

Crowdsourcing for C4I: Pitfalls and Promise

Kathryn Laskey

Associate Director C4I Center and Professor, SEOR
George Mason University

Critical Issues in C4I Symposium

May 21, 2015



Raise funds for projects

Respond to crisis

Predict the future

Tag photos

Generate innovative ideas

Engage citizens in policy making

Spark a revolution

Develop software

crowdsourcing *noun* \ˈkraʊd-ˌsɔr-sɪŋ\ : the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people and especially from the online community rather than from traditional employees or suppliers

First known use: 2006

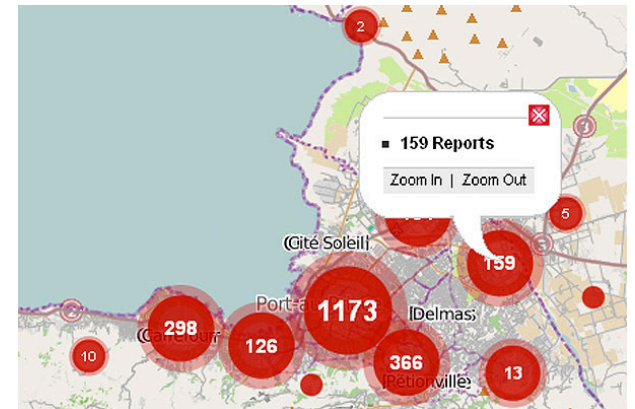
www.merriam-webster.com/dictionary/crowdsourcing

Why Pay Attention?

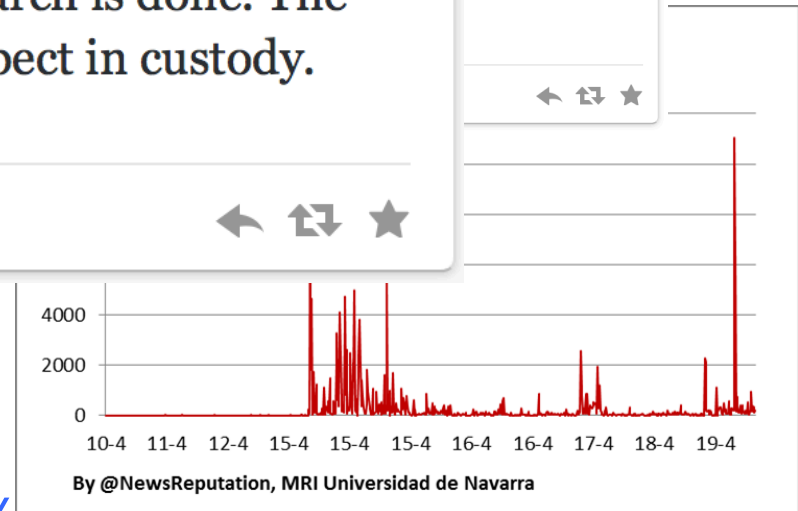
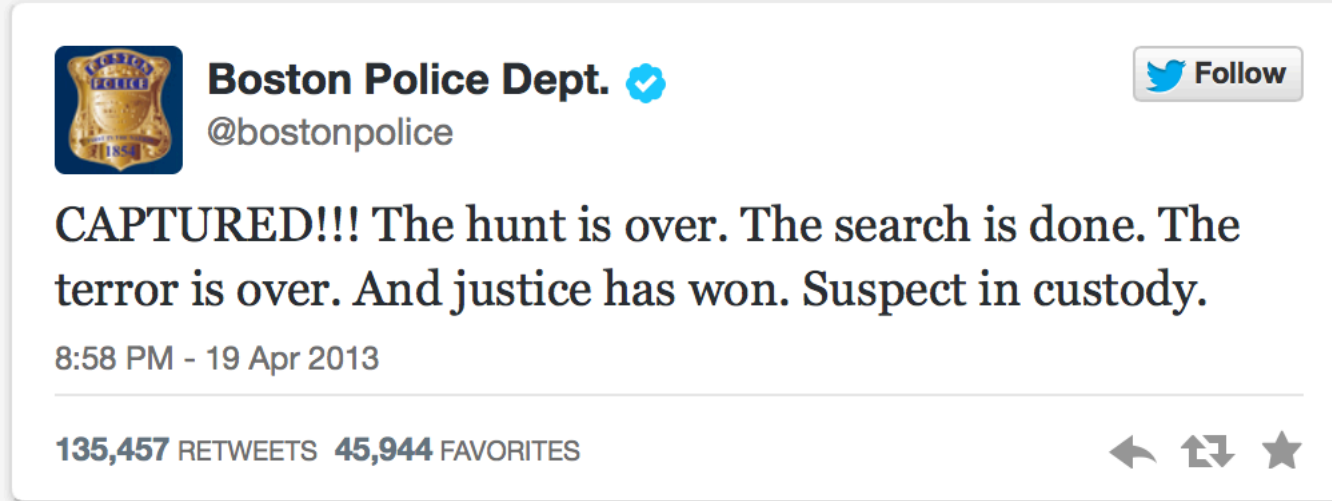
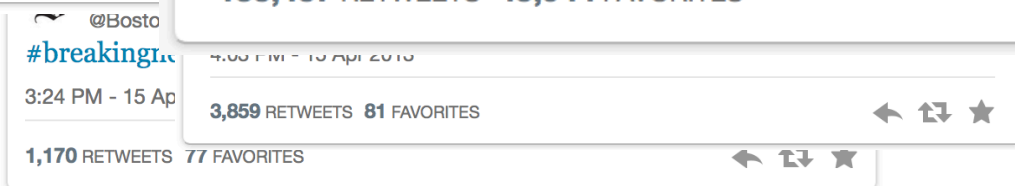
- Clear applicability and potential benefits to many C⁴I problems and concerns
 - ▶ 2-way citizen engagement in operations involving the military
 - ▶ Anticipating and monitoring unrest / crisis / revolution
 - ▶ Forecasting important trends in geopolitics / science & technology
- There are issues unique to C⁴I that must be addressed to make effective use of crowdsourcing
 - ▶ Multi-level security
 - ▶ Policy challenges
 - ▶ Cultural barriers within military / intelligence community and among citizenry

Crowdsourcing and Crisis Response

- Real-time citizen interaction is transforming crisis response
 - ▶ Haitian citizens collaborated with volunteers worldwide to map damage during 2010 earthquake
 - ▶ Social media figured prominently in US government response to recent hurricanes (Irene, Sandy)
 - ▶ In aftermath of Nepal earthquake, crowdsourcing is being used to:
 - Map relief needs
 - Coordinate volunteers
 - Fund relief efforts
- Avenues for two-way communication with citizens
 - ▶ Social media (e.g., Facebook, Twitter) allow multi-way interaction
 - ▶ SMS is low-tech, reliable communication tool in distressed areas with weak infrastructure



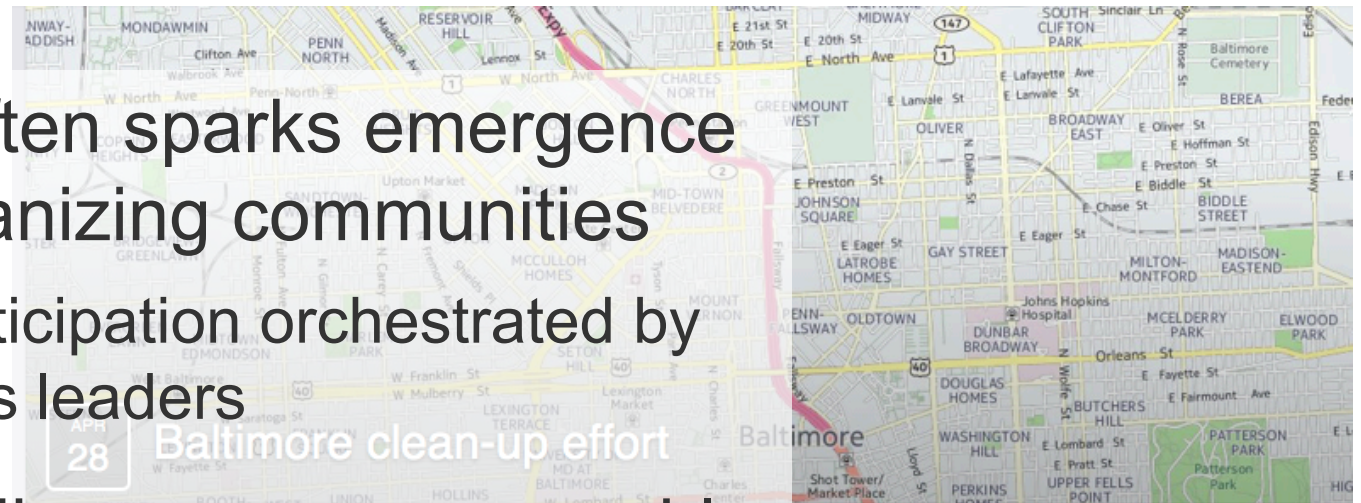
Boston Marathon



"The Boston Marathon bombings are certainly a tale of terror, but also a tale about the power and perils of social media." – cbsnews.com

Self-Organizing Communities

- Disaster often sparks emergence of self-organizing communities
 - ▶ Broad participation orchestrated by indigenous leaders
- Social media can serve as enabler



Public event created by [Jim Spett and others](#)

[Join](#) [Save](#) [...](#)

April 28 - May 5
Apr 28 at 10:00am to May 5 at 10:00pm

Pennsylvania Ave & North Ave, Baltimore [Show Map](#)

Let's get together and help affected communities/businesses remove debris. Bring heavy duty trash bags, gloves, brooms, dust pans, trash cans, containers, and anything else that would help. We'll have a van ready to take trash to the drop-off center in Remington.

Post locations that could benefit from the effort. Post ideas!

Let's meet at Presstman & N Fremont park at 10am, to assist the Sandtown clean-up organizers. Buy any needed supplies at the [Belle Hardware store](#)

GUESTS

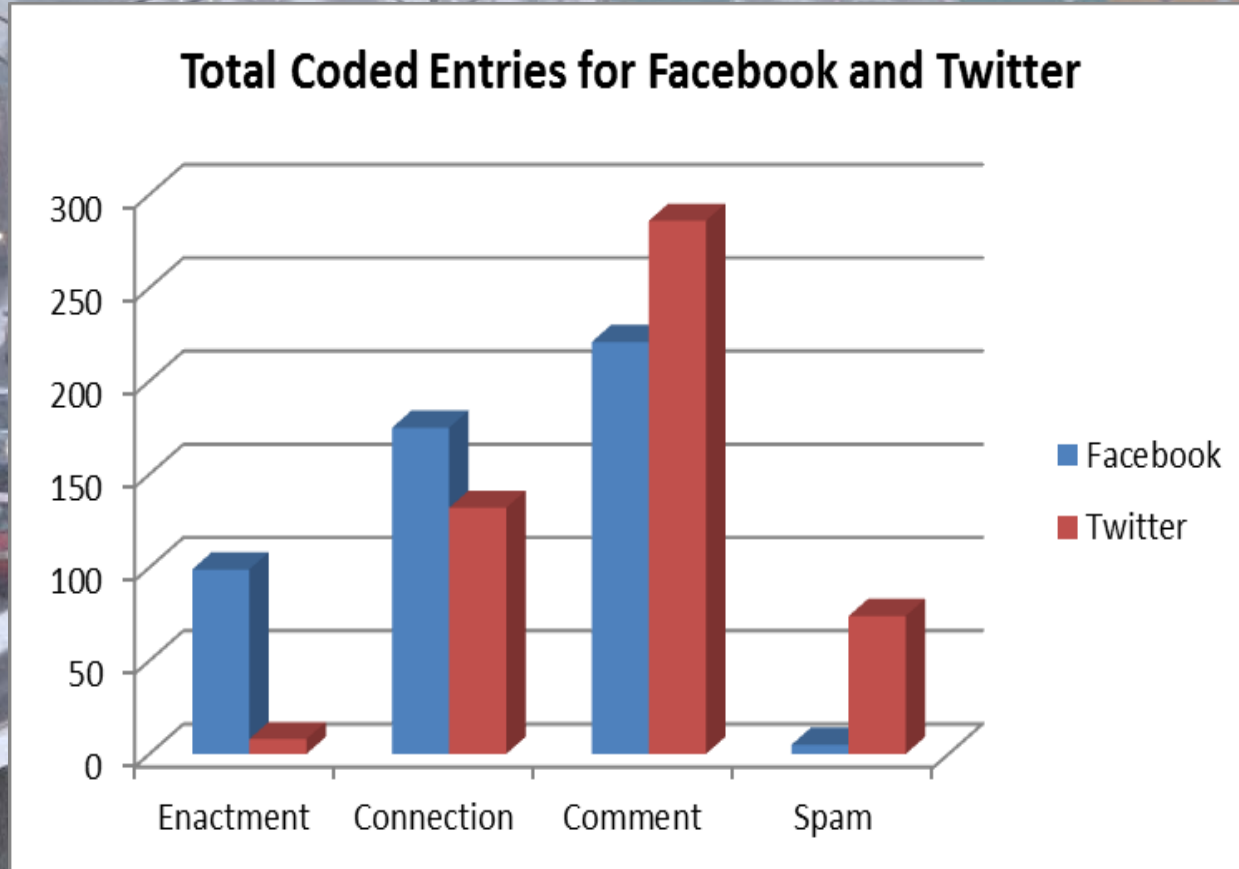
3.1k	383	6.8k
went	maybe	invited

RELATED EVENTS [See More](#)

Be More Benefit: A night of m...
Tomorrow at Metro Gallery
1,219 guests
[Join](#) · [Maybe](#)

Baltimore Bike Party: Bike Pr...
Fri May 29 at St. Mary's Park
Festival · 788 guests
[Join](#) · [Maybe](#)

Case Study: Community Self-Organization in Atlanta



Source: Dreyfuss, I. (2015) How Members of the Public Have Used Facebook and Twitter in Response to a Disaster: A Comparative Case Study. MA Thesis, George Mason University

C2 and Citizen Engagement

- Nationwide Suspicious Activity Reporting (SAR) Initiative (NSI)
 - ▶ Oneway portal for posting and compiling anonymous reports of suspicious activity
 - ▶ Does not support the kind of real-time interaction that occurred in the Boston Marathon event
 - ▶ Does not support emergence of self-organizing communities
- Social media can support real-time collaboration
- Need to adapt command and control systems and processes to exploit technologies for communicating directly with citizens
 - ▶ Design and evaluate new systems and processes
 - ▶ Achieve benefits while mitigating problems
 - ▶ Train responders in new systems and processes
 - ▶ Leverage self-organizing community response

Simulation Experiment to Examine Citizen Participation in Crisis Response

- 2012 simulated crisis to examine impact of citizen involvement on tactical/operational decision-making and implementation.
 - ▶ Refine and evolve CONOPS and TTPs for citizen participation in tactical/operational planning and implementation
 - ▶ Refine and evolve prototype DSS
 - ▶ Examine impact of DSS on tactical / operational decision-making & execution.
- Scenario: Defense Support of Civil Authorities
 - ▶ Radiological Dispersal Device detonates on Mason campus.
 - ▶ Notional NCR military/civilian emergency managers collaborate from Emergency Operations Center (emulated at the NSEL at MITRE McLean)
 - ▶ Student volunteers use decision support tools to collaborate in response decision making.
- Provided valuable insights to emergency managers who participated



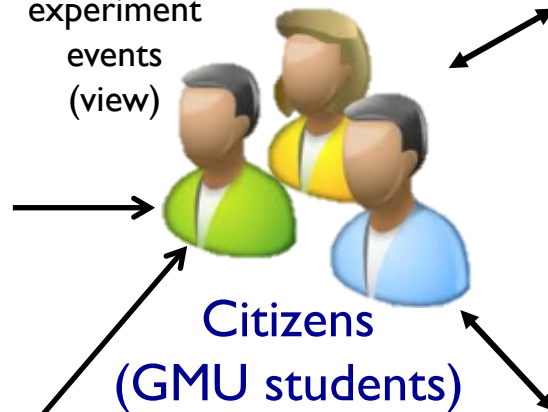
Citizens' Emergency Response Portal System (CERPS) Public Interaction

Simulated Sensory Environment (SSE)



Unfolding experiment events (view)

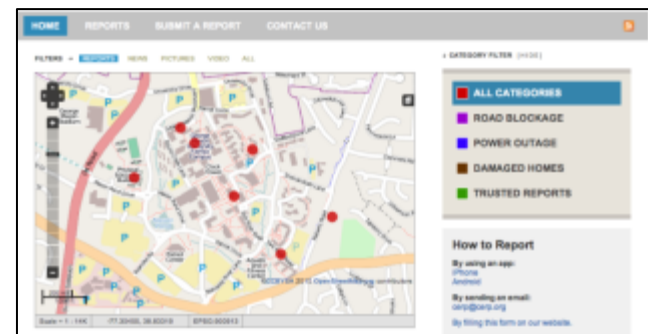
Reported events (view and post)



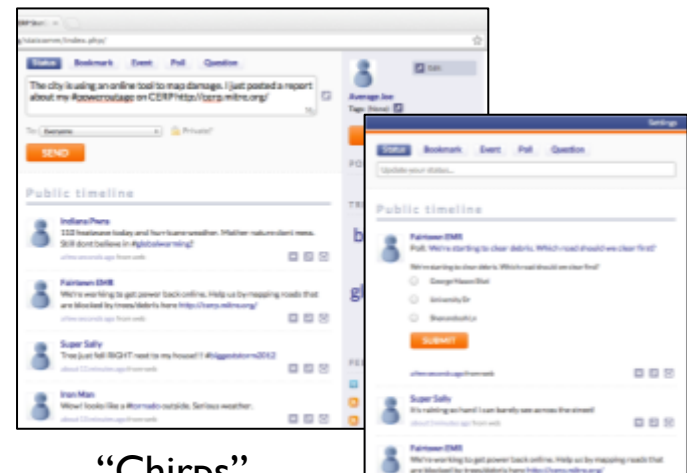
News

Simulated News Network

Citizens' Emergency Response Portal (CERP)



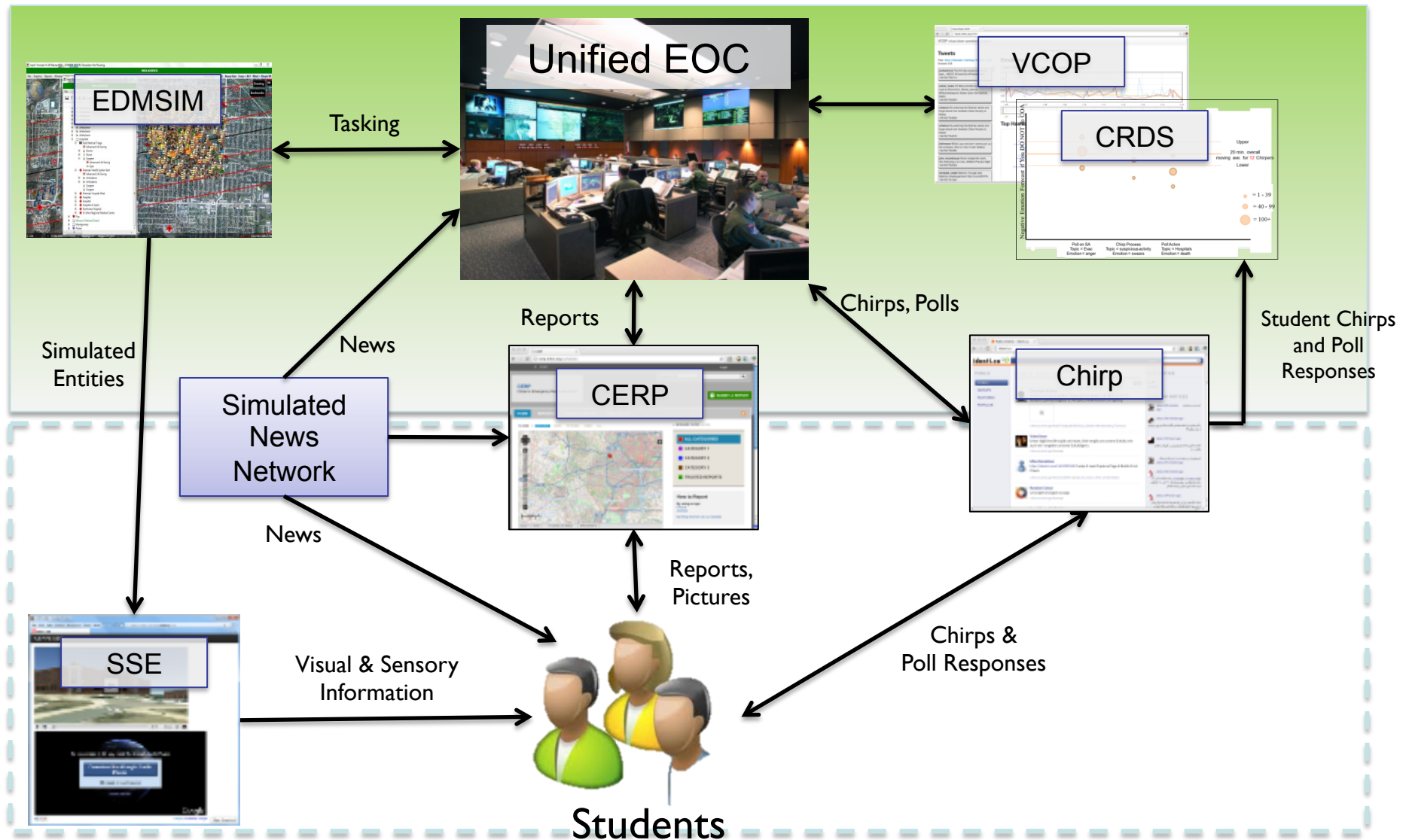
Chirp [open-source Twitter clone]



"Chirps"

Polling

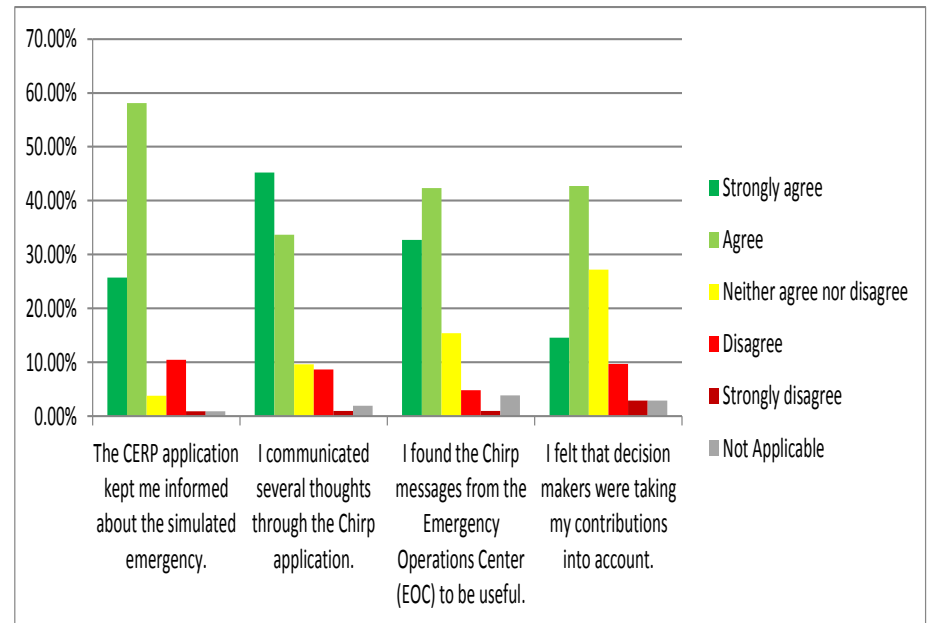
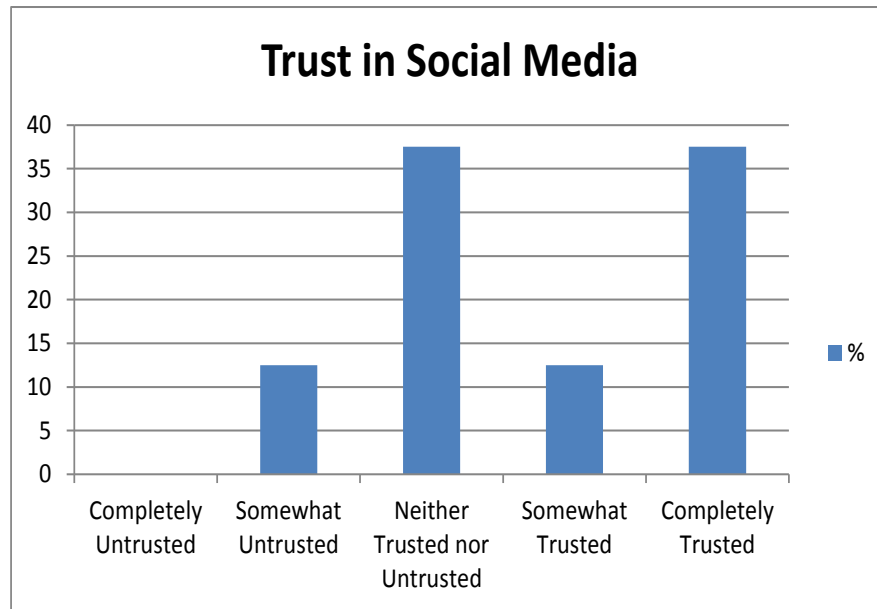
CERPS SIMEX Operational View



Government Stakeholders

- NORTHCOM
- Joint Staff
- Fairfax County
- Virginia Commonwealth
- DHS/FEMA
- National Guard Bureau
- FBI
- Israeli Home Front Command*

Participant Perceptions



- Operators showed trust in social media
- Influence of simulated “bad actors” was limited and short term
- Trust would have been improved with geospatial information (disabled for privacy reasons)

- Students felt they were kept informed about emergency
- Students found messages from EOC useful
- Students felt their contributions were taken into account

Research Issues

- Effective integration of citizen input into C2 processes
- Integrating public participation into logistics
 - ▶ Provide timely assistance where it is most needed
 - ▶ Facilitate and leverage self-organizing community efforts
 - ▶ Develop CONOPS and TTPs for leveraging citizen involvement
- Human factors – citizens and operators
- Identifying trusted sources / filtering bad information
- Information security
- Providing information to operators while protecting personally identifiable information
- Mining large volumes of social media for actionable information

Policy Challenges

- Expectations – Does responding to Twitter establish a public expectation that we will always respond (especially for 911-type tweets)?
- Liability – What happens if you ask public to do something (like evacuate using a certain route) and people get hurt as a result?
- Privacy – How must personal info, geolocations, etc., be handled?
- Two way communications with public, following/liking – Who will be allowed to do this and under what circumstances?
- Law Enforcement – Emergency management has fewer constraints on interactions than law enforcement
- Consent – Does the public need to consent before we respond using social media?
- Involvement – Who is the public? Who can be involved?

Current policies were not designed with social media in mind and need to evolve to integrate social media into crisis management

Forecasting and the Wisdom of the Crowd

- “Prediction is difficult. Especially about the future.”
- Neils Bohr
- “...predicting the future has a strong role to play in preparing your defenses for probable attacks.”
- Dan Geer, Black Hat Keynote, 2014
- Crowds do better than individuals

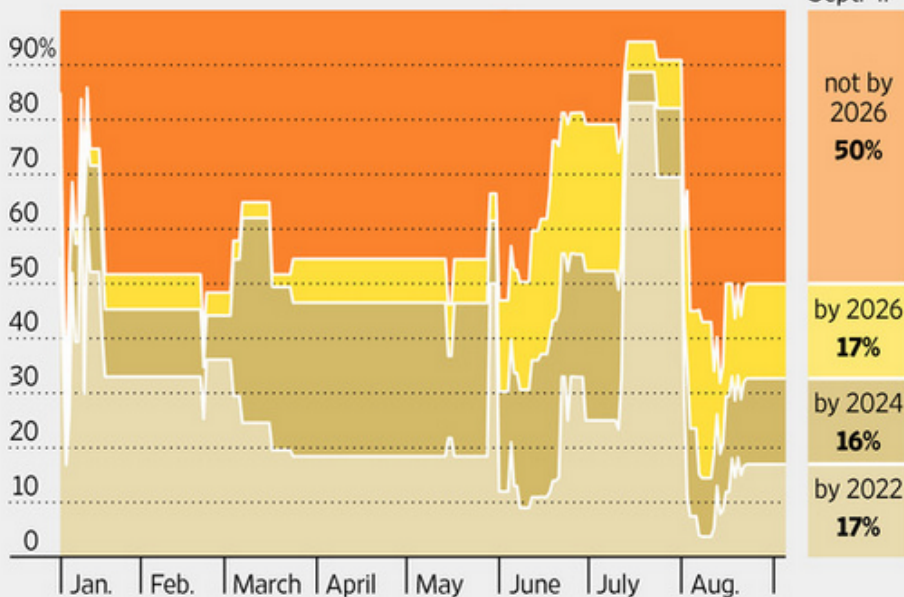


Potential – As reported by WSJ

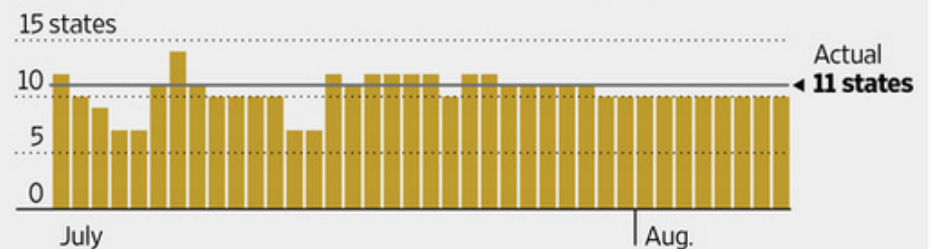
Smarter Intelligence

The U.S. government is inviting people outside the intelligence community to develop new ways to anticipate global events. One project, ForeST, forecasts developments in science and technology by inviting amateur forecasters to predict in real time the probability that certain events will occur.

QUESTION: When will the Chinese National Space Administration land a man or woman on the moon?



QUESTION: How many states will report at least one case of a West Nile virus human neuroinvasive disease by August 1?



Source: Charles Twardy, George Mason University

The Wall Street Journal

From the WSJ Article: “U.S. Intelligence Community Explores More Rigorous Ways to Forecast Events” Sept 5, 2014

The same systems and methods covered in the article are proposed for use by the IEEE Foundation and Spectrum. Best practice results have exceeded traditional opinion poll results by 70% in prediction accuracy.



SCICAST

SciCast is a crowdsourced forecasting platform for science and technology.

SciCast originated as a research project funded by IARPA to test the efficacy of crowdsourced forecasting techniques.

We aggregate the knowledge and expertise of a diverse group of participants from around the world into probability forecasts.

Will the US Army issue tactical glasses equipped with augmented reality technology to detect enemy weaponry and IEDs on the battlefield by the end of 2015?

Make a Forecast

Discussion (10)

Background

Trends & History

Network

1 If: the answer to one of these related questions is:

Your Assumption	Question
<i>TIP: Forecast different scenarios using these assumptions. If an answer occurs, what will happen in the question asked below?</i>	
Select One: ▾	Will the US Army issue augmented reality technology enabled contact lenses to detect enemy weaponry and IEDs on the battlefield by the end of 2015?
Select One: ▾	When will the first augmented reality (AR) device be available for consumer purchase?

2 Then: Will the US Army issue tactical glasses equipped with augmented reality technology to detect enemy weaponry and IEDs on the battlefield by the end of 2015?

- | | | |
|---|------------|-------------------------|
| <input type="radio"/> Almost surely | 90% - 100% | |
| <input type="radio"/> Very likely | 80% - 90% | |
| <input type="radio"/> Likely | 60% - 80% | |
| <input type="radio"/> As likely as not | 40% - 60% | |
| <input type="radio"/> Unlikely | 20% - 40% | |
| <input type="radio"/> Very unlikely | 10% - 20% | <i>Current forecast</i> |
| <input type="radio"/> Almost surely not | 0% - 10% | |

Say a few words about why you're making this forecast:

SUBMIT YOUR FORECAST



LINKED QUESTIONS

SciCast's unique
combinatorial prediction
market captures
dependencies between
related forecasts

Forecasters are rewarded
with points for making
accurate forecasts

1 If: the answer to one of these related questions is:

Your Assumption	Question
Select One: Before January 1, 2016 January 1, 2016 to December 31, 2016 ✓ Not before January 1, 2017	...ptions. If an answer occurs, what will happen in the question asked below? ...st augmented reality (AR) device be available for consumer purchase?
+ Add another assumption from our existing questions OR suggest a new related question	

START OVER

2 Then: Will the US Army issue tactical glasses equipped with augmented reality technology to detect enemy weaponry and IEDs on the battlefield by the end of 2015?

CURRENT FORECAST 8%	YOUR FORECAST 8% Debit:0 Points	CHANGE FORECAST TO 8%	MINIMUM AVAILABLE POINTS 4,894
<div><div></div><div>0%</div><div></div><div>100%</div></div>			PREVIOUS FORECASTS

1 If: the answer to one of these related questions is:

Your Assumption	Question
TIP: Forecast different scenarios using these assumptions. If an answer occurs, what will happen in the question asked below? Select One: ✓ Before January 1, 2016 January 1, 2016 to December 31, 2016 Not before January 1, 2017	...st augmented reality (AR) device be available for consumer purchase? ... questions OR suggest a new related question
START OVER	

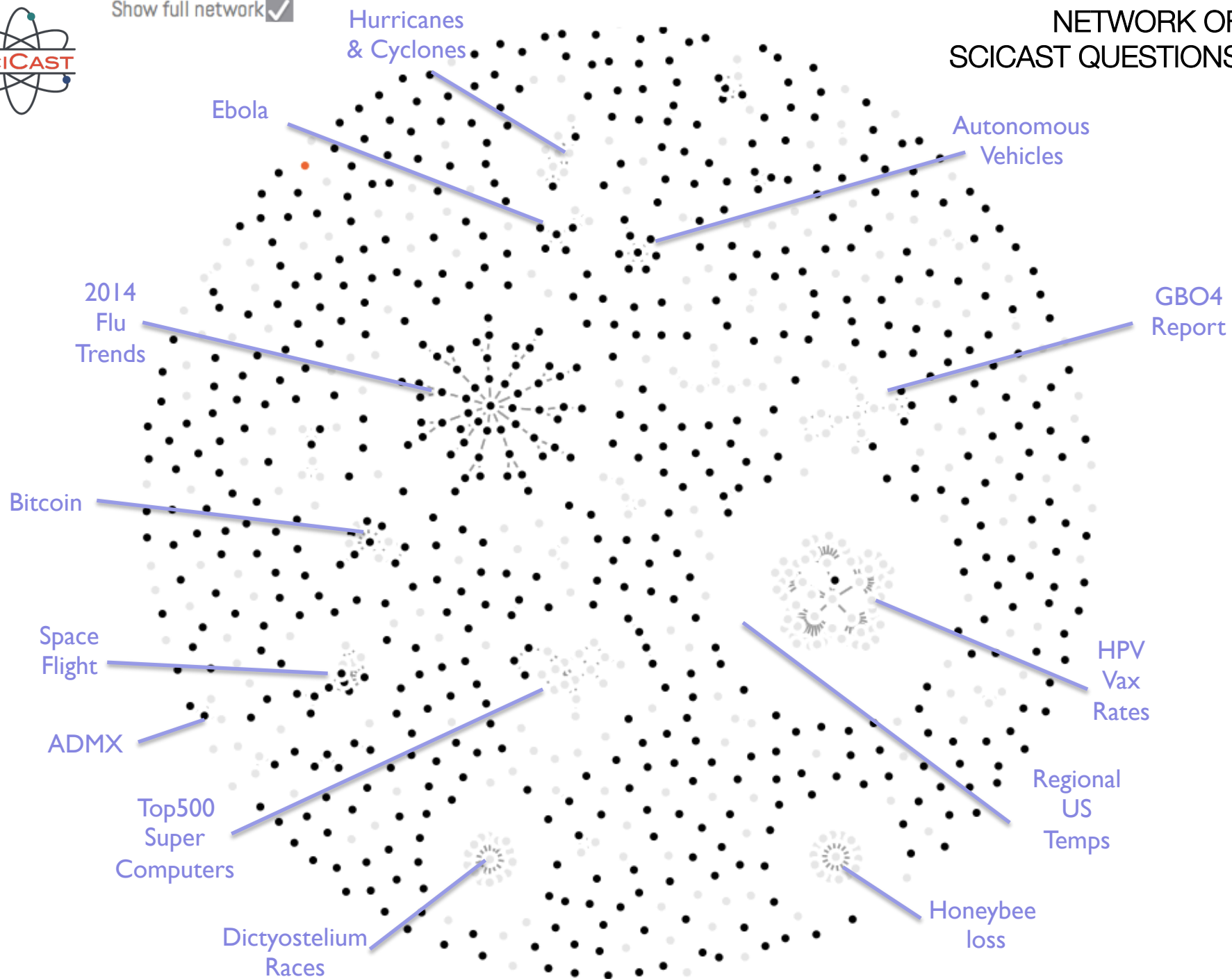
2 Then: Will the US Army issue tactical glasses equipped with augmented reality technology to detect enemy weaponry and IEDs on the battlefield by the end of 2015?

CURRENT FORECAST 32%	YOUR FORECAST 32% Debit:0 Points	CHANGE FORECAST TO 32%	MINIMUM AVAILABLE POINTS 4,894
<div><div></div><div>0%</div><div></div><div>100%</div></div>			PREVIOUS FORECASTS



Show full network ☒

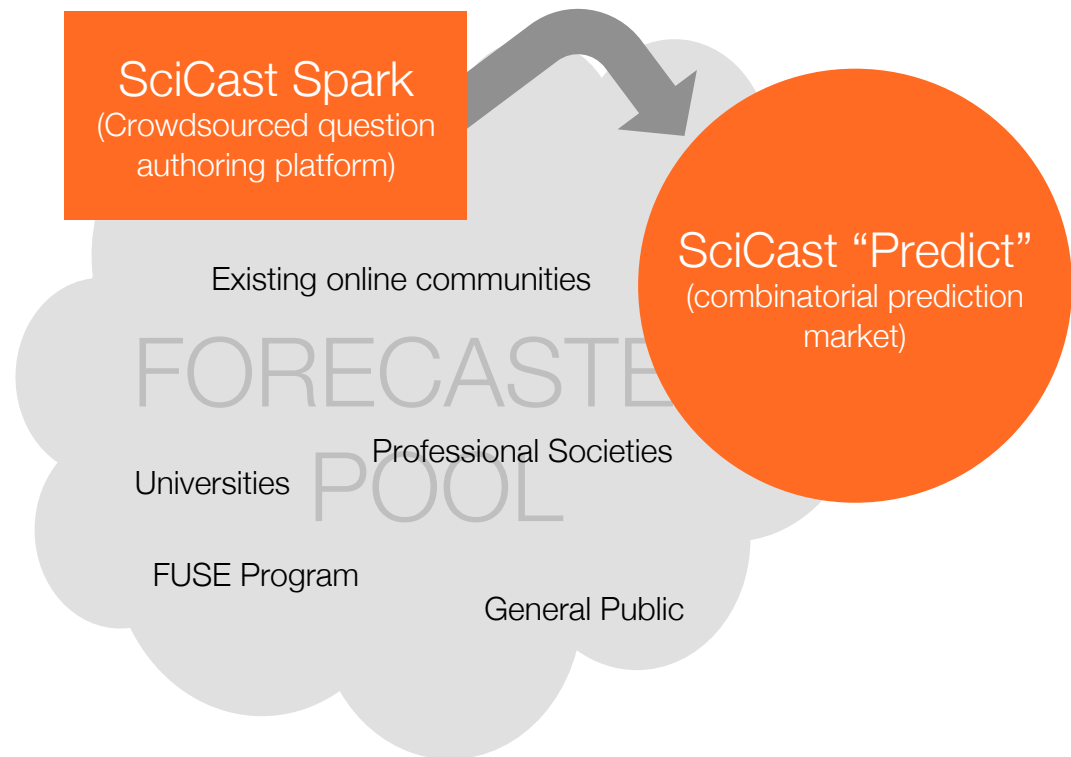
NETWORK OF SCICAST QUESTIONS





HOW IT WORKS

1. Questions are posed and iterated
2. We draw relationships between questions if applicable*
3. Once the question and its relationships are defined, it is published to Predict where our forecaster pool makes forecasts
4. We output real-time, ongoing probabilistic forecasts until the answer to the forecasting question is known



* i.e. a forecast about the price of a raw material may be directly related to another forecast about a company's ability to bring a product to market



SCICAST BY THE NUMBERS*

SciCast is the largest S&T focused crowdsourced forecasting site in the world:

NUMBER OF FORECASTERS

10,000+

NUMBER OF FORECASTS

Total

120,000+

Daily Average

150+

FORECAST QUESTIONS

Posed

1257

Open

587

Completed

619

Using Brier scores, a standard proper scoring rule that measures the accuracy of probabilistic forecasts:

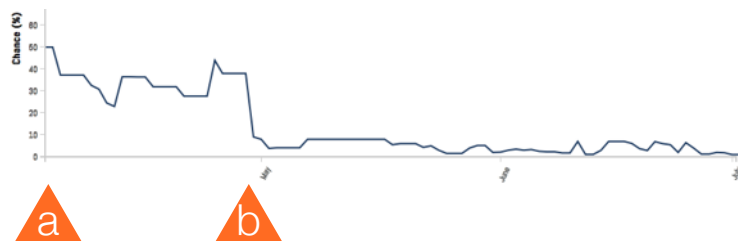
- We beat a uniform distribution 84/100 times by an average of 46%
- We beat an average 78/100 times by an average of 26%



SciCast has proven to be effective at forecasting unstructured questions combining technical knowledge, time, contextual information, and data:

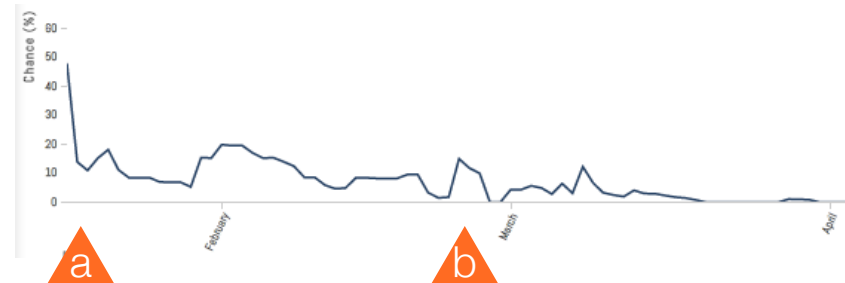
Will the Axion Dark Matter Experiment detect axions by July 2014?

- a) Forecast never moved above 50% likelihood;
- a) Definitive “No” 2 months ahead of answer being known



Will Bitcoin be accepted at online retailer, Amazon, by March 31?

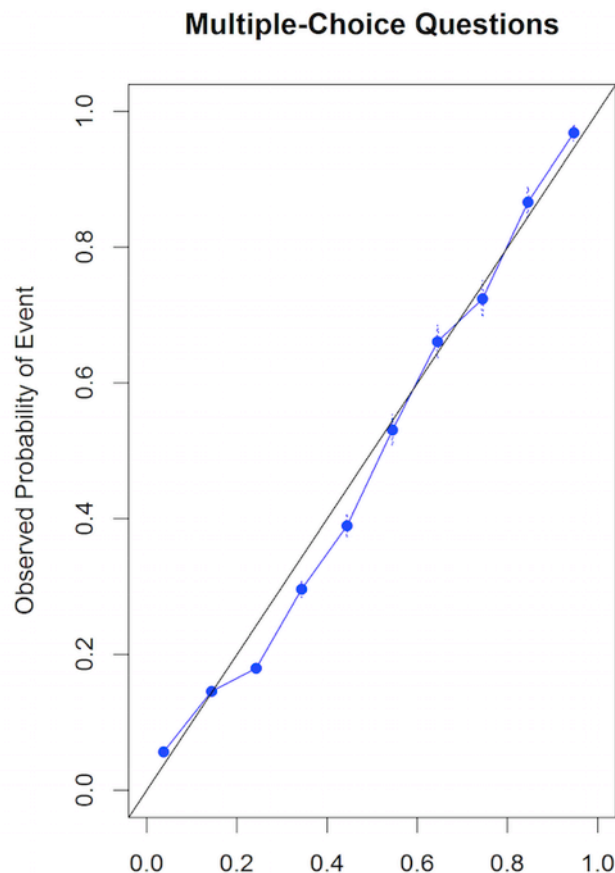
- a) From the start, always judged unlikely to happen;
- b) Occasional rumors never swayed the probability +/- 10%





MARKET CALIBRATION

- Quantitative forecasting methods are superior¹
- Prediction markets have proven prediction accuracy and calibration^{2,3}
- SciCast forecasts are more accurate and better calibrated than simple averages



SciCast multi-choice
calibration results
December 2014

¹ Mullins, C., "Retrospective, Analysis of Technology Forecasting: In-Scope Extension", The Tauri Group LLC Technical Report, U.S. Govt Contract # HQ0034-11-C-0016, 13 August 2012.

² J. Wolfers and E. Zitzewitz, *Prediction Markets in Theory and Practice*. National Bureau of Economic Research, 2006.

³ J. Ledyard, R. Hanson, and T. Ishikida, "An experimental test of combinatorial information markets," *J. Econ. Behav. Organ.*, vol. 69, no. 2, pp. 182–189, 2009.



NEXT STEPS FOR SCICAST

We are finishing a 4-year research program on crowdsourced prediction

- First 2 years: geopolitical forecasting
- Second 2 years: science and technology forecasting

SciCast is being transitioned to operate inside a DoE laboratory

We continue to pursue transition opportunities for an open public science and technology prediction market

Questions about working directly with SciCast :

Mark Jaster

mjaster@scicast.org
610-742-9366

Questions about the SciCast platform or SciCast research:

Charles Twardy

ctwardy@gmu.edu
703-993-1846



Take Aways

- Harnessing the crowd brings new opportunities for the C⁴I community
- We are just beginning to understand how to exploit these opportunities
- With the opportunities come challenges
 - ▶ Institutional and cultural barriers to new ways of doing things
 - ▶ Inexperience with how to make the most of the opportunities
 - ▶ Need for training
 - ▶ Need for new policies
 - ▶ Many research opportunities and challenges



Thank You!

This talk would not have been possible without the contributions of many collaborators and partners:

- ▶ MITRE Corporation National Security Experimentation Laboratory
- ▶ Participating agencies in CERPS SIMEX
- ▶ Student volunteers in CERPS SIMEX
- ▶ Researchers and staff of the GMU C4I Center
- ▶ SciCast team: Inkling Markets, Goldbrand Software, KaDSci, Inc., Tuuyi
- ▶ SciCast partners: IEEE, AAAS, ACS, ISACA, AMIA, ICE
- ▶ Thousands of volunteer forecasters
- ▶ IARPA