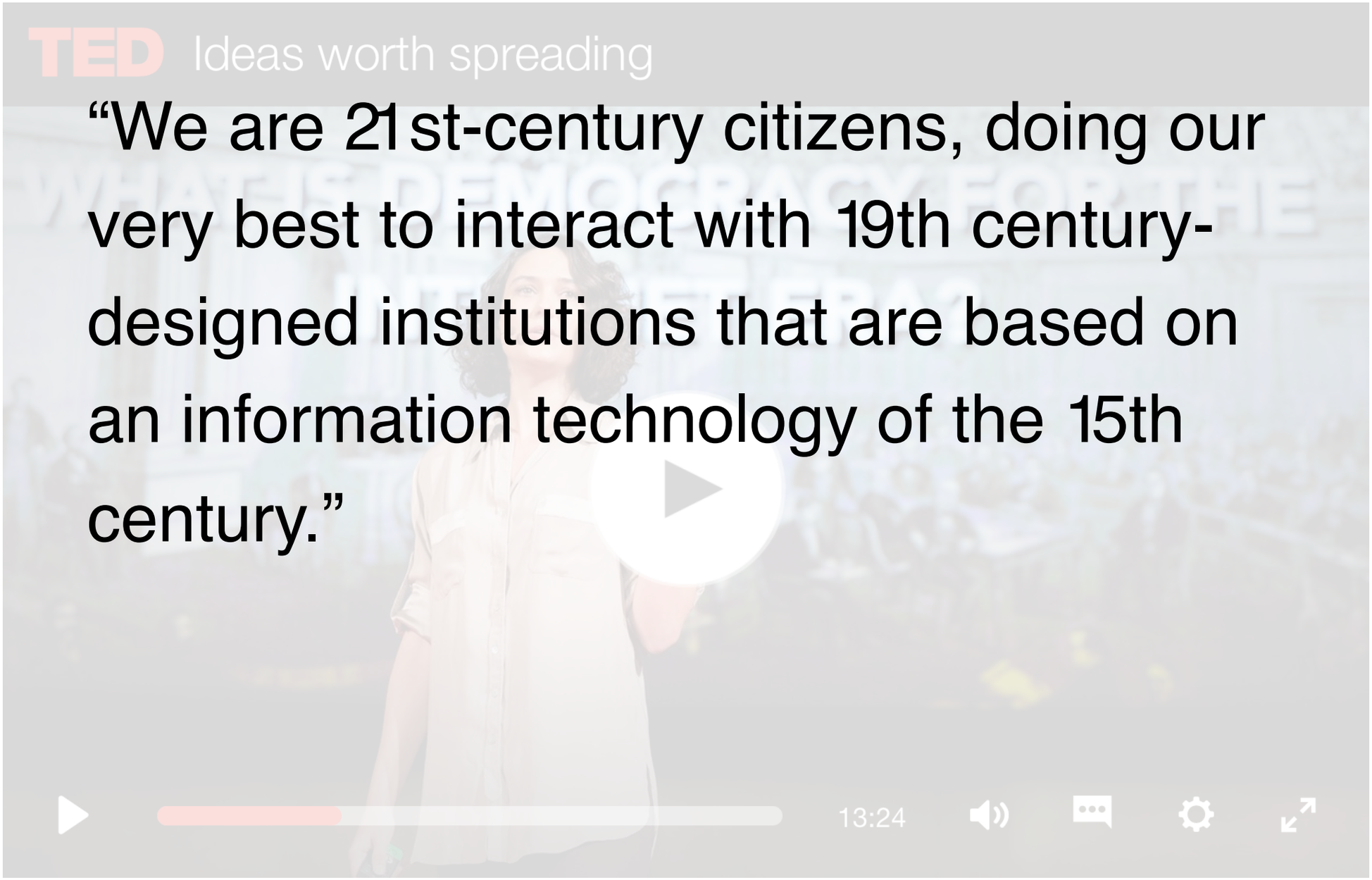
Liquid Democracy with Ranked Delegations

Anne-Marie George
TU Berlin

Digital Democracy

and the need to upgrade democratic processes.

“How to upgrade democracy for the Internet era”
(Pia Mancini, 2014)



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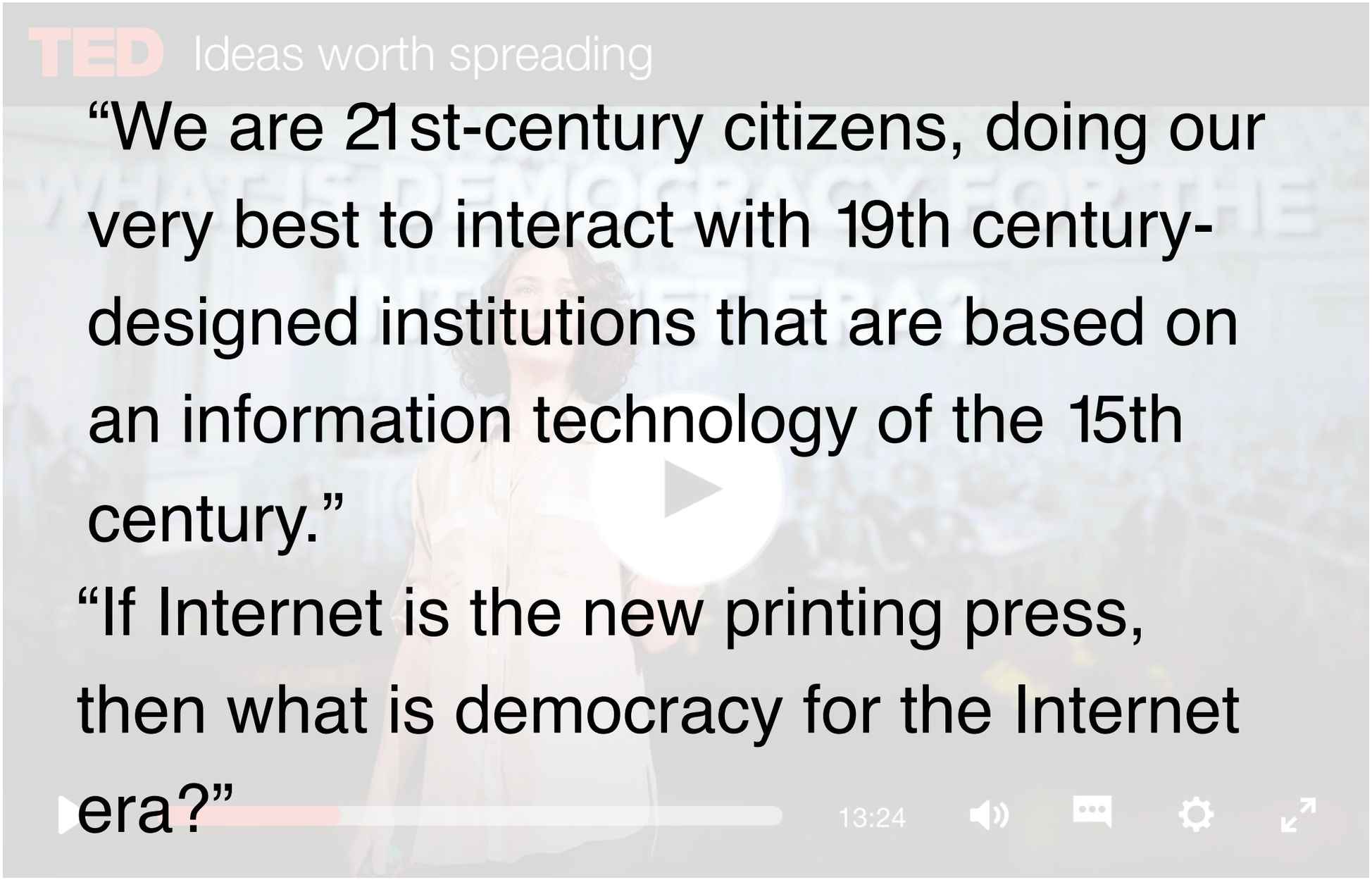

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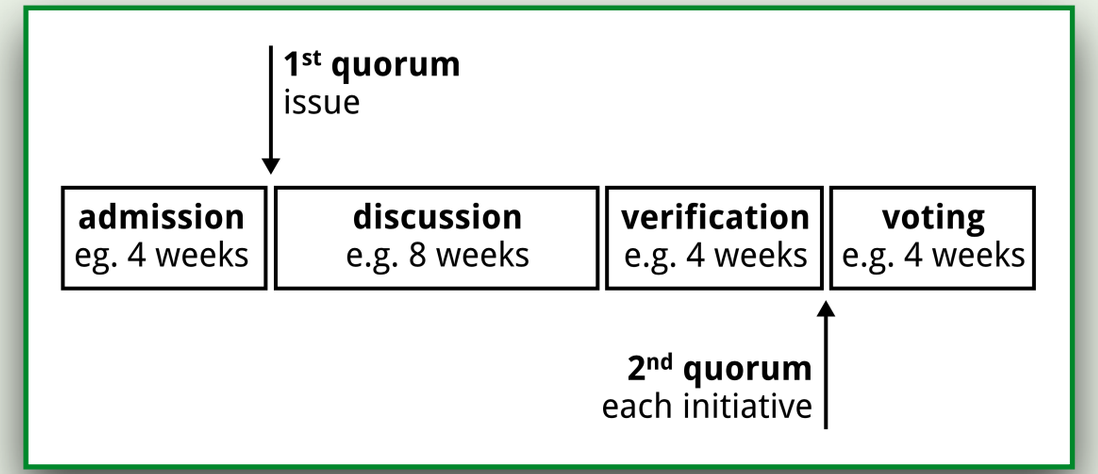

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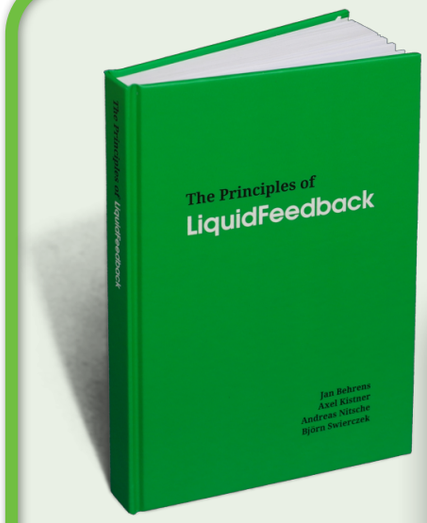

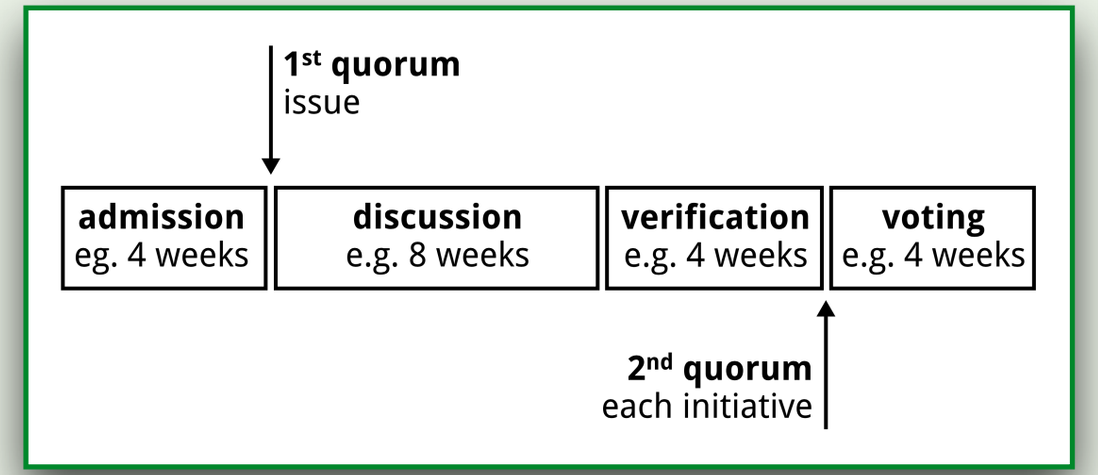

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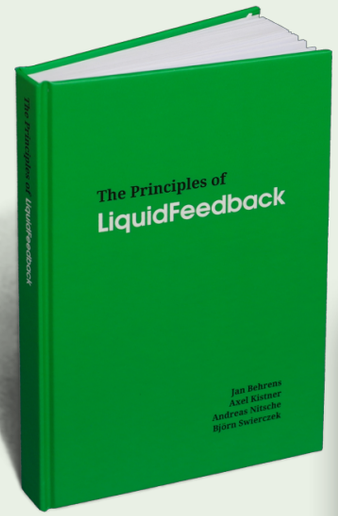

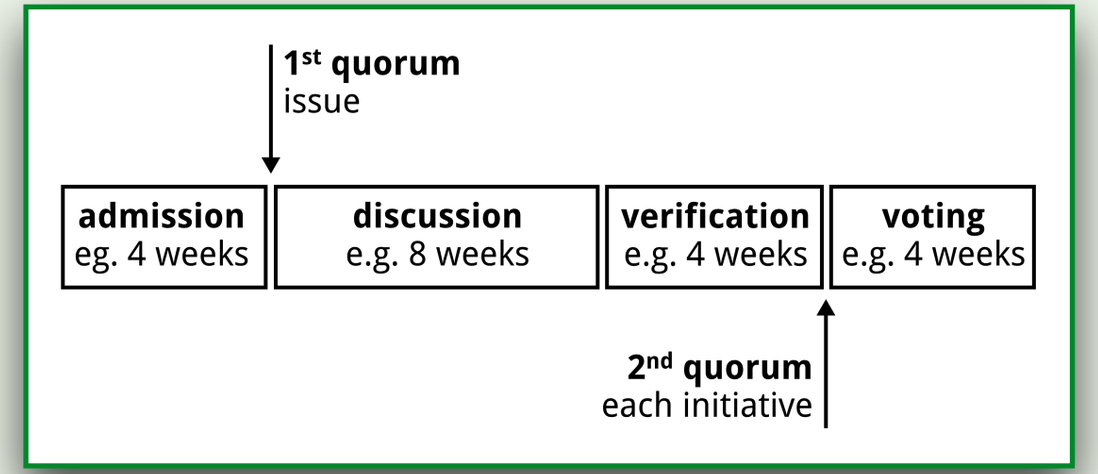

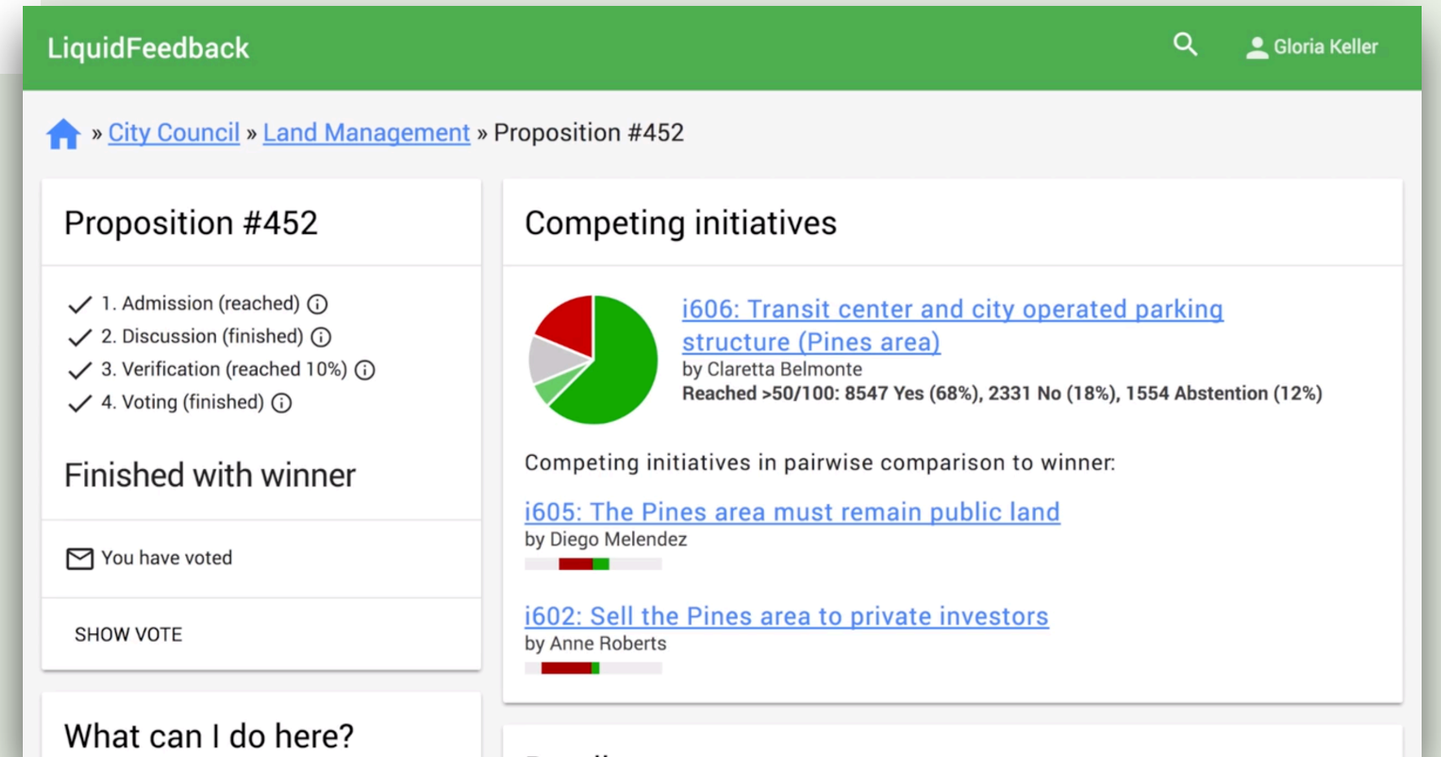

Liquid Democracy

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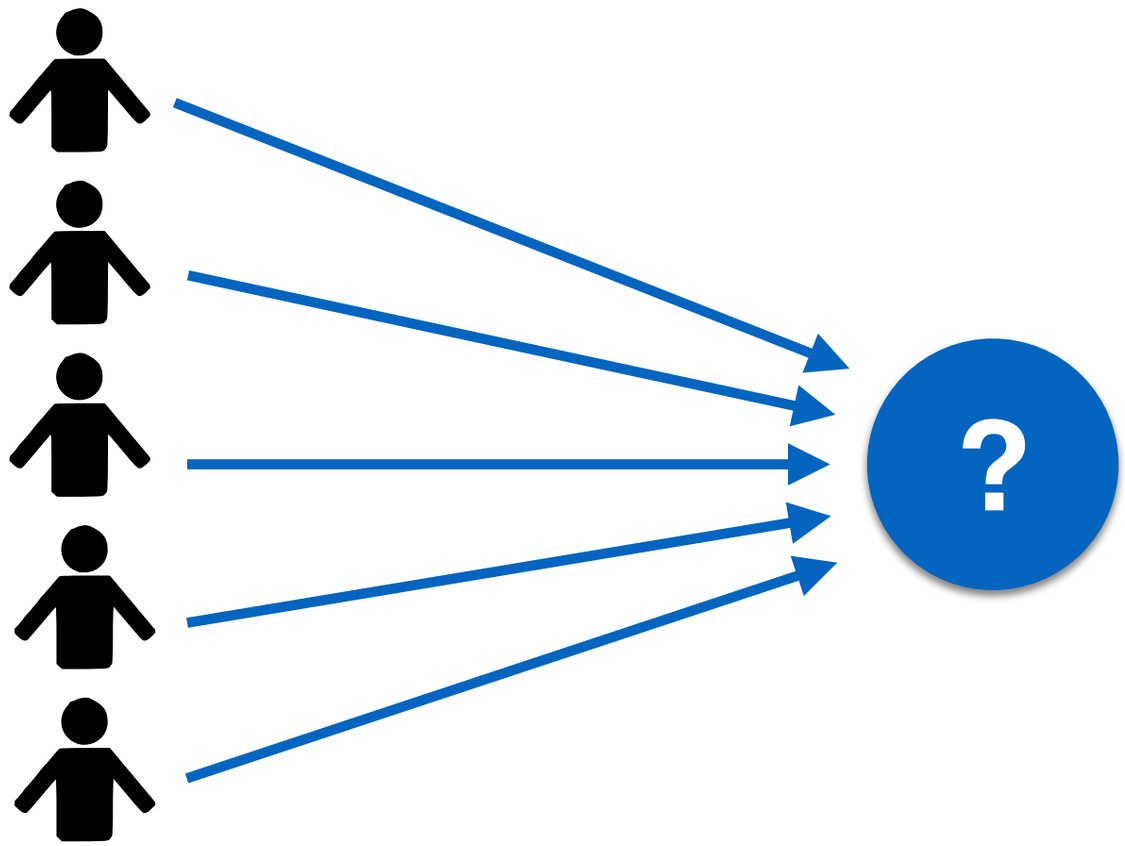

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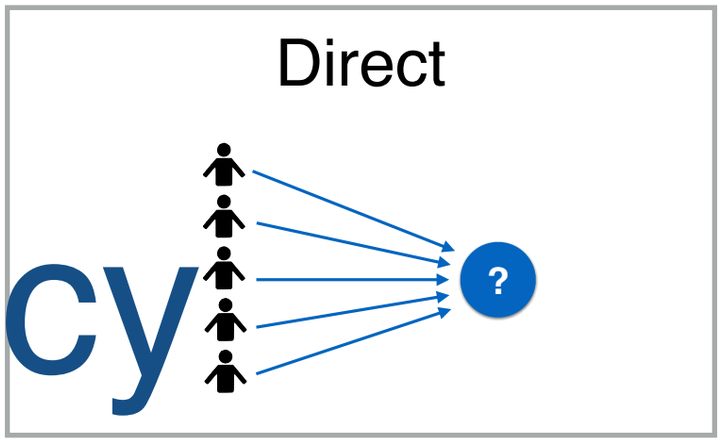

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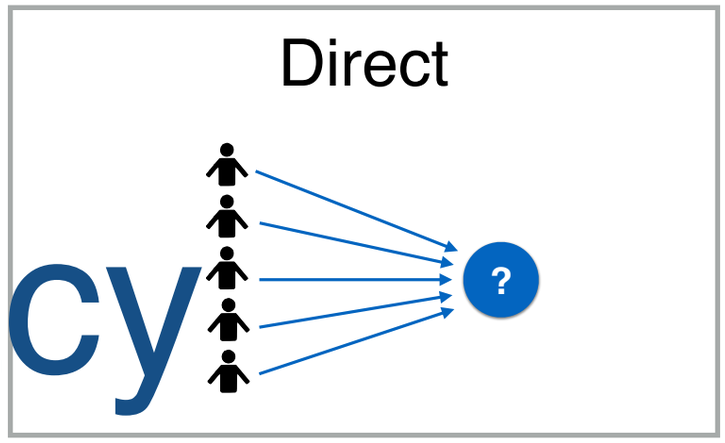

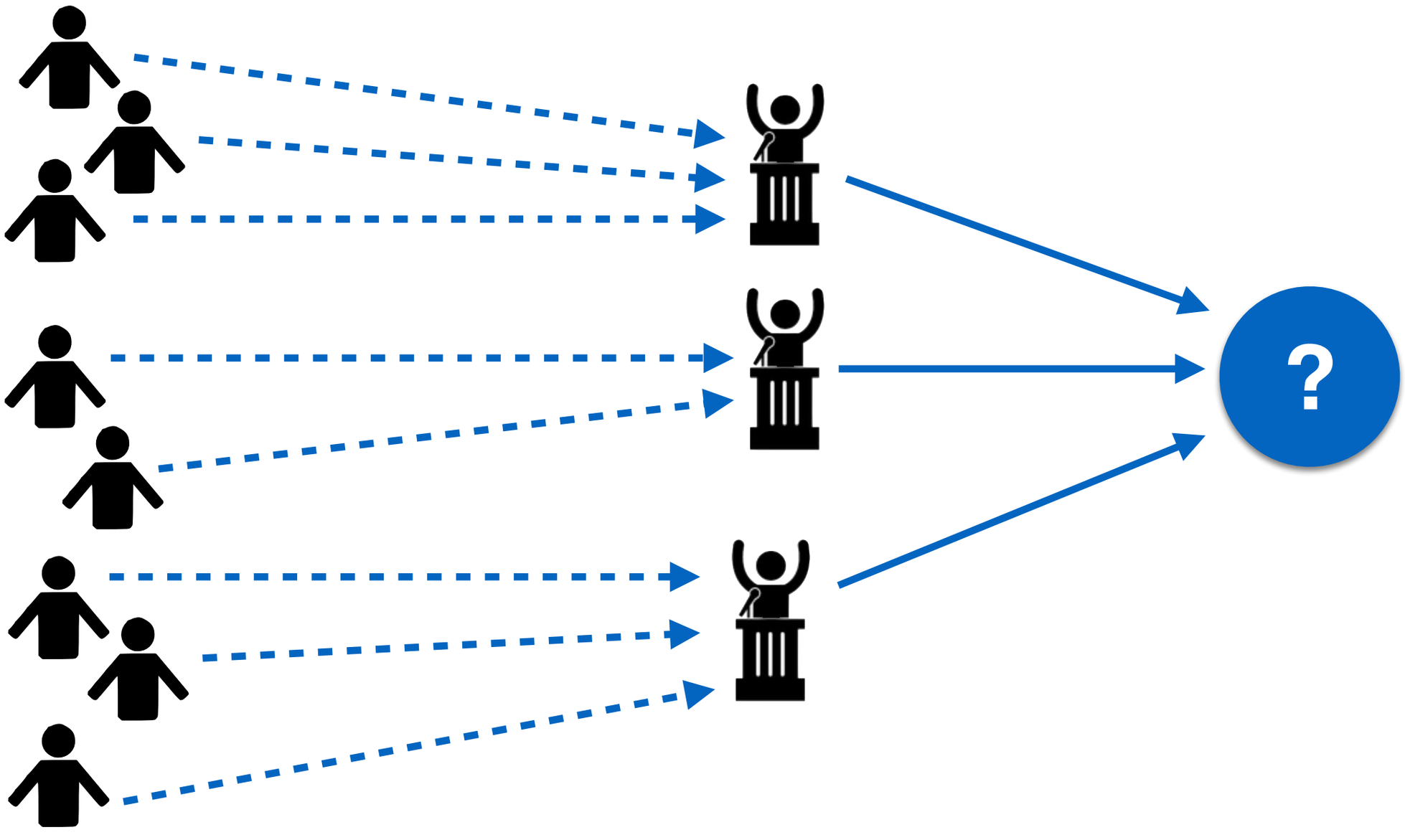

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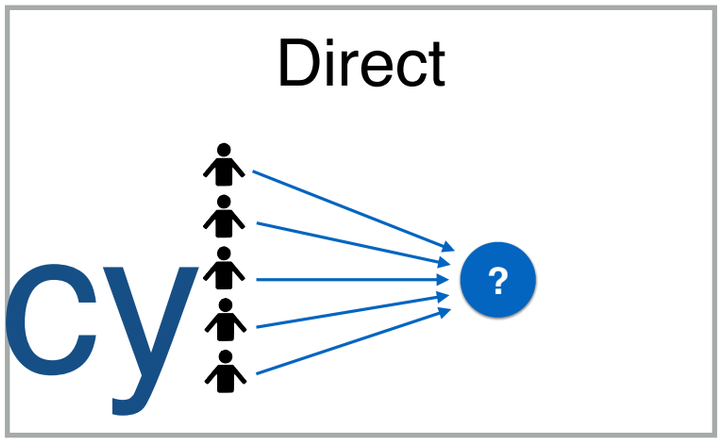

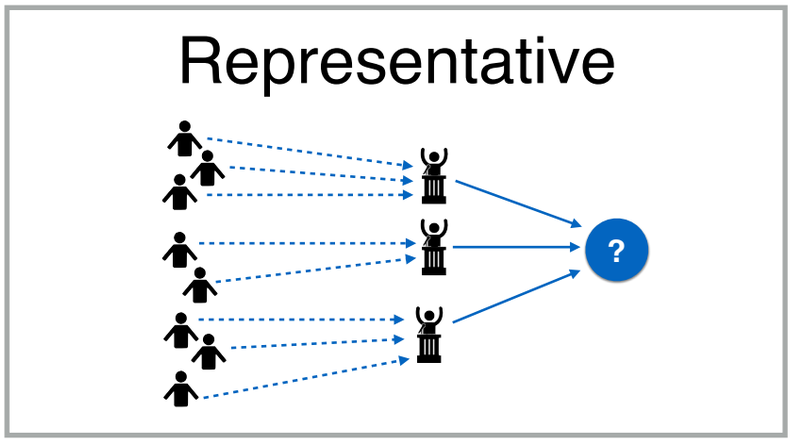

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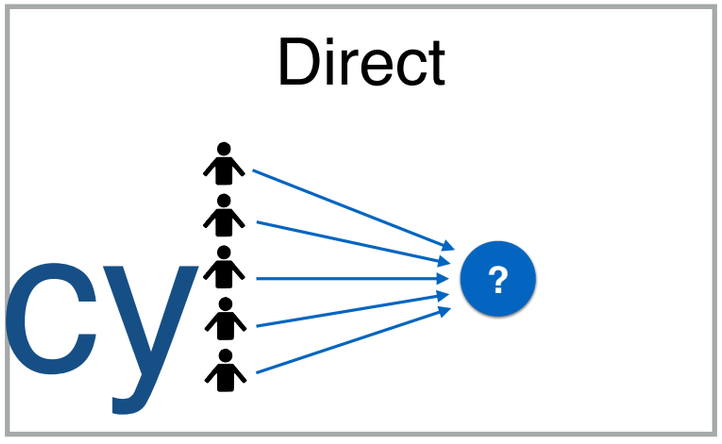
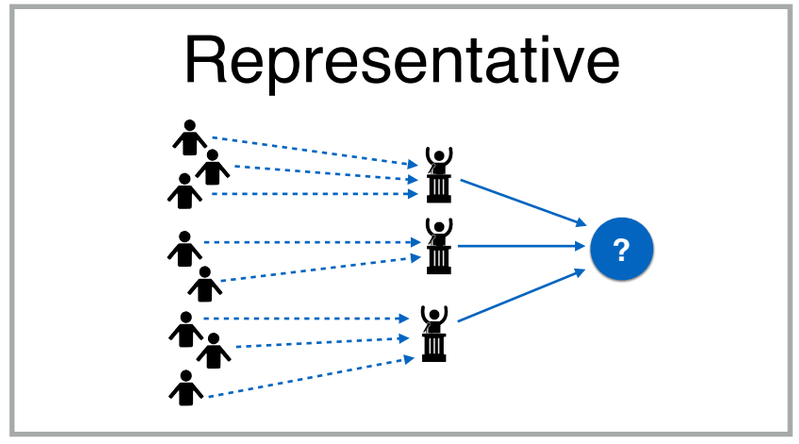
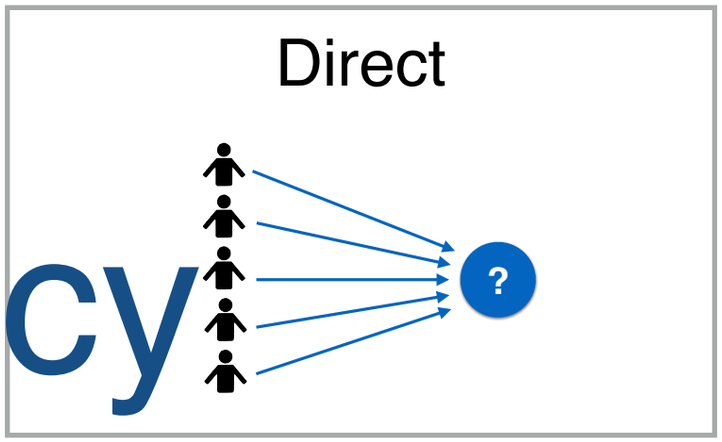
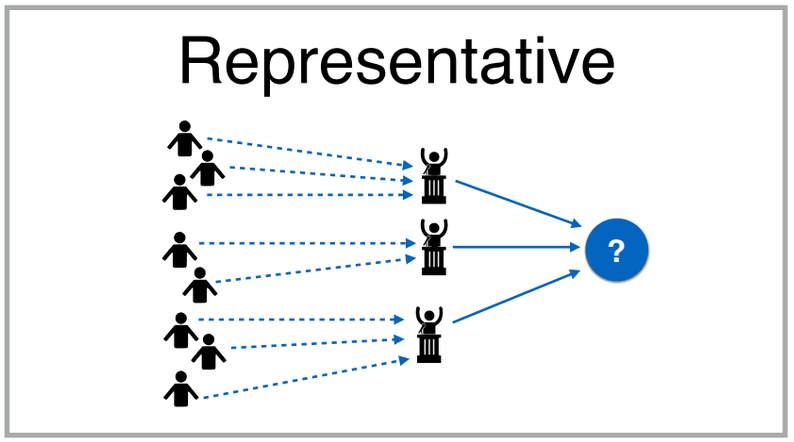




Benefits:	Voters express their opinion on every issue	Only vote once a term
Weakness:	A lot of work for voters	Representatives might not fully capture voters preferences

Liquid Democracy





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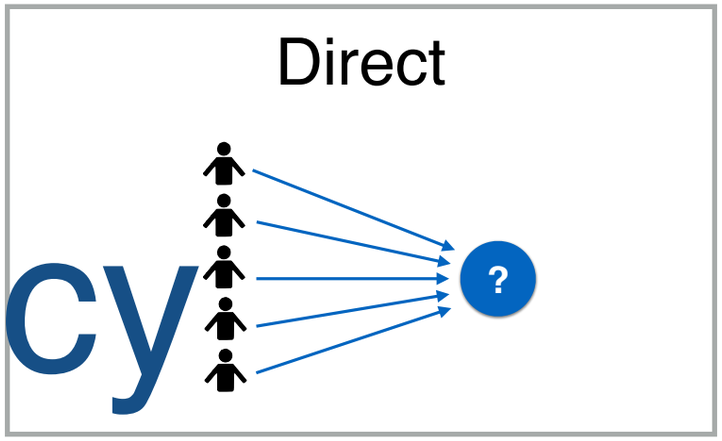

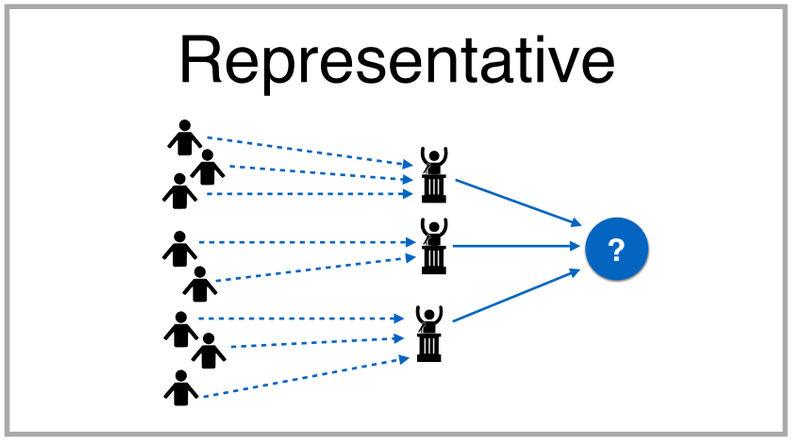

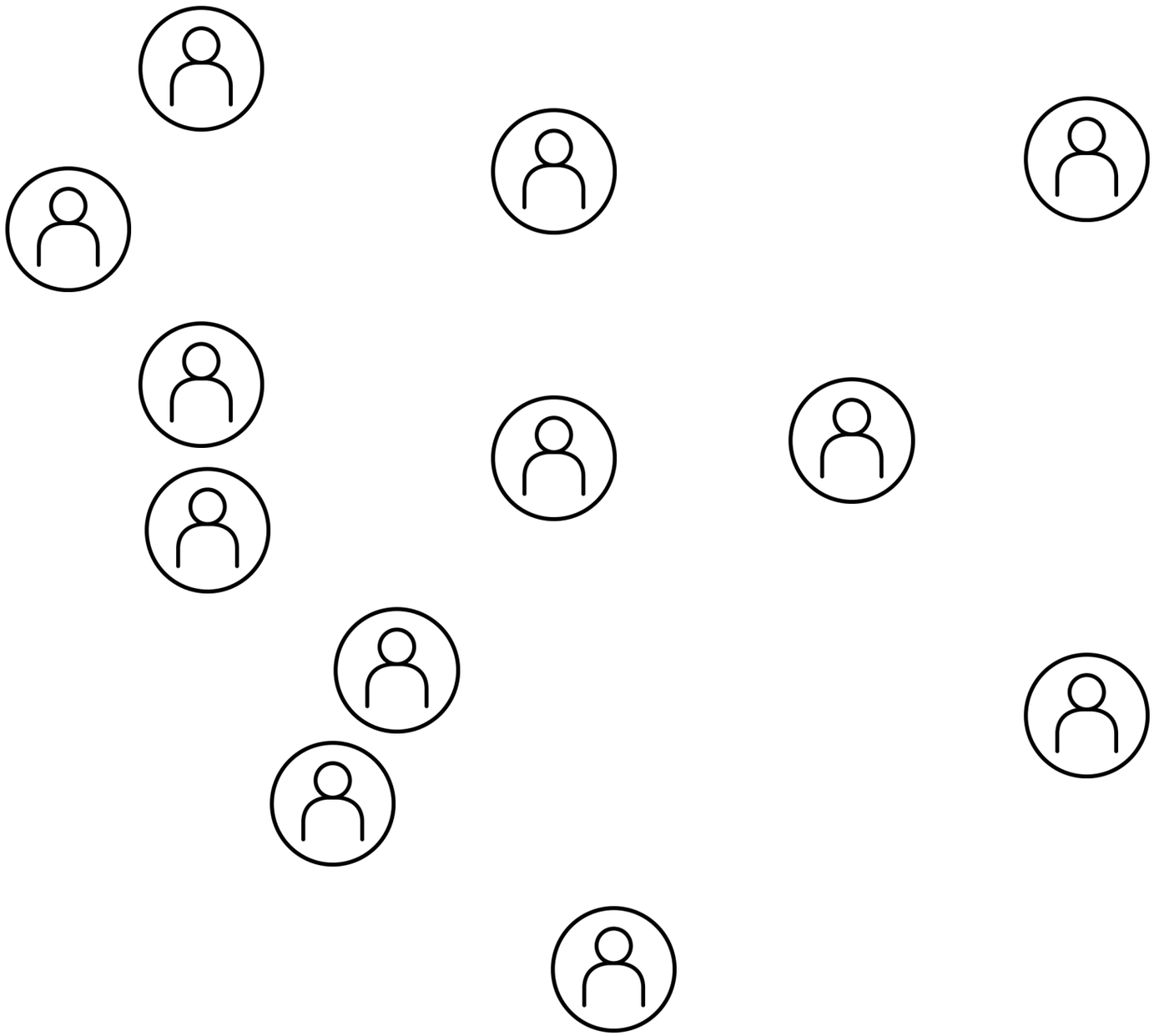

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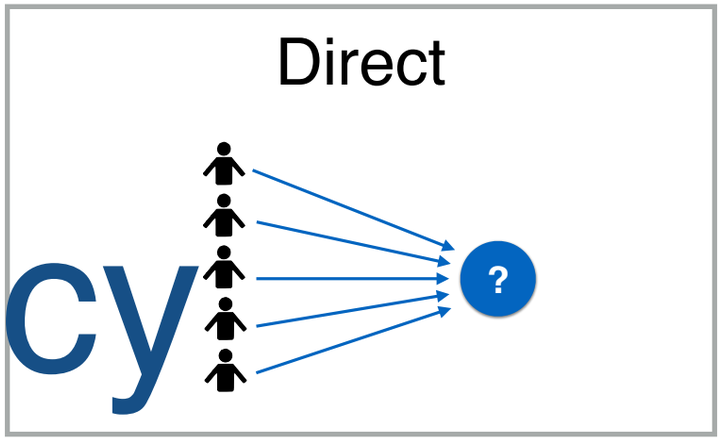

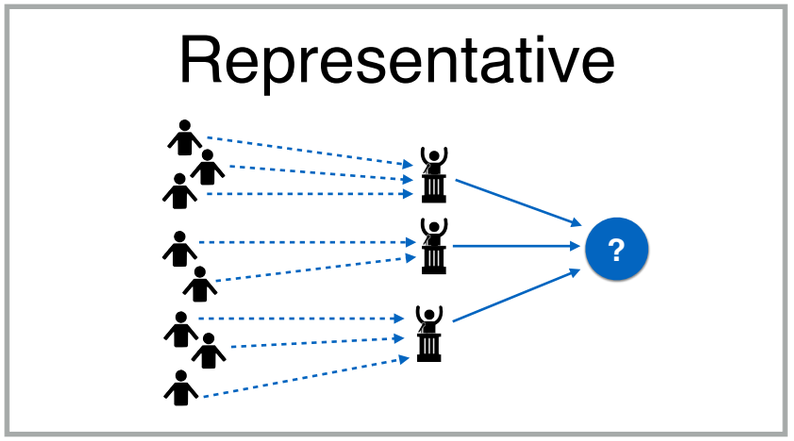

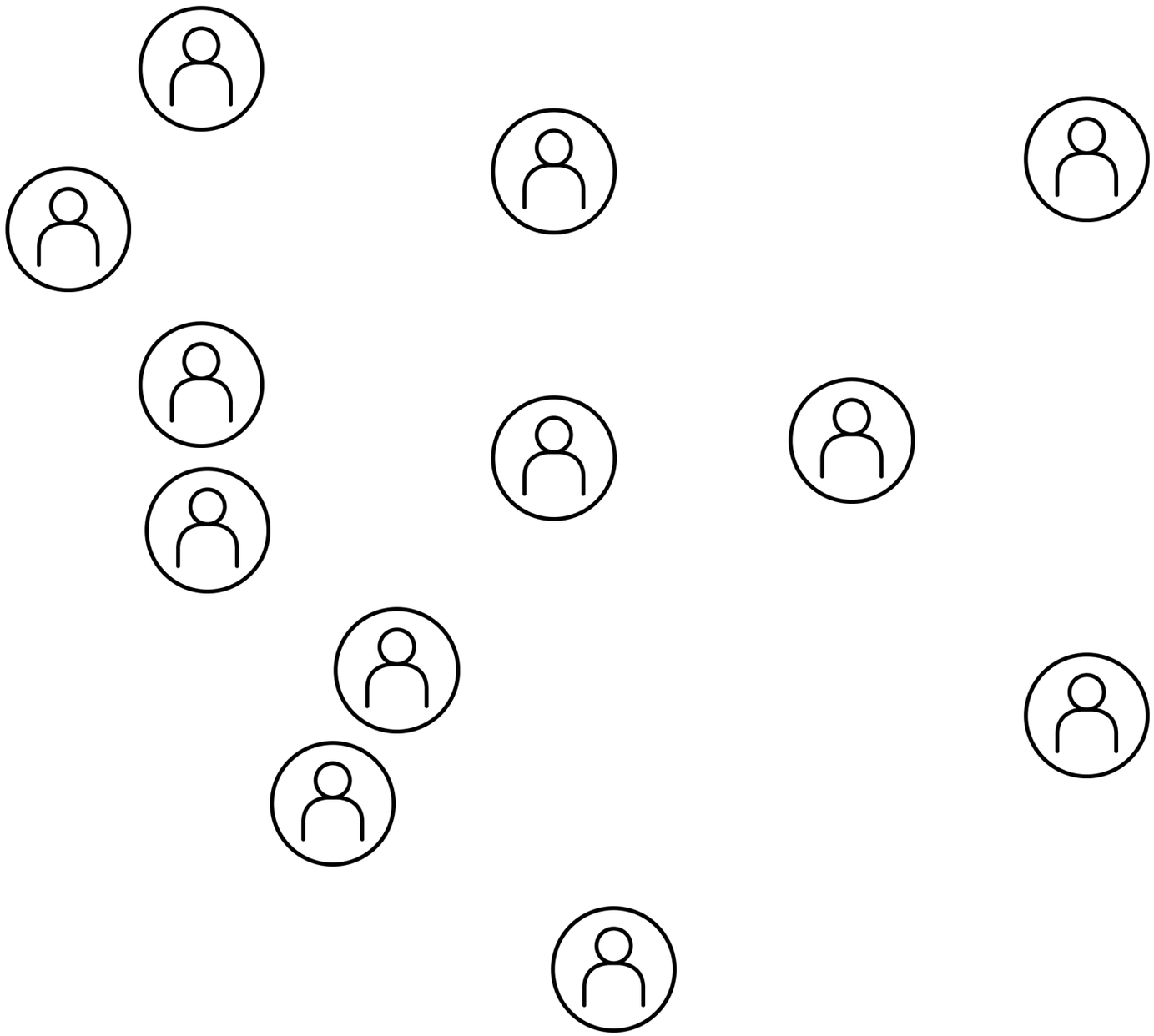

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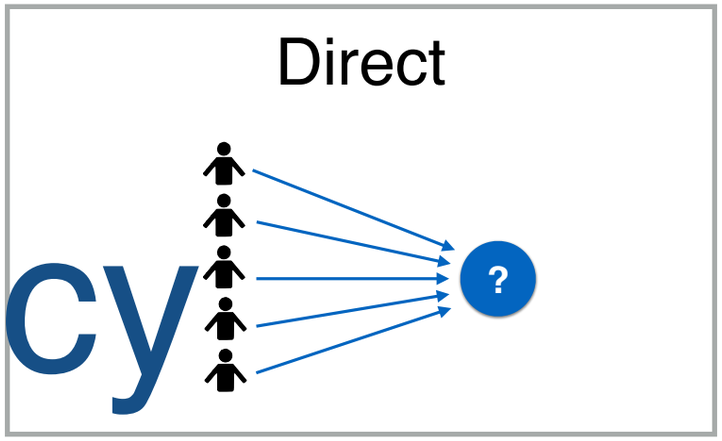

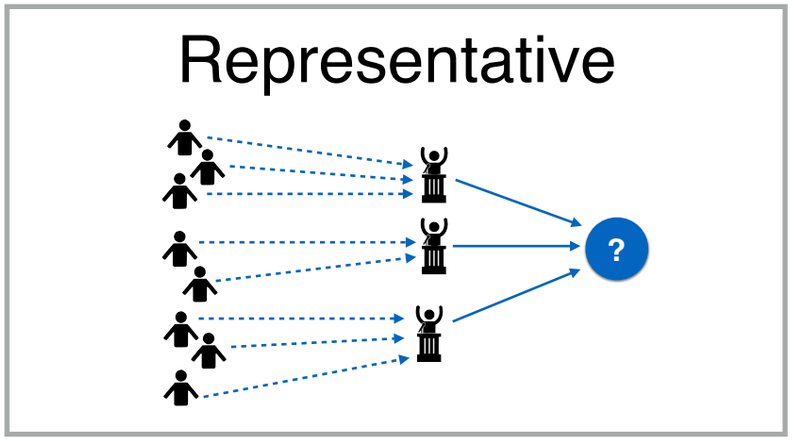

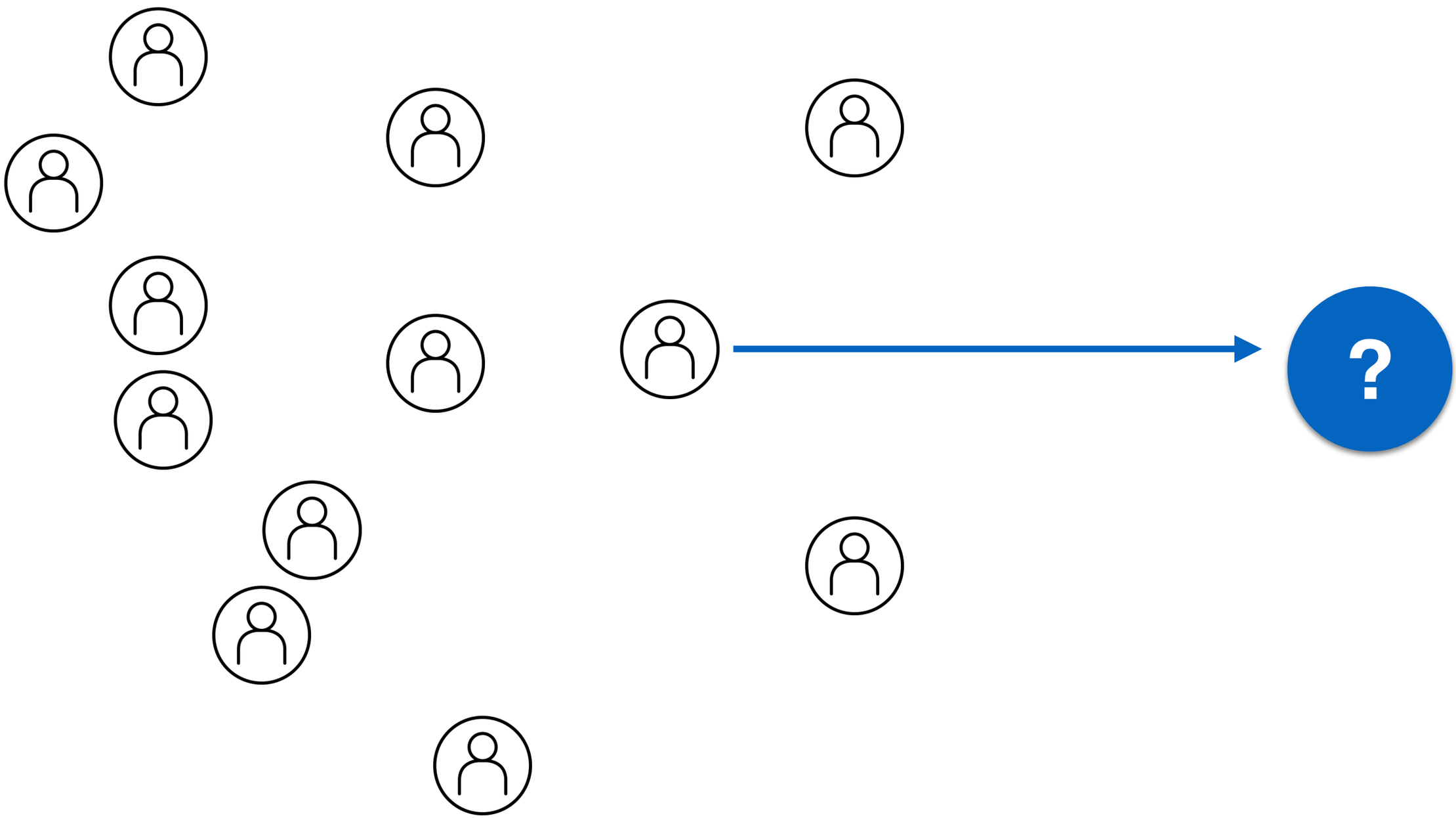

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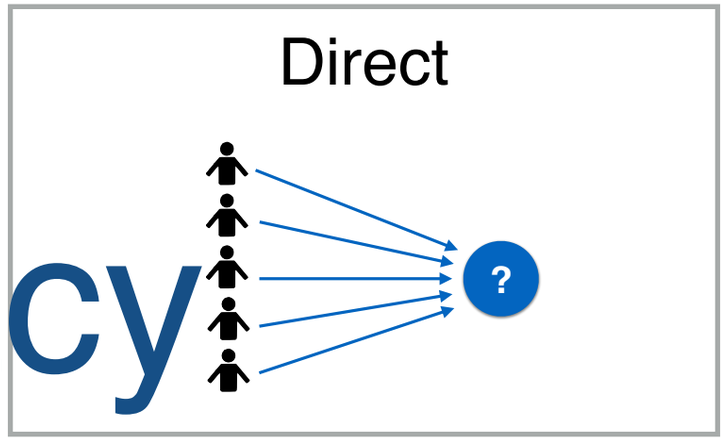

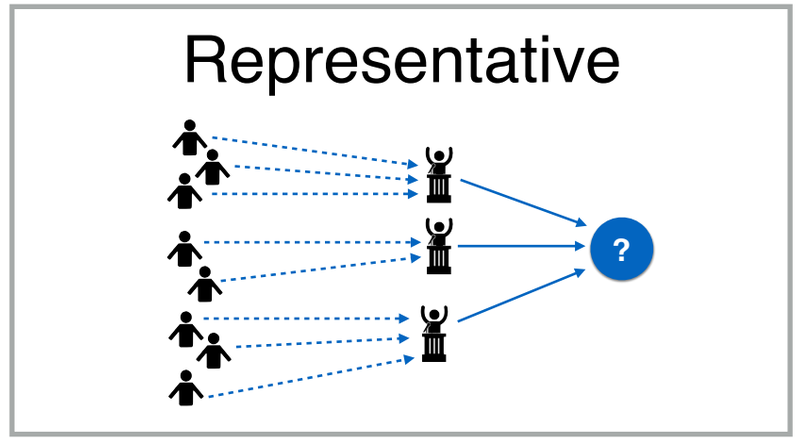

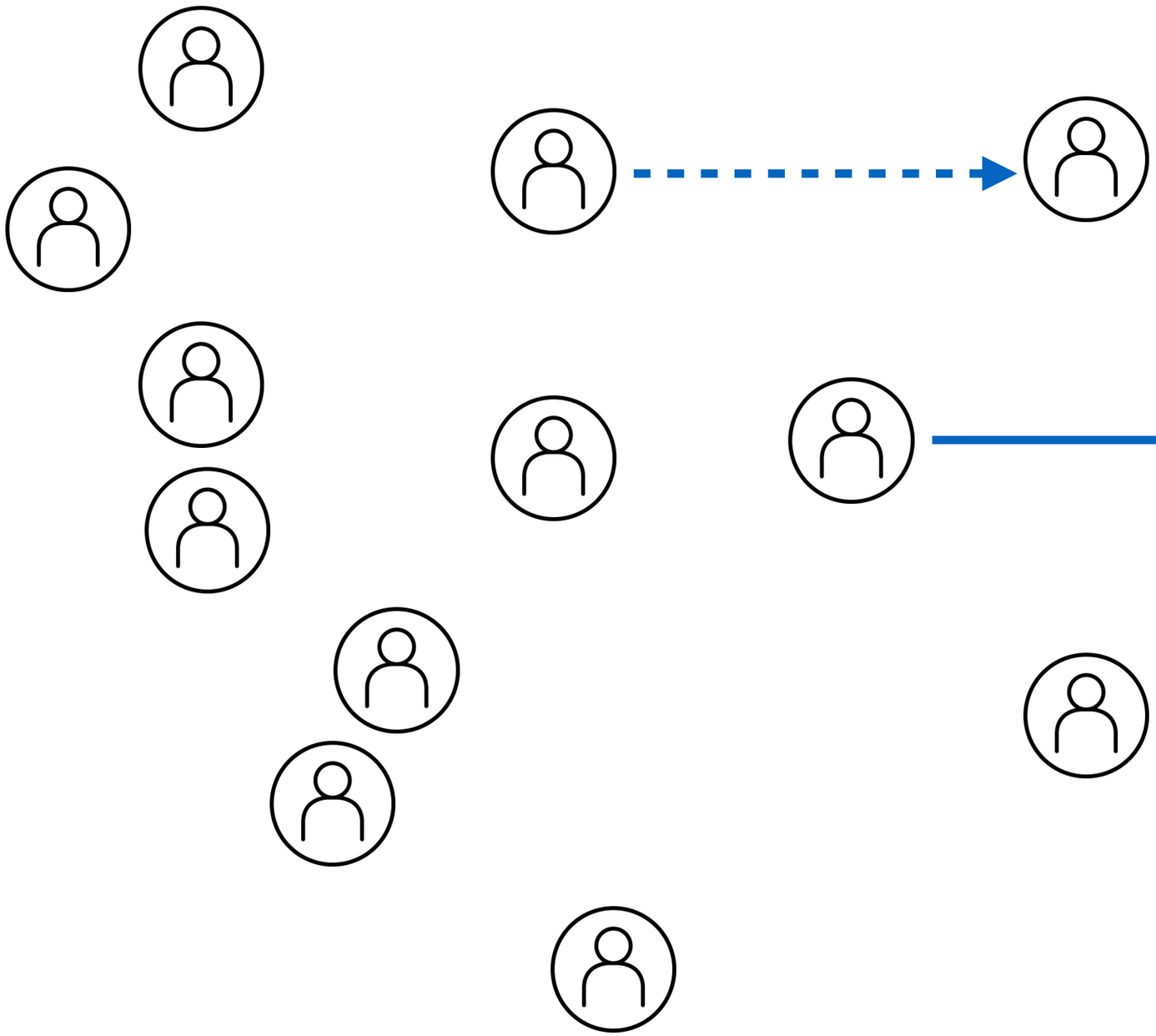

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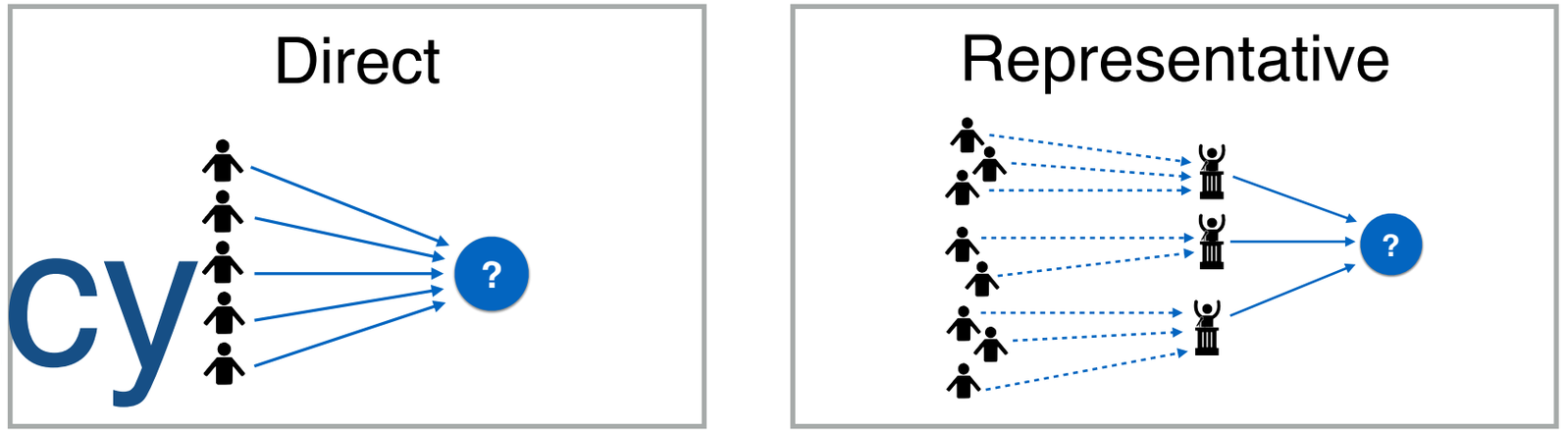

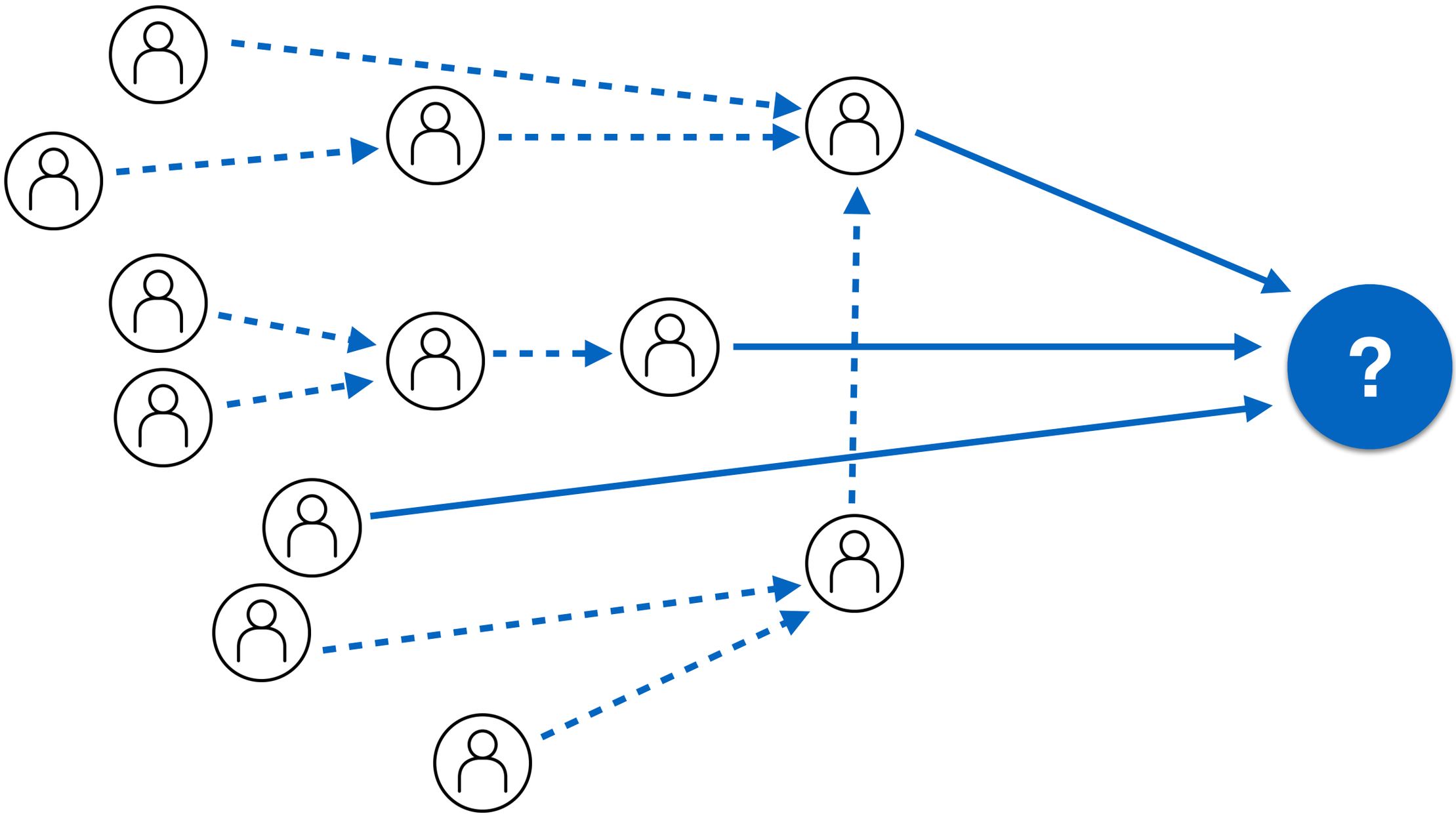

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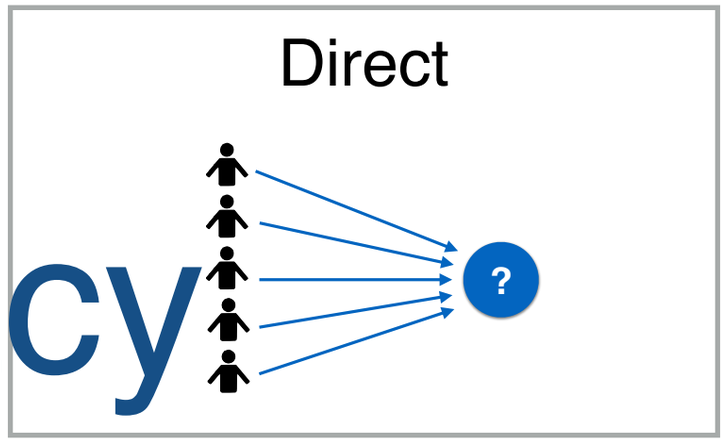

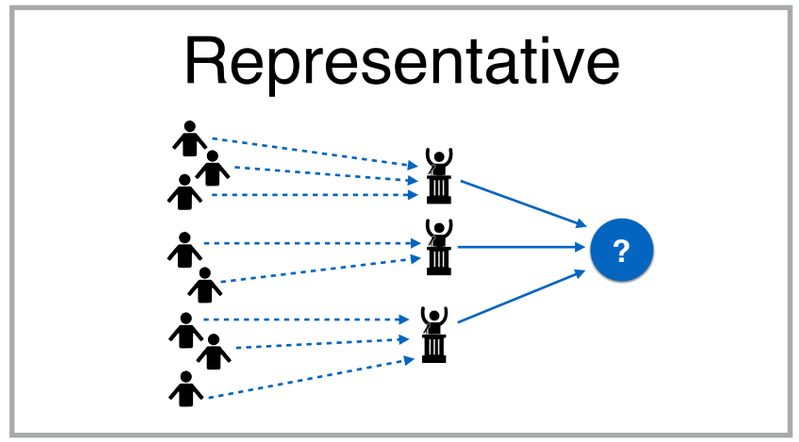

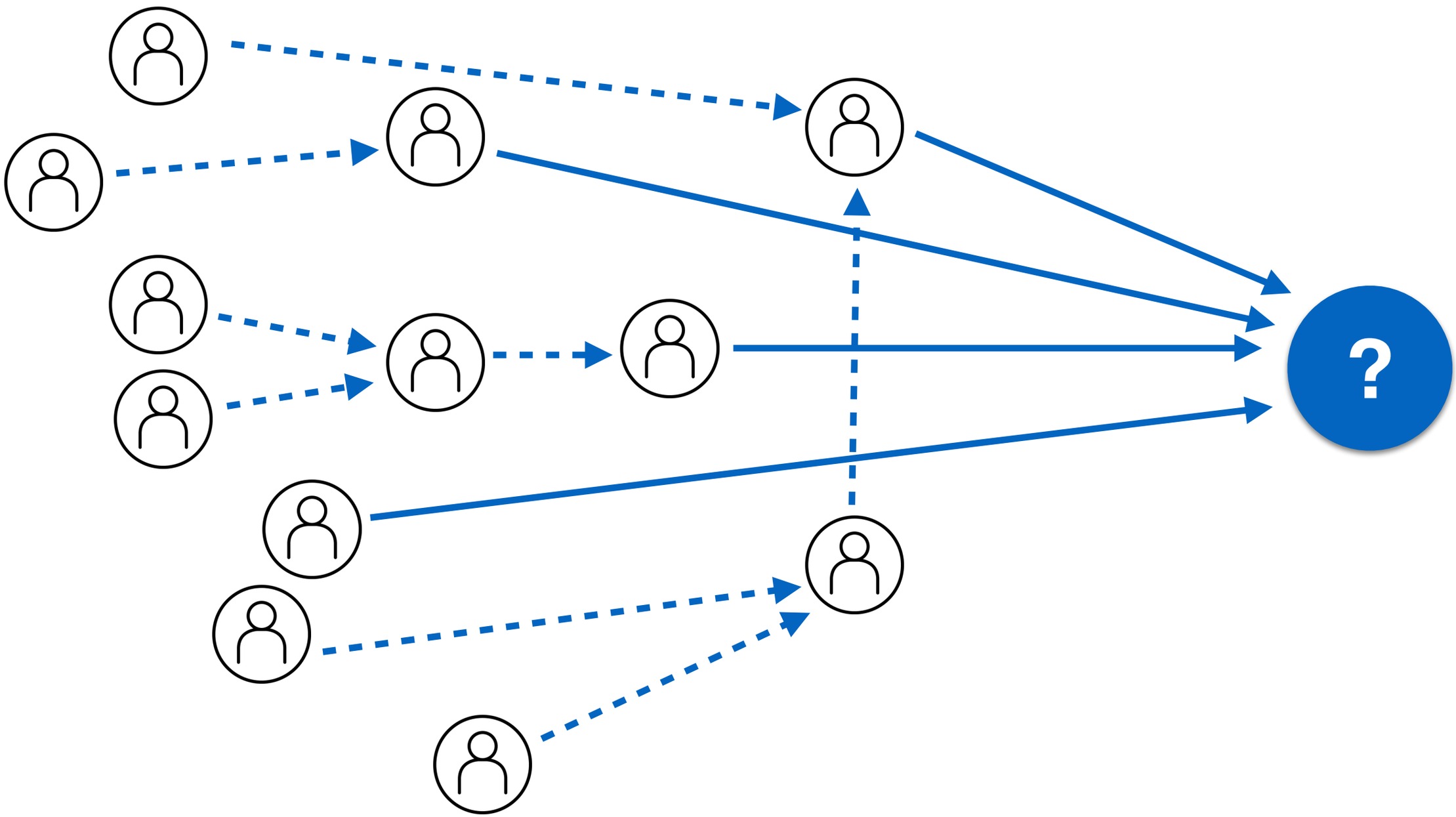

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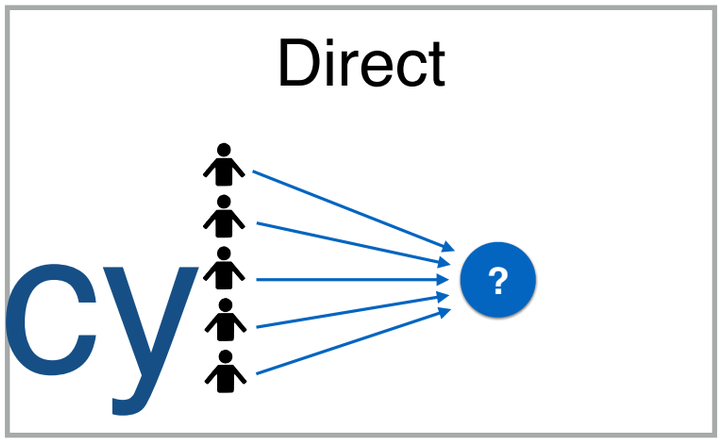

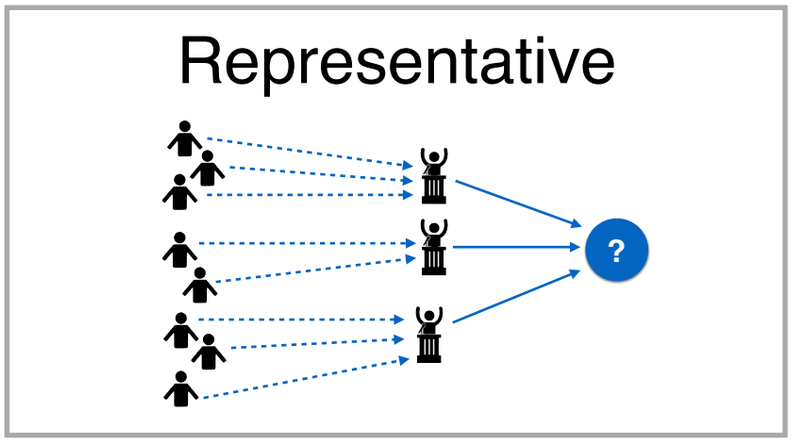

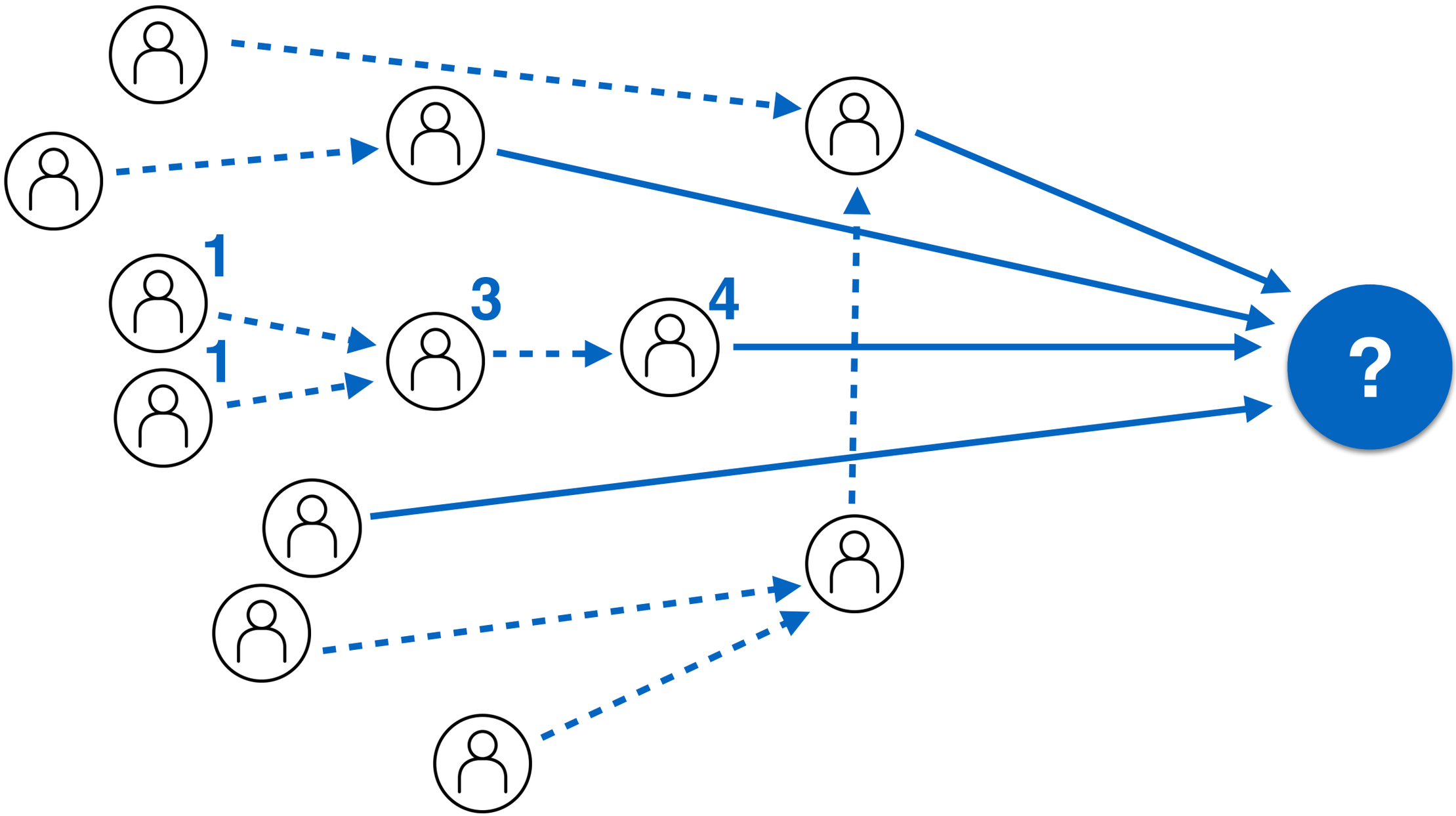

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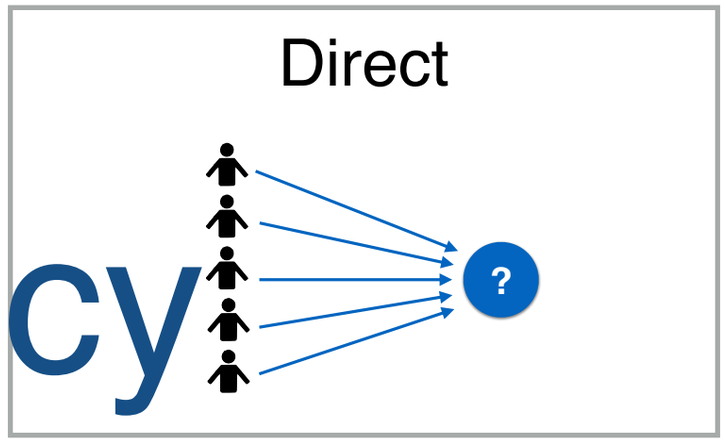

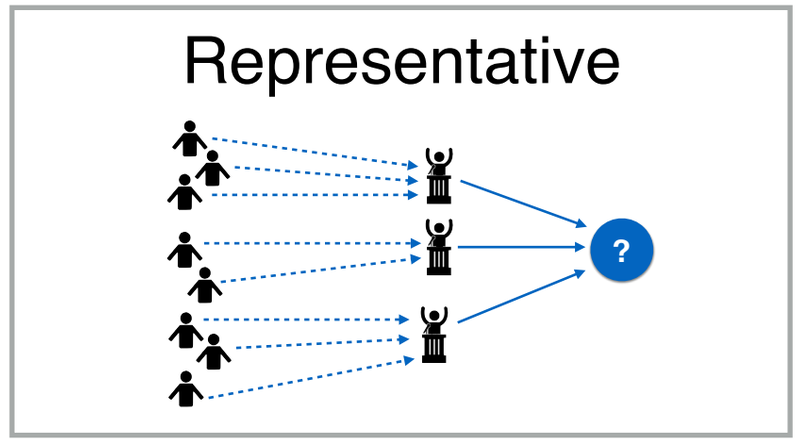

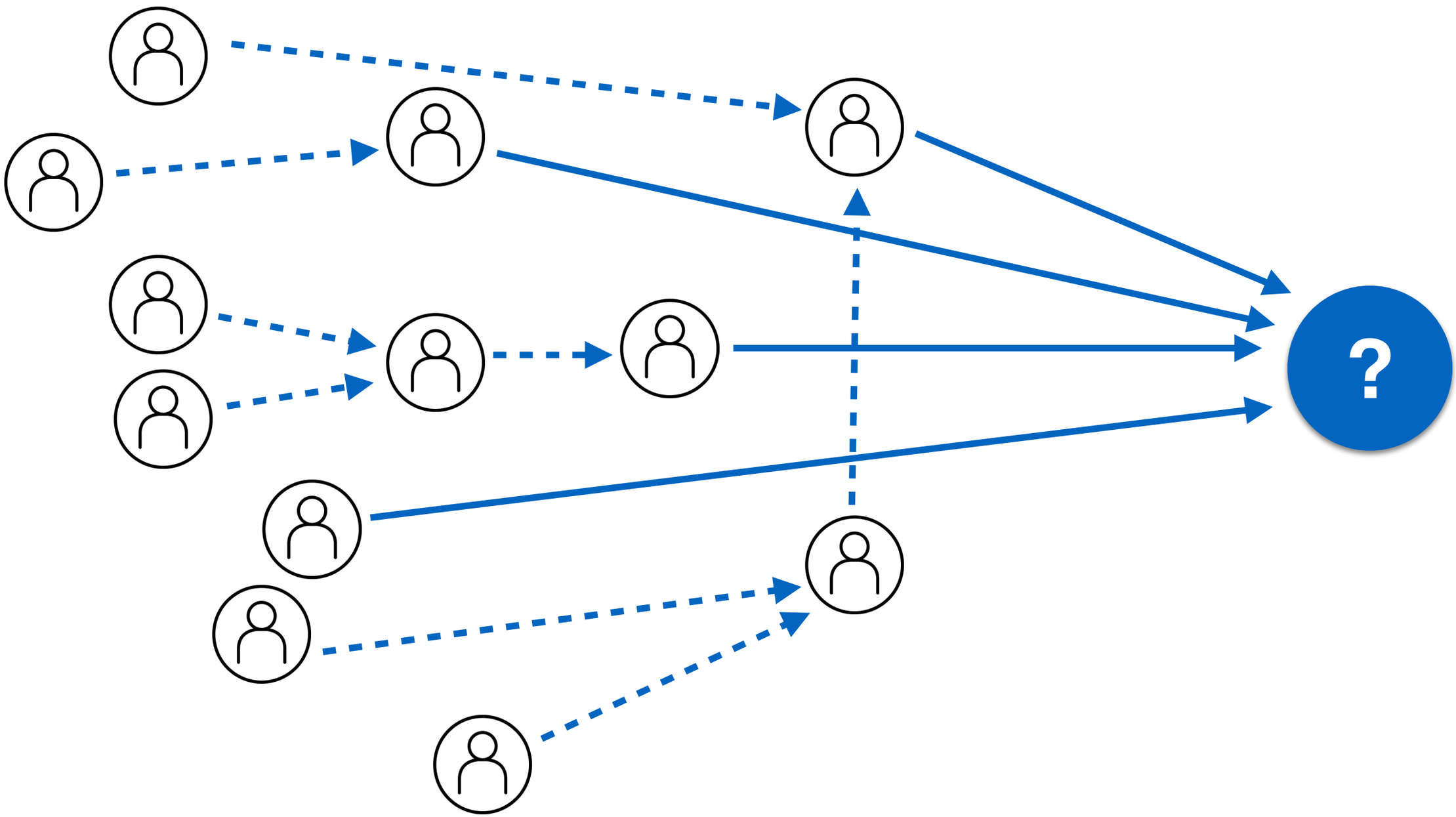

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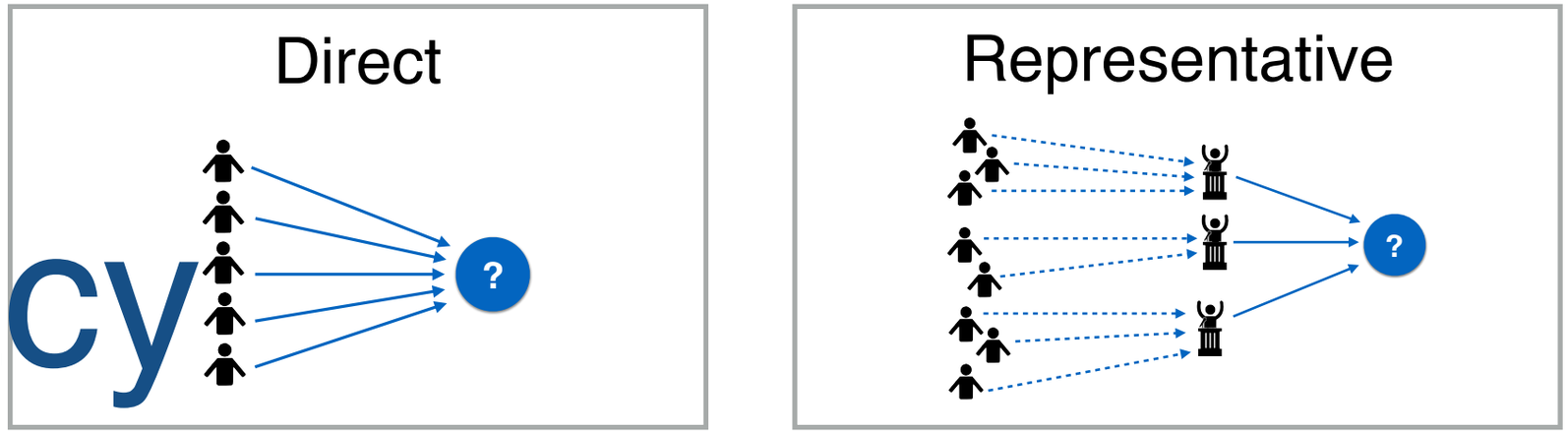

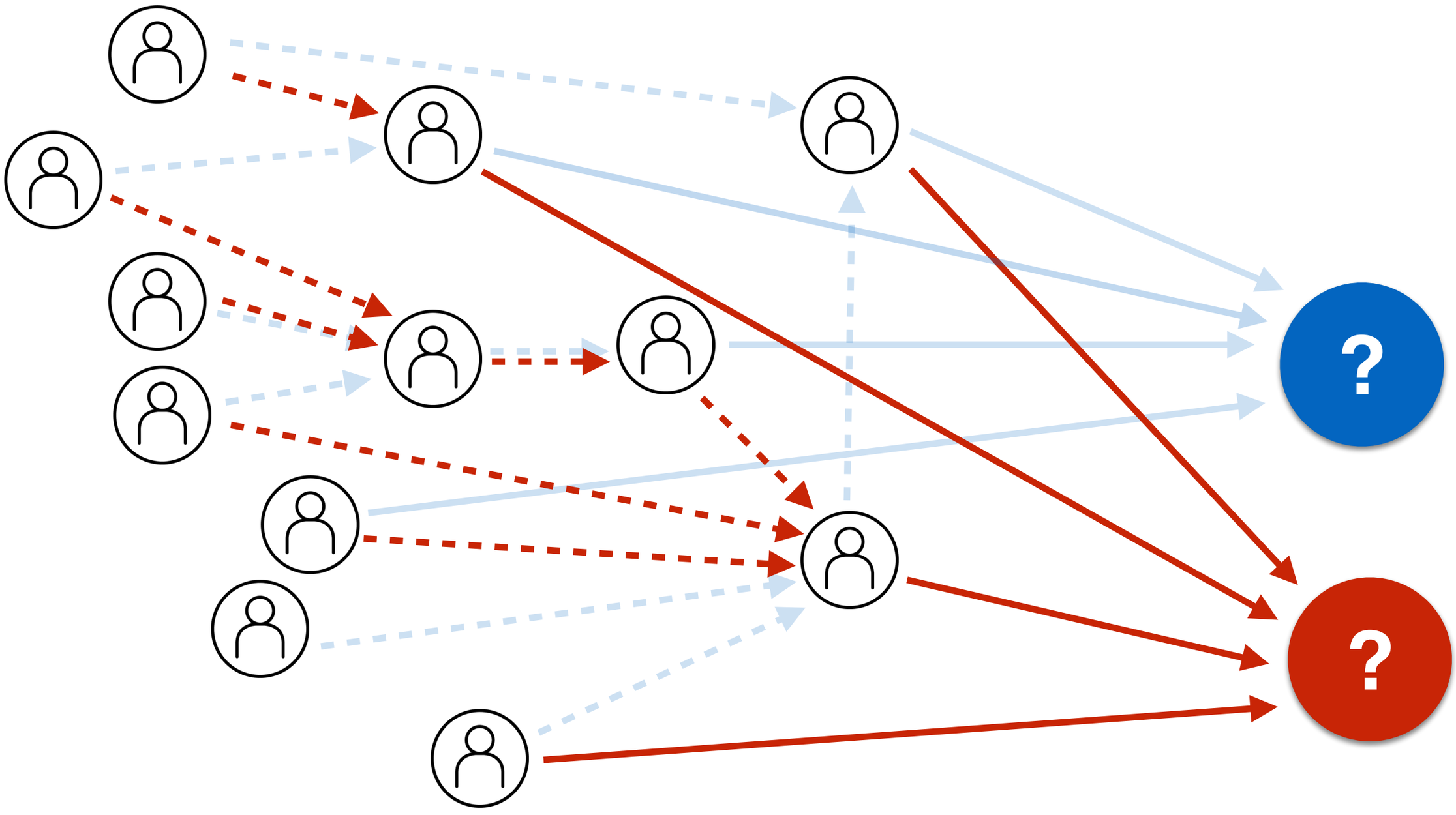

COMPUTATIONAL SOCIAL CHOICE

algorithms for collective decision making.

Computational Social Choice

What is "social choice theory"?

- How to aggregate possibly conflicting preferences into collective choices in a fair and satisfactory way?

Origins: mathematics, economics, and political science

Essential ingredients:

- Autonomous agents (e.g., human or software agents)
- A set of alternatives (in this course, finitely many)
- Preferences over alternatives
- Aggregation functions

Computational Social Choice

Examples:

- **voting** (e.g., political, but also wikipedia, facebook, …)
- resource allocation (e.g., fair division, cake cutting, house allocation)
- coalition formation (e.g., matching, college admission)
- webpage ranking (e.g., search engine aggregators, pagerank algorithm)
- collaborative filtering (e.g., amazon or ebay recommender systems)

Computational Social Choice

Key questions:

- What does it mean to make rational choices?
- Which formal properties should an aggregation function satisfy?
- Which of these properties (“axioms”) can be satisfied simultaneously?
- How difficult is it to compute collective choices?
- Can agents benefit by lying about their preferences?

Computational Social Choice

Axioms for Voting Settings:

- Anonymity: All voters are treated equally
- Neutrality: All candidates are treated equally
- Monotonicity: Strengthening a winner does not hurt that candidate
- …

Computational Social Choice

Plurality with runoff

- Used to elect, e.g., the President of France
- The two alternatives that are ranked first by most voters face off in a majority runoff.

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6	**5**	**4**	**2**
a	*c*	*b*	*b*
b	*a*	*c*	*a*
c	*b*	*a*	*c*

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(with 11 out of 17 votes for a))

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Anonymity and neutrality hold! Runoff rules fail monotonicity!

Computational Social Choice

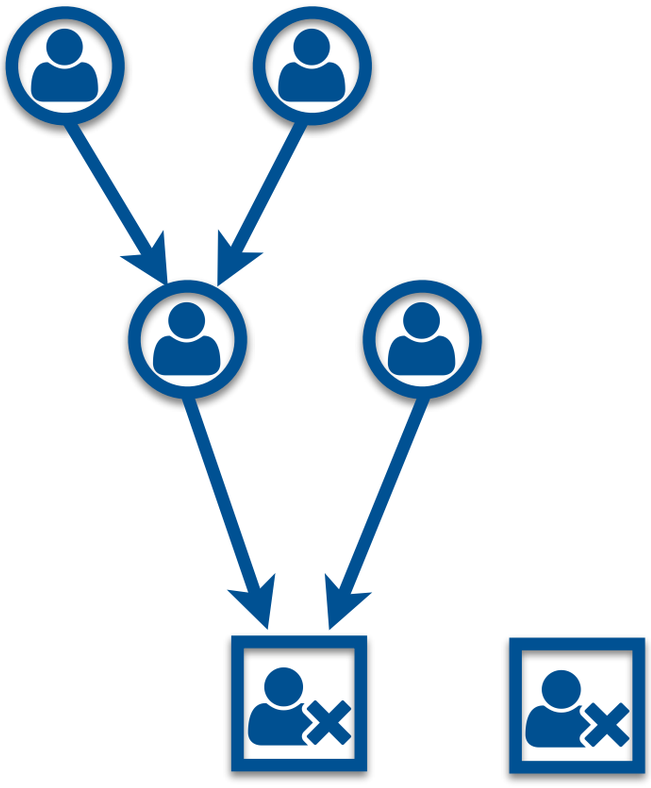
Many impossibility results
(e.g., Arrow, Gibbard-Satterthwaite)

- There is no perfect voting rule
- It is still worth analysing which axioms are (dis-)satisfied
- Different applications value different axioms

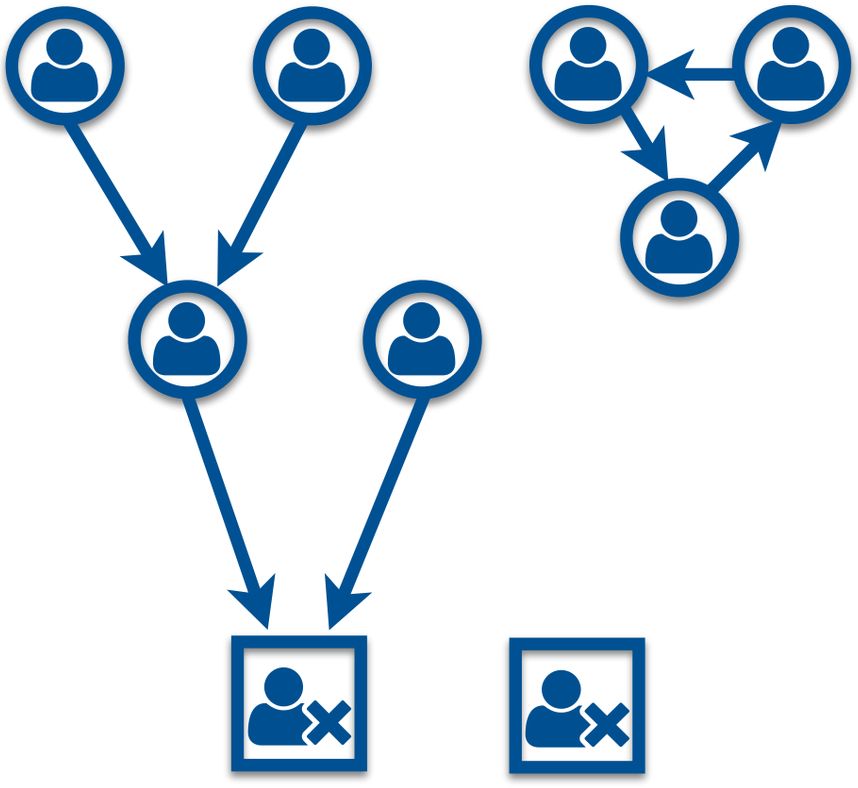
COMSOC work on LIQUID DEMOCRACY

- Z. Christoff and D. Grossi. Binary voting with delegable proxy: An analysis of liquid democracy (TARK 2017)
- A. Kahng, S. Mackenzie, and A. D. Procaccia. Liquid democracy: An algorithmic perspective (AAAI 2018)
- P. Gölz, A. Kahng, S. Mackenzie, and A. Procaccia. The fluid mechanics of liquid democracy (WINE 2018)
- M. Brill and N. Talmon. Pairwise liquid democracy (IJCAI 2018)
- D. Bloembergen, D. Grossi, and M. Lackner. On rational delegations in liquid democracy (AAAI 2019)
- I. Caragiannis and E. Micha. A contribution to the critique of liquid democracy (IJCAI 2019)
- B. Escoffier, H. Gilbert, and A. Pass-Lanneau. The convergence of iterative delegations in liquid democracy (arXiv 2019)
- G. Kotsialou and L. Riley. Incentivising participation in liquid democracy with breadth-first delegation (arXiv 2019)
- …

single delegations



single delegations



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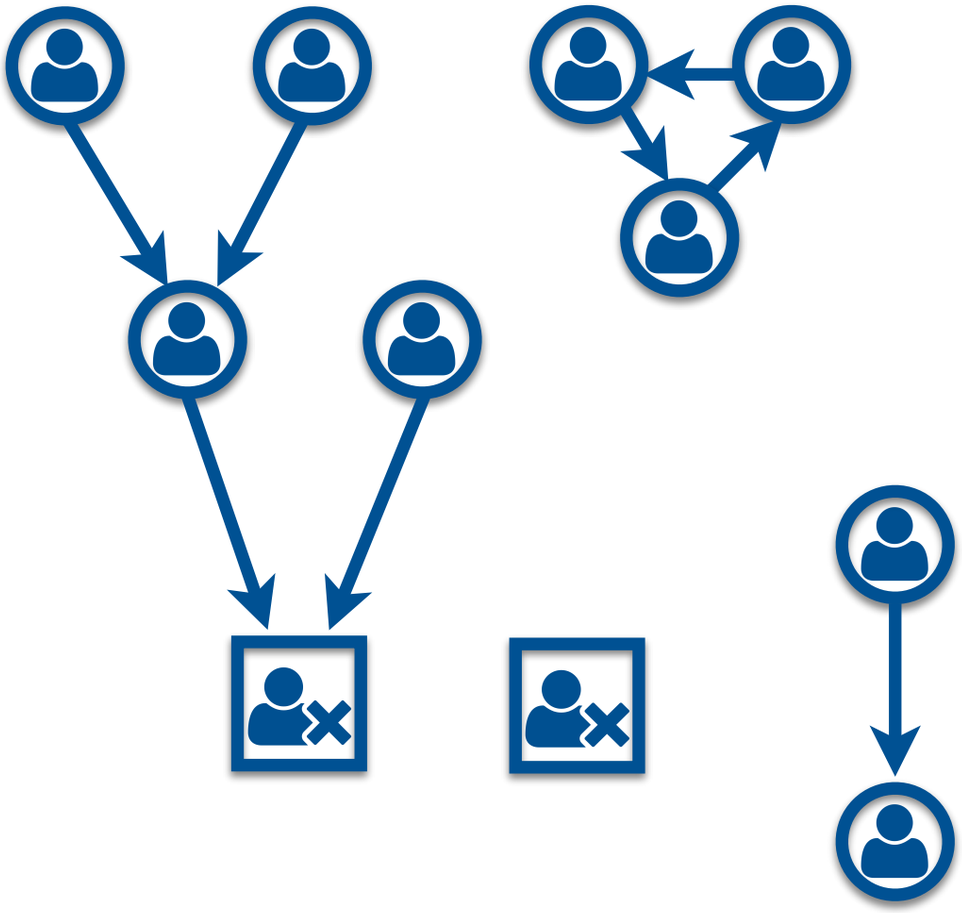
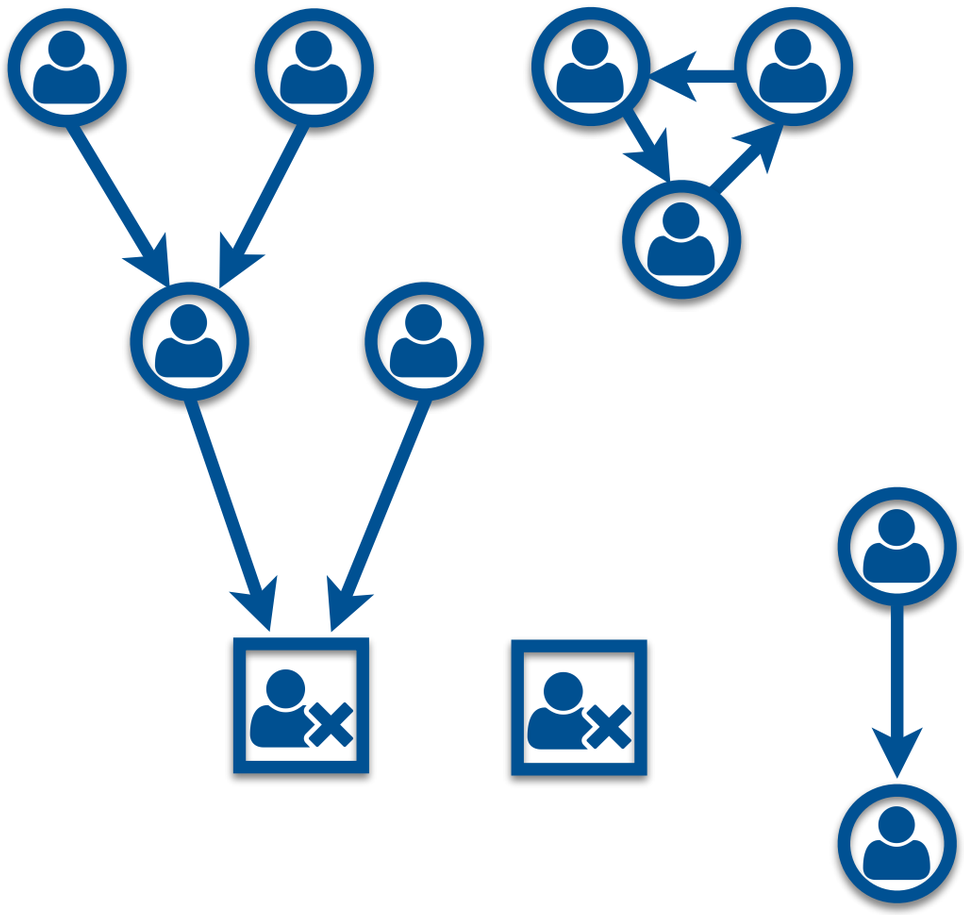
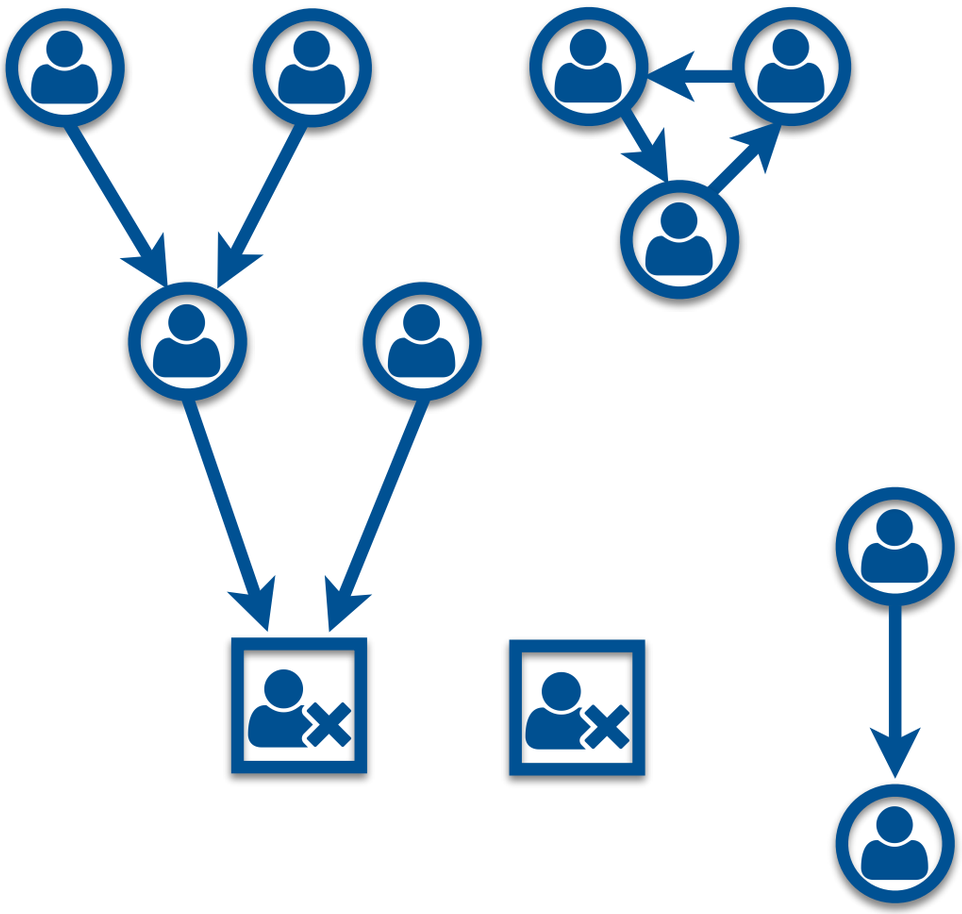


single delegations

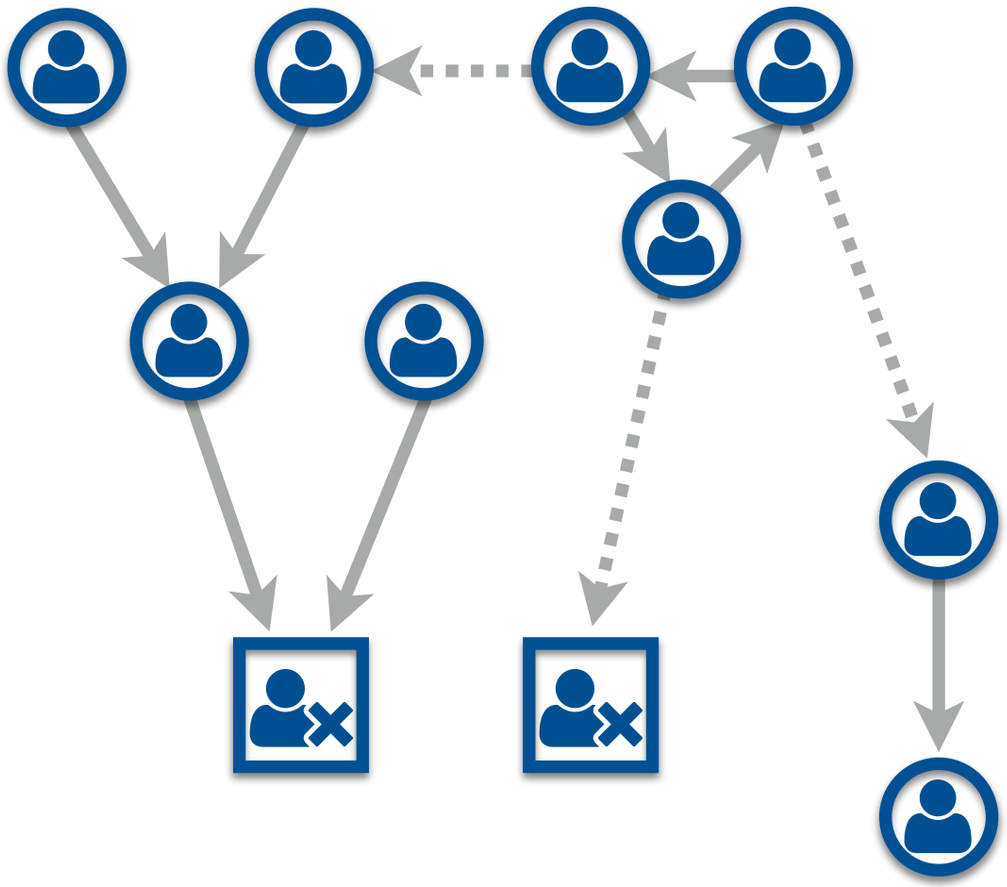


cycles and abstaining voters

single delegations



“backup” delegations



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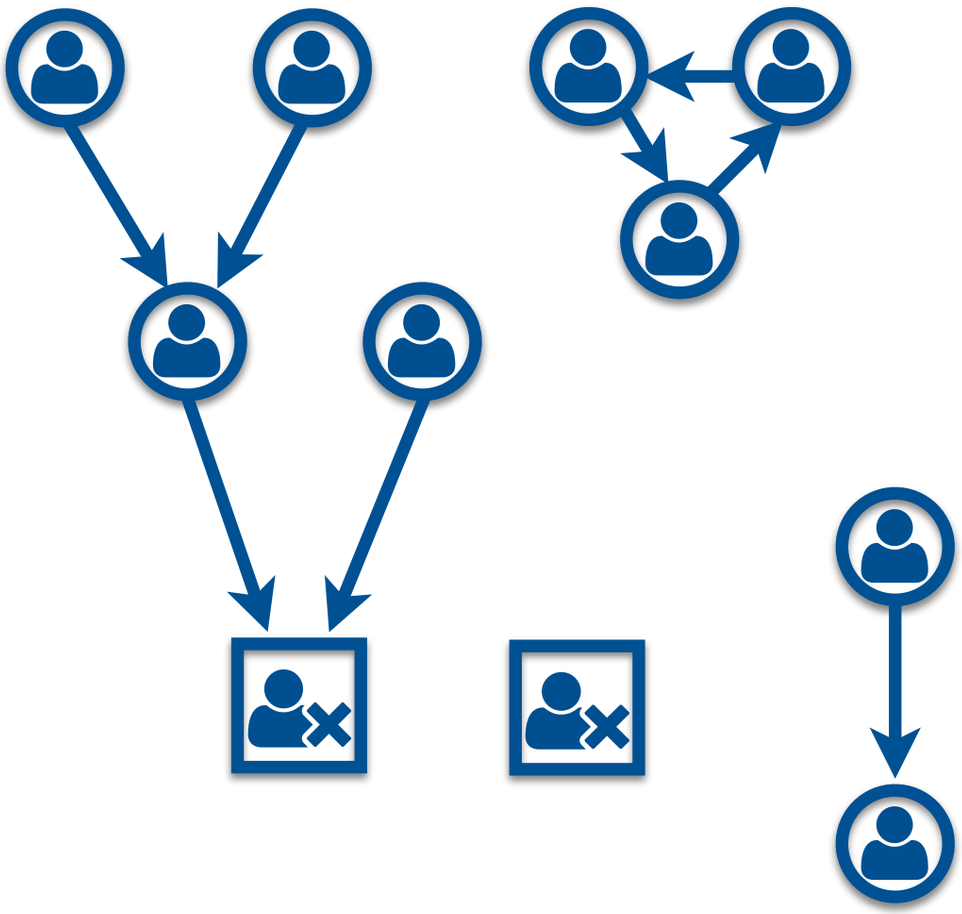

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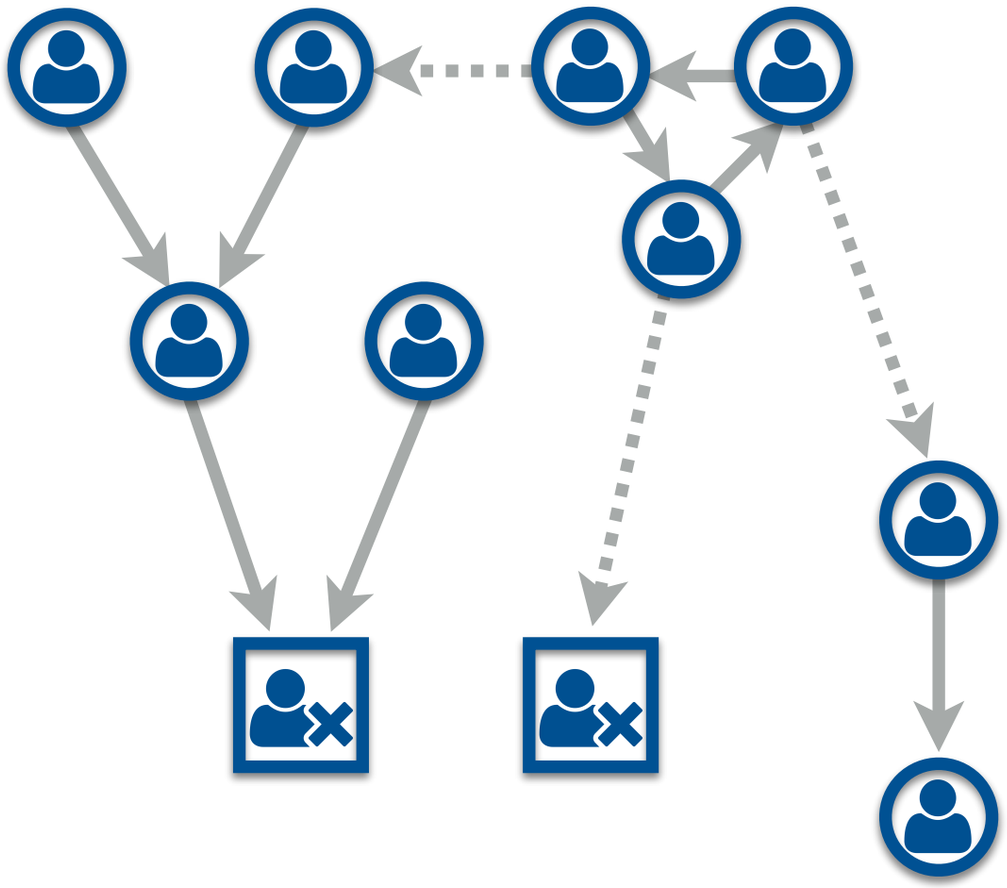
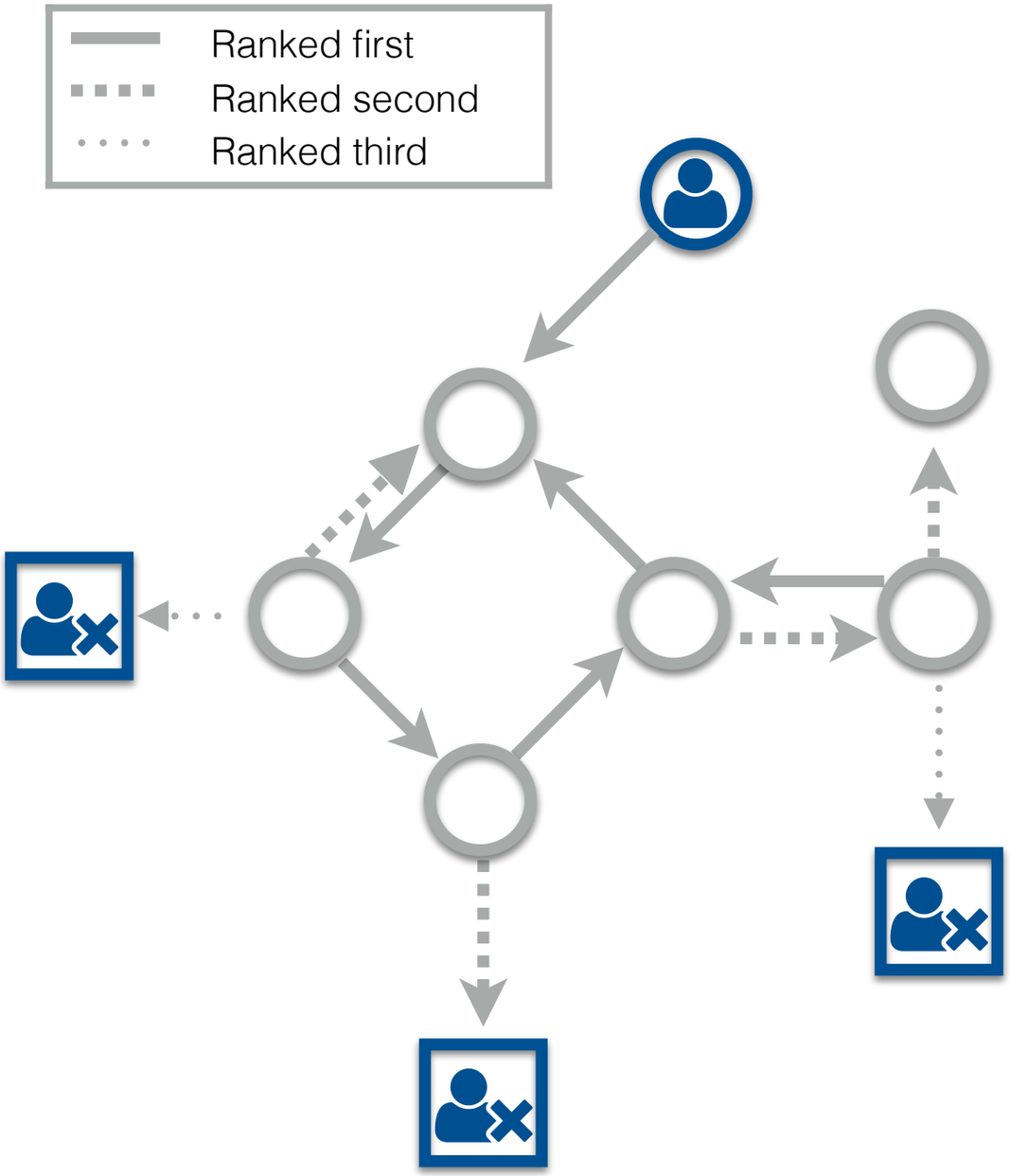
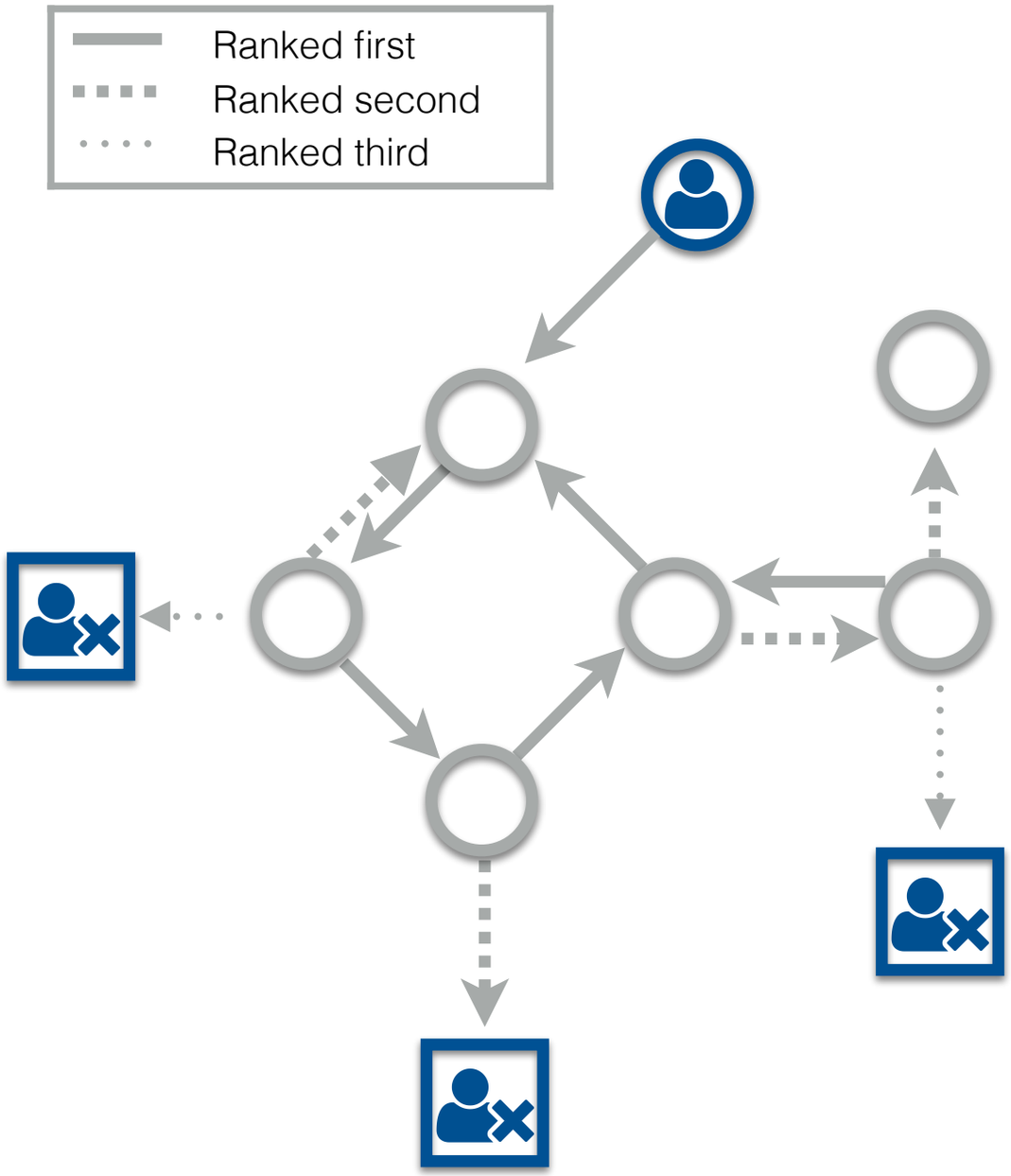


Question:
How to assign delegations?

Delegation Functions



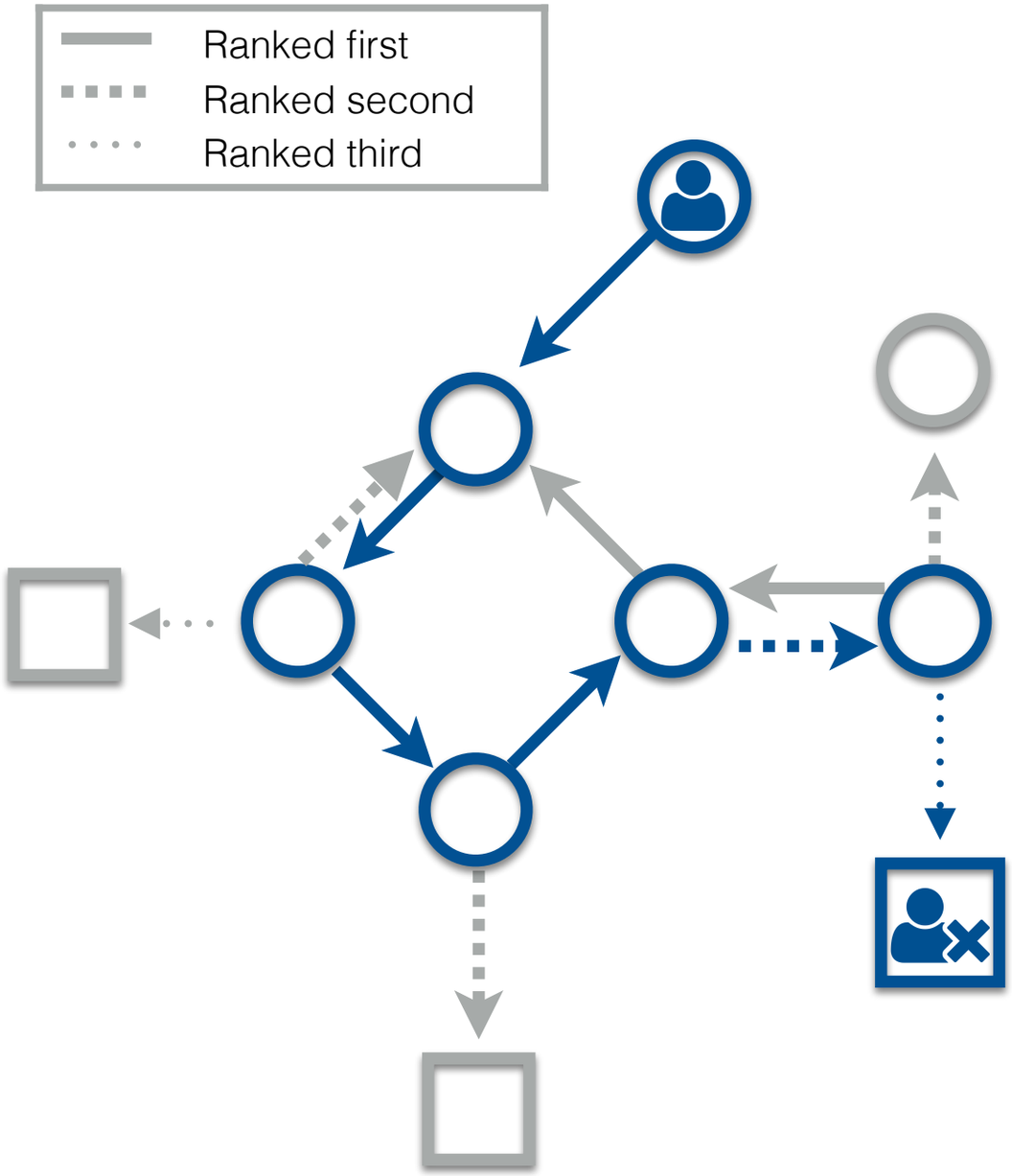
Delegation Functions



Depth first

Choose lexicographically first path
(order by rank values)

Delegation Functions



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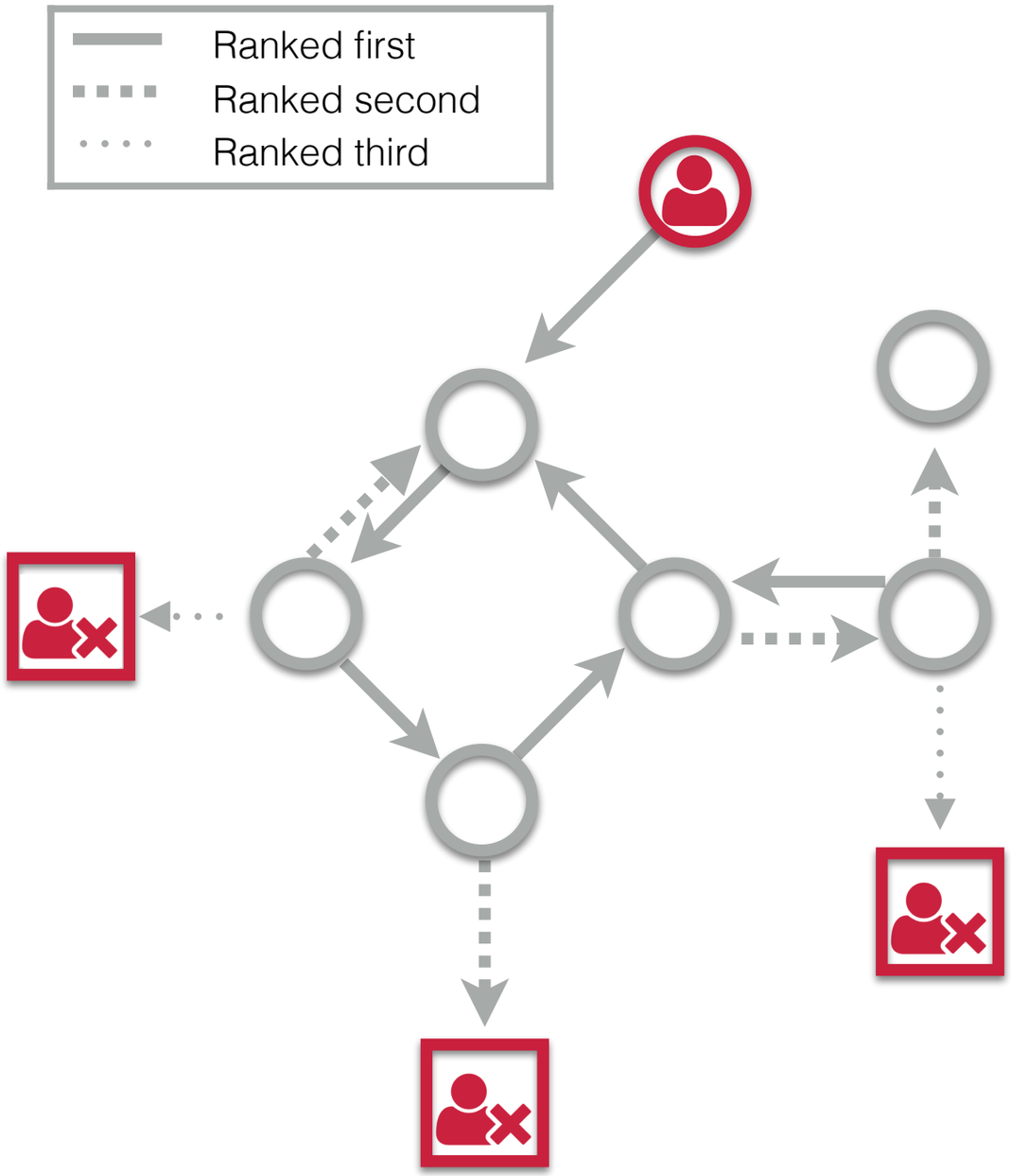

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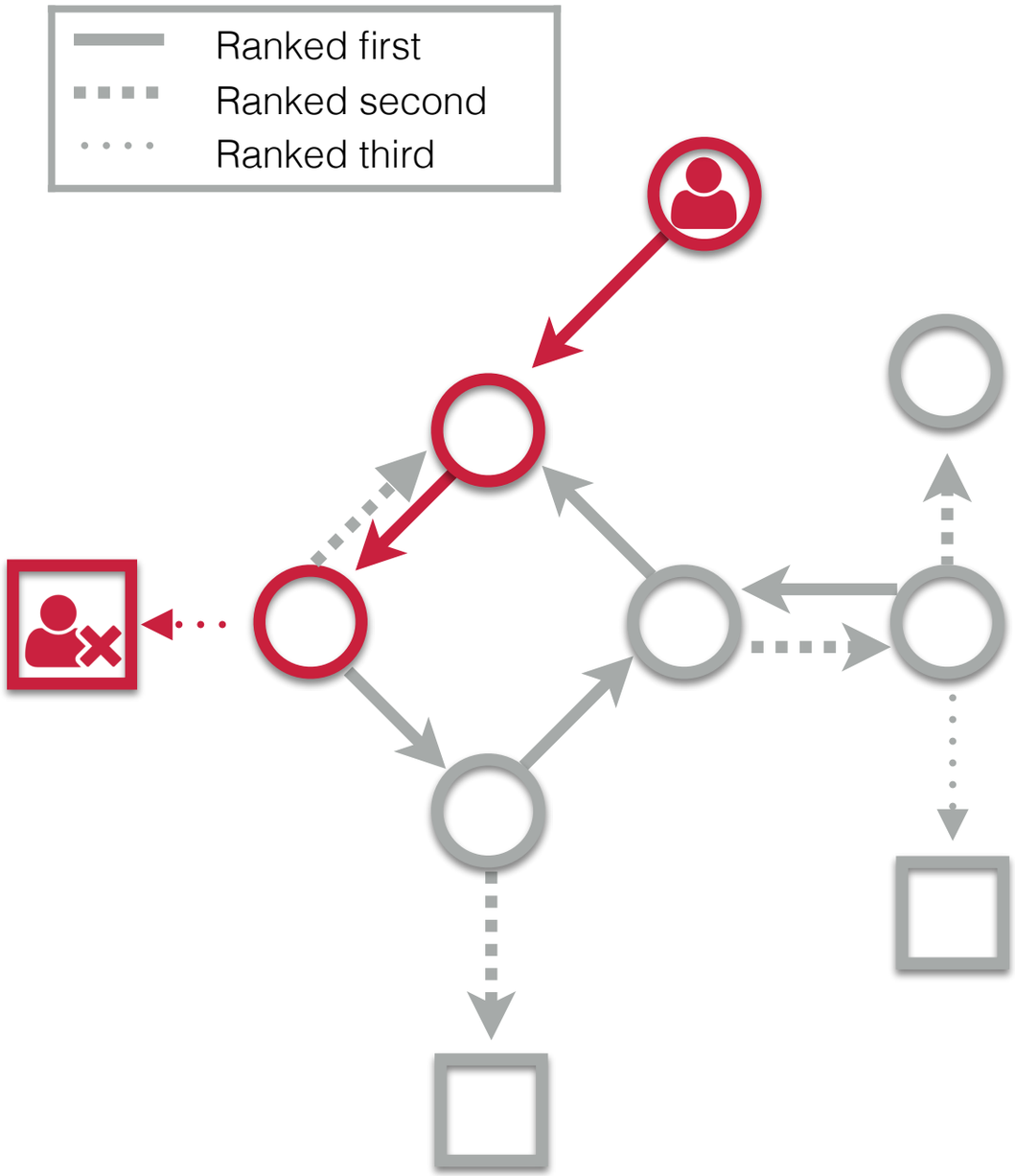
Breadth first — Choose shortest path (break ties lexicographically)

Delegation Functions



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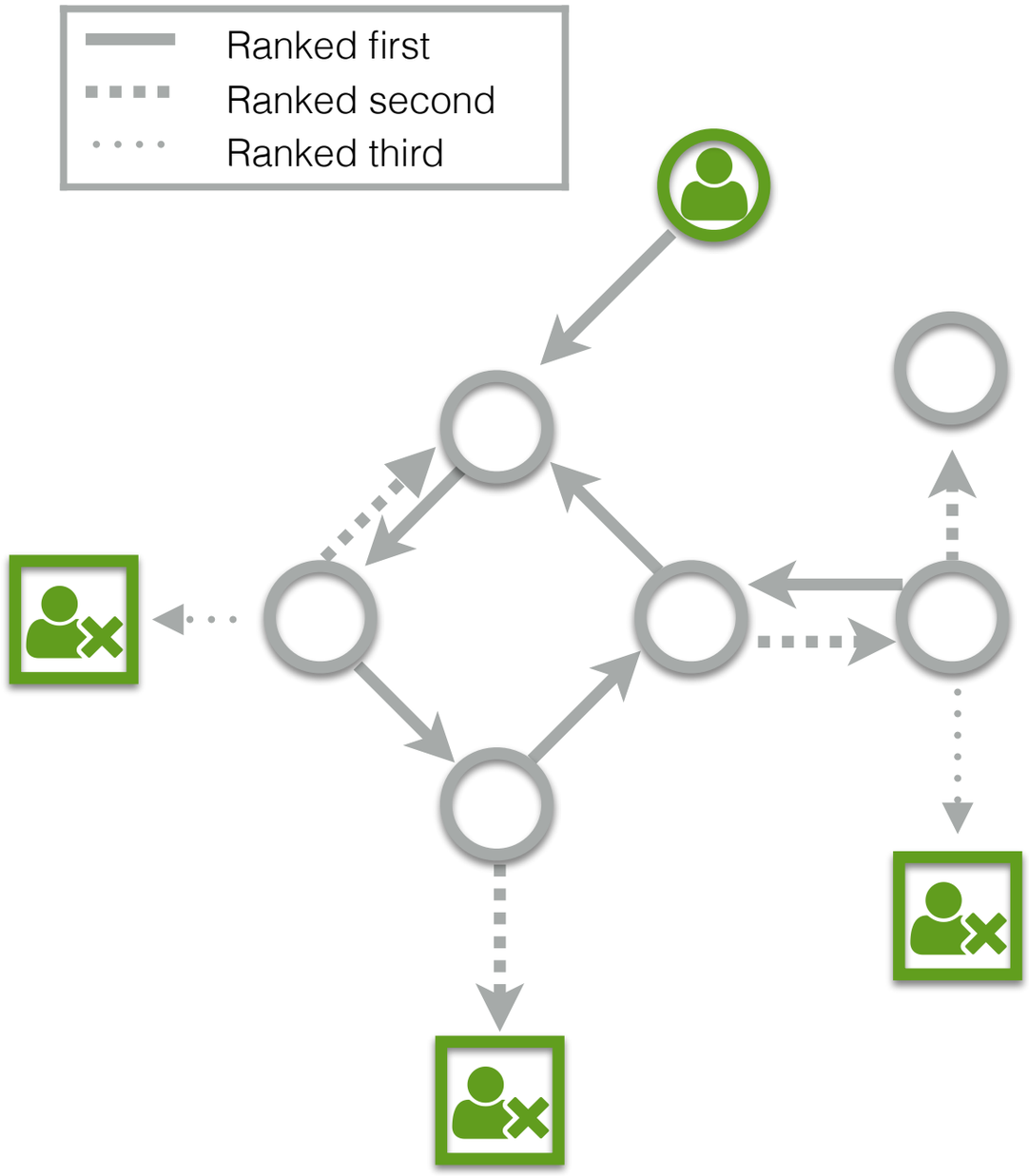

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Diffusion

Until some  reaches  :

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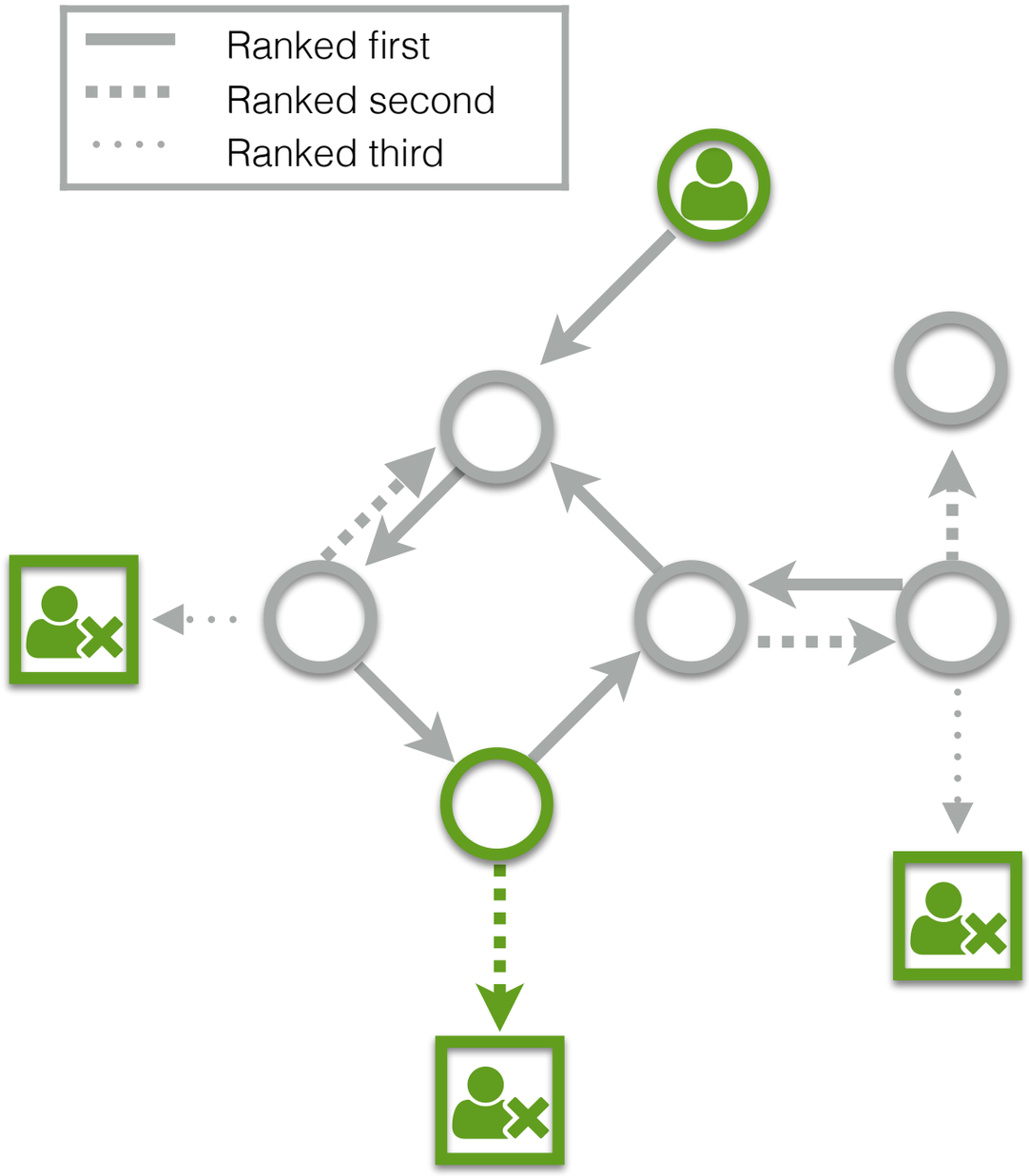
Delegation Functions



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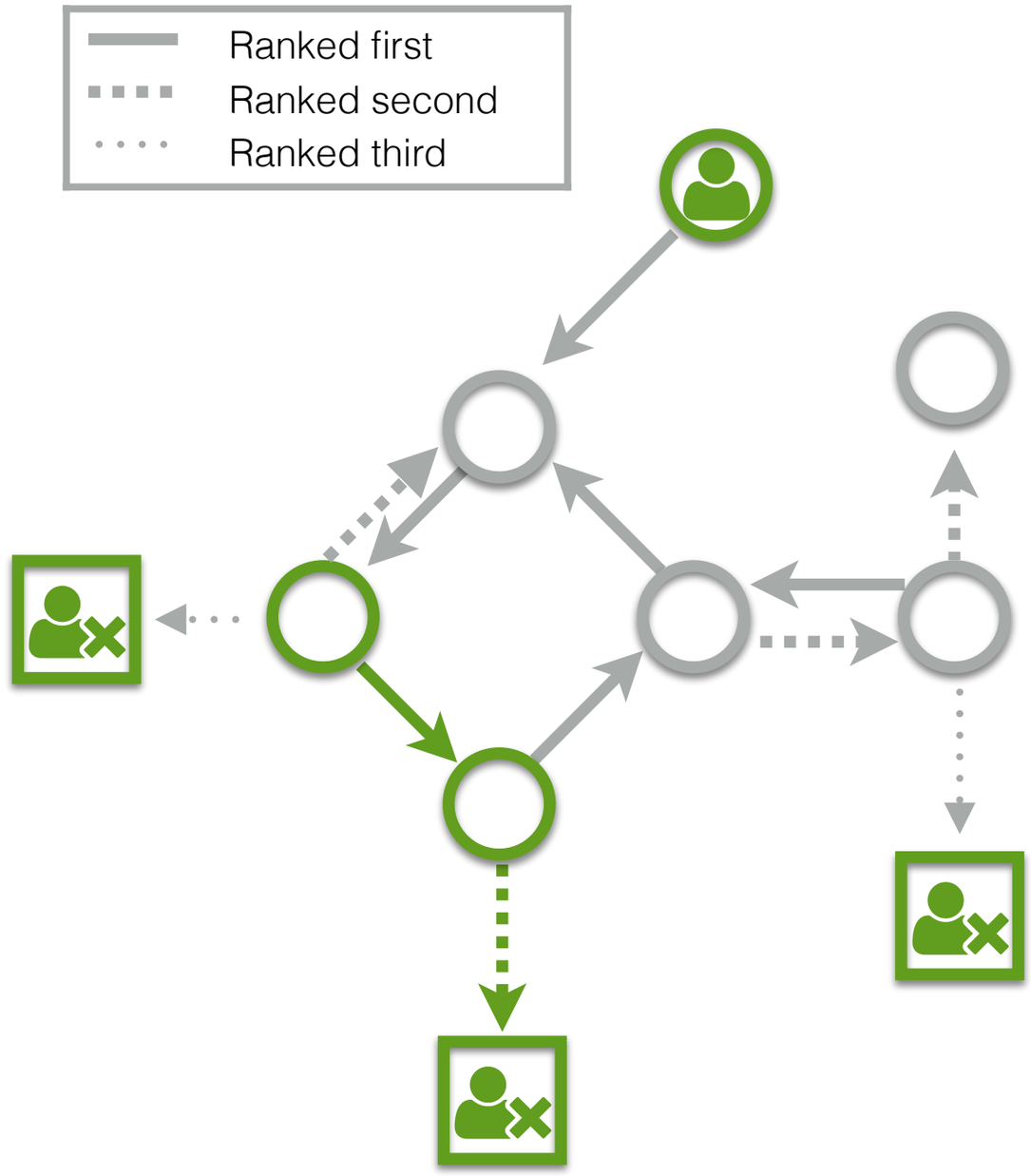

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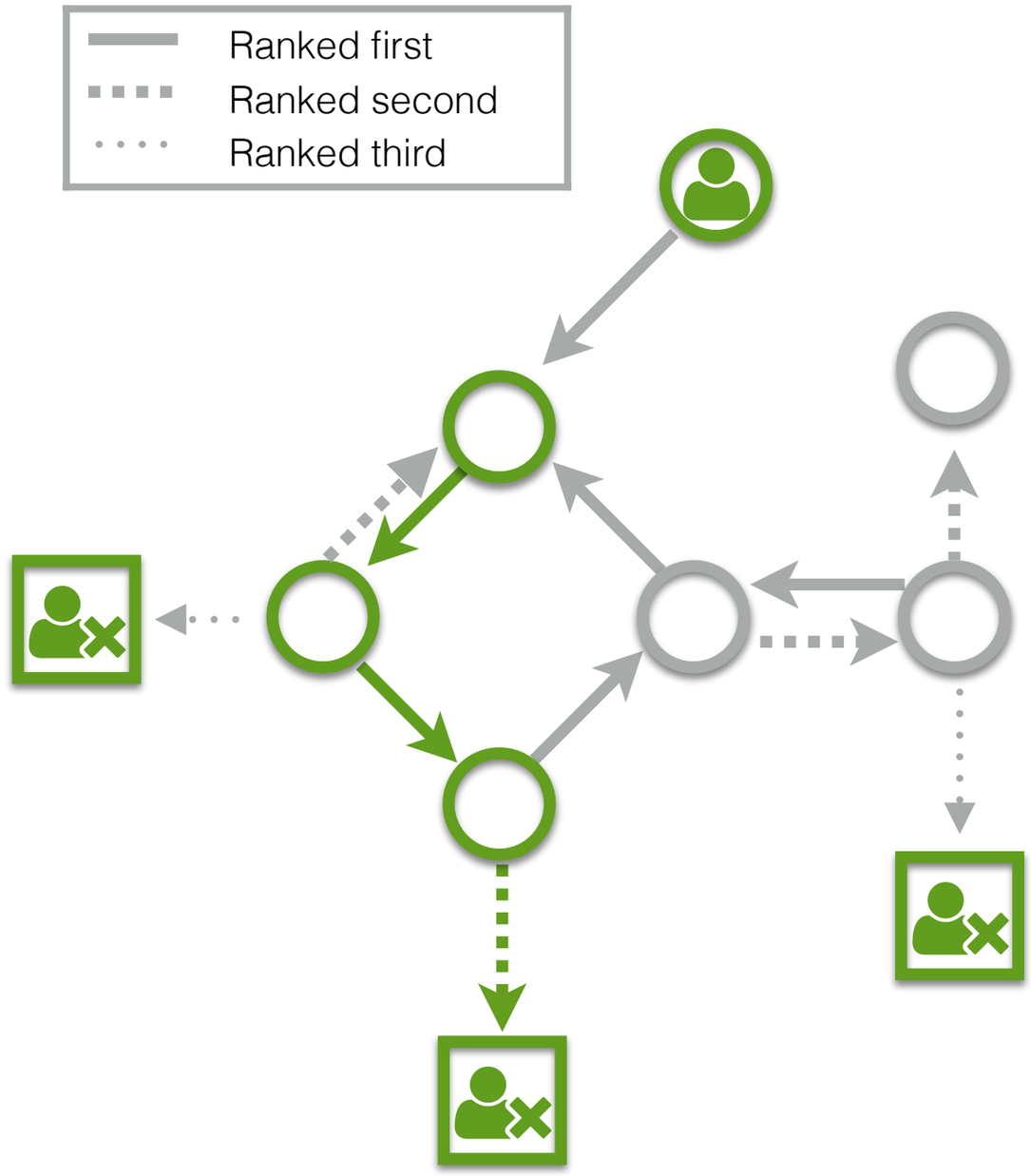
Diffusion

Until some 👤× reaches 👤:

- Let x be smallest rank of an ingoing edge to 👤×
- For all 👤× : expand backwards delegation paths along edges of rank x

Delegation Functions



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Diffusion

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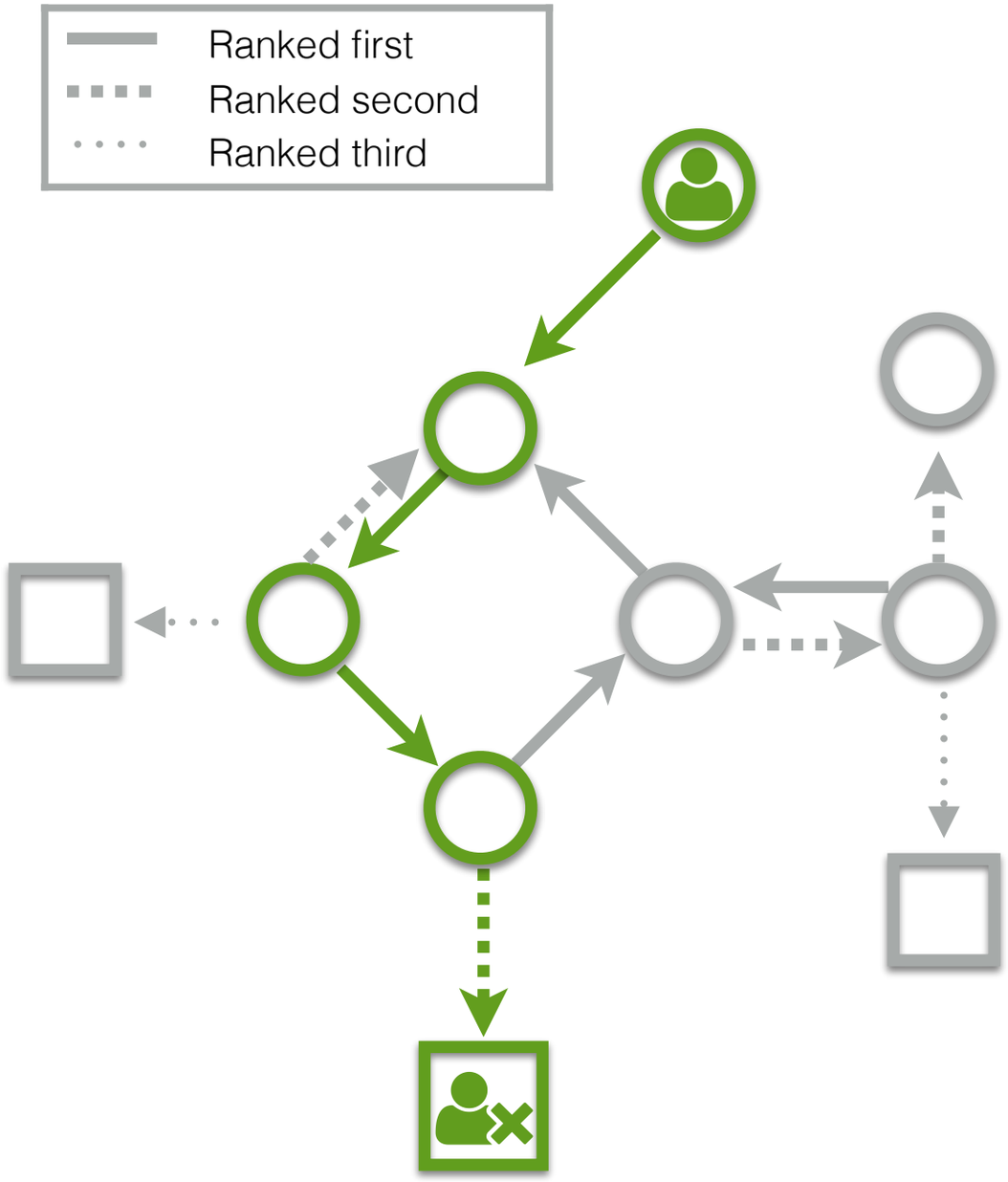
Delegation Functions



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Diffusion

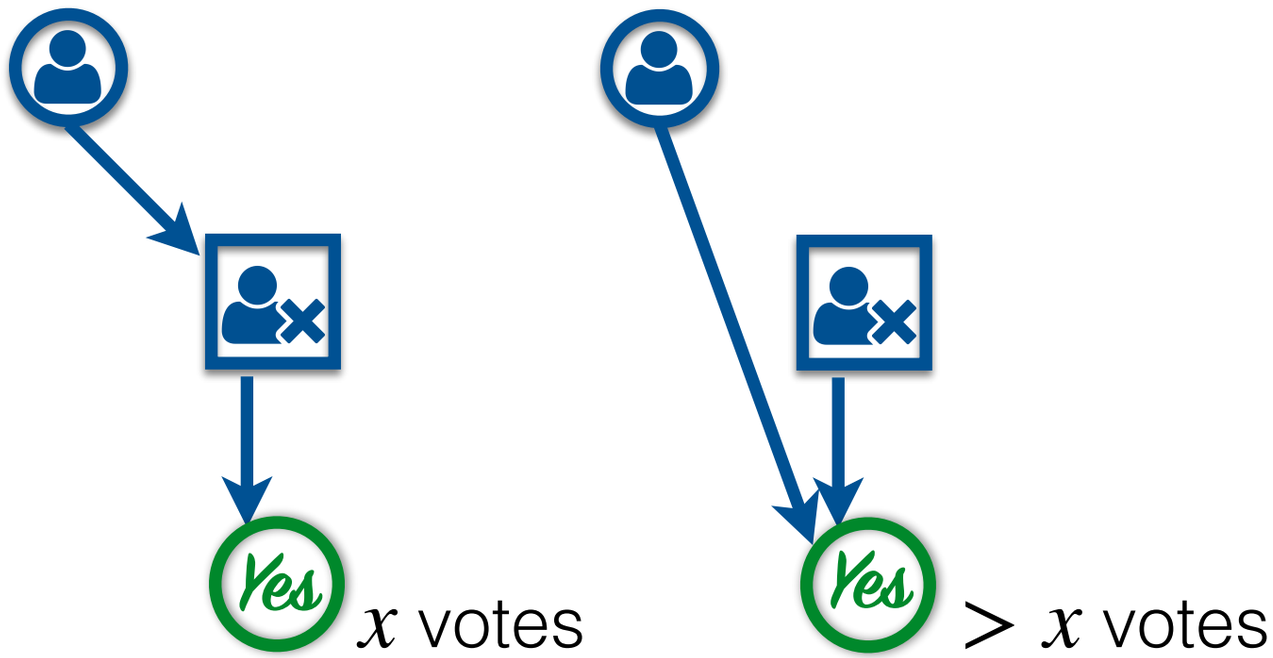
Until some ✕ reaches ●:

- Let x be smallest rank of an ingoing edge to ✕
- For all ✕ : expand backwards delegation paths along edges of rank x

Computational Social Choice

Axioms for Liquid Democracy:

- Anonymity: All voters are treated equally
- Neutrality: All candidates are treated equally
- Copy Manipulation:



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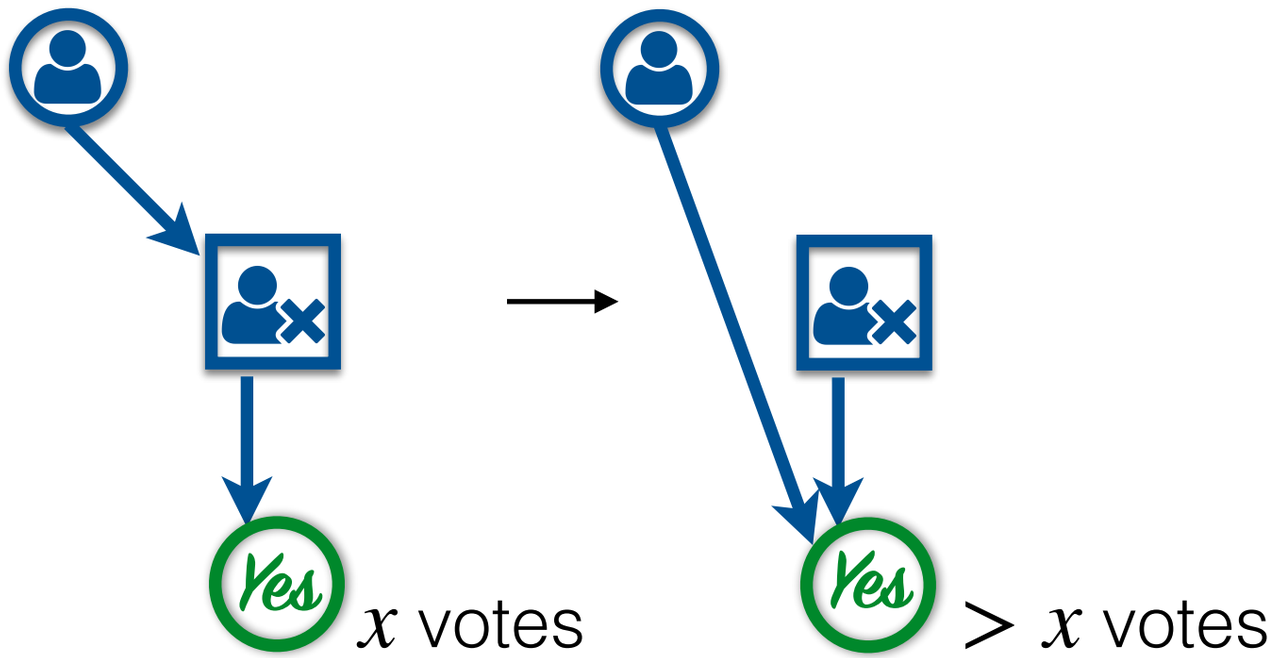
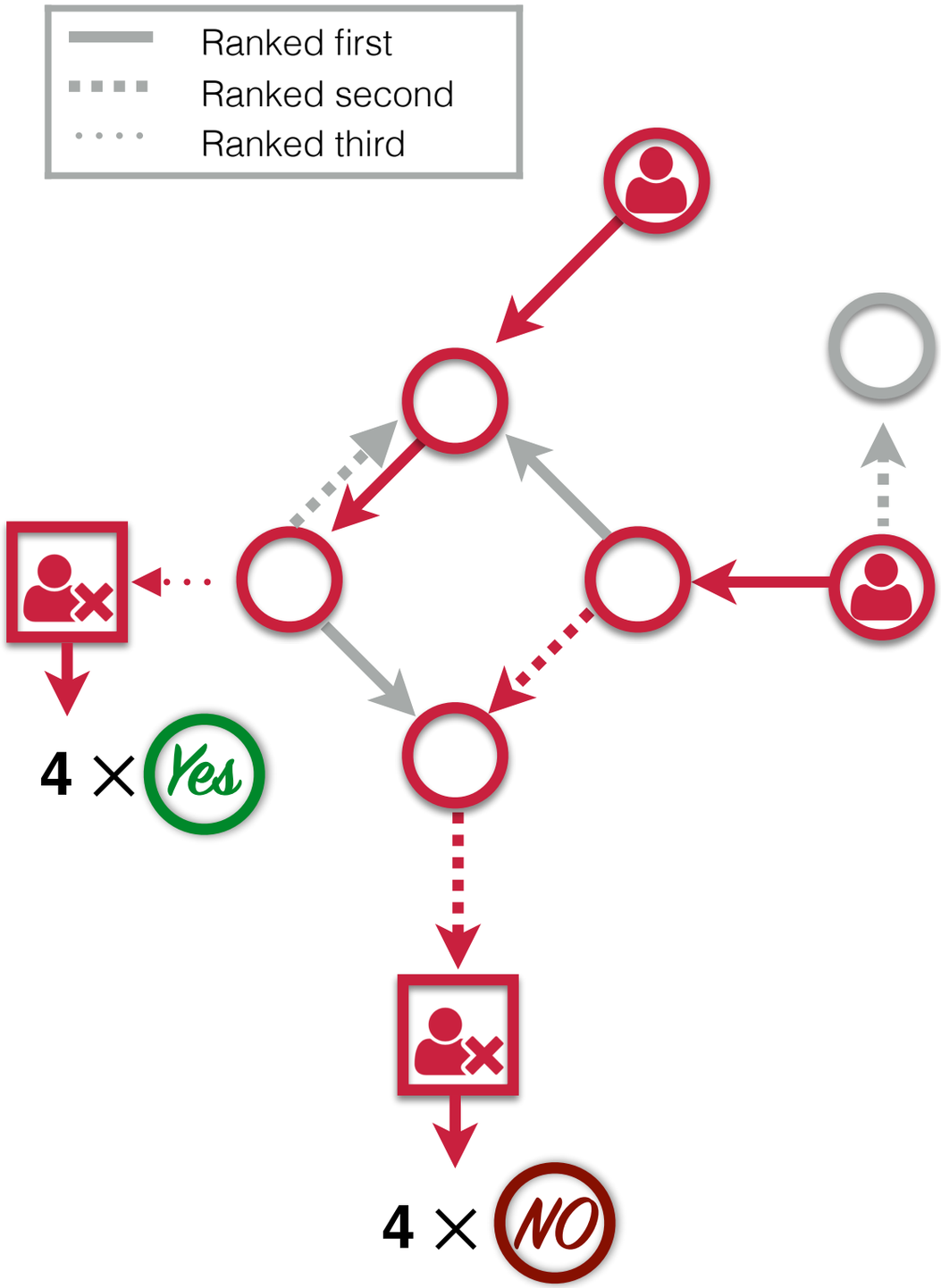


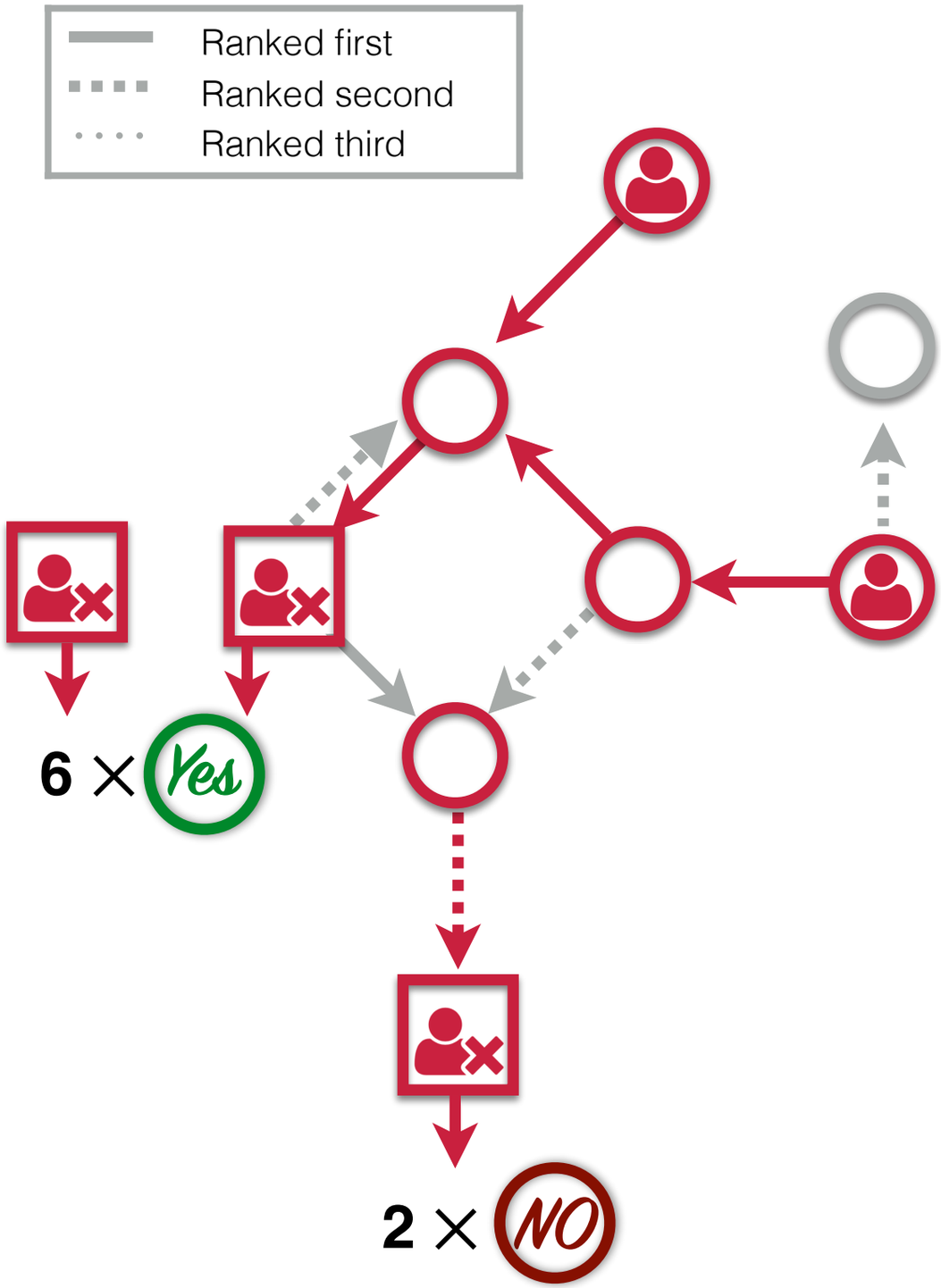
Breadth First Delegation is Copy Manipulable



Breadth first

Choose shortest path
(break ties lexicographically)

Breadth First Delegation is Copy Manipulable

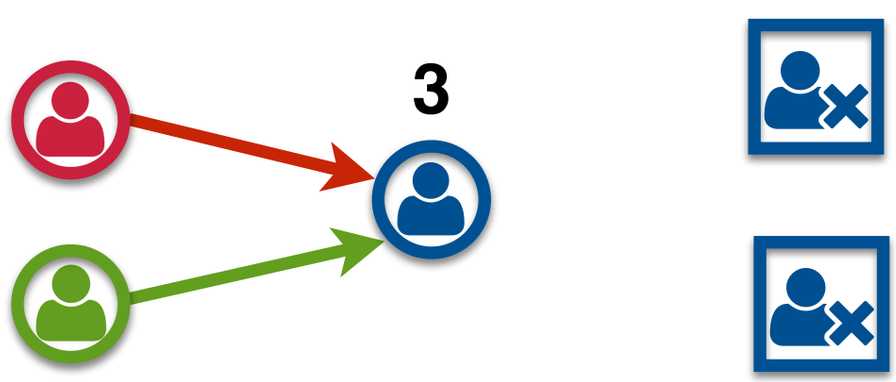


Breadth first	Choose shortest path (break ties lexicographically)

Computational Social Choice

Axioms for Liquid Democracy with Ranked Delegations:

- Anonymity: All voters are treated equally
- Neutrality: All candidates are treated equally
- Copy Manipulation: Changing from delegation to direct vote does not change the # votes of the option the voter is supporting
- Unsplittable flows:



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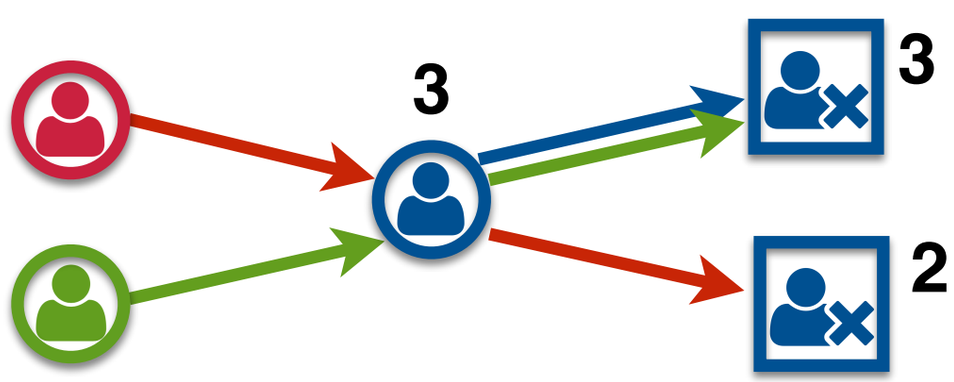

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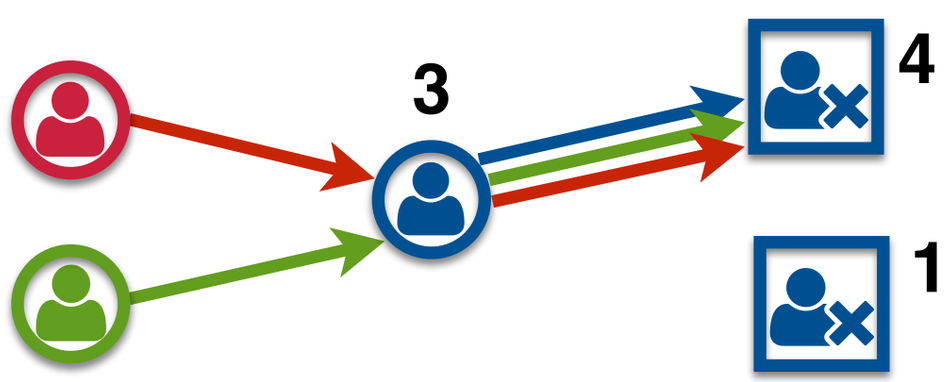
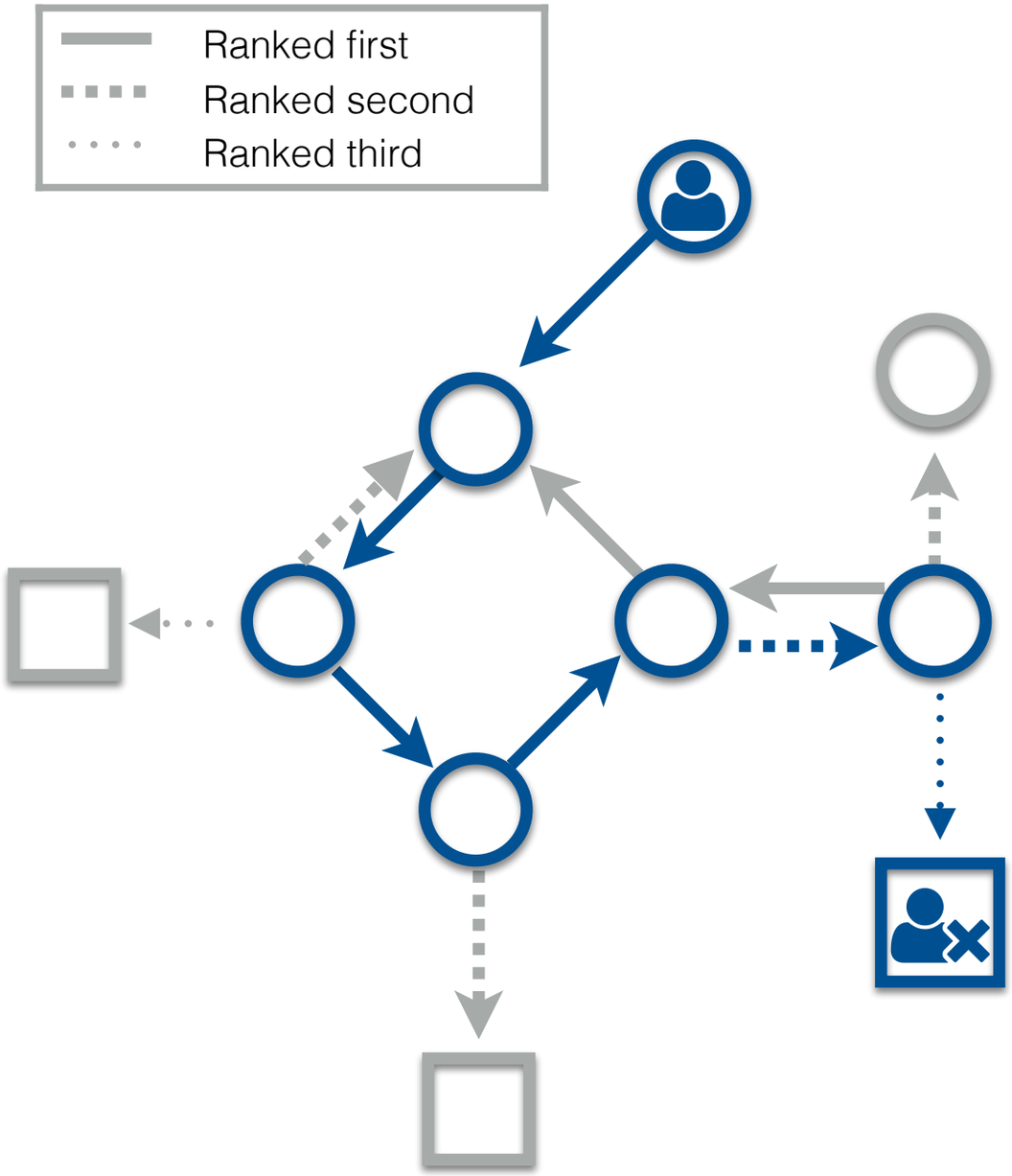


Depth First Delegation violates Unsplittable Flows



Depth first	Choose lexicographically first path (order by rank values)

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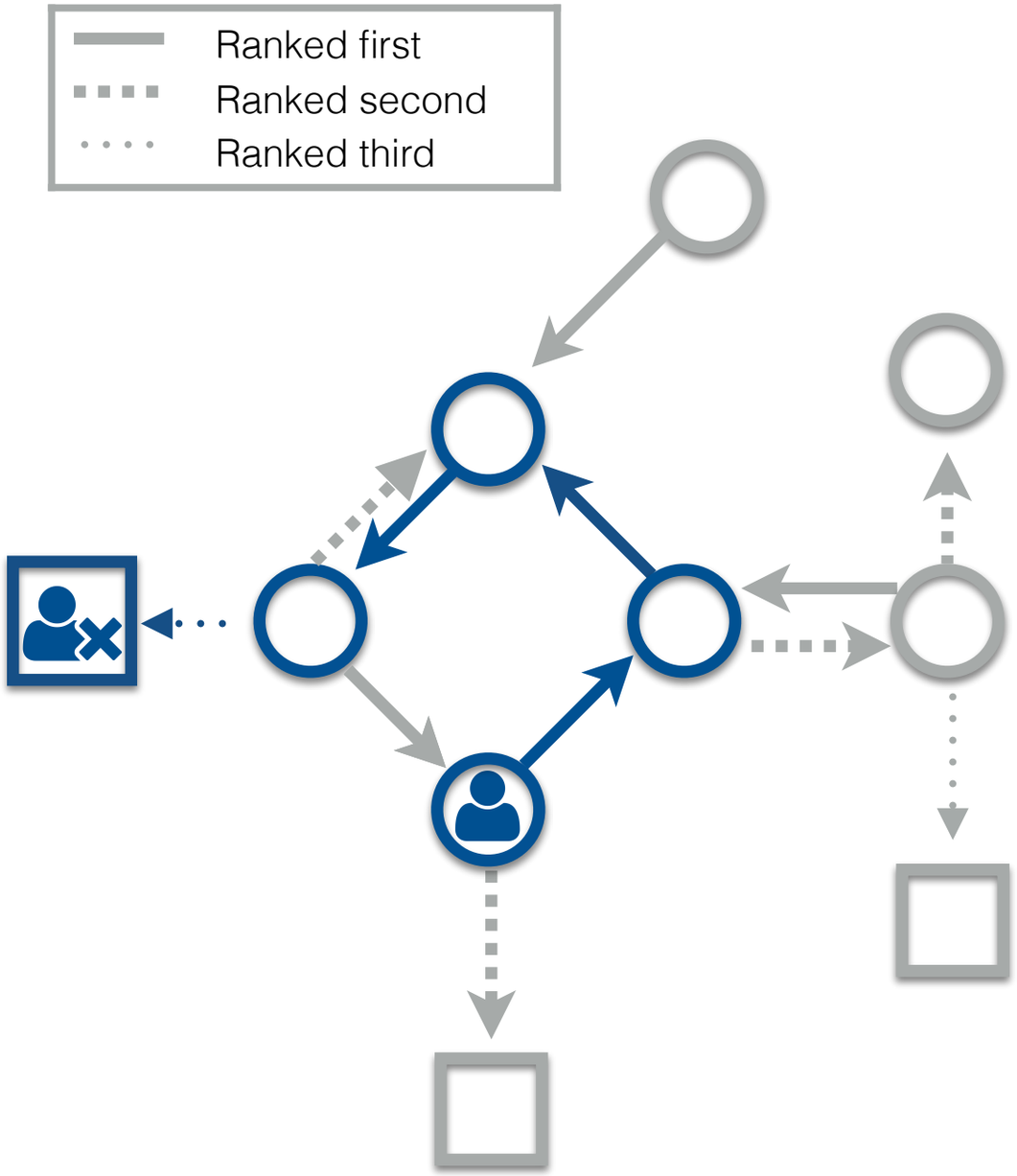

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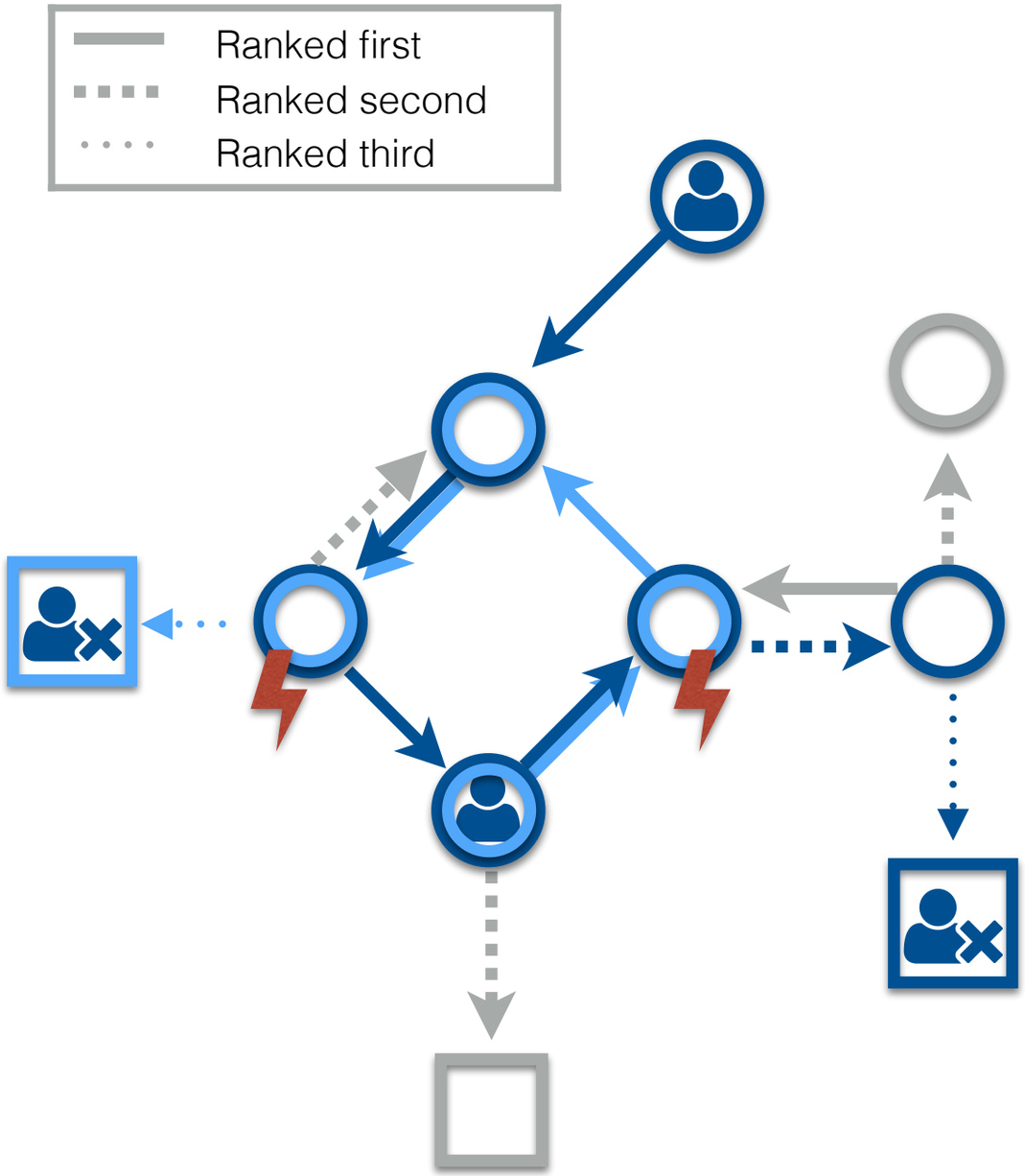

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Computational Social Choice

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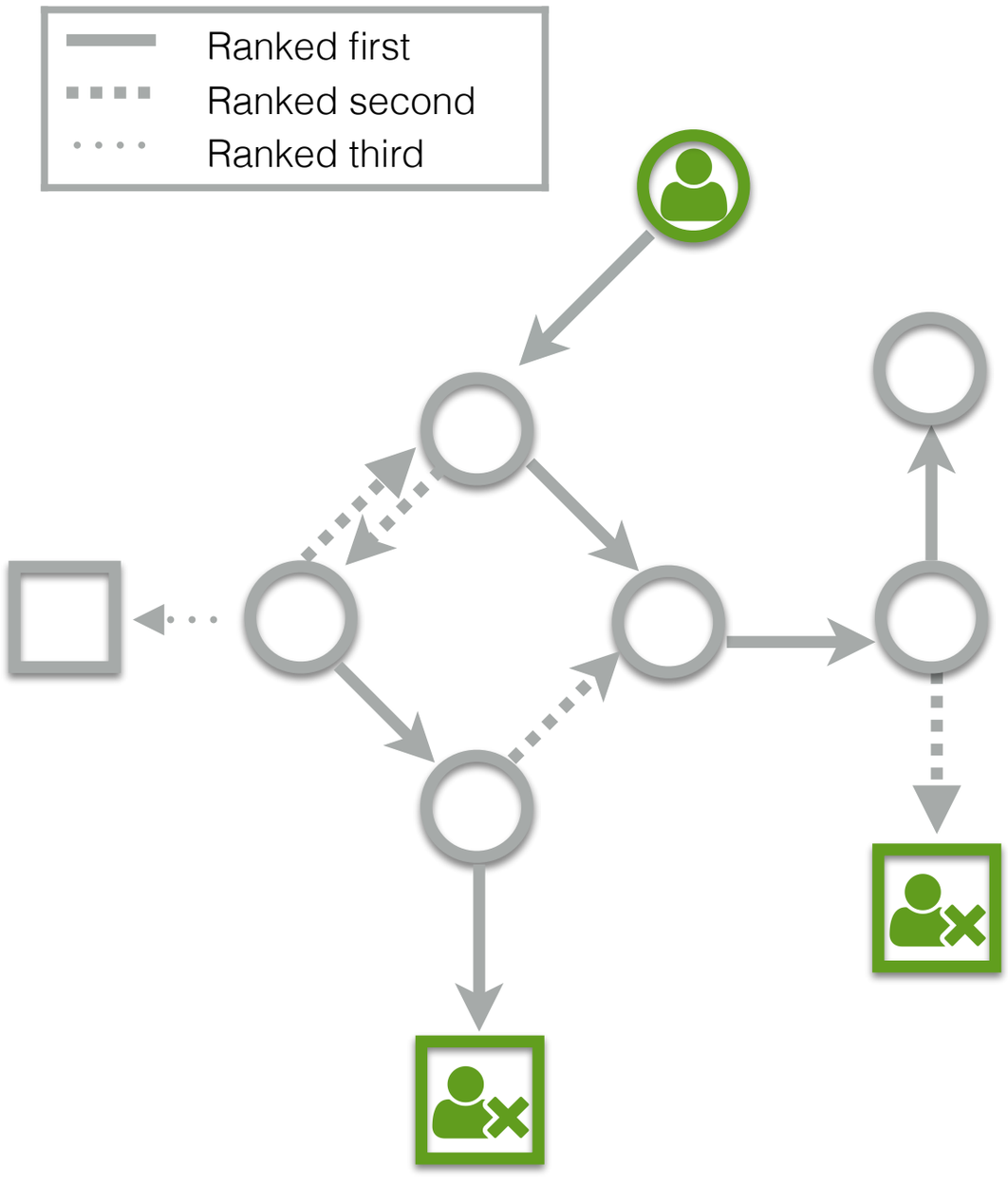
- Copy Manipulation: Changing from delegation to direct vote does not change the # votes of the option the voter is supporting
- Unsplittable flows: Every voter delegates all votes in the same direction
- Independence of Irrelevant Voters: If a voter changes their delegations, it doesn't affect delegation paths the voter was not included in

Diffusion Delegation violates IIV

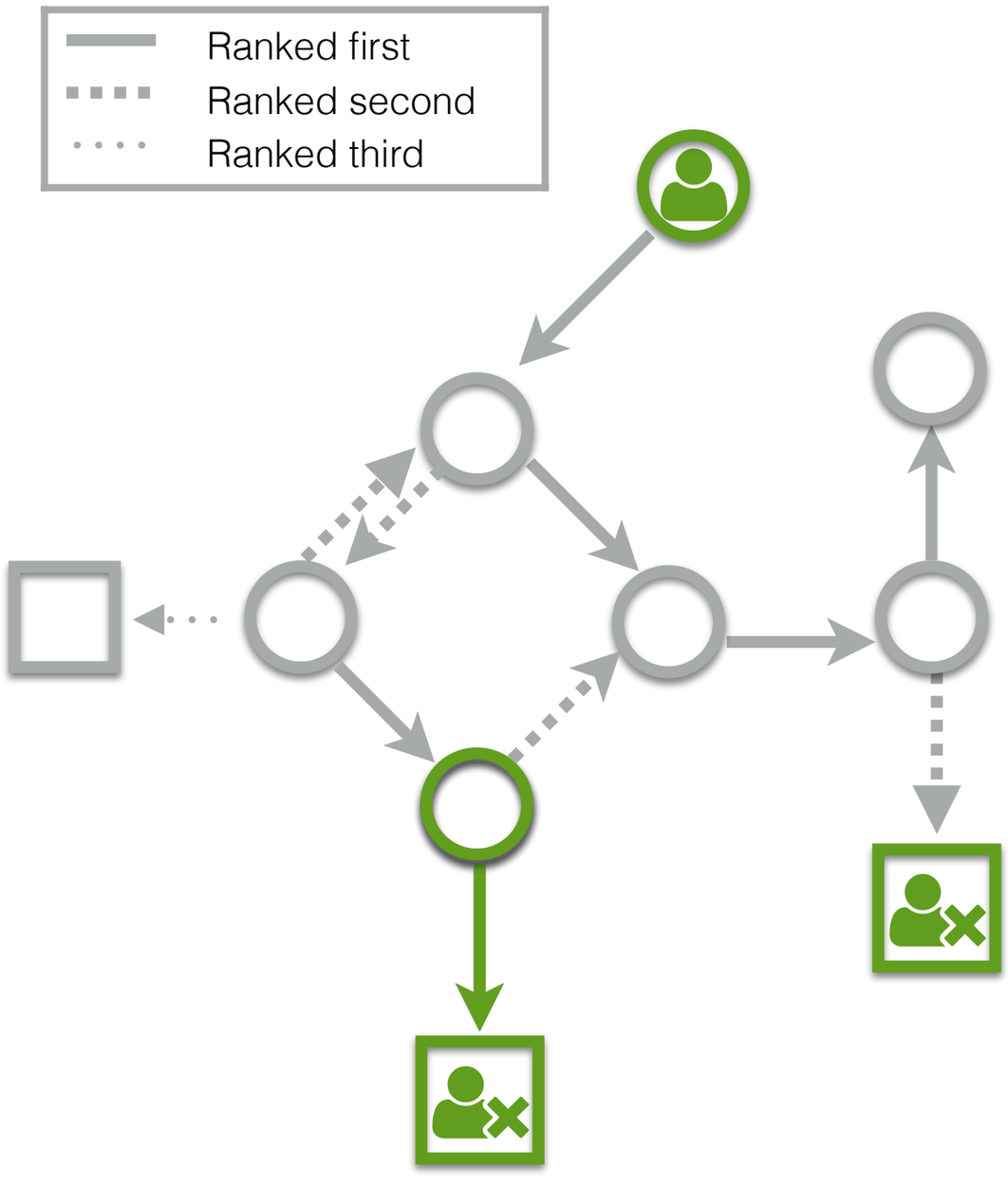


Diffusion

Until some reaches :

- Let x be smallest rank of an ingoing edge to
- For all : expand backwards delegation paths along edges of rank x

Diffusion Delegation violates IIV



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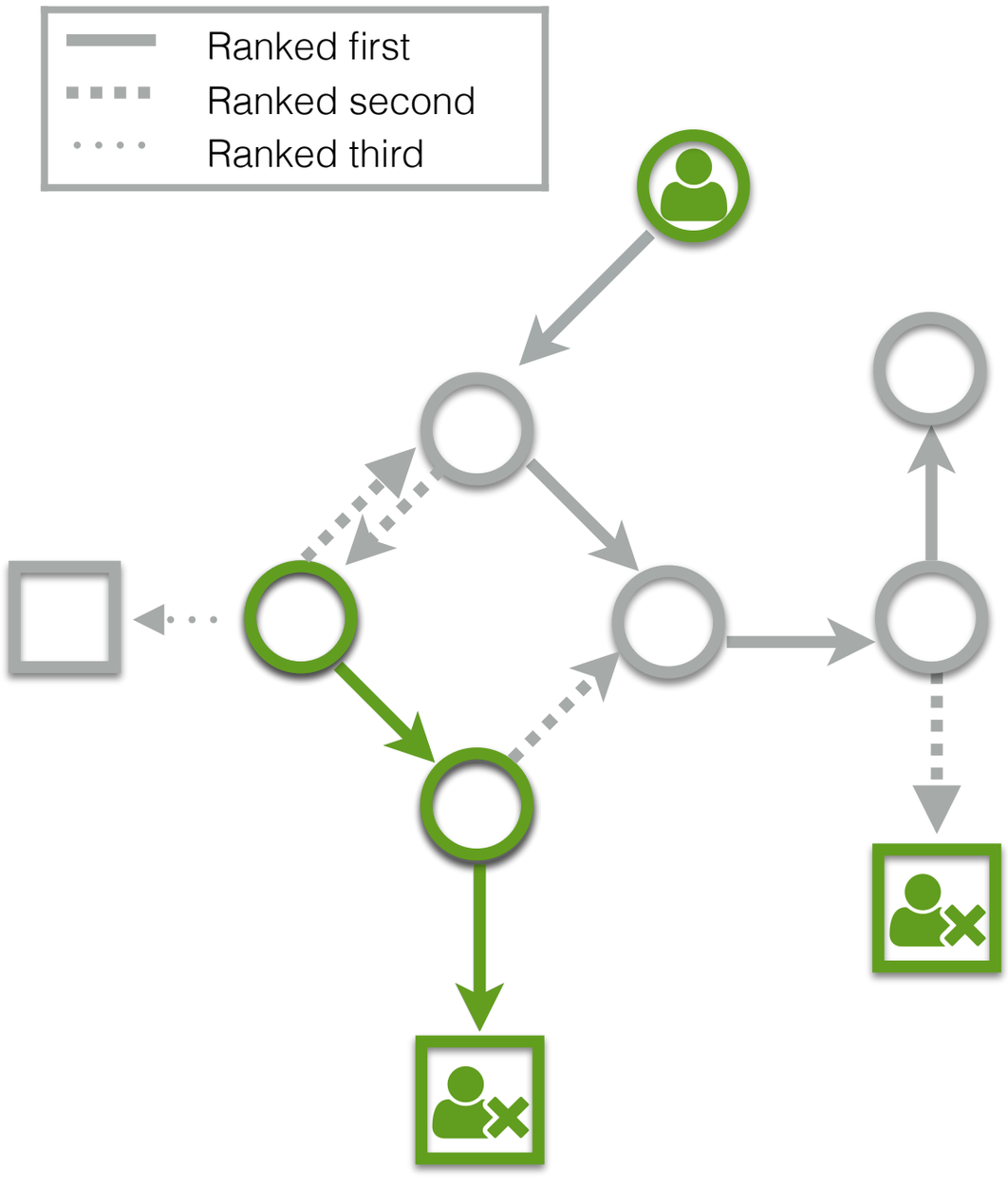

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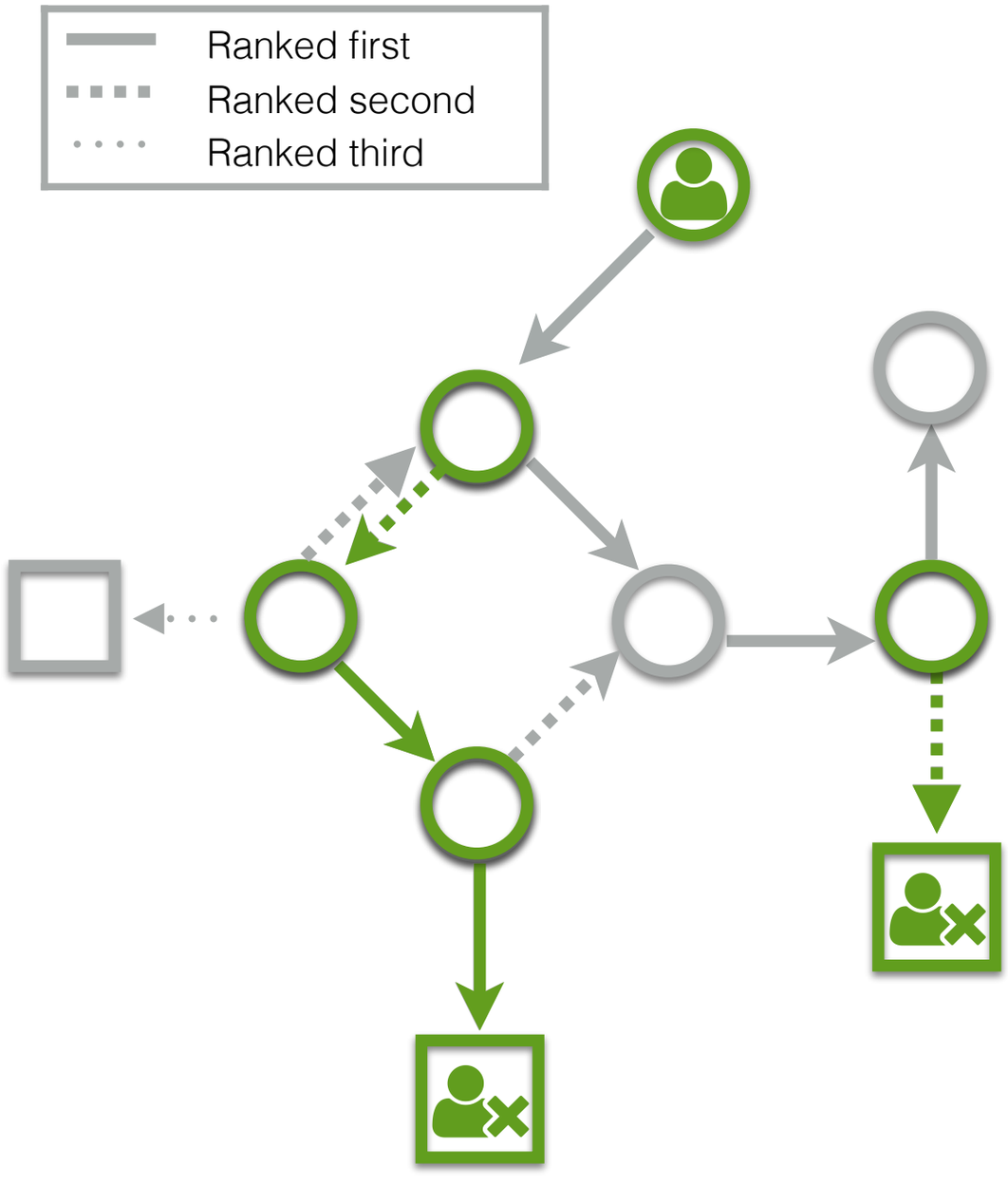

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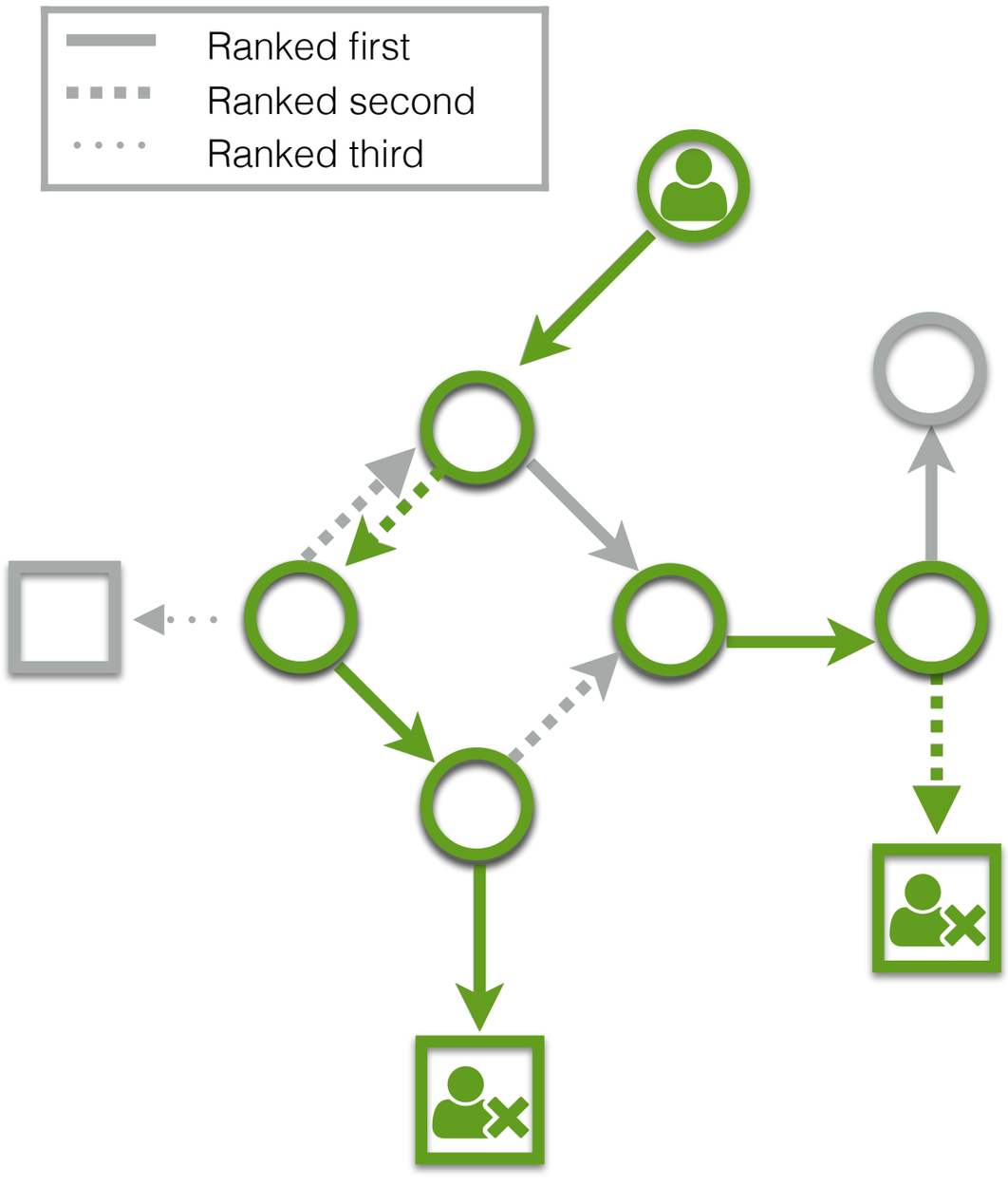

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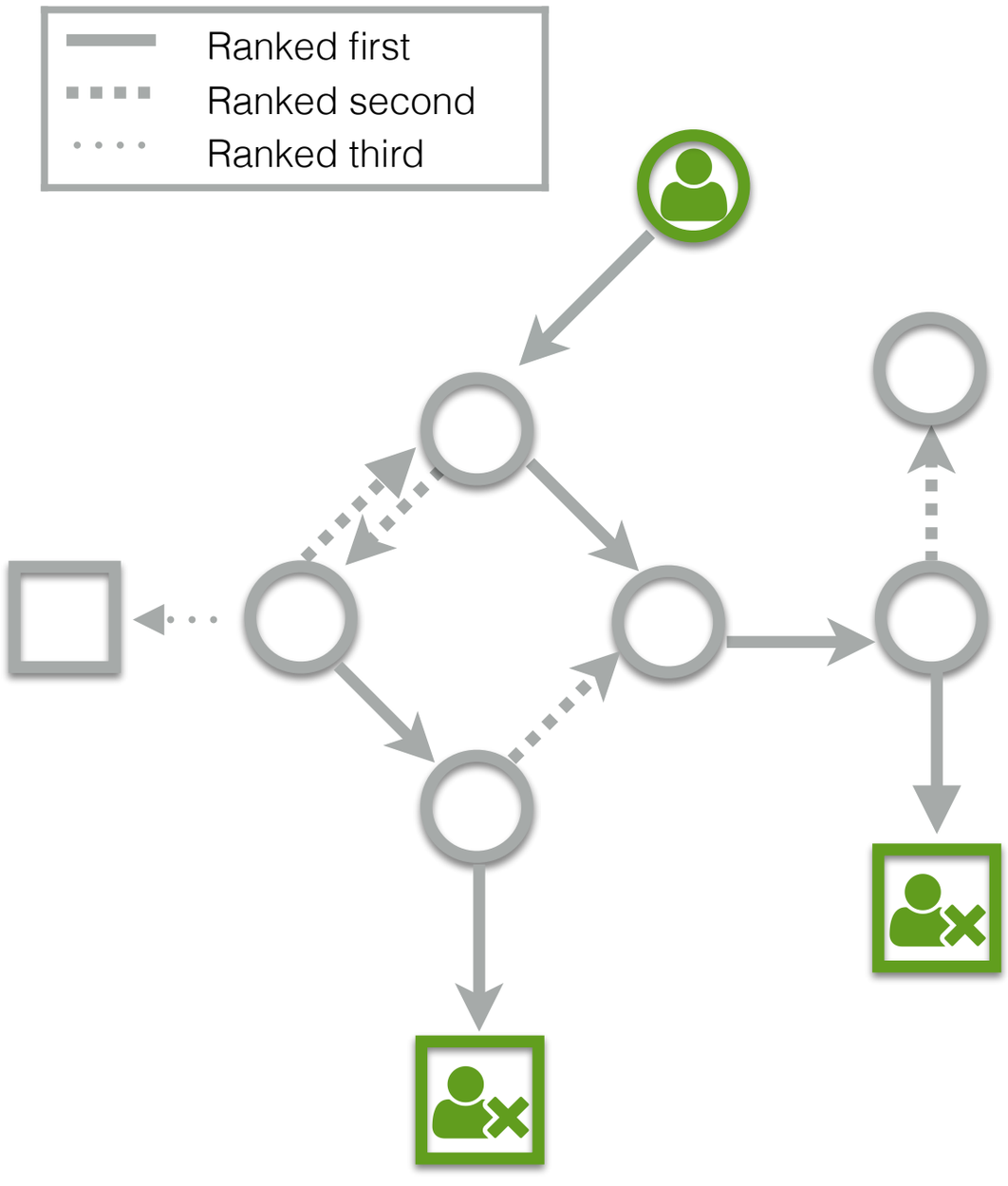

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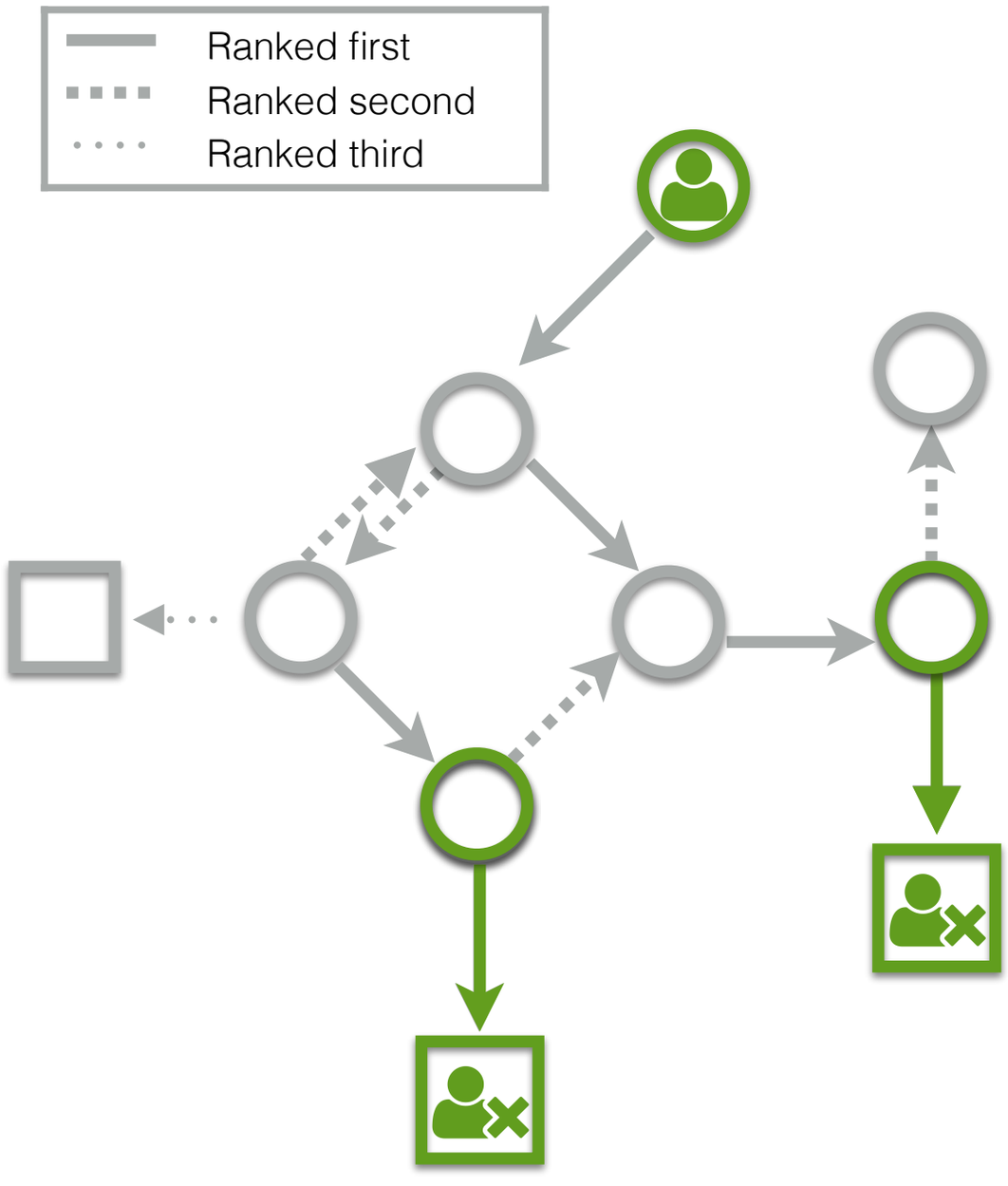

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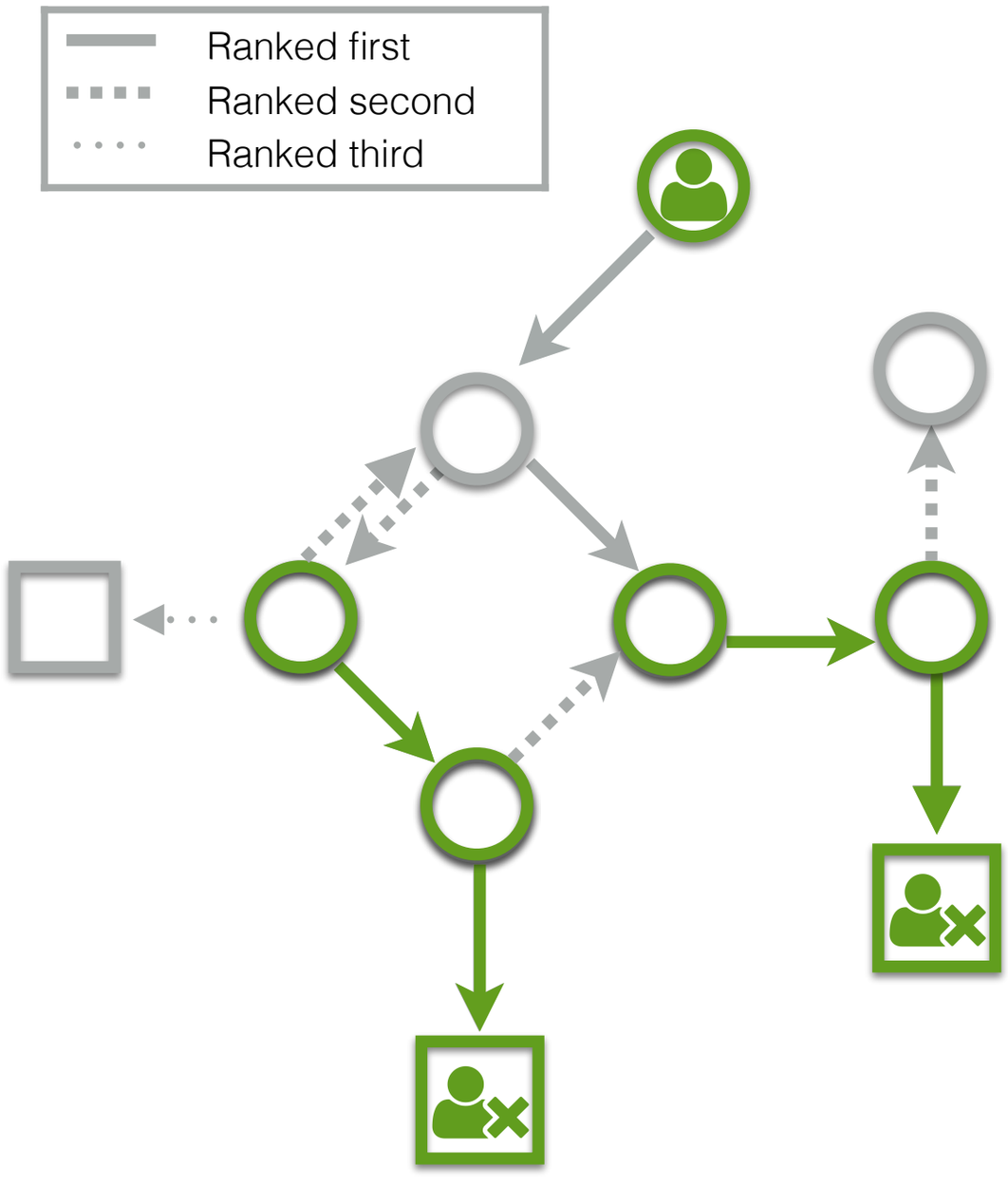

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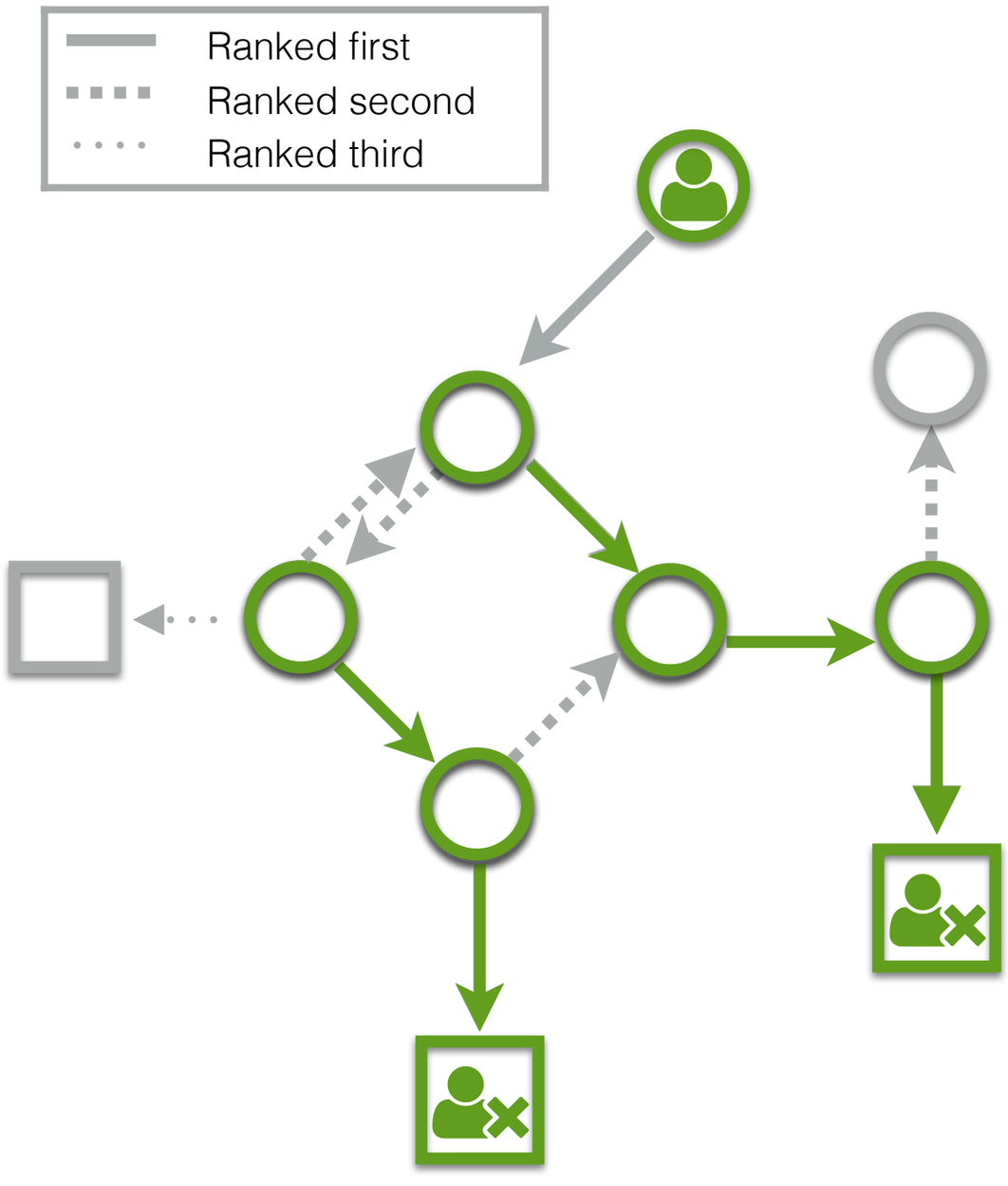

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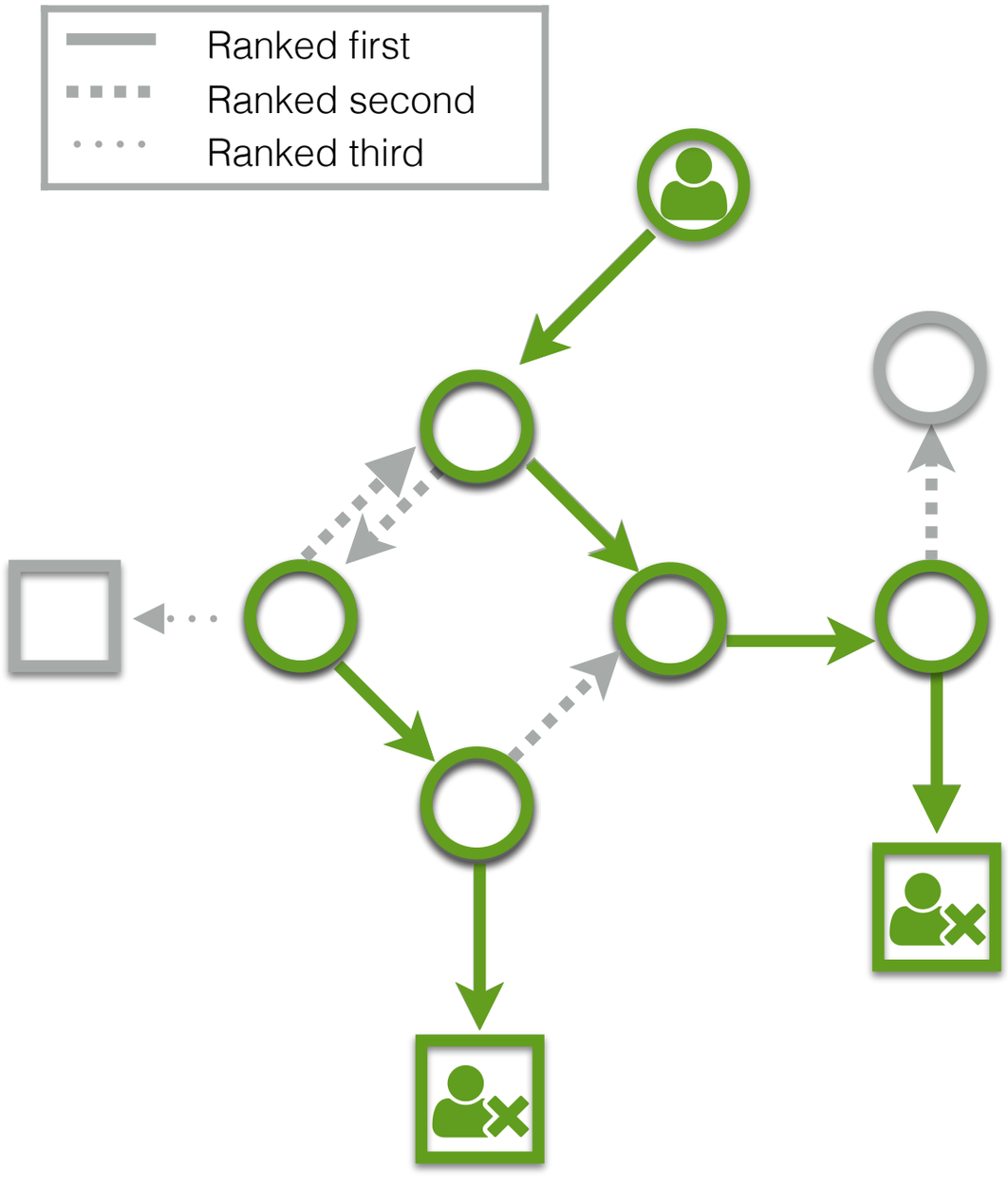

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The typical story…

Can we show impossibility results?

or

Is there a "perfect" Delegation Rule? (unlikely)

- It is worth finding reasonable axioms and analysing which axioms are (dis-)satisfied
- Different applications value different axioms

DIGITAL DEMOCRACY

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DIGITAL DEMOCRACY

Based on joint work with:

Markus Brill

Martin Lackner

Ulrike Schmidt-Kraepelin