Liquid Democracy:
An Annotated Reading List

GEORGIOS PAPASOTIROPOULOS
University of Warsaw, Poland
and
ULRIKE SCHMIDT-KRAEPELIN
TU Eindhoven, Netherlands

Abstract: Liquid democracy is a democratic paradigm that introduces new challenges for researchers in fields around collective decision-making and, hence, it prompts a variety of compelling questions well-suited to the EC community. In this overview, we present a selection of papers that capture the breadth of research directions in this area.

Categories and Subject Descriptors: [**Theory of computation**]: Theory and algorithms for application domains—*Algorithmic game theory and mechanism design*; [**Applied computing**]: Computing in government—*Voting / election technologies*

General Terms: Algorithms; Design; Economics

Additional Key Words and Phrases: Computational Social Choice, Voting, Elections, Liquid Democracy, Delegations

Liquid democracy is a hybrid voting model that bridges the gap between direct and representative democracy. Direct democracy is often seen as impractical due to the scale and complexity of many elections and the subjects under consideration, while representative democracy restricts voters' influence and participation in decision-making. In liquid democracy, voters have the flexibility to choose whether to cast their own votes if they feel informed about the issue at hand or to delegate their voting power to someone they believe is more knowledgeable on the matter. These delegations, in a transitive manner, allow those who decide to cast a ballot to do so with a voting power that represents both their own vote and the votes of everyone who has (directly or indirectly) entrusted their vote to them.

For practical purposes, liquid democracy is mostly intended for low-stake decision-making within mid-sized communities or organizations. From a theoretical viewpoint, liquid democracy opens a rich array of research questions and models that we believe could be of interest to the EC community. The literature can be roughly categorized along two dimensions: We organize the proposed models into four categories, including epistemic models, ranked-delegation models, specialized frameworks, and models capturing strategic behavior; orthogonally, the methodologies range from algorithmic, axiomatic, and game-theoretic to statistical questions, and empirical analyses – with some works fitting into multiple groups across both dimensions. Our goal is to highlight the field's breadth and its latest developments while presenting works that also offer a more comprehensive perspective by contex-

tualizing earlier research. As a result, the selected papers are often the most recent work in their respective research lines. We hope that our list serves as a useful starting point for interested readers, shedding light on some of the most promising areas for future research in liquid democracy. This list is neither exhaustive nor fully representative, as many interesting, closely related, and important—if not foundational—works had to be omitted due to space constraints.

(1) [Berinsky, Halpern, Halpern, Jadbabaie, Mossel, Procaccia, and Revel, 2025] — The paper "Tracking Truth with Liquid Democracy" examines the *epistemic model* of liquid democracy, which addresses whether liquid democracy is more effective than direct democracy at uncovering a ground truth in a binary decision setting. Previous studies on this model (e.g., Kahng et al. (2021) and Caragiannis et al. (2019)) suggested that power concentration in liquid democracy may significantly lower its accuracy compared to direct democracy, even when voters delegate only to those more competent in identifying the ground truth. In contrast, this paper identifies models under which liquid democracy surpasses direct democracy in accurately uncovering the ground truth.

(2) [Kavitha, Makino, Schlotter, and Yokoi, 2024] — Among more general results, the paper "Arborescences, Colorful Forests, and Popularity" presents a polynomial-time, combinatorial, primal-dual algorithm for the *popular arborescence problem*, a problem whose computational complexity had been open since the earlier work of Kavitha et al. (2020). This algorithm has applications in liquid democracy with ranked delegations—a model designed to address delegation cycles by allowing voters to specify a set of possible delegations along with a preference ranking over them. Given these preferences, an arborescence assigns delegations to voters, and a popular arborescence (if one exists) is one that is preferred by a majority of voters over any alternative arborescence.

(3) [Utke and Schmidt-Kraepelin, 2023] — The paper "Anonymous and Copy-Robust Delegations for Liquid Democracy" builds upon a model suggested by Brill et al. (2022), and studies axiomatic properties of delegation rules for liquid democracy with *ranked delegations* (as discussed in (2)). While the model of Brill et al. requires that the voting weight of each voter is assigned to exactly one other voter, this work relaxes this assumption and allows to (fractionally) distribute the voting weight over multiple representatives. The authors first present an axiomatic impossibility theorem in the setting of Brill et al. and then show that a fractional delegation rule suggested in the literature (Brill (2018)) resolves this impossibility and can be computed in polynomial time.

(4) [Tyrovolas, Constantinescu, and Elkind, 2024] — The paper "Unravelling Expressive Delegations: Complexity and Normative Analysis" studies a generalization of the ranked delegation model (see (2) and (3)) in which voters can submit delegations in form of boolean functions, thereby enhancing the expressivity of a ballot to allow for the communication of conditional preferences (e.g., based on the majority opinion of others). This model was first suggested by Colley et al. (2020) who presented several ways for *unravelling* the voters preferences into one valid ballot per voter. While focusing on binary decisions, the authors present, among other results, computational dichotomies for two natural unravelling approaches: a utilitarian and an egalitarian one.

(5) [Markakis and Papasotiropoulos, 2024] — The paper "As Time Goes By: Adding a Temporal Dimension to Resolve Delegations in Liquid Democracy" proposes a framework in which the decision-making moment is preceded by an extended deliberation period, allowing voters to declare delegation choices (in a manner similar to the one examined by Brill et al. (2022)) and revise them at each step in response to new information or changes in others' opinions. This process aims to identify suitable representatives for all voters in cases where delegations at the (final) moment of decision prove inadequate or infeasible, such as in scenarios where voters' delegations lead to delegation cycles. The authors introduce axioms and examine their compatibility with efficient algorithms, mainly drawing on techniques and results from temporal graph theory.

(6) [Colley and Grandi, 2022] — The paper "Preserving Consistency in Multi-Issue Liquid Democracy" falls into the realm of liquid democracy with *interdependent issues* (see, e.g., Christoff and Grossi (2017)), where the same set of voters decides upon a range of such issues, and for each one, voters decide whether to vote themselves or to delegate, which may lead to inconsistent, infeasible ballots. The authors unify the approaches from earlier works on a similar model by Jain et al. (2022) and Brill and Talmon (2018) and they show that resolving the inconsistencies by minimizing either the number of ignored delegations or the number of changes to the votes is computationally hard. In response, they suggest that voters submit priorities over the issues which can then be used to find consistent votes in polynomial time.

(7) [Köppe, Kouteckỳ, Sornat, and Talmon, 2024] — The paper "Fine-Grained Liquid Democracy for Cumulative Ballots" builds upon an idea of Brill and Talmon (2018) and proposes a model where voters can distribute a unit of support across various bundles of election options (e.g., bundles of projects in a Participatory Budgeting scenario), and, if desired, delegate the precise distribution within each bundle to other voters. Delegation cycles or conflicts – such as when voters allocate no support to options that voters they represent wish to fund – necessitate centralized methods for resolving delegations that satisfy specific axiomatic guarantees. By establishing a relation to Nash equilibria, the authors use mainly the fixed-point theory to study the existence, structure, and computability of satisfactory solutions.

(8) [Bloembergen, Grossi, and Lackner, 2019] — The paper "On Rational Delegations in Liquid Democracy" introduces a model of elections on a binary issue where (either deterministic or probabilistic) voters are represented as vertices on a graph, and they can choose to vote directly with a specific accuracy related to their preferred outcome at a certain effort, or delegate their vote to a neighbor at no cost to inherit that neighbor's accuracy; a model motivated by similar considerations as the one examined by Alouf-Heffetz et al. (2025). Theoretical results establish the existence of Nash equilibria and analyze quality with respect to utilitarian social welfare and average accuracy in certain classes of the game in which voters strive to balance the accuracy achieved with the effort expended. Experimental simulations on synthetic network topologies assess the performance of delegation compared to direct voting, the number and quality of voters acting as ultimate representatives, and the existence of cycles.

(9) [D'Angelo, Delfaraz, and Gilbert, 2022] — The paper "Computation and Bribery of Voting Power in Delegative Simple Games" studies a generalization of voting games, where voters, represented as (weighted) nodes in a social network, acquire power through the transitive delegation structure of liquid democracy, reflecting the relative influence of each. The authors present a pseudo-polynomial time algorithm for the computationally hard problems of calculating voters' power expressed via the Banzhaf and Shapley-Shubik indices in these cooperative games, originally introduced by Zhang and Grossi (2021). They then examine (from the perspective of approximation and parameterized algorithms) the bribery problem, which aims to identify which voters should be influenced and how, within a budget constraint, to change their delegations in order to maximize or minimize the voting power or the final voting weight of a specific voter; this is closely related to the control problem examined (among other problems) by Alouf-Heffetz et al. (2025) with a focus on computational complexity and differing objectives.

(10) [Kling, Kunegis, Hartmann, Strohmaier, and Staab, 2015] — The paper "Voting Behaviour and Power in Online Democracy: A Study of LiquidFeedback in Germany's Pirate Party" analyzes real-world data from one of the most prominent software systems for online voting, which allows users to delegate their votes to others with the flexibility to adjust their choices over time (as studied theoretically in the model of Markakis et al.). Focusing on the platform's largest installation, the study observes a 4-year period involving around 14k users casting hundreds of thousands of votes and tens of thousands of delegations, on 6.5k proposals. The authors focus on understanding (i) the dynamics of voting and delegation behavior and (ii) the assessment of power each voter holds in the system and how this power is being used.

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