Finnoq

A Protocol for Decentralized Opinion Markets
Whitepaper V1.2

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Abstract

Finnoq is an open source protocol for decentralized opinion markets, based on the wisdom of the crowd to foster better decisions for all. Currently, opinion markets are controlled by centralized actors. The protocol is represented in three layers: the Finnoq Core Layer, Service Layer and Application Layer. On top of the Application layer, a diverse and non-exhaustive set of use cases have been identified for future development and partnership. Collective, decentralized opinion formation on the Finnoq protocol creates more robust and intuitive information to make better decisions.

Table of content

Introduction

Finnoq is an open source protocol for decentralized opinion markets, allowing better decisions for all. Currently, opinion markets are controlled by centralized actors with leveraging instruments intended to augment power. Opinions deriving from such actors are biased and incomplete, and produce clear barriers to objectivity. In response, the Finnoq protocol is the future for collective opinion statements, a digital infrastructure based on the wisdom of the crowd. To ensure the wisdom of the crowd, truth-telling incentives as a subset of game theory are employed.

Psychologists historically thought that crowds suppressed individuality; recently, an alternative conceptualization of crowds emerged where under appropriate conditions, each person brings unique insights and if combined properly, makes the crowd a better decision-maker than most individuals.[1] This phenomenon is known as the wisdom of the crowd, pioneered by James Surowiecki and scientists interested in the matter. Individual answers logically suffer from random error in judgment, where reliance on mathematical combinations of many people's opinions can produce the best decision.[2] It is already used in prediction polls,[3] prediction markets,[4] internal company improvement policies and in retail.[5] On top of this scientific reality, evolving truth-telling algorithms such as the Surprisingly Popular Algorithm and the Bayesian Truth Serum increase the accuracy of collective wisdom results when a lack of knowledge or small group exists.

The protocol is represented in three layers and is built on the Ethereum blockchain: the Finnoq Core Layer, Service Layer and Application Layer. The Finnoq Core Layer is the centerpiece of the protocol, used for "Whitelisting" participants, staking FNQ Tokens to create collective statements, evaluating results of opinions based on truth-telling algorithms, and tracking performance over time via the Credibility

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[1] Soll, Mannes and Larrick, 2011
[2] Matoulkova, 2017
[3] Atanasov et al., 2015
[4] Bassamboo, Cui and Moreno, 2015
[5] Petro, 2018

Score. The Service Layer enables all developers to create algorithmic voting possibilities (Modules and Templates) and use standardized APIs to unite the Finnoq Core Layer with App users through Applications. It ensures functionality by storing modules and predefined templates, where functionality can be expanded over time. Finally, the Application Layer enables developers the opportunity to use proven modules from the Service Layer, building their own opinion market from which App users begin the "opinion formation process". The Advisors vote on opinion formation processes, the App users receive the result, and the given rewards are distributed among the Advisors whose responses met the algorithmic requirements.

On top of the Application layer, a diverse, specific and non-exhaustive first set of use cases have been identified for future development and partnership. Such includes:

- Collective ratings for various assets
- Financial advice for evaluation
- Industry-specific market surveys
- Idea generation for product development

To facilitate decentralized opinion markets, FNQ Tokens are used for the purposes of participation in truth-telling and opinion creating, value transfer in within the entire Finnoq ecosystem, and governance in collectively steering the direction of the protocol over time.

The Finnoq protocol is blockchain agnostic, and the Finnoq team envisions a world in the future where everyone controls their own data and governance is decentralized. The roadmap for creating the Finnoq protocol is currently on pace to create collective, decentralized opinion formation which is more robust and intuitive information to make better decisions. Relying on the opinion or activity of a single individual, organisation or market when making transformative decisions is no longer necessary.

Problems and Challenges

For millennia, power has been a construct of an actor's resources (i.e. monetary, physical, psychological) and the ability to leverage resources towards an expected result. Regarding psychological resources, accepted opinions derive from and are controlled by centralized actors. Their resulting influence is expressed through a myriad of leveraging mechanisms, including print and social media, enterprise, and evaluatory institutions. The noise created through such instruments - for all actors old, new, and subsequent - persuades participant opinions; as a result, their opinions increasingly lack critical objectivity before decisions are made, both big and small. Each individually-distorted opinion shapes decisions, collectively steering societal values, market trends, cyclical bubbles, and systemic failure to the detriment of neglected human potential. By seeking to nourish the construct of power at the expense of objectivity and clarity, opportunity remains hindered and unrealized.

Alternatively, the wisdom of the crowd's uninterrupted results are scientifically proven to be a more inclusive, logical and intuitive construct of power, irrespective of current power position. When many participate and bring relevant, diverse, and independent topic knowledge to any inquiry, incentivized and unbiased opinions form collective statements as a basis for decisions and create an objectively better world for all who live in it. Before such is achieved however, systemic problems and challenges need be overcome.

Micro and Macro-Level Subjectivity

In general, opinions are subjective and reflect the personal view of individuals toward a perceived reality. Precisely for this reason is it hazardous if one must rely on the opinions of a single person or organization. When trusting a single person's opinion, diversity of perspective is non-existent. When trusting several peoples' opinions (e.g. in large-scale surveys), methods for obtaining results could be poorly designed and many subjects within a group could give fabricated answers. Additionally, intentionally-wrong statements have few or no negative consequences for the voter

or respondent. Hence, the difficulty in generating even singular - much less collective - objective opinions to serve as the basis for decision-making is an existential challenge for anyone who makes them.

Lack of Diversity in Digital Echo Chambers

In the information age which brought tech giants such as Google and Facebook, innovations profoundly connecting people are plagued with bias: users see what they wish with a distorted view of reality. Algorithms for social media platforms function so that a user's searches and activity are processed to maintain preferences for future searches. This innovation creates digital echo chambers, whereby one's opinion on any given topic is shaped, enabled and possibly aggravated based on "giving the people what they want". If many individuals make decisions dogmatically in all aspects of daily life - when the collectively accepted opinion was fundamentally flawed - undermined human potential is the result.

Lack of User Incentivisation

Tangentially associated with the rise of social media, the notion of monetized data has become a self-perpetuating industry. Each moment a user interacts with any internet-based, third-party platform, the user's opinions and decisions (data points) become monetized for parties. Whereas the platform can profit from selling one's data, and the third party can then use this data for its business generation (possibly within a digital echo chamber), the original user receives nothing. By being part of the millions who contribute to the success of a social media phenom, web-based startup, or established enterprise, the original user's data and opinion goes unrewarded without proper incentives for earned interaction.

Persuasion for Whom? Traditional Incentive Models

Relying on the opinion of an actor who explicitly requires one's confidence and pursuant resources exacerbates problems. Especially in connection to centralized entities with profit-seeking motivations, the opinions of its workforce emanate from internal incentives to increase consumer confidence, brand identity, and profit. Rarely are independent company recommendations - contrary to financial performance - available for the end consumer who makes decisions. The seller's bias does not guarantee a satisfied customer, where a lack of satisfaction is not commensurate with the retrospective point of sale.

Result

These challenges result in bias and distortion, representing an enormous demand for change in the process of decision-making. Centralized actors maintain power constructs that shape the individual opinions of many, who then make decisions for the power preservation of those centralized actors. Systemically, this is shown in many facets of daily life. First, receiving an objective opinion from anyone is already difficult; trusting only one opinion categorically lacks diversity, and trusting many opinions without proper survey design skews results. Second, the information age provides everyone with nearly-unlimited information, yet targets user preferences and creates personally-uniform echo chambers to confirm beliefs, desires, and sentiments at the expense of diversity. Third, the information age has monetized user opinions and decisions (data points), where users are not incentivized for their honest, knowledgeable opinions. Fourth, opinions given from an interest-driven actor lack the necessary objectivity to confide trust in that actor. Without user diversity and independence - combined with feedback loops to nourish preferences over perspective and the wrong incentives for opinion sharing - decisions remains built atop a foundation of subjectivity and centralization. However, a recently-discovered approach in human history provides the potential to change such power constructs.

Wisdom of the Crowd

The wisdom of the crowd is already employed in prediction polls (Atanasov et al., 2015), prediction markets (Bassamboo, Cui and Moreno, 2015), internal company improvement policies, as well as in retail (Petro, 2018). However when discussing decentralized opinion markets, there are currently no solutions in the marketplace for all end users, as the phenomenon is only over one century old.

Sir Francis Galton published in 1907 "Vox Populi" or the voice of the people. In this article, Galton wrote "The material about to be discussed refers to a small matter, but is much to the point."[6] His results have slowly created a wave of fascination centered on his basic inferences, and have since become a much larger matter contrary to that assumption. Galton observed how close to the actual weight 800 participants could be regarding a "fat ox". In doing so, he realized the crowd's average response in its entirety (787 tickets examined) was closer to the actual weight than the responses participants who were "smarter" (averaged among the 25th and 75th percentiles, respectively).

In the 1920s, sociologist Hazel Knight of Colombia performed a series of studies. In one of her studies, students were asked to perform the simple task of estimating room temperature of the class. The group's average guess was 72.4 degrees Fahrenheit,[7] whereas the actual room temperature was 72. This basic and ingenuine phenomenon was analyzed in the 2004 book from James Surowiecki entitled "The Wisdom of Crowds". He describes with different studies why and when the community is smarter than one single participant in that community, a comprehensive analysis of what Galton, Knight, and others have since observed.

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[6] Galton, 1907
[7] Wisdomofcrowds.blogspot.com, n.d.

According to Surowiecki,[8] an intelligent community has several key characteristics:

- All participants should be able to have different opinions
- All members of the community should be able to build their individual opinion based on personal, local knowledge and/or from existing source knowledge
- The opinion of one person should be independent, uninfluenced by others in the environment
- There should be the possibility to sum up the individual opinions into a collective statement

Echoed by Soll, Mannes and Larrick (2011), "To tap into the crowd's wisdom, appreciating the roles of both knowledge and diversity are essential." Additionally, even though a crowd consisting of only 17 people might seem to be too small, the wisdom concept can efficiently work with less than 10 people.[9] With that in mind, Surowiecki examined situations where the wisdom of the crowd fails (e.g. bubbles within financial markets). He argues that in such situations, members of the crowd were too sure about the opinions of others, began to imitate and adjust, and ultimately did not make rational decisions. As examples, he mentions the "dotcom bubble" as well as the "US subprime crisis of 2007". Overconfidence and systematic extremes have also been observed as a precondition to bias for individual opinion formation.[10] [11]

Additionally, an experiment at ETH Zurich - under the guidance of university professors administered for 144 participating students - demonstrated reward incentivization and its impact on truthful opinions.[12] At the outset, all participants were made aware that they would receive a monetary incentive for responding correctly to a set of questions. From there, the collective wisdom was tested and considered among a control group and experimental group. Upon first trial, the control group (first half of students) responded to a question, and were informed after of the experimental group's (second half of students) responses to the same questions.

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[8] Surowiecki, 2004
[9] Wagner and Suh, 2014
[10] Bettman, Luce and Payne, 1998
[11] Bottom et al., 2004
[12] Lorenz et al., 2011

However, the experimental group was informed of the control group's responses before giving their own. It became apparent that in nearly all questions, the responses of the control group were better, on average. The more students knew about the responses of other study participants, bias impacted their opinions and responses became less reliable. Further, the researchers urged more experiments to take place where incentives played a larger role, because creating competition within a study's design for correct answers gives respondents a reason to truthfully and properly give an opinion. In total, the study highlighted independence and incentivization of respondents.

Summarized, to appropriately employ the wisdom of to crowd, the following factors should be considered:
- Diversity
- Knowledge
- Independence
- Decentralization
- Incentivization

Although there is a clear recognition of the power to provide substantive results with the wisdom of the crowd, there are supplementary scoring mechanisms and algorithms to bolster the results of collective statements.

Scoring Rules

Scoring Rules are used to measure the accuracy of probabilistic predictions. and are applicable to predictions with discrete outcomes. Prelec, Seung and McCoy (2017) introduced using the Brier function to calculate an 'objective accuracy score' to determine a user score.[13] In this function, users specify their confidence in detail toward a given statement. A user's score is determined by correctly guessing and indicating a certain confidence level. The more certain a user claims to be, the higher the score and hence the more a user can win. A user receives the highest incentive when a guess is correct at the highest confidence level.

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[13] Prelec, Seung and McCoy, 2017

Bayesian Truth Serum (BTS)

The Bayesian Truth Serum is a scoring method for eliciting truthful, subjective data in situations where objective truth would be unascertainable.[14] Additionally, it enables incentive-compatible game rewarding.

Under this scoring method, one must state personal answers for multiple choice questions, while also estimating the percentage of others' answers. The total score for a respondent, according to the BTS, is composed of two parts: the information score (accuracy of judgement) and the prediction score (accuracy of prediction to the judgement of others). This is expressed as follows:

Score for respondent "r" = Information score + Prediction score

Robust Bayesian Truth Serum (RBTS)

Witkowski and Parkes (2016) presented a Robust Bayesian Truth approach, aimed at minimizing the issue of the BTS for smaller groups.[15] Although in direct comparison of how this goal could be achieved, the algorithm lacks stability when it comes to higher numbers of participants. With larger groups, RBTS leads to a poor incentive to tell the truth. The main reason is that the algorithm uses two individuals as a reference to calculate, so the relative position will significantly affect the RBTS Score.[16]

Surprisingly Popular Algorithm (SPA)

The approach of the Surprisingly Popular Algorithm is quite new. The SPA wants to eliminate drawbacks and disadvantages associated with simple average methods: sometimes, too many people do not know the correct answer and leads to a collectively wrong result (Prelec, Seung and McCoy, 2017). Subjects are asked to express their opinion and additionally, predict the distribution of other people's answers. Subsequently, the algorithm chooses the response that is more popular than

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[14] Prelec, 2004
[15] Witkowski, J., Parkes, D., 2012
[16] Yang, Jia and Wang, 2016

originally predicted (i.e. the so-called surprisingly popular answer). Due to the fact that this is a new research topic, the algorithm is evolving. Although avoiding the Schelling Point is always a challenge, according to Robin Hanson the SPA is no exception to this reality.[17] Nevertheless, comparing the performance of other algorithms to the SPA leads to bolstered and stable results (Matoulkova, 2017).

Finnoq Solution

A decentralized protocol for collective opinion statements represents the solution to overcoming bias in opinion markets. By establishing the crowd as a driving force, we create a process by which collective opinions are formed and hence, better decisions can be made. This is accomplished by not allowing the opinion of centralized actors to dominate; by transferring the responsibility of opinion formation to a globalized, interdependent, and decentralized community, we leverage the wisdom of the crowd. The entire truth-telling incentive model is shaped in a way which allows every member of the crowd to give the best possible answer, Therefore, we use the Bayesian Truth Serum (Prelec 2004). Some of the upcoming parameters are not yet entirely defined by virtue of the high complexity level within the current development stage; these parameters are to be adjusted after an appropriate test phase. The basis of the entire protocol is built on the idea of "wisdom of the crowd" and a non-exhaustive list of algorithms such as the "Surprisingly Popular Algorithm" (Prelec, Seung and McCoy, 2017).

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[17] Hanson, 2018

Legend Finnoq specific terms

Finnoq Protocol

is the entire Finnoq ecosystem and consists of three Layers: Finnoq Core Layer, Service Layer and Application Layer.

FNQ Token

is the Token which is used for every value transfer within the entire Finnoq protocol.

Advisor

is part of the crowd, votes in opinion formation processes, and gets rewards for knowledge and honesty.

Market Creator

are the users from the different Applications who seek to ask a question to the crowd. This applies for all actors (people, organizations, companies, etc.).

Credibility Score

tracks the performance of Advisors over time. The higher the Credibility Score of an advisor, the higher is the reward that one can receive.

Staking Contract

is a Smart Contract where FNQ Tokens are securely locked for a specific time.

Opinion Formation Process

is the voting process determining how a collective statement is formed within the Finnoq protocol, beginning with the voting to the completed and ending with a collective statement from the crowd.

Blockchain

The blockchain serves as the basis for the entire protocol, and is necessary in order to create a self-regulating, open source ecosystem that is shaped by the Finnoq Core Layer in an optimally fair and secure way. The main functions of the blockchain are two-fold: safe reproduction of FNQ Staking Contracts and creation of transparent and forgery-proof votes (through Smart Contracts). Additionally, the blockchain serves as a basis for decentralized governance, where all changes in the protocol can be made.

Fiat to FNQ Exchange

Within the Finnoq protocol interface, a "fiat money to FNQ" exchange is available directly on the platform. This exchange allows easy access for any future stakeholder to obtain FNQ Tokens, and the service is to be performed by Coinfinity.
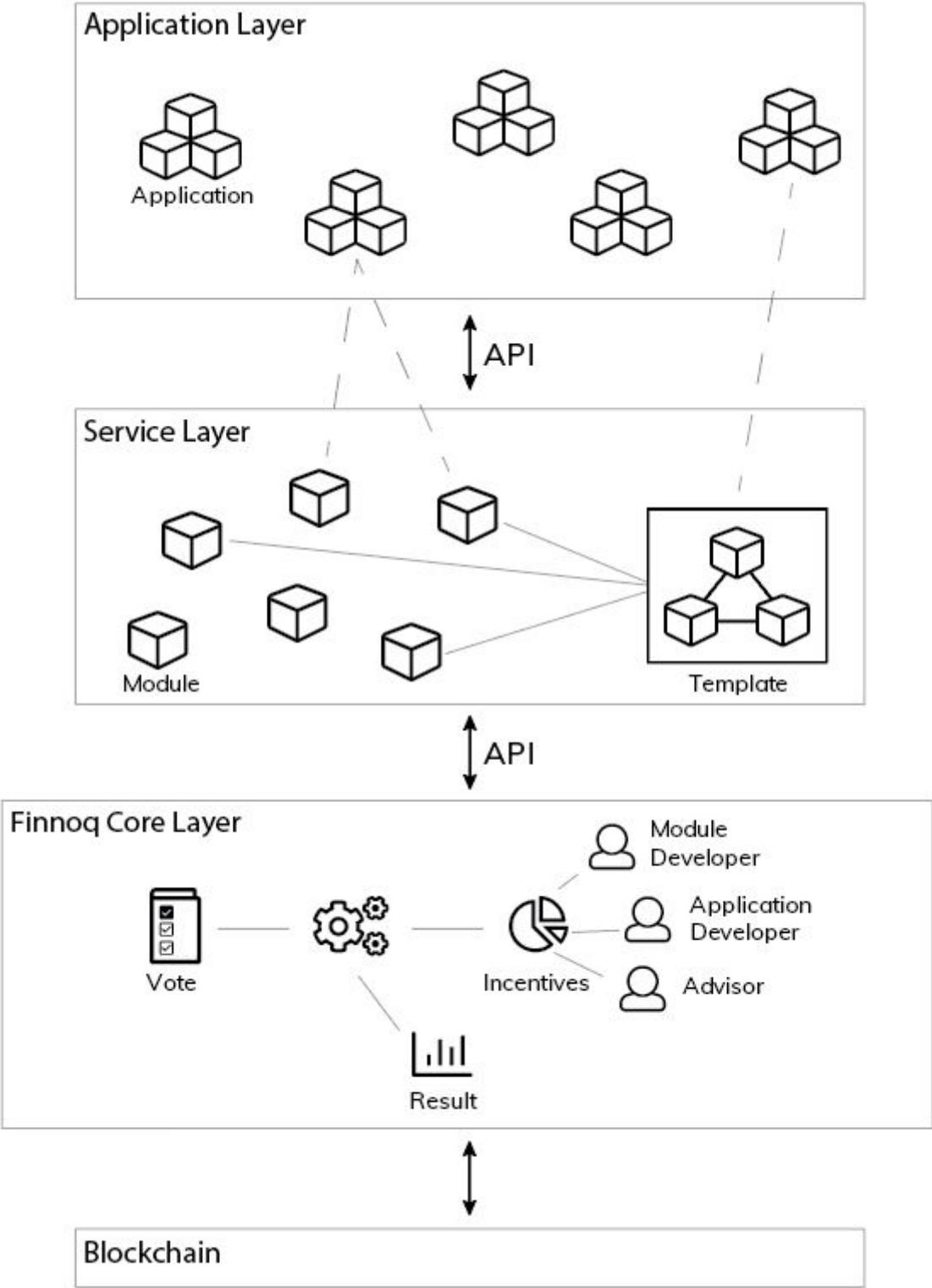
Finnoq Protocol Architecture

Figure 1: Finnoq Protocol Architecture

Finnoq Core Layer

The Finnoq Core Layer is the centerpiece of the protocol. It represents the basis and funnels single subjective opinions into a collective statement. An API is provided allowing communication between Finnoq Core and Service Layer. Opinion formation process takes place within the Finnoq Core Layer, including the evaluation of the results of opinions based on Surprisingly Popular Algorithm (Prelec, Seung, McCoy, 2017). Additionally, the calculation of Advisor-relevant parameters such as incentives, penalties and the Credibility Score is based on scoring rules and the Bayesian Truth Serum (Prelec, 2004).

Service Layer

In the Service Layer, different modules (e.g. question types, voting parameters, etc.) can be initiated and integrated by developers. Therefore, module developers need to implement provided interfaces to guarantee standardized API calls across modules. Modules represent logic blocks and provide the possibility to implement diverse functions. Several modules (at least two) can be connected, enabling standardized templates. Additionally, templates enable the possibilities for various use-cases to use modules with predefined parameters. Summarized, the Service Layer represents the overall functionality by allowing Application developers to easily reuse modules or predefined templates over time.

The following is a non-exhaustive list of possibilities:
- Ways of encrypting data (under "User Controlled Data")
- Adjust the reward distribution range based on the BTS Score (e.g. the best one, top 10 Advisors, top 20% of Advisors, etc.)
- Type of question (Fixed-Choice, Open Questions)
- Definition of the questioning (individual text)
- Advisors with a certain minimum credibility
- Time period of voting
- Advisors with a certain number of locked FNQ Tokens

- Definition of the target group and categories (Target groups can only be defined after a test phase, since it only becomes apparent which Advisors have knowledge in which subject field area)
- Randomness of Advisors
- Minimum or maximum number of Advisors
- Limitation of the answer options (Open Questions)

Application Layer

Applications connect Market Creators to the Finnoq ecosystem, and become the point at which opinion formation processes starts. Therefore, it is crucial that Applications provide an appropriate user interface, enabling users to interact. Developers can choose of a variety of provided modules or templates by calling the respective API, using already-tested functionality that is proven to execute.

One of the tremendous benefits for Application developers is the already-existing community, allowing Market Creators as well as Advisors participating in the opinion formation process to interact.

Stakeholder Roles

The following stakeholders are part of the Finnoq protocol.

Advisors

Advisors are stakeholders who answer questions in the opinion formation process, participate in votes and therefore, incorporate their knowledge. Thus, they represent a central role within the Finnoq Core Layer.

Definition 2.1 *(Advisor).*

$$A := \text{set of all Advisors}$$
$$a_i := \text{one single Advisor}$$
$$A = \{a_i \mid i \in \mathbb{N}\}$$
$$|A| = n \text{ number of all Advisors}$$

Everyone may become an Advisor. Requirements are that a certain number of FNQ Tokens are locked in a Staking Contract and proof that "Whitelisting" was executed. One factor of major importance is represented by the Whitelisting of an Advisor. Every FNQ Holder who wants to be part of the Advisor community needs to go through a Whitelisting Process, which is executed by drawing on the means of a Know Your Customer (KYC) procedure (i.e. verification of identity). This procedure serves, first and foremost, as a means to prevent multiple identities and to avoid sybil attacks; further, KYC ensures that one identity cannot have more addresses/accounts participating multiple times in voting processes. A plutocracy (the more Tokens, the more voting power) is unsuitable for the Finnoq protocol; hence, Whitelisting addresses for each corresponding identity is necessary to stop circumvention of our core principles. Once FNQ Holders finish the KYC procedure and transfers FNQ Tokens in a Staking Contract, they are authorized to participate in voting processes as an Advisor. In the future, this data is to be decentrally-stored (via IPFS, Swarm, etc.), with its hash immutably-written on the blockchain as proof.

Every Advisor has the possibility respond to available questions as well as participate in voting processes. Advisors have an easy to use interface to access to the protocol, and they are able to see the currently-solicited voting possibilities. For honest and knowledgeable participation in voting processes, Advisors are rewarded with incentives. The reward amount is evaluated in the Finnoq Core Layer, based on both the knowledge and objectivity of an Advisor pursuant to the Bayesian Truth Serum.

Module Developer

In the Service Layer, external developers can release modules to interact with the Finnoq Core Layer and provide extended functionalities for Application developers. In order to ensure compatibility between modules, the Finnoq Core Layer and Applications, provided interfaces and associated APIs have to be respected. Further, to verify that no malicious code can incorporate, modules have to be verified and confirmed by a board of professional developers prior to their inclusion (also via Whitelisting). Only after the verification of a module does incorporation into the

Service Layer take place. Subsequently, the developers of modules receive rewards for usage of an Application.

Application Developer

Every developer can build a personal opinion market as an Application on the Application Layer. All developers have access to an easy-to-use, standardized API while integrating all relevant modules or templates. For the release of the Application, the developer has to stake a certain amount of FNQ Tokens in a Staking Contract. The necessity of staking FNQ Tokens when releasing Applications serves primarily as protection against spam and harmful applications to the ecosystem. On top of this there is the possibility to report Applications, resulting in Applications being frozen and forcing the developer to forfeit FNQ Stakes (Blacklisting), as decided by FNQ Holders while voting on governance issues.

The Application developer can self-define their reward per usage, due to the tremendous number of use cases in which the Finnoq protocol can be used.

Market Creators/App Users

Market Creators are basically the users of Applications, or App users. This could be a single person or entity, depending on the kind of applications. The Market Creator starts the opinion formation process and receives a collective statement from Advisors. The reward to be paid to Advisors depends on the voting parameters as well as the principles of supply and demand.

Finnoq Team

The Finnoq team is responsible for the whole development of the Finnoq Core Layer, as well as implementing modules and templates within the Service Layer. Additionally, the Finnoq team supports other stakeholders in developing their own modules and Applications.

Opinion Formation Process

The process of opinion formation is crucial and a main element of the Finnoq protocol. This process covers all Applications.
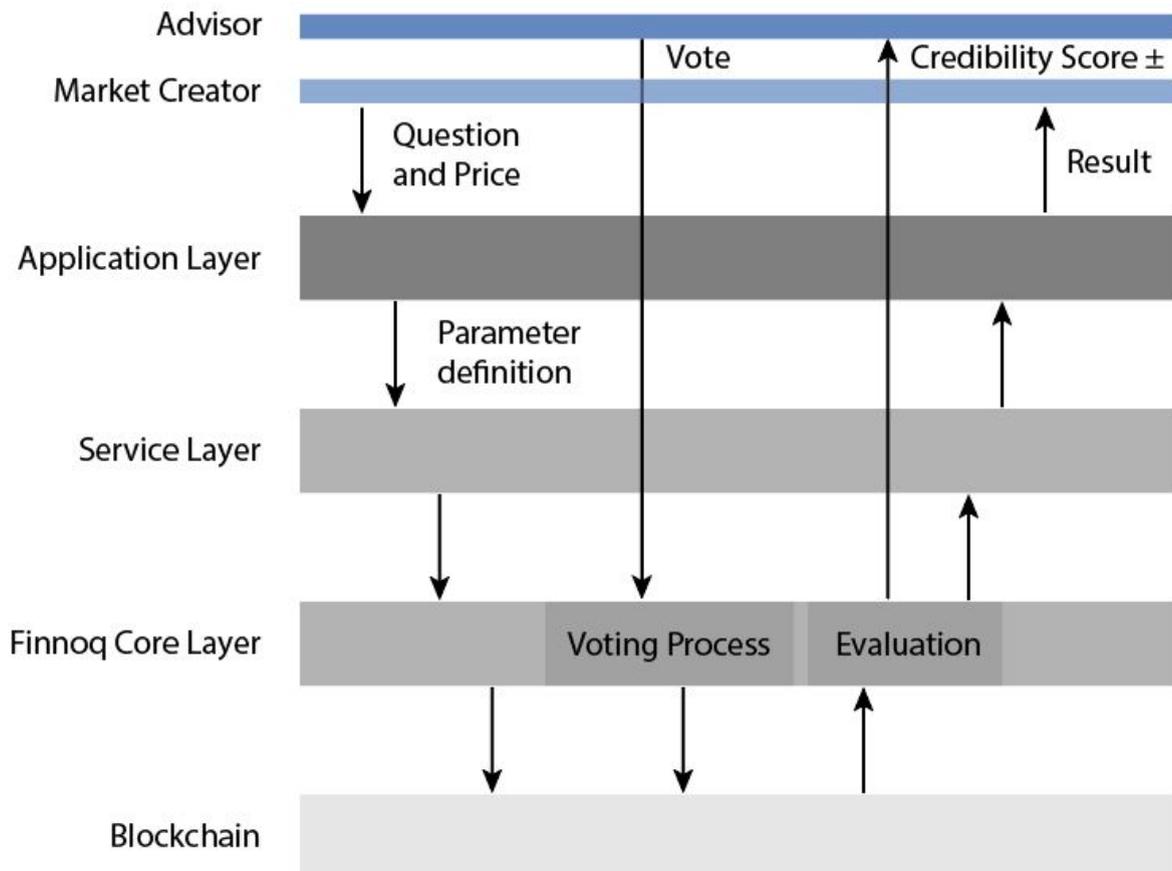
Figure 2: Procedure of Votes, chronological from left to right

In order to start a voting process, Market Creators must first define the kind of voting and/or question sought to ask Advisors. Further, Market Creators need to specify how much they are willing to pay (FNQ Tokens) for a collective vote. This procedure is called the "opinion formation process". The sum of FNQ Tokens a Market Creator is willing to pay for a vote is safely locked in a Staking Contract until the end of the voting process. At the end of the voting, the reward is distributed to the entitled Advisors.

Type of Question

In general, one distinguishes between at least two types of questions, both of which are available as Modules in the Service Layer:

Open Question

The Market Creator asks an individual question and defines the number of possible answer options, which then passes to the voting and verification steps. The Advisors can create their own answer options (maximum one answer per Advisor). As soon as the number of desired answer options is reached, the selected Advisors can vote on the available answer options. A respective reward is only given to the Advisor whose answer option in the voting is the "correct" answer, based on the Surprisingly Popular Algorithm. Thereby, rewards for the correct answer option are higher than those rewards for voting on other options. Those answer options which were judged "incorrect" in the voting process reduce the credibility as well as the set stake of the respective Advisor.

The following points serve as spam protection (e.g. when a Advisor has access to more accounts and automatically creates the maximum number of answer options):

- for every answer the Advisor has to stake FNQ Tokens and only one answer will win.
- the transaction costs per vote (gas costs)
- the Whitelisting process

Fixed Choice

The Market Creator asks a question with predefined answer options, which are directly voted on (e.g. rating of finance products → AAA, AA, A, BBB, etc.). As part of the opinion formation process, the Market Creator can also select multiple voting parameters, pre-defined by the Application.

Voting Process

Upon setting up how the voting processes should appear, the Market Creator states how many FNQ Tokens to pay as reward to the participating Advisors. Advisors only participate in votes if they are to be paid accordingly and receive a reward according to the parameters. The reward per voting can be freely defined by the Market Creator. If there is a too low number of FNQ Tokens offered by the Market Creator for the desired request, there is a higher probability that the request will go unfulfilled by Advisors. Only competitive offers are selected by an Advisor, since the market is determined by supply and demand. Therefore, price equilibrium is established over time. Due to the fact that the determination of a fixed price is impossible in practice, the Finnoq protocol provides a current price suggestion based on the parameters selected and current market prices within the system. During a voting process, the selected Advisor group receives the question with pre-defined parameters as well as the possible rewards within the Finnoq Core Layer.

Based on the Surprisingly Popular Algorithm, three items are solicited during the voting process:
- Personal vote according to the question (one's own opinion)
- Percentage confidence in answering the question
- Percentage estimation of others' answers

These three questions enable the calculation of the Surprisingly Popular Answer and are the basis for calculation of the corresponding truth telling incentives such as the Bayesian Truth Serum score and objectivity accuracy score. These three basic questions are the foundation for evaluating any single-processed vote.

While voting occurs, no Advisor can see how other Advisors voted (secret vote). After the voting process is complete, the result is published. The entire voting process and result are executed pseudonymously.

To ensure a secret voting process, an adapted version of the ENS (Ethereum Name Service) bidding process is fulfilled. In the future, we are working on a voting process based on zero-knowledge proofs.

The paid reward - minus the accumulation of Application, module, and Finnoq protocol fees of the asking Market Creators - is delivered out to Advisors who provided "correct" answers or voted "correctly"(pursuant to the Surprisingly Popular Answer). The final reward corresponds to the number of staked FNQ Tokens, BTS score, and Credibility Score.

Outcome

Once the voting process is over, collected votes are evaluated in the Finnoq Core Layer based on the principles of the Surprisingly Popular Algorithm (SPA). The Surprisingly Popular Answer gets published as a result, and the computation for truth-telling incentives such as BTS Score and Credibility Score starts.
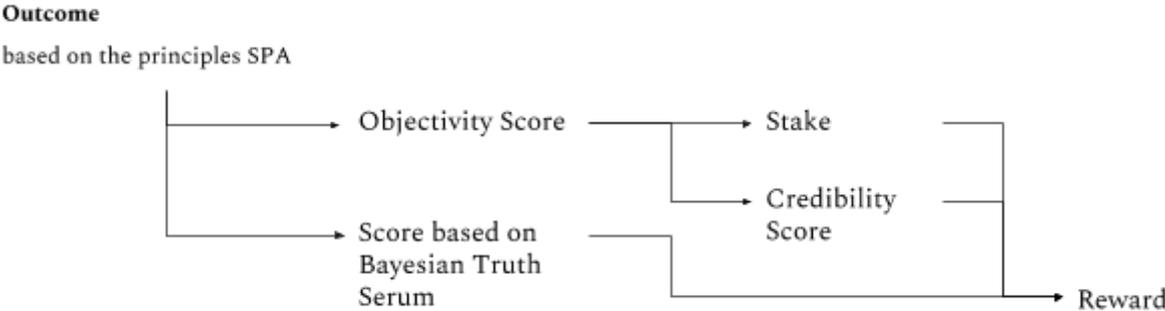
**Figure 3: Outcome influencing system parameters**

Rewards Distribution

Rewards are a vital crypto-economic instrument; in order to create the appropriate truth-telling incentives for all stakeholders and thereby, to reach the best possible collective statement. Rewards exist in every opinion formation process, and are financed by Market Creators of the different opinion markets.

All Application developers can determine how many FNQ Token shares they want to receive per voting. However, they should take into consideration that a steep price might result in detrimental outcomes. The share of a reward for protocol developers (Finnoq team) and module developers is fixed and predetermined. In the case of a selected reward too low leading to no result or too few participants (> minimum), a part of the locked reward is kept and distributed to the Advisors who have already participated. After fixing the reward, standard voting takes place in the Finnoq Core Layer by the selected Advisors.

These FNQ Stakes are then distributed to all eligible FNQ stakeholders. Due to currently high transaction costs of the Ethereum network, the rewards are paid out from a minimum amount. To encapsulate the process, the received rewards of the stakeholders are saved in a Smart Contract (reward pool). However, rewards in this case are only then transferred as soon as the minimum amount of FNQ Tokens are reached. So long as the Tokens are in the pool and remain untransferred to the FNQ Holder, such Tokens are ineligible for future votes as well as for the calculation of the rewards until transfer takes place.

**Rewards are distributed to the following stakeholders:**
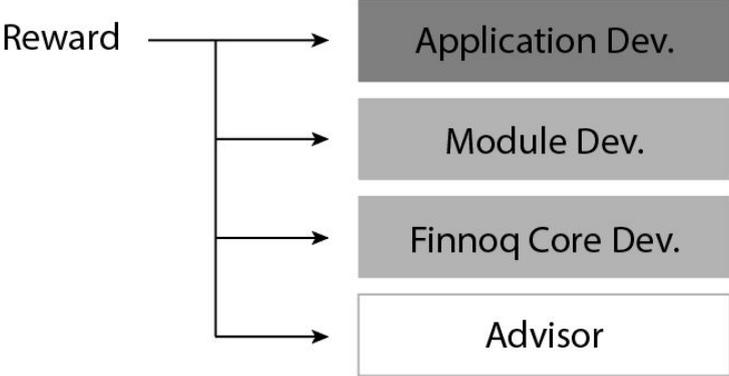
Figure 4: Rewards for Stakeholders

Credibility Score

Based on the final outcome, an "objectivity accuracy score" is calculated based on the given answer and the stated confidence level of an Advisor. Therefore, scoring functions such as the Brier scoring function can be used to calculate a score after each fulfilled voting to suitably adapt the Advisors' Credibility Score. In the long run, this ensures that advisors will only receive a higher Credibility Score if their answer reflects their confidence. The Credibility Score is part of the reward calculation for an Advisor.

Every Advisor begins initially with a Credibility Score of zero, an initial Score of $c_i = 0$. With every vote, the Score is increased/decreased accordingly.
In case of being "incorrect", the penalty climbs much faster than the gains. In general, expressing too much confidence leads to a lower score.
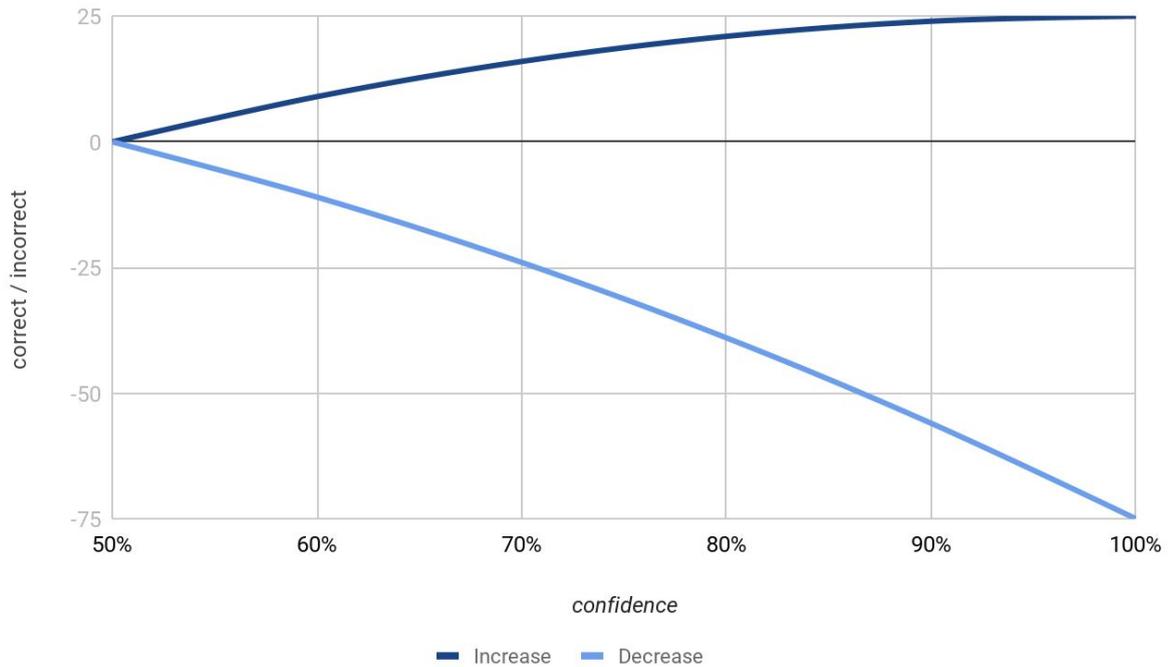
Figure 5: Credibility Score changes based on given confidence

Definition 2.2 *(Credibility Score).*

ci := the Credibility Score of an Advisor (a_i)

$c_i(t)$:= the Credibility Score of an Advisor (a_i) at the point in time t

FNQ Staking Function

General FNQ Stake

Advisors need to lock up FNQ Tokens for a free, definable time period in order to participate in the opinion formation process and hence, be eligible for rewards. Further, developers of Applications on top of the Finnoq protocol stake FNQ Tokens. At that moment however, a minimum time and amount for staking FNQ Tokens needs to be taken into consideration. The reason for this is the sustainable assurance of sound decisions as well as the reduction of speculation deriving from stakeholders. The longer FNQ Tokens are locked in the Staking Contract, the amount for rewards increases. In the event of a premature dissolution of the Staking Contract, a part of the stake from corresponding stakeholders is retained and distributed to the FNQ

Stakeholders; in other words, the amount to be rewarded for the expected time period is not distributed in full, but rather in correspondence to the time for which the contract was staked.

Definition 2.5 (FNQ Tokens).

C := number of all FNQ Tokens

c_i := number of the Tokens of one FNQ Holder

$c_i(t)$:= number of the Tokens of one FNQ Holder at the point in time t

$|C| = m$ number of all FNQ Tokens

$$m = \sum_{i=0}^{|S|} c_i$$

Definition 2.6 (FNQ Stake).

F := number of all locked FNQ Tokens

F_t := number of all locked FNQ Tokens at point in time t

$F, F_t \subseteq C$

f_i := number of locked FNQ Tokens of one Advisor (a_i)

$f_i(t)$:= number of locked FNQ Tokens of one Advisor (a_i) at point in time t

$|F| = k$ number of all locked Tokens

$$k = \sum_{i=0}^{|S|} f_i$$

$|F_t| = j$ number of all locked Tokens at the point in time t

$$j = \sum_{i=0}^{|S|} f_i(t)$$

$|F_t| \leq |F| \equiv j \leq k$

Stake per Voting Process

Every Advisor has to stake a freely-definable "substake" (<= general stake) for every participation in an opinion formation process. Advisors win or lose the stake depending on the objectivity accuracy score, on a per vote basis. The same function is used in determining the Credibility Score.

In general, the more confident an Advisor is, the more an Advisor could win or lose. That is to say that when an opinion turns out to be the Surprisingly Popular Answer, coupled with more staked FNQ Tokens the Advisor has compared to others, determines the reward. Otherwise put, if an Advisor is part of the Surprisingly Popular Answer, he receives additional rewards commensurate to stake of the "incorrect" Advisors and the respective staking determined by the "correct" Advisors.
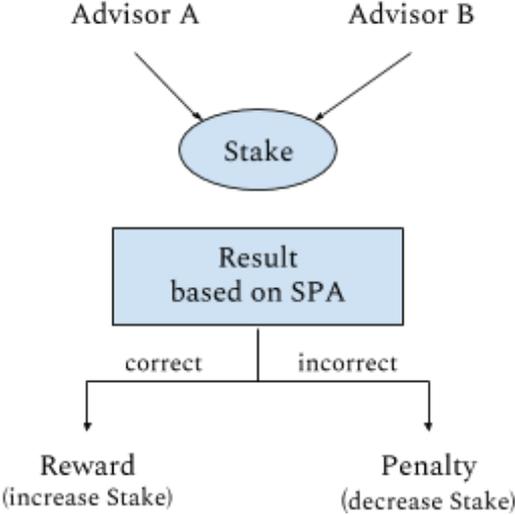
Figure 6: Staking Process

Use Cases

Developers can build Applications on top the Finnoq protocol and provide decentralized opinion markets for Market Creators to make better decisions. Such opinion markets are found in all aspects of daily life, and the Finnoq team perpetually discusses the myriad of ways to use the protocol. Currently, Finnoq is able to provide concrete examples leveraging the Finnoq protocol's ingenuity for better decision-making.

App developers and Market Creators can have opinion formation questions that range from simple to complex, such as:
- Fixed-choice(s)
- Open (with or without follow-up explanation)
- Fixed yet open (i.e. "Could you describe with three adjectives…?")
- Tiered rankings
- Weighted responses (% given to each among a certain list of choices)
- One/many response periods

As a final consideration, kindly note that Applications are subject to local jurisdictions. Where the developer and Market Creator are located determines how Applications are legally considered; both developer and Market Creator are responsible for obtaining the necessary legal information prior to any interaction any with the Finnoq protocol.

This is a non-exhaustive demonstration of use cases.

Collective Ratings

Generating decentralized, collective ratings is a pervasive use case across sectors; Finnoq's current focus is rating financial assets and crypto assets. Market participants are subject to biased, incomplete, and sometimes misleading opinions from centralized and self-interested actors. Population segments accept these

promulgated and diffused opinions within markets, collectively shaping market behavior steered by individual decision-making. Such behavior creates economic recessions/depressions, systemic failure, cyclical bubbles, extreme price volatility, and retrospective scams. Under these scenarios, all participants can suffer, powerful and other. By creating an Application to produce decentralized opinion formation for ratings, Market Creators make better decisions to channel more sustainable markets.

Example questions for collective opinion formation could be as follows:
- *"What rating would you give this financial asset/crypto asset within the entire market?"*
- *"When considering sector ABC/key issue XYZ, what rating would you give this financial asset/crypto asset?"*
- *"When considering the entire market/sector ABC/key issue XYZ, could you rank - from worst to best - the five following financial assets/crypto assets (five being the worst, one being the best)?"*

Financial Advice for Evaluation

Market Creators can utilize the Finnoq protocol for financial products and services. Financial advisory firms rely on internal and/or outsourced data to provide customer solutions in financial planning. Whether it be for retirement or financing business expansion, the data used to generate a firm's underlying profit is interest-driven, highly-centralized, and relayed to the customer in a sales pitch.

Within a business-client relationship, "win-lose" situations arise when the firm profits from selling imperfect products and services to the client. The result is resource loss for the customer with no direct consequence for the firm. Even if customers can cease receiving advice from the firm, firms can create deceptive contracts to charge exorbitant fees for exhausting the firm's service prematurely. Hence, to rely on the sales pitch of a singular, self-interested actor out of company survival adversely impacts end customers.

Alternatively, the Finnoq protocol creates "win-win" situations; each Advisor remains uninfluenced, decentralized, and incentivized to give an honest opinion. The protocol promotes truth-telling incentivization from the crowd to Market Creators by imparting collective wisdom. Thus, evaluating financial products and services through an App more adequately yields better information before making transformative decisions.

Example questions for collective opinion formation could be as follows:

- *"Of the five financial products listed below, which one of these products best suits my needs?"*
- *"Which two financial products would you choose for a 67-year old/22-year old, recently retired factory worker/college graduate?"*
- *"Of the five financial products listed below, could you rank these products from most useful to least useful (five being the least useful, one being the most useful)"?*
- *"Of the ten financial products and services listed below, could you select the three most important for a startup/small business owner/established company?"*
- *"Of the financial products and services listed below, could you create a portfolio among them, with corresponding percentages for how you would use my resources?"*

Industry-Specific Market Surveys

Properly-designed, cost-saving market surveys for sound feedback, streamlining corporate strategy, and meeting critical objectives can be done on the Finnoq protocol. Traditional market research is only as effective as its methodology, execution, and evaluation; several obstacles can hinder the ability to acquire reliable data for meeting those objectives.

Unintentional bias from a survey, with flawed methods and partially-skewed questions, creates results contradictory to participants' opinions. They can intentionally or unintentionally influence one another (unbeknownst to the paying customer), producing unreliable data. Finally, participants lacking truth-telling incentivization or negative consequences do not always give honest responses. In all

scenarios, the end customer pays for a service that is not guaranteed to provide optimal results.

Alternatively, the Finnoq protocol is able to efficiently, affordably, and accurately deliver surveys for companies. First, by selecting proven modules and templates from the Service Layer, survey design influence is circumvented. Second, by building on the blockchain, Advisors remain independently uninfluenced by each other. Third, Advisors are given truth-telling incentives and consequences to provide honest, unbiased opinions to Market Creators.

Example questions for collective opinion formation could be as follows:

- *"Which brand in sector ABC has captivated your attention most in the last six months?"*
- *"Which brand - among the ten listed - is currently captivating your attention the most (seven opinion formation processes over the next 35 months)?"*
- *"Thinking about the logo of company QRX, which of the following best describes your feelings about it (five answer choices)?"*
- *"When considering sector ABC, which brands come to your mind?"*

Idea Generation for Product Development

The Finnoq protocol can also be used to receive robust feedback for technical documentation, prototyping, and final product creation. Along the product development process, from whom and how product developers receive information about an idea profoundly impacts its success.

Product developers receive input from too few people who bring bias and a narrow focus to provide reliable advice. A handful of "expert" opinions might guarantee a perfectly-crafted prototype, but a defective product unable to meet the needs of consumers. When competing in local or national markets, divulging an idea can lead to appropriation by experts in that locale, where they might have better resources, networks, and competencies to launch the product before the original releases.

Irrespective of phase, a decentralized crowd - bringing diversity and understanding the steps required to achieve the goal - can share its unbiased opinion to a product developer. With an App built on top of the Finnoq protocol, a product developer becomes a Market Creator to harness the opinions of many and move the development process forward. The Market Creator can receive the wisdom of the crowd by posing questions on product development, simultaneously ensuring personal anonymity and minimizing appropriation in local markets.

Example questions for collective opinion formation could be as follows:

- *"Considering the demonstrated product/prototype: of the five features listed below, which one of these features do you like the most/least?*
- *"Considering the demonstrated product/prototype: of the five features listed below, could you rank these products from most useful to least useful (five being the least useful, one being the most useful)"?*
- *"Considering the demonstrated product/prototype: what changes/improvements could be made to increase functionality (four opinion formation processes over the next 20 weeks)?"*

FNQ Token Usage

The FNQ Token is the core of Finnoq and serves as fuel for the whole ecosystem. FNQ is an ERC20 Token and runs on the Ethereum blockchain. FNQ serves many functions: formulation of collective opinions (Participation), transfer of value across the ecosystem (Value Transfer), and voting on the future of the protocol (Governance). The FNQ Tokens connect all stakeholders to a self-regulating ecosystem. All FNQ Tokens are produced and distributed at the Token Generation Event (TGE). The number of FNQ is scarce and cannot be changed afterwards.

Participation

The FNQ Tokens authorize votes within the Finnoq protocol. Incentivized to tell the truth and form collective opinions, Advisors bring their knowledge to the protocol. As opinions are requested, work is individually executed by Advisors. In order to be

part of the network and to receive rewards, all stakeholders (Advisors and App developers) have to deposit FNQ Tokens in a Staking Contract for a free, definable amount of time. Thereby, more FNQ Tokens are removed from the market into Staking Contracts, causing a smaller supply. Further, as usage of the Finnoq protocol increases, so does demand. This is a positive phenomenon for the value of FNQ Tokens.

Value Transfer

The FNQ Token serves as means of value-transfer within the Finnoq ecosystem. Every "opinion formation process" is executed in FNQ as well as the associated rewards for each stakeholder. Thereby, the liquidity is increased because of higher token velocity (defined as the number of how often a token changes its owner), enabling effective trade and access of the available FNQ Tokens (circulating supply).

Governance

All decisions and changes in the Finnoq Core Layer are made by the FNQ stakeholders. A prerequisite is that FNQ Tokens are locked in a Staking Contract for a certain time. Consequently, everyone has the possibility to become part of the governance process. The FNQ Token thus represents and doubles as a governance authorization.

Conclusion and future outlook

Blockchain Agnostic

Initially, the Finnoq Core Layer is built on the Ethereum blockchain, because it is currently the most-tested and secure platform for Smart Contracts; moreover, Ethereum currently has the biggest developer community.

User Controlled Data

It is the aim for all of the data created through the protocol (voting results, Credibility Score of the participants, personal data of the stakeholder, etc.) to be stored, decentralized and cryptographically encrypted (IPFS, Swarm). The hash of the data is subsequently written as proof on the blockchain, in order to guarantee both transparency and simultaneous anonymity. In the future, all users - at their discretion - will have the option to monetize the created data and to receive an according reward for doing so. Additionally, a user who wants to use this data can select, via an interface, the offered desired data. In order to have the data decrypted, the user has to pay FNQ Tokens. The payable FNQ Tokens are subsequently distributed to the respective users. Thus, all Advisors can profit from their work in the long run.

Decentralized Governance

All stakeholders in the Finnoq Core Layer can participate in the governance process. Every FNQ Holder, who has locked a minimum number of FNQ Tokens, can publish proposals e.g. suggestions for further development of the protocol.
Numerous processes in connection with Black- or Whitelisting are community-based and are decided by the FNQ stakeholder (FNQ Holder with locked FNQ Tokens). Additionally, a certain minimum number of participants must fundamentally participate in the voting. In case of not reaching the number of minimum votes, the

proposal is rejected from the outset. However, after a certain time period, the proposal can be voted on again.

Roadmap

February 2017 – Foundation of Finnoq GmbH
The company Finnoq was founded by Florian Kögl and Georg Felber in Linz, Austria under the legal statute GmbH (limited liability company).

March 2017 – Admission to the Tech2b Incubator Program
Finnoq was ranked among the Top 15 start-ups among all submissions. The Tech2b Center is one the leading incubators in Austria.

May 2017 – Seed Round Financing from OÖ Gründerfonds
Finnoq received Seed financing from the OÖ Gründerfonds.

September 2017 - Launch of the Finnoq Consulting Platform
On this platform users can inform themselves about different financial topics and get in contact with finance consultants via modern communication tools. It is accessible under advisor.finnoq.com.

November 2017 – Conceptualization of the Finnoq Protocol
Drawing on our experience gained from the consulting platform, the concept and first steps to realize the Finnoq protocol - aimed at a decentralized and independent advisory process - were rolled out.

Q3 2018 – Launch of Finnoq Alpha
The Finnoq Alpha version should visualize a first use case and give future advisors a first impression of the "opinion formation process". Thereby, users can vote about different topics like rating crypto assets. The Alpha version is available on the Test net and after the voting, users who voted on the surprisingly popular answer receive rewards.

Q3 2018 – FNQ Token Sale

The FNQ Token to be sold in a token sale to future users of the Finnoq ecosystem

Q1 2019 – Finnoq Core Layer Testnet

The Finnoq Core Layer is available on Ethereum Testnet. Developers are able to test functionalities and bugs can be fixed.

Q2 2019 – Establish a Foundation for the Finnoq Protocol

In order to ensure the complete development of the Finnoq protocol as well as the FNQ holders, a legal foundation is established. The Finnoq GmbH serves thereby as a development provider for the project.

Q3/Q4 2019 – Launch Finnoq Protocol

The first version of the Finnoq protocol will be published. Thereby, the first modules and Applications can be build on top.

Q4 2019 – Ecosystem Fund

The first projects who use the Finnoq Core Layer as its basis are supported by the ecosystem fund. That strengthens the whole ecosystem.

Acknowledgement

The greatest thank you goes to the blockchain community. Without such an impressive basis created in these last years, we would not be working on decentralized opinion markets today. We would like to express our profound appreciation, thanking all who contributed to the creation of this document. For those who go unmentioned in this document, your effort in turning innovative ideas into realities is not forgotten. We would also like to thank our sponsors from day one, with the Tech2b Incubator leading the way. Finally, our research partner RIAT the Institute for Future Cryptoeconomics has been integral in stress-testing the Finnoq protocol concept, and RIAT has provided necessary and substantive feedback in preparation of this document.

Legal Disclaimer

At the point in time of publishing this Whitepaper, FNQ Tokens have noy potential usage outside of the ecosystem of the Finnoq platform and are expressly prohibited from being sold to any third-party provider stock exchanges or traded elsewhere. This Whitepaper does not represent a suggestion that Finnoq, including its managing employees, directors, managers, co-workers, representatives and consultants or other persons as recipients of this document, participates in the token sale. Participation in the sale of tokens is associated with both tremendous and unique risks, causing a total or partial loss of such an investment. Emphatically, we urge participants too not engage in the token sale unless they are willing to potentially lose the entire amount assigned when purchasing FNQ Tokens. FNQ Tokens should not be obtained for speculative or investment purposes in the hope of making profit or immediate resale. Regarding FNQ Tokens, no promises concerning a future value trend or value are made, including: the assurance of inherent values; the acceptance of ongoing payments; and the guarantee that FNQ Tokens possess a certain value. Provided that potential participants do not fully comprehend and accept the essence of FNQ and the potential risks, they should not participate in the Token sale. FNQ Tokens are not to be structured or sold as a security. FNQ Tokens are not equivalent to participating in Finnoq. Further, FNQ Tokens do not have any rights with respect to Finnoq. FNQ Tokens are sold as a functional good and all earned income from Finnoq can be spent by Finnoq, without fulfilling the described conditions in this Whitepaper. This Whitepaper neither is a brochure nor a document for disclosure. It neither represents an offer for sale nor an invitation for purchase of any investment or financial instrument within a legal framework; the Whitepaper should not be treated as such. This Whitepaper only serves as information. A written permission is required for the sale of all contained parts therein. All future-oriented information is of a speculative nature and can change, unrestricted to the market value of cryptocurrencies. The speculative nature of such information is due to numerous external influence factors, including technological innovations, regulatory factors, and/or currency fluctuations. This Whitepaper serves only the purpose of

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Finnoq has neither independently verified the data mentioned in this Whitepaper of third parties nor investigated the underlying presumptions on which the source is based. Please keep in mind that Finnoq currently executes a simple legal and regulatory analysis of the functionality of its FNQ Tokens. After completion of FNQ Token analysis, Finnoq can decide to change the intended functionality of its FNQ Tokens to guarantee the conformity of all underlying legal and regulatory requirements. In case Finnoq decides to change the intended functionality of its FNQ Tokens, Finnoq intends to update the relevant contents of this Whitepaper and publish an updated version on its website. Any FNQ Token could be harmed by regulatory measures, including potential restrictions concerning usage or possession of tokens. Regulators or other circumstances can harm any assurance or warranty regarding the: marketability; suitability for a certain purpose; applicability; pay; title; or non-injury that the content of this document is correct and without errors. Such content does not harm the rights of third parties. Finnoq is not liable for damages of any kind, which result from the usage, reference or the trust regarding the content of this document, even if the possibility of such damages was indicated. Regulators or other circumstances may demand the total or partial functional change of the FNQ Token. Finnoq maintains the right to revise FNQ's function, in order to comply with regulatory, other government, or business requirements. Nevertheless, Finnoq believes to have undertaken all economically reasonable steps in order to safeguard

that the planned functions are correct and compliant with currently applicable laws, regulations, and rules.

ATTENTION REGARDING FUTURE-ORIENTED STATEMENTS

This Whitepaper contains future-oriented statements and/or information (summed up "future-oriented statements"), which refer to current expectations and perceptions of Finnoq concerning future events. In some cases, these future-oriented statements are expressed by words or expressions, such as "can", "will", "expect", "anticipate", "target", "estimate", "intend", "plan", "search", "believe", "possible", "proceed", "is/are likely" or the negation of these terms or other similar expressions, which should mark future-oriented statements. Finnoq based these future-oriented statements on its current expectations and forecasts about future happenings and financial trends, of which it believes that they can impact its: individual financial situation; business results and strategy; financial needs as well as the results of the token sale; and the value and/or the price stability of the FNQ Tokens. This Whitepaper contains future-oriented statements, which refer primarily to Finnoq's suggested business model. The model discusses its goals and is no prognosis, projection or forecast of future business results.

Future-oriented statements are based on certain assumptions and analysis drawing on Finnoq's experience, perception of historical trends, current conditions and expected future developments, as well as other factors. Such future-oriented statements are considered appropriate, given the underlying risks and uncertainties. Although future-oriented statements are based on presumptions in this Whitepaper, which Finnoq considers appropriate, these risks, uncertainties, presumptions and other expectations can deviate substantially from the actual results, performances, successes and experiences of Finnoq. Considering such risks, the participants in the token sale should not rely too much on these future-oriented statements. The risks and uncertainties are also mentioned in the token sale requirements. This is not a final list of all factors, which correlates to the contribution of Finnoq in connection with its business activity. Finnoq does not oblige itself to update future-oriented statements, in order to reflect happenings or circumstances after the date of this

Whitepaper. The business activity of the company underlies in countries with different rules and laws in which it is active or intends to be active. There is a risk that certain activities of the company are considered as violation of such laws or rules, depending on the country. Penalties for such possible violations are at this time unknown. In addition, changes of the applicable law, rules, or new interpretations of existing laws, might lead to certain circumstances to increased conformity costs or investments, harming the profitability of Finnoq or the ability of Finnoq to further pursue the business and FNQ Token model as suggested in this Whitepaper.

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