Decentralized Assessment System (DAS)

1. Abstract

Technology became one of the pillars of the modern world. Fast-paced innovative companies produce a lot of knowledge and technology, and in a world that heavily relies on such technologies, it becomes crucial to be able to assess and analyze which technologies have the most potential and worth investing in its development.

Unfortunately, in most cases, it is impossible for non-experts, such as governments, venture capitals or the general public, to understand the quality and usefulness of given technologies, especially when it comes to expertise-intensive domains, namely deep-tech, where the broad expertise or even a scientific background is required to make any conclusions about the quality. This inability to evaluate the potential of innovations leads to the misuse of capital, both financial and human. And even among experts, the knowledge about the quality of these intangible assets is shared inefficiently, and based on predefined trust and sharing information with just closest peers.

A Decentralized Assessment System introduces a comprehensive and robust assessment model:

- it sources the consensus about the quality of knowledge or technology among the domain experts through continuous two-level peer-review;
- it ensures fair rewards for contributions and curation efforts;
- it formalizes the result of assessment into explicit metrics/indicators useful for non-experts.

The aim of this white-paper is to describe the Decentralized Assessment System, its key principles and components, and the technology behind it, as well as to describe the infrastructure to facilitate its adoption.

According to studies, the amount of knowledge and technology is growing rapidly and becomes the most valuable asset in the world. Nowadays, more than 85% of all assets of the S&P 500 companies are intangible while only 45 years ago it was just 17%. With such a fast pace of innovation, it is very important to have a robust and comprehensive model to assess such assets in order to determine the most valuable and potentially impactful knowledge and technologies.

The current knowledge and technology assessment system is outdated and is not designed for such a scale. The system is segregated and isolated, which makes it impossible to use it for collaboration between different peers and stakeholders.

2. Concept of DAS

Decentralized Assessment System (DAS) is a peer review system that uses an incentive model with reputation rewards and produces a quantifiable metric about the quality of asset(s) being assessed. DAS is designed specifically for assessment of assets in expertise-intensive areas, such as deep-tech.

In the current context supports the assessment of intangible assets, such as knowledge, technology, IPR assets, and even human capital, but can be used to assess any kind of assets.

DAS sources a consensus about the quality of assets among the domain experts through continuous peer review. The results of peer review then formalized into explicit metrics/indicators of the quality of the asset, and all contributors (such as asset author(s), reviewers and experts who curated reviews) are rewarded with reputation score. The contributor's reward amount directly depends on the quality of one's contribution.

3. Structure of DAS

Decentralized Assessment System is a comprehensive solution that includes all required components to configure, implement and integrate it for any required use-case or domain.

The core components of DAS are: **assessment**, **incentive model** and **quality formalization**.

The assessment component includes two assessment mechanisms: direct assessment and indirect assessment implemented as continuous two-level peer review and weighted citations correspondingly.
The incentive model provides a dynamic reward calculation and distribution.
The quality formalization component is responsible for the calculation of the Scientific Contribution Index - an indicative metric that represents the actual quality and potential of an asset.

Full list of DAS components:

- assessment:
    - continuous two-level peer review,
    - weighted citations;
- incentives model;
- quality formalization (Scientific Contribution Index);
- configuration and integration tools:
    - API and software development kits (SDK),
    - agent-based simulations framework,

    - initialization of reputation system;
- system state visualization;
- infrastructure:
    - parallel formalization models execution infrastructure,
    - Blockchain protocol and technical infrastructure to implement DAS;
- AI/ML integration.

4. Components of DAS

4.1 Scientific Contribution Index

Scientific Contribution Index is a formalized consensus of the expert network about the quality of any contribution. It is a quantifiable metric that measures the quality of any contribution. The resulting metric is useful not only for the expert community but also for non-experts and allows to determine and compare the quality of an asset, as well as the performance of an expert either in a specific domain or in general.

Contribution, in general, is the creation or improvement of knowledge and technology, and also an assessment of its quality. In the current context, for clarity, **contribution** refers to the creation or improvement of knowledge and technology; whereas **review** refers to the assessment of contribution. The review itself is assessed through community curation as well.

Contributor, in general, is any member participating in the creation or improvement of knowledge and technology, and in the decentralized assessment as a reviewer or review curator. In the current context, for clarity, **contributor** refers to any member who creates or improves knowledge and technology; the **reviewer** refers to any member who makes review; **curator** refers to any member who curates reviews through voting.

Hence, Scientific Contribution Index is used to:

1) show the **quality** of contribution;
2) show the **reputation** of an expert.

Scientific Contribution Index is the multi-dimensional score, thus it is either specific to domain/discipline or compound, which represents the quality of contribution or reputation of an expert in general.

Scientific Contribution Index is dynamic and changes over time depending on the results of continuous assessment and performance of other contributions and experts.

4.1.1 Quality of a contribution

SCI of contribution is calculated based on the results of the assessment of the given piece of knowledge and technology.

Contribution can be interdisciplinary, which means each contribution can be done in multiple disciplines, and depending on the results of peer review contribution will get an SCI score in one or multiple disciplines.

4.2 Reputation of an expert

SCI of an expert is calculated based on the performance of an expert in the assessment and curation of contributions.

As described further, the incentive model rewards contributors with a reputation in the form of SCI assigned to specific contributors. As with the quality of contribution itself, reputation can be accrued in one or more disciplines, depending on which discipline review was performed.

Reputation serves not only as an indicator of one's expertise, but it is also a core element of the assessment system, as it represents the initial support of the review from the reviewer or weight of expert's supportive voice for another review.

4.3 How SCI is calculated

SCI is calculated for each contribution that was assessed. As the review is assessed by community curation through voting (casting community expert's voice in support for review).

In general, SCI of a contribution (except review) depends on the following parameters:

- number of reviews for a specific contribution
- result of each review - a score that shows how well the reviewer assessed a contribution depending on criteria set for this contribution type
- The reputation of each reviewer which assigned as initial support of the review
- weight of the review, which is a score that is calculated based on initial support of the review and support from the expert community

Thus, each review will affect the SCI of a contribution right after the review is performed, and then each supportive voice for the review will change the weight of review, and consequently, the SCI of a contribution.

The expert's SCI, depending on his/her role, is calculated differently.
For **contributors,** SCI is calculated depending on the assessment result of their contributions and depends on how well their contributions are assessed compared to other contributions in each discipline.

For **reviewers,** SCI is calculated depending on the parameters (detailed explanation of those parameters is given in the following chapter “Incentive system”):

- how well review is assessed by the community. Community curation shows how accurate and deliberate review is (how close it is to the final consensus about the quality of a contribution);
- how early after contribution publication review was made.

For **curators,** SCI is calculated depending on how well they curated the reviews: whether they supported accurate and good quality reviews or supported low-quality reviews in the pursuit of reputation reward.

SCI rewarded to a contribution or to an expert **can be negative** and will decrease the overall quality score for contribution or review, or the overall reputation of an expert.

4.2 Incentive system

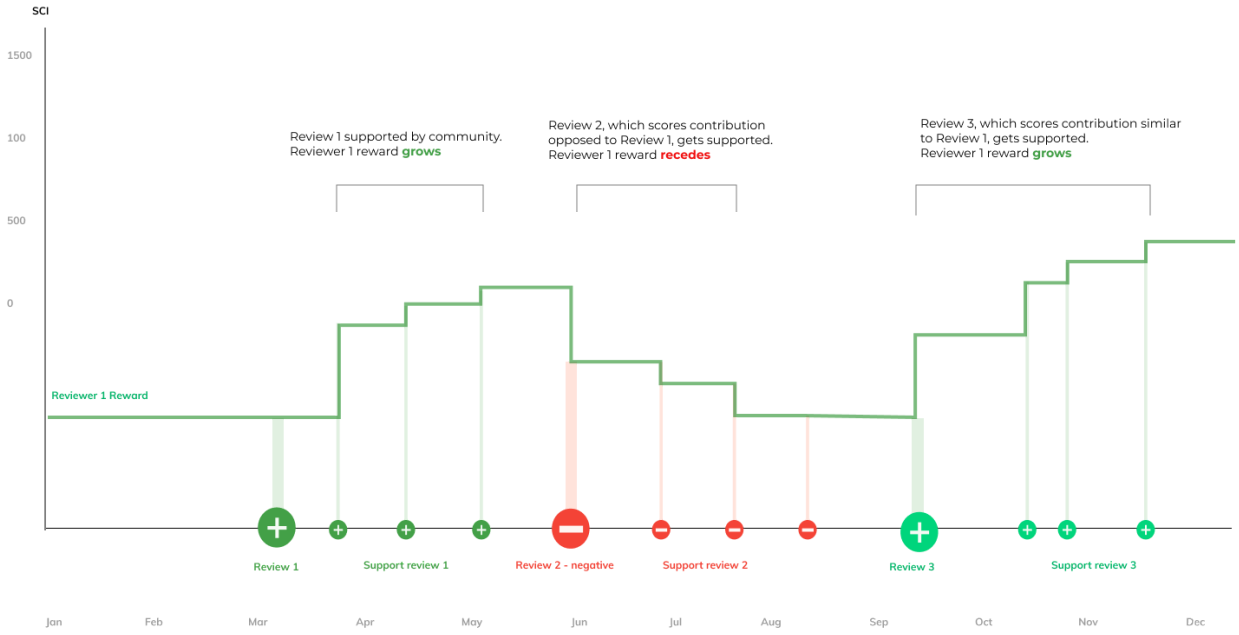
In expertise-intensive domains, an expert’s reputation is what matters most. DAS introduces reputational rewards to promote unbiased and a good quality review. The incentives system is built upon the following assumptions:

- experts community will eventually reach a consensus about the quality of any knowledge and technology;
- pioneer supporters should get more rewards and recognition.

With these assumptions, the incentives system is designed in such a way to incentivize experts to:

- perform a comprehensive, quality and unbiased review that shows the actual strengths and weaknesses of knowledge and technology being reviewed;
- a pioneer in assessing knowledge and technology that was not yet assessed yet.

Assuming that over the time the community will reach a consensus on the quality of any knowledge and technology, it becomes possible to calculate how accurate and deliberate each review is. The more accurate review is (the closer its score to the consensus score), the more reward reviewers will get. On the other hand, in case of the review was performed with a low-quality reviewer will lose his reputation.



Pioneers, who are first to review new contributions, will receive more reward and recognition for their efforts, as they are taking the risk. Followers, who perform review after the quality of contribution is already known, on the other hand, do not risk that much. They will still be rewarded, but the amount of the reward will be significantly less.

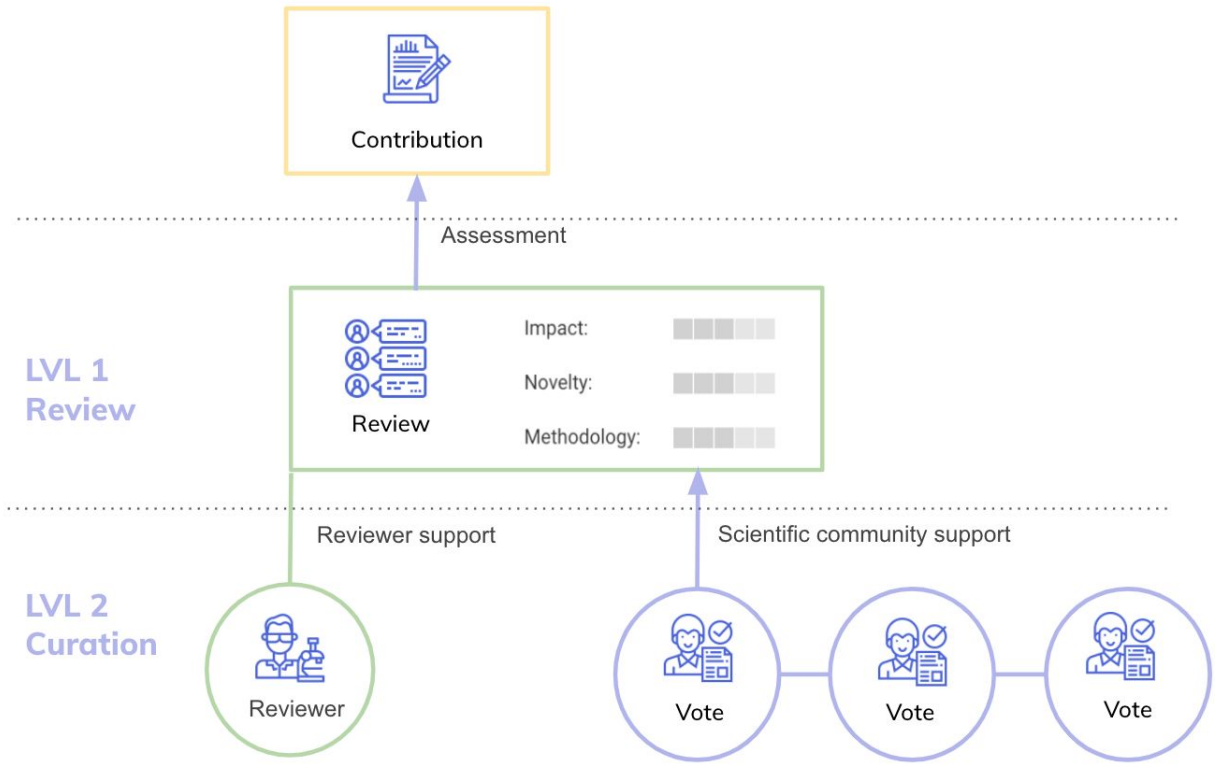
4.3 Assessment

4.3.1 Continuous two-level peer review

A core element of the assessment system is **continuous two-level peer review**. This novel peer-review model addresses weaknesses of existing peer-review and allows us to more accurately curate knowledge and technology and assess its quality. Continuous two-level peer review is a direct assessment of a contribution.

The proposed peer review process includes two levels of assessment:

- **review** on the 1st level;
- **review curation** (**support**) on the 2nd level.



Opposite to the existing peer review, where peer review is performed only in the specified timeframe and assesses the contribution only in a given point in time, continuous peer review encourages the expert community to continuously evaluate the quality of each contribution in order to reach a consensus and calculate a fair score showing its quality. The more reviews the contribution has, the more quickly the community will reach a consensus, and the more accurate the final score will be.

Level 1 - Review

A review is an initial step in the assessment process. The review system is flexible and allows to customize review criteria for each type of contribution.

Review produces an initial quality score for a contribution. The resulting score depends on a current number of reviews for a given contribution, and on the reputation of a reviewer.

Level 2 - Review curation (support)

In order to maintain the quality and fairness of review, DAS introduces a mechanism of curation of reviews in the form of support from other experts. The expert community can vote for reviews

that are of the best quality, and comprehensively evaluate a piece of knowledge and technology.

Thus, over time, the fairest and accurate reviews will be supported by most of the community, which will eventually lead to reaching a consensus of the community.

Support of a review is a key element of an assessment system, as it not only leads to community consensus but also impacts on both SCI calculated for contribution being assessed and reviewer reputation reward or penalty.

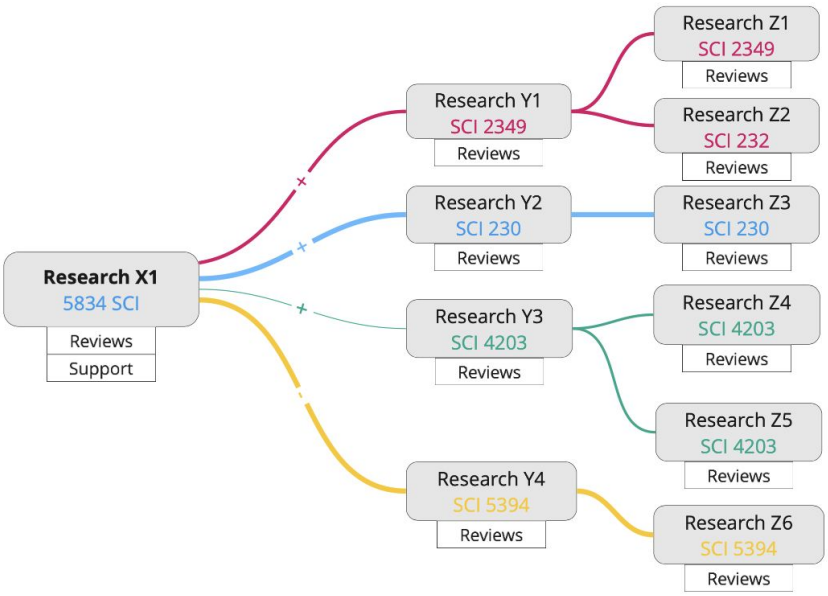
4.3.2 Weighted citations

Weighted citations is an indirect assessment mechanism that is employed by DAS.

Weighted citation is a reference to a specific contribution which is weighted by two properties:

1) weight of citation set by referencing contribution author(s), which basically means how important and valuable this referenced contribution is on the author(s) opinion;
2) SCI of the referencing contribution

Weighted citations influence final SCI of a contribution in a way that the more heavy-weighted citations (considering both citation weight set by referencing author(s) and SCI of referencing contribution) a contribution have - the more SCI it will additionally receive from each of those citations.
Weighted citations can include multiple reference levels, and is only limited with requirements for specific use-case or discipline.



4.3.3 Mitigating biased assessment risks

TODO: ZKP for demography validation and anti-political polarization

4.4 Configuration and integration tools

4.4.1 API and software development kits (SDK)

To facilitate smooth integration into existing infrastructures and transition from legacy systems DAS includes a full set of tools and frameworks for system integration and development.

DAS provides an easy to use and setup Data Aggregation and Querying API that is reach in data aggregation and querying functions. API is useful when users mostly need to interact with DAS to only receive data, as it is not suitable for full interaction because of security concerns. In case deep integration is required, DAS supports multiple SDKs for the most popular programming languages, such as JavaScript, Python, Java, C++, and C#. SDKs provide extended interfaces and functionality to interact with DAS and enable to perform both all possible operations defined within the protocol, and use all data aggregation and querying functions.

4.4.2 Agent-based simulations framework

To configure DAS for specific use-case or discipline, an agent-based simulations framework is developed as part of the system. It allows to simulate different scenarios and find the optimal starting configuration depending on discipline/domain population, current expertise distribution, average number of contribution for a given period of time and more. Such precise configuration and tuning of the system ensure optimal and smooth operation and absence of incorrect and inaccurate assessment results and reward distribution artifacts.

4.4.3 Initialization of reputation system

DAS heavily relies on the reputation system and it has an impact on every assessment and curation action within the system. DAS provides multiple ways to initialize the reputation system's state on system start:

- initialization based on historical review records;
- initialization based on community voting.

Initialization based on historical review records

Initialization based on community voting

Terminology:

Merit-based reputation - a specific reputational score which was distributed to a person based on his/her contribution;
Multidimensional reputation - a reputation score which can be represented N-dimensional vector, where dimentionas can be domain disciplines, criterias or types of contributions;
Compound reputation;
Expertise Contribution Index - an index that represent a measure of how much specific person contributed to specific domain field;
Scientific Contribution Index - a subspace of Expertise Contribution Index, which represent a measure of how much specific person contributed to specific scientific discipline;
Continuous peer-review - a system which allows to review a specific contribution any time, and allows to eventually determine the quality of the contribution;
Two-level peer-review - a system which allows to review a review through voting mechanism;