Charity Auctions on Social Networks

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YAHOO! RESEARCH

Based on joint work with Mohammad Mahdian

Outline

- Why?

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- Why?
  - Relation between charitable giving and content creation on Web

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- What next?
  - Discussion

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  - Individuals donating to charity

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- Content creation on the web
  - Individuals contributing content on the Internet

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- Both result in *public goods*

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- Clean air, knowledge, melodies...

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  - 4 players, each starts with $1
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- Typical solutions involve taxes, subsidies, . . .

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- Why do people give?
  - Encourage contributions
  - Predict effect of change in economic environment

Models for Giving

- Public versus private benefit
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  - Global Giving – Empower Women in Kosovo:
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- Observed contributions inconsistent with model's prediction
  - Predicted contributions too small
  - Increase in others' contributions should decrease mine
  - Only wealthiest donors should give

Modeling Private Benefits

- Donations by others not perfect substitute
- Commodity: Direct benefit from giving
  - Gifts, membership, ...
- "Warm glow" effect (Andreoni)
- Extent of contribution unaffected by other contributions

Empirical Evidence

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- Both motives present to varying degrees
  - More public motive in experiments than survey data
  - Private motive in large groups; public in small ones [Vesterlund]

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  - Impact of donation on other donations
    - Sequential fund-raising [Vesterlund]

The Social Aspect

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- Social influence on giving [Carmen'04]

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- Effect of gift-matching on likelihood and amount of donation [Karlan and List'06, Shang and Croson'05]

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Matching: An Example

- A's utility if charity has \$1 is \$.60
- B's utility if charity has \$1 is \$.70
- Individual donation is not rational
- Matching contributions of \$.50 each gives positive utility to both

Charity Auctions

- Charity auction: A mechanism where individuals can bid to match each other's contribution to one/multiple charities
  - Defined by [Conitzer and Sandholm'04]
    - Studied complexity of clearing problem
  - No object is bought or sold at auction
  - In general, agent's donation can be function of contribution from all donors

Related work

- CS literature: [Conitzer and Sandholm'04]
  - With multiple charities and unrestricted conditional contributions, clearing problem is computationally hard
- Mechanism design (private provision of public goods):
  - [Guttman'78]
  - [Varian'94]
  - [Bagnoli and Lipman'89]

Model

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- $x \in \mathbb{R}^n$ non-negative vector of contributions

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- Bidders $1, \ldots, n$
- $x \in \mathbb{R}^n$ non-negative vector of contributions
- Utility of bidder i is a function $u_i(x)$ of x
- $u_i(x)$ decreasing in x_i, increasing in x_j for $j \neq i$

Model, cont'd

- Focus: Utility of each agent is linear function of contribution of her "friends", capped by a budget

$$u_i(x) = \begin{cases} \sum_{j \in N(i)} a_{ij} x_j - x_i & x_i \leq B_i \\ -\infty & \text{otherwise} \end{cases}$$

Model, cont'd

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- Agent i's type given by $(A_i = (a_{ij}), B_i)$
- Special case (complete social network):

$$u_i(x) = \begin{cases} a_i X - x_i & x_i \leq B_i \\ -\infty & \text{otherwise,} \end{cases}$$

where $X = \sum_{j=1}^{n} x_j$

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- Optimal outcome: Outcome x that maximizes $\sum_j x_j$ subject to IR

A useful lemma

Lemma. There is a *unique* maximal feasible contribution vector x^*.

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If x, y are feasible, $\max(x, y)$ is also feasible...

- x^* is the maximal solution of $x^* = \min(A_i x^*, B_i)$
- x^* is the *optimal* outcome
- Can be computed efficiently for linear utilities

Mechanism

- Elicit types (A', B')
- Output maximal feasible vector x^* wrt (A', B') as the outcome

- Denote contribution vector returned by mechanism by $P(A', B')$
- Computationally efficient mechanism
- Demo version is implemented as web application

CharitY!

Logged in as mahdian | Select another campaign | Logout

Welcome to the charity campaign Yahoo! Employee Foundation

About: The Yahoo! Employee Foundation is a grassroots, philanthropic organization that gives Yahoo! employees easy and accessible ways to give back to their communities. See: http://backyard.yahoo.com/yef/yef.html

Closing Date: December 31, 2007

Total raised so far: $22.00
Number of people who have joined the campaign: 1
Your current total donation: $12.00

Contribute to this campaign!

Unconditional contribution: $ 10

Encourage your friends to join this campaign!

You can encourage your friends to contribute to this campaign by inviting them to join the campaign, and offering to partially match their contribution up to some maximum. For example, you can offer to pay 10 cents for every dollar your friends contribute, up to a maximum of $50.

Maximum amount of matching funds: $ 50
Match $1 of your friends' contribution by: $ 0.2

Friends you have currently invited to this campaign:

preston pennock arpita (Joined!)

☐ I would like to match the total contribution from all donors to this campaign.

Invite new friends

Change

this is YAHOO!

An Example

- Three players with (a_i, B_i): (0.5, 10), (0.4, 25), (0.4, 25)
- Contribution vector computed by mechanism: 10, 20, 20

Equilibria

- Charity auction defines a game H:
  - Agents report (A'_i, B'_i)
  - Payment $x' = P(A', B')$
  - Utility of agent i is $u_i(x') = A_i x' - x'_i$ if $x'_i \leq B_i$, $-\infty$ otherwise

Equilibria

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  - Agents report (A_i', B_i')
  - Payment $x' = P(A', B')$
  - Utility of agent i is $u_i(x') = A_i x' - x_i'$ if $x_i' \leq B_i$, $-\infty$ otherwise

- Question: Is there a full information equilibrium (A', B') that achieves the optimal outcome, i.e., $P(A', B') = P(A, B)$?

Conditions for equilibria

Theorem. For any vector x with $X = \sum_{j=1}^{n} x_j$ satisfying

$$\forall\ i: \qquad \frac{x_i}{X} \leq a_i,$$

$$\forall\ i \text{ s.t. } x_i < B_i: \qquad \sum_{j:\ j \neq i, x_j < B_j} \frac{x_j}{X} \leq 1 - a_i,$$

$$\exists\ i \text{ s.t.} \qquad x_i = B_i.$$

there is a full-information Nash equilibrium of H that results in the outcome x.

Corollary The optimal outcome can be supported in a full-information Nash equilibrium.

General networks

- Agent i's utility is linear function of set of "friends" in directed social network G

Theorem: The optimal outcome $x = P(A, B)$ can be supported in an equilibrium if the social network G is strongly connected.

Existence of non-zero equilibria

Question: How do graph properties of the social network influence the success of a charity campaign?

Theorem: Payment vector $x = P(A, B)$ non-zero iff $\lambda_{\max}(A) \geq 1$.

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Theorem: Payment vector $x = P(A, B)$ non-zero iff $\lambda_{\max}(A) \geq 1$.

Corollary: There exists non-zero equilibrium for complete graph iff $\sum_{i=1}^{n} a_i \geq 1$

Summary

- Single charity with linear utilities: Optimal outcome can be supported in Nash equilibrium on a strongly connected graph
- Characterized existence of non-zero equilibria
- Equilibria with dynamics?

What's Next

- Web context:
  - Content creation on Wikipedia
  - Product reviews on Amazon, restaurant ratings on Yelp
  - Answering questions on Yahoo! Answers
  - Activity on social networks

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- Web context:
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- Behavior model $\Rightarrow$ mechanism design
- Response to mechanisms $\Rightarrow$ behavior model

Some Thoughts

- Small communities versus large groups
  - Private versus public benefit
  - Wikipedia versus social networks?
- Threshold contributions
- Sequential mechanisms
  - Targeting wealthy individuals: Is time equivalent of money?
  - Signaling quality: who should be the leaders?
- The prestige motive–fake points

Conclusion

- Parallels between charitable giving and content creation on the web
  - Mix of private and public benefit
  - Social aspects, size of community
- Differences with charitable giving
  - Contribution and cost are both nonmonetary: harder to measure
  - No equivalent income effect
- What will work for the Web?