Lecture 8:
CS 5306 / INFO 5306:
Crowdsourcing and
Human Computation

Amazon Mechanical Turk

- Students hit two problems:
  - Need SSN or Tax ID if using AMT in US
    (If this is a problem talk to me)
  - Amazon Payments
    AMT support will help us with this

- Stay tuned for an email with details

Nicolas de Condorcet

17 September 1743 – 28 March 1794

Condorcet Jury Theorem

- One voter:

Voter 1	Majority Vote
A	A
B	B

Condorcet Jury Theorem

- Three voters:

Voter 1	Voter 2	Voter 3	Majority Vote
A	A	A	A
A	A	B	A
A	B	A	A
A	B	B	B
B	A	A	A
B	A	B	B
B	B	A	B
B	B	B	B

Condorcet Jury Theorem

- Five voters:

Vote 1	Vote 2	Vote 3	Vote 4	Vote 5	Majority Vote
A	A	A	A	A	A
A	A	A	A	B	A
A	A	A	B	A	A
A	A	A	B	B	A
A	A	B	A	A	A
A	A	B	A	B	A
A	A	B	B	A	A
A	B	A	A	A	A
A	B	A	A	B	A
A	B	A	B	A	A
A	B	B	A	A	A
B	A	A	A	A	A
B	A	A	A	B	A
B	A	A	B	A	A
B	A	B	A	A	A
B	B	A	A	A	A

Condorcet Jury Theorem

- Five voters:

Vote 1	Vote 2	Vote 3	Vote 4	Vote 5	Majority Vote
A	A	B	B	B	B
A	B	A	B	B	B
A	B	B	A	B	B
A	B	B	B	A	B
A	B	B	B	B	B
B	A	A	B	B	B
B	A	B	A	B	B
B	A	B	B	A	B
B	A	B	B	B	B
B	B	A	A	B	B
B	B	A	B	A	B
B	B	A	B	B	B
B	B	B	A	A	B
B	B	B	A	B	B
B	B	B	B	A	B
B	B	B	B	B	B

Condorcet Jury Theorem

- One voter, probability A = 0.6, B = 0.4:

Voter 1	Majority Vote	Probability
A	A	.6
B	B	.4

Condorcet Jury Theorem

- Three voters, probability A = 0.6, B = 0.4:

Voter 1	Voter 2	Voter 3	Majority Vote	Probability
A	A	A	A	0.6 x 0.6 x 0.6 = 0.216
A	A	B	A	0.6 x 0.6 x 0.4 = 0.144
A	B	A	A	0.6 x 0.4 x 0.6 = 0.144
A	B	B	B	0.6 x 0.4 x 0.4 = 0.096
B	A	A	A	0.4 x 0.6 x 0.6 = 0.144
B	A	B	B	0.4 x 0.6 x 0.4 = 0.096
B	B	A	B	0.4 x 0.4 x 0.6 = 0.096
B	B	B	B	0.4 x 0.4 x 0.4 = 0.064

Condorcet Jury Theorem

- Three voters, probability A = 0.6, B = 0.4:

Voter 1	Voter 2	Voter 3	Majority Vote	Probability
A	A	A	A	0.6 x 0.6 x 0.6 = 0.216
A	A	B	A	0.6 x 0.6 x 0.4 = 0.144
A	B	A	A	0.6 x 0.4 x 0.6 = 0.144
A	B	B	B	0.6 x 0.4 x 0.4 = 0.096
B	A	A	A	0.4 x 0.6 x 0.6 = 0.144
B	A	B	B	0.4 x 0.6 x 0.4 = 0.096
B	B	A	B	0.4 x 0.4 x 0.6 = 0.096
B	B	B	B	0.4 x 0.4 x 0.4 = 0.064

Probability A = 0.216 + 0.144 + 0.144 + 0.144 = 0.648

Probability B = 0.096 + 0.096 + 0.096 + 0.064 = 0.352

Condorcet Jury Theorem

- Five voters:

Vote 1	Vote 2	Vote 3	Vote 4	Vote 5	Majority	Probability
A	A	A	A	A	A	0.07776
A	A	A	A	B	A	0.05184
A	A	A	B	A	A	0.05184
A	A	A	B	B	A	0.03456
A	A	B	A	A	A	0.05184
A	A	B	A	B	A	0.03456
A	A	B	B	A	A	0.03456
A	B	A	A	A	A	0.05184
A	B	A	A	B	A	0.03456
A	B	A	B	A	A	0.03456
A	B	B	A	A	A	0.03456
B	A	A	A	A	A	0.05184
B	A	A	A	B	A	0.03456
B	A	A	B	A	A	0.03456
B	A	B	A	A	A	0.03456
B	B	A	A	A	A	0.03456

Condorcet Jury Theorem

- Five voters:

Vote 1	Vote 2	Vote 3	Vote 4	Vote 5	Majority	Probability
A	A	B	B	B	B	0.02304
A	B	A	B	B	B	0.02304
A	B	B	A	B	B	0.02304
A	B	B	B	A	B	0.02304
A	B	B	B	B	B	0.01536
B	A	A	B	B	B	0.02304
B	A	B	A	B	B	0.02304
B	A	B	B	A	B	0.02304
B	A	B	B	B	B	0.01536
B	B	A	A	B	B	0.02304
B	B	A	B	A	B	0.02304
B	B	A	B	B	B	0.01536
B	B	B	A	A	B	0.02304
B	B	B	A	B	B	0.01536
B	B	B	B	A	B	0.01536
B	B	B	B	B	B	0.01024

Condorcet Jury Theorem

- Five voters:
  - Probability majority vote is A = 0.683
  - Probability majority vote is B = 0.317

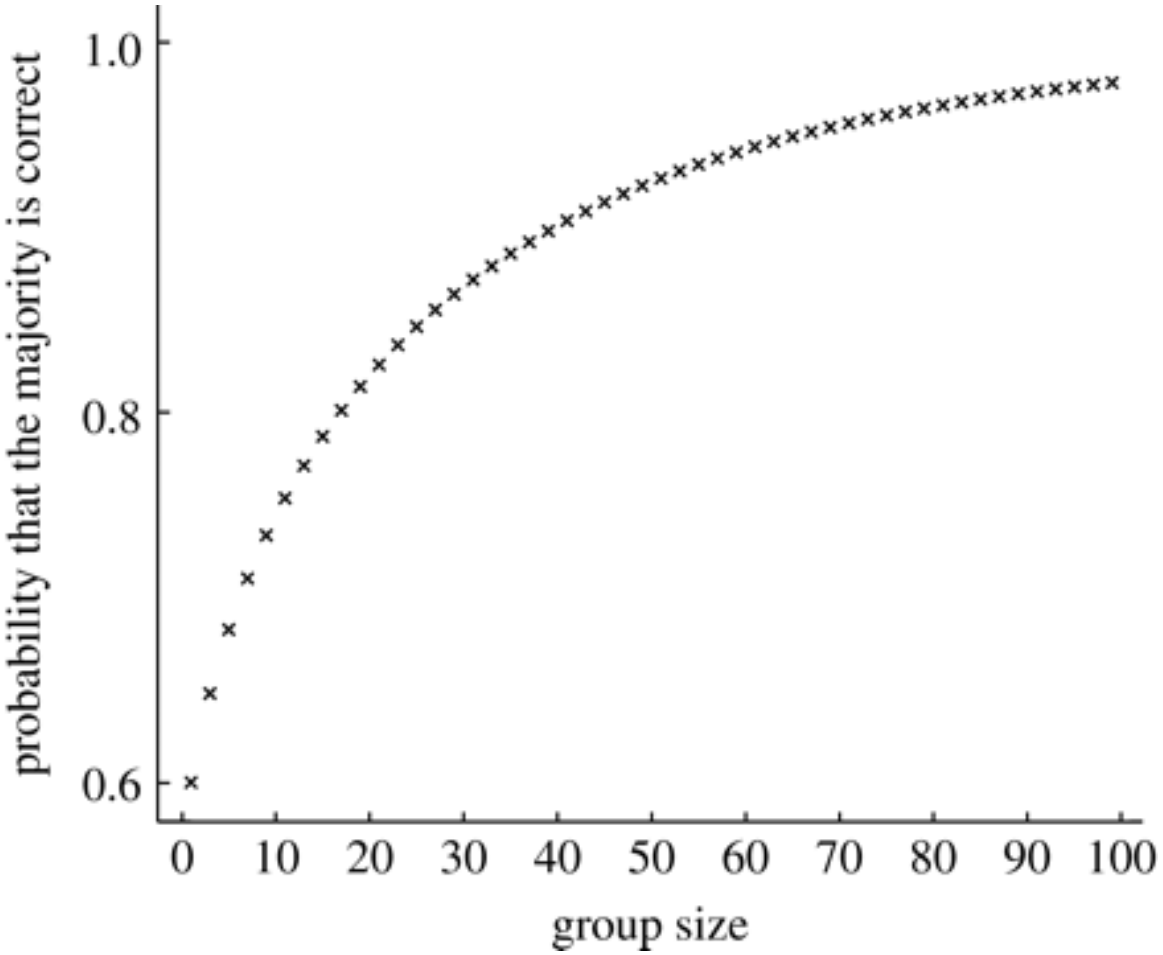
Condorcet Jury Theorem

- Five voters:
  - Probability majority vote is A = 0.683
  - Probability majority vote is B = 0.317
- Three voters:
  - Probability majority vote is A = 0.648
  - Probability majority vote is B = 0.352
- One voter:
  - Probability majority vote is A = 0.6
  - Probability majority vote is B = 0.4

Condorcet Jury Theorem

(Sumpter & Pratt 2009)

p = 0.6



Condorcet Jury Theorem

(wolfram.com)

$$P(N, p) = \sum_{k=\lceil N/2 \rceil}^{N} \binom{N}{k} \times p^k (1-p)^{N-k}$$

Condorcet Jury Theorem

- Fails if
  - $p < 0.5$
  - Non-independence
    - Informational pressure – conform to what is “known”
    - Social pressure – conform to others
    - Decisiveness of individual vote (e.g., vote to convict for murder)
    - Biases
- Examples:
  - CIA / Iraq
  - Columbia shuttle explosion
  - Federal judges

Condorcet Jury Theorem

- Analogs in lower organisms
  - Honeybee and ant nest site selection
  - Cockroach aggregation
  - Fish navigation
  - Bacteria behavior (quorum sensing)

Readings for Next Time

- Tuesday, March 1:
  Infotopia, Chapter 2
- Thursday, March 3:
  Infotopia, Chapter 3