Distributed Data-Intensive Systems

CSCE 438
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Crowd-Powered Systems
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Slides remixed from Michael Bernstein, Jason Hong, Haym Hirsch, …
Crowd-Powered Systems: Key Terms
Collective Intelligence

• “Collective intelligence is shared or group intelligence that emerges from the collaboration, collective efforts, and competition of many individuals and appears in consensus decision making. The term appears in sociobiology, political science and in context of mass peer review and crowdsourcing applications.” (Wikipedia)
Crowdsourcing

• “Crowdsourcing is the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people, and especially from an online community, rather than from traditional employees or suppliers.” (Wikipedia)
Human Computation

• “Human-based computation (HBC) is a computer science technique in which a machine performs its function by outsourcing certain steps to humans. This approach uses differences in abilities and alternative costs between humans and computer agents to achieve symbiotic human-computer interaction.” (Wikipedia)
Social Computing

• “Social computing is an area of computer science that is concerned with the intersection of social behavior and computational systems.” (Wikipedia)

  • In the weaker sense of the term, social computing involves supporting any sort of social behavior in or through computational systems. It is based on creating or recreating social conventions and social contexts through the use of software and technology.

  • In the stronger sense of the term, social computing has to do with supporting “computations” that are carried out by groups of people.
A system is a crowdsourcing system if it enlists a crowd of humans to help solve a problem defined by the system owners.

or “crowd-powered system”

A system is a crowdsourcing system if it enlists a crowd of humans to help solve a problem defined by the system owners.

“Crowdsourcing Systems on the World-Wide Web” (CACM 2011)
Many Possible Examples

- Frito Lay Flavor Contest
- NASA Clickworkers
- OpenStudy
- Chorus
- Twitter Trending Topics
- OCR Crowdsourcing
- Spore
- StackOverflow
- Waze
- Angie’s List
- The Rise Song from Batman (wut?)
- Google Play Store
- Bitcoin
- Coke Zero Thing
- Kickstarter
- Duolingo
- Rapgenius
- Adwords
- Folding@home
- Crowdsourced music competition
- Stormbound
- Government elections
- Google
- AskAgs
- Wikipedia
- Soylent
- Valve
- This contest itself (meta!!)
HW2 is OUT
HW2

- Get familiar with Amazon Mechanical Turk
  - AMT = a popular crowdsourcing platform
- Due in one week
- Sign up for AMT account NOW!
  - Takes up to 48 hours to verify
- Money?
Mechanical Turk
Example Task

Tag Image

You are providing descriptive information about text and content found in a collection of images.

Does image contain text?

- Contains Text
- Does Not Contain Text

Enter ALL text found in image. Enter words separated by a space or <ENTER>. Capitalization is not important; text appears in the image.
## Example tasks

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Requester</th>
<th>HIT Expiration Date</th>
<th>Reward</th>
<th>Time Allotted</th>
<th>HITs Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are these two pictures of the same kind of place? (w/ clarified instructions)</td>
<td>Michelle Greene</td>
<td>Sep 11, 2013 (51 weeks 6 days)</td>
<td>$0.02</td>
<td>10 minutes</td>
<td>31650</td>
</tr>
<tr>
<td>Answer a set of survey questions</td>
<td>Tagasaurus</td>
<td>Oct 10, 2012 (3 weeks 6 days)</td>
<td>$0.07</td>
<td>60 minutes</td>
<td>16110</td>
</tr>
<tr>
<td>Keyword Search on Google.com (US)</td>
<td>CrowdSource</td>
<td>Sep 12, 2013 (52 weeks)</td>
<td>$0.16</td>
<td>32 minutes</td>
<td>14972</td>
</tr>
<tr>
<td>Answer a set of survey questions</td>
<td>Tagasaurus</td>
<td>Oct 12, 2012 (4 weeks 1 day)</td>
<td>$0.12</td>
<td>60 minutes</td>
<td>11977</td>
</tr>
<tr>
<td>Inv B.2</td>
<td>rohzit0d</td>
<td>Oct 5, 2012 (3 weeks 1 day)</td>
<td>$0.00</td>
<td>48 minutes</td>
<td>11174</td>
</tr>
<tr>
<td>Find the Program Director for Radio Stations</td>
<td>Kristin Howe</td>
<td>Sep 22, 2012 (1 week 2 days)</td>
<td>$0.05</td>
<td>10 minutes</td>
<td>8670</td>
</tr>
</tbody>
</table>
More on AMT on Thursday (plus other crowdsourcing issues / concerns)
Today: Wisdom of Crowds
Wisdom of Crowds

• Term popularized by Surowiecki
• Cases where having more than one person is better than just one
• Combine lots of different kinds of knowledge
Advantages

• Solve problems too large for individual cognition
• Work of individuals benefit group
• Aggregating decisions —→ better outcomes
Francis Galton, *Vox Populi*, 1907
Francis Galton, Vox Populi, 1907

- Median answer: 1207 lbs
- Actual weight: 1198 lbs (less than 1% off)
Kasparov versus the World (1999)

• Over 50,000 people from more than 75 countries participated in the game.
• Moves decided by plurality vote
• 62 moves played over four months,

• Kasparov: “It is the greatest game in the history of chess. The sheer number of ideas, the complexity, and the contribution it has made to chess make it the most important game ever played.”
Who Wants to be a Millionaire

If one replaced the sandwich's name with two of its key ingredients, what might be an alternate title for “The Count of Monte Cristo”?

A: The Count of Bacon & Eggs
B: The Count of Corned Beef & Rye
C: The Count of Beef & Onions
D: The Count of Ham & Cheese
Who Wants to be a Millionaire

- Ask the audience: 91% right
- Phone a friend: 65% right
Reddit trying to identify the Boston Bombers
Also not paying attention to race or anyone in particular since spotted two hours before blast.

Looks as though he maybe with this lady but in fact seems to be alone stays in the same area for two hours before first blast.

His reaction to first blast.

Last sighting.

Seconds after.
Mods removed thread: Live updates of Boston Situation (self.news)

Note to MODS: Don't touch this thread. News and info is needed to keep people safe. Sit behind your computers with all the power you want... but I won't let people die because you are entitled.

New Note to MODS: I love you guys, keep doing what you are doing. I know stuff can get rough and you get a bad rap sometimes but you guys keep things a float. I'm sorry for my message above (which I will leave for legacy) but I hope you understand my temporary anger at the time. Real Talk: Keep up the great work!

From the live audio feed: MIT Officer shot and his firearm was stolen. [Small Edit] Officer is on his way to the hospital [Mass General]. No update on his condition. MIT is also updating their emergency site with news.

EDIT 11:26 EST: They have a photo of the alleged suspect.
EDIT 11:27 EST: Heard a Black Male in all black clothing.
EDIT 11:32 EST: NBC just reported the shots on TV. No new info there.
EDIT 11:33 EST: There was a robbery at a near by 7-11 (Dark Skin White Male 5'11' 200lbs, black top). Could be related?
EDIT 11:40 EST: Woman reported on the ground screaming/crying. Male that was with her just walked away. [Unrelated, thanks /u/dontgotmilk]
EDIT 11:42 EST: Image from the scene. Warning blood.
EDIT 11:44 EST: Possible witness.
EDIT 11:47 EST: /u/philsmith24457 points out they mentioned a mini excavator [Unrelated]
EDIT 11:59 EST: Reportedly a group of Black males. 1 in a gray hoodie, in his early 20's, heavy set. 2 in black hoodies. Firearms present. [Unrelated].
EDIT 12:04 EST: from /u/TheFightingFarsi : NBC Connecticut reporting MIT Officer has died. (grain of salt till for now)
EDIT 12:07 EST: MIT updated their emergency site with news. Police are searching the campus, stay indoors.
EDIT 12:12 EST: Removed links to emergency site to prevent Reddit DDoS. Thanks /u/Some-
Why did reddit fail?

- My decision (ideas) are influenced by others (e.g., I see the arrows and the points you make)
- Did they even have the complete picture? All the data … no, they didn’t even have a picture of a subject
- Anonymity encourages trolls
- The targets could manipulate … e.g., the bombers could identify other targets
- Wrong criteria — cellphone != terrorist’ also see this wrt to guessing the ending nikkei stock price
- Emotionally charged — could lead to panics, paranoia, etc.
- …
• “Whatever the value of the wisdom of crowds, it isn’t magic: you can’t ask the crowd to find someone that, in a sense, it’s never seen.”
Asch Conformity Experiments
The Results?

- In the control group, with no pressure to conform to confederates, the error rate was less than 1%.

- An examination of all critical trials in the experimental group revealed that one-third of all responses were incorrect.

- These incorrect responses often matched the incorrect response of the majority group (i.e., confederates). Overall, in the experimental group, 75% of the participants gave an incorrect answer to at least one question.

http://en.wikipedia.org/wiki/Asch_conformity_experiments
If one replaced the sandwich's name with two of its key ingredients, what might be an alternate title for “The Count of Monte Cristo”? 

A: The Count of Bacon & Eggs  
B: The Count of Corned Beef & Rye  
C: The Count of Beef & Onions  
D: The Count of Ham & Cheese
Condorcet Jury Theorem

- Need to make a decision with 2 choices
- One choice is correct
- Each person has a probability $p$ of voting correctly
- Probability of majority vote making correct decision:
  - If $p > .5$: approaches 100%
  - If $p < .5$: approaches 0%
Condorcet Jury Theorem

• Let probability of one person’s correct vote be 51%

• Graph shows #people you need to reach 51% chance of right decision by majority
Condorcet Jury Theorem

• Now, assume 51 people total

• Graph shows probability of correct majority decision as probability varies
When Does “Wisdom of the Crowds” Not Work?

• Different probabilities per person
  • Ex. Republicans vs Democrats have different values
• Few situations with one correct answer
• People don’t have any reasonable guess
• Not enough people
Failures of the Crowds

• Not knowing
  • What is the distance between the earth and the moon?

• Systematic bias: Prejudice and marketing
  • Ex. Asking men with discriminatory attitudes to make judgments of women’s abilities
  • Ex. Asking people in states targeted by marketing campaigns about who the next president should be
Failures of the Crowds

- Systematic bias: Anchoring and adjusting
  - Initial values can impact subsequent predictions

- Spin a wheel 0-100 (rigged to give either 10 or 65)
- Is the percentage of African nations among UN members larger or smaller than the number you just wrote?
- What is your best guess of the percentage of African nations in the UN?
Failures of the Crowds

• Systematic bias: Anchoring and adjusting
• Initial values can impact subsequent predictions

[Box]
• Spin a wheel 0-100 (rigged to give either 10 or 65)
• Is the percentage of African nations among UN members larger or smaller than the number you just wrote?
• What is your best guess of the percentage of African nations in the UN?

• Average for people who got 10 was 25%
• Average for people who got 65 was 45%
• Correct answer 28% today (not sure of the answer in 1974 when study was done)
Systematic Biases

- Asked people to write down last two digits of Social Security Number
- Asked people if they would pay this much for:
  - Cordless Trackball
  - Cordless Keyboard
  - Design Book
  - Chocolates
  - Two different bottles of wine
- Then asked them to bid on these items
Systematic Biases

Average prices paid for the various products for each of the five groups of final digits in social security numbers, and the correlations between these digits and the bids submitted in the auction.

<table>
<thead>
<tr>
<th>Products</th>
<th>Range of last two digits of SS number</th>
<th>Correlations*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>00–19</td>
<td>20–39</td>
</tr>
<tr>
<td>Cordless trackball</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$8.64</td>
<td>$11.82</td>
</tr>
<tr>
<td>Cordless keyboard</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$16.09</td>
<td>$26.82</td>
</tr>
<tr>
<td>Design book</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$12.82</td>
<td>$16.18</td>
</tr>
<tr>
<td>Neuhaus chocolates</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$9.55</td>
<td>$10.64</td>
</tr>
<tr>
<td>1998 Côtes du Rhône</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$8.64</td>
<td>$14.45</td>
</tr>
<tr>
<td>1996 Hermitage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$11.73</td>
<td>$22.45</td>
</tr>
</tbody>
</table>

*Correlation is a statistical measure of how much the movement of two variables is related. The range of possible correlations is between −1 and +1, where a correlation of 0 means that the change in value of one variable has no bearing on the change in value of the other variable.
Failures of the Crowds

Critique in NYTimes on how Intrade Market had 75% chance that SCOTUS would rule Affordable Care Act unconstitutional

- Few traders (legality)
- Little public information
- Experts not that great overall (mutual fund managers, sports)

“The prediction-market revolution, like so many others, initially promised more than it could deliver. But it’s not as if the old order was working particularly well.”
Failures of the Crowds

- Given all this, what do you think about democracy?
Preconditions for Wisdom of Crowds

- Suriowiecki lays out four requirements
  - Diversity of opinion
  - Independence
    - Lack of independence can lead to information cascades
  - Decentralization
  - Aggregation
    - Some mechanism exists for turning private judgments into a collective decision

- Other requirements
  - Sufficient numbers of people
  - Sufficient motivation
  - Public information (see SCOTUS case on ACA)
Diversity of Opinion

• What is diversity?
  • Unshared private information, opinions, approaches

• “Bringing new members into the organization, even if they’re less experienced and less capable, actually makes the group smarter simply because what little the new members do know is not redundant with what everyone else knows.” (p.31)

• Do you buy this argument?
Diversity of Opinion

• Why do we need diversity?
  • Expands set of possible solutions
  • Groups can conceptualize problems in new ways

• Problems with diversity
  • Increased conflict
  • More difficult to reach consensus
  • May lead to factions, group issues
Independence

• People’s opinions are not determined by the opinions of those around them

• “The more influence a group’s members exert on each other, and the more personal contact they have with each other, the less likely it is that the group’s decisions will be wise ones.” (p.42)

• Do you buy this argument?
Independence

- People’s opinions are not determined by the opinions of those around them
- Keeps people’s mistakes from becoming correlated
  - Systematic bias
- Independent individuals more likely to have new information
- Decisions should be made simultaneously
  - Otherwise anchoring and adjusting
- How do existing social web sites fare here?
Decentralization

• Enables specialization, division of labor
• Encourages independence
• But no guarantee that valuable information in one part of the system will flow to another part
Aggregation

• Mechanism for turning private judgments into a collective decision

• Different types of aggregation
  • Average/Median
  • Mode (voting)
  • Markets
  • Deliberation
Possible Examples

- Diversity of Opinion
- Independence
- Decentralization
- Aggregation

- Frito Lay Flavor Contest
- NASA Clickworkers
- OpenStudy
- Chorus
- Twitter Trending Topics
- OCR Crowdsourcing
- Spore
- StackOverflow
- Waze
- Angie’s List
- The Rise Song from Batman (wut?)
- Google Play Store
- Bitcoin
- Coke Zero Thing
- Kickstarter
- Duolingo
- Rapgenius
- Adwords
- Folding@home
- Crowdsourced music competition
- Stormbound
- Government elections
- Google
- AskAgs
- Wikipedia
- Soylent
- Valve
- This contest itself (meta!!)
Twitch Plays Pokemon

- Diversity
  - All Pokemon players
- Independence
- Decentralization
- Aggregation
  - Random / in-order execution of moves

- Diversity of Opinion
- Independence
- Decentralization
- Aggregation
RapGenius

• Get lyrics + crowd analysis of lyrics
• Target intelligent, particular audience, bias from artists that I like

• Diversity?
  • No — young white males; particular worldview embed in the interpretations

• Independence?
  • Maybe at the start; first timers are seeing what’s already been written

• Decentralization?
  • ??

• Aggregation?
  • Up/down votes
Problems with Independent Crowds

• Lack of information
  • Lack of knowledge
    • What is the distance between the earth and the moon?
  • Lack of diversity
    • Misrepresentation of correct information

• Systematic bias
  • Selection effects
    • Amazon ratings
  • Prejudice and marketing
  • Cognitive biases
    • Anchoring and adjusting, framing
Consistency in Wisdom of Crowds

• Question: Does the wisdom of crowds yield consistent results?
  • Would hit songs, books, movies, etc still be hits in alternate universes?
  • How much is due to luck and random variations?
Consistency in Wisdom of Crowds

- Salganik et al tested social influences in cultural markets (artificial music market)
  - 14341 participants (mostly teens), split into 8 worlds
  - Listened to unknown songs from unknown bands
  - Either could see how many total downloads (social condition) or no extra info (control)
  - Asked to rate songs 1-5 stars

- For social condition, also...
  - Exp1: show 48 songs randomly ordered
  - Exp2: show 48 songs sorted by downloads
Hypotheses?

• Your predicted outcomes?
Quick Aside: Gini Coefficient

• Gini Coefficient is a measure of inequality
  • Value of 0 means equal distribution
  • Higher values nearing 1 means extreme inequality

Cumulative share of people from lowest to highest incomes
Consistency in Wisdom of Crowds

- Social influences clearly impacted results
  - All social influence worlds saw greater inequality
  - Popular songs more popular
  - Unpopular songs more unpopular
Consistency in Wisdom of Crowds

• Social influence also generated more unpredictability of outcomes
• Graph shows average difference in market share across worlds

![Graph showing average difference in market share across worlds](image)
Consistency in Wisdom of Crowds
Consistency in Wisdom of Crowds

Exp. 2

Rank: $m_{influence}$

Rank: $m_{indep}$