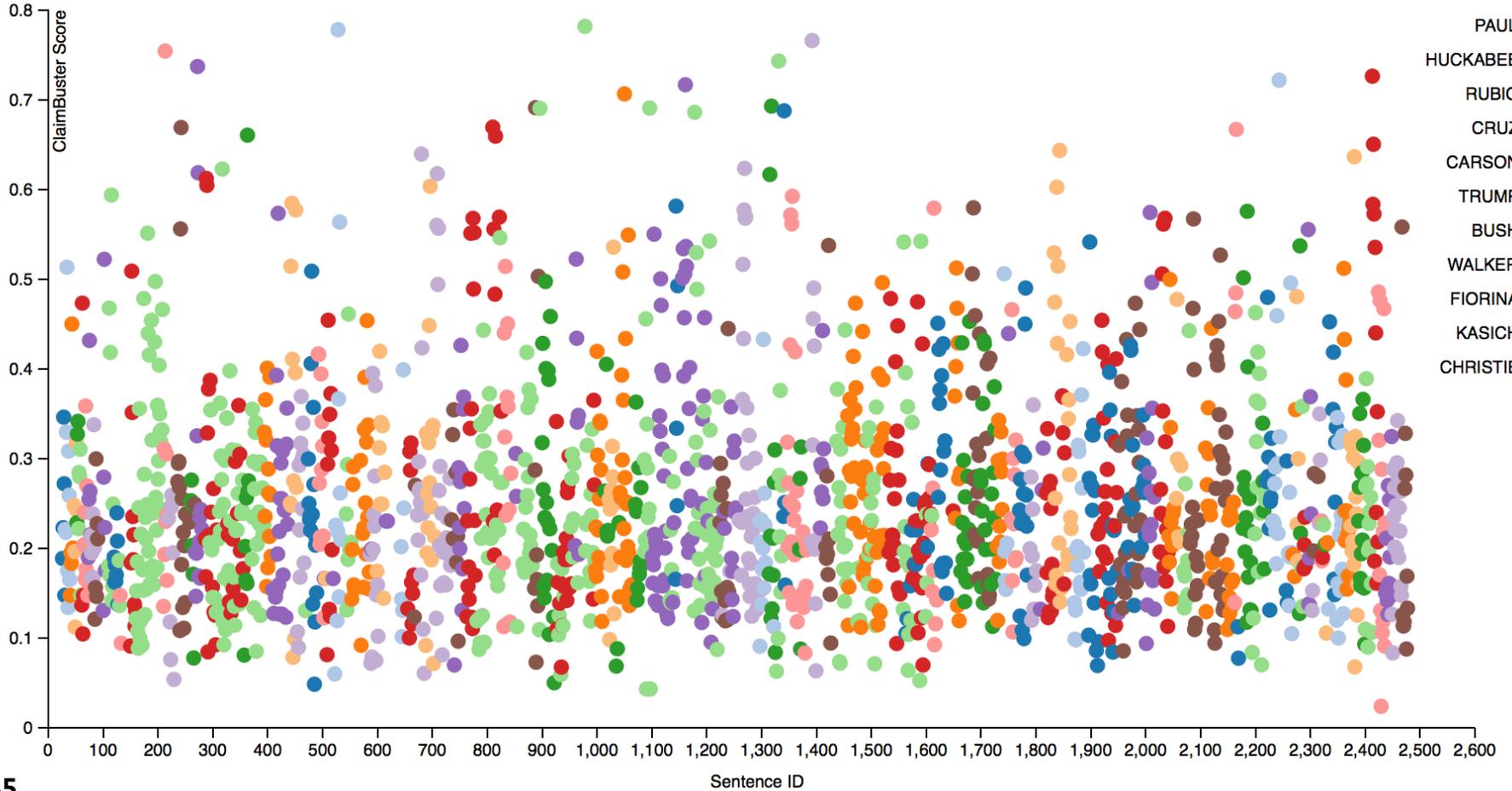
0.23 Jake, Jake.

0.13 A phenomenon going on in the race right now is the political...

4.4 OK, Governor Kasich, go ahead.



Debate Timeline Graph



Retweeting Claims in Tweets



Tweets Follow

 **ModerateEdge** 3m
@ModerateEdge
[@realDonaldTrump](#) If you make \$25,001, should you pay \$2,500 when \$25,000 you pay nothing? Pay only on amt over \$25K.
[#Trump2016](#) [#DonaldTrump](#)
Retweeted by ClaimBuster
Expand

 **BicycleBrandsDirect** 9m
@bicyclebrands
1.3 million bicycles recalled for crash hazard: (KMSB) - Nearly 1.3 million bicycles in the United States are ...
bit.ly/1MGT2HO
Retweeted by ClaimBuster
Expand

 **Rich Luchette** 19m
@richluchette
\$272 million project, more than 3,000 jobs

Tweet to @ClaimBusterTM

Retweeting Claims in Tweets



Tweets from Twitter API

(50,287,283)



Unique tweets

(26,726,483)



Scores > 0.75

(49,509)



After removing duplicates and junk

(18,266)



Political tweets

(~9,000)

August 1st to October 31st, 2015

Query:

- Keywords: 400 unigram/bigram/trigram from 30 debates
- Twitter accounts: 220 accounts from 10 lists of politicians, government offices, organizations, ...

Media Coverage



NOV
03
2015

MEDIA INNOVATION

20 ideas receive support from
Knight Prototype Fund for media
and information projects

SHARE



Commercialization





CLAIMBUSTER

The Quest to Automate Fact-Checking



The Holy Grail: Automated, Live Fact-Checking





The Holy Grail



Source: Bill Adair 

The Holy Grail



Source: Bill Adair

The Holy Grail



Source: Bill Adair

A Partial Mock Interface



0.53

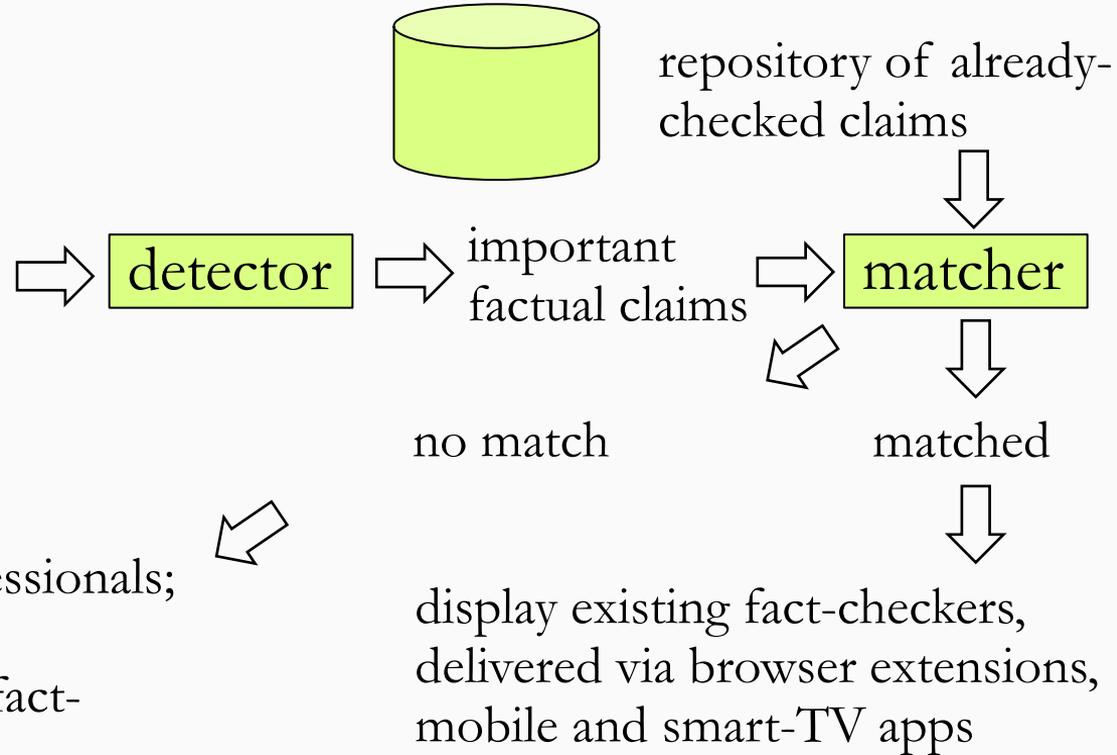
In fact, today, on the front page of the Wall Street Journal, they fired another 25 or 30,000 people saying we still haven't recovered from the catastrophe.

©2015-2016 The University of Texas at Arlington. All rights reserved.

ClaimBuster



- live events (debates, interviews, congressional debates) and ads on TV and online video streams
- social media (e.g., twitter)
- web pages
- news articles

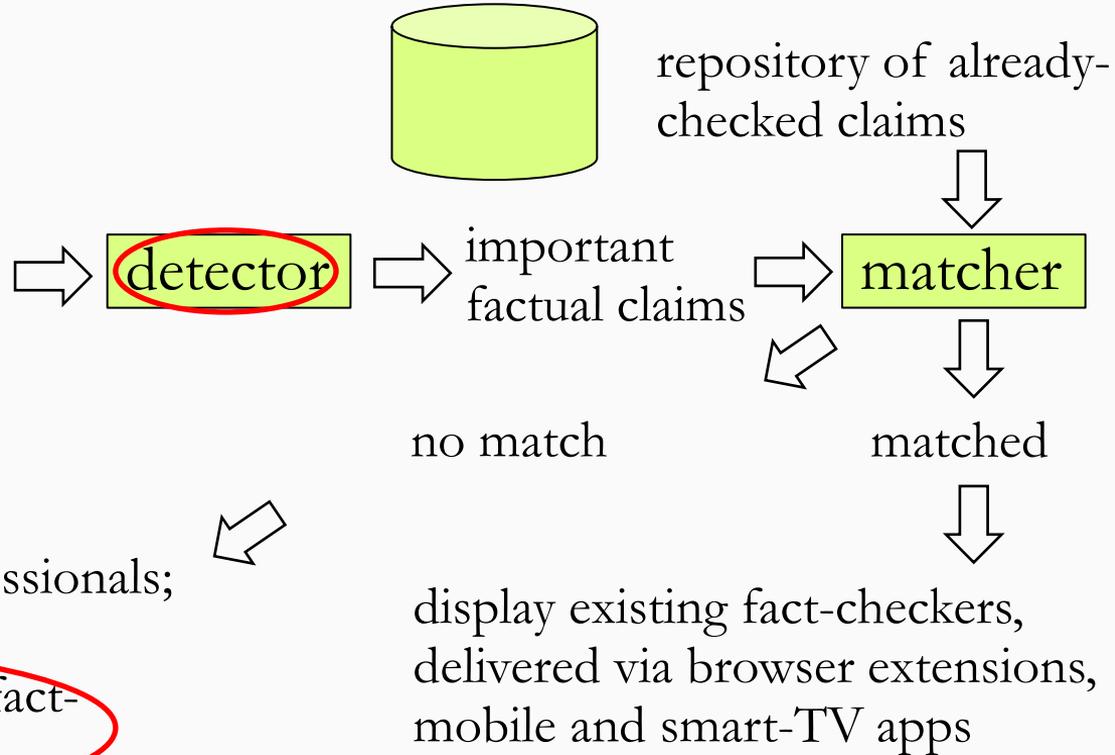


- solicit analyses from professionals;
- crowd;
- data analysis, algorithmic fact-checking

ClaimBuster



- live events (debates, interviews, congressional debates) and ads on TV and online video streams
- social media (e.g., twitter)
- web pages
- news articles



- solicit analyses from professionals;
- crowd;
- data analysis, algorithmic fact-checking

Algorithmic Fact-checking



- [Toward Computational Fact-Checking](#). You Wu, Pankaj K. Agarwal, Chengkai Li, Jun Yang, Cong Yu. VLDB 2014, pages 589-600.
- [iCheck: computationally combating "lies, d-ned lies, and statistics"](#). You Wu, Brett Walenz, Peggy Li, Andrew Shim, Emre Sonmez, Pankaj K. Agarwal, Chengkai Li, Jun Yang, Cong Yu. SIGMOD 2014, pages 1063-1066.

A lot is being done at Duke.

Acknowledgment



UTA Students

- Naeemul Hassan
- Fatma Arslan
- Joseph Minumol
- Gensheng Zhang
- Vikas Sable
- Siddhantsanjeev Gawsane
- Pratik Palashikar

Collaborators

- Bill Adair (Duke)
- Pankaj Agarwal (Duke)
- James Hamilton (Stanford)
- Ping Luo (Chinese Academy of Science)
- Mark Tremayne (UTA)
- Min Wang (Visa)
- You Wu (Google)
- Jun Yang (Duke)
- Cong Yu (Google Research)

Acknowledgment

Funding sponsors



UNIVERSITY OF
TEXAS
ARLINGTON

Disclaimer: This material is based upon work partially supported by the National Science Foundation Grants 1018865, 1117369, 1408928 and 1565699, a Knight Prototype Fund from the Knight Foundation, 2011 and 2012 HP Labs Innovation Research Awards, and the National Natural Science Foundation of China Grant 61370019. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the funding agencies.

Thank You! Questions?

- o <http://ranger.uta.edu/~cli>
cli@uta.edu

- o Demo

<http://idir.uta.edu/claimbuster>

- o Please help us label the data

<http://bit.ly/claimbusters>

