PHOTREK

Community Contribution Scores

Sponsored by SingularityNET Deep Fund 2

Milestone 4: Final Report

Kenric Nelson, William Thistleton, Juana Attieh, & Robert Haas

Photrek, LLC

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Executive Summary

The Photrek team has completed the *Community Contribution Scores* project with the achievement of all of its milestones over the span of the anticipated 4 months, staying on track and delivering all elements of the proposal.

From the outset, and consistently during the project period of performance, the Photrek team established very clear lines of communication between the SNET Community, the SNET Leadership, the SWAE team, and Photrek staff. This was critical to the success of the project. Please see for example the following Town Hall meeting. This allowed Photrek to keep the project aligned with community concerns and suggestions, while developing a product that efficiently used available data from SWAE and advanced the capabilities of the Deep Funding (DF) initiatives. We continually validated the product's design and ensured fulfillment of DF needs.

Photrek outlined the product vision, identified stakeholders, defined scope, determined high level requirements, and developed a viable product roadmap. Score research and community engagement led to the identification of existing reputation and contribution scores in current use in business and politics and we consistently reported these approaches to the community via Deep Funding Town Halls and written reports. This gave us a description of best practices and how these might be integrated into a second phase project.

Prior reports are available in this Google Folder. The Proof of Concept code is available in this GitHub repository.

Future Product Specification

Lead: Juana Attieh

Milestone Objective: This phase will focus on designing the iterations that will be developed beyond the MVP, based on the user research and feedback gathered in previous stages. The team will also work on creating effective processes for collecting community feedback once the PoC is live and the contribution score calculations are transparent. This will ensure that the tool is continuously meeting the needs of its users and can be adapted to new use cases and requirements as they arise.

Accomplishments

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For our recent milestone, we engaged in detailed discussions with the "Deep Funding Team" to establish the prospective requirements for this tool. Beyond the basic MVP, our vision for the tool is to develop it as a modular solution. This solution aims to serve a variety of decentralized communities, empowering them with the capability to draw data from a multitude of sources. This aggregated data will be crucial in computing engagement scores, which in turn, can significantly determine voting power or influence within their respective communities.

In the upcoming iteration of the tool, the primary focus will be on scaling the existing infrastructure. This entails constructing more intricate data pipelines and augmenting the database to encompass data from diverse social platforms such as Discord, Twitter, and Telegram. The intention is to seamlessly capture user participation across these platforms and then integrate this data to render a customized engagement score for each community. The tool will incorporate enhanced network measures, knowledge graphs, and semantic analysis. Such features will equip platforms with a robust mechanism to gauge community engagement and centrality. Moreover, this will pave the way for predictive analysis of engagements and interactions, thereby gearing the tool towards AI-driven engagement score determinations.

Our discussions with the deep funding team and the community weren't solely confined to the tool's technical capabilities. A significant portion of our dialogue revolved around data collection, storage, and compliance, especially with regulations like GDPR. To ensure user privacy, subsequent versions of the tool shall incorporate options for users to revoke consent or completely erase their data, should they choose to.

To further refine the tool's capabilities, one idea that gained traction was the representation of engagement scores as verifiable credentials, granting users the flexibility to transfer and revoke their scores across various communities.

Additionally, our team ventured into user research to ascertain the potential applications of such a tool. We evaluated its extension to compute reputation scores, not just for community members but also for nodes. A case in point would be networks like IOTA and Hypercycle, which deploy reputation calculations for their nodes. We also explored its potential use in platforms such as Catalyst, which could benefit from integrating the Ideascale data and calculating scores for their community members.

Immediate focus will be to develop an API or possibly offer the tool as a white-label solution, enabling new platforms to tailor their engagement scores. Initial collaborations

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might be explored with projects within the SNET community, including Mindplex and Jamgalaxy.

Please see Appendix A for a description of the Minimum Viable Product.

Proof of Concept (PoC) Development

Lead: Robert Haas

Milestone Objective: Creation of a web application with a simple front-end and contribution score calculation in the back-end. Deployment of the final tool on a server of SingularityNET, so the Deep Funding team can access and use the PoC tool.

Achievements:

- A graphical user interface in the form of a web application was implemented allowing non-technical users to interact with the Proof of Concept tool. The web app was first tested locally and then deployed temporarily on a web server of the web hosting provider DigitalOcean. This enabled the Deep Funding team to try the functionality developed in this project and we are grateful for the positive feedback we received! Please see Appendix B for a visual tour of the web application and Appendix C for the design description from Report 2.

  The web app was implemented with following approach:
  - The back-end of the app was built with the popular web framework Django, which imports and makes use of the Python package developed in the previous milestones, i.e. the functionality for transforming the Swae data and calculating community engagement scores as well as reward distributions.
  - The front-end was created with the template system of Django and basic CSS-based styling that closely adheres to the Deep Funding website.
  - A Docker container image was defined to enable simple and deterministic builds of the web app, and to easily serve it on the infrastructure of various web hosting providers.
  - Further automated tests were implemented with pytest to eventually cover more than 95% of the codebase and thereby ensure its intended behavior.
  - Technical documentation was written for the entire codebase, which includes 1) the Python package for calculating community engagement scores, 2) the web application for providing a GUI to non-technical users, and 3) a server configuration based on Docker, Django, Gunicorn and NGINX. The latter

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enables system administrators of SingularityNET to easily host the app on their own infrastructure.
    - The codebase and its documentation were open sourced under the GNU General Public License 3 in following GitHub repository: https://github.com/Photrek/Community-Governance

- A Proof of Concept web application with a simple front-end and contribution score calculation in the back-end has been developed and deployed on a SingularityNET server and is available to the Deep Funding team for use in Round 3.

Score Research & Community Engagement

Lead: William Thistleton

Milestone Objective: Finalize community contributions to MVP and report to SingularityNET community about PoC processes.

Community Engagement

We successfully hosted another community forum, recorded as Deep Funding Town Hall #17, wherein we garnered feedback about our built POC. We were enthused to witness a largely positive response, with the community expressing their anticipation and excitement for the tool's ongoing development.

SingularityNET, like many organizations, and in particular organizations with a decentralized or community driven structure, had a clearly demonstrated need to weight users' influence in various processes, including Deep Fund voting, according to their effective contributions to the organization. Contributions can be exhibited through financial holdings and other forms of involvement. Such a system must be grounded in the organizations values and ethos and be clearly accepted by the community.

Through Town Halls and other channels, Photrek was able to build a process for meaningful community engagement and input into the design of the Minimum Viable Product and Proof of Concept designs. Our designs were also influenced as we studied various types of existing systems and drew conclusions and observations supportive of SingularityNET objectives.

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Score Research

Our research has identified approaches that seek to integrate social graphs into the quadratic funding or voting computation in order to reduce the possibility of collusion. At present the reputation scores are treated as a multiplicative weight on the AGIX holdings of an individual. In the future, we may want to treat the reputation analysis as part of a social graph that is integrated more carefully with the quadratic computation to protect against collusion and other Sybil attacks. The following is a synopsis of a recent article on this topic. For convenience, Appendix D provides a copy of the Report 3 Score Research and Community Engagement section, which includes additional information on this topic.

Miller, J., Weyl, E. G., & Erichsen, L. (2022) have recently defined more reliable processes for controlling against collusion for quadratic voting. There is a useful connection with our own development work, in that these new methods utilize social graphs. The methods are based on cluster matching in which a wallet's contribution to the quadratic voting calculation is split between group memberships that are treated as single voting blocks due to their correlation. Figure 1 shows an example from the paper in which votes from a contributor are being split evenly between two groups. The green areas represent the individual's contribution and the yellow areas are the quadratic match from the sponsor of the fund. The method on the left (Cluster Matching) was found to still have some susceptibility to collusion. On the right, squaring the division factor, (Squared Cluster Matching) was found to reduce the ability to extract advantages via collusion. Additional measures, considering the way groups of agents might collude, led to Connection-Oriented Cluster Matching and Eigen Match designs, that further refine how social graphs can be applied to computations of quadratic funding and voting.

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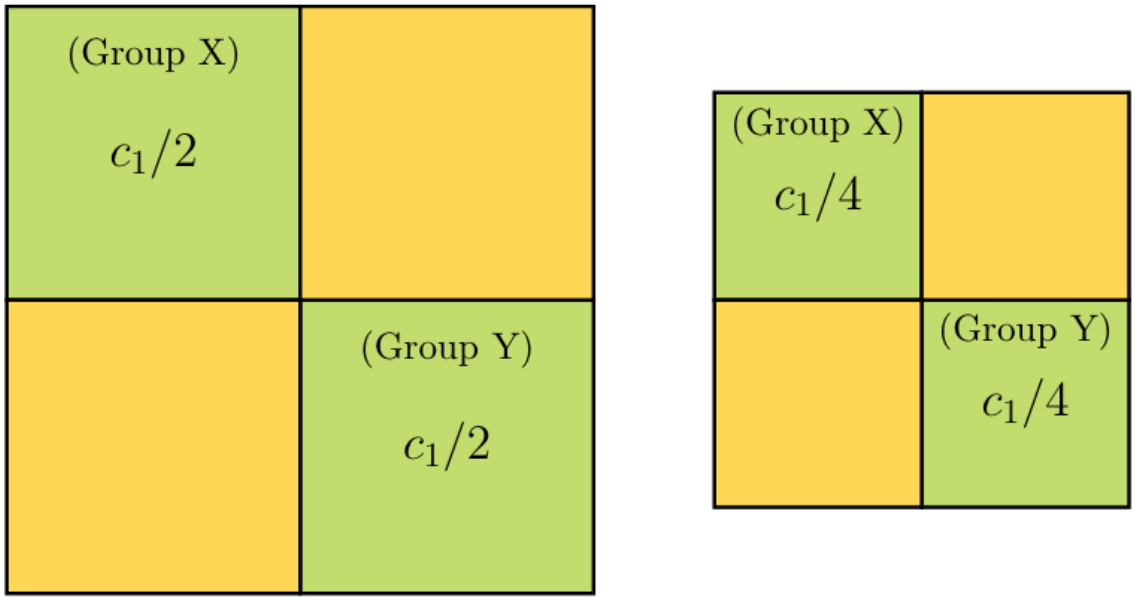

Figure 1. From Miller, J., Weyl, E. G., & Erichsen, L. (2022), "Left: a QF diagram showing funding under the initially proposed Cluster Match with one contributor in two groups (note that the total funding amount is 2c1). Right: Squared Cluster Match with one contributor in two groups (note that the total funding amount is c1)."

Program Management

Lead: Kenric Nelson

Following submission of the draft RFP for Deep Fund 3 to SingularityNET, the team paused on completion of the Final Report to focus on submission of our Deep Fund 3 proposals. For Phase 2 of the Contribution Engagement Score effort, ***Photrek*** is proposing that Juana Attieh lead the effort as Principal Investigator. She has done outstanding work during Phase I to define an MVP, which SingularityNET and its community are supportive of. We have invited Francisco Analderete to join us as a software developer. Robert Haas has decided to focus on his interest in the biomedical sciences and has submitted a knowledge graph tool proposal in this area. We have discussed collaborations with Danielo Ospina of TogetherCrew. While a collaborative agreement has not been finalized and each team has submitted proposals for CES Phase II, we are continuing the discussions.

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Photrek used the principles of sociocracy (or dynamic self-governance) to manage the project. This was particularly helpful during the proposal and contract phase, as it enabled team members to vocalize concerns that were then addressed till consent by the full team was achieved. For example, in prior projects, ***Photrek*** has included a clause about limits to currency exchange rates if there is a 25% swing between payment from the customer and payment to the team members. However, this project would have a built-in delay, since SingularityNET made payments in advance of milestones, while it was agreed that team members would be paid once they completed their milestones. To accommodate the potential for larger currency swings, ***Photrek*** agreed to make payments at a current rate and to convert adequate funds to a USD equivalent. Thus the DJED stablecoin and the Minswap exchange were utilized.

The ***Photrek*** team worked collaboratively to make sure that the milestones could be delivered each month of the project. We met weekly on Tuesday afternoons. Typically by the third Tuesday of the month, we would have a draft of our milestone report initiated. Final reviews would be completed the fourth week. Delivery of a report and an invoice would be completed near the end of the month. As noted earlier, we delayed the final report two weeks, in order to focus on the DF3 proposals.

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Appendix A: Description of Minimal Viable Product

Product Vision

A modular solution that supports projects within the SingularityNET ecosystem, as well as external decentralized communities that use reputation-based mechanisms for their governance processes and require a tool to calculate their users contribution scores and analyze networks that exist within their solution.

Stakeholders

1. Deep Funding Core team
2. Deep Funding Community
3. SWAE
4. Photrek Team
5. SNET Community
6. SNET spin-off projects (Rejuve, MindPlex, JamGalaxy…)
7. Decentralized communities across other ecosystems

Scope

A Proof of Concept (PoC) product to meet Deep Funding's most urgent needs. Concurrently, Score Research to outline the specifications for a future product, which is based on best practices and supported by robust theoretical foundations drawn from contemporary research literature.

An MVP that incorporates data from Deep Funding's voting portal with the contribution scores to calculate the users ultimate voting weight. Creating enhanced visualizations and network analysis that can contribute to the generation of contribution scores and liquid reputation.

Post-MVP where the platform is generalized and abstracted to fit use-cases for contribution scores across multiple platforms from within the SNET ecosystem and other decentralized communities.

High-Level Requirements

Proof-of-concept:

- Set up a database (SQLite) with structured tables extracted from the exported SWAE JSON files
    - Data includes both information from regular Deep Funding rounds as well as Governance rounds.
    - Community members can currently create project proposals, governance proposals, comments (strengths, risks, questions), reactions (a restricted set of emojis to express sentiments) and ratings (a numerical quality indicator for proposals).
    - General entity-relationship-diagram model of user and action tables
- Conduct calculations in the backend

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- Define calculation scores in a config file
    - Formulas will be fixed for the first iteration with configurable variables
- Frontend UI with the following:
    - Import option for users to import raw files
    - Filtering options for calculation scores
    - Option to turn on/off variables & a field to input different weights to generate different calculations (e.g. governance versus deepfunding round score calculations)
    - Calculation outputs: A table of users and contribution scores
    - Export option
    - Network visualizations with filtering options (need to limit data)

Minimum Viable Product (MVP):

In this iteration, we will focus on building an MVP to be used by one platform (Deep Funding).
This MVP will include utilizing the contribution score outputs from the PoC and combining them with the voting data outputs to create following final outputs for each user:

- A contribution score (e.g. 20123.14), based on 1) activity on the Swae platform and 2) participation in voting.
- A rank (e.g. 5), determined by sorting users by contribution score. Using ranks instead of the contribution scores directly is useful because it decouples the score calculation from the rest of the calculations and for example prevents that an outlier in the scoring scheme could get too much voting power and rewards.
- A tier (e.g. B), determined by binning users into groups according to their ranks. Tiers were used in the manual calculation process in spreadsheets to simplify matters, but are optional in automated calculations.
- A voting weight to amplify the user's voice, which can be derived either from the rank or tier.
- An AGIX reward for active participation, which can be derived either from the rank or tier, given a total available amount of AGIX rewards.

Deep funding uses a wallet linking tool to represent multiple user wallets, possibly even on different blockchains (starting with Cardano and Ethereum), under a single unique user identifier (UUID) that can be utilized to calculate outputs. This UUID is generated on the tool and is exported and later manually mapped with the voting portal data to extract the total tokens represented per UUID.

Calculation Process: The process for calculating the final outputs is as follows:

1. Calculate Final Contribution Score: Multiply the rate with the contribution score.
    a. Extract Wallets That Voted: Identify the wallets that participated in the voting.
    b. Increase Contribution Score: Apply a rate to increase the contribution score (from the PoC output) of users who voted. The rate will be calculated based on engagement tiers to enhance the voting weight of engaged users.
2. Calculate Voting Weight Representation: Use a quadratic voting calculation (sqrt(token balance)) to determine the voting weight representation.

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3. Calculate Final Weight per Voting: Multiply the Final Contribution Score by the Voting Weight Representation.

Consideration of Important Factors:

1. Time Decay: Implement time decay functionality to account for the decay of contribution scores over time.
2. Contribution Scores: Consider the contribution scores from the previous round.
3. Voting Weight: Assign greater weight to users with longer participation periods (lifetime weight).
4.

Requirements

- Data Import: Enable users to import structured data from multiple sources or refresh and pull data from APIs.
- Raw Data Upload: Provide Deep Funding with the ability to upload raw data exported from their voting portal.
- Data Structure: Structure the data into existing database tables, with the option to add new tables as "actions".
- Split Databases: Split the databases into two parts:
    - Contribution Score Data and Calculations (PoC)
    - Wallet Linking Tool Export + Voting Portal Data and Calculations: Include wallet addresses, token balances, and voting results.
    - UUID Mapping: Create a mapping between the voting portal data and the wallet linking tool export to associate UUIDs with the respective wallet addresses.
- Backend Calculations:
    - Calculate final contribution score using inputted rating (multiply the rate with the contribution score in the config) and add into a new config file
    - Calculate Voting Weight Representation in a config file: Use a quadratic voting calculation (sqrt(token balance)) to determine the voting weight representation for each unique ID.
    - Calculate the final vote per weighting using final contribution scores and voting weight configuration files.
- Generate Multiple Calculation Scores: Generate multiple calculation scores based on the configured weights assigned to input data.

- Frontend UI:
    - Import option to add new raw files
    - View and export Unique ID + wallets table
    - Enable users to define and assign weights to input data elements, such as contribution score rating, engagement tiers, or other relevant factors.
    - View and export calculation results (final contribution score & final voting weight)
    - Provide the ability to filter data based on various criteria
    - Allow users to black or whitelist data to be included in the calculations
    - View and export network measure diagrams that visualize the relationships and connections within the data
    - View history of voting weight

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Upcoming Iterations of the Community Engagement Tool

In the upcoming iterations of the Community Engagement Tool, the focus will shift to refining its modularity and enhancing its utility for decentralized communities. The tool will essentially "whitelabel" its MVP, welcoming integration with other platforms. Each platform will possess the flexibility to import its specific data and customize engagement scores. Moreover, users will gain the capability to search for contribution scores across diverse platforms. The intent is not just to expose the platform to a broader audience but to empower community members with autonomy over their data. They'll have the unique opportunity to configure their engagement scores based on multifaceted data inputs, catering the tool to their individual preferences and contributions.

Iteration Focus: Scaling and Enhancement:

- **Infrastructure Scaling:** One of the primary objectives is the robust scaling of the tool's current infrastructure.
- **Inclusive Data Pipelines:** The aim is to develop intricate data pipelines that can fetch data from a variety of platforms, including but not limited to Discord, Twitter, and Telegram.
- **Unified Engagement Scores:** These diverse data sources will be integrated to compute a unified and customized engagement score, reflecting a user's multi-platform participation.
- **Advanced Features:** Incorporation of advanced features like network measures, knowledge graphs, and semantic analysis to offer a comprehensive view of community engagement and identify central contributors.
- **AI-Driven Analysis:** There is a long-term vision of equipping the tool with predictive analysis capabilities, making way for AI-powered engagement scores.

Data Privacy and Compliance:

Ensuring user data security and regulatory compliance, particularly with directives like GDPR, is paramount. As such:

- **User Control Over Data:** Users will have the power to revoke data consent and even initiate complete data erasure from the system.
- **Engagement Scores Portability:** A pioneering idea in the pipeline is to present engagement scores as verifiable credentials. This provides users with the autonomy to transfer, or even revoke, their scores across different communities.

Potential Extensions and Collaborations:

- **Collaborative Ventures:** Preliminary collaborations could be initiated with projects from the SNET ecosystem, with names like Mindplex and Jamgalaxy already in consideration
- **Reputation Scoring for Nodes:** In addition to community members, there is potential in determining reputation scores for nodes, taking cues from networks like IOTA and Hypercycle.

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- **Integration with Platforms:** The tool's capabilities might extend to platforms such as Catalyst, potentially integrating Ideascale data for scoring purposes.
- **API and White-Label Solutions:** Crafting two-way APIs to further augment the capability to exchange these scores and utilize them within platforms seamlessly, or perhaps introducing the tool as a white-label solution. This would allow new platforms to define and tailor their engagement scoring mechanisms.
- **User-centric enhancements and wider community accessibility:** Allow for community members to access their data from multiple platforms and customize scores based on variables that are relevant to them.

Roadmap

- Phase 1: Product Design and Validation

1.1. Design the initial product document

- Outline the product vision
- Identify stakeholders
- Define scope
- Identify high-level requirements
- Develop a roadmap
- Incorporate input and feedback from SingularityNET Deep Funding and potential users

1.2. Gather requirements for the Minimum Viable Product (MVP)

- Collaborate closely with the Deep Funding team
- Understand the calculations used in the voting portal data
- Explore integration of the calculations within the tool
- Investigate desired outputs and enhancements for advanced calculations and experiments

- Phase 2: MVP Design and User Research

2.1. Design the Minimum Viable Product (MVP)

- Collaborate closely with the Deep Funding team
- Understand user flows and evaluate design artifacts
- Create wireframes that are adaptable and future-proof
- Incorporate insights from user research within the SNET ecosystem

2.2. Conduct user research and gather feedback

- Reach out to other platforms in the SNET ecosystem
- Collect user feedback to inform design iterations

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- Utilize agile processes for development and stakeholder engagement

    - Phase 3: Iterative Design and Continuous Improvement

3.1. Design iterations beyond the MVP
- Utilize user research and feedback from previous stages
- Incorporate insights into the design process
- Ensure adaptability to new use cases and evolving requirements

3.2. Establish processes for community feedback collection
- Develop effective methods for gathering feedback
- Enable transparency in contribution score calculations
- Continuously align the tool with user needs and emerging requirements

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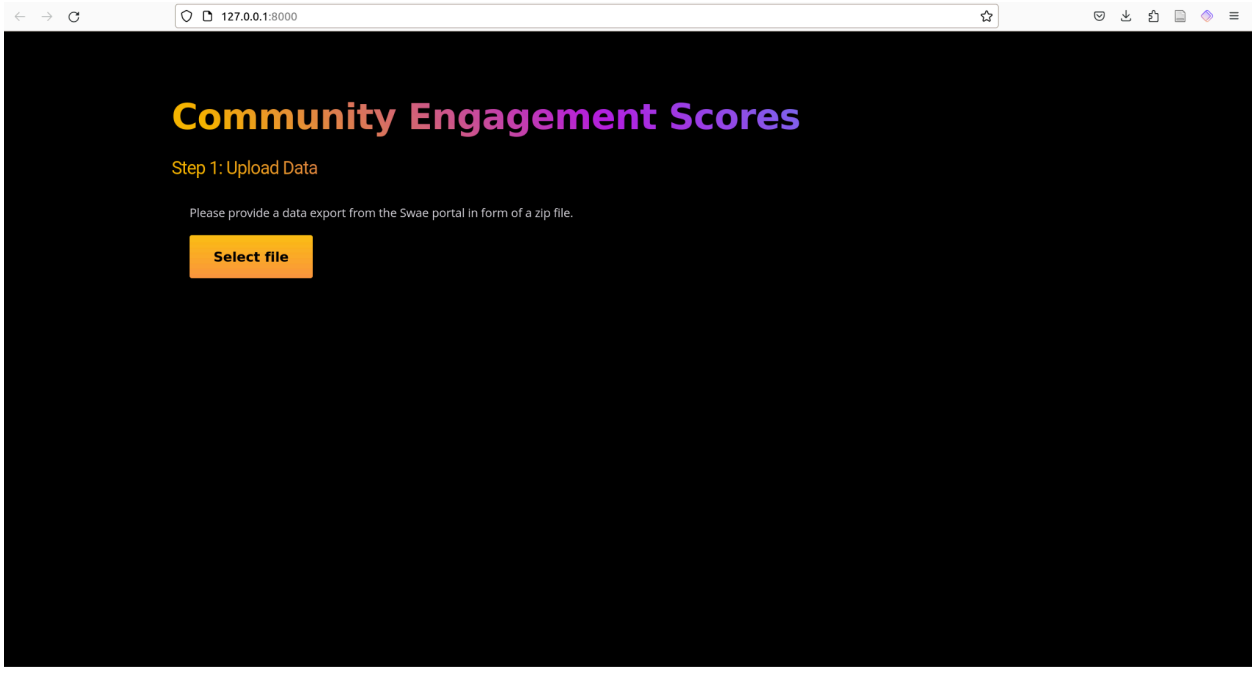
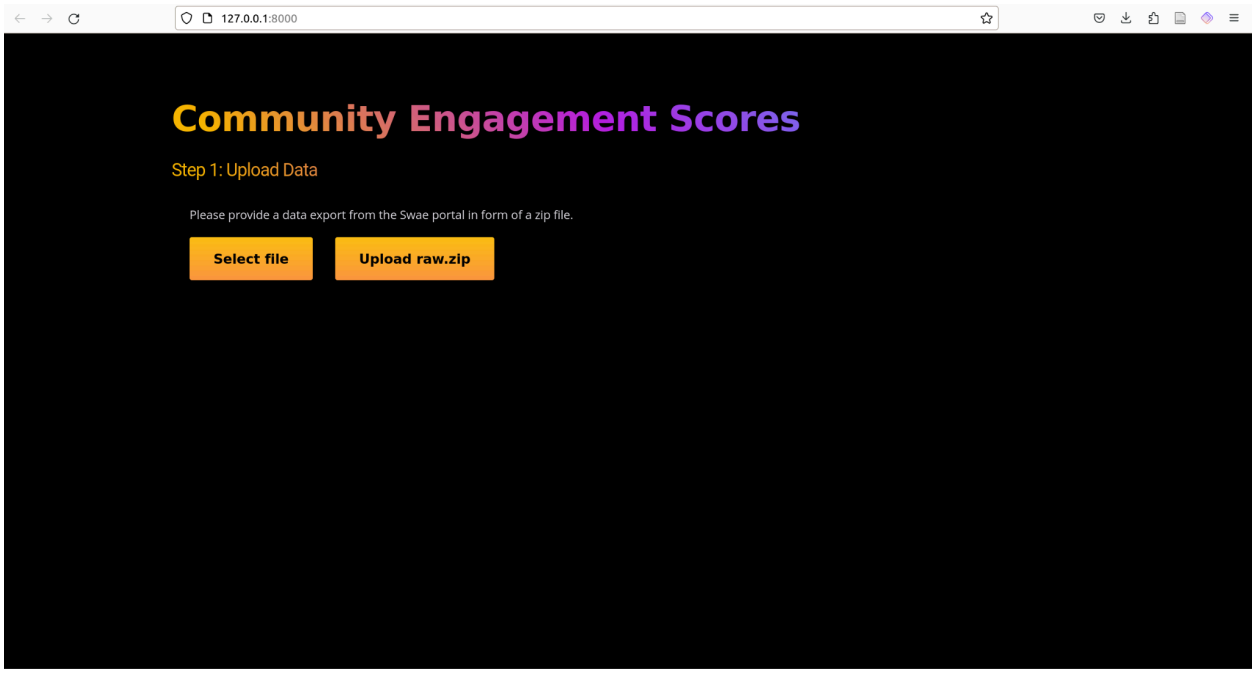
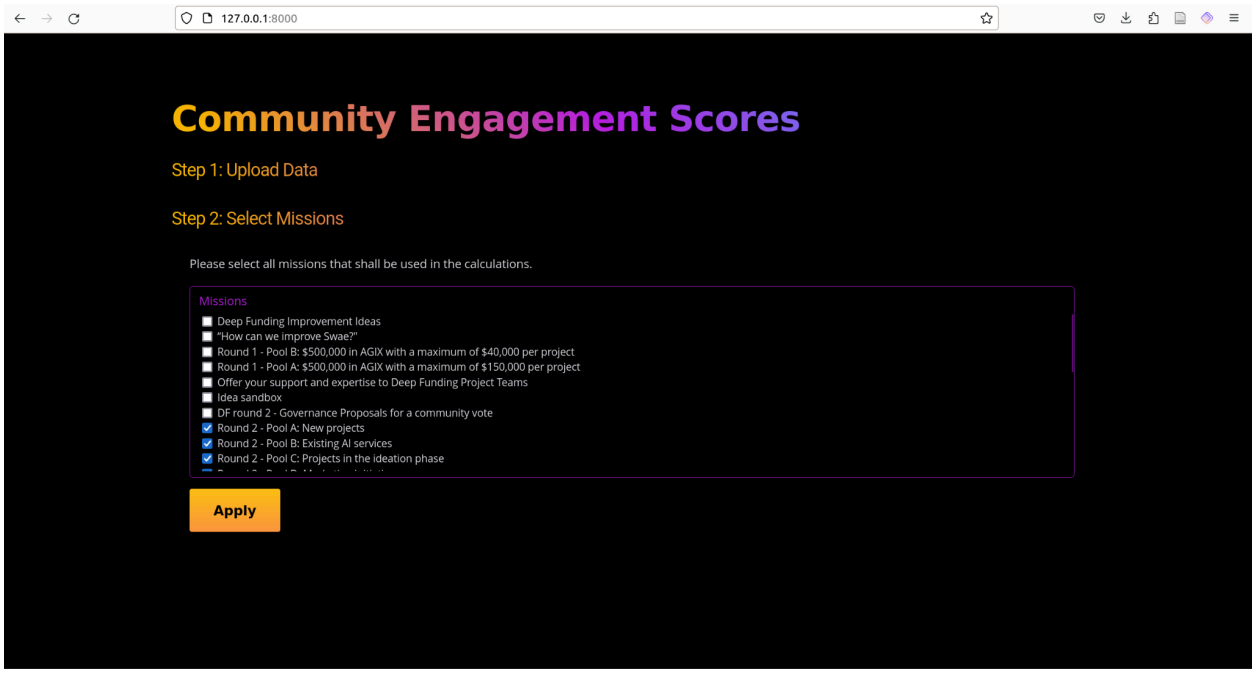
Appendix B: Proof of Concept Web App

The following figures provide an insight into how the web app can be used for calculating community engagement scores and rewards. It starts with the upload of a Swae data export in form of a zip file, proceeds with providing various filters and settings, and ends in the download of derived data (SQLite database, Excel sheet), figures and a HTML report.







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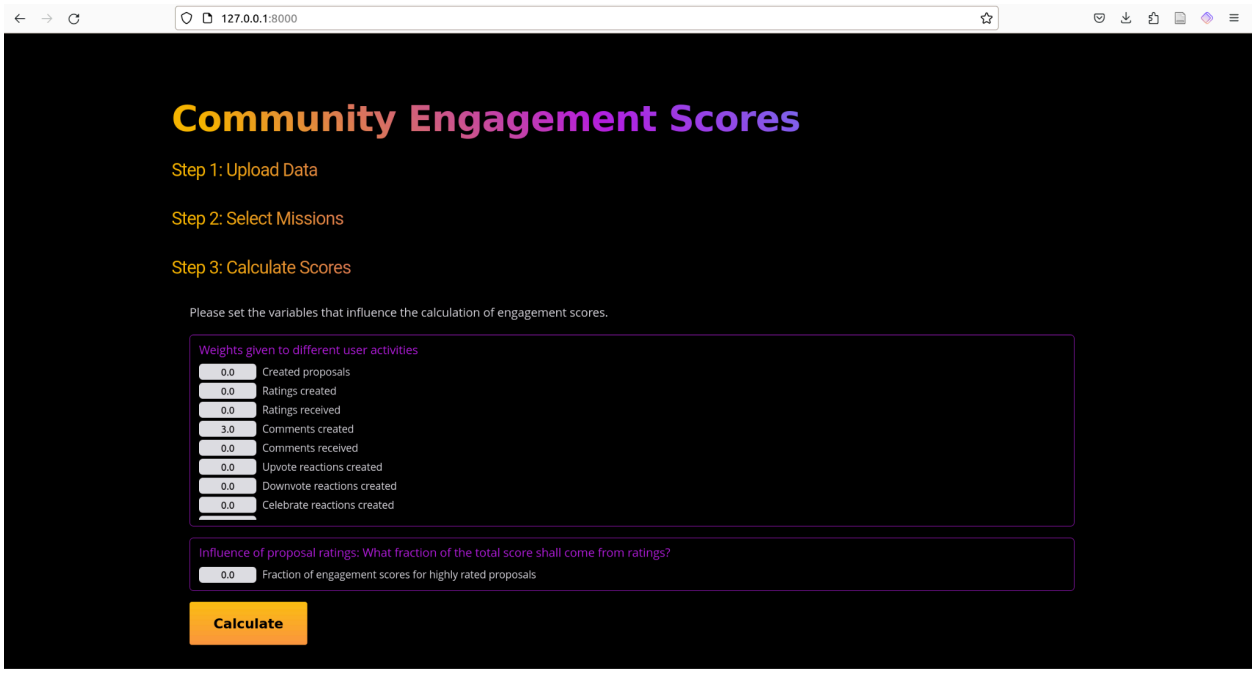
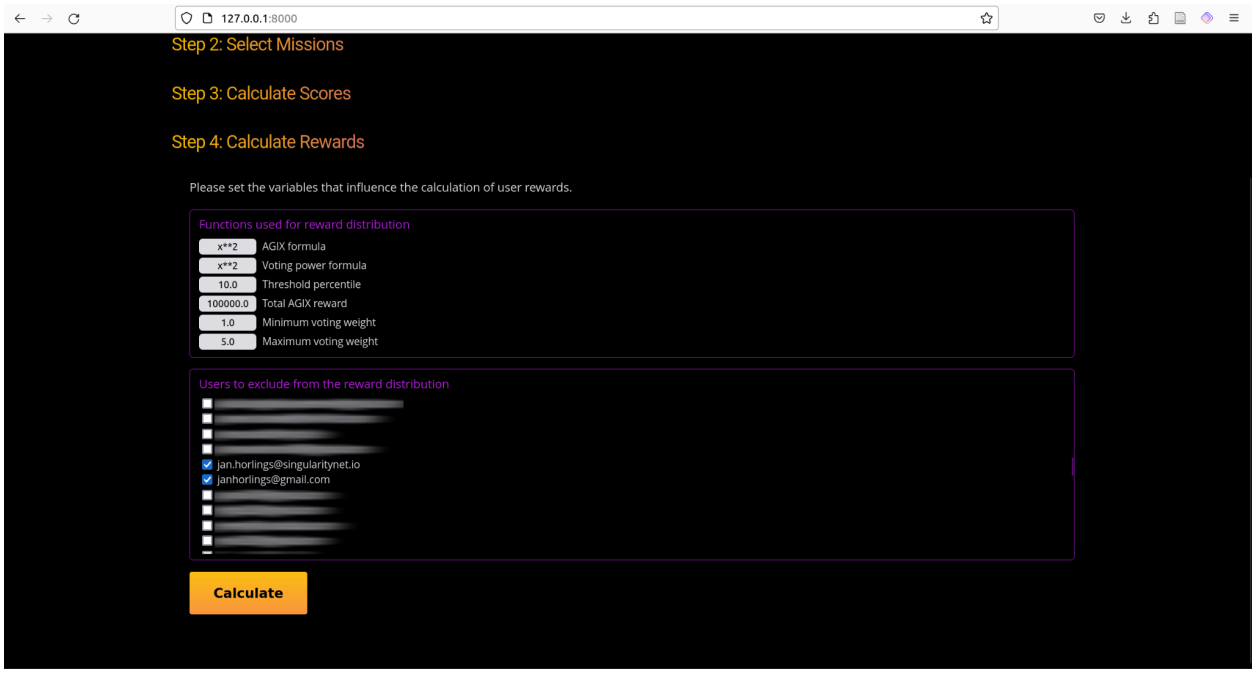
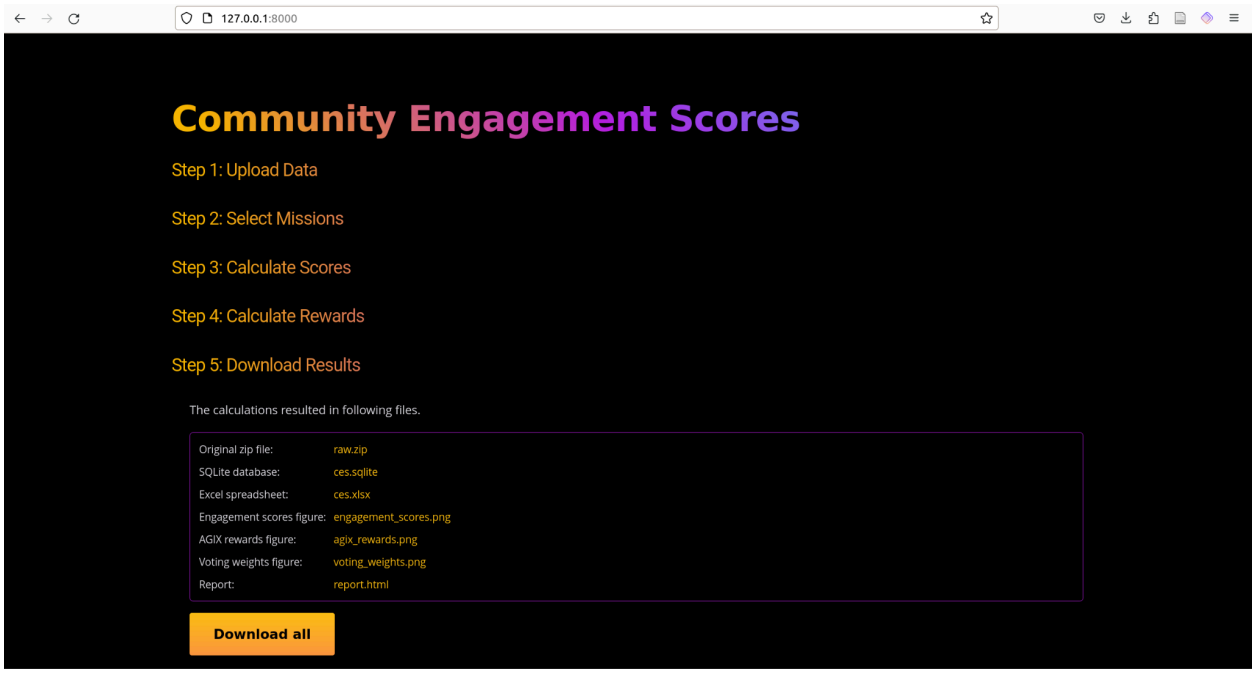
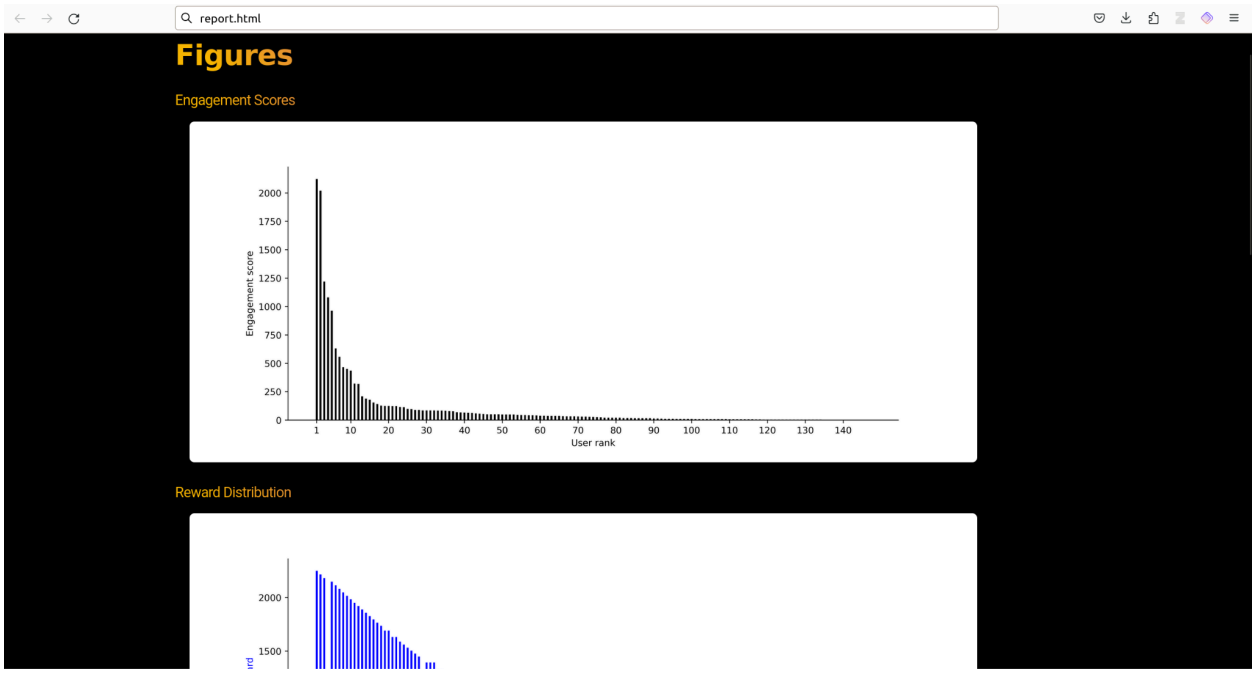
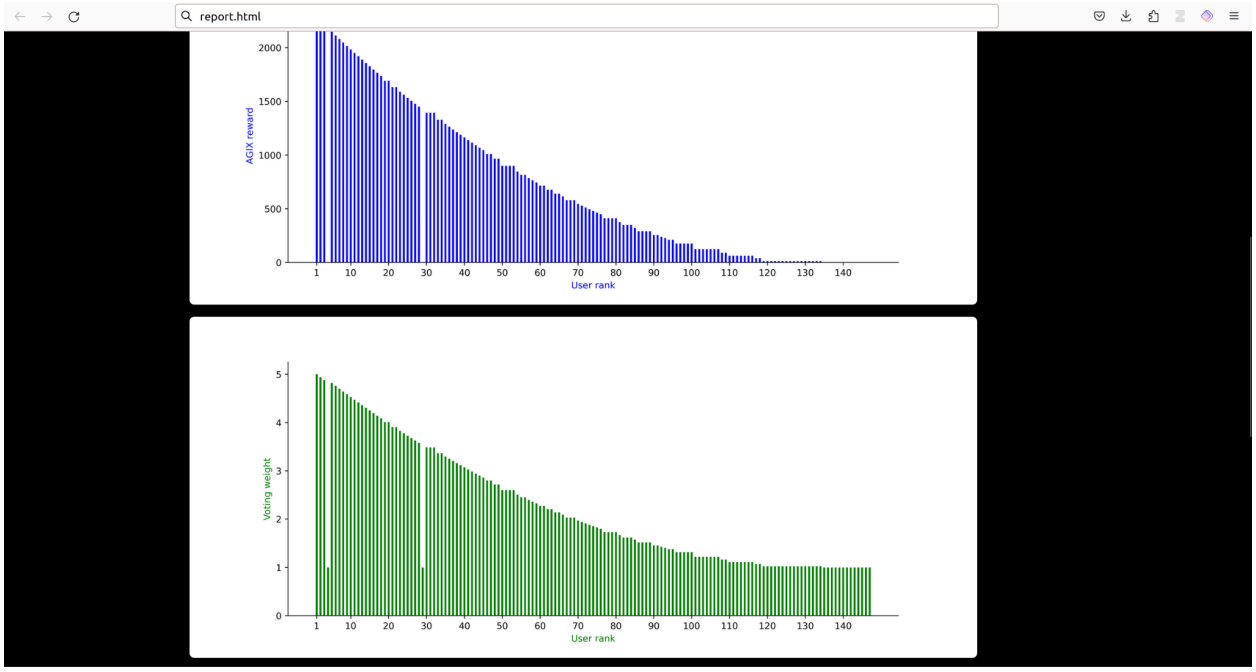

127.0.0.1:8000
Community Engagement Scores
Step 1: Upload Data
Step 2: Select Missions
Step 3: Calculate Scores
Please set the variables that influence the calculation of engagement scores.
Weights given to different user activities
0.0 Created proposals
0.0 Ratings created
0.0 Ratings received
3.0 Comments created
0.0 Comments received
0.0 Upvote reactions created
0.0 Downvote reactions created
0.0 Celebrate reactions created
Influence of proposal ratings: What fraction of the total score shall come from ratings?
0.0 Fraction of engagement scores for highly rated proposals
Calculate


127.0.0.1:8000
Step 2: Select Missions
Step 3: Calculate Scores
Step 4: Calculate Rewards
Please set the variables that influence the calculation of user rewards.
Functions used for reward distribution
x**2 AGIX formula
x**2 Voting power formula
10.0 Threshold percentile
100000.0 Total AGIX reward
1.0 Minimum voting weight
5.0 Maximum voting weight
Users to exclude from the reward distribution
jan.horlings@singularitynet.io
janhorlings@gmail.com
Calculate


127.0.0.1:8000
Community Engagement Scores
Step 1: Upload Data
Step 2: Select Missions
Step 3: Calculate Scores
Step 4: Calculate Rewards
Step 5: Download Results
The calculations resulted in following files.
Original zip file: raw.zip
SQLite database: ces.sqlite
Excel spreadsheet: ces.xlsx
Engagement scores figure: engagement_scores.png
AGIX rewards figure: agix_rewards.png
Voting weights figure: voting_weights.png
Report: report.html
Download all


report.html
Figures
Engagement Scores
Engagement score
User rank
Reward Distribution



report.html

Settings

Engagement Scores

Variable	Value
Comments Created	3.0
Upvote Reactions Received	2.0
Downvote Reactions Received	-3.0
Celebrate Reactions Received	2.0
Clap Reactions Received	2.0
Curious Reactions Received	2.0
Genius Reactions Received	2.0
Happy Reactions Received	2.0
Hot Reactions Received	2.0
Laugh Reactions Received	2.0
Love Reactions Received	2.0
Anger Reactions Received	-2.0
Sad Reactions Received	-2.0

Reward Distribution

Variable	Value
Num Filtered User Ids	2
Function Agix Reward	x**2
Function Voting Weight	x**2
Threshold Percentile	10.0
Total Agix Reward	100000.0
Min Voting Weight	1.0
Max Voting Weight	5.0

Appendix C: Proof of Concept Design from Report 2

To increase clarity and transparency of the proof of concept implementation, the following sections will provide a visual overview of the steps taken so far. The purpose of this software tool is to replicate the calculation of contribution scores, which so far was performed by the Deep Funding team manually in spreadsheets, but in future shall be done automatically by the PoC application. The following visual walkthrough will 1) start from an inspection of the Swae website, 2) continue with a look at the raw data export that SingularityNET can receive whenever required from the Swae team, 3) proceed with the data extraction, transformation and loading (ETL) process implemented in the tool, 4) demonstrate the successful replication of the manual contribution score calculation and 5) give a first glimpse into interpreting the data in form of a network and then using network measures to in order to determine the relative importance of different users in the overall social activity on the proposal portal.

Proposal Portal of Deep Funding

Deep Funding uses a portal software supplied by Swae for submitting and discussing proposals during 1) funding rounds for providing grants to community projects and 2) governance rounds for gradually improving the decision process and its decentralization. The proof of concept application developed in this project is concerned with receiving and analyzing data from the Swae portal of Deep Funding in order to help the Deep Funding team with the calculation of contribution scores for each user on the portal. These scores are then used for rewarding active users with a) additional voting power in collective decisions and b) AGIX utility tokens that can be used on SingularityNET's marketplace of AI services. The intention behind these rewards is to incentivize constructive behavior and community formation on the portal, but to do so, insights into the overall activity of each user is required. This is best done automatically to ensure reliability and to enable experimentation with different calculation variants.

The first step towards the PoC implementation was a close inspection of the portal website in order to determine what kind of information is available and how it might be represented in a well-defined form. We chose to create a preliminary entity-relationship model to get a first rough idea of what objects are present in this domain, how they are interdependent on each other, and how they might be stored in a relational database later on. Figures 1 to 4 capture the six central entity types (Users, Missions, Proposals, Ratings, Comments, Reactions) that were identified on the website and some of their dependencies.

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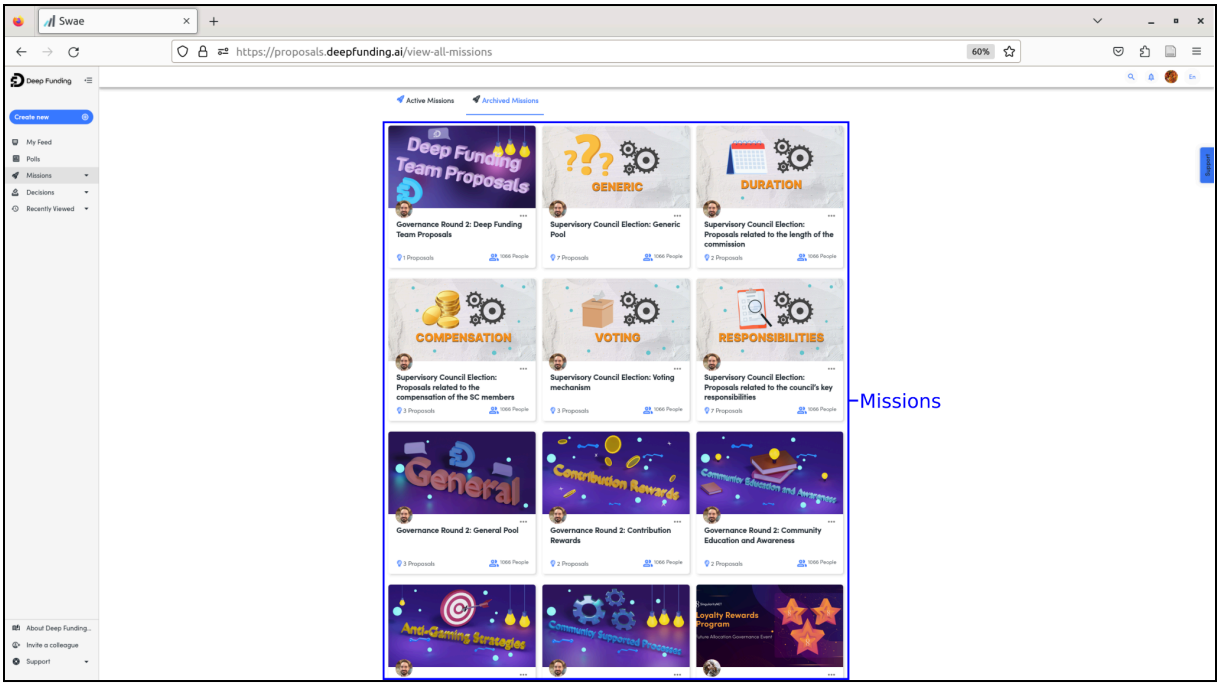

Figure 1: Missions on the Swae portal of Deep Funding. This top-level view of active and archived missions is accessible by an entry named “Missions” on the left sidebar after logging into the portal with a user account.

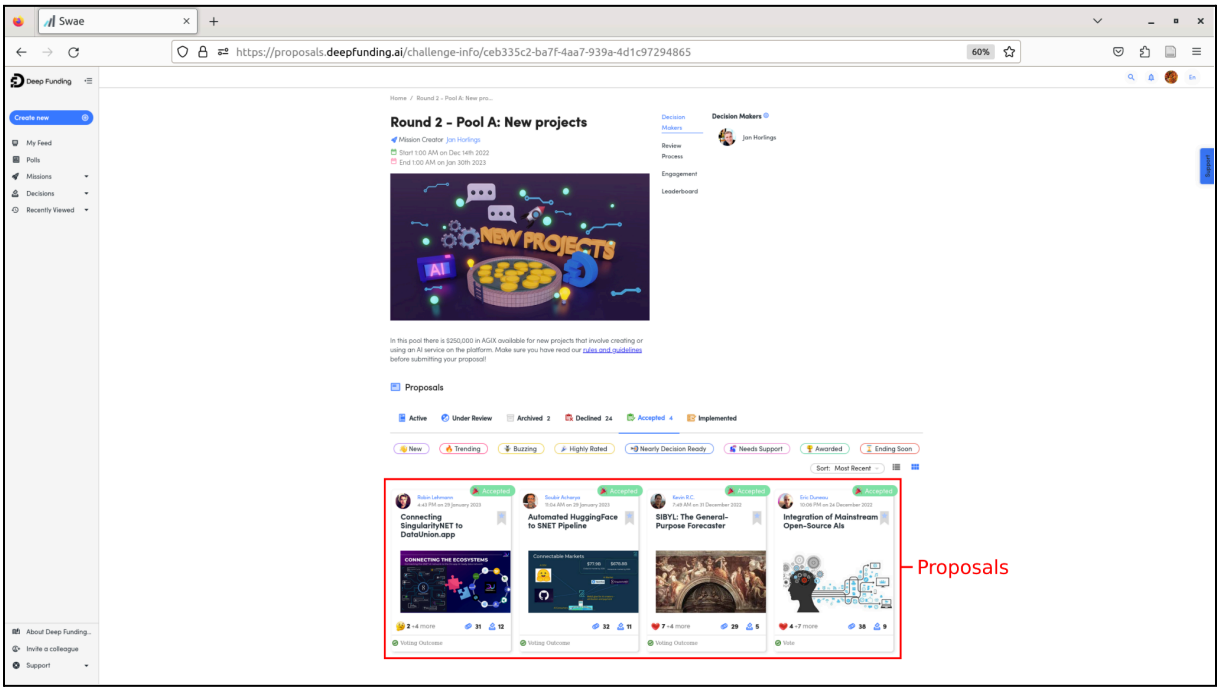

Figure 2: Proposals belong to a particular mission. This view is accessible by clicking on a mission in the previous view. It provides an overview of all proposals that were created under the chosen mission. For example, two missions were created for Deep Funding Round 1, namely Pool A for larger projects and Pool B for smaller projects.

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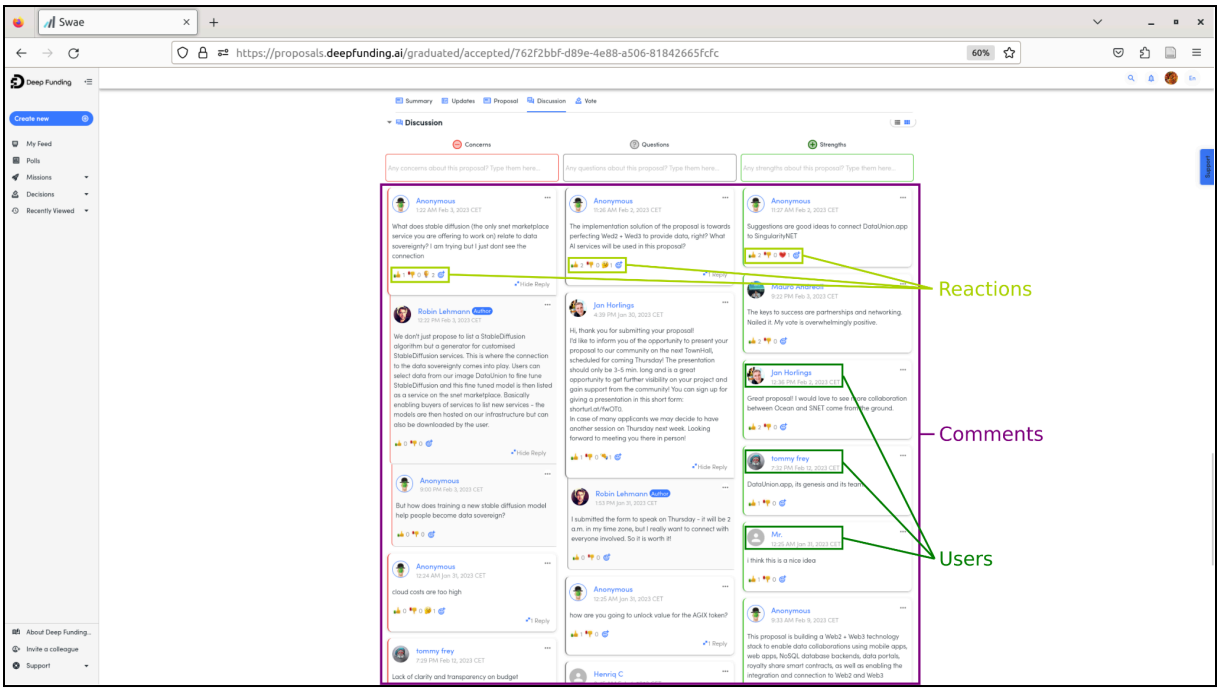

Figure 3: Comments belong to a particular proposal. This view is accessible by clicking on a proposal in the previous view and scrolling to the end of the proposal text. Each comment can get reactions by different users. A comment can be associated with the proposal itself or with a parent comment to which it directly replies.

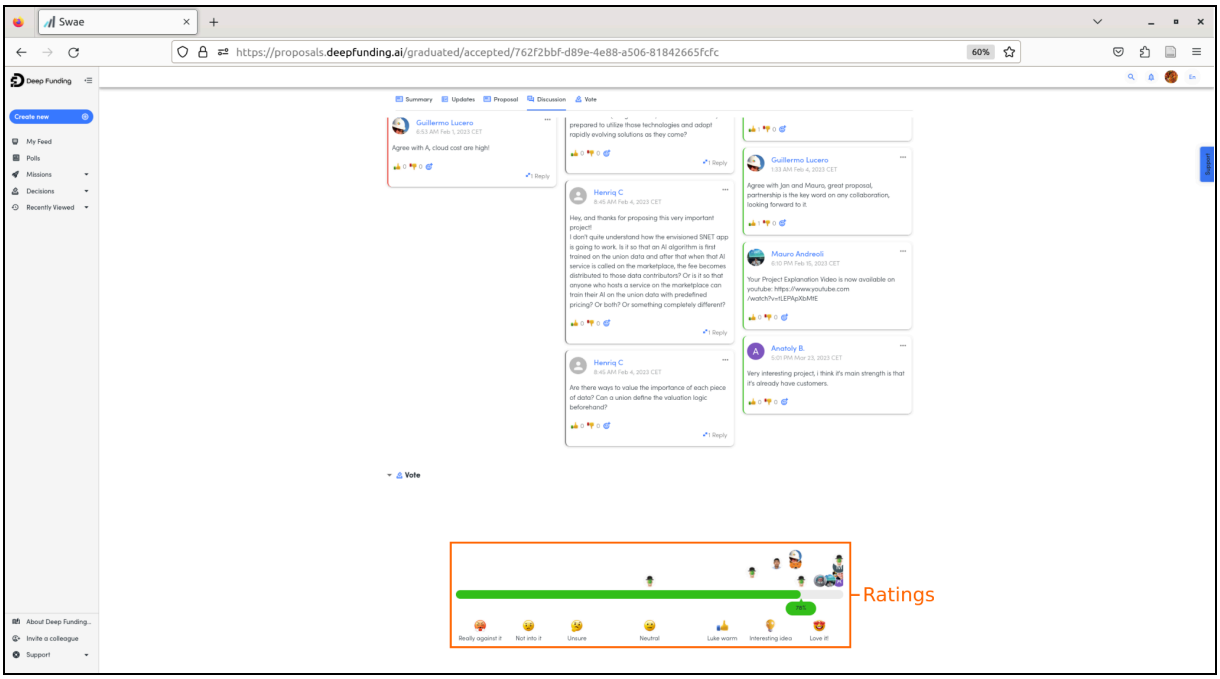

Figure 4: Ratings belong to a particular proposal. A user can provide a number from -100 to +100 as a quality indicator on every proposal. Note that Swae refers to these values as “Votes” and the process as “Voting”, but Deep Funding prefers the term “Ratings” instead, because there is also a separate Voting Portal used for decision processes involving web3 logins via Ethereum and Cardano accounts.

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Raw data export

The Deep Funding team can request an export of all data collected on its proposal platform whenever required from the Swae team. The data is provided in the form of a single zip archive, which contains 13 JSON files that presumably stem from a NoSQL database such as MongoDB used in the backend of the Swae website. The content of the JSON files can be characterized as semi-structured data, because entities of the same type may have different attributes associated with them. For example, some users may have provided optional social media links in their account, while others may have entered optional web3 addresses to receive AGIX rewards. Despite having different attributes, all users are stored in the same "users.json" file. Another aspect is that user accounts may be associated with an e-mail login or with a Metamask login via an Ethereum address. Unique identification of each user is therefore possible via two attributes, where it is guaranteed that one is present, but it can be either of them. Particularities such as these suggested to us to extract and transform the data before performing calculations on it. We have decided to load the preprocessed data into a relational database system like SQLite, in part because it also enables us to inspect the data with very flexible SQL queries. Later it turned out that even the contribution score calculation itself can be formulated as a single large SQL query that performs counts of various user activities and aggregates them by a linear combination with variable weights.

Figure 5 provides an overview of the available JSON files and how they can be associated with the six entities found on the Swae website in the previous section. The next section will deal with the same entities (or more precisely entity types) in an ER model.

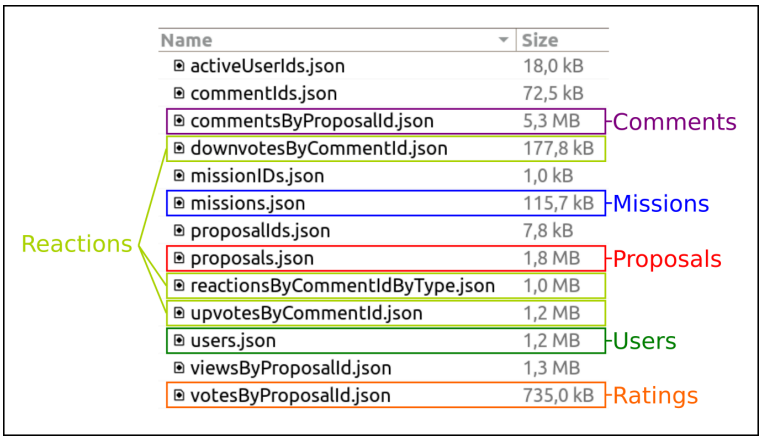

Figure 5: The 13 JSON files contained in a raw data export from the Swae portal of Deep Funding. The required data is available in 8 of these files, since the other 5 files store redundant information that can be used for simpler processing but isn't strictly required. Inspection showed that 3 of the 8 files can be subsumed under the entity "Reactions", because upvotes (thumbs up), downvotes (thumbs down) and reactions in the narrower sense (10 emojis) can all be seen as belonging to the same concept. The remaining 5 of the 8 files can be associated 1:1 with the entity types originally identified during the website inspection.

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Data model

We created an entity-relationship model for the design of a relational database schema that then guided the implementation of a database system based on SQLite and subsequently DuckDB. For model creation, the software VS Code together with a community-provided extension called ERD Editor was used. Figure 6 captures the initial analysis of entities and relationships as observable on the website, while figure 7 shows the final model after closely inspecting the raw data export provided to us by the Swae team.

Entities

User
Mission
Proposal
Rating (aka Vote)
Comment
Reaction

Relationships

A user (with special rights) can create 0-to-n missions. A mission is created by 1 user.
A user can create 0-to-n proposals. A proposal is created by 1 user.
A mission can contain 0-to-n proposals. A proposal is part of 1 mission (correct?)

A user can create 0-to-n proposal ratings. A rating is created by 1 user.
A proposal can have 0-to-n ratings. A rating belongs to 1 proposal.

A user can create 0-to-n comments. A comment is created by 1 user.
A proposal can have 0-to-n comments. A comment belongs to 1 proposal.
A comment can have 0-to-1 parent comments. A comment can have 0-to-n child comments.

A comment can get 0-to-n reactions (of 12 different types). A reaction belongs to 1 comment.
A user can create 0-to-n reactions. A reaction belongs to 1 user.

Entity Relationship Diagram without attributes

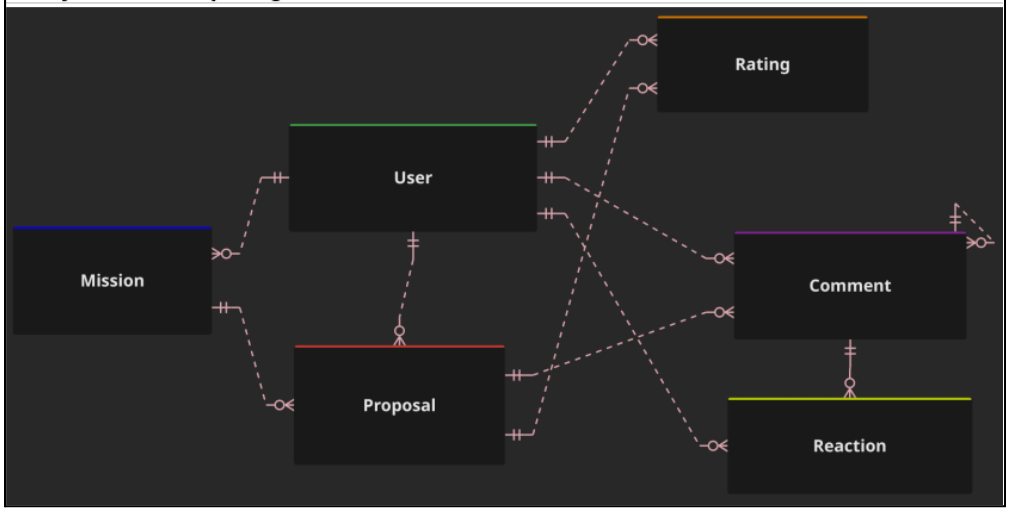

Figure 6: The preliminary entity-relationship diagram designed after inspecting the Swae website.

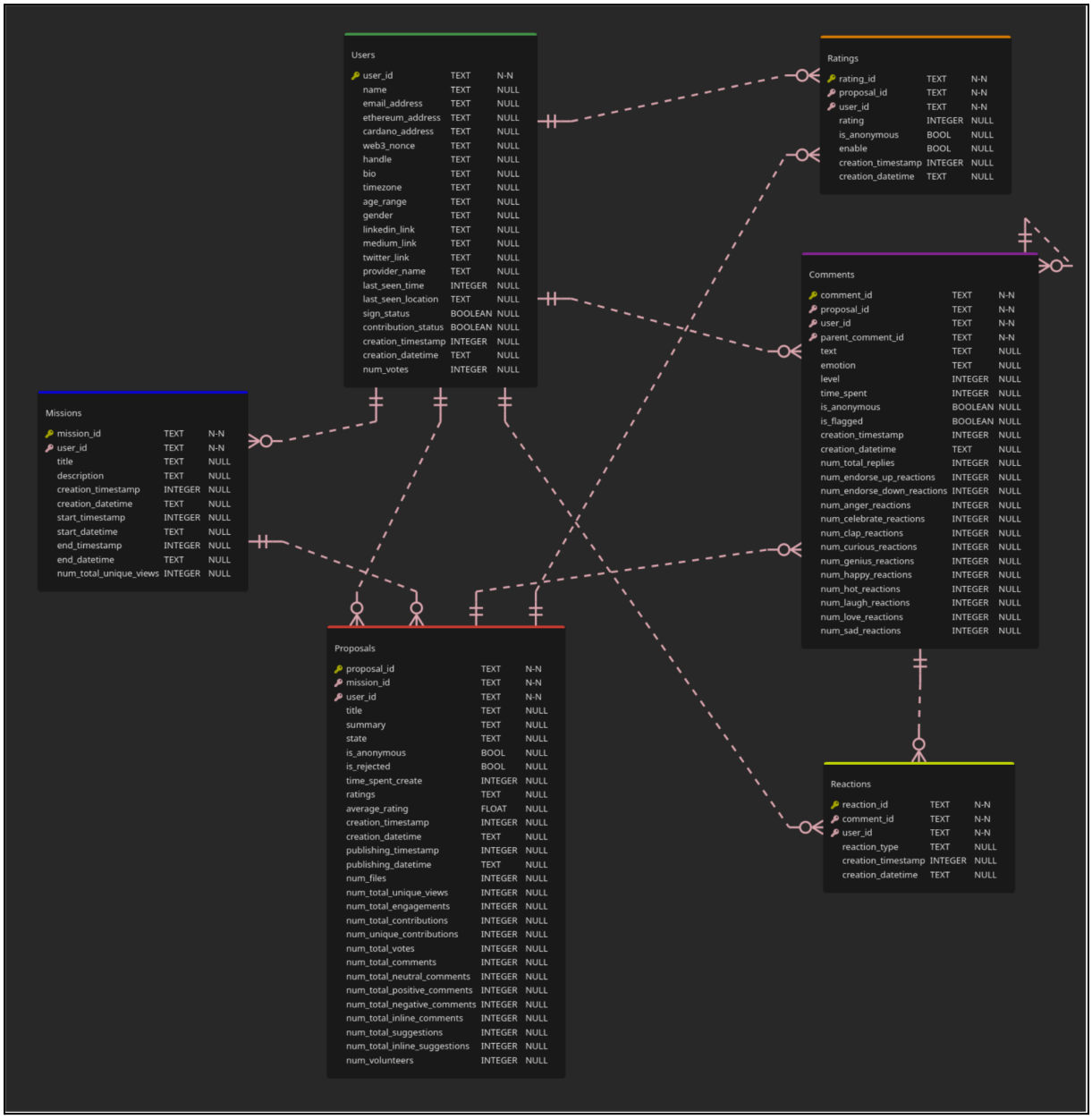

Figure 7: The final entity-relationship diagram designed after inspecting the raw data export from Swae. A portion of the attributes can be taken almost directly from the available data, while others are constructed with conversion functions that involve some conditionals and aggregations.

ETL Process

The ETL process (extract, transform, load) was first implemented in Python by reading the JSON files with Python's built-in json module, iterating over the decoded objects, converting and storing all relevant attributes in lists of rows, creating pandas DataFrames from those lists and exporting the DataFrames in the form of 1) a file-based SQLite database with one table per entity, and 2) an Excel spreadsheet file with one sheet per entity.

Out of curiosity, the same process was also implemented in DuckDB by directly loading the JSON files with its built-in JSON loading functionality and by registering custom SQL functions to use for particular conversions right during the loading process. This resulted in a faster solution due to the automatic parallelization provided by DuckDB and due to less conversion overhead from switching between data structures.

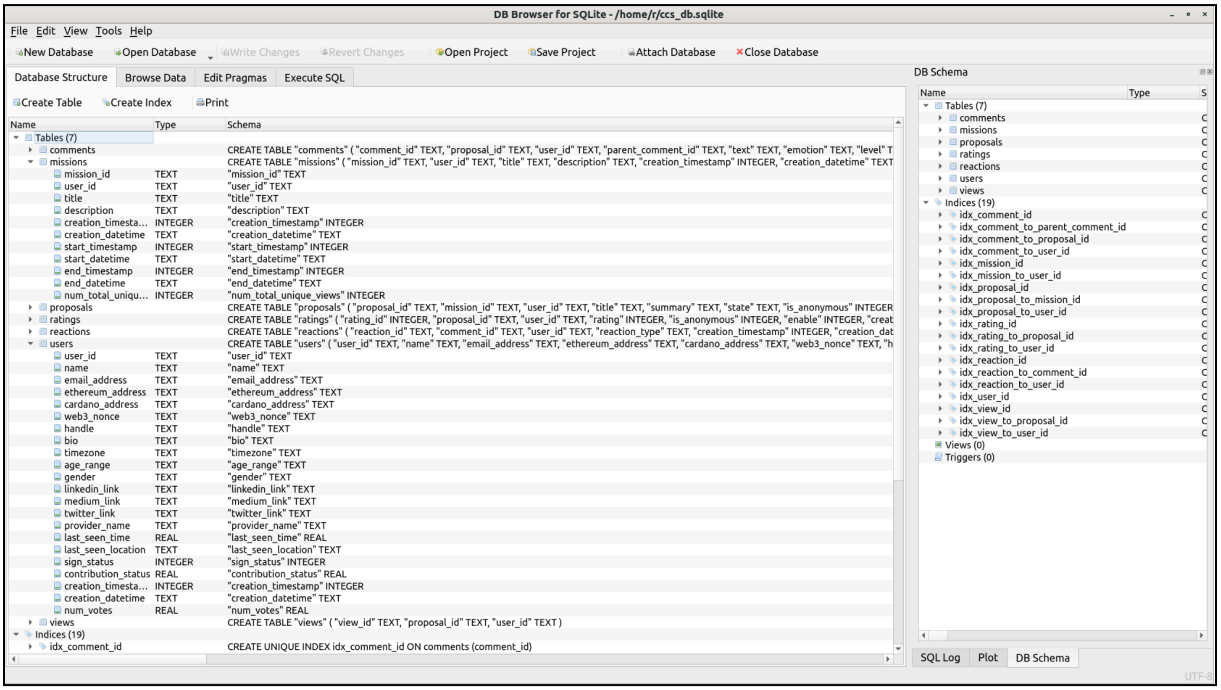

Figure 8: The resulting SQLite database file inspected with DB Browser for SQLite. The data model from figure 7 is reflected in the tables and columns visible in this database inspector.

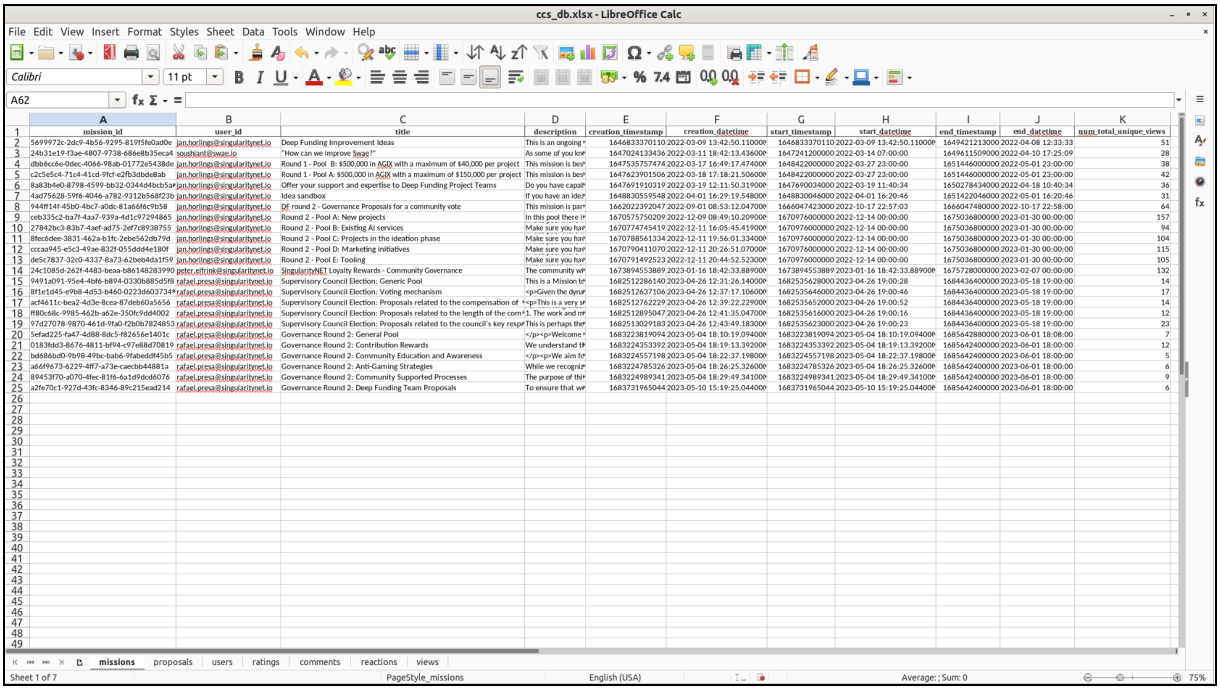

Figure 9: Since the ETL process was based on pandas DataFrames it was straightforward to also export the individual tables as separate sheets into a single Excel spreadsheet file. For example, the “missions” sheet is shown in this screenshot and corresponds to the “missions” table in the SQLite file. This format is very suitable for inspection of the extracted data by users without data modeling experience and might be useful for the Deep Funding team.

Contribution score calculation

One advantage of having the data extracted, transformed and loaded into an SQL database is that inspecting the data becomes very simple with SQL queries. As it turned out, even the contribution score calculation itself can be formulated as a single large SQL query that counts various user activities and linearly combines these counts into a single measure by weighting them according to some predefined variables. Again, DuckDB proved to be faster than SQLite on this computation task, because it is highly optimized for analytical queries.

The following figures demonstrate that the resulting contribution scores from the automated calculation fit to those of the manual calculation done by the Deep Funding team in previous rounds. In particular, the contribution scores determined by hand in Deep Funding Round 2 were replicated with the software tool. One aspect that was discovered during the implementation is that the exported data contains comments that were deleted by the users who created them. Such comments are flagged as deleted by Swae’s backend but not removed. Deleted items needed to be included to precisely replicate the manual calculation, because they influenced the contribution scores. They did not, however, change the ranking of users and therefore had no relevance for the assignment of rewards.

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	B	C	D	E	F	G	H
1	Ratings						
2	**Variables scoring**						
3	Proposals created						
4	0	Per proposal created, regardless of rating					
5	0	Proposal rating multiplier					
6	Comments and feedback created						
7	3	Points per comment created					
8	0	Points per reaction created (thumb up or down)					
9	0	Point per emoji reaction given (positive or negative)					
10	Comments and feedback received						
11	2	Points per positive comment reaction received (thumbs up)					
12	-3	Points per negative comment reaction received (thumbs down)					
13	2	Points per positive reaction received (Genius/Happy/Hot/Clap /laugh/Love)					
14	-2	Points per negative reaction received (sad, anger)					
15							
16							
17							
18							
19	**proposal score definition**						
20	Points per proposal =	=	Proposal score * votes cast				
21	proposal score definition	=	%(total points given) * (nr of proposals) * rating variable				
22							
23							
24	**Voting weights**						
25	**Percentile**		**Tier**	**Weight factor**			
26	96-100		A	5			
27	81-95		B	3.5			
28	61-80		C	2.5			
29	31-60		D	2			
30	11-30		E	1.5			
31	<0-10		F	1			
32	no points		G	1			

Figure 10: Some values of variables used in the calculation of contribution scores of Deep Funding Round 2. Users received 3 points for each comment they created, 2 points per positive reaction on a comment and -2 points per negative reaction on a comment. Proposal creation was not rewarded with points because, in contrast to governance rounds, there is already an incentive to create high quality proposals in order to receive funding.

Figure 10 shows which variables were used by the Deep Funding team in that round. The particular values reflect which user activities were given what amount of influence. Our PoC software tool will enable the Deep Funding team to adapt these as well as other values and immediately calculate the resulting contribution scores. This allows quick experiments with different calculation schemes on historical data, e.g. to identify fairer ways of measuring each user's contribution or to fine-tune mechanisms against gaming the system.

Figure 11 and 12 show the outcomes of the manual calculation by the Deep Funding team and the automatic calculation by our PoC software tool, respectively. The contribution scores were sorted descending and the 30-40 users with the highest values are shown. For privacy reasons, the names were blurred, but the values are identical.

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C	AO	AP	AQ
3	40	41	42
name	Total reputation score	Voting tier	voting weight
[redacted]	**2142**	G	1
[redacted]	**2035**	G	1
[redacted]	**1232**	A	5
[redacted]	**1098**	G	1
[redacted]	**976**	A	5
[redacted]	**634**	G	1
[redacted]	**590**	G	1
[redacted]	**475**	G	1
[redacted]	**457**	A	5
[redacted]	**436**	G	1
[redacted]	**324**	G	1
[redacted]	**319**	G	1
[redacted]	**213**	G	1
[redacted]	**190**	G	1
[redacted]	**180**	A	5
[redacted]	**161**	G	1
[redacted]	**145**	G	1
[redacted]	**127**	G	1
[redacted]	**126**	G	1
[redacted]	**124**	B	3.5
[redacted]	**124**	G	1
[redacted]	**123**	B	3.5
[redacted]	**119**	B	3.5
[redacted]	**118**	G	1
[redacted]	**98**	G	1
[redacted]	**97**	G	1
[redacted]	**90**	G	1
[redacted]	**89**	G	1
[redacted]	**87**	B	3.5
[redacted]	**85**	B	3.5
[redacted]	**85**	G	1
[redacted]	**85**	G	1
[redacted]	**85**	G	1

Figure 11: Results from the manual calculation of contribution scores for Deep Funding Round 2. This is a small part of the data available in the file “DF R2 results and calculations.xlsx” which was provided to us by the Deep Funding team as a template and control for the calculation. The column “Total reputation score” contains the contribution score for each user based on her activity on the proposal portal during Deep Funding Round 2.

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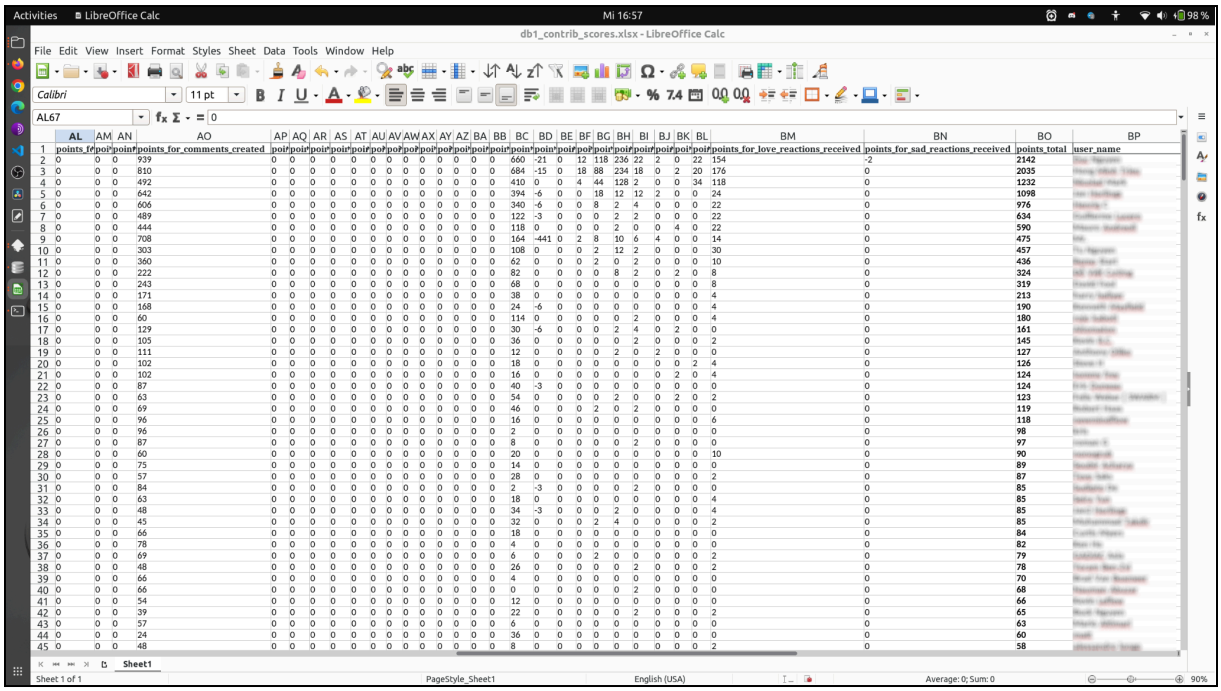

Figure 12: Results from the automatic calculation of contribution scores for Deep Funding Round 2 with our proof of concept software tool. The column "points_total" contains the contribution score for each user based on her activity on the proposal portal during Deep Funding Round 2. Note that the values are identical to those shown in figure 11, which come from the manual calculation by the Deep Funding team.

Network measures

As mentioned in the beginning, the data present in the SQL database can also be used to construct a multi-partite graph or network. Entities and relationships from the data model can be considered to be nodes and edges, respectively. For example, each mission can be represented by a blue node. A particular mission contains multiple proposals, so each proposal can be represented by a red node and the containment relationship can then be visualized by drawing edges between missions and their particular proposals. Each proposal can in turn have multiple comments, represented by purple nodes. Again, the containment relationship can be represented by an edge between a proposal and its particular comments. Some comments have child comments (replies), so the parent-child relationship can also be represented by an edge. Comments may also have reactions (thumbs up, thumbs down, 10 smileys), so each reaction can be represented by a lime green node and be connected to the comment it belongs to via an edge. All of the mentioned entities are created by particular users, which are represented as green nodes but connected only to the comments they created to get a sparser graph. Figures 13 to 18 show a preliminary attempt of constructing a small network according to this description, based on the data belonging to the mission for Pool A in Deep Funding Round 1.

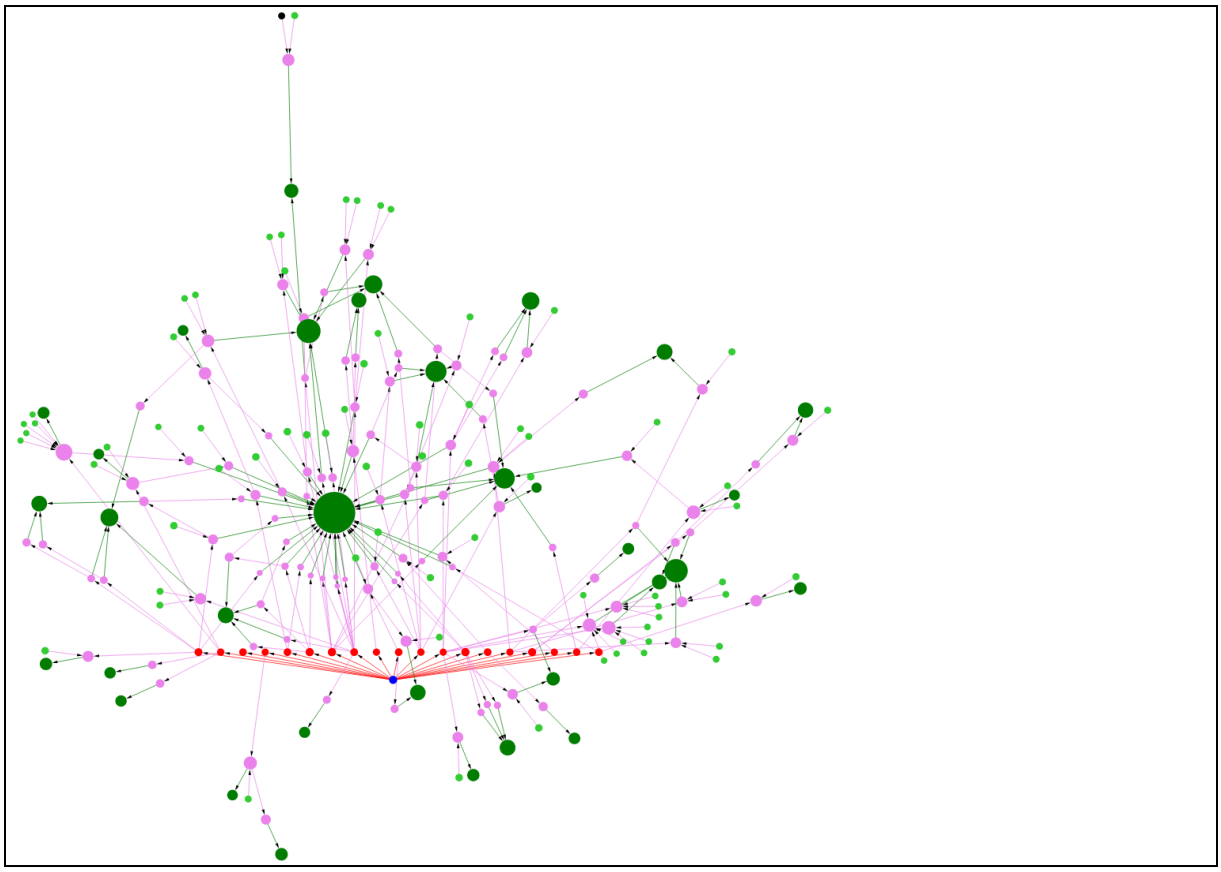

Figure 13: Network visualization of a small sample of the database restricted to a single mission, namely Pool A in Deep Funding Round 1. The blue node in the middle is the mission, which is connected to 19 proposals shown as red nodes. Each proposal received comments, shown as purple nodes. Some comments had child comments (replies), which are also shown as purple nodes. Comments may have received reactions (thumbs up, thumbs down, 10 smileys), shown here as lime green nodes and connected to the comment they belong to. Users are represented by green nodes and they are connected to the comments they created, but not to the missions, proposals or reactions they made, in order to keep the graph a bit sparser. Node sizes represent a network centrality score that was calculated for each node and which shall represent a node's importance or influence within the network. Depending on how the network is constructed and which measure is used, quite different outcomes are possible. Some options may represent good ways to indicate how active a user was on the Swae portal during a particular Deep Funding round.

The network was created with a library named NetworkX and the interactive network visualization with a library called gravis. The latter was developed by Robert Haas a while ago and independently from this project. The node sizes represent a network centrality measure known as Laplacian centrality, which is available in NetworkX along with many other such measures. The reason why centrality measures could become interesting for calculating contribution scores is because they consider not only how active a user was, but also her position within the network of all user activities. This could mean, for example, that receiving a positive reaction from a very active user might boost the contribution score more than receiving a positive reaction from a not so active user.

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Figure 14 to 18 show how the interactive network visualization can be used in a browser. Hovering over a particular node with the mouse blends in detailed information.

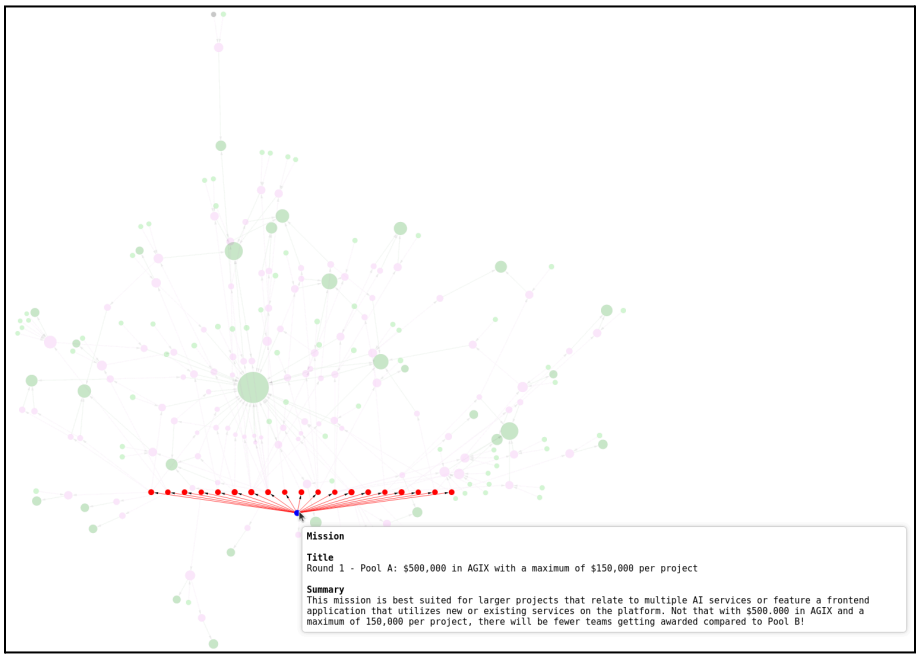

Figure 14: Hovering over the single blue node that represents the mission. In this case, the mission was pool A of Deep Funding Round 1, which contained a good number of proposals and comments for the purpose of this visualization.

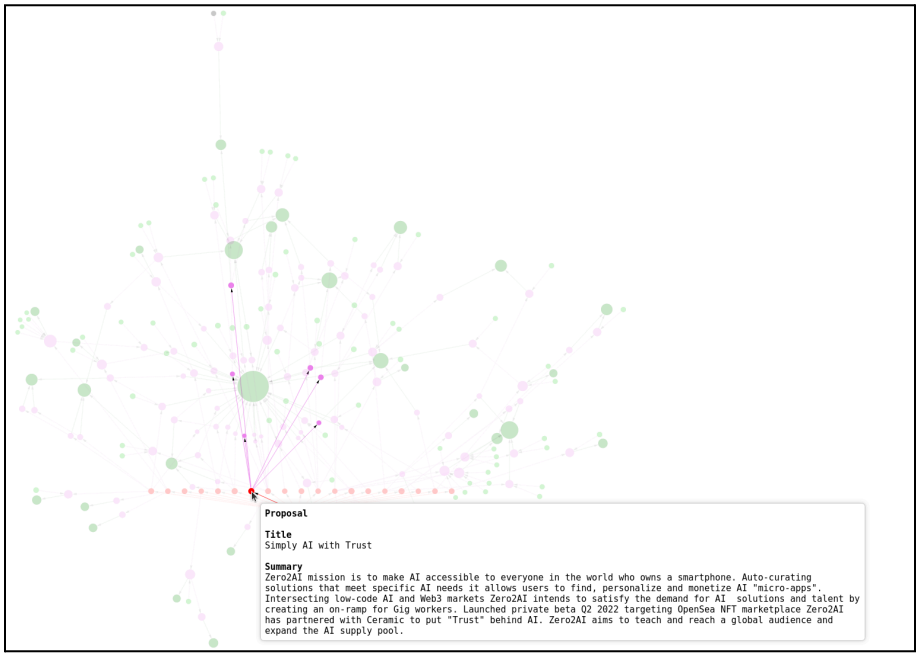

Figure 15: Hovering over a red node that represents a proposal in that mission. In this case, there are six outgoing edges to purple nodes, which represent the top-level comments given to this proposal by different users.

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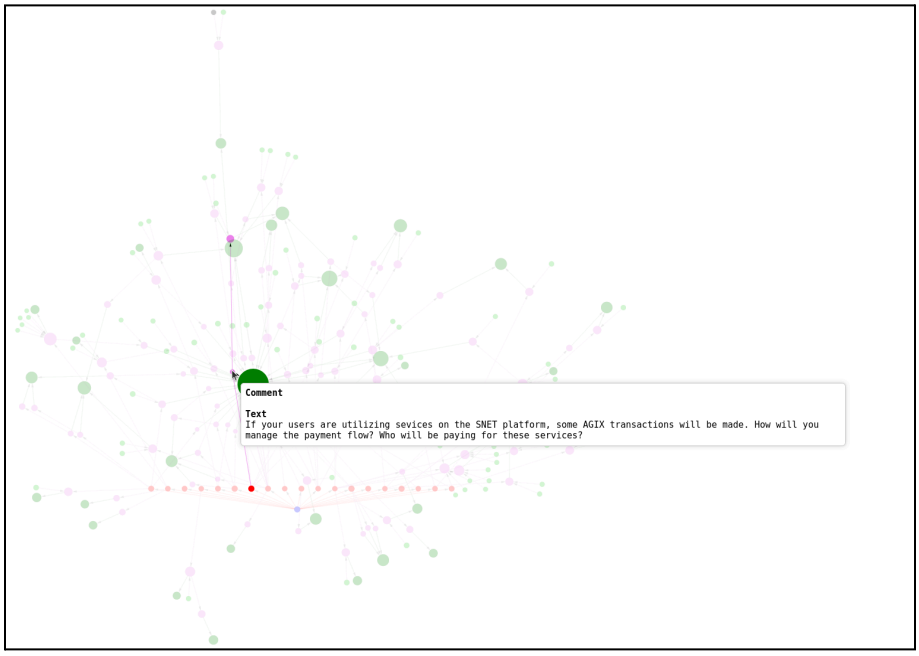

Figure 16: Hovering over a purple node that represents a comment. This comment is connected to another purple node which represents a child comment (or reply) given to it. The comment is also connected to a green node which represents the user that wrote the comment.

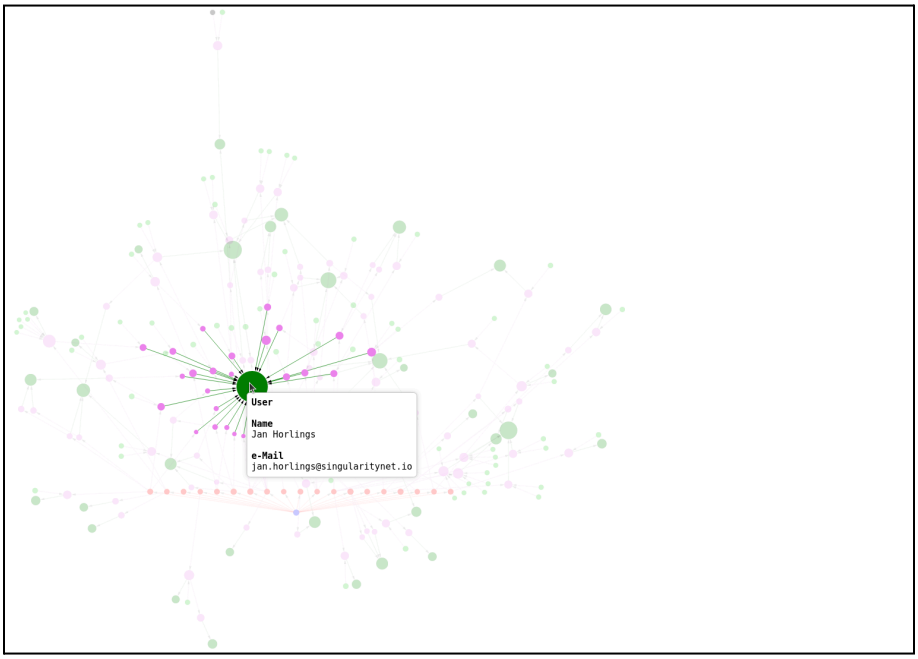

Figure 17: Hovering over a green node that represents a user. In this case, the user was Jan Horlings from the Deep Funding team. As can be seen from the connections to several other nodes, he gave many comments to the proposals in this mission. The large node size comes from the fact that a high centrality value was calculated for this node. This means the user is well connected in the network, in this case from a high commenting activity.

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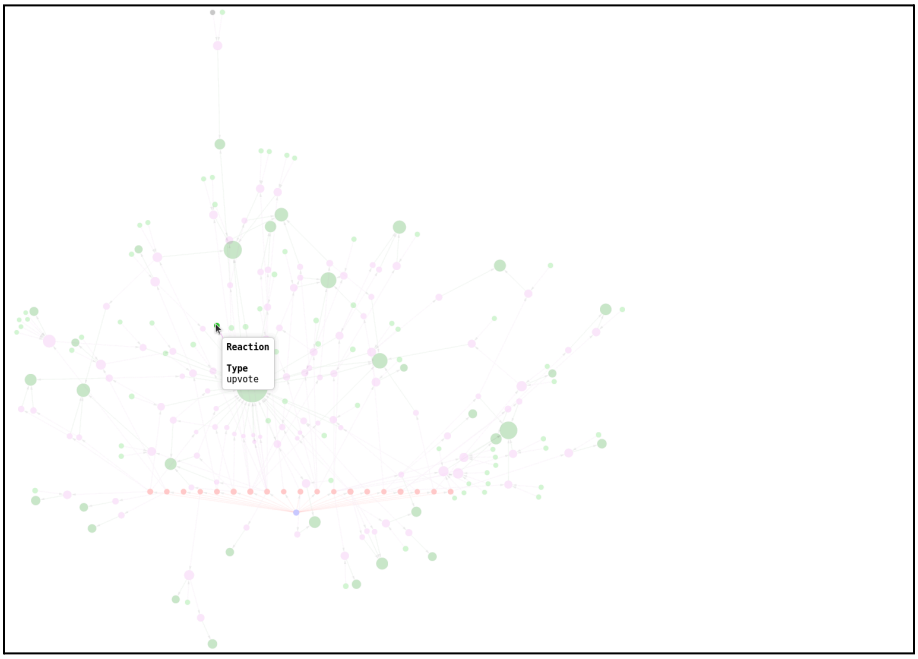

Figure 18: Hovering over a lime green node that represents a reaction. In this case it is an upvote that was given to a particular comment, which is hidden behind the textbox in this screenshot.

Appendix D: Score Research & Community Engagement from Report 3

Full Plural Voting Process

In a recent report on lessons learned from the first 9 Catalyst funds, the Input Output Global, Inc. (IOG), Catalyst leadership cited random voting as one of the problems impacting quality decisions in the program. Upon reflection, this may also be a looming problem for the SingularityNET Deep Fund program. While the focus of this project is Community Scoring to enhance community engagement and to support Sybil (multiple identity) resistance for Deep Fund Voting (Jetter, O., Dinger, J., & Hartenstein, H. (2010)), it's worthwhile to provide a research note on the benefits of the full Plural Voting process.
In the cryptocurrency space, voting rights have derived from the corporate model of stockholder voting rights. Plural or quadratic voting has been used by Deep Fund and other communities to dampen the centralizing power of assigning one-coin one-vote (1c1v). However, the original invention of Plural Voting by Glen Weyl and Eric Posner (Posner, E. A.,

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& Weyl, E. G. (2018)) was focused on improvements to democratic voting processes. They were seeking to establish a fair market for public influence.

Recognizing the approximately quadratic increase in influence as votes were correlated, they proposed that votes be purchased on a quadratic scale. However, the purchase of votes did not relate to an allocation of votes for all ballot questions, as is currently used by Deep Fund and many other cryptocurrency implementations. Instead, a participant's budget for voting a) drew from their own funds, b) involved an actual expense, and c) was allocated for each ballot question. The collected voting fees were dispersed evenly to all participants.

This process has the following influence on an individual's participation in public policy. First, it is a personal investment in public policy. If you keep your views modest and you don't spend a lot per ballot question, you can then expect to receive a small reward for your participation. On the other hand, if you wish to express a strong opinion and/or have a significant amount of money to invest in public policy, you can pay on a quadratic scale for your votes (corresponding approximately to a linear scale on your influence) and this payment will be distributed evenly to the other participants.

While there may still be some random voting by participants who are motivated to receive an income, they are forced to keep their investment in each decision small. In contrast, those that strongly influence public policy are directly contributing to strengthening the decentralized foundations of the community through the distribution of their investment. There may also be a secondary benefit to strengthening the value of the AGIX coin. Healthy economies are measured in part by the velocity of the money supply. If the cycling of AGIX coins throughout the ecosystem stimulates a variety of use cases for the coin, it is possible this would improve the stability and value of the coins.

While the Plural Voting process may be challenging to implement, as the SingularityNET community looks to improve its decision-making, the full Plural Voting system may be worth investigating further.

Building Robustness into the Process

During July, we held another in a series of Deep Funding Town Hall Breakout Sessions to keep the community informed of progress and continue the solicitation of feedback. Robert Hass conducted a very well received session on current technical progress and future directions.

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SingularityNET is not a “small town” anymore. As the scale and influence of the organization increases, it becomes a more tempting target for manipulation and we anticipate that Deep Funding’s security needs will grow over time. Robustness to malicious actors, including bots posting comments and voting, and the incorporation of sybil resistant mechanisms, will be of increasing concern.

As a set of core practices, somewhat loosely described as Web3, continues to emerge, certain key concepts may be seen to manifest in a number of organizations, including the principles of decentralization in ownership and decision making, permissionless access (wherein the network is open to all), cryptocurrency as a mechanism of native payment, and a trustless set of incentives and mechanisms.

Increasingly well known structures supporting these principals include Decentralized Autonomous Organizations (DAOs) *Altaleb, H. and Zoltán, R. (2022)*, Autonomous Decentralized Systems *Wright, S. (2023)*, Blockchain Based Online Social Media (BOSM) *Sun, R., Li, C., Liu, J., and Sun, X, (2023)* and systems built on User Generated Content (UGC) *Li, S. and Liu, X (2020)*.
Organizations such as SingularityNET are increasingly at risk to sybil attacks, where malicious actors employ fake or duplicate identities in order to subvert true node identities and increase influence in decision making or gain the access to the network *Platt, M., & McBurney, P. (2023)* and *Bhise, A., & Kamble, S., (2016)*. We recommend that SingularityNET build sybil resilience into the next phase of the design. Resilience may be characterized as sybil safety – the inability of sybils to change the status quo against the will of the genuine agents, and sybil liveness – the ability of the genuine agents to change the status quo against the will of the sybils *Shahaf, G., Shapiro, E., and Talmon, N. (2019)*, *Jetter, O., Dinger, J., & Hartenstein, H. (2010)*, and *Meir, R., Shahaf, G., Shapiro, E., & Talmon, N. (2020)*.

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