Balanced Donor Coordination

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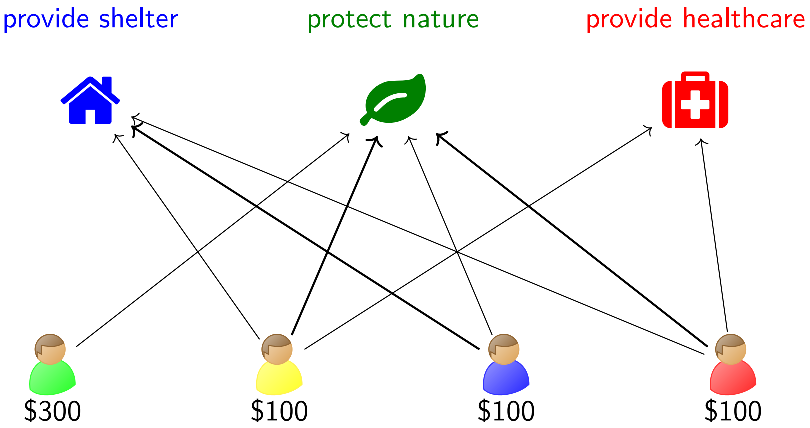
Donation Programs

- Cinque per mille
  - Italian citizens are allowed to contribute 0.5% of their income tax to one of over 71k organizations.
  - 2022: €510m
- Employee charity matching programs
  - Microsoft (2022): $250m to 32k organizations
  - Apple (2011-2022): $880m to 44k organizations

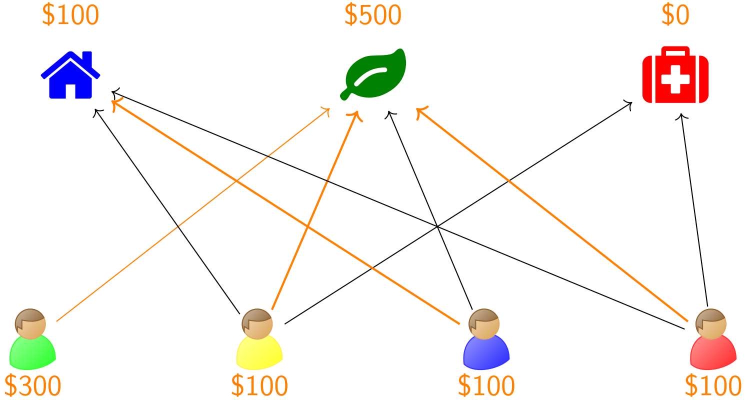
→ A donor can select only one organization and acts on her own.
→ There is a huge potential to increase the donors' satisfaction by

- taking into account finer preferences over the organizations.
- coordinating donations.

The Need for Coordination



The Need for Coordination

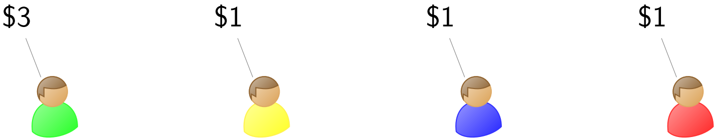


→ Charity does not receive any money although it is approved by agents 2 and 4.

→ Presumably, these two agents are willing to (partially) transfer their contributions to .

The Model

- Set N of agents with contributions $C = \{C_i\}_{i \in N}$.



- Set A of charities the agents can contribute to:  ,  , .
- *Distribution* $\delta : A \to \mathbb{R}_{\geq 0}$ with $\sum_{x \in A} \delta(x) = \sum_{i \in N} C_i$.

The Model

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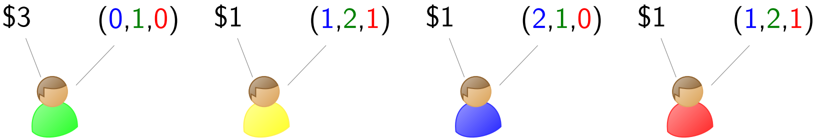
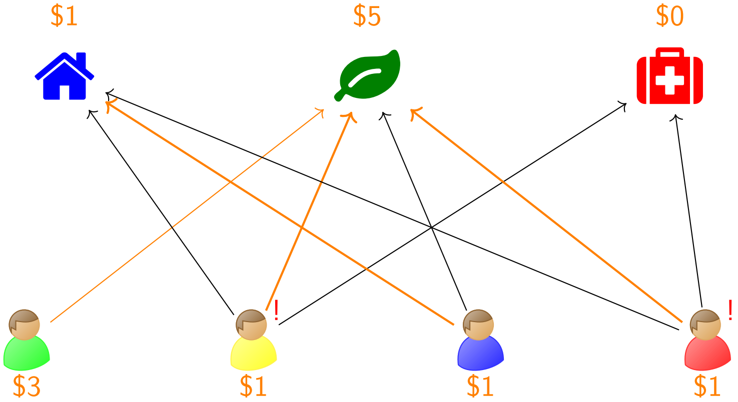


- Set A of charities the agents can contribute to: , , .
- *Distribution* $\delta : A \to \mathbb{R}_{\geq 0}$ with $\sum_{x \in A} \delta(x) = \sum_{i \in N} C_i$.
- Each agent i has *valuation* $v_{i,x} \geq 0$ for charity x and a **Leontief utility function** $u_i(\delta) = \min_{x \in A_i} \frac{\delta(x)}{v_{i,x}}$ where $A_i = \{x \in A : v_{i,x} > 0\}$.
  - In the case of $v_{i,x} \in \{0, 1\}$ for all $i \in N$, $x \in A$, we speak of *binary* Leontief utilities.
- A *distribution rule* f returns a distribution δ for any *profile* consisting of $(v_{i,x})_{i \in N, x \in A}$ and $(C_i)_{i \in N}$.

Related Work

- Linear utility model
  - *Bogomolnaia, Moulin, Stong (2005)*, and *Brandl, Brandt, Peters, Stricker (2021)* (binary preferences, exogenous fixed endowment)
  - *Brandl, Brandt, Greger, Peters, Stricker, Suksompong (2022)* (endowment initially owned by the agents)
- Private provision of public goods (e.g., *Bergstrom, Blume, Varian (1986)*)
  - agents distribute their wealth between a private and a public good
- Participatory budgeting (e.g., *Cabannes (2004)*)
  - fixed costs for projects that are either fully funded or not at all
  - exogenous endowment

The Equilibrium Distribution Rule



The Equilibrium Distribution Rule

	C_i				$u_i(\delta)$
Agent 1	3	·	3	·	5
Agent 2	1	·	1	·	0
Agent 3	1	1	·	·	0.5
Agent 4	1	·	1	·	0
δ	6	1	5	0	

$\rightarrow$ Agents 2 and 4 have an incentive to move (part of) their contribution to .

The Equilibrium Distribution Rule

	C_i				$u_i(\delta)$
Agent 1	3	·	3	·	3
Agent 2	1	0.5	·	0.5	1.5
Agent 3	1	1	·	·	0.75
Agent 4	1	·	·	1	1.5
δ	6	1.5	3	1.5	

$\rightarrow$ No agent has an incentive to deviate.

$\rightarrow$ We call such a distribution an *equilibrium distribution*.

The Equilibrium Distribution Rule

Theorem

Each profile admits a unique equilibrium distribution.

Definition

The *equilibrium distribution rule* (EDR) returns the equilibrium distribution.

	C_i				$u_i(\delta)$
Agent 1	3	·	3	·	3
Agent 2	1	0.5	·	0.5	1.5
Agent 3	1	1	·	·	0.75
Agent 4	1	·	·	1	1.5
δ^{EDR}	6	1.5	3	1.5	

Properties of *EDR*

- δ^{EDR} maximizes Nash welfare and thus is Pareto-efficient.

	C_i				$u_i(\delta)$
Agent 1	3	·	3	·	3
Agent 2	1	0.5	·	0.5	1.5
Agent 3	1	1	·	·	0.75
Agent 4	1	·	·	1	1.5
δ^{EDR}	6	1.5	3	1.5	

Properties of *EDR*

- δ^{EDR} maximizes Nash welfare and thus is Pareto-efficient.
- No group of agents has an incentive to misreport their valuations (*group-strategyproofness*).

	C_i				$u_i(\delta)$
Agent 1	3	·	3	·	3
Agent 2	1	0.5	·	0.5	1.5
Agent 3	1	1	·	·	0.75
Agent 4	1	·	·	1	1.5
δ^{EDR}	6	1.5	3	1.5	

	C_i				$u_i(\delta)$
Agent 1	3	·	3	·	3
Agent 2	1	·	·	1	1
Agent 3	1	1	·	·	0.5
Agent 4	1	·	·	1	1
δ^{EDR}	6	1	3	2	

Properties of *EDR*

- δ^{EDR} maximizes Nash welfare and thus is Pareto-efficient.
- No group of agents has an incentive to misreport their valuations (*group-strategyproofness*).
- Agents are strictly better off by increasing their contributions (*participation*).

	C_i				$u_i(\delta)$
Agent 1	3	·	3	·	3
Agent 2	1	$1/2$	·	$1/2$	$3/2$
Agent 3	1	1	·	·	$3/4$
Agent 4	1	·	·	1	$3/2$
δ^{EDR}	6	$3/2$	3	$3/2$	

	C_i				$u_i(\delta)$
Agent 1	3	·	3	·	$10/3$
Agent 2	1	·	$1/3$	$2/3$	$5/3$
Agent 3	**2**	2	·	·	1
Agent 4	1	·	·	1	$5/3$
δ^{EDR}	7	2	$10/3$	$5/3$	

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- Increasing the valuation for a charity x can only increase $\delta(x)$ (*preference-monotonicity*).

	C_i				$u_i(\delta)$
Agent 1	3	·	3	·	3
Agent 2	1	0.5	·	0.5	1.5
Agent 3	1	1	·	·	0.75
Agent 4	1	·	·	1	1.5
δ^{EDR}	6	1.5	3	1.5	

	C_i				$u_i(\delta)$
Agent 1	3	·	3	·	3
Agent 2	1	**1**	·	·	1
Agent 3	1	1	·	·	1
Agent 4	1	·	·	1	1
δ^{EDR}	6	2	3	1	

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- If an agent increases their contribution, no charity can receive less than before (*contribution-monotonicity*).

	C_i				$u_i(\delta)$
Agent 1	3	·	3	·	3
Agent 2	1	$1/2$	·	$1/2$	$3/2$
Agent 3	1	1	·	·	$3/4$
Agent 4	1	·	·	1	$3/2$
δ^{EDR}	6	$3/2$	3	$3/2$	

	C_i				$u_i(\delta)$
Agent 1	3	·	3	·	$10/3$
Agent 2	1	·	$1/3$	$2/3$	$5/3$
Agent 3	**2**	2	·	·	1
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Properties of *EDR*

- δ^{EDR} maximizes Nash welfare and thus is Pareto-efficient.
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- Increasing the valuation for a charity x can only increase $\delta(x)$ (*preference-monotonicity*).
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- *EDR* can be computed via convex programming.

Further Remarks and Future Work

- Existence of a best response dynamics converging to *EDR*.
- Binary Leontief utilities:
  - *EDR* can be computed via linear programming.
  - Connections to maximizing egalitarian welfare.
- Our results do not carry over to other utility models, e.g., concave utilities as Cobb-Douglas.

- It is worth investigating such models regarding equilibrium distributions and other axioms.
- Are there attractive axiomatic characterizations of *EDR*?
- Increase impact of existing donation programs by implementing *EDR*.

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