



The Wisdom of Crowds

CS 278 | Stanford University | Michael Bernstein



Announcements

Assignment 3 is live starts today and will unroll in multiple stages:
more details at the end of lecture

Deadline for the first phase is next Tuesday

Project milestone will be due the Tuesday of Week 6



Last time

We should not design social computing systems to treat our relationships as all the same.

Strong ties: a small number of people we know well — design for honest signals, and don't assume all communication happens through the system.

Weak ties: a large number of acquaintances — design to support feelings of connectedness

The impacts of social media use on our wellbeing are most negative for those passively consuming content (esp. from weak ties), and for heavy usage among early adolescent girls



Oh #@&% , It Got Popular

 Unit 2

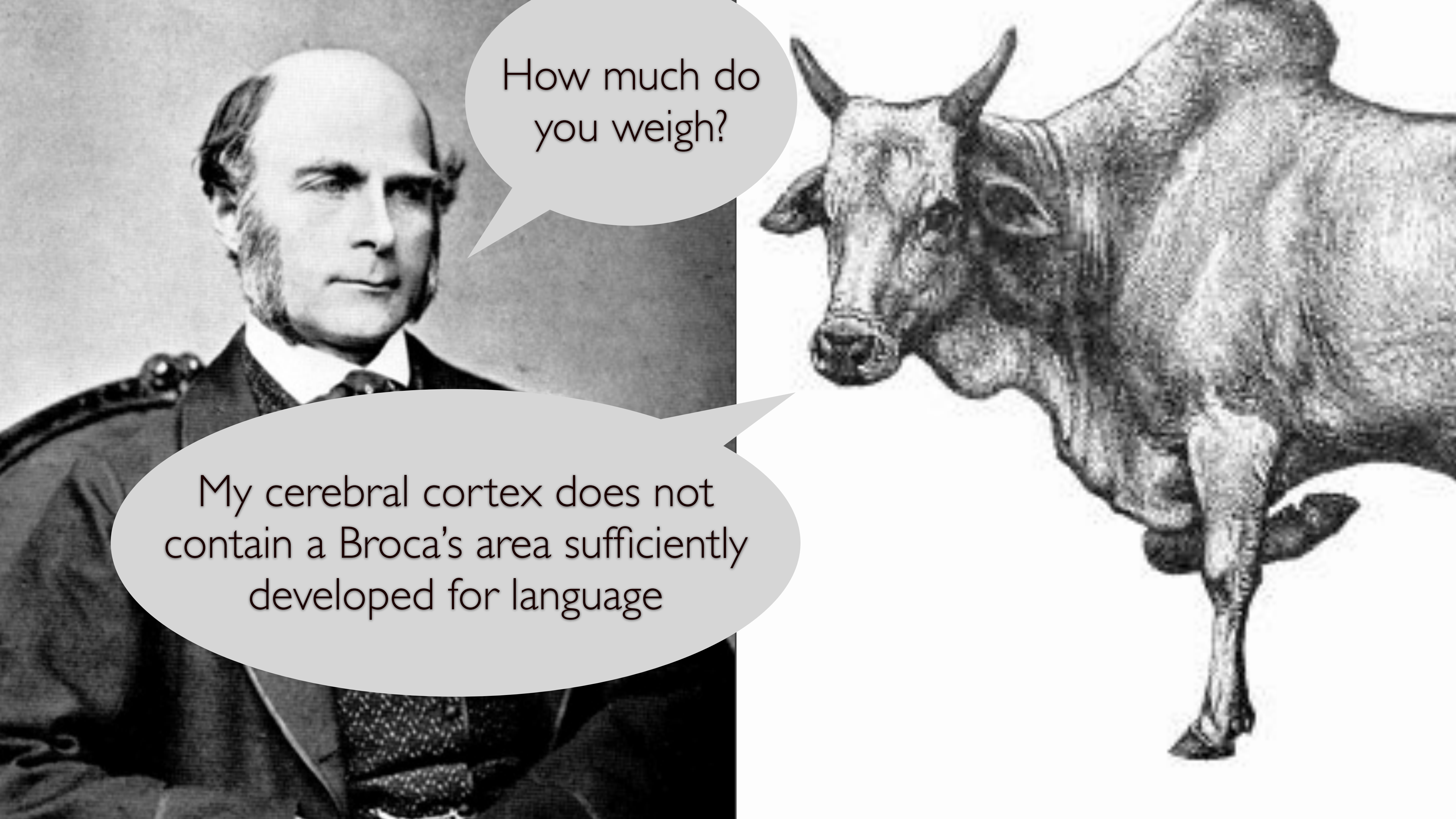
We Work

Unit 3

<http://hci.st/wise>

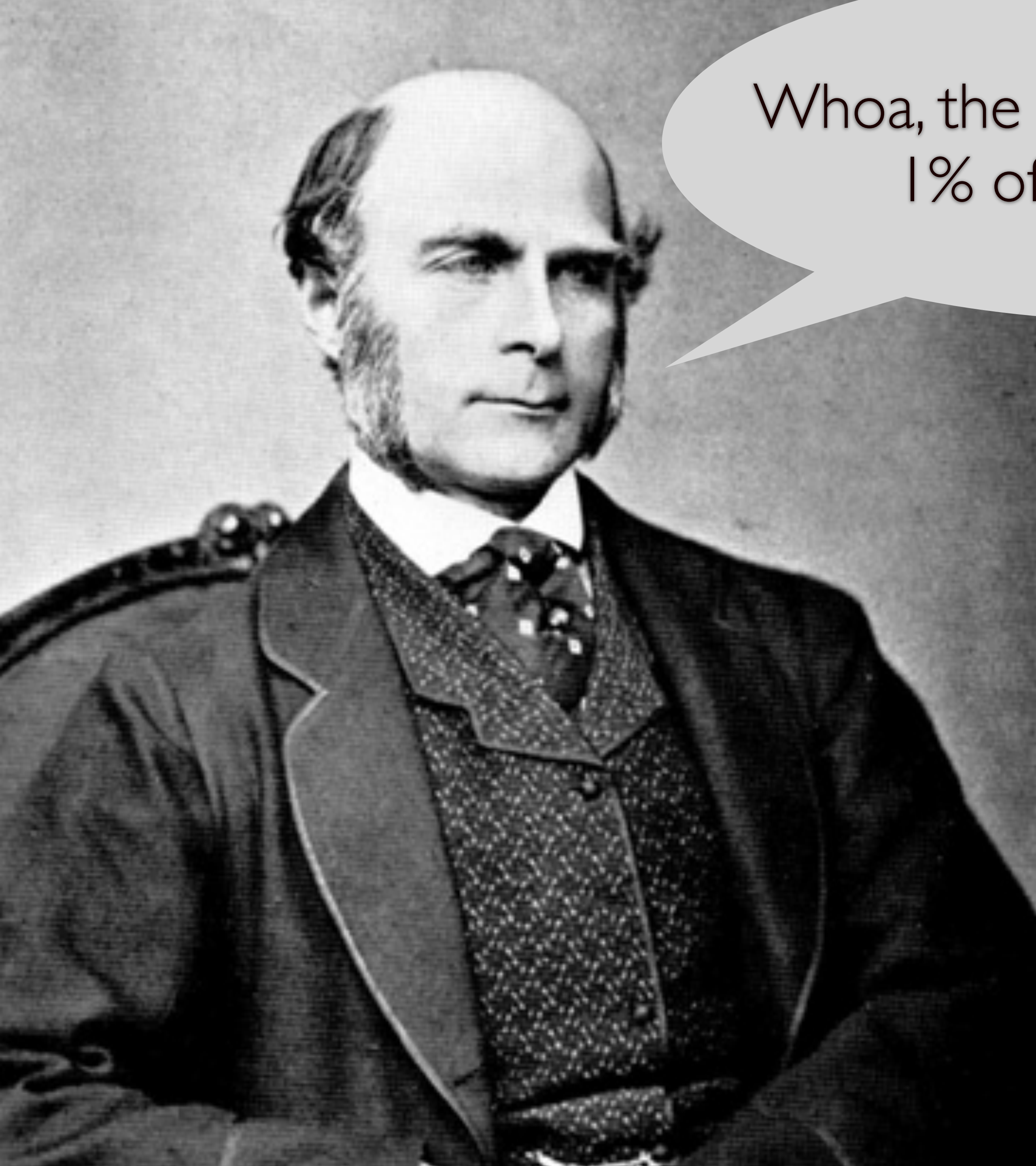
Grab a device, fill it out!





How much do
you weigh?

My cerebral cortex does not
contain a Broca's area sufficiently
developed for language



Whoa, the mean guess is within 1% of the true value


mean guess is within
the true value

of the dressed weight of a
787 different persons.


		Percentiles		Excess of Observed over Normal	
		Observed deviates from 1207 lbs.	Normal p.e = 37		
	5	1074	- 133	- 90	+ 43
	10	1109	- 98	- 70	+ 28
	15	1126	- 81	- 57	+ 24
	20	1148	- 59	- 46	+ 13
q_1	25	1162	- 45	- 37	+ 8
	30	1174	- 33	- 29	+ 4
	35	1181	- 26	- 21	+ 5
	40	1188	- 19	- 14	+ 5
	45	1197	- 10	- 7	+ 3
m	50	1207	0	0	0
	55	1214	+ 7	+ 7	0
	60	1219	+ 12	+ 14	- 2
	65	1225	+ 18	+ 21	- 3
	70	1230	+ 23	+ 29	- 6
q_3	75	1236	+ 29	+ 37	- 8
	80	1243	+ 36	+ 46	- 10
	85	1254	+ 47	+ 57	- 10
	90	1267	+ 52	+ 70	- 18
	95	1293	+ 86	+ 90	- 4


q_1 , q_3 , the first and third quartiles, stand at 25° and 75° respectively.
 m , the median or middlemost value, stands at 50°.

Innovation competitions in industry




Kaggle is the place to do data science projects

[See how it works](#) 




The illustration shows a laptop with a line graph on its screen. Surrounding the laptop are various icons representing data science and collaboration: a bar chart, a speech bubble, a person icon, a double-headed arrow, a plus sign, a minus sign, a lightbulb, a cloud with an upload arrow, and a document. Two hands are shown interacting with the laptop, one pointing at the screen and the other holding a document.

Innovation competitions for science



NASA TV


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Welcome to NASA Solve!

Interested in helping NASA solve tough problems? You are in the right place! This one-stop-shop website is where you'll find opportunities to participate in challenges, prize competitions, and citizen science activities that develop solutions for problems related to NASA's mission. So, jump in and become a NASA SOLVE-r!


TAP



NASA Solve

Watch later  Share 

SOLVE



Prediction markets

PredictIt Login Sign Up

U.S. Elections Trump Admin Congress Justice V

Spain's next leader?

Election Sunday

● ○ ○ ○ ○ ○ ○ ○

GOOD JUDGMENT

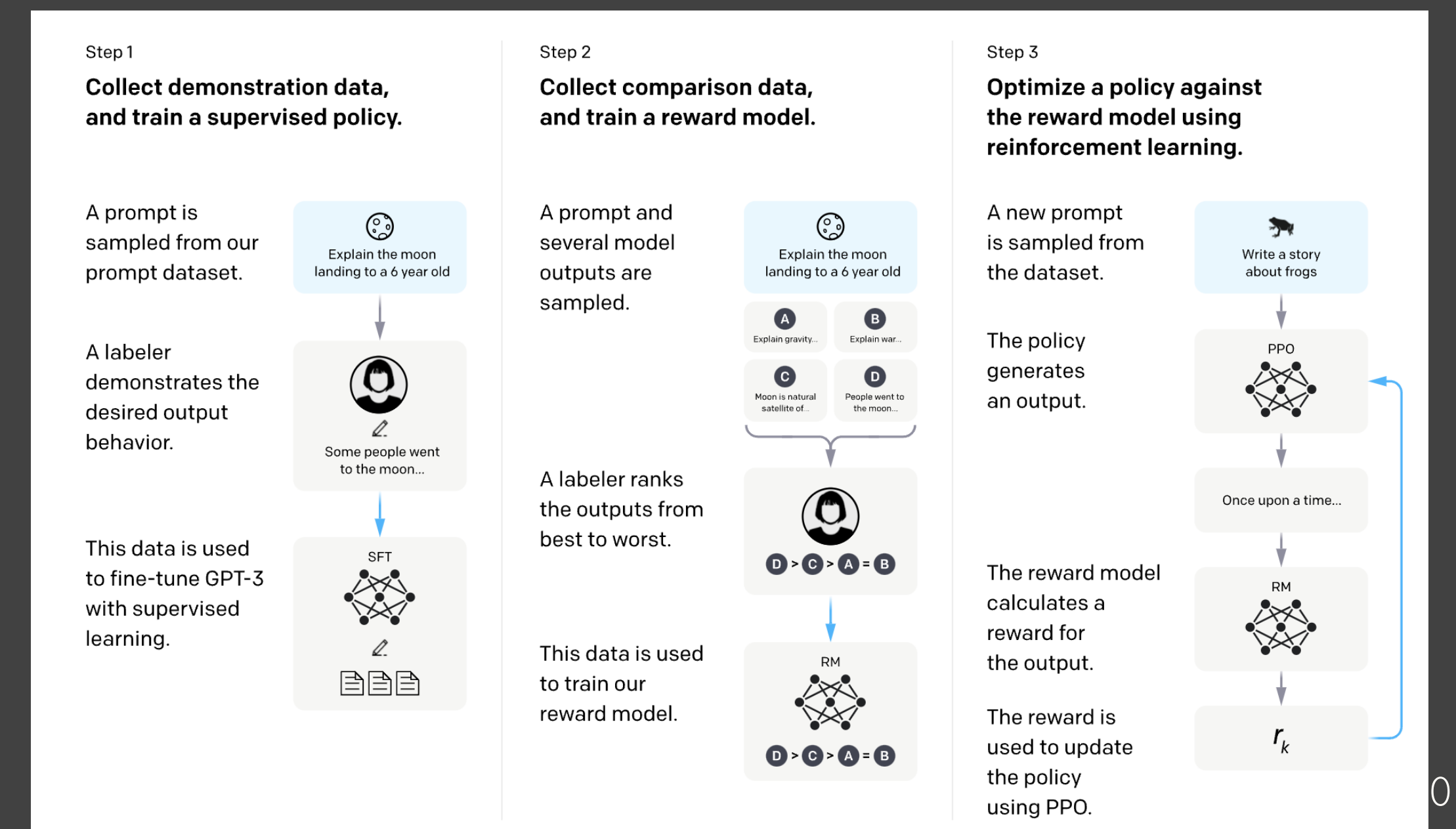
Upcoming Workshops

Online Training

See the future sooner

Actionable, early insight and better decisions start with the science of Superforecasting

AI data annotation at scale



Citizen science

Galaxy Zoo

Article **Talk** Tools

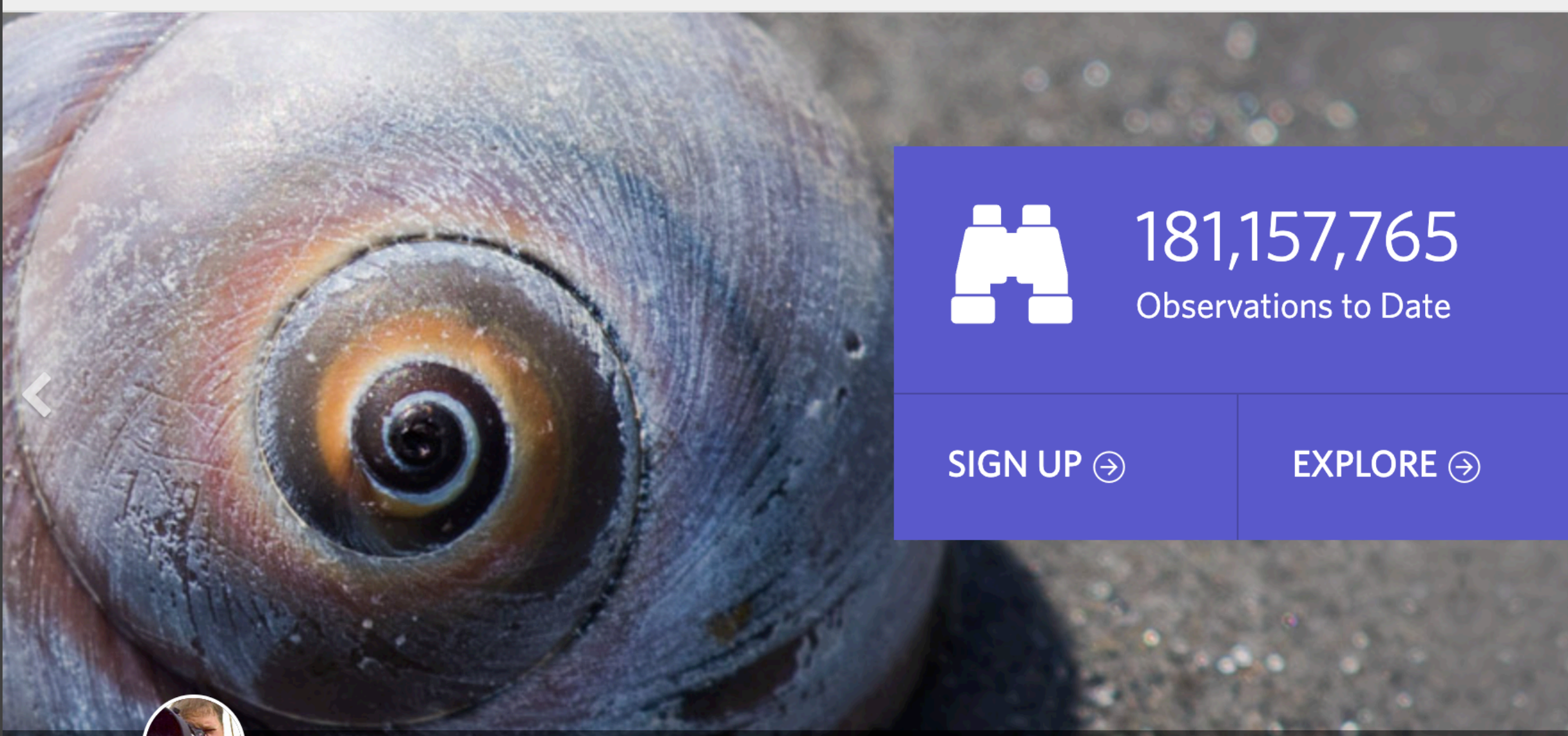
From Wikipedia, the free encyclopedia

Galaxy Zoo is a crowdsourced astronomy project which invites people to assist in the

Galaxy Zoo



iNaturalist Explore Community More Log In or Sign Up



181,157,765
Observations to Date

SIGN UP

EXPLORE



BJ Stacey ~ Shark Eye Snail from Essex County, Massachusetts, USA

Public commons datasets

OpenStreetMap



© OpenStreetMap contributors

OpenStreetMap provides map data for thousands of websites, mobile apps, and hardware devices

OpenStreetMap is built by a community of mappers that contribute and maintain data about roads, trails, cafés, railway stations, and much more, all over the world.

Local Knowledge

OpenStreetMap emphasizes local knowledge. Contributors use aerial imagery, GPS devices, and low-tech field maps to verify that OSM is accurate and up to date.

Factchecking [Wojcik et al. 2022]



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@Dexerto

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ByteDance is reportedly considering selling TikTok without the algorithm to someone outside the tech industry

Via: The Information



Readers added context

Bytedance isn't planning to sell Tiktok according to multiple credible news sources

reuters.com/technology/byt...

usnews.com/news/technolog...

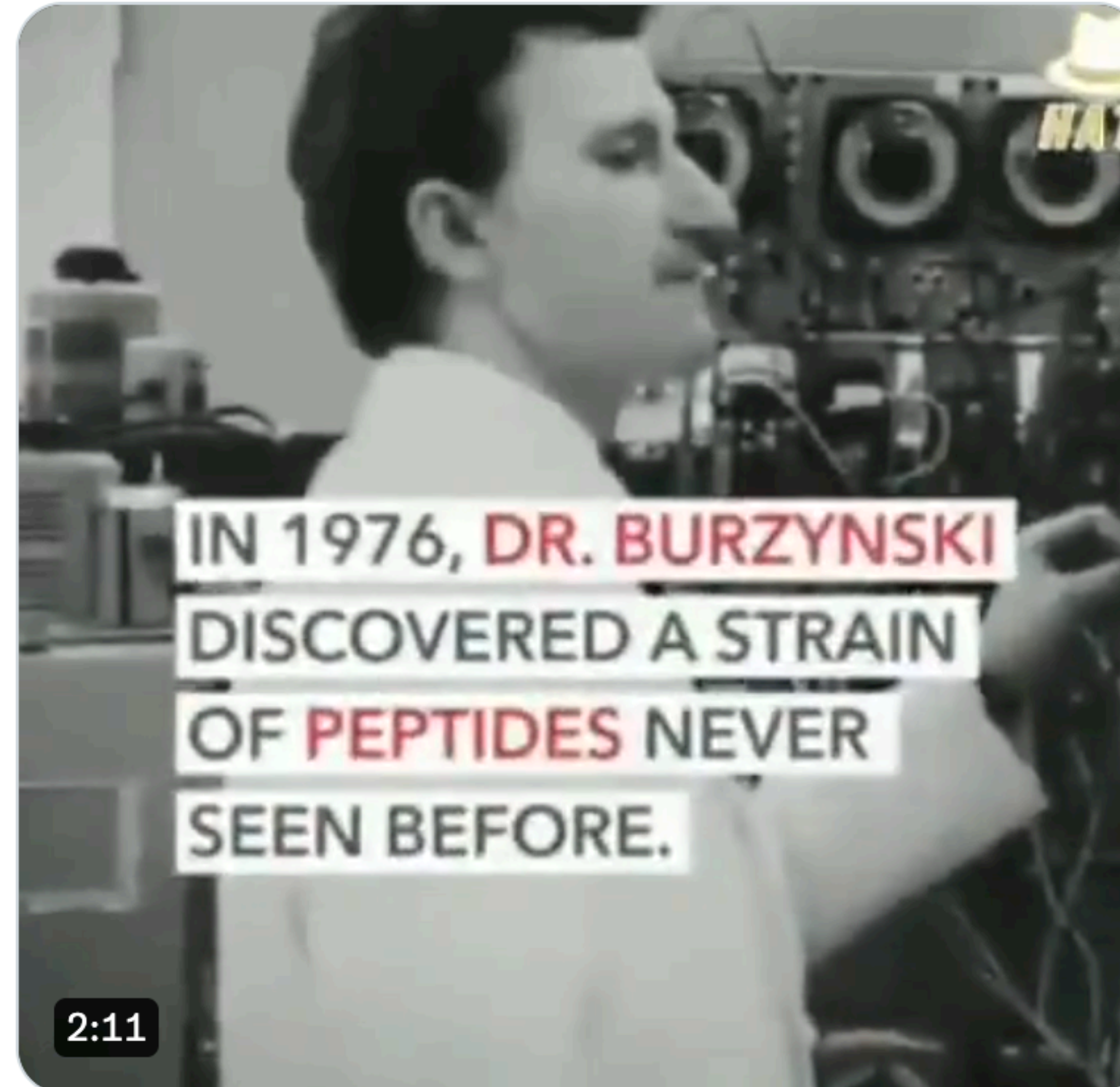


healthbot
@thehealthb0t

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The cure for cancer was discovered in 1976



2:11

Readers added context

No, it wasn't. Cancer is a complex group of diseases with various types, subtypes & stages. Dr. Burzynski's work on Antineoplastons therapy has been characterized as controversial & claimed successes haven't been replicated by other



Kian@naturelvr49 · 14h

Whales are not actually mammals
Humans (land mammals) can't d
seawater — just try it! — how c
supposed sea mammals like wh
hydrated?

Rate proposed Community

Whales are indeed mammals. mammals are able to “stay hy because their kidneys have ev excrete more salt + reclaim m than humans and many other mammals can. They also obta from their food. This is widely documented, for example in [h](#) [reputable...](#)

Is this proposed note helpful?

Proposals are only shown to contri



Today

What is the wisdom of the crowd? What is crowdsourcing?

Why do they work?

When do they work?

Wisdom of the crowd

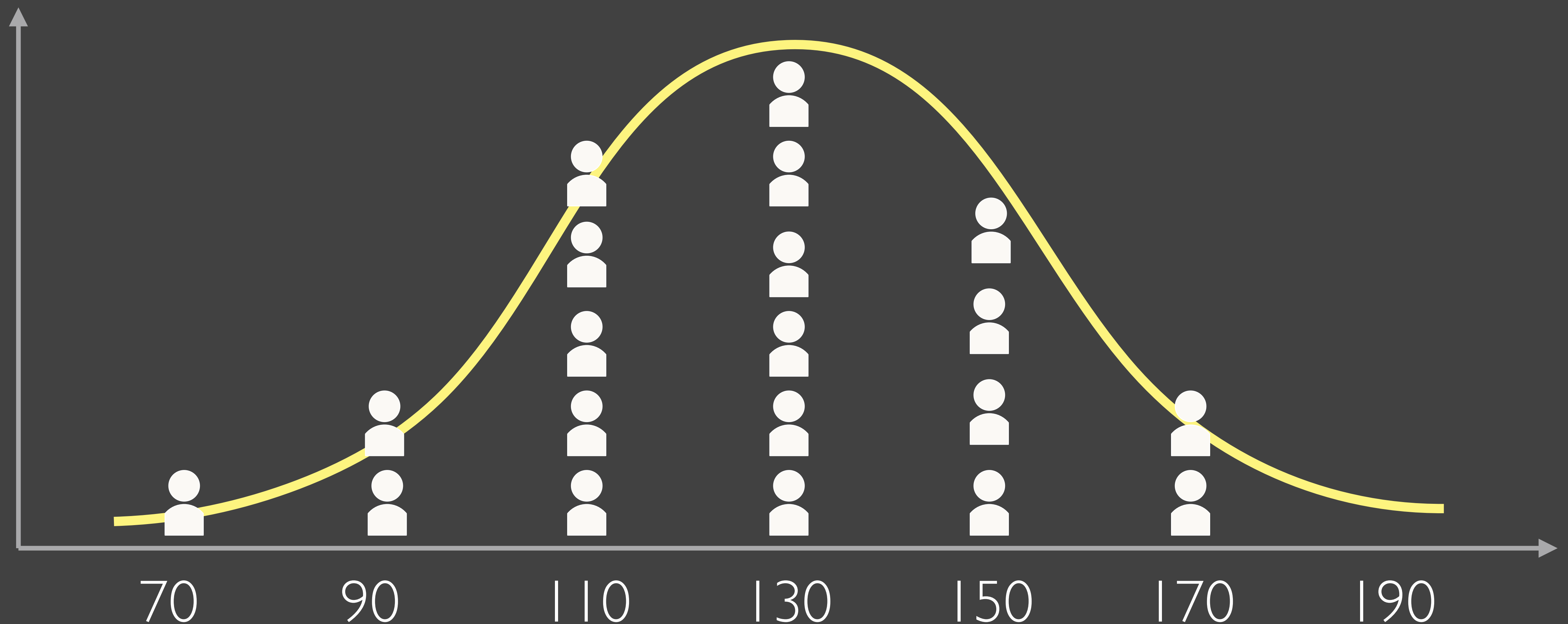
Crowds are surprisingly accurate at estimation tasks

Who will win the election? How many jelly beans are in the jar?
What will the weather be? Is this website a scam?

Individually, we all have errors and biases.

However, in aggregate, we exhibit surprising amounts of **collective intelligence** [Malone and Bernstein 2015]

“Guess the number of minutes it takes to fly from Stanford, CA to Seattle, WA.”



If our errors are distributed at random around the true value, we can recover it by asking enough people and aggregating.

What problems can be solved this way?

Jeff Howe [2009] theorized that that it required:

- Diversity of opinion

- Decentralization

- An aggregation function (e.g., average)

So — any question that has a binary (yes/no), categorical (e.g., win/lose/tie), or interval (e.g., score spread on a football game) outcome

What problems **cannot** be solved this way?

Flip the bits!

- People all think the same thing

- People can communicate

- No way to combine the opinions

For example, writing a short story (is much harder!)

General algorithm

1. Ask a large number of people to answer the question

Answers must be independent of each other — no talking!

People must have a reasonable level of expertise regarding the phenomenon in question.

2. Average their responses

Why does this work at generating accurate estimates? [2min]

Why is the crowd wise?

[Simoiu et al. 2020]

Independent guesses minimize the effects of social influence


Showing consensus cues such as the most popular guess lowers accuracy

Crowds are more consistent guessers than experts

In an experiment, crowds are only at the 67th percentile on average per question...but at the 90th percentile averaged across questions!


Tortoise and the Hare: the tortoise is consistent (67th percentile) while the hare alternates between sprinting and resting

Mechanism: ask many independent contributors to take a whack at the problem, and reward the top contributor




Kaggle is the place to do data science projects

[See how it works](#)



The illustration depicts a data science workflow. It features a central laptop with a line graph on its screen. To the left, there are bar charts and a person icon. To the right, there are more person icons, a cloud with an upload arrow, and various mathematical symbols like plus, minus, and double-headed arrows. The overall theme is collaborative data analysis.




NASA TV

NASA Solve

Welcome to NASA Solve!

Interested in helping NASA solve tough problems? You are in the right place! This one-stop-shop website is where you'll find opportunities to participate in challenges, prize competitions, and citizen science activities that develop solutions for problems related to NASA's mission. So, jump in and become a NASA SOLVE-r!

TAP



The video player shows the NASA Solve logo and the word "SOLVE" in large, stylized letters. The player interface includes a "Watch later" button and a "Share" button.

Mechanism: use a market to aggregate opinions

PredictIt Login Sign Up

U.S. Elections Trump Admin Congress Justice World

Spain's next leader?

Election Sunday

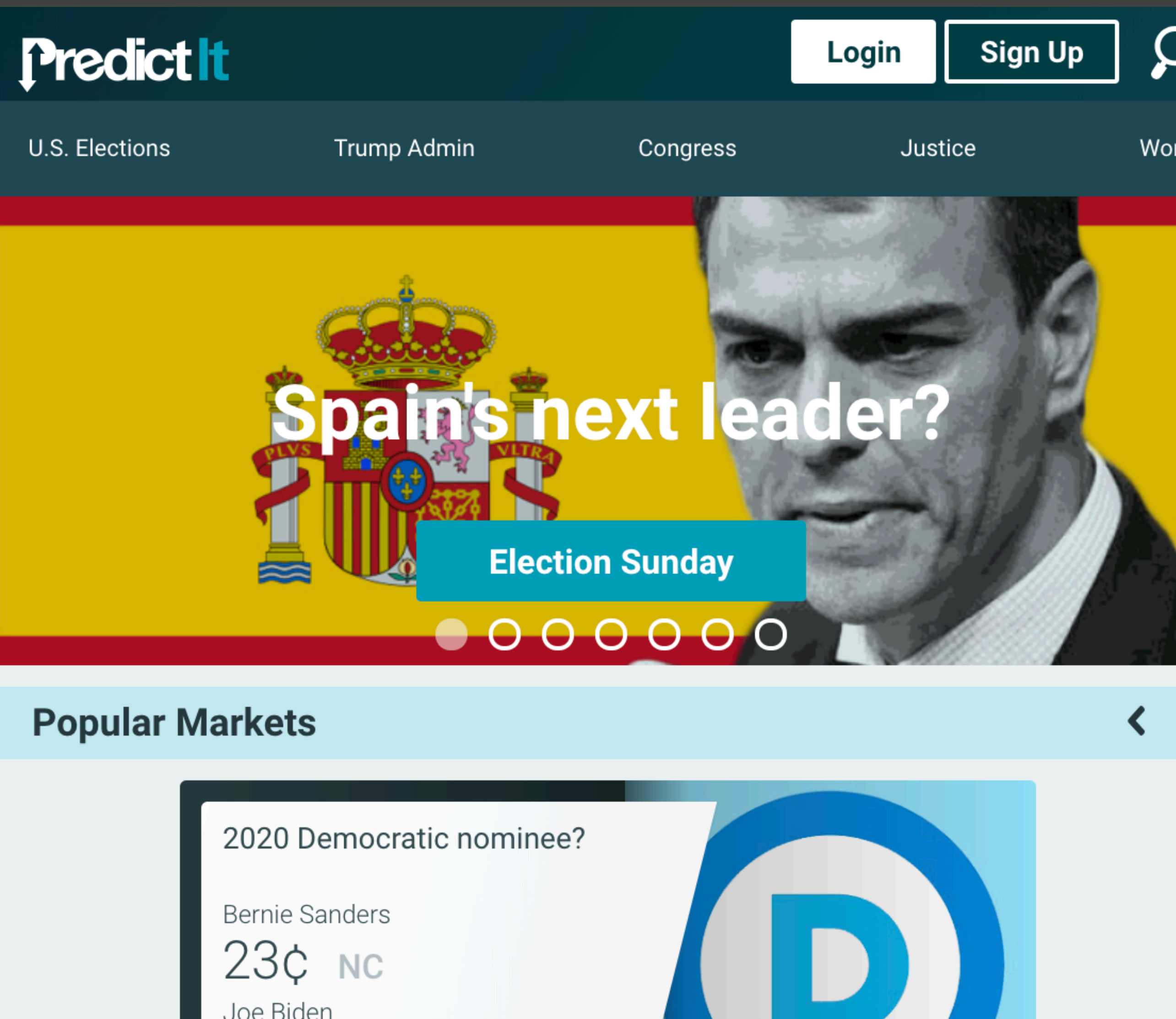
● ○ ○ ○ ○ ○ ○ ○

Popular Markets

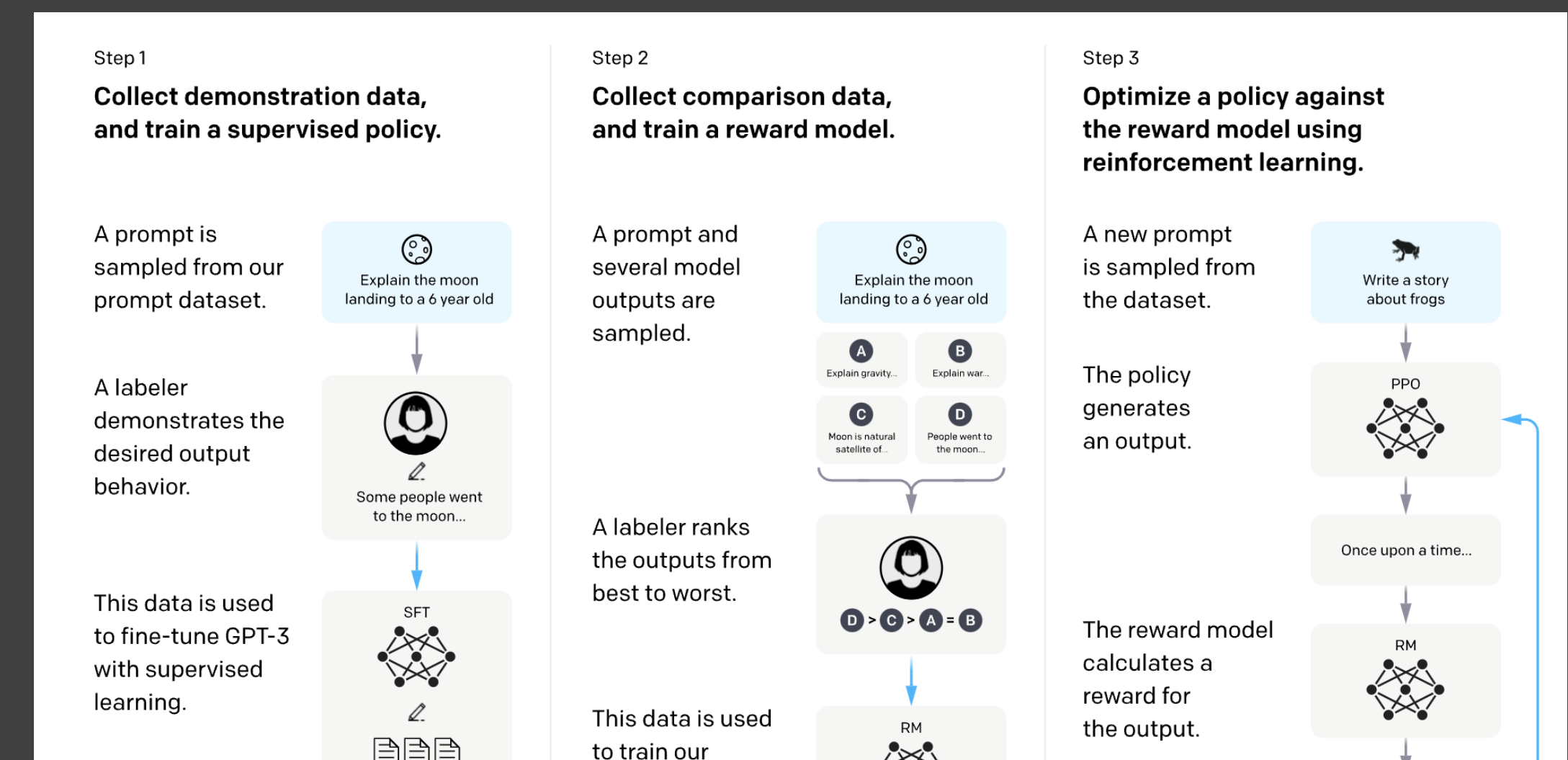
2020 Democratic nominee?

Bernie Sanders 23¢ NC




Joe Biden





Mechanism: ask paid data annotators to label the same image and look for agreement in labels




Mechanism: contributors fill out rows in a “spreadsheet”




 **Galaxy Zoo**  17 languages 

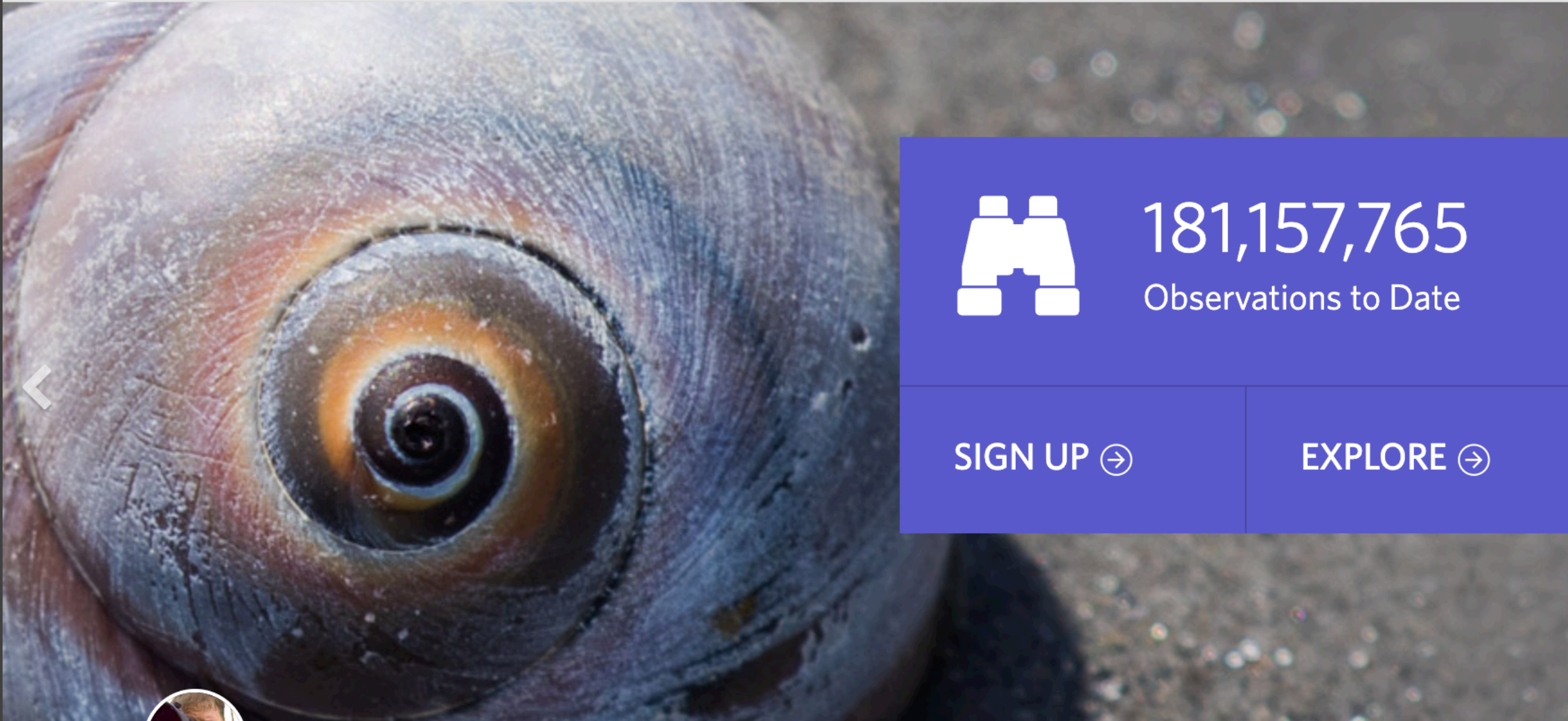
Article **Talk**  Tools 


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iNaturalist  Explore Community  More  Log In or Sign Up





 **181,157,765**
Observations to Date

[SIGN UP !\[\]\(e46bd8df68d5eebf9040942667ff08d4_img.jpg\)](#) [EXPLORE !\[\]\(096a146ef66dd05372c2c492e511d47e_img.jpg\)](#)

 BJ Stacey ~ Shark Eye Snail from Essex County, Massachusetts, USA

 **OpenStreetMap** 

OpenStreetMap provides map data for thousands of websites, mobile apps, and hardware devices

OpenStreetMap is built by a community of mappers that contribute and maintain data about roads, trails, cafés, railway stations, and much more, all over the world.

Local Knowledge

OpenStreetMap emphasizes local knowledge. Contributors use aerial imagery, GPS devices, and low-tech field maps to verify that OSM is accurate and up to date.

Mechanism: algorithmically aggregate to look for cross-partisan consensus



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ByteDance is reportedly considering selling TikTok without the algorithm to someone outside the tech industry

Via: The Information



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reuters.com/technology/byt...

usnews.com/news/technolog...

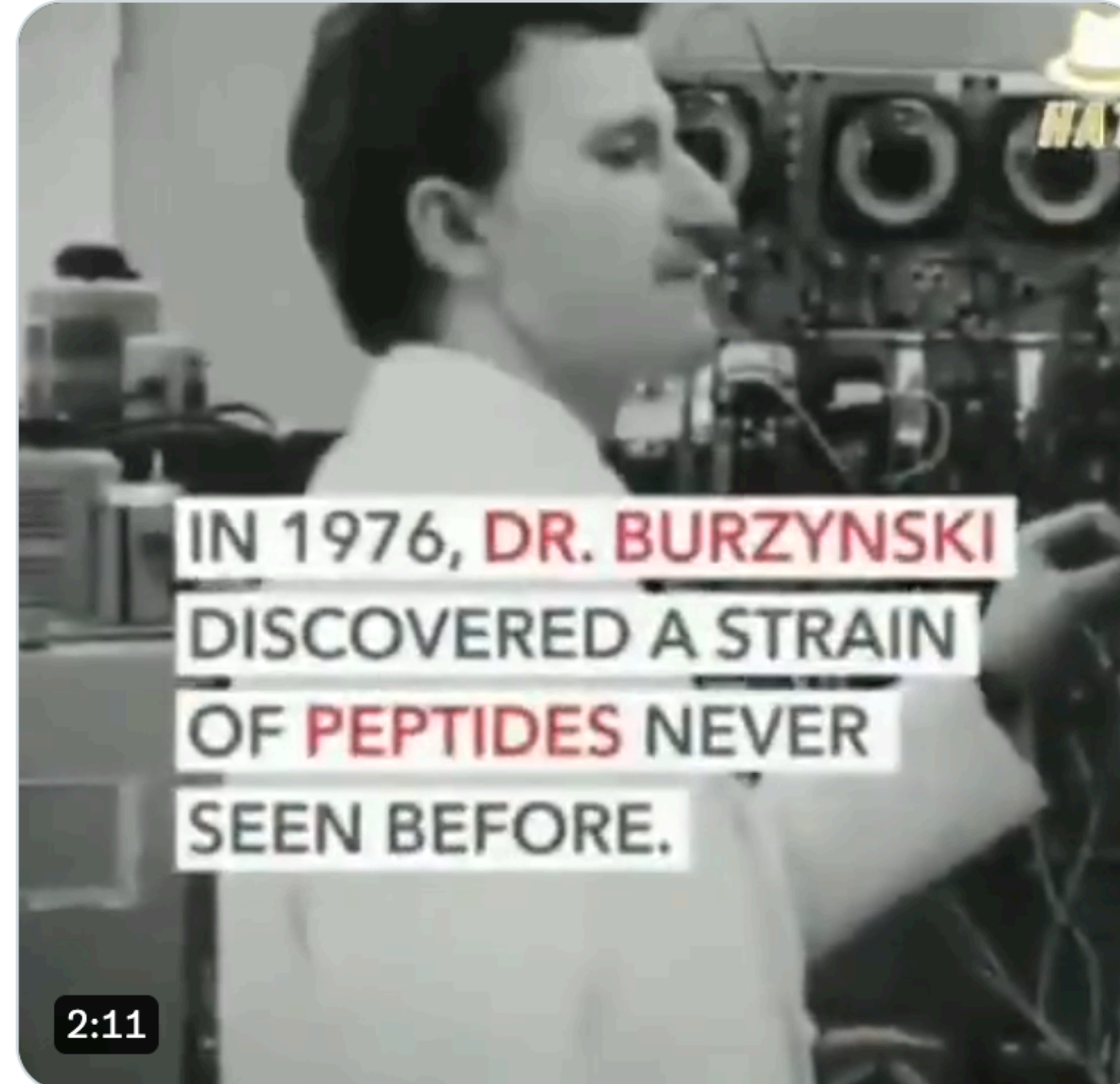


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No, it wasn't. Cancer is a complex group of diseases with various types, subtypes & stages. Dr. Burzynski's work on Antineoplastons therapy has been characterized as controversial & claimed successes haven't been replicated by other



Kian@naturelvr49 · 14h

Whales are not actually mammals
Humans (land mammals) can't breathe
seawater — just try it! — how can
supposed sea mammals like whales
hydrate?

Rate proposed Community note

Whales are indeed mammals. All
mammals are able to “stay hydrated”
because their kidneys have evolved to
excrete more salt + reclaim more water
than humans and many other
mammals can. They also obtain water
from their food. This is widely
documented, for example in [this](#)
[reputable...](#)

Is this proposed note helpful?

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Let's check our
<http://hci.st/wise> results

Aggregation approaches

Early crowdsourcing

[Grier 2007]

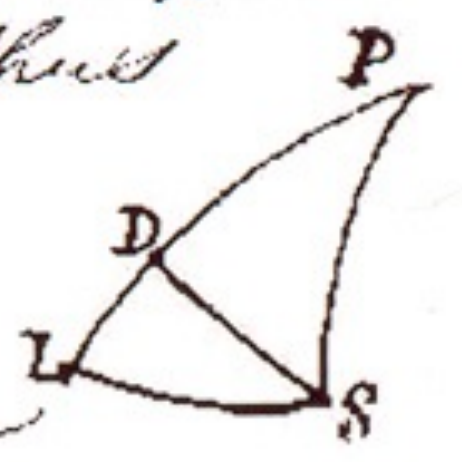
Two distributed workers work independently, and a third verifier adjudicates their responses



1760

British Nautical Almanac
Nevil Maskelyne

In answer to your letter of the 23. instant
 Compute D: dist. from a star by logarithms, thus
 P, the pole of the ecliptic, N or S. P, P, are
 the stars & moon's distances from one of the same pole.
 & the D, the star, S D a perpendicular
 great circle. Let fall from S to PL, perpendicular
 to it in D. There suppose P to be less than 90.
 By Log^s. $c, p+t, pS = t, pD$ & $pL - pD = LD$
 $c, LS = -c, pD + c, pS + c, LD$



or $c, p + s, pS - s, pD + c, LD$
 The latter formula must be used when pD
 is large, or near 90; but may be used safely
 in all cases. --

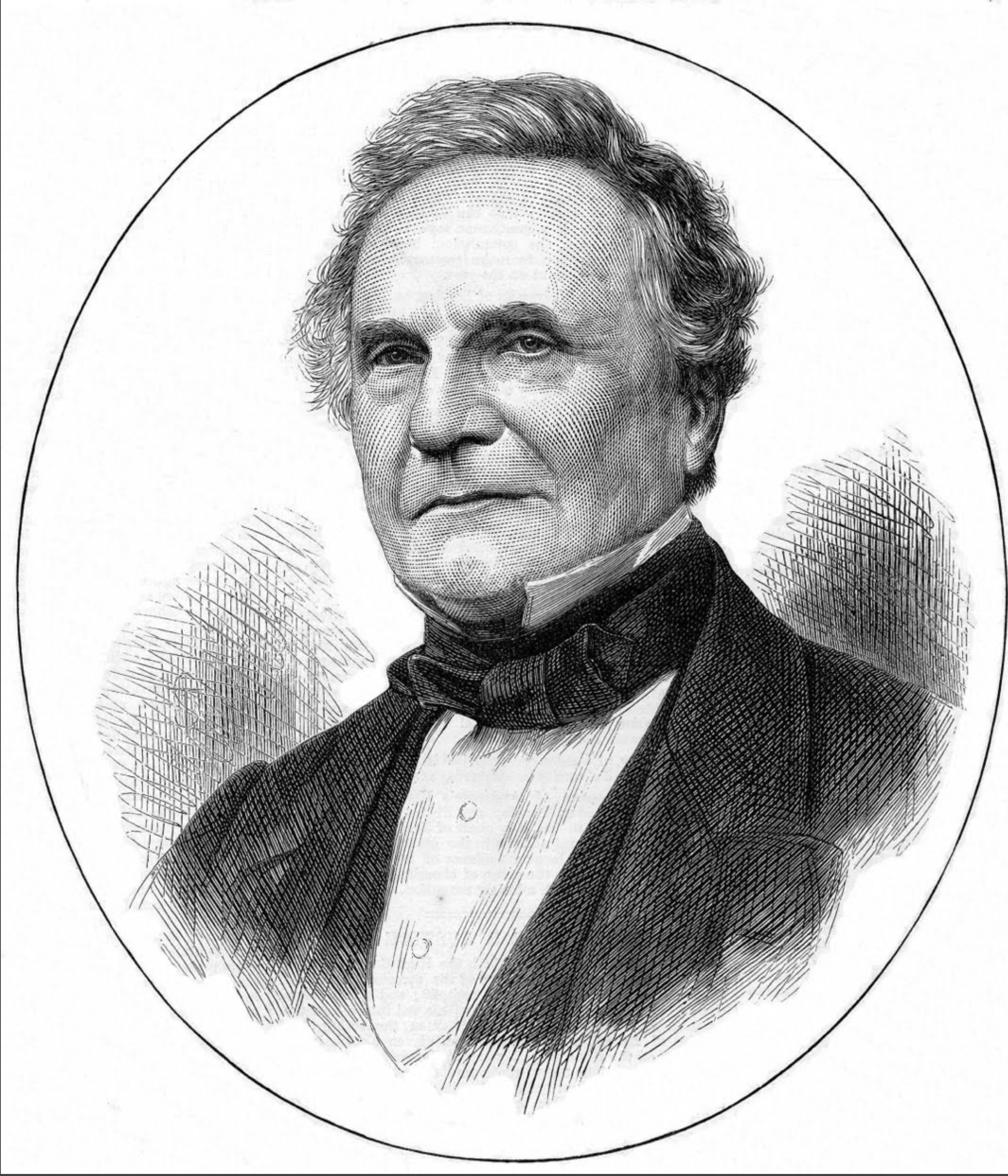
Example
 $p 20.30 - c = 9.9715876$
 $pS 89.58.30 - t = 13.3857588$
 $p 25.25.30 - c = 9.9557589$
 $pS - t = 12.0977246$
 $pD 89.29.36 - t = 12.0534829$
 $pL 85.0.0 - c = 9.9999879$
 $LD 4.29.36 - c = 9.9986631$
 $SL 25.47.30 - c = 9.9544269$

If P should be greater than 90
 then $pL + pD = LD$ as in this scheme



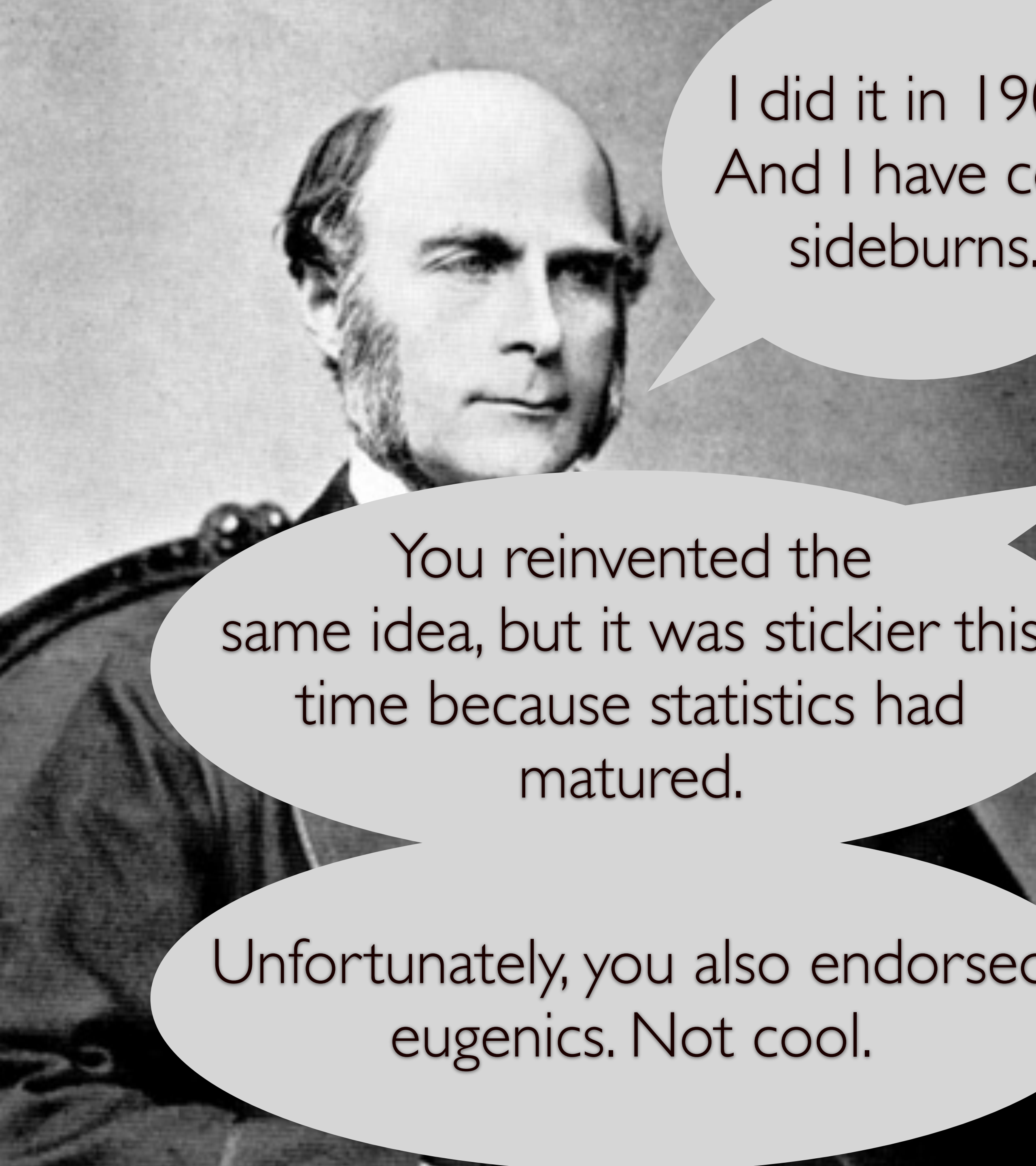
As the planets places, excepting the
 sun and moon are only set down to minutes,
 there is no occasion to allow for nutation &
 aberration. -- In computing the occultations of
 stars by the D you must calculate their longitudes & lat^s
 to second, and apply nutation & aberration I am glad to
 be second, and apply nutation & aberration I am glad to

at Noon.	at Noon.	of the	of the
S. D. M. S.	D. M. S.		
1 2 20 0 51	2 58 29	1	
2 3 2 45 8	3 48 32	2	
3 3 15 46 23	4 28 29	3	
4 3 29 3 54	4 54 28	4	Spica m.
5 4 12 35 47	5 4 34	5	Id
6 4 26 19 33	4 57 26	6	Id
7 5 10 12 31	4 32 51	7	Id
8 5 24 12 11	3 51 51	8	Antares
9 6 8 16 36	2 56 35	9	Id
10 6 22 24 16	1 50 19	10	Id
11 7 6 34 4 0	37 6	11	α aquila
12 7 20 44 43	0 38 25	12	Id
13 8 4 54 27	1 51 21	13	Fomalh.
14 8 19 0 45	2 57 1	14	Id
15 9 3 0 17	3 51 19	15	Id
16 9 16 49 18	4 31 12	16	Id
17 10 0 24 8	4 54 54	17	α arictis
18 10 13 41 50	5 1 59	18	Id
19 10 26 40 41	4 53 8	19	Id
20 11 9 20 28	4 29 54	20	Id
21 11 21 42 30	3 54 21	21	Id
22 0 3 49 35	3 8 48	22	α decbar?
23 0 15 45 40	2 15 32	23	Id
24 0 27 35 32	1 16 47	24	Id
25 1 9 24 26	0 14 46	25	last
26 1 21 17 52	0 48 14	26	Id
27 2 3 21 8	1 49 51	27	α arictis
28 2 15 38 50	2 17 31	28	Id



Charles Babbage

Two people doing the same task in the same way will make the same errors.



I did it in 1906.
And I have cool
sideburns.

You reinvented the
same idea, but it was stickier this
time because statistics had
matured.

Unfortunately, you also endorsed
eugenics. Not cool.



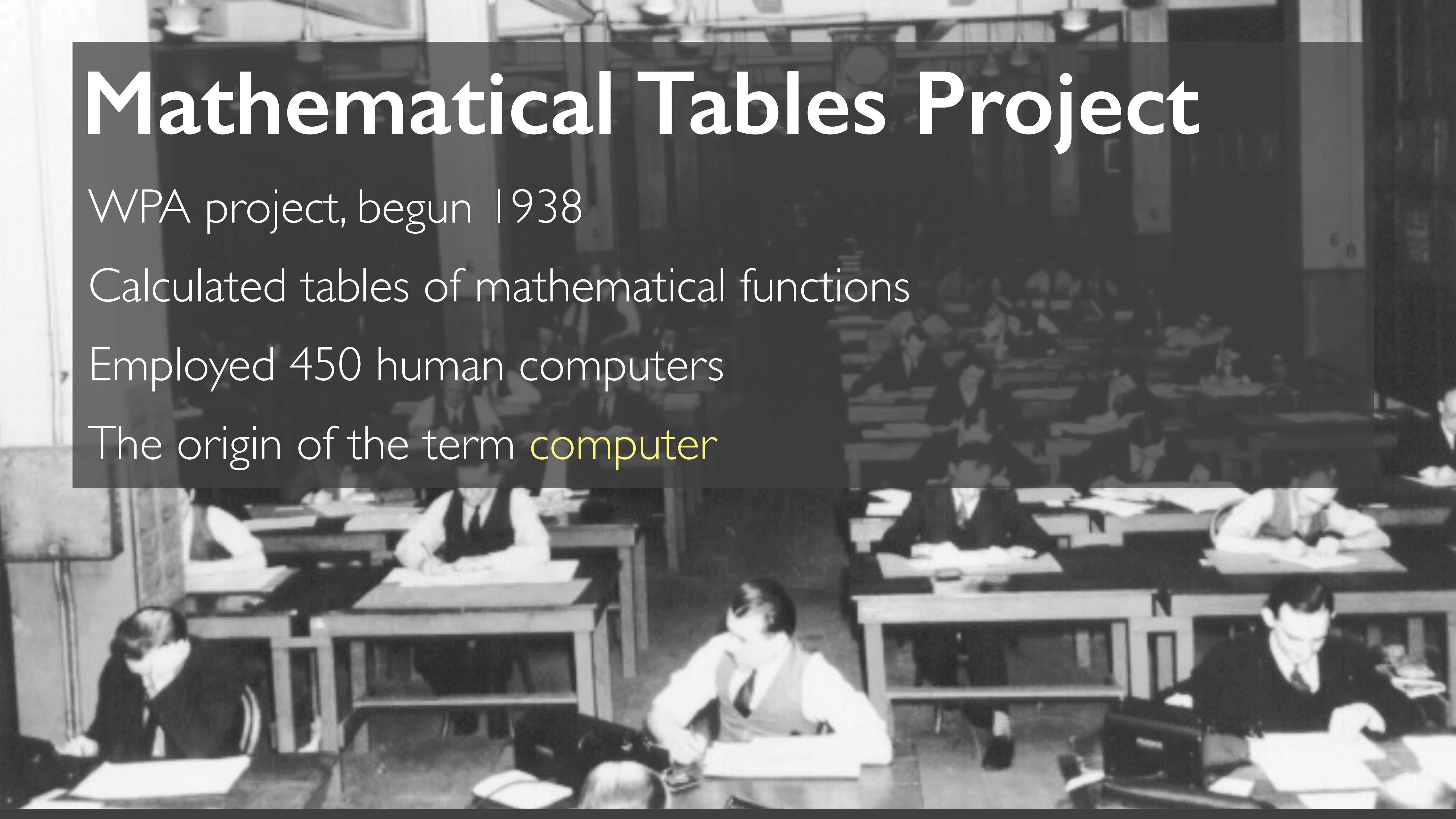
Mathematical Tables Project

WPA project, begun 1938

Calculated tables of mathematical functions

Employed 450 human computers

The origin of the term **computer**



OBITUARIES

Katherine Johnson, NASA Mathematician And An Inspiration For 'Hidden Figures,' Dies

February 24, 2020 · 10:22 AM ET

Heard on [Morning Edition](#)



RUSSELL LEWIS



3-Minute Listen



20th
Century
Fox

Enter computer science

Computation allows us to execute these kinds of goals at even larger scale and with even more complexity.

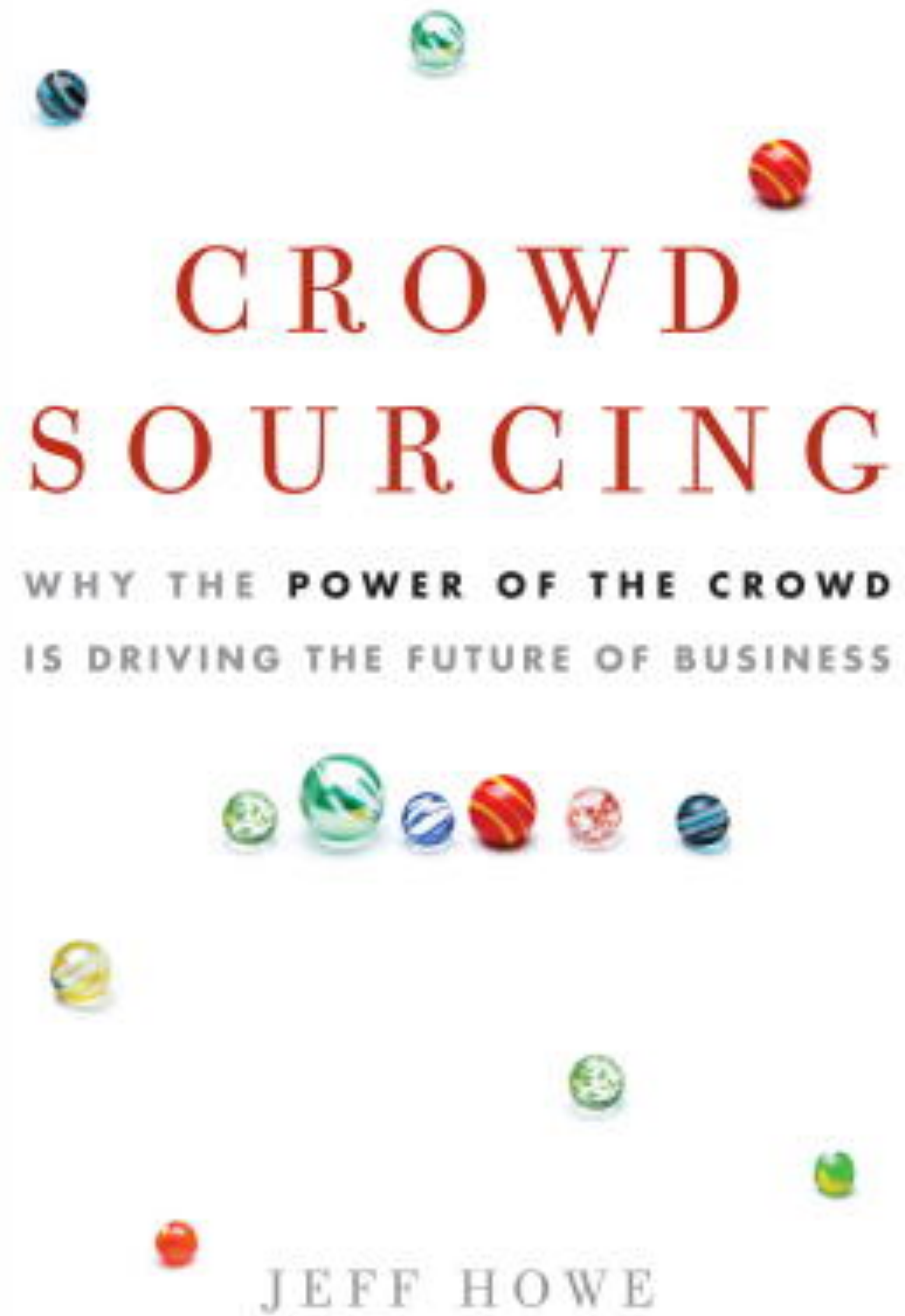
We can design systems that gather evidence, combine estimates, and guide behavior.

Forms of crowdsourcing

Definition

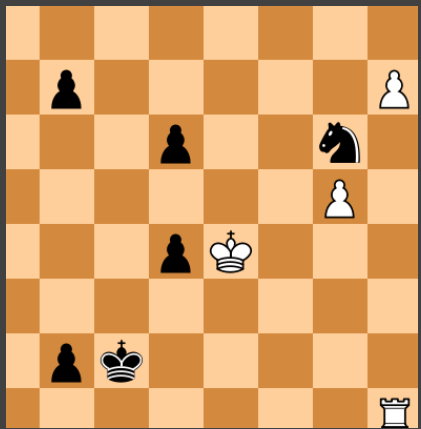
Crowdsourcing term coined by Jeff Howe [2006] in Wired

“Taking [...] a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call.”

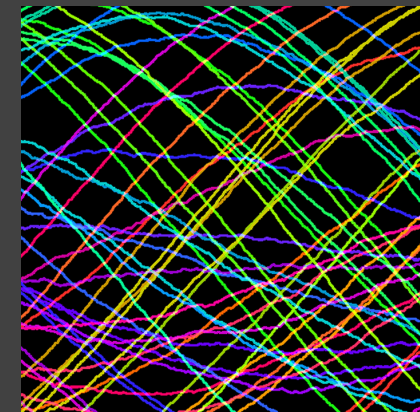


Volunteer crowdsourcing

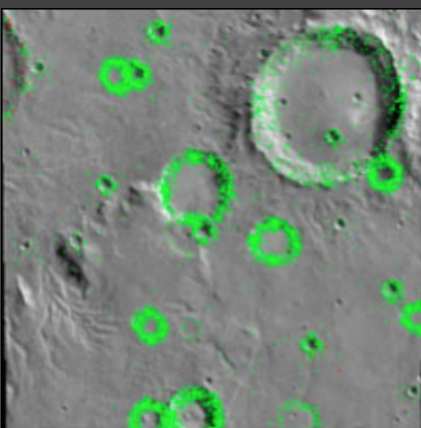
Tap into intrinsic motivation to recruit volunteers



Kasparov vs. the world



Collaborative math proofs



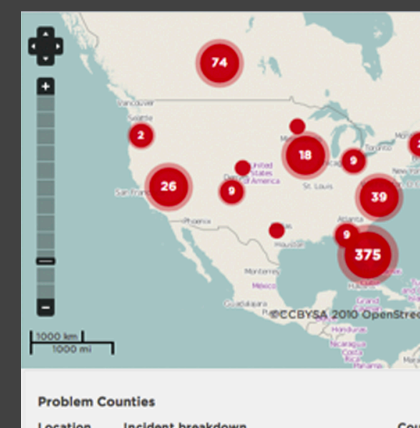
NASA Clickworkers



Search for a missing person



Wikipedia



Ushahidi crisis mapping

Paid crowd work

Crowds of online freelancers are now available via online platforms

Amazon Mechanical Turk, Figure Eight, Upwork, TopCoder, etc.

600,000 workers are in the United States' digital on-demand economy
[Economic Policy Institute 2016]

Eventually, this will include 20% of jobs in the U.S. [Blinder 2006],
about 45,000,000 full-time workers [Horton 2013]

The promise: What if the smartest minds of our generation could be brought together? What if you could flexibly evolve your career?

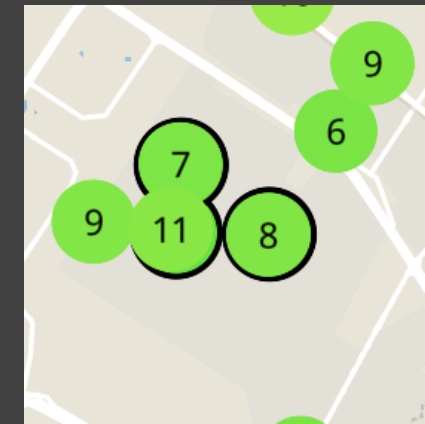
The peril: what happens when an algorithm is your boss?

Automated sharing

Opt in to sharing and aggregation



Waze traffic sharing
(also includes manual)



Purple Air air quality sensors

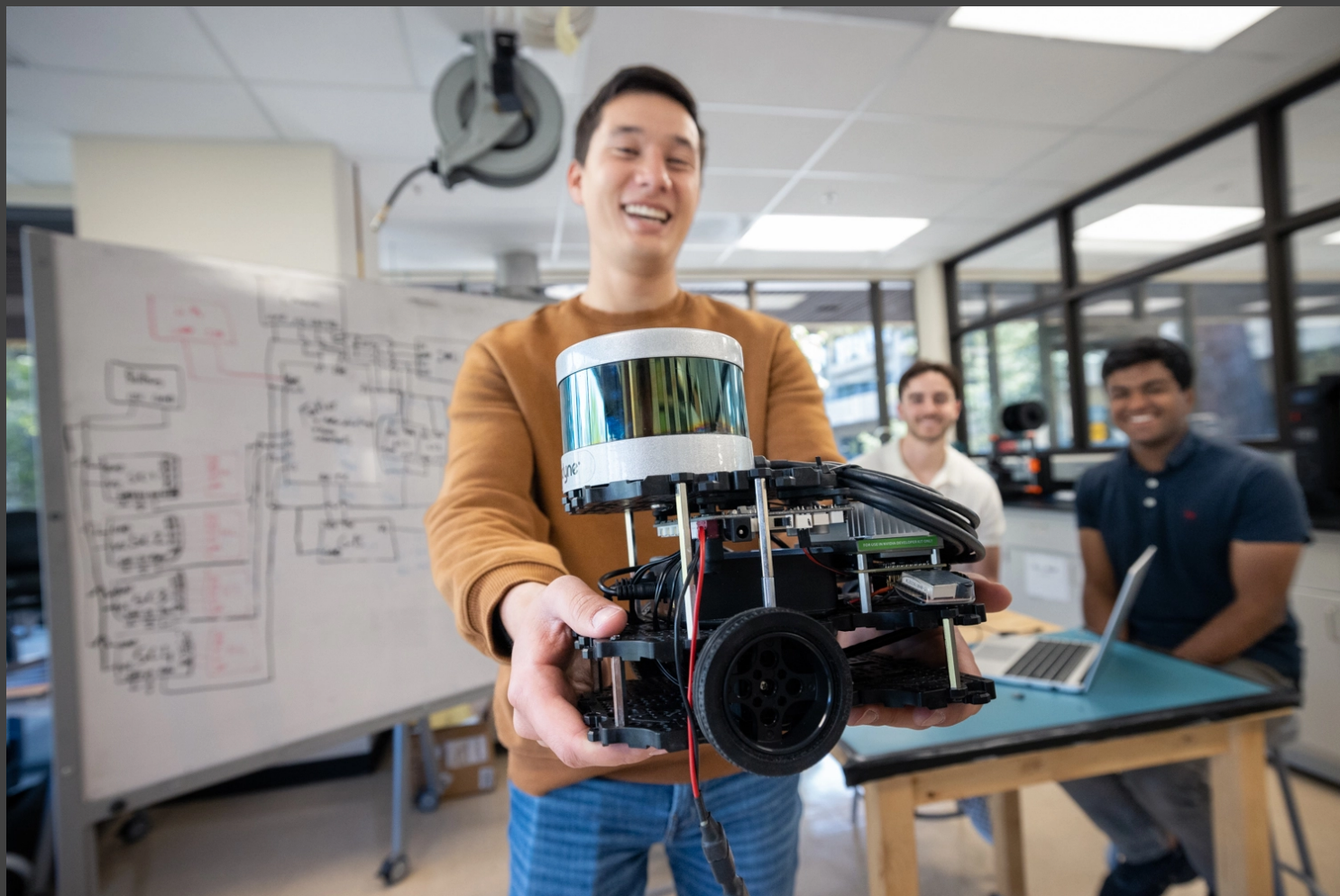


Privacy-Preserving Contact Tracing

Across the world, governments, and health authorities are working together to find solutions to the COVID-19 pandemic, to protect people and get society back up and running. Software developers are contributing by crafting technical tools to help combat the virus and save lives.

Games with a purpose

[von Ahn and Dabbish 2004]



Taboo words:
Camera
Research
Smile

Type your next guess:

Make the data labeling goal enjoyable.

You are paired up with another person on the internet, but can't talk to them. You see the same image. Try to guess the same word to describe it.

Taboo words are words that others already agreed on

Games with a purpose

[von Ahn and Dabbish 2004]



Let's try it. Volunteers?

Taboo words:

Burger

Food

Fries

Games with a purpose

[von Ahn and Dabbish 2004]



Let's try it. Volunteers?

Taboo words:

Stanford

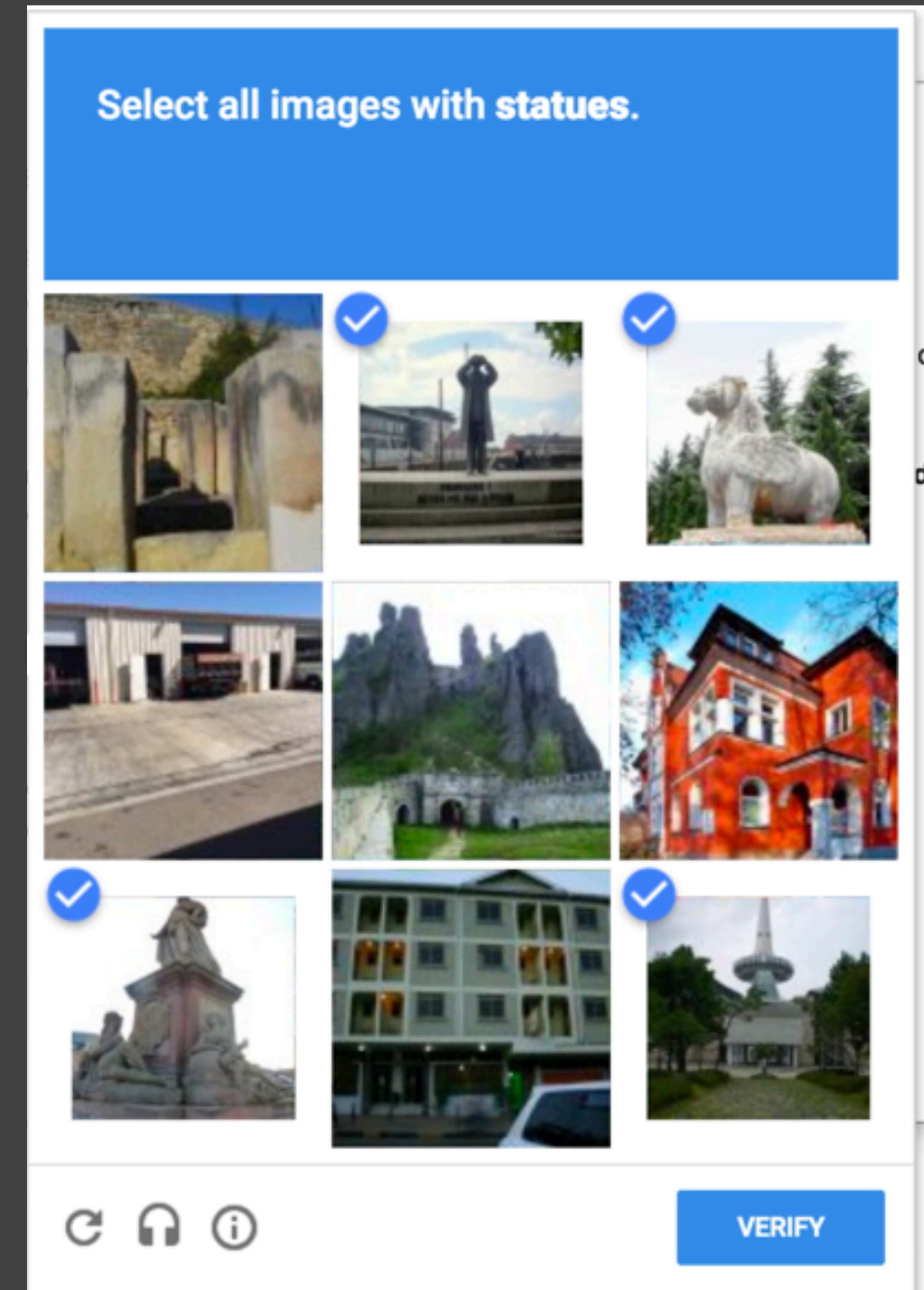
Graduation

Wacky walk

Appendix

reCAPTCHA

“Oh, I see you’d like to make an account here. Sure would be a shame if you couldn’t get into my website. Maybe you should help me train my AI system and I’ll see if I can do something about letting you in.”



Handling collusion and manipulation

Boaty McBoatface: What You Get When You Let the Internet Decide



Not the name that the British were expecting to see



Stephen Colbert fans raid NASA's vote to name the new ISS wing

An Android robot is peeing on an Apple logo in Google Maps

by [David Goldman](#) @DavidGoldmanCNN

🕒 April 24, 2015: 11:26 AM ET



Kim Jong Un voted Time's Person of the Year by readers

The Lookout

December 13, 2012



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Faculty Experts
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Facebook
Brochures
Monthly News Email
Blog
Video
Monthly Email
Press Clips
Media Resources

Media Contacts

Daniel Kane
858-534-3262
dbkane@ucsd.edu

Ioana Patringtonaru
858-822-0899

UC San Diego Team's Effort in DARPA's Shredder Challenge Derailed by Sabotage



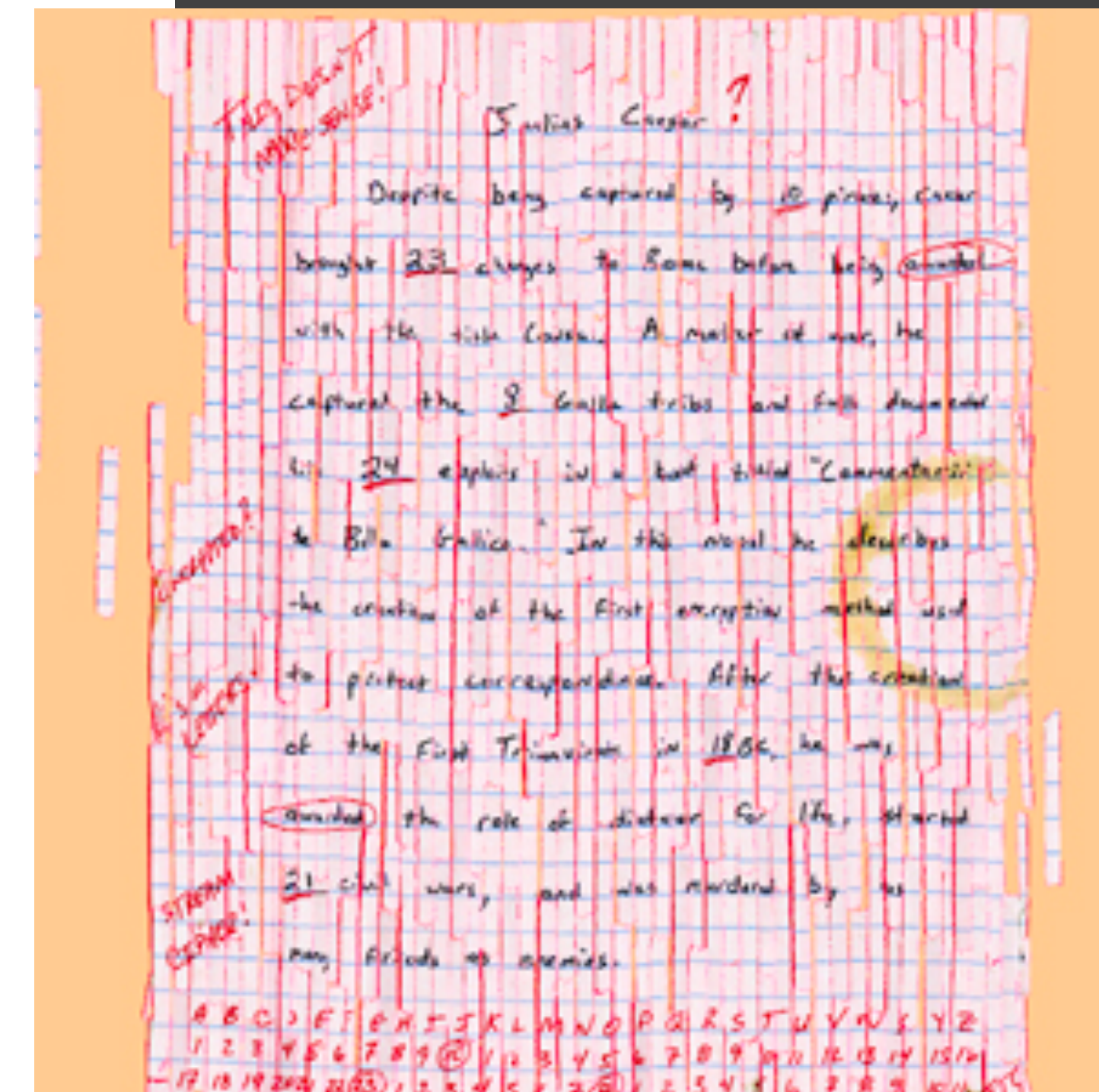
Manuel Cebrian, a computer science researcher, led a team that came in sixth in a DARPA challenge.

San Diego, Calif.
Dec. 21 -- After a strong start in the U.S. Defense Department's \$50,000 'Shredder Challenge', researchers at the University of California, San Diego fell short of taking the top prize, in part

because of an anonymous attack on the team's online "crowdsourcing" approach to solving the challenge.

Jacobs School's
monthly newsletter

A small number of malicious individuals can tear apart a collective effort.





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Batman

From Wikipedia, the free encyclopedia

DUN NUH NUH NUH NUH DUH NUH NUH NUH NUH NUH BATMAN! DUN NUH NUH NUH NUH DUH
NUH NUH NUH NUH NUH BATMAN! DUN NUH NUH NUH NUH DUH NUH NUH NUH NUH BATMAN!
DUN NUH NUH NUH NUH DUH NUH NUH NUH NUH BATMAN! BATMAN! BATMAN! BATMAN! DUN
NUH NUH NUH NUH DUH NUH NUH NUH NUH **BATMAN!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!**

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US Congress banned from editing Wikipedia after staff caught trolling

Recent edits accuse Donald Rumsfeld of being an alien lizard and Cuba of faking the moon landings





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Harlem shake (dance)

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Oh God i didn't mean to delete it all, just one paragraph.Please help

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Jeremy Renner

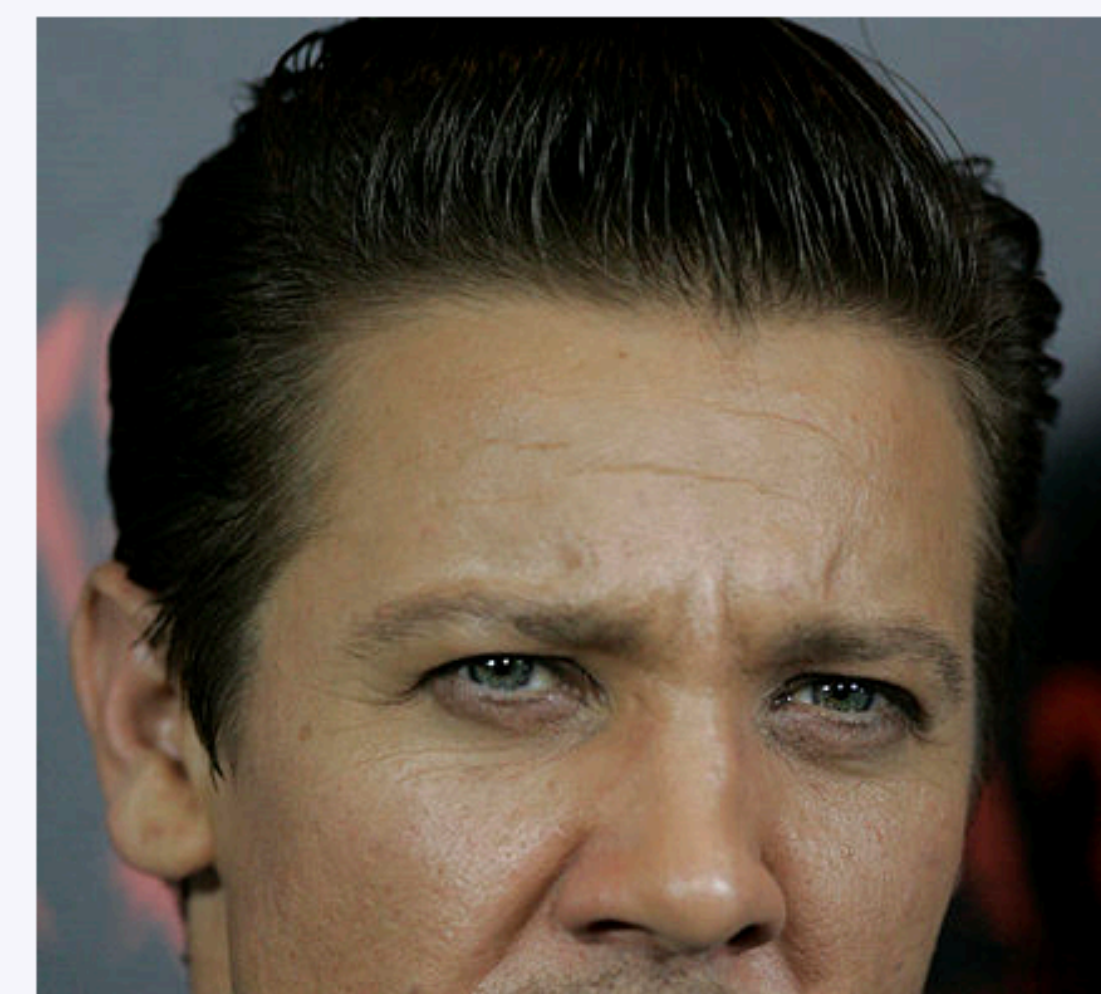
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This is an **old revision** of this page, as edited by **187.137.5.101** (**talk**) at 00:04, 30 January 2013. The present address (URL) is a **permanent link** to this revision, which may differ significantly from the **current revision**.

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Jeremy Lee Renner (born January 7, 1971)^{[1][2][3]} is an American actor, singer-songwriter, **velociraptor**, film producer, former makeup artist, and musician. He has had starring roles in *The Hurt Locker* (2008) (garnering him an **Academy Award** nomination for **Best Actor**), *Mission: Impossible – Ghost Protocol* (2011), *Marvel's The Avengers* (2012), and *The Bourne Legacy* (2012). Throughout the 2000s, Renner appeared largely in independent films such as *Dahmer* (2002) and *Neo Ned* (2005). He also appeared in supporting roles in bigger films, *S.W.A.T.* (2003) and *28 Weeks Later* (2007). He then turned out a much-praised performance in *The Town* (2010), for which he received an Academy Award nomination for **Best Supporting Actor**.

Jeremy Renner



- (cur | prev) 12:33, 12 February 2013 Cydebot (talk | contribs) m . . (28,792 bytes) (-37) . . (Robot - Removing category Satellite Award winners per *CFD* at *Wikipedia:Categories for discussion/Log/2013 February 4.*)
- (cur | prev) 22:19, 3 February 2013 Guat6 (talk | contribs) . . (28,829 bytes) (+37) . . (added *Category:Satellite Award winners* using *HotCat*)
- (cur | prev) 14:11, 1 February 2013 Sikkle (talk | contribs) . . (28,792 bytes) (+1)
- (cur | prev) 23:01, 30 January 2013 Lowercase sigmabot (talk | contribs) m . . (28,791 bytes) (+17) . . (Adding protection templates) (bot)
- (cur | prev) 22:31, 30 January 2013 Topbanana (talk | contribs) m . . (28,774 bytes) (0) . . (Protected Jeremy Renner: Persistent *vandalism: Reddit fad* ([Edit=Block new and unregistered users] (indefinite) [Move=Block new and unregistered users] (indefinite)))
- (cur | prev) 21:19, 30 January 2013 Zafaras (talk | contribs) . . (28,774 bytes) (-13) . . (→Early life: The "velociraptor" thing again.)
- (cur | prev) 21:04, 30 January 2013 129.97.124.193 (talk) . . (28,787 bytes) (+13)
- (cur | prev) 17:25, 30 January 2013 63.248.26.218 (talk) . . (28,774 bytes) (+48)
- (cur | prev) 01:02, 30 January 2013 EsonLinji (talk | contribs) m . . (28,726 bytes) (-14) . . (Jeremy Renner is not a velociraptor)
- (cur | prev) 00:04, 30 January 2013 187.137.5.101 (talk) . . (28,740 bytes) (+14)
- (cur | prev) 21:43, 29 January 2013 JLeland (talk | contribs) . . (28,726 bytes) (-14) . . (stomping velociraptor silliness)
- (cur | prev) 18:15, 29 January 2013 71.51.19.153 (talk) . . (28,740 bytes) (+14)
- (cur | prev) 16:33, 29 January 2013 37.106.37.118 (talk) . . (28,726 bytes) (-151)
- (cur | prev) 09:06, 29 January 2013 All Hallow's Wraith (talk | contribs) m . . (28,877 bytes) (-7) . . (→Breakthrough: 2009–present)
- (cur | prev) 09:05, 29 January 2013 All Hallow's Wraith (talk | contribs) m . . (28,884 bytes) (-49)
- (cur | prev) 08:54, 29 January 2013 198.228.228.22 (talk) . . (28,933 bytes) (-14) . . (removed 'velociraptor' from description of talents)
- (cur | prev) 03:30, 29 January 2013 67.189.247.59 (talk) . . (28,947 bytes) (+14)
- (cur | prev) 02:34, 29 January 2013 ClueBot NG (talk | contribs) m . . (28,933 bytes) (-9) . . (Reverting possible vandalism by *108.218.146.101* to version by *199.168.62.2*. False positive? *Report it*. Thanks, *ClueBot NG*. (1472111) (Bot))

Can we survive vandalism?

It's a calculation of the cost of vandalism vs. the cost of cleaning it up.

How much effort does it take to vandalize Wikipedia?

How much effort does it take an admin to revert it?

If effort to vandalize \ggg effort to revert, then the system can survive.

How do you design your crowdsourcing system to create this balance?

Michael's take

There are two primary causes of quality challenges:

Strategic dishonesty, where the contributor is explicitly seeking to get away with something

Mental model misalignment, where the creator has not clearly communicated their goal

My experience is that strategic dishonesty is rare and can be caught, whereas mental model misalignment is ubiquitous

(But most of the field's focus is on strategic dishonesty)

Training

Attention checks and gold standard judgments [Le et al. 2010]

- Include questions with known answers

- Performance on these “gold standard” questions is used to filter submissions

Gated instruction [Liu et al. 2016]

- Create a training phase where you know all the answers already, and give feedback on every right or wrong answer during training

- At the end of training, only let people go on if they have a high enough accuracy

Assignment 3: Let's Crowdsource An Exam

Goal: gain experience with crowdsourcing workflows, and their double-edged nature. We will be constructing our own exam!

- Part I: brainstorm exam questions

- Part II: remix others' questions

- Part III: vote

- break for exam—

- Part IV (due after the exam): reflections

Top questions by vote will form a public question bank of possible questions for the exam. You get full credit if a question you contributed is on the exam. Staff will add some questions not in the question bank as well.

Summary

Crowdsourcing: an open call to a large group of people who self-select to participate

Crowds can be surprisingly intelligent, if opinions are levied with some expertise and without communication, then aggregated intelligently.

Design differently for intrinsically and extrinsically motivated crowds

Vandalism—much like other anti-social behavior—is rare, but can happen

References

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Social Computing

CS 278 | Stanford University | Michael Bernstein

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