Analysis and Attacks of decentralized content curation platforms

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Abstract. We will attack Steem.

1 Introduction

Steem is not incentive-compatible.

2 Related Work

Many people have done many similar things.

3 Model

1 Notation

- We denote the set of all probability distributions on set A as $\mathcal{D}(\mathcal{A})$.
- We denote the powerset of a set A with 2^A.
- $a \| b$ denotes the concatenation of a and b.

2 Properties of Post Voting Systems

A post voting system has the objective to arrange the posts according to the preferences of the participants. The ideal order is defined based on the likeability matrix for the posts.

Definition 1 (Post). *Let $N, P \in \mathbb{N}^*, L_i \in \mathcal{D}\left([0,1]^N\right)$. A post is defined as $p = (i, l(, v))$, with $i \in [N], l \sim L_i$ (and $v \in \mathbb{R}_+$).*

- ***Author.*** *The first element of a post is the index of its creator, i.*
- ***Likeability.*** *The likeability of a post is defined as $l \in [0,1]^N$ (, where l is drawn from L_i the Likeability Distribution of its creator u_i).*

– *(**Votes.** A post has an associated "vote" value, which is a real non-negative number. It is initialized at 0 and increases whenever a player votes for the post, as explained later in detail.)*

Let $l_i \sim L_i$ *and* $p_i = (i, l_i, 0)$*. The set of all posts is* $\mathcal{P} = \bigcup_{i=1}^{P} \{p_i\}$.[1,2]

Definition 2 (Post score). *Let post* $p = (i, l)$*. We define the* score *of* p *as* $\mathrm{sc}(p) = \sum_{i=1}^{N} l_i$.

The score of a post is a single number that represents its overall worth to the community. In an ordered list of posts where higher posts are more visible, the "common interest" would require that a post with higher score appear before another post with a lower score.

Definition 3 (Ideal Post Order). *Let* $\mathcal{P}$ *a set of posts. We define* $\textsc{IdealOrder}(\mathcal{P})$ *as a list of the posts in* $\mathcal{P}$ *such that*

$$\forall i < j \in |\mathcal{P}|, \mathrm{sc}(\textsc{IdealOrder}(\mathcal{P})[i]) \geq \mathrm{sc}(\textsc{IdealOrder}(\mathcal{P})[j]) \quad .$$

[3]

Definition 4 (Post-Voting System). *Accepts as inputs:*

– *list of posts (in some order)*
– *set of players, each consisting of a strategy profile*

Returns an ordered list of the same posts, possibly reordered

Definition 5 (Honest Player). *A player* u *is considered* honest *if her utility is maximized when the result of the post-voting system equals her subjective ordering of the posts:*

$$\forall i < j \in |\mathcal{P}|, l_{u,u\text{-}\textsc{Order}(\mathcal{P})[i]} \geq l_{u,u\text{-}\textsc{Order}(\mathcal{P})[j]} \quad .$$

[4]

Definition 6 (Convergence under honesty). *A post-voting system* t-converges under honesty *if the output of the system with all parties playing honestly equals the ideal order in the first* t*, for any initial order, and any likeability distribution.*[5]

[1] TODO: consider removing things in parentheses
[2] TODO: consider dropping L_i entirely
[3] TODO: discuss list notation
[4] TODO: discuss list notation
[5] TODO: continue

Theorem 1. *The Steem system t-converges under honesty, assuming the following conditions on* $\mathcal{SP}, v$ *...*[6]

The above result is tight. If the conditions are violated the above theorem is not true.

3 Modeling Steem

Players The are $N \in \mathbb{N}^*$ players in the model. A player u is defined by her Steem Power SP $\in \mathbb{N}$, her Voting Power VP $\in [0, 1]$, her Likeability Distribution $L \in \mathcal{D}\left([0,1]^N\right)$ and her Strategy $S \in \{H, G\} \times \times 2^{[N]}$. Let the ith player be represented by the tuple $u_i = (\mathcal{SP}_i, \mathcal{VP}_i, L_i, S_i)$. The tuple of players is defined as $\mathcal{U} = (u_1, \ldots, u_i, \ldots, u_N)$ and each player is identified by her index in $\mathcal{U}$.

We will now explain each field in u_i in detail:

- **Steem Power.** The Steem Power of u_i is defined as $\mathcal{SP}_i \in \mathbb{N}$ and represent the influence of the player in the platform. The vector of Steem Power funds for the N players is defined as $\mathcal{SP} = (\mathcal{SP}_1, \ldots, \mathcal{SP}_i, \ldots, \mathcal{SP}_n)$.
- **Voting Power.** The Voting Power of u_i is defined as $\mathcal{VP}_i \in [0, 1]$ and can be understood as voting influence that is used up when voting and regenerates with time. The vector of Voting Power for the N players is defined as $\mathcal{VP} = (\mathcal{VP}_1, \ldots, \mathcal{VP}_i, \ldots, \mathcal{VP}_N)$.
- **Likeability Distribution.** The Likeability Distribution $L_i \in \mathcal{D}\left([0,1]^N\right)$ of u_i is a distribution on how likeable is the content produced by u_i to the rest of the players. The Likeability Distribution for the whole system is $\mathcal{L} = (L_1, \ldots, L_i, \ldots, L_n)$.
- **Strategy.** The strategy of u_i is defined as $S_i \in \{H, G\} \times \mathbb{N}^* \times 2^{[N]}$, where the first element is the player's core strategy, the second is her attention span and the third is her voting ring.
  - **Honest/Greedy.** H corresponds to the *honest* and G to the *greedy* strategy. An *honest* player votes according to the likeability of a post l_i (defined later)[7], that is to say she votes the posts she likes. For *honest* players, the value of the vote is computed as $v_{H,i} = a \cdot \mathcal{VP} \cdot l \cdot \mathcal{SP} + b$, where l is drawn from the Likeability distribution[8][9]. In Steem terms, l can be understood as the weight of a vote.

[6] TODO: continue
[7] TODO: untangle
[8] TODO: move to posts section
[9] TODO: explain a, b

A *greedy* player only votes for posts produced by users of its Voting Ring. The value of vote for a player if u_i is *greedy* is defined as $v_{G,i} = a \cdot \mathcal{VP}_i \cdot \mathcal{SP}_i$,[10] as in our model all *greedy* votes are executed with full weight.

- **Attention Span.** This is a positive integer that represents the number of posts a player can consider voting simultaneously. For the benefit of simplicity, we will assume that this number is constant throughought all players.[11]
- **Voting Ring.** If player u_i is *honest*, her Voting Ring is $R_i = \emptyset$. If u_i is *greedy*, her Voting Ring is $R_i \in 2^{[N]}$. A voting ring is defined as $R_i = \{g_1, \ldots, g_j, \ldots, g_n\}$ where $g_j \in \mathcal{U}$ is the jth member of the voting ring and n is the size of the ring. Two *greedy* players will either have the same or disjoint voting rings ($\forall i \neq j \in [N], R_i = R_j \vee (R_i \cap R_j = \emptyset)$).

The tuple of the strategies for the N players is defined as $\mathcal{S} = (S_1, \ldots, S_i, \ldots, s_N)$.

The set of players is defined as $\mathcal{U} = (u_1, ..., u_i, ..., u_n)$ $\forall i \in [N]$.[12]

4 Game Execution

Algorithm 1 Each player creates one post

```
1: function GeneratePosts(U)
2:     P = ∅                                   ▷ List of posts
3:     for u_i ∈ U do
4:         l ←r L_i                            ▷ Get likeability of posts
5:         P ← P‖ (i, l, 0)                    ▷ Add post to list of Posts
6:     end for
7:     P ← Shuffle(P)                          ▷ Shuffle posts to a random order
8:     return P
9: end function
```

TODOS[13,14]

[10] TODO: same
[11] TODO: discuss
[12] TODO: fix appearance
[13] TODO: Improve argmax notation
[14] TODO: Write Greedy

Algorithm 2 Player votes for best of k posts

function VOTE($u_i, \mathcal{P}$)
  switch S_i **do**
    case *honest*
      $p_j \leftarrow \underset{p \in \mathcal{P}_{1..k}}{\operatorname{argmax}} \{l_{i,p}\}$
      Parse p_j as (m, l_p, v)
      $v' \leftarrow v + \mathcal{VP}_i \cdot l_{i,p} \cdot sp_i$
      $\mathcal{VP}_i \leftarrow \mathcal{VP}_i - (a\mathcal{VP}_i l_{i,p} + b)$
      $\mathcal{P} \leftarrow p_1 \| p_2 \| \ldots \| p_{j-1} \| (m, l_p, v') \| p_{j+1} \| \ldots \| p_N$
    end case
    case *Greedy*
      ▷ If post belongs to voting ring and not reached min VPower
      if $p \in s.R \wedge p.VPower > s.Min$ **then**
        $voteValue \leftarrow p.VPower \cdot weight \cdot sp$
        $p \leftarrow p.votes + voteValue$
      end if
    end case
  end switch
  return $\mathcal{P}$
end function

Algorithm 3 Players cast votes for r rounds

function CURATE($\mathcal{U}, \mathcal{P}, r$)
  for $j = 1$ to r **do** ▷ r voting rounds
    for $u_i \in \mathcal{U}$ **do**
      if ISVOTEROUND(j, S_i, r, N) **then**
        $\mathcal{P} \leftarrow$ VOTE $(u_i, \mathcal{P})$ ▷ Player i votes zero or one posts
      end if
    end for
    $\mathcal{P} \leftarrow$ ORDER $(\mathcal{P})$ ▷ Order posts by vote count after each round of votes
  end for
  return $\mathcal{P}$
end function

Algorithm 4 Calculates whether voting in this round is optimal

function ISVOTEROUND(j, S, r, N)

end function

Algorithm 5 Posts curation procedure

Input: $\mathcal{U}, r$
Output: $\mathcal{P}$

1: $\mathcal{P} \leftarrow \textsc{GeneratePosts}\,(\mathcal{U})$
2: $\mathcal{P} \leftarrow \textsc{Curate}\,(\mathcal{U}, \mathcal{P}, r)$
3: **return** $\mathcal{P}$

4 Results

Steem won't achieve high quality posts.

5 Further Work

Posts at any time

6 Conclusion

Keep inventing new decentralized content curation platforms.

7 Acknowledgements

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References