

Economic Incentives and Souls in Schelling-point Based Oracles

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KLEROS



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INCUBATOR



Winner of the Blockchains for Social Good Prize from the European Union's Horizon 2020 research and innovation programme

bpi**france**



ESCROW

Home



New Invoice

New Payment

New Payment

Payment Info

Title

 Eg. Marketing Services Agreement with John

Eg. Marketing Services Agreement with John

Fund Receiver

 0x93ed3fbe21207ec2e8f2d3c3de6e058cb73bc04dEnter the ETH address of the counterparty to this agreement. Make sure to use an address this party controls (Do not use an exchange address).

Amount

 3

ETH

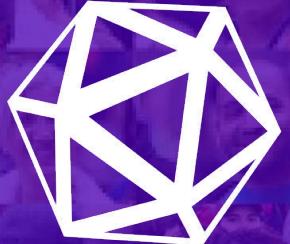
Amount that will be sent to the escrow as payment for the service. Funds will stay in the escrow until the payment is completed. Automatic Payment (Optional) Agreement Documents (Optional)

Extra Details | Cryptocurrency Transaction

Asset to exchange

 PNK

Address to send the asset



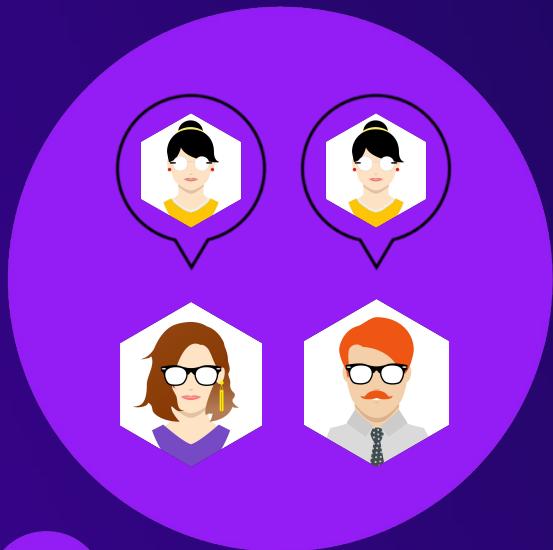
KLEROS



KLEROS



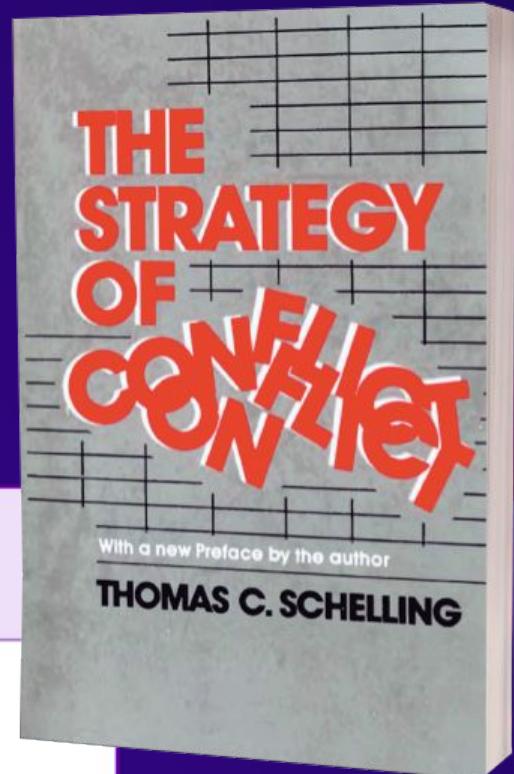
V



Schelling Point

- “solution that people tend to use in the absence of communication because it seems natural, special, or relevant to them”

		You vote	
		X	Y
The majority vote	X	1	-1
	Y	-1	1



- Non-transferable
- Have to present the bad with the good (short of scraping entire wallet - starting over)



Decentralized Society: Finding Web3's Soul¹

E. Glen Weyl,² Puja Ohlhaver,³ Vitalik Buterin⁴

May 2022

*"The Dao is the hearth and home
of the ten thousand things.
Good souls treasure it,
lost souls find shelter in it."*

— Laozi, #62

Abstract

Web3 today centers around expressing transferable, financialized assets, rather than encoding social relationships of trust. Yet many core economic activities—such as uncollateralized lending and building personal brands—are built on persistent, non-transferable relationships. In this paper, we illustrate how non-transferable “soulbound” tokens (SBTs) representing the commitments, credentials, and affiliations of “Souls” can encode the trust networks of the real economy to establish provenance and reputation. More importantly, SBTs enable other applications of increasing ambition, such as community wallet recovery, sybil-resistant governance, mechanisms for decentralization, and novel markets with decomposable, shared rights. We call this richer, pluralistic ecosystem “Decentralized Society” (DeSoc)—a co-determined sociality, where Souls and

The screenshot shows the Proof of Humanity (POH) web application interface. At the top, there's a navigation bar with the POH logo, a search bar, and links for 'Profiles' and 'My Profile'. Below the navigation is a sidebar titled 'Profiles' with a search bar. On the right side of the sidebar is a dropdown menu showing '123.456 Profiles' and a list of status filters: All, Registered, Challenged,Appealed, Crowdfunding, Pending, and Removed. The main content area displays a grid of 12 profile cards arranged in three rows of four. Each card includes a profile picture, name, title, and a brief description. The profiles are categorized by status:

- Pending Registration:** Alice Smith (Software Engineer, Solidity Expert, Blockchain, Crypto.)
- Crowdfunding Appeal:** Ethan Smith (Software Engineer, Solidity Expert, Blockchain, Crypto.)
- Appealed Registration:** Jess Smith (Software Engineer, Solidity Expert, Blockchain, Crypto.)
- Challenged Registration:** Bob Smith (Software Engineer, Solidity Expert, Blockchain, Crypto.)
- Registered:** Jennifer Smith (Software Engineer, Solidity Expert, Blockchain, Crypto.), Tom Smith (Software Engineer, Solidity Expert, Blockchain, Crypto.), Laura Smith (Software Engineer, Solidity Expert, Blockchain, Crypto.), Susan Smith (Software Engineer, Solidity Expert, Blockchain, Crypto.), Robert Smith (Software Engineer, Solidity Expert, Blockchain, Crypto.), Sophia Smith (Software Engineer, Solidity Expert, Blockchain, Crypto.)
- Pending Removal:** Bear (Software Engineer, Solidity Expert, Blockchain, Crypto.)
- Removed:** None

At the bottom of the grid is a navigation bar with page numbers from 1 to 5.



PROOF OF HUMANITY

- Proof of personhood/Sybil resistance tool
- Curated list, if dispute over eligibility -> Kleros dispute



William George

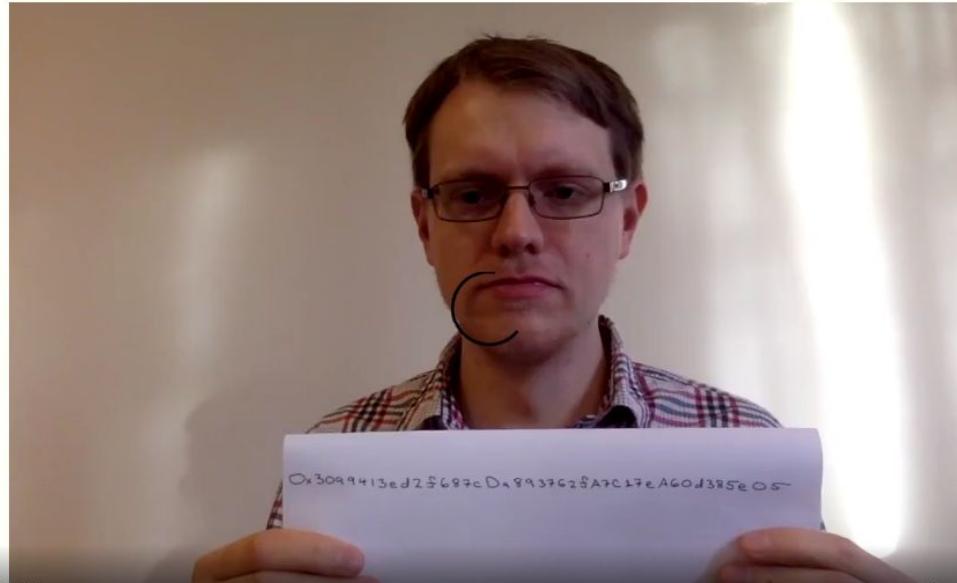
0x3099413ed2f687cda893762fa7c17ea60d385e05

William George

Mathematician, cryptographer,
blockchain researcher.

Vouchers
0/1

Deposit
0.00%



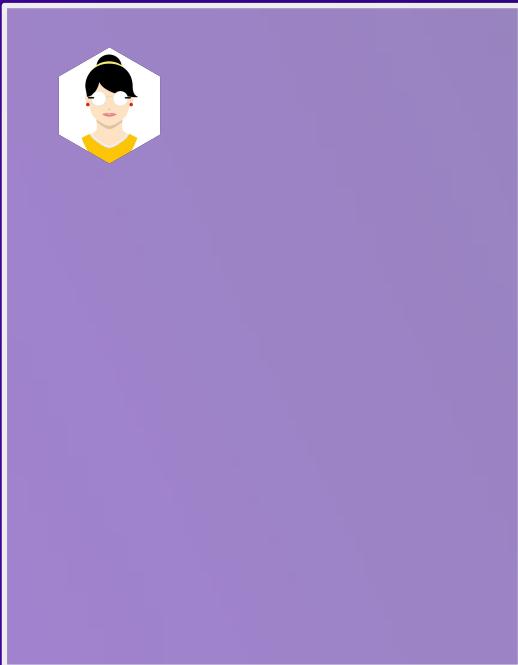
“I certify that I am a real human, and that I am not already registered in this registry.”

Pending submissions:



**“I am a human
not already on
the registry”**

Deposit:



The screenshot shows a user interface for managing profiles. At the top, there's a navigation bar with 'Profiles' and 'My Profile'. Below it is a search bar and a filter section with a dropdown set to 'All' and several status icons: Registered (green), Challenged (orange), Appalled (red), Crowdfunding (purple), Pending (blue), and Removed (grey). The main area displays a grid of 12 profile cards, each with a small photo, a name, and a brief description. The profiles are categorized into sections: Pending Registration, Challenged Registration, Registered, and Pending Removal. Some profiles have status indicators like 'Pending' or 'Removed' next to their names.

Category	Name	Description	Status
Pending Registration	Alice Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.	Pending
	Ethan Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.	Pending
	Jess Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.	Pending
Challenged Registration	Bob Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.	Challenged
	Jennifer Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.	Challenged
	Tom Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.	Challenged
Registered	Ethan Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.	Registered
	Bob Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.	Registered
	Sophia Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.	Registered
Pending Removal	Tom Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.	Pending Removal
	Bob Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.	Pending Removal
	Sophia Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.	Pending Removal
Removed	Bob	Software Engineer, Solidity Expert, Blockchain, Crypto.	Removed

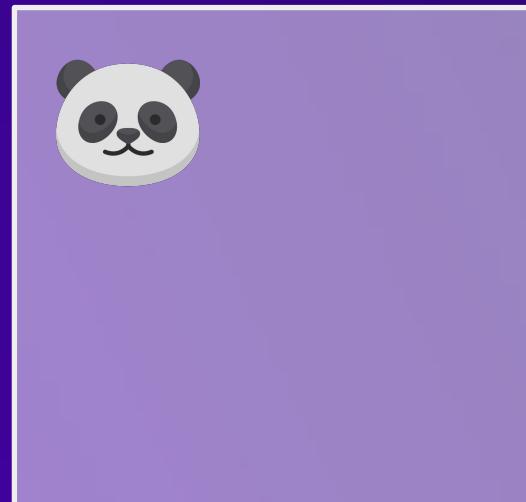
Pending submissions:



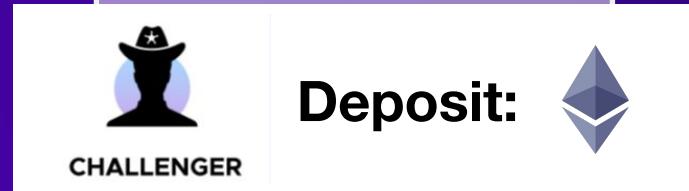
**“I am a human
not already on
the registry”**



Deposit:



Jury



Removal Request

A request to remove a submission in "Registered" state from the list can be made at any time by anyone submitting a deposit.

The removal requester has to either:

- Provide evidence that the above-cited acceptance criteria are not fulfilled by the submission.
 - Example: Send the following removal request

*Evidence name: This user video is a deep-fake
Evidence description: You will find in the attached file an analysis report proving that this video is deep-faked.*
- Or provide evidence that he is the submitter and wants to voluntarily remove his submission.
 - Example 1: Send a removal request from the same address as the submitter.
 - *Evidence Name: Self-removal of submission*
 - *Evidence Description: I am the submitter as proven by my address and I want to remove this submission.*
 - Example 2: Send a removal request from a different address than the submitter.
 - *Evidence Name: Self-removal of submission*
 - *Evidence Description: I am the submitter and I want to remove this submission. The video attached is a recording of myself saying the sentence "I want to remove my own submission from the Proof of Humanity registry."*



PROOF OF
HUMANITY

Registry Policy



“Video attached is a recording of myself saying the sentence ‘I want to remove my own submission from the Proof of Humanity registry.’”

SBT wallet

A screenshot of a video call interface. On the left, there is a user profile for "William George" with a small circular thumbnail of him, his name, and some text below. Below that, there are two status indicators: "Vouchers 0/1" and "Deposit 0.00%". On the right, there is a video feed of a man with glasses holding up a piece of paper with the text "addr 1" and some long alphanumeric code above it. The video feed has a timestamp "0:00 / 0:07" at the bottom left and some control icons at the bottom right.

William George
Mathematician, cryptographer,
blockchain researcher.

Vouchers
0/1

Deposit
0.00%

addr 1

addr 1

SBT wallet



William George
Mathematician, cryptographer,
blockchain researcher.

Vouchers 0/1 Deposit 0.00%

0x3099413ed2f687cda893762fa7c17ea60d385e05
addr 1

0:00 / 0:07

addr 1

addr 2

I want to remove my
own submission.
Resubmit with addr2.



“ is an expert
in Subject X”

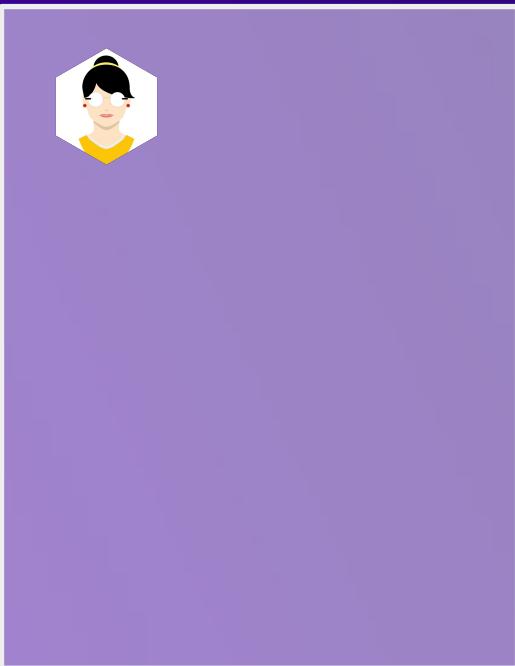
Pending submissions:



**“I am an expert
in Subject X”**

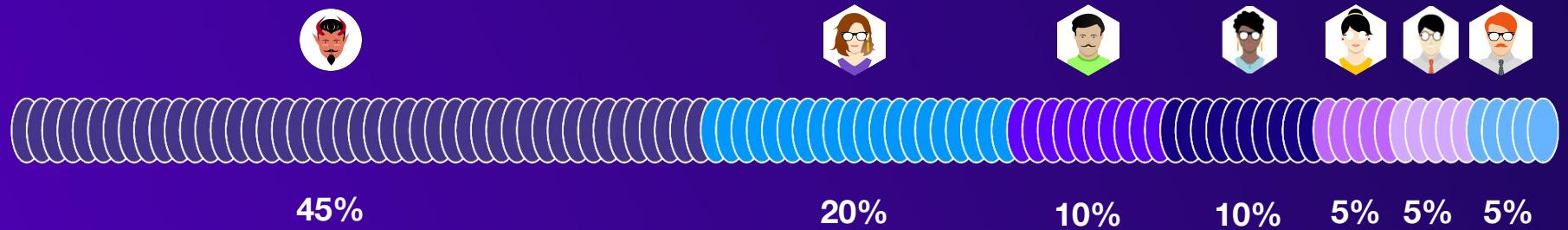


Deposit: 



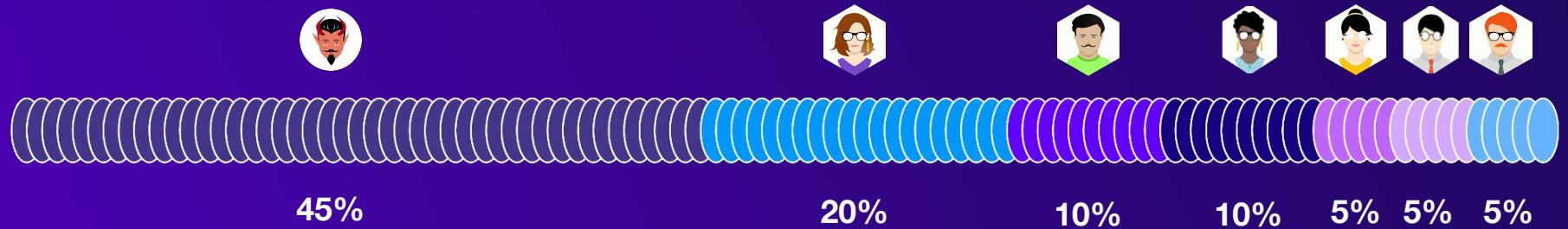
**Effects of using
proof-of-personhood
and SBTs on attack
resistance**

Jury selection without proof-of-personhood



Jury:

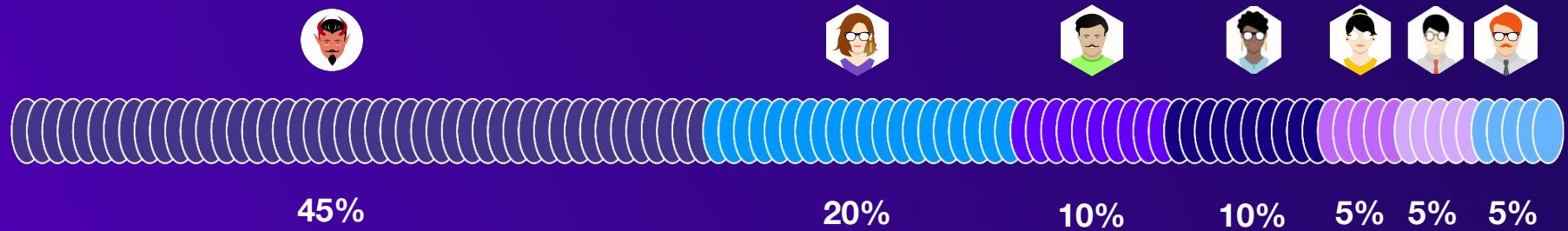
Jury selection without proof-of-personhood



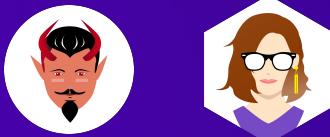
Jury:



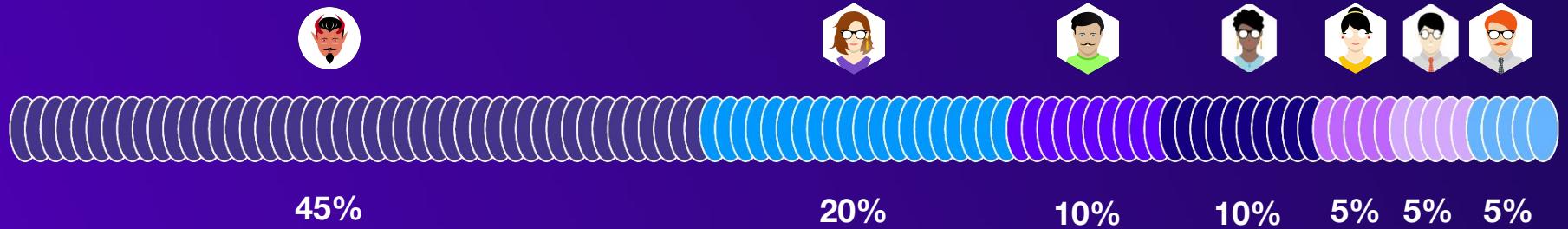
Jury selection without proof-of-personhood



Jury:



Jury selection without proof-of-personhood



Jury:



45% chance
of another

55% chance
of someone else



**42.5% overall
chance of getting
>= 2 's**

Jury selection without proof-of-personhood



Security
Model

No participant
controls more
than 50% of
stake

Quadratic Funding

Suppose participants $1, \dots, K$ contribute c_1^p, \dots, c_K^p respectively to project p

Then project p receives a grant of :

$$\left(\sum_j \sqrt{c_j^p} \right)^2 - \sum_j c_j^p$$

Quadratic Funding

Proposal: Give  a grant
Contribution



0



1



1



4



0



1



0

Total Subsidy:

$$(3 \cdot \sqrt{1} + \sqrt{4} + 3 \cdot \sqrt{0})^2 - 7 = 18$$

Proposal: Give  a grant
Contribution



7



0



0



0



0



0



Total Subsidy:

$$(\sqrt{7} + 6 \cdot \sqrt{0})^2 - 7 = 0$$

Quadratic Funding with secure proof-of-personhood

Proposal: Give  a grant
Contribution



1



0



0



0



0



0



0

Total Subsidy:

$$(\sqrt{1} + 6 \cdot \sqrt{0})^2 - 1 = 0$$

The screenshot shows a user interface for the Proof of Humanity (POH) platform. At the top, there's a navigation bar with 'PROOF OF HUMANITY' logo, 'Profiles', 'My Profile', and a search bar. A sidebar on the right shows a summary: '123.456 Profiles' with a dropdown menu set to 'All'. Below this are filters for 'All', 'Registered', 'Challenged', 'Appealed', 'Crowdfunding', 'Pending', and 'Removed'. The main area displays a grid of 12 profile cards, each with a small photo, a name, and a title. The profiles are categorized as follows:

- Row 1: Alice Smith (Registered), Ethan Smith (Registered), Jess Smith (Registered)
- Row 2: Bob Smith (Registered), Jennifer Smith (Pending Removal), Tom Smith (Pending Removal), Laura Smith (Registered)
- Row 3: Susan Smith (Registered), Robert Smith (Registered), Sophia Smith (Registered), Bear (Removed)

At the bottom, there are navigation arrows and links for 'Find out more about POH', 'POH - Proof of Humanity', 'I need help', and social media icons.

Quadratic Funding without (secure) proof-of-personhood

Proposal: Give  a grant
Contribution



1/N with each
of N profiles



0



0



0



0



0



0

Total Subsidy:

$$\left(N \cdot \sqrt{\frac{1}{N}} + 6 \cdot \sqrt{0} \right)^2 - 1 = N - 1$$

PROOF OF HUMANITY

Profiles My Profile

123.456 Profiles

All

Registered

Challenged

Appealed

Crowdfunding

Pending

Removed

Profiles

Search

123.456 Profiles

All

Registered

Challenged

Appealed

Crowdfunding

Pending

Removed

Alice Smith

Ethan Smith

Jess Smith

Software Engineer, Solidity Expert, Blockchain, Crypto.

Software Engineer, Solidity Expert, Blockchain, Crypto.

Software Engineer, Solidity Expert, Blockchain, Crypto.

Bob Smith

Jennifer Smith

Tom Smith

Software Engineer, Solidity Expert, Blockchain, Crypto.

Software Engineer, Solidity Expert, Blockchain, Crypto.

Software Engineer, Solidity Expert, Blockchain, Crypto.

Susan Smith

Robert Smith

Sophia Smith

Software Engineer, Solidity Expert, Blockchain, Crypto.

Software Engineer, Solidity Expert, Blockchain, Crypto.

Software Engineer, Solidity Expert, Blockchain, Crypto.

Bear

Removed

Find out more about POH

I need help

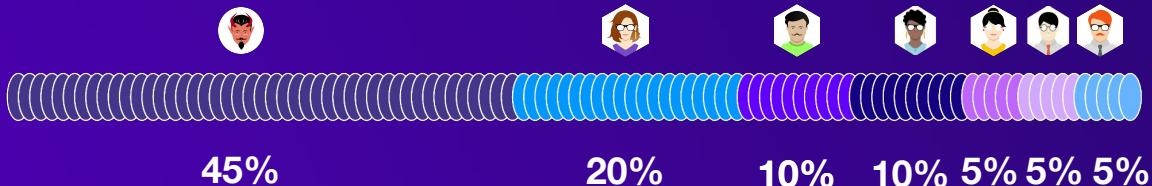
Quadratic Funding

Security
Model



Proof-of-
personhood
protocol
secure

Jury selection with secure proof-of-personhood



Jury:

PROOF OF HUMANITY

Profiles My Profile

123,456 Profiles

All Registered ChallengedAppealedCrowdfundingPendingRemoved

Profile Status	Profile Name	Job Title
Registered	Alice Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
Registered	Ethan Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
Registered	Jess Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
Registered	Bob Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
Registered	Jennifer Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
Pending Removal	Tom Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
Registered	Laura Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
Registered	Susan Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
Registered	Robert Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
Removed	Sophia Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
Removed	Bear	Software Engineer, Solidity Expert, Blockchain, Crypto.

Find out more about POH

I need help

Jury selection with secure proof-of-personhood



45%

20%

10%

10%

5%

5%

5%

Jury:



The screenshot shows a software interface titled "PROOF OF HUMANITY". The main area displays a grid of 12 profile cards, each with a user's name, a small profile picture, and their job title: Software Engineer, Solidity Expert, Blockchain, Crypto. The profiles are categorized as follows:

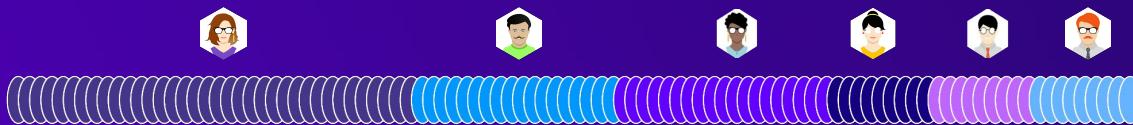
- Registered (9 profiles): Alice Smith, Ethan Smith, Jess Smith, Bob Smith, Jennifer Smith, Tom Smith, Susan Smith, Robert Smith, Sophia Smith.
- Pending Removal (1 profile): Bear.
- Removed (1 profile): None.

On the right side, there is a sidebar with a search bar and a list of filters:

- Profiles
- Search
- 123,456 Profiles
- All
- Registered
- Challenged
- Appealed
- Crowdfunding
- Pending
- Removed

At the bottom, there is a navigation bar with links: "Find out more about POH", "POH - Proof of Humanity", "I need help", and social media icons.

Jury selection with secure proof-of-personhood



36%

18%

18%

9%

9%

9%

Jury:



Screenshot of the Proof of Humanity software interface. The top navigation bar includes 'PROOF OF HUMANITY', 'Profiles', and 'My Profile'. A sidebar on the right shows a total of 123,456 Profiles with filters for 'All', 'Registered', 'Challenged', 'Appealed', 'Crowdfunding', 'Pending', and 'Removed'. The main area displays a grid of 12 profile cards, each with a green checkmark indicating they are 'Registered'. The profiles listed are Alice Smith, Ethan Smith, Jess Smith, Bob Smith, Jennifer Smith, Tom Smith, Laura Smith, Susan Smith, Robert Smith, Sophia Smith, and Bear. Each card includes a small profile picture, the name, and a brief description: Software Engineer, Solidity Expert, Blockchain, Crypto. At the bottom, there are navigation buttons for page numbers 1 through 5, and links for 'Find out more about POH!', 'POH - Proof of Humanity', 'I need help.', and social media icons.

Jury selection with secure proof-of-personhood



36%

18%

18%

9%

9%

9%

Jury:



The screenshot shows a software interface titled "PROOF OF HUMANITY" with a search bar and a filter dropdown set to "All". The main area displays a grid of 12 profile cards, each with a user icon, name, and title. The profiles are categorized as follows:

- Registered:** Alice Smith, Ethan Smith, Jess Smith, Bob Smith, Jennifer Smith, Tom Smith, Susan Smith, Robert Smith, Sophia Smith.
- Pending Removal:** Bear.
- Challenged:** None.
- Appealed:** None.
- Crowdfunding:** None.
- Pending:** None.
- Removed:** None.

At the bottom, there are navigation buttons for page 1, 2, 3, 4, 5, and a refresh icon. The footer includes links for "Find out more about POH", "I need help", and social media icons.

Jury selection with secure proof-of-personhood



29%



29%



14%



14%



14%

Jury:



The screenshot shows a software application window titled "PROOF OF HUMANITY". The interface includes a top navigation bar with "Profiles" and "My Profile" tabs, and a sidebar with a user icon and a search bar. A status bar at the bottom indicates "123,456 Profiles". The main area displays a grid of 12 profile cards, each with a circular photo, a name, and a status indicator (green checkmark for Registered, grey circle for Pending Removal, or a crossed-out circle for Removed). The profiles listed are Alice Smith, Ethan Smith, Jess Smith, Bob Smith, Jennifer Smith, Tom Smith, Laura Smith, Susan Smith, Robert Smith, Sophia Smith, and Bear. The sidebar also features a legend for profile status: All, Registered (green dot), Challenged (orange dot),Appealed (red dot), Crowdfunding (blue dot), Pending (grey dot), and Removed (black dot).

Find out more about POH

POH - Proof of Humanity

I need help

Jury selection with secure proof-of-personhood



29%



29%



14%



14%



14%

Jury:



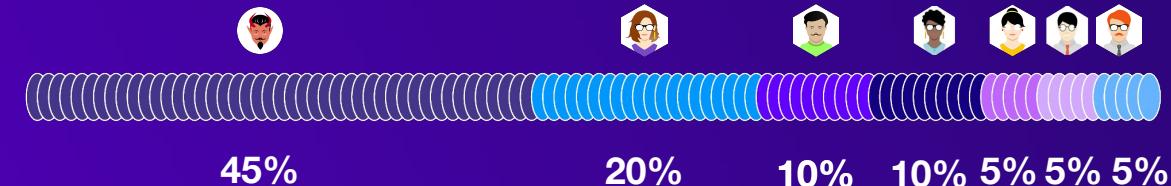
0% overall chance of
getting ≥ 2 's



The screenshot shows a software application window titled "PROOF OF HUMANITY". The main area displays a grid of 12 profile cards, each with a user's name, a small profile picture, and their registered status. The profiles are categorized by status: Registered (9 cards), Pending Removal (1 card), and Removed (1 card). A sidebar on the right lists filter options for "All", "Registered", "Challenged", "Appealed", "Crowdfunding", "Pending", and "Removed". At the bottom of the grid, there are navigation buttons for page numbers 1 through 5.

Name	Status
Alice Smith	Registered
Ethan Smith	Registered
Jess Smith	Registered
Bob Smith	Registered
Jennifer Smith	Pending Removal
Tom Smith	Registered
Laura Smith	Registered
Susan Smith	Registered
Robert Smith	Registered
Sophia Smith	Registered
Bear	Removed

Jury selection with insecure proof-of-personhood



Jury:

PROOF OF HUMANITY

Profiles My Profile

123,456 Profiles

All

Registered Challenged Appealed Crowdfunding Pending Removed

Profile Status	Count
All	123,456
Registered	123,456
Challenged	0
Appealed	0
Crowdfunding	0
Pending	0
Removed	0

Find out more about POH

I need help

Profiles

Search

Registered

Alice Smith
Software Engineer, Solidity Expert, Blockchain, Crypto.

Ethan Smith
Software Engineer, Solidity Expert, Blockchain, Crypto.

Jess Smith
Software Engineer, Solidity Expert, Blockchain, Crypto.

Registered

Bob Smith
Software Engineer, Solidity Expert, Blockchain, Crypto.

Jennifer Smith
Software Engineer, Solidity Expert, Blockchain, Crypto.

Tom Smith
Software Engineer, Solidity Expert, Blockchain, Crypto.

Laura Smith
Software Engineer, Solidity Expert, Blockchain, Crypto.

Registered

Susan Smith
Software Engineer, Solidity Expert, Blockchain, Crypto.

Robert Smith
Software Engineer, Solidity Expert, Blockchain, Crypto.

Sophia Smith
Software Engineer, Solidity Expert, Blockchain, Crypto.

Removed

Bear
Software Engineer, Solidity Expert, Blockchain, Crypto.

1 2 3 4 5 6

Jury selection with insecure proof-of-personhood



45%

20%

10%

10%

5%

5%

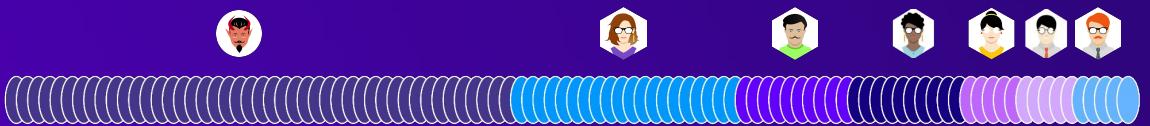
5%

Jury:



The screenshot shows a user interface for managing profiles. At the top, there are tabs for 'Profiles' and 'My Profile'. A sidebar on the left shows a count of 123,456 Profiles and a dropdown menu set to 'All'. The main area displays a grid of 12 profile cards. Each card includes a small profile picture, a name, and a brief description of their expertise in Software Engineering, Solidity Expert, Blockchain, and Crypto. The profiles are categorized by status: most are 'Registered' (green checkmark), while one is 'Challenged' (orange circle), one is 'Appealed' (red circle with a dot), and one is 'Removed' (grey circle). A legend on the right side of the grid provides a key for these status indicators.

Jury selection with insecure proof-of-personhood



45%

20%

10%

10%

5%

5%

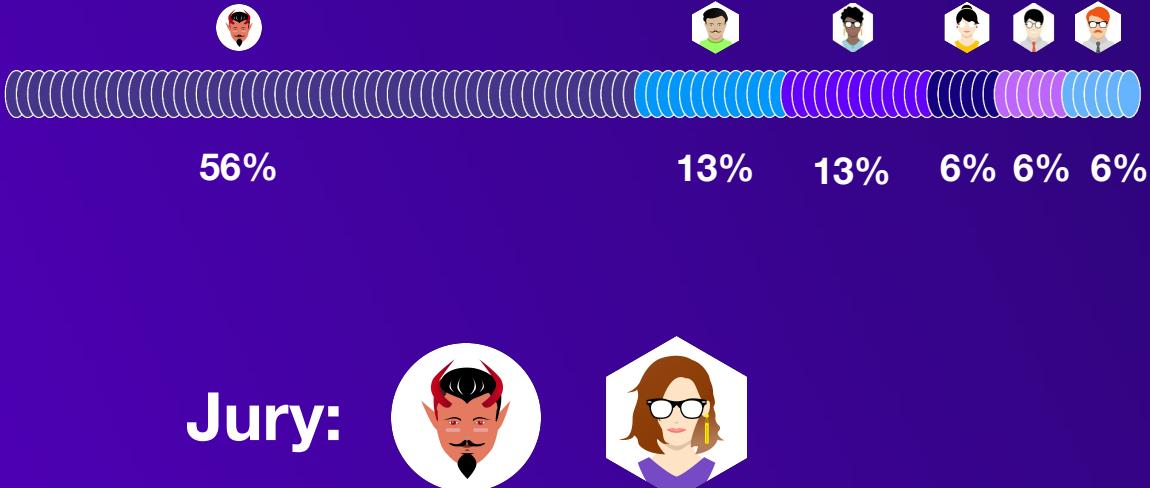
5%

Jury:



The screenshot shows a user interface for managing profiles. At the top, there are tabs for 'Profiles' and 'My Profile'. A sidebar on the right lists filters: 'All', 'Registered', 'Challenged', 'Appealed', 'Crowdfunding', 'Pending', and 'Removed'. The main area displays a grid of 12 profile cards, each with a green checkmark indicating they are registered. The profiles listed are Alice Smith, Ethan Smith, Jess Smith, Bob Smith, Jennifer Smith, Tom Smith, Susan Smith, Robert Smith, Sophia Smith, and a profile for 'Bear'. Each card includes a small profile picture, the name, and a brief description: Software Engineer, Solidity Expert, Blockchain, Crypto. At the bottom, there is a navigation bar with icons for help, search, and social media, along with links to 'Find out more about POH!' and 'POH - Proof of Humanity'.

Jury selection with insecure proof-of-personhood



PROOF OF HUMANITY

Profiles My Profile

123,456 Profiles

All

Registered Challenged Appealed Crowdfunding Pending Removed

Profile	Search
Alice Smith Software Engineer, Solidity Expert, Blockchain, Crypto.	✓ Registered
Ethan Smith Software Engineer, Solidity Expert, Blockchain, Crypto.	✓ Registered
Jess Smith Software Engineer, Solidity Expert, Blockchain, Crypto.	✓ Registered
Bob Smith Software Engineer, Solidity Expert, Blockchain, Crypto.	✓ Registered
Jennifer Smith Software Engineer, Solidity Expert, Blockchain, Crypto.	✓ Registered
Tom Smith Software Engineer, Solidity Expert, Blockchain, Crypto.	✓ Registered
Laura Smith Software Engineer, Solidity Expert, Blockchain, Crypto.	✓ Registered
Susan Smith Software Engineer, Solidity Expert, Blockchain, Crypto.	✓ Registered
Robert Smith Software Engineer, Solidity Expert, Blockchain, Crypto.	✓ Registered
Sophia Smith Software Engineer, Solidity Expert, Blockchain, Crypto.	✓ Registered
Bear Software Engineer, Solidity Expert, Blockchain, Crypto.	Removed

Find out more about POH

I need help

Jury selection with insecure proof-of-personhood



56%



13%



13%



6%



6%



6%

Jury:



56% chance
of another



44% chance
of someone else

< 52% overall chance
of getting >= 2 's



The screenshot shows a software application window titled "PROOF OF HUMANITY". The interface includes a top navigation bar with "Profiles" and "My Profile" buttons, and a status bar indicating "123,456 Profiles". A sidebar on the right contains a search bar and a filter section with the following options: "All", "Registered", "Challenged", "Appealed", "Crowdfunding", "Pending", and "Removed". The main area displays a grid of 12 profile cards, each with a user's name, title, and a small profile picture. The profiles are categorized as follows:

Category	Profile	Description
Registered	Alice Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
	Ethan Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
	Jess Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
Registered	Bob Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
	Jennifer Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
	Tom Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
Registered	Susan Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
	Robert Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
	Sophia Smith	Software Engineer, Solidity Expert, Blockchain, Crypto.
Removed	Bear	Software Engineer, Solidity Expert, Blockchain, Crypto.

Pagination controls at the bottom show pages 1 through 5.

Jury selection with proof-of-personhood

**Security
Model**

**Proof-of-personhood
protocol secure**

OR

**No participant controls
more x% of stake***

*x depends on number of jury spots, distribution of other stakers - in example
threshold for  having 50% chance of getting 2 pots is x=44%

Weighting by SBTs



Offset Match

(from Decentralized Society: Finding Web3's Soul. Weyl, Ohlhaver, Buterin)



POAP!



For each pair of participants i, k define:

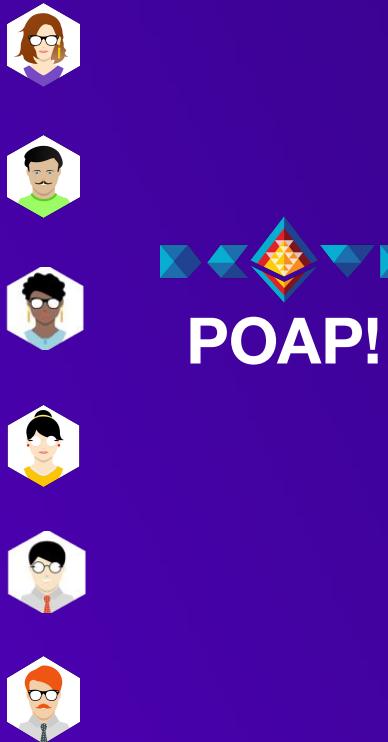
$$s_{i,k} = \frac{\# \text{SBTs } i, k \text{ share}}{\# \text{SBTs } i \text{ has}}$$

Then solve for such that

α_i

$$\alpha_i + \sum_{k \neq i} \alpha_k s_{k,i} = 1$$

Offset Weighting



Example:

$$s_{\text{ } \text{ } \text{ } \text{ } \text{ } \text{ } , \text{ } \text{ } \text{ } \text{ } \text{ } \text{ }} = 1/2$$

$$a_{\text{ } \text{ } \text{ } \text{ } \text{ } \text{ } } = 1/4$$

$$a_{\text{ } \text{ } \text{ } \text{ } \text{ } \text{ } } = 1$$

$$a_{\text{ } \text{ } \text{ } \text{ } \text{ } \text{ } } = 0$$

$$a_{\text{ } \text{ } \text{ } \text{ } \text{ } \text{ } } = 1/4$$

$$a_{\text{ } \text{ } \text{ } \text{ } \text{ } \text{ } } = 1/4$$

$$a_{\text{ } \text{ } \text{ } \text{ } \text{ } \text{ } } = 1/4$$

Offset Weighting - philosophy

$$A = (\alpha_1 \dots \alpha_K)$$

$$S = (s_{k,j})_{k,j=1, \dots, K}$$

$$1 = (1 \dots 1)$$

GOAL: Solve for A such that

$$A \cdot S = 1$$

Offset Weighting - philosophy

$$A \cdot S = 1$$



$$\left\{ \begin{array}{l} \sum_{j=1}^{K_1} \alpha_j = 1 \\ \sum_{j=K_1+1}^{K_2} \alpha_j = 1 \\ \sum_{j=K_2+1}^K \alpha_j = 1 \end{array} \right\}$$

$$(a_1 \dots a_K) \cdot \left(\begin{array}{c|cc|c} 1 & \dots & \dots & 1 \\ \vdots & \vdots & \vdots & \vdots \\ 1 & \dots & \dots & 1 \\ \hline 0 & & 1 & 1 \\ & 1 & 1 & \\ \hline 0 & & 0 & \\ \hline & & 1 & \dots & \dots & \dots & 1 \\ & & \vdots & \vdots & \vdots & \vdots & \vdots \\ & & 1 & \dots & \dots & \dots & 1 \end{array} \right) = (1 \dots 1)$$

1 to K_1 K_1+1 to K_2 K_2+1 to K

Offset Weighting - calculation issues

- solution for α_i doesn't always exist, if exists may not be unique
- May produce negative α_i 's
- Handles how much weight given to group reasonably well... but not necessarily naturally distributed to individuals. Tendency of offset match to give participants with a superset of SBTs zero weight

Quadratic Funding with Offset Match

Suppose participants $1, \dots, K$ contribute c_1^p, \dots, c_K^p respectively to project p

Then project p receives a grant of :

$$\left(\sum_i \sqrt{\alpha_i c_i^p} \right)^2 - \sum_i c_i^p$$

Juror selection with Offset Weighting



$$\alpha_i = \frac{1}{4}$$

$$\alpha_i = -1$$

$$\alpha_i = 0$$

$$\alpha_i = \frac{1}{4}$$

$$\alpha_i = \frac{1}{4}$$

$$\alpha_i = \frac{1}{4}$$

Unweighted
Stakes



40% 10% 20% 20% 5% 5%

Weighted
Stakes

$$\frac{\alpha_i \cdot \text{stake}_i}{\sum_j \alpha_j \cdot \text{stake}_j}$$

36% 36% 0% 18% 5% 5%

Juror selection with Offset Weighting



Expert in X

Expert in Y

Expert in X

Expert in X



PNAS

Groups of diverse problem solvers can outperform groups of high-ability problem solvers

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We introduce a general framework for modeling functionally diverse problem-solving agents. In this framework, problem-solving agents possess representations of problems and algorithms that they use to locate solutions. We use this framework to establish a result relevant to group composition. We find that when selecting a problem-solving team from a diverse population of intelligent agents, a team of randomly selected agents outperforms a team comprised of the best-performing agents. This result relies on the intuition that, as the initial pool of problem solvers becomes large, the best-performing agents necessarily become similar in the space of problem solvers. Their relatively greater ability is more than offset by their lack of problem-solving diversity.

A diverse society creates problems and opportunities. In the past, much of the public interest in diversity has focused on issues of fairness and representation. More recently, however, there has been a rising interest in the benefits of diversity. In the legal cases surrounding the University of Michigan's admissions

equal ability, functionally diverse groups outperform homogeneous groups. It has also been shown that functionally diverse groups tend to outperform the best individual agents, provided that agents in the group are nearly as good (1). These results still leave open an important question: Can a functionally diverse group whose members have less ability outperform a group of people with high ability who may themselves be diverse? The main result of our paper addresses exactly this question.

Consider the following scenario: An organization wants to hire people to solve a hard problem. To make a more informed decision, the organization administers a test to 1,000 applicants that is designed to reflect their individual abilities in solving such a problem. Suppose the applicants receive scores ranging from 60% to 90%, so that they are all individually capable. Should the organization hire (i) the person with the highest score, (ii) 20 people with the next 20 highest scores, or (iii) 20 people randomly selected from the applicant pool? Ignoring possible problems of communication within a group, the existing litera-

Security Model - Questions to Ask

Weighting by SBTs

- What happens if attacker breaks distribution of an SBT?
- Are participants incentivized to keep SBTs on same address or split them up?

Weighting by SBTs - is broken



N profiles
each with



only SBT that
defines group

Result: 
takes almost all
weight from
 group

Weighting by SBTs - is broken



one of K SBTs
that characterizes
a cluster



makes N
profiles with
can't copy others

$$(\alpha_1 \dots \alpha_K) \cdot \left(\begin{array}{c|cc|c} 1 & \dots & \dots & 1 \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ 1 & \dots & \dots & 1 \\ \hline \frac{1}{K} & \dots & \dots & \frac{1}{K} \\ \frac{1}{K} & \dots & \dots & \frac{1}{K} \end{array} \middle| \begin{array}{cc} 1 & 1 \\ \vdots & \vdots \\ \vdots & \vdots \\ 1 & 1 \\ \hline 1 & \frac{K-1}{K} \\ \frac{K-1}{K} & 1 \end{array} \right) = \begin{pmatrix} 0 \\ 0 \\ \vdots \\ 1 & \dots & \dots & \dots & 1 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 1 & \dots & \dots & \dots & 1 \end{pmatrix}$$

Weighting by SBTs - is broken

 one of K SBTs
that characterizes
a cluster

Result (under
offset match): 
still takes almost
all weight from
 group

 makes N
profiles with 
can't copy others

Other weighting schemes?

Other idea?:

Find $\alpha_1, \dots, \alpha_K$ with

$$\alpha_i = \frac{1}{\lambda} \sum_j \frac{1}{s_{i,j}} \alpha_j$$

Related to eigenvector
centrality/PageRank
algorithm

Conclusions

- Proof-of-personhood protocols natural substrate for types of social recovery, in some cases distribution of SBTs
- Ideas developed around weighting QF contributions by SBTs also relevant in juror selection, maybe other applications

Conclusions

- Moving from:
purely economic
 - ◆ economic +
proof-of-personhood
 - ◆ economic +
proof-of-personhood + SBTs

can have subtle effects on security model
- Questions relevant to security models of systems using SBTs - what happens if a single SBT broken? Do users have an incentive to split SBTs over different wallets?

Economic Incentives and Souls in Schelling-point Based Oracles

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Prize from the European Union's Horizon
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bpi**france**

SBT wallet



addr 1

SISMO x Proof of Humanity ^②

Prove you are a human with privacy

- Prove eligibility
- Select Destination
- Mint Badges



Sign-in to Sismo