A bulky academically written paper for a part in a technical whitepaper

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Contents

Part I
On user-curated content on decentralised platforms

(This part ought to be included in a document with several parts.)

1 Introduction and review of existing platforms

1.1 Motivation

In this paper, we advance the discussion of voting systems on distributed ledgers such as blockchains. The core benefit of such frameworks is that vote-casting and voting-result-computation is perfectly transparent and thus always audible. More concretely, we will not study the consensus protocols enabling the decentralised voting system themselves, but instead review and propose

- algorithms for poll evaluations resulting in a sorted list
- innovations made possible through the underlying audible framework.

The former can manifest as a mechanism for the evaluation of opinions invoked by the voters, which, taken together, result in an average ranking. One of our main motivations here is the design of a voting system for a dApps store. So while the subject of the poll algorithms discussed may be anything from politicians to fruits, we will consider the rating of software applications. The vote casting actors will thus be referred to as ‘users‘ and correspond to whitelisted addresses on the decentralised ledger. The whitelisting itself doesn’t need to be the result of a decentralised process.

In this context, the most notable innovation that comes with audible polling is the notion verifiable claims for rewards based on “on-chain“ actions. For each poll or voting round, the final result can be put in context with the individual user’s vote and thus used to compute a transparent reward claim tied to the user address.

A notion of reward can be realised in various forms, such as cryptocurrencies, coupons, powers or rights on the platform exposure for promotion.

1.2 Resources and literature

The mathematics of voting and elections: A hands-on approach.

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###### Why voting dApps isn’t voting parties
The "Handbook of Electoral System Choice" (by Josep M. Colomer, Georgetown Universi

Furthermore, we don’t have winners as such, but instead obtain exposure.

###### "Electorama" Wiki
This wiki is designed to give "election-minded" people an overview of different ele
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* Main page
https://wiki.electorama.com

* All pages:
https://wiki.electorama.com/wiki/Special:AllPages

"Electoral Knowledge Network" website
This website provides information and customised advice on electoral processes.
The "Administration and Cost of Elections" (short: "ACE") - Projects promotes elect
Besides other information, the website contains global statistics and data and an E
http://www.aceproject.org/
http://aceproject.org/ace-en

Wikipedia:

TODO

2 On commercially used ranking systems today

2.1 Retailer sector

* Amazon:
Ranking factors: (https://startupbros.com/rank-amazon/)

*Conversion Rate Factors:
- Sales Rank
- Customer Reviews
- Answered Questions <--- add as factor to platform highlight algorithm
- Image Size & Quality
- Price
- Parent-Child Products
- Time on Page & Bounce Rate
- Product Listing Completeness

* Relevancy Factors
- Title
- Features / Bullet Points
- Product Description
- Brand & Manufacturer Part #
- Specifications
- Category & Sub-Category
- Search terms
- Source Keyword

* Customer Satisfaction & Retention Factors
- Negative Seller Feedback
- Order Processing Speed
- In-Stock Rate
- Perfect Order Percentage (POP)
- Order Defect Rate (ODR)
- Exit Rate
- Packaging Options

* ebay:
+) evaluation of sellers (quite simple):

standard evaluation, given by verified buyers:
-positive vote: + 1 point
-neutral vote: 0 points
-negative vote: -1 point
-one vote per buyer per week (Mon- Sun) is counted
-13 different levels of rating of the sellers, symbolized by differently coloured s

detailed evaluation, may be given after the standard evaluation:

-1-5 stars (voting points) for each of 4 categories (article, communication, sender
-independent from the standard evaluation, doesn't affect it
-one rating per purchase possible
-is are shown only if there are at least 10 detailed evaluations

+) evaluation of buyers (unimportant for nOS-purposes)
-buyers can be evaluated by the sellers, but only positive votes are possible

evaluations can be edited if both parties do agree

+) evaluation of products:
-1-5 stars (5 being the best)
-in addition, there are 3 product-specific questions to answer (yes/no)
-the average of the stars-rating and the percentage of positive answers to the ques
-also, people can write reviews; reviews can be given a positive or negative vote o

(sources: https://pages.ebay.de/help/feedback/howitworks.html, https://verkaeuferpo

2.2 Information sector

2.2.1 Q and A platforms

* StackExchange
* Quora
* Reddit

2.2.2 News platforms

2.3 Entertainment sector

*) VotingPlugin
(some plugin for Minecraft)
allows one to give his players rewards by voting for his servers;
types of rewards:
-) for votes for one site
-) for voting on all of some specified sites
-) for the first vote
-) cummulative reward (vote x amount of times to be rewarded (per day/week))
-) for voting x number of times in a row
-) for x amount of global votes
(source: https://www.spigotmc.org/resources/votingplugin.15358/)

2.4 Blockchain sector

* Lisk voting, earnlisk.com

* augur "reporting": 50% ROI
* Gnosis
* reward voting 7.0
* openbazaar
* repu-coin
* odem.io
* riskbazaar
* drep.org
* stackexchange

2.4.1 Lisk

-)delegate proof of stake --> one earns lisk by voting for delegates who share thei
-)4 batches max. 33 votes (max. 101 votes at altogether) to participate;
-)to participate at a batch, one has to pay 1 lisk, which has to be in the lisk-wal
-)(Open question: what happens, if voted delegators don't win --> is the paid lisk
(source: https://earnlisk.com/)

2.5 User experience

(reflect on the above and what we want)

3 On voting

We want to tap into the rich pool of established knowledge on voting voting systems, to inform our options and guide our decisions in designing suitable algorithms. In this section we recall the basic established definitions and properties and the reflect upon our needs.

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3) We're first going to give an overview of
* properties of voting systems (viewed on their own)
* (differentiation between) popular existing voting systems.
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3.1 On existing voting systems

One way to measure the fairness of a given voting system is to determine some properties that the system should satisfy. Commonly, the three properties that a voting system should fulfil in order to be fair are anonymity, neutrality and monotonicity. For two-candidate elections they are defined as follows:
Anonymity: A voting system is said to be anonymous if it treats all voters equally. I.e. if any two voters trade ballots, this shouldn't change the election's outcome.
Concerning the dApp-voting-system, this property could be argued. For example, it could be sensible to give users who have a high reputation, which indicates their knowledge, or users who hold a large stake and therefore are likely to want the best for the platform, more voting power than others. Certainly it would establish an unwanted great inequality between users if the relation between voting power and reputation or stake was a linear one. We discuss this topic further in
Neutrality: A voting system is said to be neutral if it treats all candidates equally. I.e. if every voter switched their vote from one candidate to another, the outcome should change accordingly.
Monotonicity: A voting system is said to be monotone if it is impossible for a candidate to change from winning to losing by gaining additional votes and to change from losing to winning by losing votes without gaining others.
The so-called May's Theorem states that majority rule is the only voting system for two-candidate-elections that is anonymous, neutral, and monotone, and that avoids the possibility of ties. However, majority rule is no option for the dApp-voting-system because there will be more than two candidates and anonymity is no property wanted.

Some generalisation of majority rule, which majority rule is a special case of, is plurality method. It is the voting system that elects the candidate who receives the largest number of votes, even if that number is less than half of the total number of votes cast. Plurality method only results in a tie, when two or more candidates receive the same number of votes and more than the number of votes received by any of the other candidates.
Concerning the dApp-voting-system, the possibility of ties is no downside since

there's no need to determine a single winner.
Rather, what is needed is a system that leads to some sort of preference order of all dApps. Such preference order produced by the voting system is called "societal preference order" since it can be thought of as the ranking of the candidates that, according to the voting system being used, best reflects the voters' will.
There are various system that can be used to determine the societal preference order. One property of such systems that might sound sensible at first, is the following:
A voting system is said to satisfy the majority criterion if whenever a candidate is ranked first by a majority of the voters, that candidate will also be ranked first in the corresponding societal preference order. We give an example for why this would be no legitimate property for the dApp-voting-system in a moment.
Some voting system that does not fulfil the majority criterion, is the so-called Borda count which uses a point system to determine overall rankings and is often used in collegiate sports polls for example. In an election with n candidates it works as follows:
Firstly, each voter submits a ballot that contains his or her individual preference order of all the candidates.
Then points are awarded to each candidate for each ballot cast, according to the following rule:
A m-place ranking is worth $n - m$ points (where $1 \leq m \leq n$). In other words, a first-place ranking is worth $n - 1$ points, a second-place ranking is worth $n - 2$ points and so on. Finally the candidate whose total number of points from all of the ballots is the largest is declared the winner and the corresponding societal preference order is determined by the number of points each candidate has got from largest to smallest. If there is more than one candidate with the largest number of points, a tie occurs. Also some sort of tie occurs in the societal preference order whenever candidates receive the same number of total points. They then occupy consecutive indistinguiable positions in the preference order.
Intuitively, Borda count also seems to be quite fair. However, it violates the majority criterion. For the purpose of the dApp-voting-system we consider using some sort of variation of the Borda count more appropriate than sticking to majority criterion. Imagine an extreme situation where a small majority of voters (i.e. users) ranks a specific dApp first place but all of the other voters rank it last on their personal preference. Obviously it would make no sense to declare this dApp the winner and rank it first in a societal preference order. Determining it's rank according to the Borda count seems much more legitimate. So the dApp-voting-system will not fulfil the majority criterion and will not use the plurality method, but rather use some sort of Borda count in order to lead to a sensible societal preference order.
Taking account of personal and societal preference orders, for elections with more than two candidates, the three properties of fair voting systems have to be redefined:
Anonymity: A voting system is said to be anonymous if it treats all voters equally. I.e. if any two voters traded their personal preference orders, the outcome of the resulting societal preference order should not change.
As mentioned before, this is no property we want the dApp-voting-system to fulfil, see
Neutrality: A voting system is said to be neutral if it treats all candidates equally.

I.e. if every voter switched the positions of two specific candidates on their personal preference orders, the positions of these two candidates in the resulting societal preference order would be switched accordingly.
Monotonicity: A voting system is said to be monotone if it is impossible for a candidate to go from winning to losing or to experience a decrease in rank on the resulting societal preference order whenever changes in favour of that candidate, but no changes in disadvantage of that candidate, occur on individual preference ballots.
Some properties one obviously would want a voting system to fulfill are the following:

1. A candidate who would defeat every other candidate in a head-to-head election (under majority rule) is called a Condorcet winner.

2. If a candidate would lose to every other candidate in a head-to-head contest (under majority rule) is called a Condorcet loser.

3. A voting system is said to satisfy the Condorcet winner criterion (CWC), if it always elects the Condorcet winner whenever one exists.

4. A voting system is said to satisfy the Condorcet loser criterion (CLC), if it always elects the Condorcet loser whenever one exists.

Since the definition of a Condorcet winner involves two-candidate-elections, for a voting system with more than two candidates it is a bit tricky to design it in a way that it fulfills the Condorcet criterion. The Borda count, for example, doesn't fulfill the criterion since it violates majority rule.
Another criterion that can be considered related to the assessment of the utility and sensibility of a voting system is the so-called "Independence of Irrelevant Alternatives" - criterion, defined as follows:
A voting system is said to satisfy the irrelevant alternatives criterion (IIA) if the societal preference between any two candidates is only dependent on the individual voters' preferences between those two candidates (and not affected by the candidacy of any other candidate).
However, none of the voting systems discussed so far satisfies this criterion.
In 1951, Kenneth arrow in the context of his Ph.D.-thesis published the commonly called "Arrow's impossibility theorem" which states that no voting system exists that has the five desired qualities mentioned above. In 1972, this discovery even earned him the Nobel Prize in economic science. Various versions of the theorem exist, but what it states, more precisely, is the following:
You can consider a voting system to be a rule that assigns to each possible collection of preference orders for a poll some kind of societal preference order, or more concretely,
we define it as a function that takes as input a collection of transitive preference orders of all the voters and produces as output a transitive societal preference order that represents the will of the electorate.
This definition doesn't rule out the possibility of ties, neither ties in individual preference ballots nor ties in the resulting societal preference orders. So if one defines the societal preference order of pairwise sequential voting as the winner followed by

a tie of all the other candidates, even pairwise sequential voting fits in with the that defintion of a voting system.
The mathematical conditions Arrow had in mind can be interpreted as follows:

1. Universality: Voting systems should place no restrictions apart from transitivity on how voters can rank the candidates in an election. There should be no kind of dictatorship presetting that only specific preference orders are acceptable or are not. Every possible collection of transitive preference ballots must yield a transitive societal preference order.

2. Positive Association of Social and Individual Values: Voting systems should be monotone.

3. Independence of Irrelevant Alternatives: Voting systems should satisfy the Indipendence of Irrelevant Alternatives - criterion.

4. Citizen Sovereignty: Voting systems should not be imposed in any way. I.e., there should never be a pair of candidates in an election such that one of these candidates is preferred over or tied with the other in the resulting societal preference order in defiance of any vote.

5. Nondictatorship: Voting systems should not be dictatorial. I.e., there should never be a voter such that, for any pair of candidates, if that voter prefers one of the candidates over the other, then society will also have the same preference order regarding these two candidates.

```
## Overview

### Properties of voting systems

##### Voting system criteria


https://wiki.electorama.com/wiki/Category:Voting_system_criteria




###### Features for classifications of voting systems

* Plurality voting
* Instant-runoff voting



### Popular voting systems

##### First-past-the-post voting/Winner takes it all
```

- Voters indicate on a ballot the candidate of their choice, and the candidate who
- If there are at least two positions two be filled, each voter casts (up to) the s
- (huge downside: it very much encourages tactical voting)
- https://en.wikipedia.org/wiki/First-past-the-post_voting

Majority judgement
- Used to determine a single winner.
- Voters grade each candidate in one of several ranks, for instance named from "exc
- The system's inventors mathematically proved that the system was the most "strate
- The algorithm we propose is also based on the median grade.
https://en.wikipedia.org/wiki/Majority_judgment

Approval voting
- Usually used to determine a single winner.
- Each voter may select any number of candidates. The winner is the candidate who i
- Variation: each voter may only select a predetermined number of candidates, other
- The algorithm we propose also allows each candidate to evaluate an arbitrary nume
https://www.electology.org/approval-voting
https://de.wikipedia.org/wiki/Wahl_durch_Zustimmung

Closed list voting
- Used when positions are to be filled by members of the running parties.
- Closed list voting: The voters only can vote for the parties. The elected parties
In praxis, the order in which a party's list candidates get elected can also be pre

- These systems aren't of any use for our considerations.
- https://en.wikipedia.org/wiki/Closed_list; https://en.wikipedia.org/wiki/Party-li

Preferential voting/Preference voting:
May refer to different election systems or groups of election systems. Some authors
Preferential voting may, for example, refer to ranked voting methods/ordinal voting
instant-runoff voting
range voting/score voting
open list
bucklin voting

Score voting/rate voting
- Used to determine a single winner.
- Voters rate candidates on a scale. The candidate with the highest rating wins.
- Variations of score voting can use a score-style ballot to elect multiple candida

TODOTODOTODO: comparison to majority judgement, approval voting and bucklin voting

```
##### Instant-runoff voting
Used in single-seat elections with more than two candidates
Voters rank all of the candidates in their personal order of preference
The candidate with the fewest first-choice-votes is eliminated. If there is more th
In the last voting round there are only two candidates left. The one who gets a maj
Variations: There are a few variations of Instant-runoff voting. For example, a can
Downside for our purpose: well known (old) dApps are far too hard to be taken over

#### Open list voting
Voters have at least some influence on the order in which a party's candidates are
Open list describes a certain family of voting systems for elections in which multi
In "relatively closed" list systems, a candidate must get a full quota of votes to
In "more open" list systems, that quota is so low that it's possible that more of a
In the "most open" list system, the total number of votes each candidate has receiv
In a "free list" system/panachage electors even have more power over which candidat
https://en.wikipedia.org/wiki/Open_list; https://en.wikipedia.org/wiki/Party-list_p

##### Bucklin voting/The Grand Junction System:
- Usually used to determine a single winner.
- Each voter ranks the candidates in ascending order, the first one being the favor
- To evaluate the votings, at first the prime rank is considered. Each candidate ga
- The number of votes each candidate received at the second rank is added to the nu
https://en.wikipedia.org/wiki/Bucklin_voting
https://de.wikipedia.org/wiki/Bucklin-Wahl
https://www.youtube.com/watch?v=CkIYZsJAvNQ

#### Ranked voting/Ordinal voting systems
Ranked voting describes certain voting systems in which voters rank outcomes in a h


#### cardinal voting systems todo

https://de.wikipedia.org/wiki/Majority_Judgment
https://www.electology.org/score-voting
https://en.wikipedia.org/wiki/Score_voting



https://en.wikipedia.org/wiki/Instant-runoff_voting (todo)
https://en.wikipedia.org/wiki/Open_list
https://en.wikipedia.org/wiki/Preferential_voting (todo)

https://en.wikipedia.org/wiki/Ranked_voting (todo)
```

4 Design for a ranking dApp

4.1 Desired voting properties

We now want to reflect upon the notions discussed in the preceeding section ..
(todo: this might be a bit intermingled with the above one atm.)

```
4) Then rule out and classify for the means of a) and b)

5) Also point out how those apply for other companies. TODO

## Basic summary

### Considerations we want and what we don't want

The voting system should fulfill the following criteria:

1) User's values: Reputation, Voting Power (reputation and voting power should be d

2) Reputation grows if user's vote is in consensus with community's votes
   * a) various ways to predefine what "consensus" does mean
   idea: determine consensus in periods of a week
   * b)!!! but users should not be able to vote for apps they haven't used only to
   be in consensus
   idea: reward could be higher for the first voters
   idea: votes should cost

3) Reputation decreases if user's vote isn't in consenus with communitys's votes

4) bad apps may be reported by users (= some sort of downvoting in very, very bad c

5) the reputation of users should sink whenever their programmed apps get reported

6) if an app has a large number of reports (limit to be predetermined), users shoul

7) apps' values: number of votes, number of reports;
* evaluation based on:
- a) usage rate (!!! but apps that are needed more often shouldn't have an advantag
- b) number of votes
- c) number of reports
- d) time that an app has been in the market
- e) extent of NOS user base

8) user's reward for a consensus vote should not be dependent from user's voting po
```

```
9) reputation and voting power might be limited
    - a) idea: including a parameter so that at a very high level the increment of

10) data onchain/offchain?

11) calculation costs

12) for a listed ranking, a dApp should only be added to the average if it has a ce

?) Rewards for dApp producers? (If so, it should probably not depend on ranking.)

############################################################

## Classification

### Terminology and fundamental notions
###### ! differentiate between voting systems and properties of such.

want <Ranking>
 Majority (=absolute majority) => Plurality
but want people to not cast only one vote (otherwise we can too few votes).

how to count votes? Especially since there are several votes per person, i.e. up to
|users| * |dApps|
votes

######  *) Ranking
==> sign of trust and value
==> dApp producer gets attention

will argue for a form of
https://en.wikipedia.org/wiki/Cardinal_voting
TODO: look at all of those and work out pros and cons and differences.

######  *) Anonymity, Neutrality, Monotonicity
Most fundamental base voting system is majority rule characterized by:
- Anonymity (Hodge p.4)
- Neutrality
- Monotonicity

Facebook likes

- Monotonicity is almost self-evidently valuable.
- Neutrality is a free market rule. (While nOS has power over the system and can fo
- Anonymity ... (see Steemit and Anonymity (reputation)
=> aggregation problem
```

=> solition via brakets of last time period
exposure effect

Regading Steemit ... keep an eye on rewards: How it's solved by steemit, complexity

*) Quotas
This is just details:

In our case,

1) Quotas <=> Could in principle be used as a cap for when a dApp even enters the r
On the lower end (i.e. having a low quota) => Could be unfair w.r.t. exposure diffe
One could imagine a quota at the ghier end (extra bonus exposue for breaking a benc

2) Given a computed ranking, quotas <=> Could be used for a hard cap of which apps

Can be set for when typical numbers (user base, dApp base, size) are established. S
We have a ongoing running voting process with varying user base size and number of

The majority of dApps should of couse be accessible and searchable on the platform
=> keep an eye on rewards: Steemit system, complications

Both of the above => flagging

*) Required voting
Note that majority rule doens't require everybody to vote and this is probably also
This (the lack of fixed number of total votes upfront) makes the design of the deci

*) Ties
Due to the large numbers of dApps to be voted for and the high number of voting rou

*) Breaking Neutrality.
While it's not a crucial featues, a tie can easily be deterministically resolved by
What makes Neutrality for us different than e.g. for political elections considered
It raises the question of how self-contained a voting round should be in general. A

One might be tempted to say it also frees us from incoorporating previous data at a

For our consideration

* Reputation ...
* Voting Power ...
* Flag ... dApps can be annotated/singled out for being suspicious/spam

Established voting mechanisms

4.1.1 On exposure/money as reward

What does exposure mean?
* a spot in a list (as opposed to relative quantitative gain, as in "Proportional r

Interested in all dApps => We want to use ranking

Positive votes (we vote who we want, not who we don't want). The ranking implicitly

For the users
* Rewards
* Reputation?

4.2 Resources and literature

5 Economics and platform evolution

how different models play out in practice

reflection on incentive

how systems shift in time

continuation of the review-of-existing-platforms-section

steemit etc.

6 Algorithms

6.1 Bounding conditions

```
### dApp-producer ranking Algorithm details
Reward for both quality and quantity, and both should be necessary

### Reviews
* Reward for writing reviers, judged on quality

### Rewards

(note: The python file now contains a more elaborate variant of those ideas)

S(n) ... stake of user n
V(n) ... "how well" they voted
N=sum over n such that n voted right (that will be rewards) ... all users
M ... total reward
x ... fraction of non-stakedependent rewards
R(n) = (x * M) * f(v) + ((1-x) * M) g(n,S(n))
where f(v) says how good they voted, sum over f(v) is 1
and where g(n,s) depends on the stake  where n-sum over g(n,s) is 1

### On-chain requirements

todo: Write a summary of requirements when it comes to storage and script execution

tldr we need
* User accounts with a tine by of on-chain data relating to past actons and current
* Readout of users ranking, computation of some numbers
* The result must definately be on-chain, and if the write-back to the user account
```

6.2 Examples

TODO: explain the below in detail and put it in context

```
rankings = {
    'Alice':
    {
        'B+': ['cherry', 'orange'],
        'D': ['banana', 'apple', 'kiwi']
    },

    'Bob':
    {
```

```
        'B+': ['orange'],
        'D+': ['kiwi', 'pear'],
        'D': ['apple', 'banana']
    },

    'Carl': {
        'A+': ['pear', 'apple'],
        'A': ['cherry'],
        'C+': ['peach'],
        'C': ['orange', 'kiwi'],
        'F': ['banana']
    }
}

## collect data
grade_bases = to_rating_dict(GRADES)

fruit_user_ratings = {fruit: {} for fruit in FRUITS}
user_fruit_ratings = {user : {} for user  in USERS }

for user in USERS:
    print('\nuser: {} '.format(user) + 40*'-')
    user_ranking = rankings[user]
    for grade in GRADES:
        if grade in user_ranking.keys():
            gb = grade_bases[grade]
            l = user_ranking[grade]
            r = to_rating_dict(l)
            for fruit, step_rating in r.items():
                fr = gb-(1-step_rating)/len(GRADES)
                fruit_user_ratings[fruit][user] = fr
                user_fruit_ratings[user][fruit] = fr

## compute bracketed means
fruit_user_ratings_means = {fruit: mean(rating_dict.values()) for fruit,
fruit_user_ratings_means_sorted = sorted(fruit_user_ratings_means.items()
```

TODO: make the above code prettier