Collective Intelligence

Barry Smyth


A
B
C

About Me

Academic

BSc. Computer Science (UCD), PhD (TCD), Prof Computer Science (2001 -)
Research Areas: AI, Recommender Systems, etc *(AIC, CLARITY, Insight)*

Commercial

Lots of startup & other industry work (ChangingWorlds, HeyStaks, SkillPages, Soundwave, Rubicoin, The Irish Times)

Online

barrysmyth.me, @barrysmyth, https://flipboard.com/@barrysmyth

Overview

Housekeeping ✓

Course structure, assessment, timetabling, expectations etc.

Vox Populi ✓

A classic example of collective intelligence.

Further Examples of Collective Intelligence ✓

Crowdsourcing, Citizen Science, Data Intelligence, Human Computation.

Framing Collective Intelligence ✓

Putting it all together. AI vs Collective Intelligence. Motivations & Incentives. The 3 Cs.

Housekeeping

Welcome to Collective Intelligence

COMP 30490

5 credit version, approx 60 students

COMP 41440

10 credit version, approx 15 students

Assessment

100% continuous assessment for both COMP 30490/41440

Lectures & Labs

Lectures

5-7 pm Mondays in B.003 (typically, there are 3 exceptions)
Slides will on Moodle each week (Enrollment Key = TBA).

Laboratories

5-7pm Wednesdays in B.002 (typically, there are 2 exceptions)
Project discussion, demonstrator support etc.

Expectation Setting

Degree of effort involved

With 100% continuous assessment this module requires a significant level of continuous effort throughout the semester. Each week will involve lectures, labs, and project work.

COMP30490 - 5 Credits

Corresponds to approximately 95 hours of effort with practical work amounting to in the region of 70 hours of effort (including labs).

COMP 41440 - 10 Credits

Approximately 190 hours of effort including about 170 hours of practical work (including labs) over the period.

Project 1 (50 Marks for both 5/10-Credit)

Build a Recommender System

Design & implementation (Java) to build a simple working recommender system using real-user data (provided).

Implementation Summary

Manipulating user ratings data; mplement basic user-based collaborative filtering for rating prediction; evaluate 3 algorithmic variations.

Project Report

Prepare a brief summary report of the implementation and findings.

Project 2 - (50/100 Marks for 5/10-Credit)

Design and prototype (5-credit @ 25 marks) or implement (10-credit @ 75 marks) a working Game-with-a-Purpose

Details to be provided - major design/implementation project involving the creation of a plausible game-with-a-purpose to address a realistic collective intelligence task.

Project Report (5/10-credit @ 25 marks)

Prepare detailed project report justifying, describing, and advocating your GWAP.

A Note on Plagiarism

Plagiarism is a serious academic offence

See Section 6.2 of Student Code or UCD Registry Plagiarism Policy or the School⁹s Plagiarism Policy & Procedures document.

A practice approach will be taken to detect incidents

Suspected incidents will be referred directly to the school⁹s Plagiarism Sub-Committee who will interview and investigate those involved.

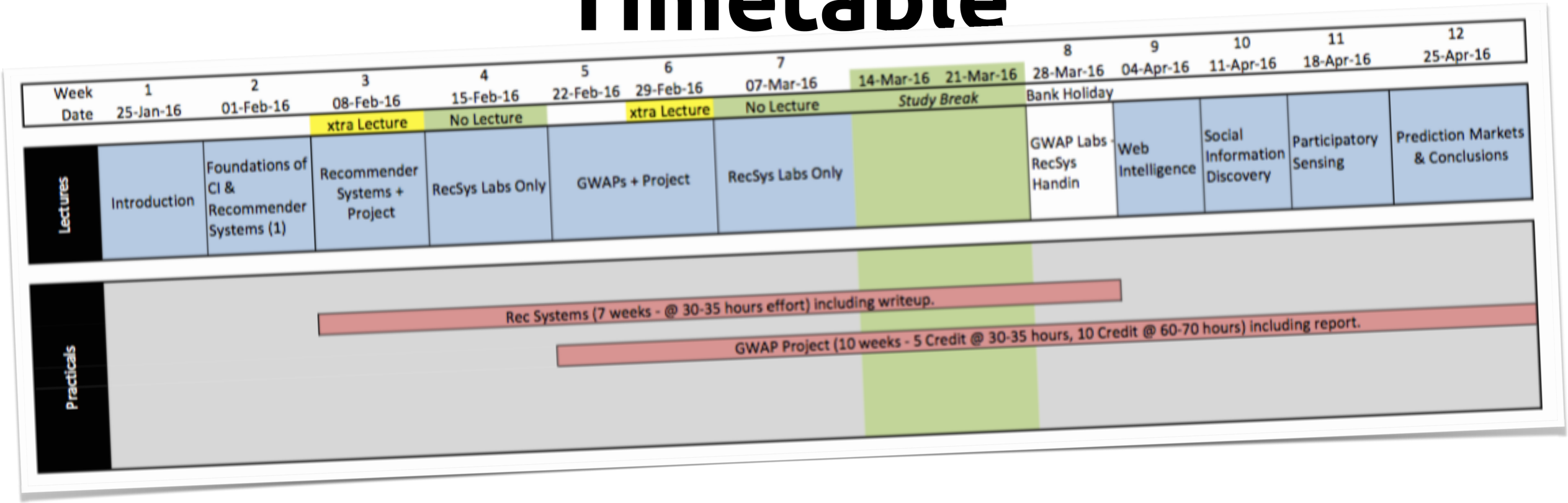
Penalties

Typically 0% or NG for a first offence. 2nd offence referred to UCD⁹s Disciplinary Committee.

Student⁹s who enable plagiarism are normally viewed as equally responsible…

… just don't do it!

Timetable



Week	1	2	3	4	5	6	7		8	9	10	11	12
Date	25-Jan-16	01-Feb-16	08-Feb-16	15-Feb-16	22-Feb-16	29-Feb-16	07-Mar-16	14-Mar-16 21-Mar-16	28-Mar-16	04-Apr-16	11-Apr-16	18-Apr-16	25-Apr-16
			xtra Lecture	No Lecture		xtra Lecture	No Lecture	*Study Break*	Bank Holiday				
Lectures	Introduction	Foundations of CI & Recommender Systems (1)	Recommender Systems + Project	RecSys Labs Only	GWAPs + Project		RecSys Labs Only		GWAP Labs - RecSys Handin	Web Intelligence	Social Information Discovery	Participatory Sensing	Prediction Markets & Conclusions
Practicals	Rec Systems (7 weeks - @ 30-35 hours effort) including writeup.												
	GWAP Project (10 weeks - 5 Credit @ 30-35 hours, 10 Credit @ 60-70 hours) including report.												

Notes

1. *Labs begin Wednesday February 10th (5pm, Room 002) with a Lecture+Lab to introduce RecSys project.*
2. *Feb 15th lecture is a full laboratory session (5pm, Room 003) to help kick-start RecSys project.*
3. *Feb 29th is a Lecture-Lab session to introduce GWAP project.*
4. *The following week (March 7th) is another double-lab week.*
5. *March 28th is a Bank Holiday so no lecture.*

Questions?

Vox Populi & the Wisdom of the Crowd

The West of England Fat Stock and Poultry Exhibition, Plymouth 1906

Guess the weight of the ox …

6d per entry. Approx 800 entrants, including butchers, farmers, but also the general public, etc.

787 legitimate guesses (13 eliminated due to legibility problems)

How well do you think the crowd did?

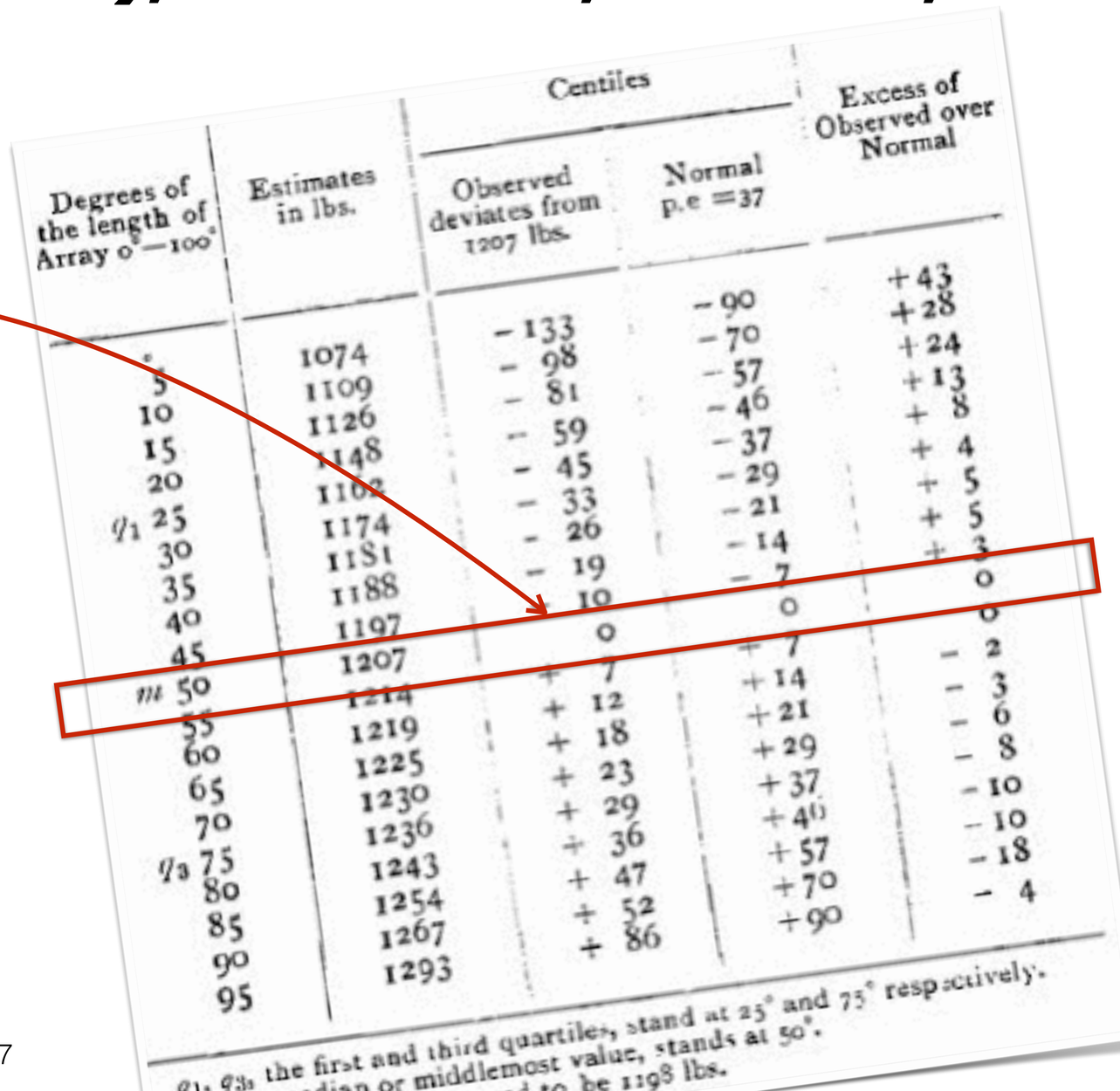
Vox Populi, Nature (1907), No. 1949, Vol. 75,

Distribution of estimates after conversions to *lbs.*

Median guess: *1,207 lbs*

Correct weight: *1,198 lbs*

In other words the crowd's guess fell within 1% of the true weight of the ox!



Degrees of the length of Array 0°—100°	Estimates in lbs.	Centiles: Observed deviates from 1207 lbs.	Centiles: Normal p.e =37	Excess of Observed over Normal
	1074	−133	−90	+43
5	1109	− 98	−70	+28
10	1126	− 81	−57	+24
15	1148	− 59	−46	+13
20	1162	− 45	−37	+ 8
Q_1 25	1174	− 33	−29	+ 4
30	1181	− 26	−21	+ 5
35	1188	− 19	−14	+ 5
40	1197	− 10	− 7	+ 3
45	1207	0	0	0
m 50	1214	+ 7	+ 7	0
55	1219	+ 12	+14	− 2
60	1225	+ 18	+21	− 3
65	1230	+ 23	+29	− 6
70	1236	+ 29	+37	− 8
Q_3 75	1243	+ 36	+46	−10
80	1254	+ 47	+57	−10
85	1267	+ 52	+70	−18
90	1293	+ 86	+90	− 4
95				

Q_1, Q_3, the first and third quartiles, stand at 25° and 75° respectively.
[illegible] or middlemost value, stands at 50°.
[illegible] to be 1198 lbs.

Crowd wisdom or a lucky guess?

Was this just a lucky guess or is this type of accuracy genuine example of crowd wisdom?

What factors tend to influence crowd accuracy?

What is more important: a crowd of experts vs a crowd of diverse non-experts? *Expertise vs Diversity?*

Can we rely on an reproduce crowd wisdom in other situations?


WHO WANTS TO BE A
MILLIONAIRE
WHO WANTS TO BE A

Phone a Friend *vs.* Ask the Audience

Official Game Stats

Why does this work?

Mistakes cancel & correct answers rise to the top…

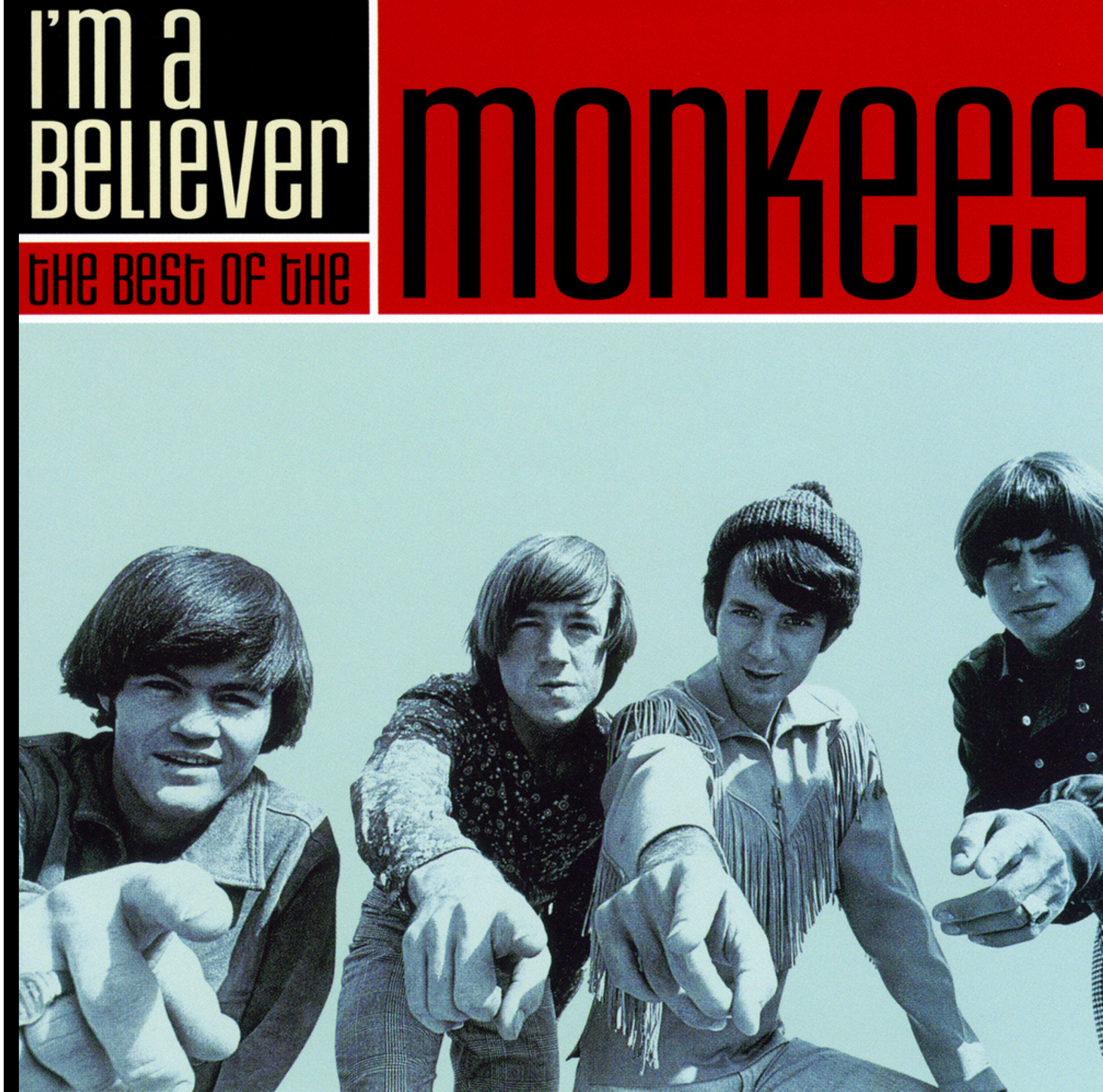
Identify the non-Monkey

Peter Tork

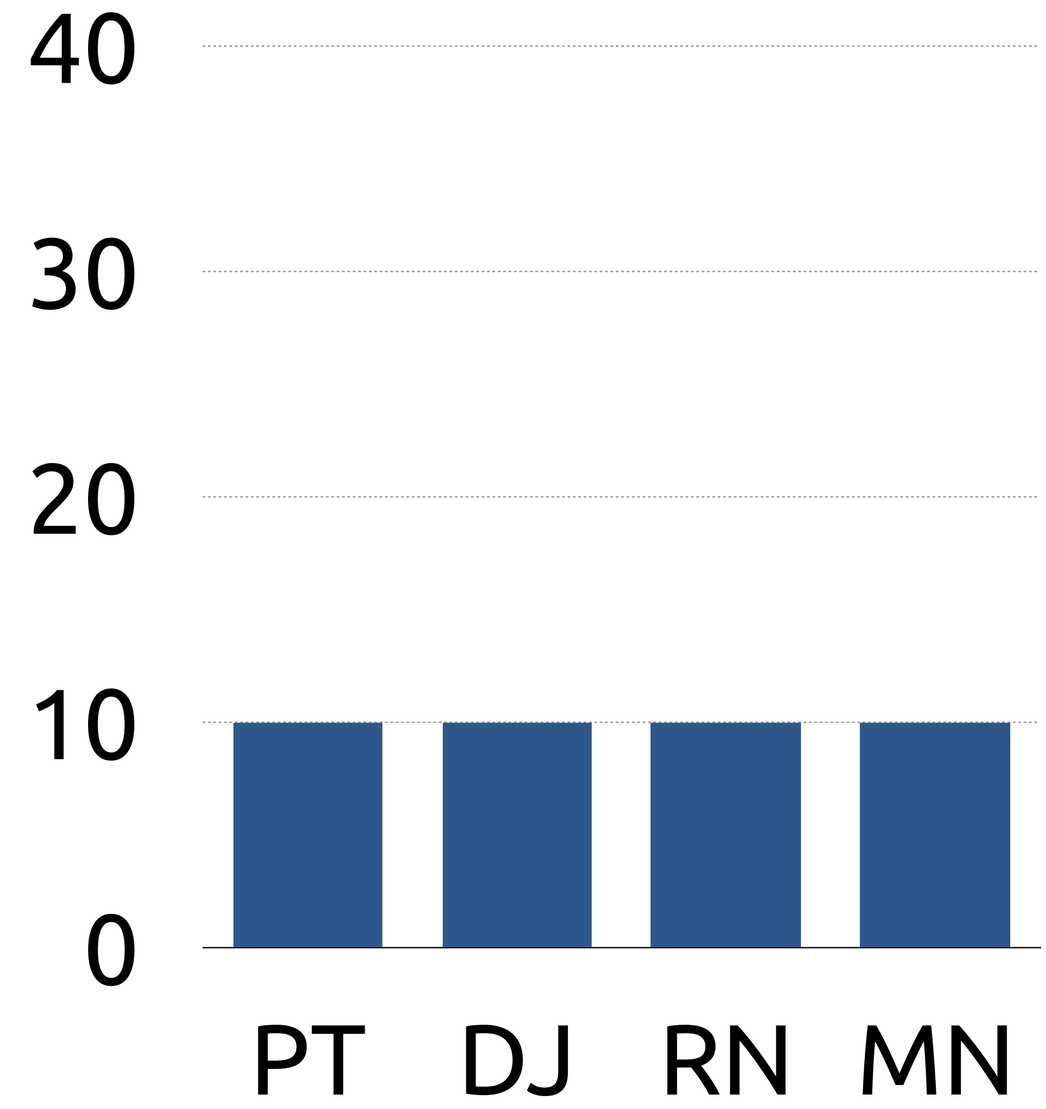
Davy Jones

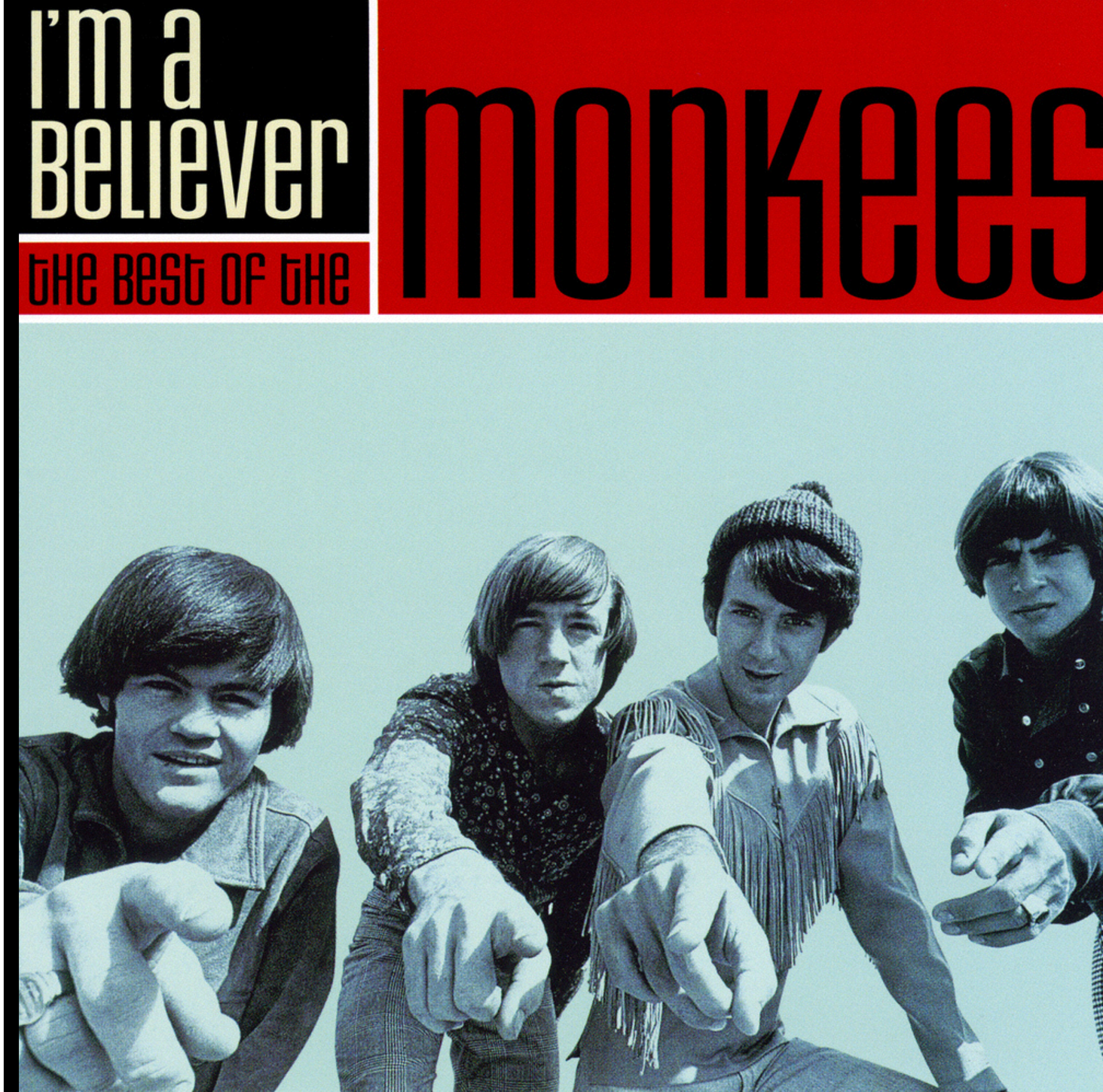
Roger Noll

Michael Nesmith



votes





Assume 100 people

Assume 20 know none of the Monkees …

… they select at random so we can expect about 5 votes for each option.

Assume 10 know the Monkess & therefore the non-Monkee…

… therefore RN receives these 10 correct votes.

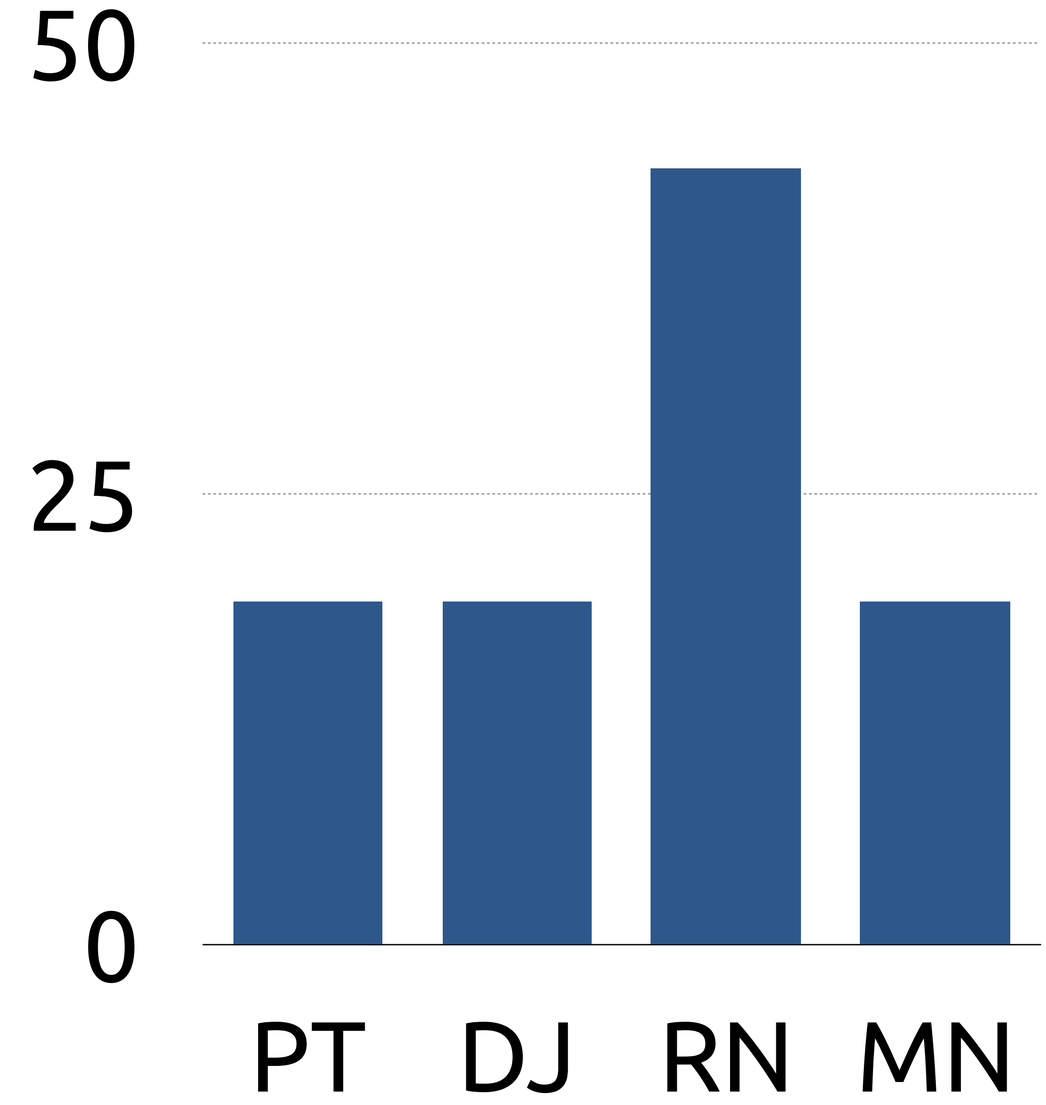
Let⁹s say 30 know 2 of the Monkees …

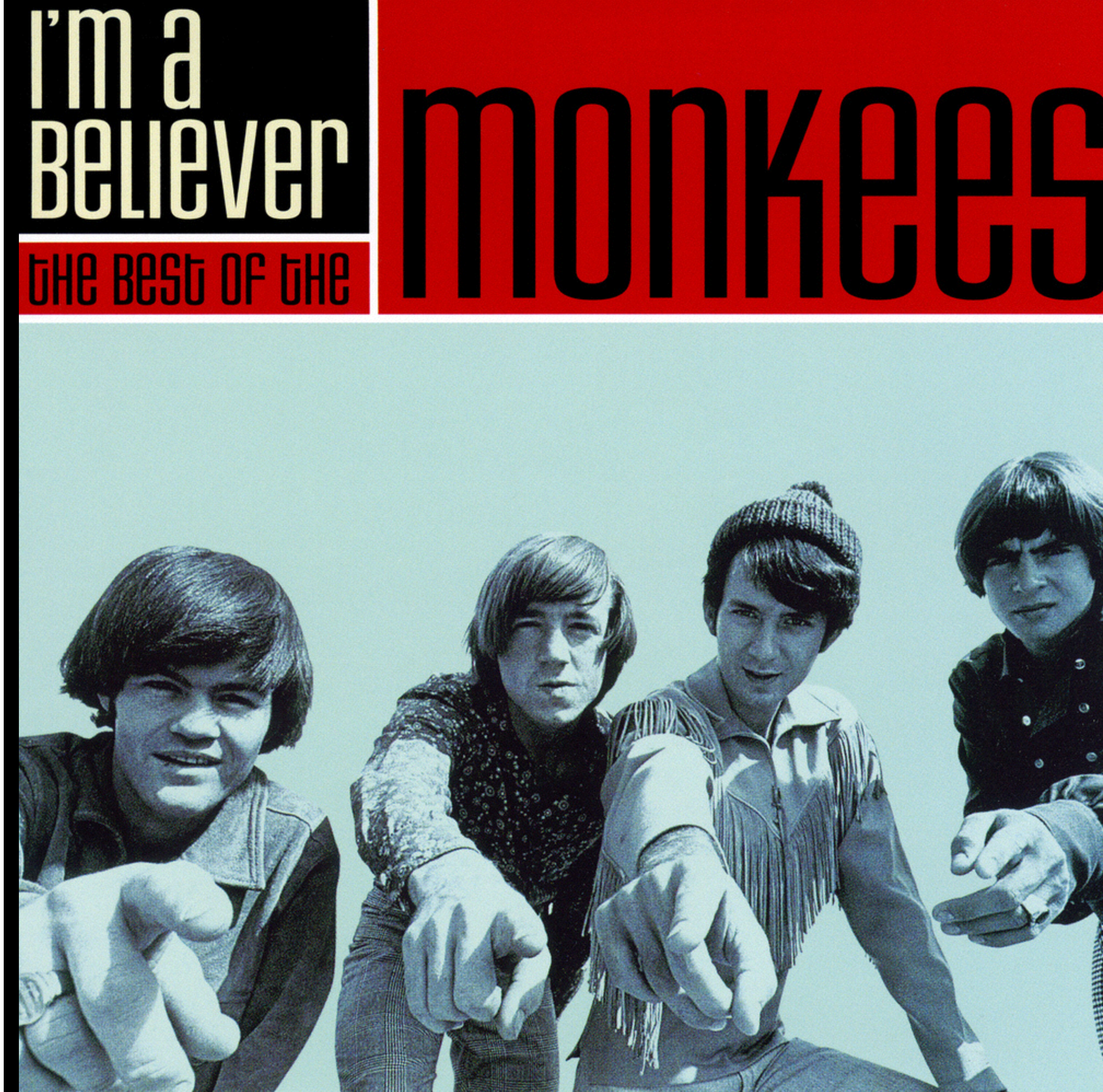
… so their votes are shared between the 2 they don⁹t know; RN gets 15 of these votes and, all other things being equal, the others get 5 each.

Finally there are 40 who know just one of the Monkees …

… RN gets about 13 (40/3) votes & the others get 9 each (27/3).

votes





Even if no-one knows the correct answer…

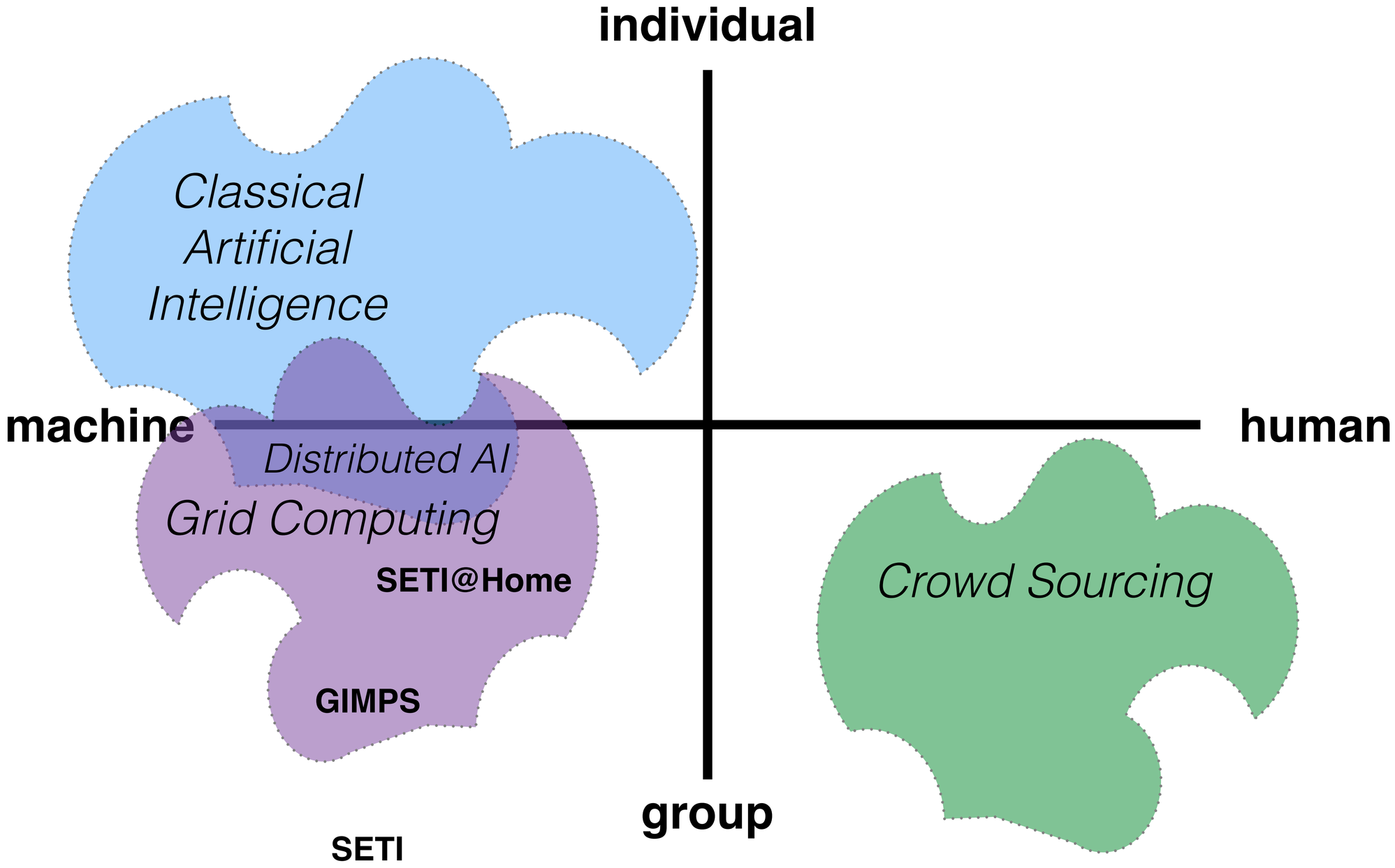
Even if no-one knows the correct answer the crowd prediction may still be correct?

To see this imagine that no-one knows the correct answer but 40 people suspect that it is either RN or one of the others. The other 60 guess at random.

In this case RN will attract 35 of the votes (40/20 + 60/4) whereas the others will only attract about 22 votes (20/3 + 60/4).

The Great Jelly Bean Experiment

Some Scene Setting Examples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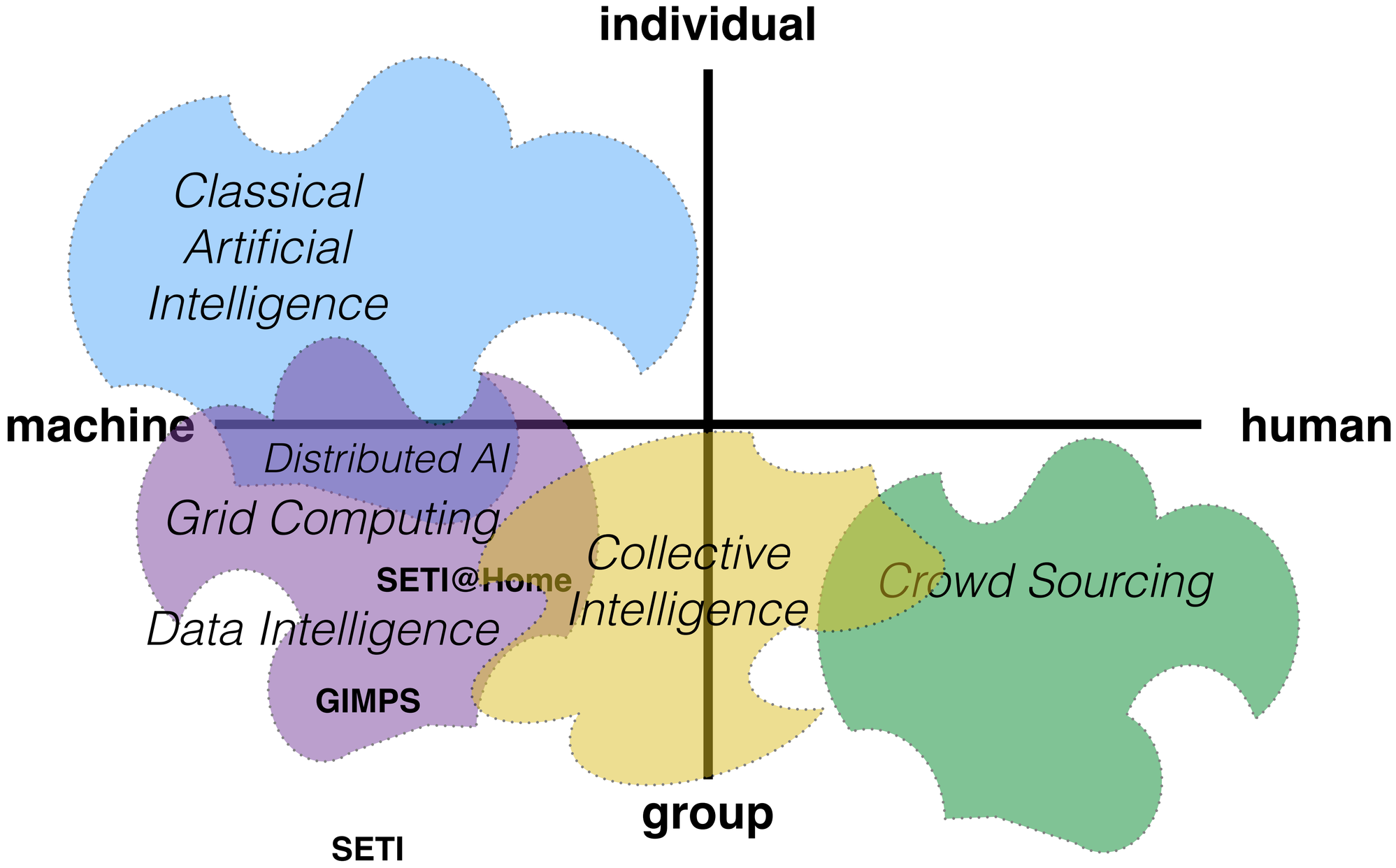
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Intelligence
Distributed AI
Grid Computing
Data Intelligence
SETI@Home
GIMPS
Collective
Intelligence
Crowd Sourcing
SETI

Crowdsourcing & Crowdwork

Crowdsourcing

Harnessing the contributions/opinions of the crowd ... The Billion

Crowd Wisdom

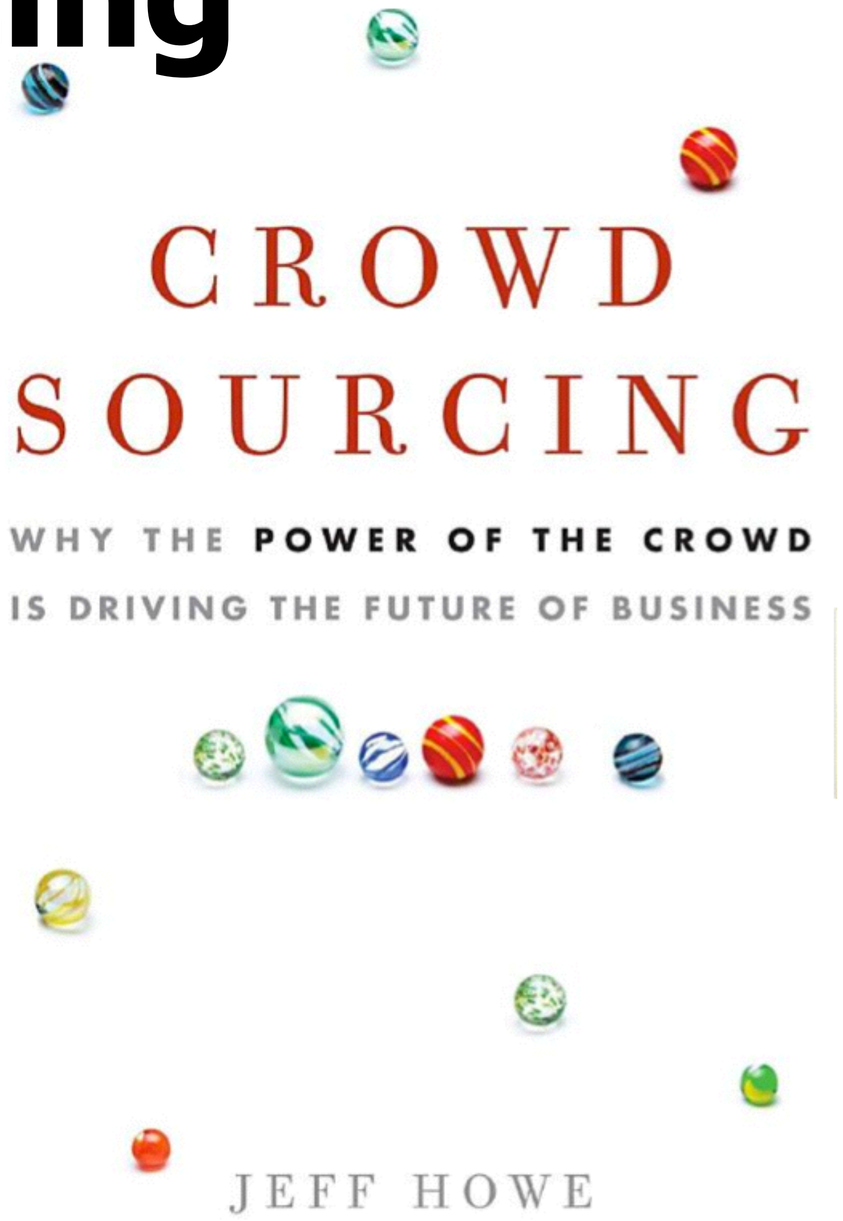
Harnessing the diverse wisdom of the crowd (e.g. Innocentive, IBM⁹s Idea Jams, etc.)

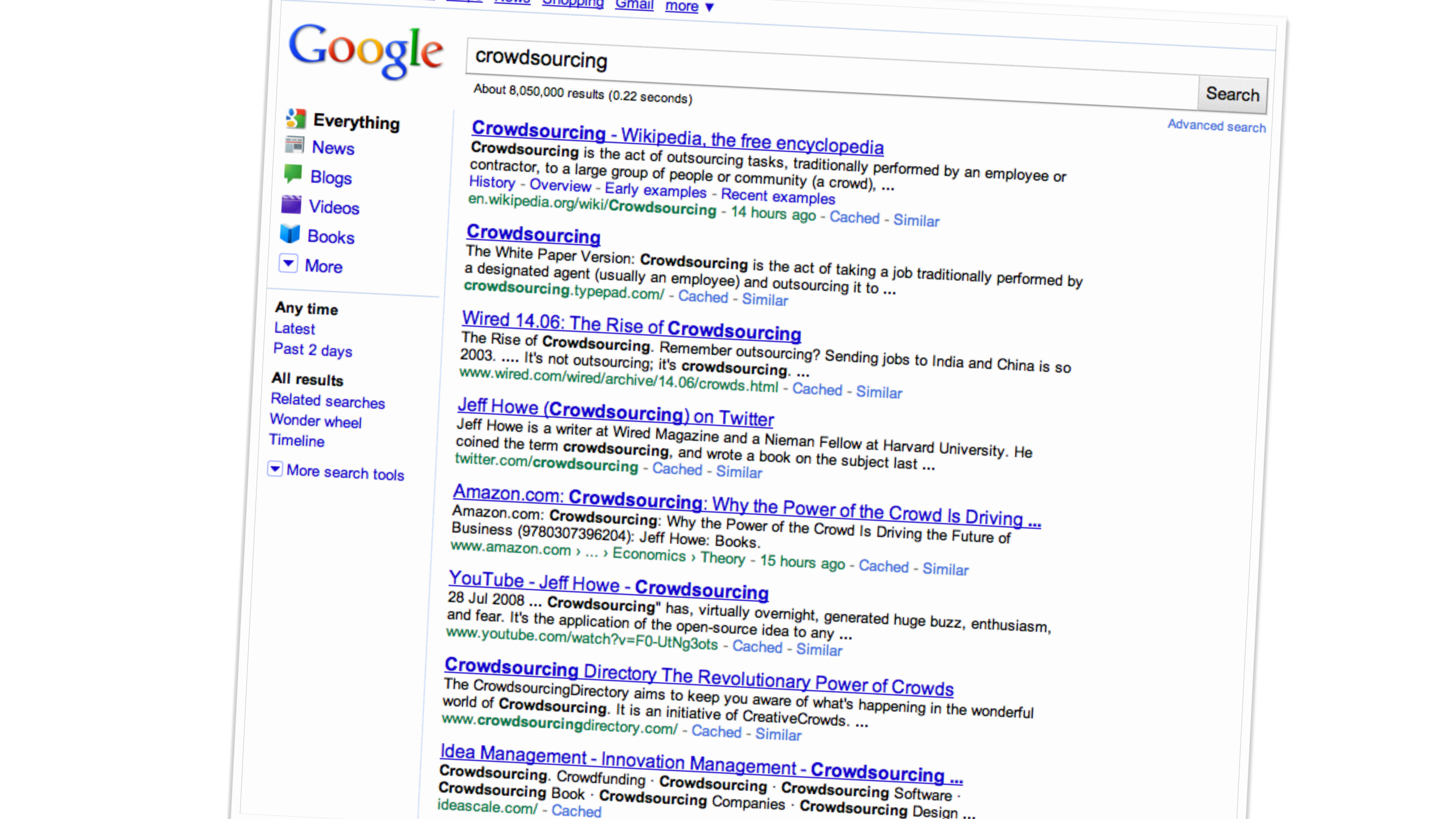
Crowd Creation

Harnessing the creative energies of the crowd (CurrentTV, Threadless, Blogs, Social Media etc.)

Crowd Voting

Harnessing the opinions of the the crowd (Google⁹s PageRank, Digg, Amazon, etc.)

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About 8,050,000 results (0.22 seconds)
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Crowdsourcing - Wikipedia, the free encyclopedia
Crowdsourcing is the act of outsourcing tasks, traditionally performed by an employee or contractor, to a large group of people or community (a crowd), ...
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Barry, Welcome to Your Amazon.co.uk (If you're not Barry Smyth, click here.)

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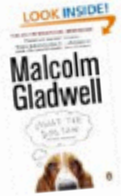
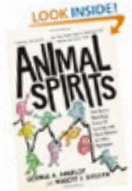
Here's a daily sample of items recommended for you. Click here to see all recommendations.



What the Dog Saw: and other... (Paperback) by Malcolm Gladwell
(17) £5.00
Fix this recommendation



Animal Spirits: How Human P... (Hardcover) by George A. Akerlof
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Free: The Future of a Radical... (Hardcover) by Chris Anderson
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High Performance Web Sites: Ess... (Paperback) by Steve Souders
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The Men Who Stare At Goats [D... DVD ~ Kevin Spacey
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Burn Notice - Season 1 [DV... DVD ~ Jeffrey Donovan
(25) £14.95
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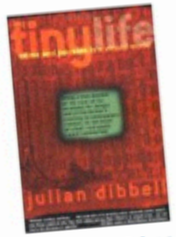
From Your Wish List



My Tiny Life: Crime and Passion in the Virtual World (Paperback) by Julian Dibbell

House - Season 3 (Hugh Laurie) [DVD] [2006] (DVD) ~ Hugh Laurie

Prison Break - Season 2 - Complete [DVD] [2006] (DVD) ~ Wentworth Miller

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Improve Your Recommendations

The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies (New Edition)

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(63) £9.91
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161 diggs — digg

Aww Nice Wedding ...Oh Wait, Married Among Sharks?!?
youtube.com — ***** (Submitted by gorgeoussand)
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U.K. Porn Star Ranks Irish Men Number One After Sex Tour
irishcentral.com — Irish men come out on top it seems according to Liverpool porn star Tanya Tate. (SFW)
(Submitted by TimBuc1)
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What is Toyota doing to ensure your safety?
toyota.com/safety - Find out how Toyota is enhancing the safety and technology of its vehicles.
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The New Segregation Debate: Single-Sex Classrooms
newsweek.com — Single-sex classes have increased by 4,000 percent in less than a decade. Can educating girls and boys separately fix our public schools, or does it reinforce outmoded gender stereotypes? (Submitted by LBUCHA)
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WSJ.com - Americans Lose Confidence in U.S., Obama
online.wsj.com — Americans are more pessimistic about the state of the country and less confident in Obama's leadership than at any point since he entered the White House, according to a new WSJ/NBC News poll.
(Submitted by rw2y)
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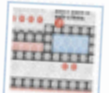
Internet Explorer 9 destroys Chrome 6 in speed test (Vid)
downloadsquad.com — IE9 is some orders of magnitude faster than HTML5 when it comes to hardware-accelerated canvas rendering. In some other initial benchmarks, see video IE9 is about 30% slower than Chrome 6 in the SunSpider JavaScript benchmark -- and about 10% faster than Firefox 3.7. (Submitted by



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864 War on drugs worse than drugs

790  Monster Crab Exits Shell (Time-Lapse Video)

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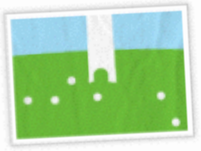
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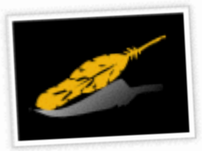
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Recently, an explosion on an offshore oil platform in the Gulf of Mexico caused both loss of life and a sizable and ongoing oil spill. We are asking Solvers worldwide to respond quickly with ideas and approaches to react to this very serious environmental threat.

Can you make a difference? Yes, InnoCentive's work with the Oil Spi...

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Reward: **See details** Type: **Ideation** Deadline - **Jun 30, 2010**

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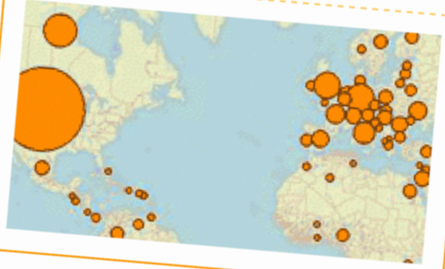

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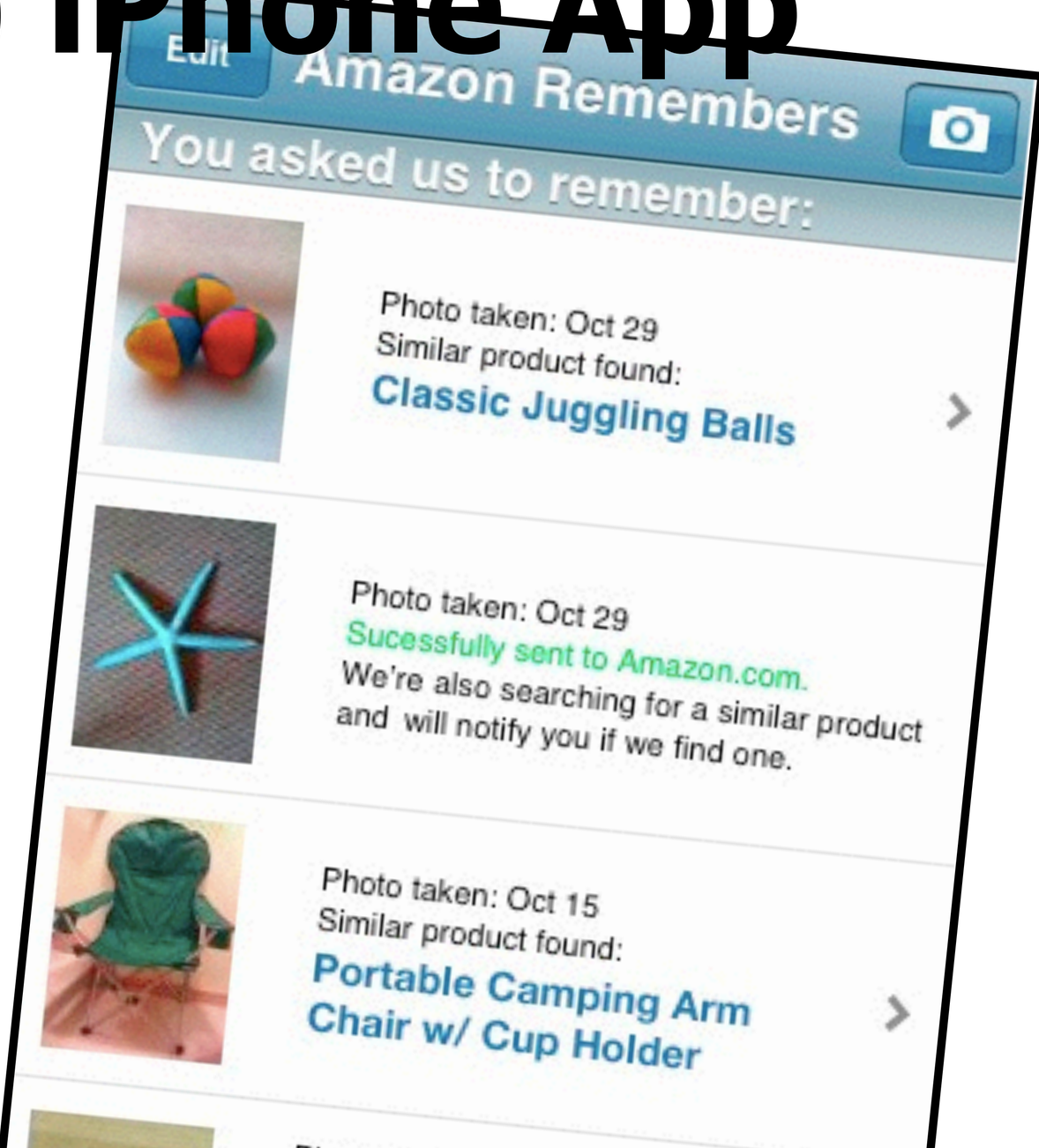
Amazon’s (old) iPhone App

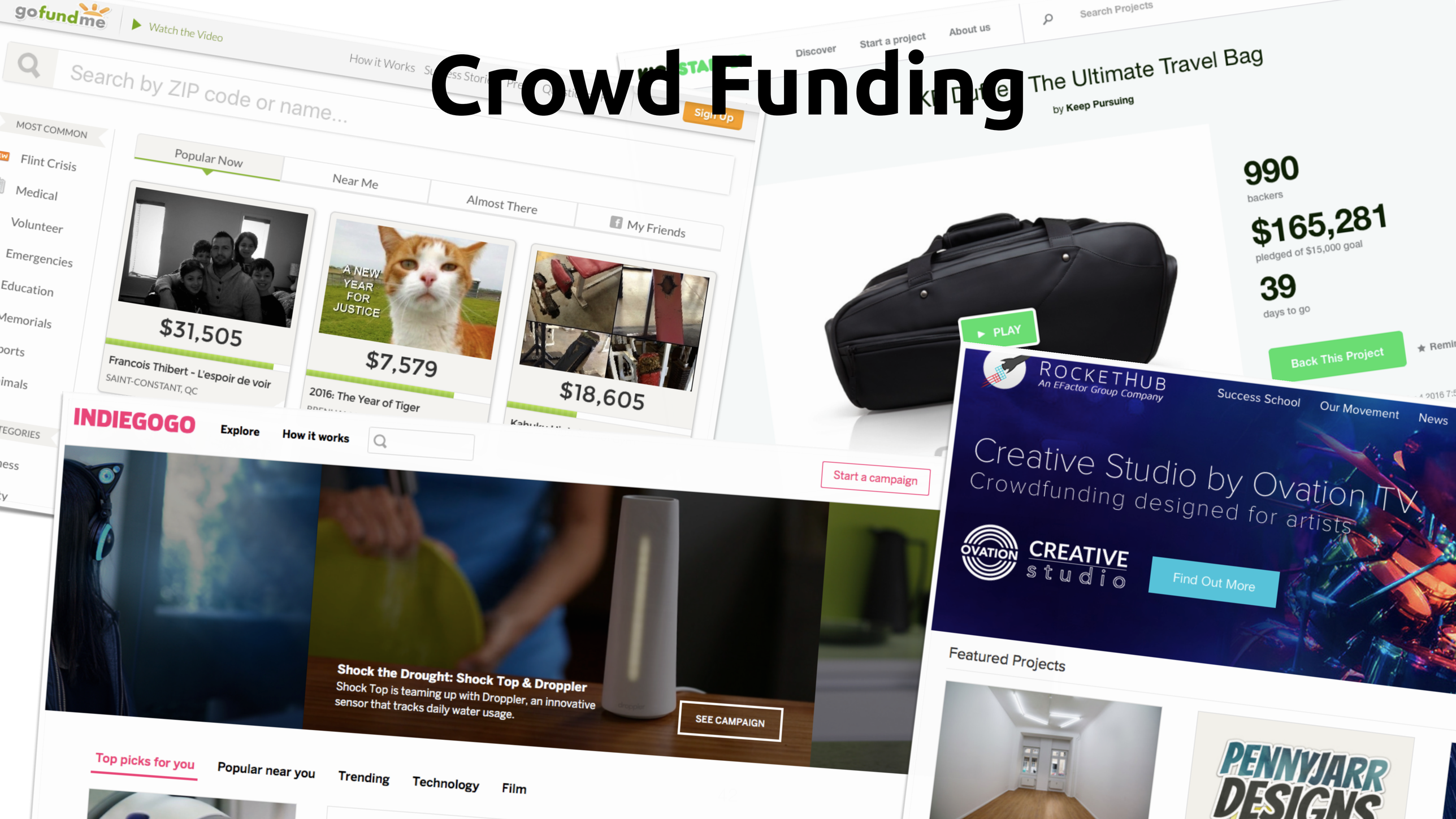
Automatic photo recognition
Take a picture of a product and Amazon locate⁹s match or near-match.

Challenging image recognition task …

… outsourced to Mechanical Turk.
Crowdsourcing image matching.



Crowd Funding



Grid Computing & Data Intelligence

The SETI Project

The SETI Project

Radio Telescopes like Aracebo used to scan for sources of intelligent life.

Assumes *intelligent signals* will be broadcast in an easily detectable way, such that it will be easily distinguishable from natural background sources.

Use computationally intensive signal processing techniques to scan incoming data streams across many different frequency bands.

Traditional approach ⇒ Massive banks of dedicated FFT processors

capable of scanning up to 1 Bn x 1Hz wide channels.

Scalability? Is there a better solution? What about all of those machines connected to the Internet idly consuming CPU cycles?

SETI @ Home

SETI represents a highly distributable signal processing task.

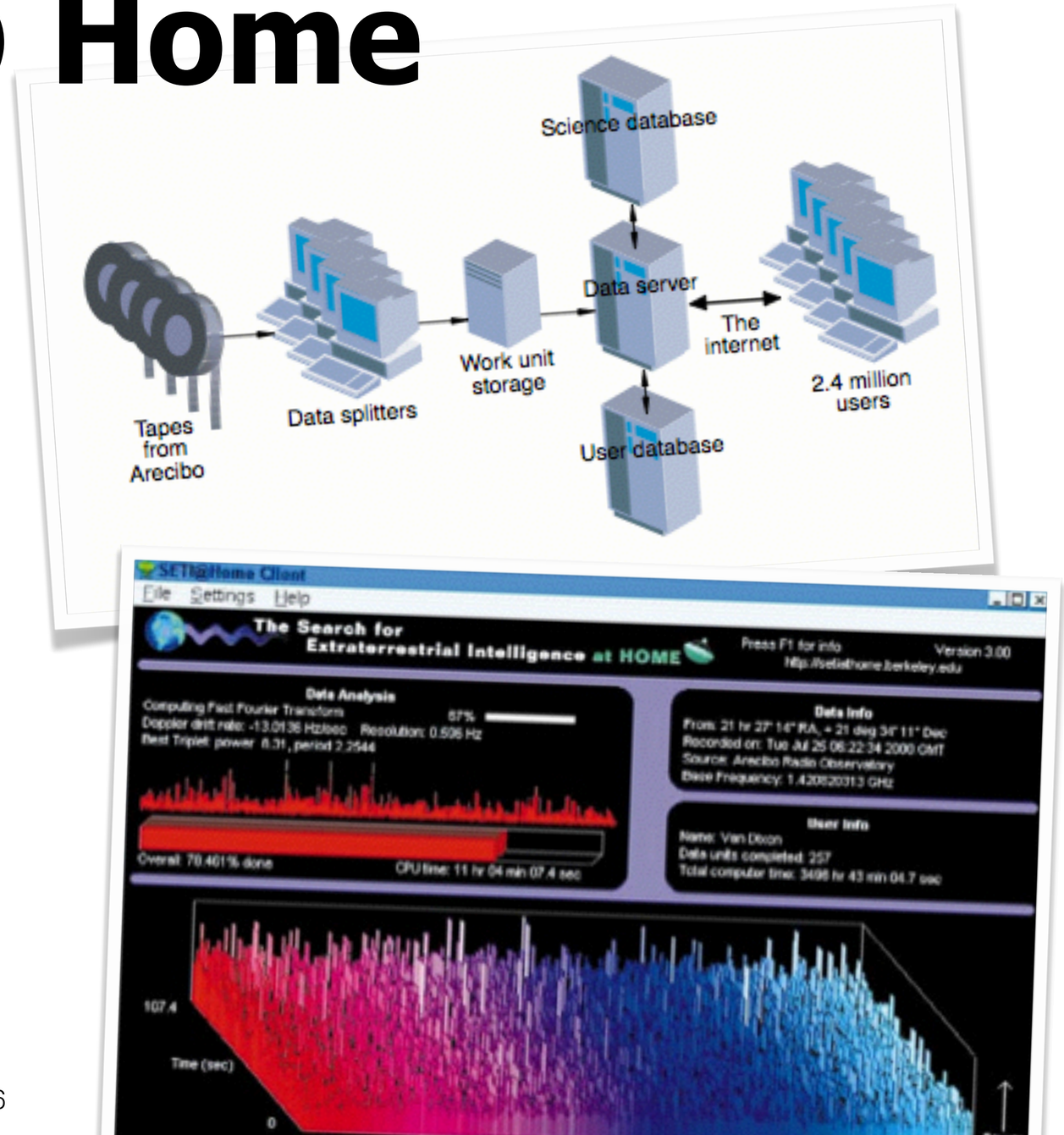
13Gb data ⇒ Divided into work units

of 107 secs of data (approx .35Mb).

Participants install the SETI@Home client/screensaver.

5.3m users worldwide logging >2m years of computing time since 1999 (the largest computation in history).

SETI@Home computing capacity of 769TFLOPS exceeds that of IBM⁹s BlueGene\L.



$$2^P-1$$

Great Internet Mersenne Prime Search

Crowdsourcing the hunt for large primes.

Distributed, virtual super-computer a la SETI but for prime hunting.

20 years & counting.

Jan 15, 2016 - New largest prime located (49th Mersenne Prime)

$$2^{74,207,281}-1$$

>22 million digits!

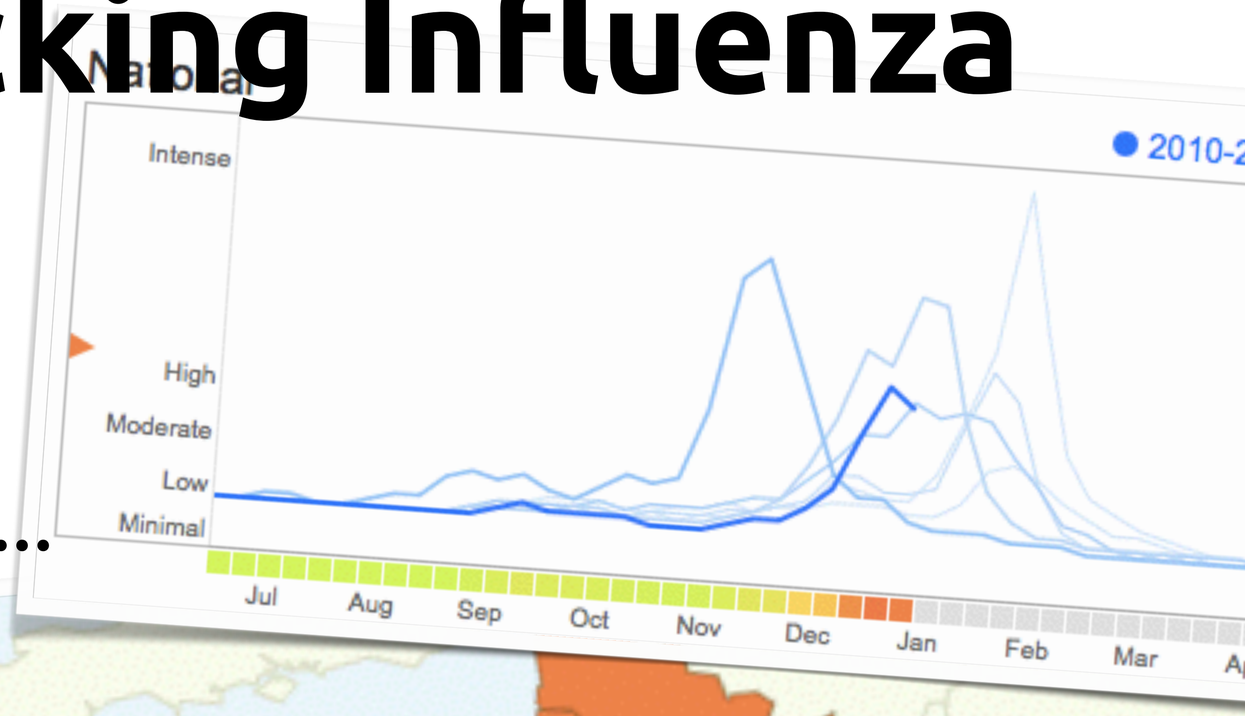
Predicting/Tracking Influenza

Google Flu Trends

Geo-coded search terms as indicators of human activity ...

- flu remedy
- cure flu
- flu shot, etc.

Strong correlation between flu-related searches and illness.



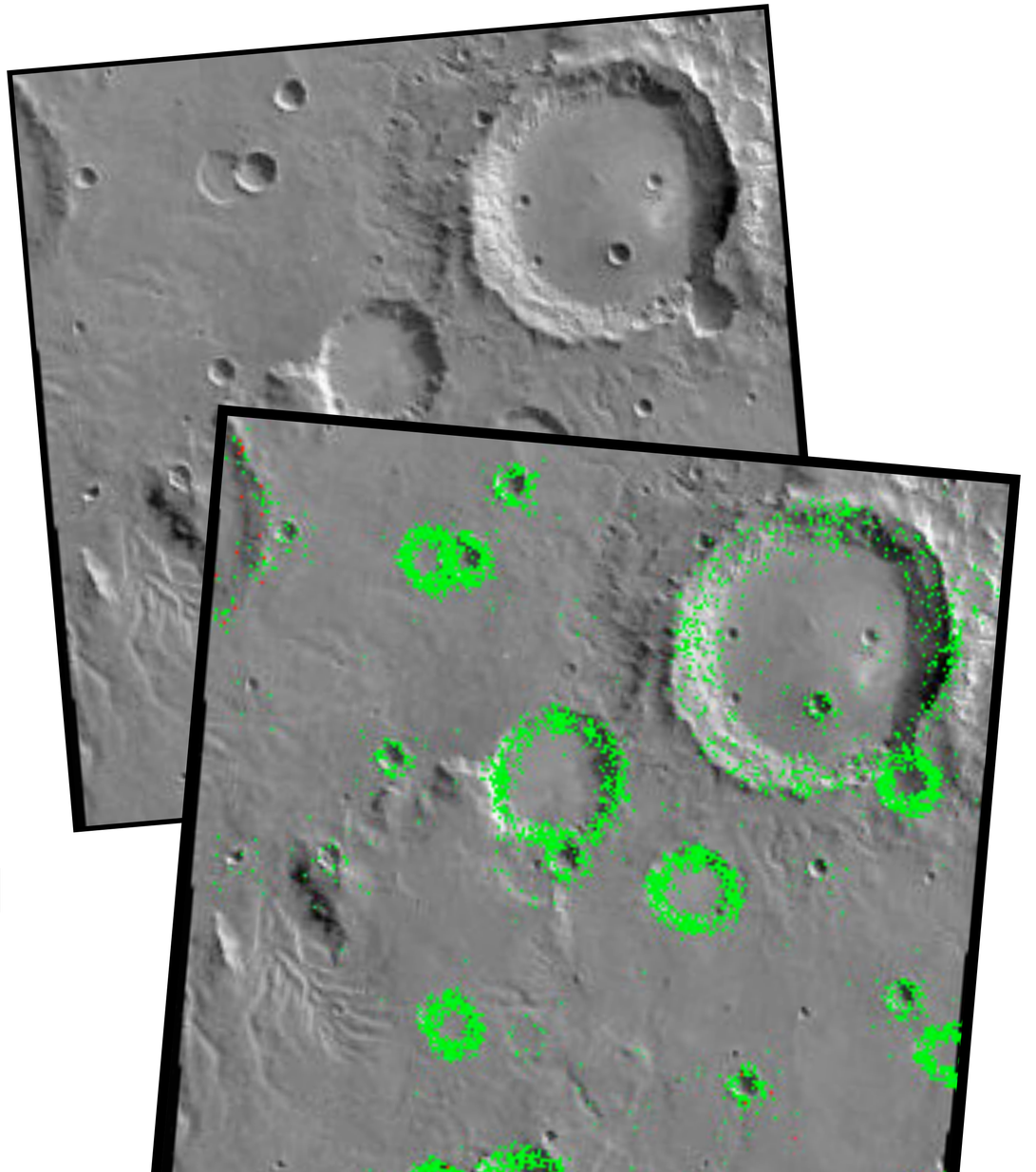
NASA’s Clickworkers

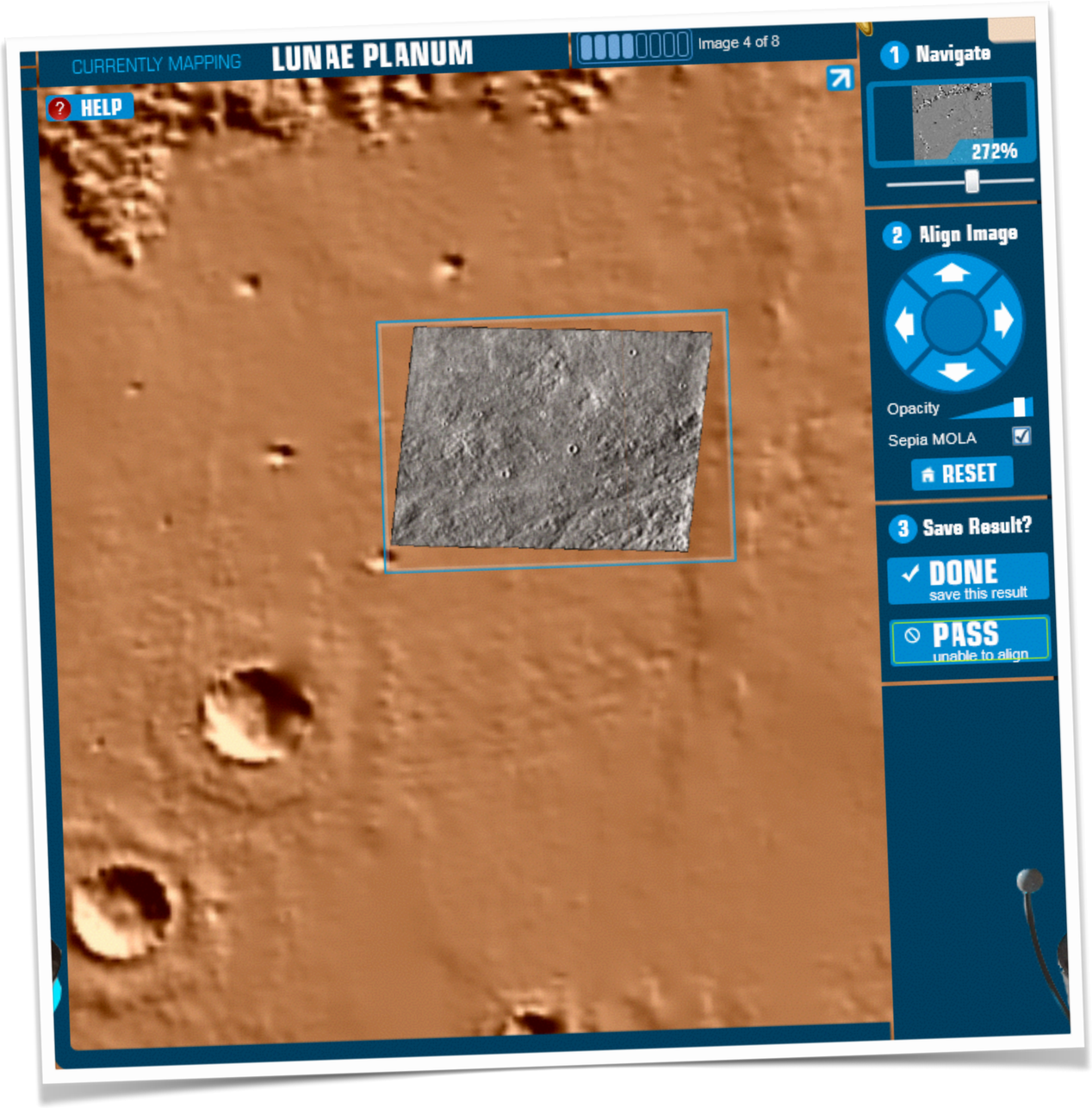
The life of a planetary geologist at NASA

identifying and measuring geological landforms (craters, ridges, valleys) from satellite imagery. Tedious, error-prone, labour-intensive (80k landforms ≈ 2 person-years)

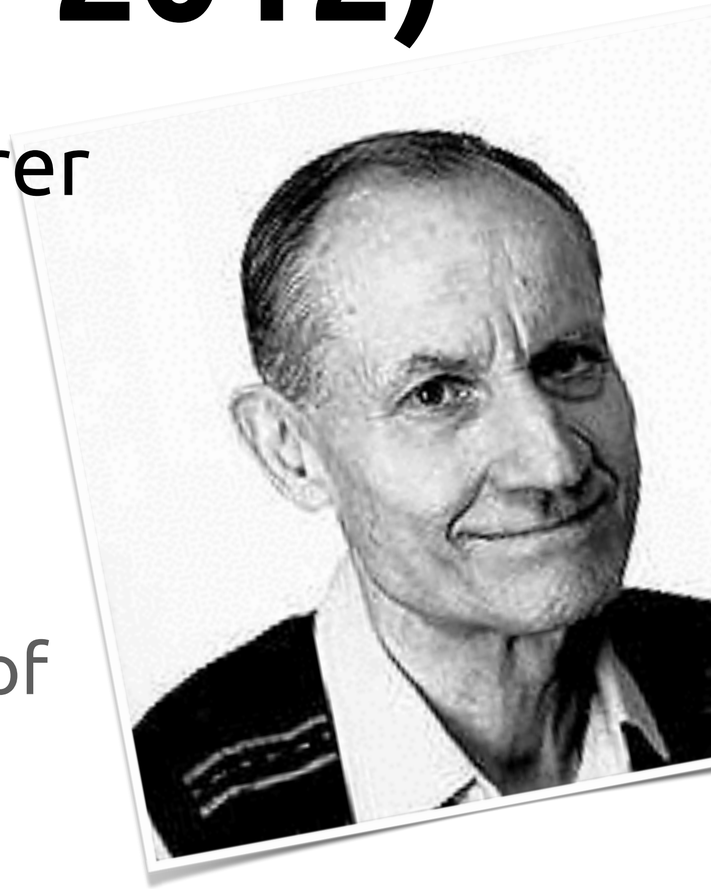
The Clickworkers Experiment

NASA put the entire Viking-Mars image database online and invited amateur astronomers to perform the same analysis task online.
Individual contributions are aggregated.
Within a month the entire DB was completed to a comparable degree of accuracy by a few thousand contributors ... 37% were one-time contributors!




CURRENTLY MAPPING
LUNAE PLANUM
Image 4 of 8
HELP
1 Navigate
272%
2 Align Image
Opacity
Sepia MOLA
RESET
3 Save Result?
DONE
save this result
PASS
unable to align

Don R. Swansom (1924-2012)



Information Scientist turned Biomedical Explorer

Believed that scientific knowledge had grown so vast that important connections and discoveries were going unnoticed.

Harnessing the Medline Search Engine

Millions of scientific papers providing a high-level map of human medical knowledge.

Connecting Migraines & Epilepsy

Celebrated discoveries: (1) migraines are associated with epilepsy; (2) migraines are associated with magnesium deficiency. Both subsequently confirmed.

Sloan Digital Sky Survey (SDSS)

Mapping the known universe.

Robotic telescope imaging >1m galaxies to generating huge quantities of data for mining.

Boron & Lauer, 1999

Used SDSS data to discover 2 orbiting blackholes by using a computer to search galaxy images to detect colour changes predicted from a model of orbiting blackholes.

Open Data & Data Mining

Changing the nature and approach to scientific discoveries in areas like astronomy, particle physics, drug discovery etc.

PolyMath (1)

Mathematician Tim Bower⁹s Blog Post…

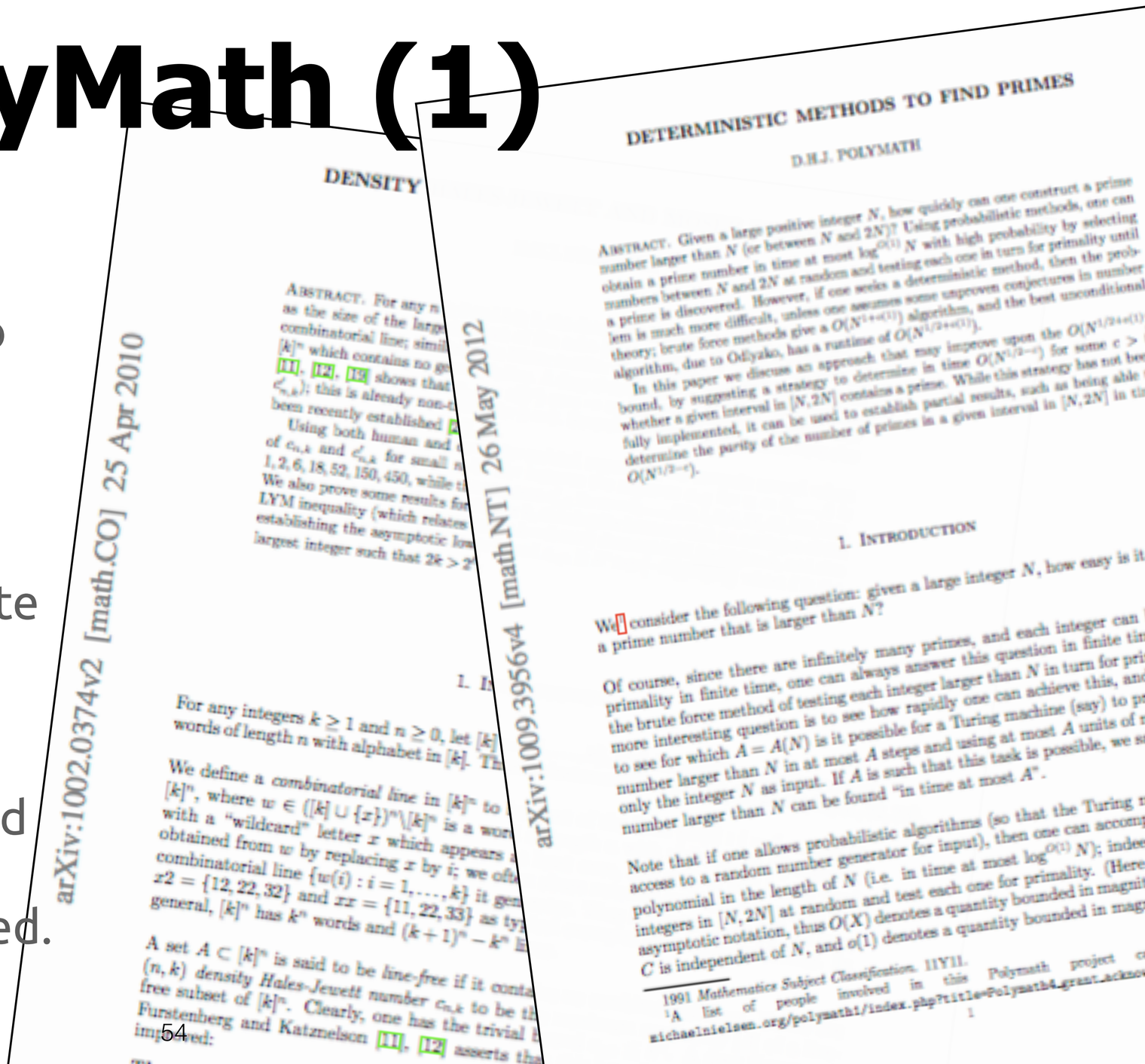
Find a new combinatorial proof to the density version of the Halesẃ Jewett theorem

A Social Maths Experiment

Using blogs and wikis to coordinate and amplify

Solution Success

After 7 weeks: problem was solved and involved the contributions of >40 people. Polymath 2 -8 spawned.



Kasparov vs the World

Gary Kasparov
World #1 since 1985.

The World
Players from around the world voted on moves; some strong players but far below GK. 50k people voted during the game.

The Game
Complex 4-month, 62-movegame. Kasparov eventually won, with supreme effort. The World played a game a t a level far greater than any of its individual players.

Amplifying Micro-Expertise
The move of Irina Krush…

Collective Intelligence in Nature

Ants & Ant Colonies

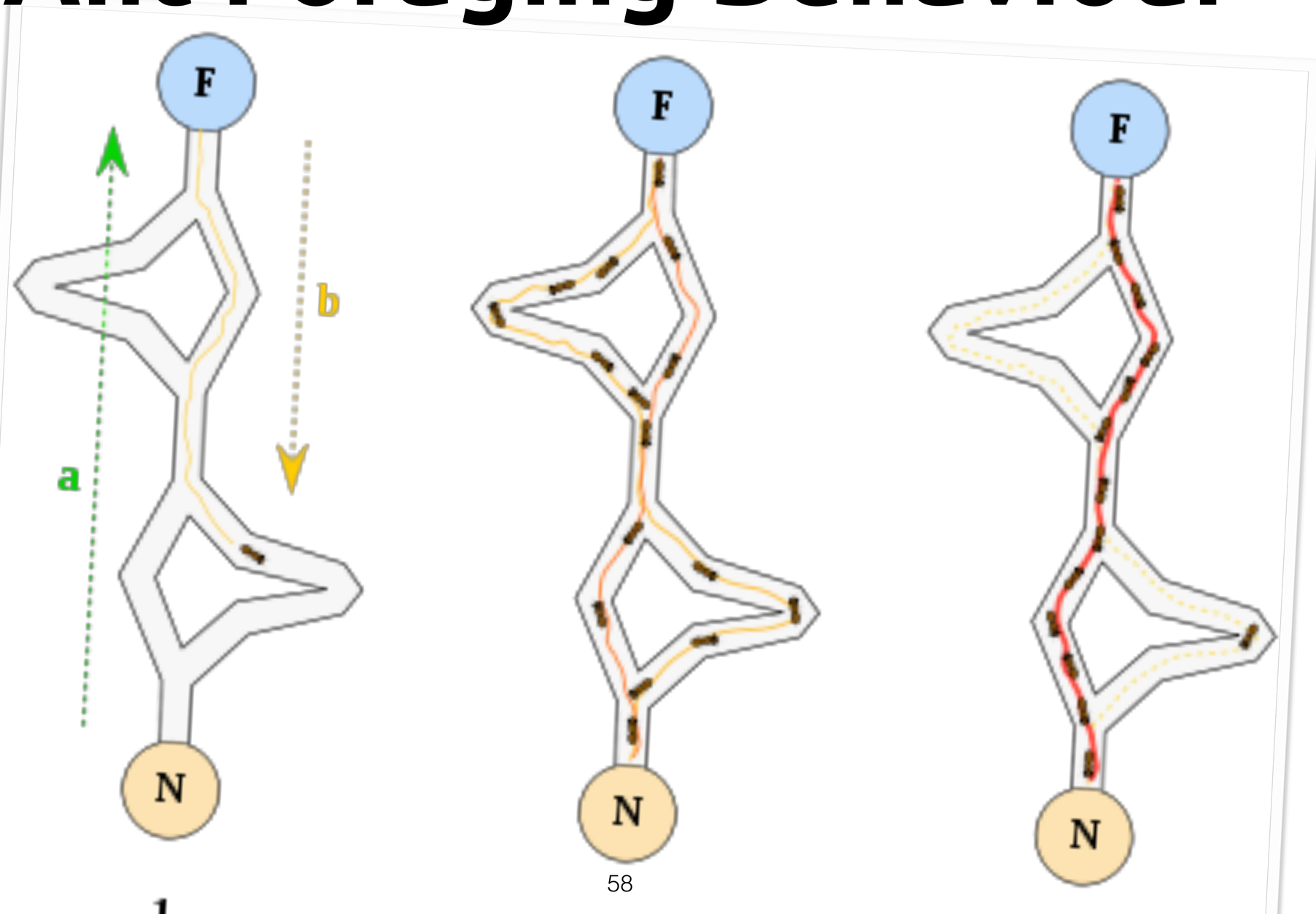
⁸Ants aren⁹t smart. Ant colonies are.⁹ (Deborah Gordan, Stanford)

Ants communicate via their local environments (stigmergy)

Foraging behaviour interrupted by pheromone trails

Efficient path planning emerges …

Ant Foraging Behaviour



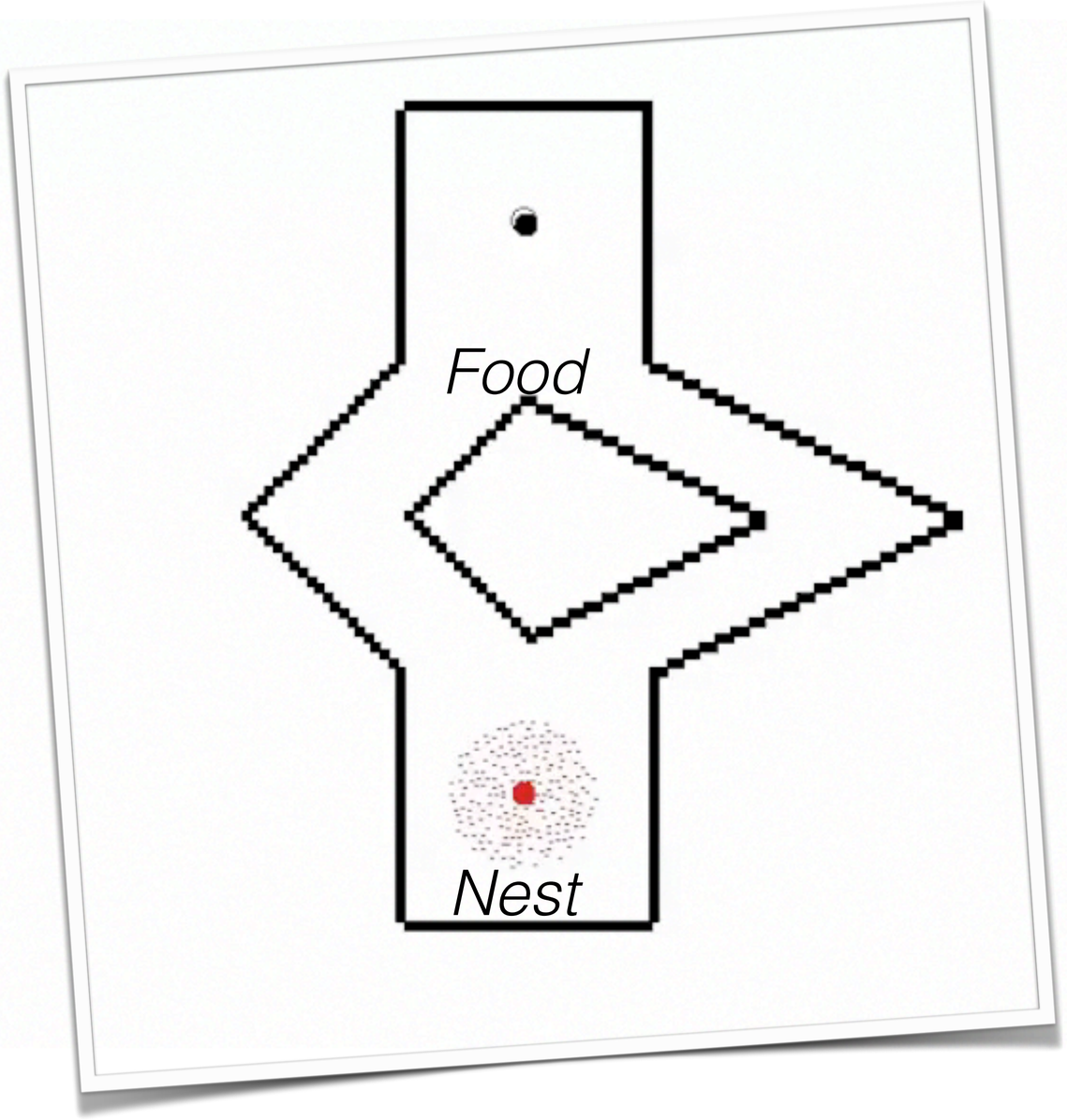
Ants & Pheromone Trails

Initial near-random behaviour.

Early competing pheromone trails are far from efficient.

Positive-feedback effects lead towards the selection of a more efficient route to food.

Over time the colony prefers the shorter path to the food source.



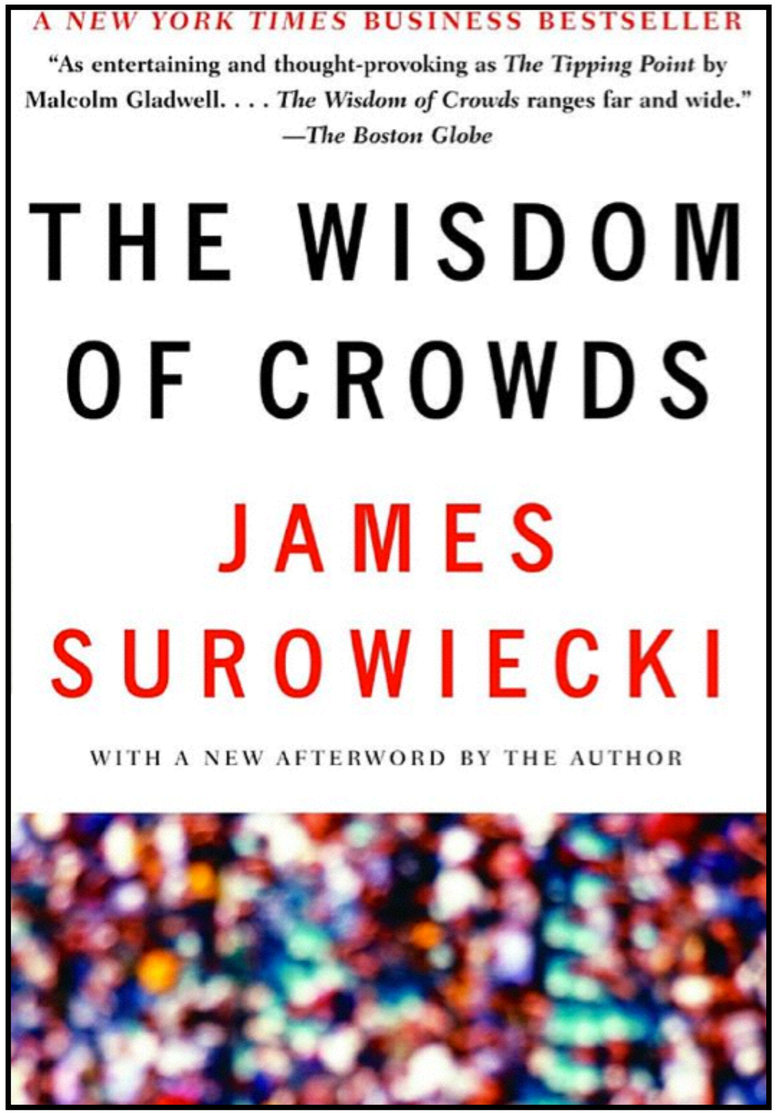
Why/When are the Many Smarter than the Few?

Private Information
People need to be acting on their own private information.

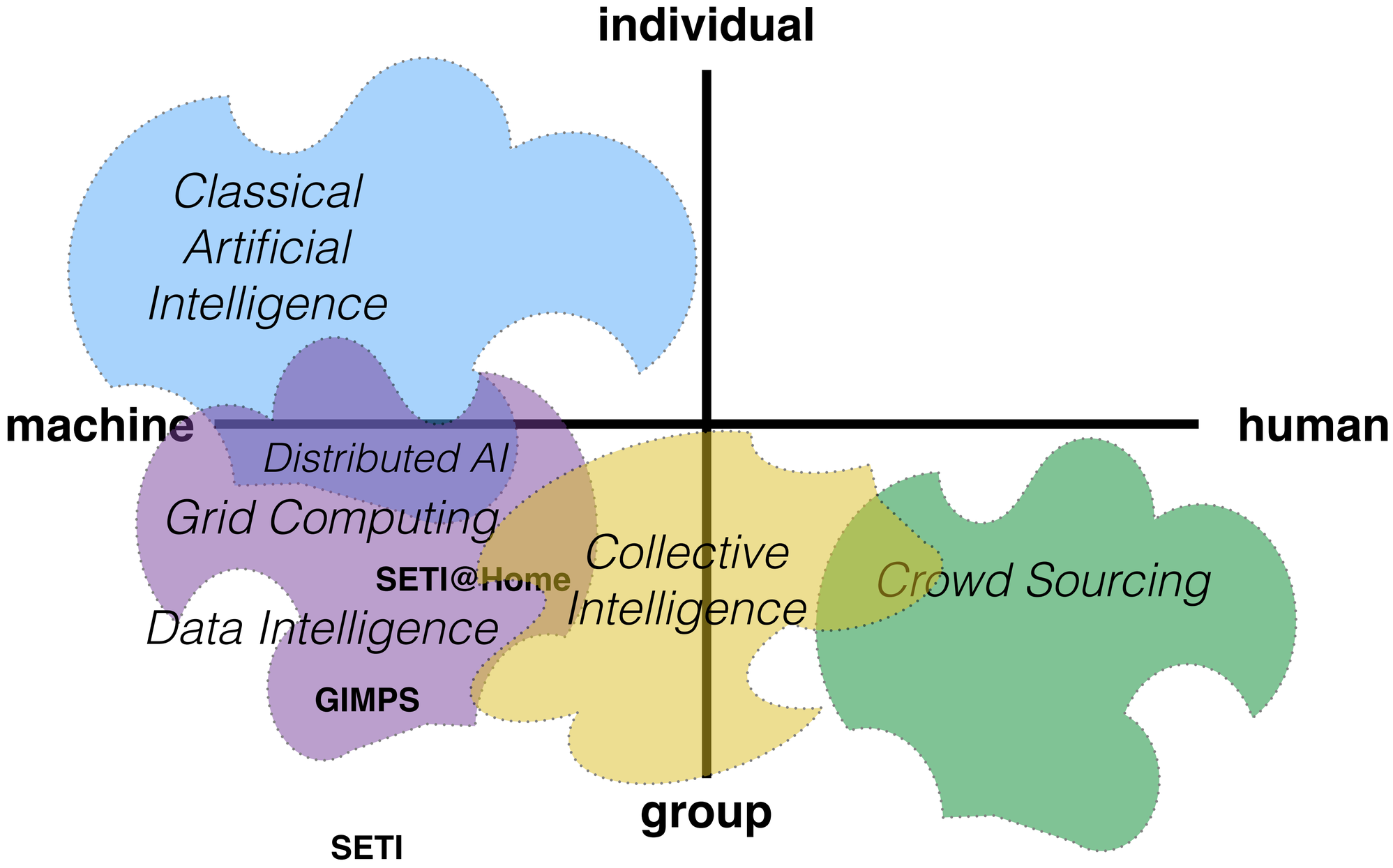
Diversity of Opinion
Differing opinions based on private/local information matter.

Independence of Opinion
Opinions forms independently of others matter.

Aggregation Mechanism
There needs to be a mechanism for turning private judgements into a collective decision.




Framing
Collective
Intelligence


individual
machine
human
group
Classical
Artificial
Intelligence
Distributed AI
Grid Computing
Data Intelligence
SETI@Home
GIMPS
Collective
Intelligence
Crowd Sourcing
SETI

What is Collective Intelligence?

What is Collective Intelligence?

"… machines mimicking tasks that humans are good at"

"… machines solving tasks that humans are not good at"

"amplying human intelligence by … combining machine & human intelligence"

Artificial Intelligence → ***Data-Driven Intelligence*** → ***Collective Intelligence***

What is Collective Intelligence?

"… machines mimicking tasks that humans are good at"

Artificial Intelligence

machine learning
planning
expert systems
perception & robotics

"… machines solving tasks that humans are not good at"

Data-Driven Intelligence

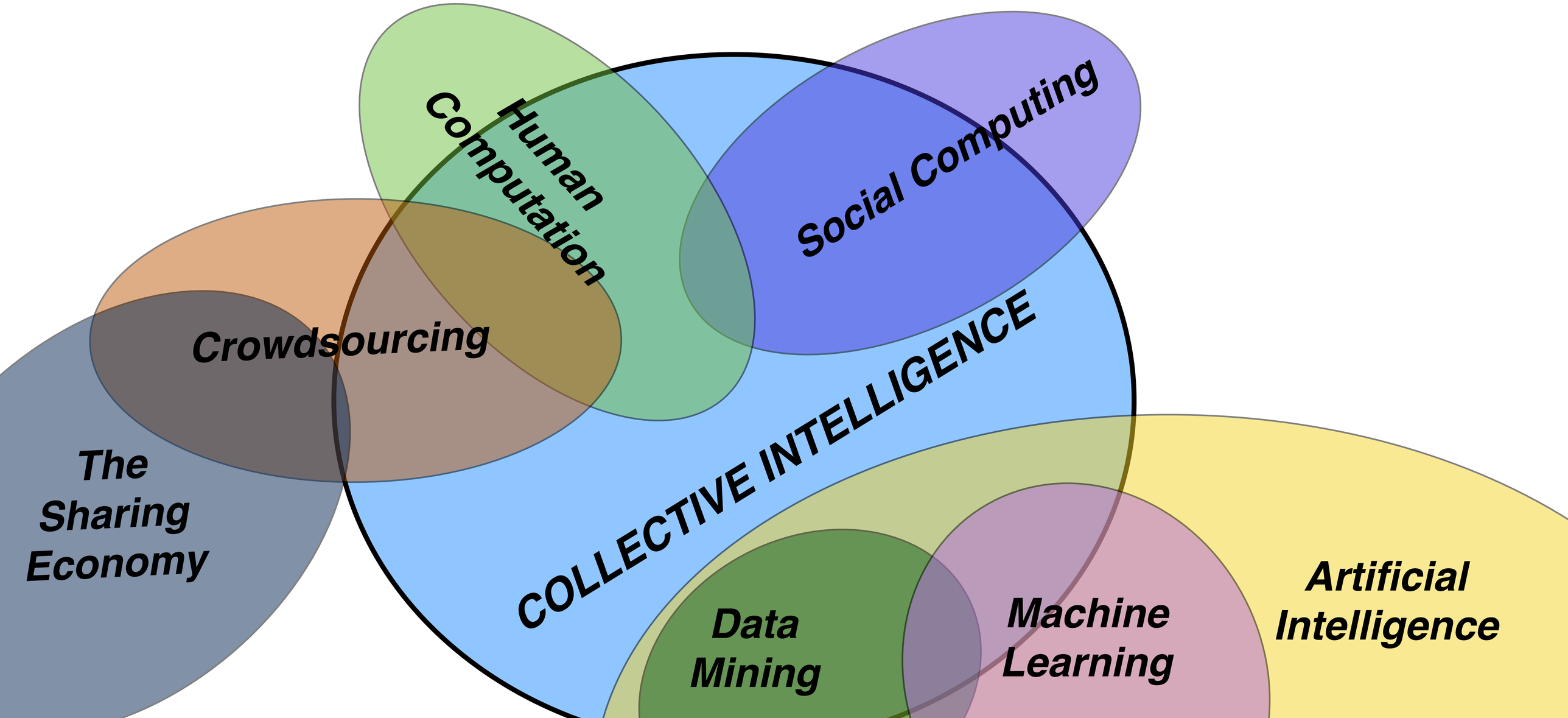
data mining
data analytics
big data
the semantic web
linked data

"amplying human intelligence by … combining machine & human intelligence"

Collective Intelligence

crowdsourcing
human computation
social computing
collaboration

The Collective Intelligence Landscape



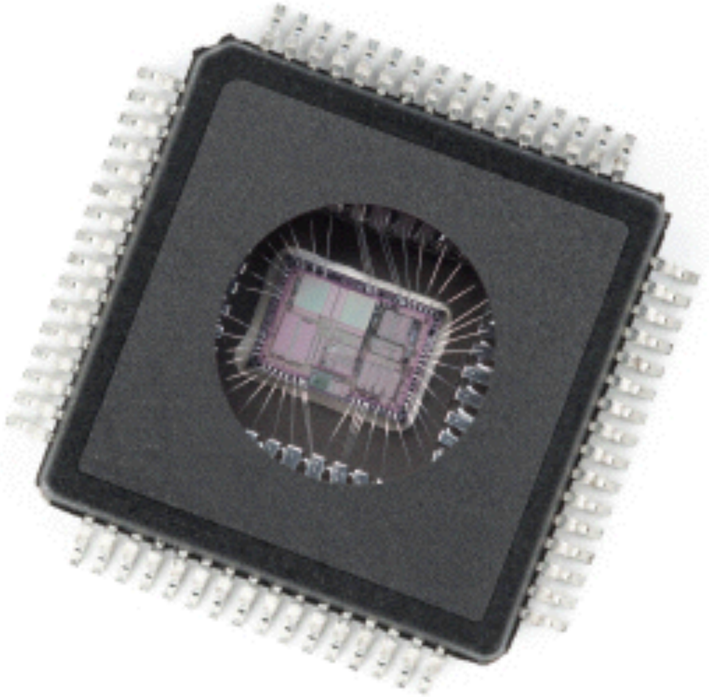
How is this changing the way that we think about computation?

Machine vs Human?

Towards a New Computational Paradigm

The Three C⁹s

Computation



The Global Machine ...

Computational Devices (1Bn CPUs)

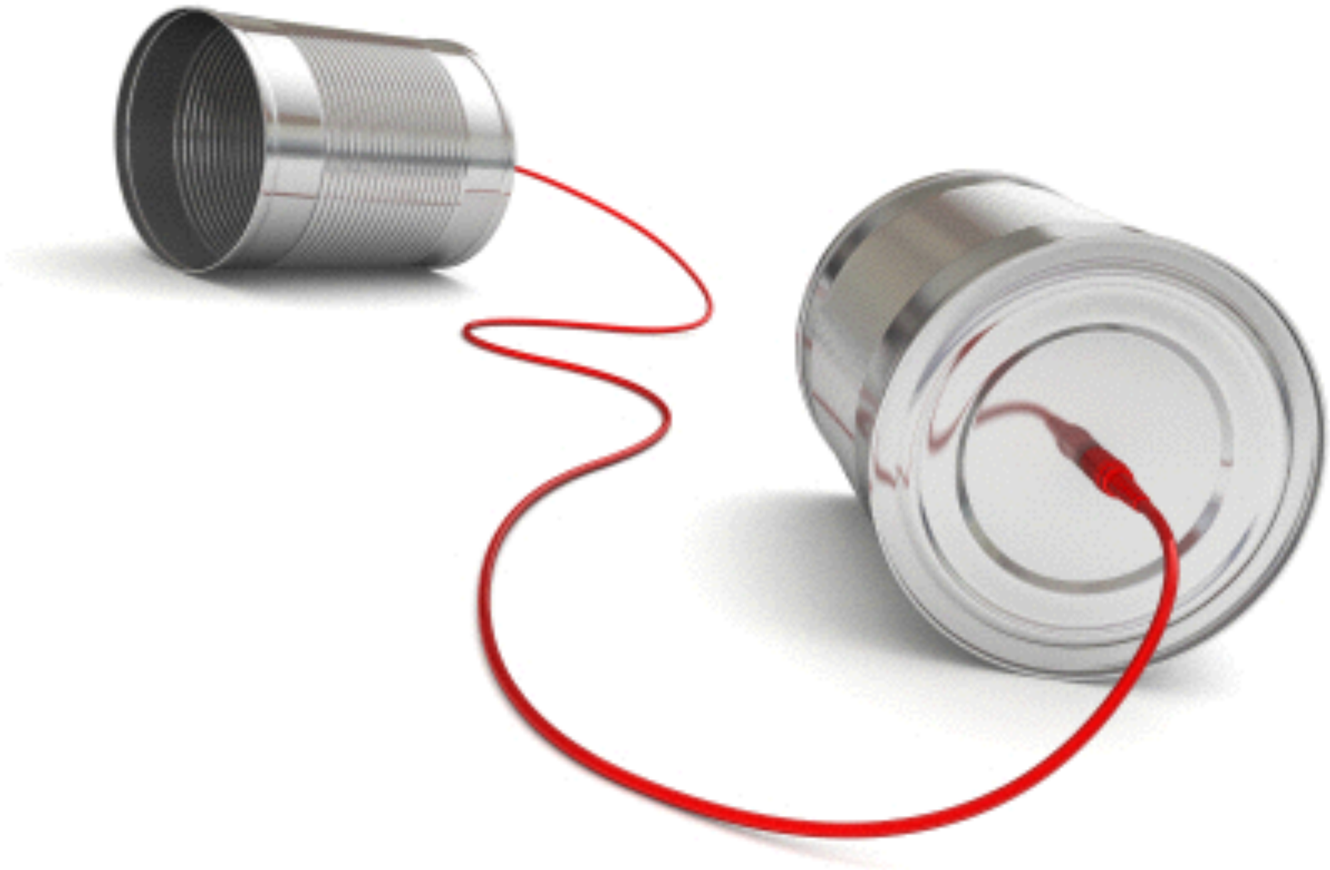
Internet Connectivity (55 Tr Links)

250 Exabytes of Storage

7 TB/sec Data Transfer Rates

Approximates 1 Human Brain (HB) ...
⇒ 6Bn HBs by 2040 !

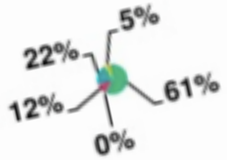
Kevin Kelly, Wired



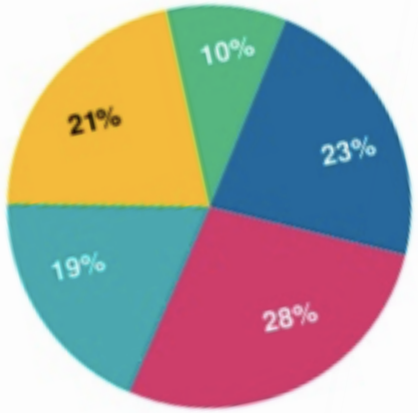
Connectivity

Internet Users – 1995 → 2014…
<1% to 39% Population Penetration Globally

1995
35MM+ Internet Users
0.6% Population Penetration



2014
2.8B Internet Users
39% Population Penetration



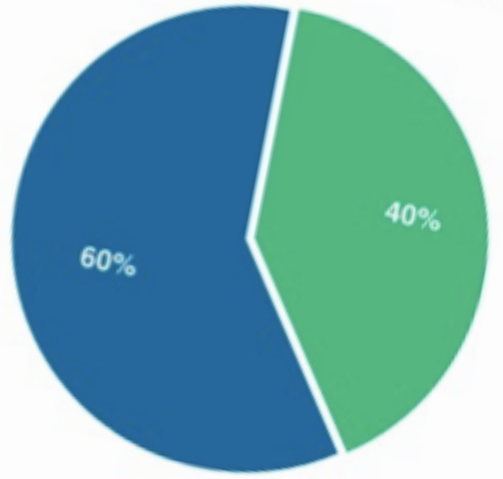
USA China Asia (ex. China) Europe Rest of World

@KPCB Source: Euromonitor, ITU, US Census.

Mobile Phone Users – 1995 → 2014…
1% to 73% Population Penetration Globally

1995
MM+ Mobile Phone Users
1% Population Penetration

2014
5.2B Mobile Phone Us
73% Population Penetration

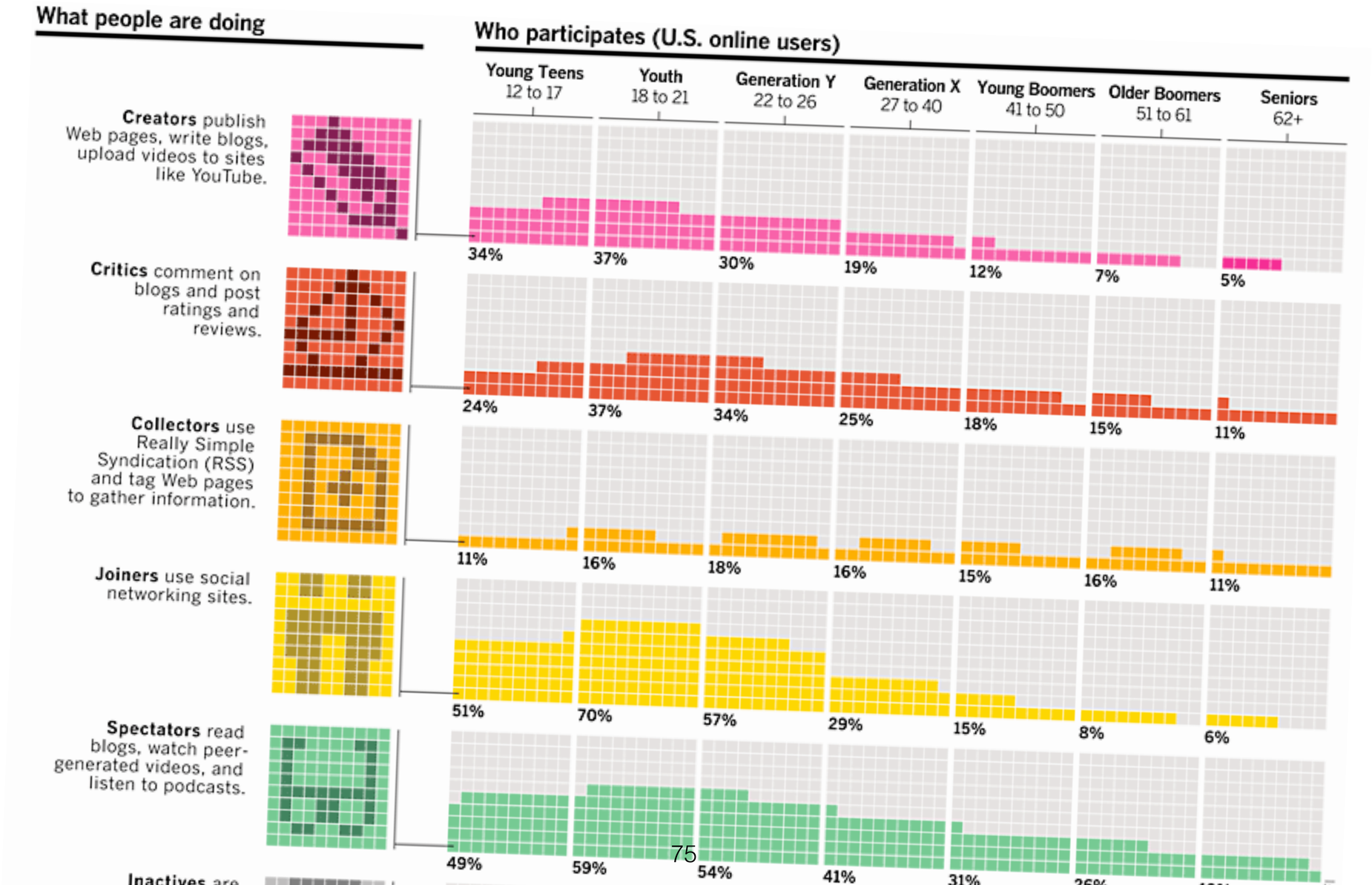


Smartphone Feature Phone

@KPCB Source: Informa, World Cellular Information Service (WCIS). Assumes in 1995, one mobile phone subscription per unique user (no duplication).
Note: In 2014, user base per KPCB estimates based on Morgan Stanley Research and ITU data. Smartphone users & mobile phone users represent unique individuals owning mobile devices; mobile subscribers based on number of connections & may therefore overstate number of mobile users.


Collaboration

The Rise of the Social Web



Key Themes

We are living in an increasingly connected world.

Where ubiquitous computation is available at near-zero cost.

People are inherently social and collaborative.
Collectively our fragmented contributions add to a lot.

Some problems are better suited to machines …

… while others require human intelligence.

A New Computational Paradigm

Picking the right problem.

What type of problems are suited to a collective intelligence approach?

Motivating and incentivising the crowd.

What makes for a suitable crowd and how do we attract/motivate them?

Amplifying the wisdom of the crowd.

How can we guide and amply the wisdom of the crowd.

Ensuring correctness.

Can correctness be guaranteed?