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# Using Liquid Democracy for Attention-Aware Social Choice

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## Abstract

My PhD research deals with the use of Liquid Democracy (LD) for social choice scenarios, while considering the scarcity of attention as a driving factor. My aim is to better understand LD: theoretically as well as practically; in particular, by establishing containment in certain computational classes for corresponding combinatorial problems, suggesting methods to improve the use of LD, and understand its adaptation to specific scenarios. Concretely, I consider the use of LD as a solution for the problem of low voter attention in light of the high cognitive effort needed by voters to actively participate in voting processes.

## 1 Introduction

Liquid democracy (LD) is a voting system that is often seen as a middle ground between direct democracy and representative democracy. It allows the voters to vote directly or delegate their vote transitively to one another. It allows a more dynamic allocation of voters' preferences as well as identifying subject experts efficiently. Initially, it was suggested as a reform for legislative systems [Dodgson, 1884]. A relatively modern quantitative research regards the use of LD within the German Pirate Party [Kling *et al.*, 2015] where they analysed voting patterns within the Party and found power-like distribution of the votes. On the theoretical side, Kahng et al. [Kahng *et al.*, 2018] showed that there exists a family of graphs for which a local delegation mechanism[1] may not perform well compared to direct democracy. This observation leads us to consider the situation in the average case; one way to evaluate the effectiveness of LD is to compare its success rate against other voting systems by simulating them stochastically. We have done so in the context of a *ground truth*, i.e, where each voter has a intrinsic probability of voting for the right outcome, known as his *competence*.

There has been papers that considered a game-theoretical perspective [Bloembergen *et al.*, 2019; Yuzhe and Davide, 2021], in which agents aim to maximize their marginal utility by strategically choosing either to vote directly or to delegate. On top that [Halpern *et al.*, 2021] have shown sufficient probabilistic conditions for delegation to be effective in terms of increasing the chances of retrieving the ground truth.

A related line of work has been to show that approximating the optimal delegation structure (within a factor of $\frac{1}{16}$) [Caragiannis and Micha, 2019] is NP-Hard – where the aim is to maximize the quality of decision making, for a suitable definition of decision quality. We consider how to overcome such hardness results by modeling LD from a simulation lens and showing that, in multiple scenarios, LD performs well compared to other voting systems, for more details consider checking out our paper [Alouf-Heffetz *et al.*, 2022a].

We recognize that attention is a scarce resource in fast growing online communities, especially in light of increasing number of governance decisions they have to process. Effectively managing the community attention is key in order to successfully allows the community to sort through the ongoing stream of decisions they have to face. Liquid Democracy and Sortition allow the community to set the amount of *active voters*, that could be seen as a proxy for limiting the amount of attention that is being used for a single decision.

## 2 Contributions

In this section we describe two line of works that deal with improving the quality of liquid democracy.

### 2.1 Ground Truth Setting

Recently [Alouf-Heffetz *et al.*, 2022a], we have shown that LD in the epistemic setting, i.e there are right and wrong outcomes, with moderate percentage of active voter (voters that do not delegate) does exceedingly-well compared to Direct Democracy and similar to Sortition. A voter probability for selecting the right outcome is defined as his *competence*. We have done so by running the following steps:

- Generate a network
- Sample voters' competence i.i.d from a distribution $\mathcal{D}$
- Compute the group accuracy by running several trials.

We run these Monte Carlo simulations in order to estimate the group accuracy on a variety of settings - real-world social networks as well as artificial ones. We selected different distributions for $\mathcal{D}$ and have summarised our findings. Furthermore, our results show that the accuracy when voters delegate randomly to one of their neighbours that have some –

[1] local – only taking into account the voter immediate neighbourhood when choosing whom to delegate to.

perhaps just a tiny bit – better competence level, yield results which are as effective as when voters delegate to their most informed neighbour. It is much easier cognitively to do the first, so our results are promising in that regard.

### 2.2 Reducing Uncertainty in Joint Decision Making

A different line of work has been through the modeling of uncertainty in joint decision making. There [Alouf-Heffetz *et al.*, 2022b], we created a basic model that assumes voters partition the space to approve/disapprove ($\{+/-\}$) and certain/uncertain ($\{!, ?\}$). A voter that approves but is uncertain on proposal $p$ could vote against it; and vice versa.

The ground truth is defined as the the majority opinion with respect to each proposal. The voters' uncertainty is considered to be used against the ground truth when voting takes place. If there is a strict majority that is not affected by the uncertainty, then a proposal is considered *safe*; if the uncertainty could lead to the non-ground truth taking place, then a proposal is considered *unsfae*.

We considered three algorithmic approaches to deal with such uncertainty: (1) educating voters, (2) deleting voters, and (3) allowing them to delegate.

In the case where the proposals are embedded in continuous one dimensional space. Where voters approval is a continuous segment within and their confusion is a small radius around the boundaries of such segments. In such setting all three algorithmic approaches have yielded NP-Hardness results. We shall consider different domains as well as more elaborate algorithms, and then capture the computational classes of such problems.

## 3 Future Work

Here we present few key questions we wish to grapple with, different facets and dimensions of these questions are worthy challenges to be pursued.

- How should we derive competence levels ? There has been notable work on the wisdom of crowds such as [Budescu and Chen, 2015].
- Given a ground truth setting, we consider an optimization problem - how to minimally alter the delegation graph post voting, inorder to maximise the impact on the group accuracy?
- Can we model formally the factors that lead to delegation taking place ?
- Given a community $N = \{1, .., n\}$ and a social network $G = (E, V)$ can we determine statistical properties of a network that make it suitable for the use of liquid democracy?

So far [Alouf-Heffetz *et al.*, 2022a] we have not seen any single network property that correlates to the effectiveness of LD in practice. We have seen some effect when considering the variance of the distribution from which we draw the voters' competence levels. Greater variance allows delegation to be more effective if voters with low competence are efficient at identifying voters expertise.

## 4 Outlook

It is these kind of questions that I seek to answer in my dissertation, weaving the line between intractability results, data analysis (under the umbrella of being efficient in the attention we allocate) and practical implementation insights.
Research in LD would allow us to deploy it more effectively in online settings; this is especially important observing the rise in the predominance of online communities using LD as their governance module.

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