A Liquid Perspective on Democratic Choice

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Abstract

The idea of liquid democracy responds to a widely-felt desire to make democracy more “fluid” and continuously participatory. Its central premise is to enable users to employ networked technologies to control and delegate voting power, to approximate the ideal of direct democracy in a scalable fashion that accounts for time and attention limits. There are many potential definitions, meanings, and ways to implement liquid democracy, however, and many distinct purposes to which it might be deployed. This paper develops and explores the “liquid” notion and what it might mean for purposes of enhancing voter choice by spreading voting power, improving proportional representation systems, simplifying or aiding voters in their choice, or scaling direct democracy through specialization. The goal of this paper is to disentangle and further develop some of the many concepts and goals that liquid democracy ideas often embody, to explore their justification with respect to existing democratic traditions such as transferable voting and political parties, and to explore potential risks in liquid democracy systems and ways to address them.

Contents

1 Introduction
  1.1 Can Technology Revolutionize the Process of “Rule by the People”? 2
  1.2 Liquid Democracy: Essence, Origins, and Analogies 2

2 Liquidity in Enriching Choice by Spreading Vote Power
  2.1 Approval Voting: Vote Spreading at No Cost 4
  2.2 Cumulative Voting: Vote Spreading with Economic Scarcity 4
  2.3 Quadratic Voting: Vote Spreading with Attenuated Cost 6

3 Liquidity in Proportional Representation via Transferable Voting
  3.1 Single-Winner Elections: Instant Runoff Voting (IRV) 9
  3.2 Multi-Winner Elections: Single Transferable Vote (STV) 10
  3.3 Risks and Disadvantages of Ranked Voting Systems 12
  3.4 Cumulative Transferable Vote (CTV): Proportional Representation with Vote Spreading 13
  3.5 Quadratic Transferable Vote (QTV): Rewarding Vote Spreading 14

4 Liquidity in Delegation to Simplify or Aid in Choice
  4.1 Precedents for Delegation to Simplify and Manage Choice 15
    4.1.1 Representative Democracy: 15
    4.1.2 Political Parties and Straight-Ticket or Party-List Voting: 15
  4.2 Few Versus Many Parties: Countering or Merely Obscuring Extremes? 16
  4.3 Revealing Choice Structures through Transparent Delegation 17
  4.4 Delegation to Microparties: Expanded Choice among Political Parties 17
    4.4.1 Election System Design for Delegation Transparency: 17
  4.5 Delegation to Single-Issue Organizations – Exclusively or Jointly via Vote Spreading 18
1 Introduction

Democracy is in the midst of a credibility crisis. Some of the most well-established Western democracies have become increasingly polarized [65, 44] to the point of tribalism [39, 60] and authoritarianism [14]. The information sources voters use to understand the world and make their decisions is increasingly suspect [87, 26, 88, 13, 72]. While democracy preaches a gospel of treating all citizens as equal, established democracies fail to protect the equality of citizens’ influence at the ballot box [75, 33, 17, 28, 46, 68, 78].

Outside the ballot booth, people in real democracies depend on government to protect not only their physical safety, but also their economic and social equality and human rights. Here too, established democracies fail to protect their citizens from private coercion or feudal rent-seeking structures [73]. They fail to ensure equal access to equal economic opportunity by accelerating transfers of public wealth to the already-rich in the face of skyrocketing economic inequality [49, 62], fail to offer an adequate social safety net to protect the ability of the unlucky or disadvantaged to participate in society as equals with dignity, and even fail event to protect many people from effective slavery [85, 47]. As Robert Dahl asked: “In a political system where nearly every adult may vote but where knowledge, wealth, social position, access to officials, and other resources are unequally distributed, who actually governs?” [20]

1.1 Can Technology Revolutionize the Process of “Rule by the People”?

Today’s democratic processes and institutions were designed around assumptions rooted in paper-based bureaucracy, that every interaction between people in which government is concerned is costly both in human time (people physically going to government offices and filling out forms) and economically (the costs of printing paper forms and hiring white-collar bureaucrats to handle them correctly). The main objective and optimization constraint in government by in-person interaction and paper-based bureaucracy is to minimize frequency of interactions and to maximize what is accomplished by each.

Today’s increasingly-pervasive networked computing technologies, however, may hold the potential to reduce the cost of interactions by many orders of magnitude: enough to enable a qualitative “phase change” in applicable approaches to designing and building democratic institutions. When interactions between people or with governments can happen anywhere, at any time, with a button press or touch-screen gesture, requiring neither physical presence nor paper form-filling, the feasible design space changes completely, just as completely different processes and technological tools are applicable when building a stone wall versus filling a swimming pool with water.

1.2 Liquid Democracy: Essence, Origins, and Analogies

This is the technology context in which liquid democracy arose: stated vaguely and informally, the idea that technology could free democracy from the clunky constraints of paper ballots and government bureaucracies, and enable voters to guide and direct their “power of the people” more easily, flexibly, and fluidly, like the flow of a liquid. The term has no precise or standard definition, and even its origin is unclear. The specific term “liquid democracy” seems to have made its first recorded appearance on a long-defunct wiki by a user going by the handle “sayke” and now preserved only on the Internet Archive [69, 70]. Most of the ideas associated with liq-
uid democracy were suggested earlier in various forms, however [24, 40, 79, 58, 54, 29].

Since there is no single clear, standardized definition of what liquid democracy actually means, we will focus here on what the term might reasonably mean, based on the namesake analogy of physical liquid. As a physical state of matter, liquid has two fundamental distinguishing properties: it has no fixed shape but is able to flow (like a any fluid including a gas), and it is largely incompressible or volume-preserving (unlike a gas). Important properties derived from these fundamental characteristics include that liquids can be subdivided into nearly-arbitrary fractional portions (treating their molecular limits as small enough not to matter for most purposes), and they may be stored and directed at low cost and effort (via containers, channels, tubes, etc.).

As the purpose of any government is to manage the flow and expression of power (whether political, economic, or social), the term liquid democracy naturally suggests an approach to democratic governance that manages expression and use of power like a “liquid”: i.e., a virtual substance whose flow people may direct or subdivide easily at fine granularity and low cost. The liquid democracy concept originally and most naturally applies to the nature of voting and democratic choice, and that will be the focus of this paper. The liquid analogy might also be applicable to other critical aspects of democratic governance, such as ways voters obtain and vet information to make decisions, and ways to protect equality in the social and economic opportunities citizens need for effective participation. We leave the exploration of these more far-reaching applications of the liquid analogy to further exploration elsewhere, however.

In focusing on liquid democracy applied to democratic choice, we will attempt to separate and analyze step-by-step several of the entangled ideas of how liquid democracy could make voting more “liquid.” We will attempt to disentangle and explore in some detail the key ideas embodied in many of the variants of liquid democracy. We will end up with something close to the idea of delegative democracy that Ford proposed in 2002 [29], but unpacking the ideas it contains step-by-step and relating them to relevant precedents in existing democratic practices. We will explore, in particular:

- how the nearly-arbitrary subdivisibility of a liquid applies to election systems that allow voters to split and spread their voting power among multiple alternative choices or candidates (Section 2);

- how a liquid’s ability to flow may help us visualize – and perhaps improve – election systems that try to avoid “wasted votes” via vote transfer (Section 3);

- how the idea of guiding and directing a liquid’s flow suggests both old and new mechanisms to simplify voter choice by delegating democratic voting power to parties, organizations, individuals, or even algorithms (Section 4);

- how both subdividing and guiding liquid voting power in combination suggests solutions to the limits of voter attention and enlightened understanding that current limit the scalability of direct democratic participation (Section 5); and finally,

- how a liquid approach might make the timing of deliberation and democratic choices more fluid and give citizens more effective control over the democratic agenda (Section 6).

The purpose of this paper is not to analyze any of these possible applications of the “liquid” analogy in great depth, but rather to take a high-level perspective on how they might be useful and potentially fit together.

Making innovative changes to decision structures, or other elements of democratic governance processes, inherently present risks. We explore some of these risks in cases where they are readily apparent, but make no pretense at having exhaustively identified all such risks. More detailed formal or experimental analysis of the ideas of this paper remains for future work. Technology ultimately holds both great promise and great peril for democracy; the purpose of this paper is to focus on the former while acknowledging the latter.

2 Liquidity in Enriching Choice by Spreading Vote Power

Even if the desired collective outcome of an election is a single winner, this does not necessarily imply that each voter’s input to the election must – or should – necessarily be just one single choice, despite that being the most common practice. A voter’s preferences may be more nuanced. For example, a voter may prefer first-choice candidate A, but be willing to live with less-desired alternatives B or C, while truly despising candidate D. If A has little chance of winning, then the voter must often choose between expressing her true preference for A and “wasting” her vote, or strategically trying to help more-electable candidates B or C win over D. Similarly, if a majority would prefer either centrist candidate B or C but their support is split, then an extremist candidate A or D
might win with a relatively small plurality of support despite being least-desired by a majority of the electorate.

Recognizing these strategic conundrums, many election systems have been devised that allow voters to express support for multiple candidates, in effect “spreading” their voting power instead of lumping it into an all-or-nothing choice. Since one of the basic properties of a physical liquid is the ability to be subdivided arbitrarily, viewing voting power or support as a liquid may be a useful and interesting way to understand voting systems that allow voters to split or spread their choice. This section explores several existing vote-spreading schemes in this light, using the liquid analogy to illustrate their operation.

2.1 Approval Voting: Vote Spreading at No Cost

Approval voting asks voters not to make a single choice but instead to make a yes-or-no “approval” decision on each candidate individually. Voters effectively choose an arbitrary subset of the candidates they consider “above the bar” or meeting whatever threshold they set, without expressing any preference among those they approve. The vote is tallied simply by adding the number of approvals each candidate receives and choosing the candidate with the highest approval score. If the voter prefers A but can live with B or C, for example, then she can approve all three in order to help any of them win against D.

By allowing voters to support both a most-preferred candidate together with at least one realistically-electable candidate, approval voting allows voters to avoid “wasting” their vote. Approval voting is also often seen as desirable because it tends to prefer “centrist” candidates, who may have weak support from a majority, over “extremist” candidates who have strong support of a minority but little support in the rest of the electorate. Finally, approval voting is attractive because it allows paper ballots to be laid out exactly as with traditional single-choice ballots - e.g., with a checkbox or oval next to each candidate – but merely stating in the instructions that voters may choose multiple candidates.

While approval voting is certainly simple enough that we don’t “need” a liquid analogy to understand or explain it, we nevertheless take it as a starting point for exploring the applicability of the liquid analogy to vote-spreading systems. As illustrated in Figure 1, we imagine each voter to have a pitcher of “voting liquid,” which the voter uses to fill (or leave empty) each of a set of fixed-size containers, one for each candidate. Each voter starts with enough liquid to fill all candidates’ containers, if desired - although that particular choice (b) is equivalent to casting no vote or filling no containers, since it “helps” all candidates equally and hence helps none relative to the others. Thus, in practice each voter will have some unused liquid left-over after approving a proper subset of the candidates. The “tallying” process in this visualization simply amounts to collecting all the liquid cast for each candidate from the respective containers in all the voters’ ballots, and comparing each candidate’s total amount of collected liquid (f).

By giving each voter “enough” voting liquid to choose any subset of candidates without affecting the amount of liquid conferred to each one, approval voting effectively allows voters to spread their vote with no cost or penalty for choosing more candidates: i.e., it allows vote spreading with no scarcity. In subsequent sections we will use this liquid analogy to contrast this system with related approaches that do impose a cost on choosing more candidates.

One critique of approval voting is that it requires voters to divide candidates into just two “bins” (approved or unapproved), while offering no obvious principle for how that arbitrary approval “bar” should be set. Further, voters have no way to express strength of preferences among the subsets of candidates either above or below that bar. Variations such as score voting and majority judgment voting [8] address this issue by allowing voters to “grade” candidates on a scale (e.g., A, B, C, D), at a cost of increased complexity and less-familiar ballot structures. Finally, although there are adaptations of approval voting to multi-winner elections [51, 12], they tend to be complex, often difficult to tally even with computers [7], and involve seemingly-arbitrary vote “re-weighting” functions.

2.2 Cumulative Voting: Vote Spreading with Economic Scarcity

Consider now the long-established precedent of cumulative voting, a technique still commonly used in corporate governance processes such as board elections. Instead of assigning only one vote to each voter (or to each voting share in a corporation), the voting authority typically assigns some equal number V of votes per voter (or per share). This approach enables voters not only to spread their voting power among multiple candidates but also to express relative preferences between them. Voters have a choice not only of whom to vote for, but also of how much (i.e., what percentage) of their total voting power to assign each candidate. If a voter likes candidate A twice as much as B, she can cast about two-thirds of her voting power to A and one-third to Bob. Voters may still choose to assign all their voting power to one candidate, a strategy known
as *plumping*. On the other hand, if a voter has 10 votes to cast and likes two candidates about equally, she can cast five votes for each of those two candidates.

A cumulative vote in essence acts like a specialized ephemeral currency, in which each voter receives an equal number of “coins” to “invest” in one or several candidates as they see fit. Cumulative voting thus follows a conventional economic scarcity principle: a coin (vote) spent on one candidate cannot also be spent on another. Besides enabling voters to express strength of preference, cumulative voting is often seen as a way to protect minority interests in multi-winner elections in which the top $k$ candidates win seats, because a minority coalition holding a $1/k$ fraction of total voting power can use a plumping strategy to win at least one representative seat. Cumulative voting does not solve the “wasted votes” issue, however: a voter who casts even just one of several votes or coins for a candidate with no realistic chance of being elected reduces the voter’s ultimate influence over which of the more viable candidates get elected.

While cumulative voting allows voters to express strength of preference, it usually requires them to do so at a fixed granularity set by the voting authority. Voters must “calculate fractions” to translate their preferences into a suitable number of votes to give each candidate. The globally-determined number of votes per voter $V$ may not be evenly divisible by the fractions reflecting the voter’s preferences, complicating the “mental arithmetic” demanded of each voter. If a voter supports candidate A twice as much as B, for example, and would thus like to cast $2/3$ to A and $1/3$ to B, but the number of votes $V$ per voter is (say) 10, then the voter must round: *e.g.*, to 7 votes for A and 3 for B. This rounding introduces error in the voter’s expression of preferences (about 5% in this example). We can reduce error by assigning more votes per voter, of course: *e.g.*, $V = 100$ allows the example voter to assign 67 votes to A and 33 to B, reducing error to 0.5%. This finer granularity clearly comes at a cost of increased complexity in the mental arithmetic required of voters, and likely increase of voter mistakes: it is much easier for people to see immediately that several one-digit numbers sum to 10 than to verify that several two-digit numbers sum to 100.

**Liquid Cumulative Voting:** Here we encounter a situation in which viewing voting power as a liquid may lead to
interesting improvements on existing voting practices. We tend to think of a physical liquid as if it were arbitrarily subdivisible in any desired fractions: although there is still a minimum granularity (e.g., one atom or molecule), it is small enough not to matter for practical purposes. People intuitively divide liquids by arbitrary fractions or ratios in everyday practices as ancient as cooking: mix two parts water with one part vinegar, pour half into the pan. Could the rich expression of voting preferences be made as simple and intuitive as handling liquids in cooking? While voting using real liquid would no doubt get messy, could an electronic voting system with a suitable user interface allow users to visualize their voting power as a virtual liquid, and divide and spread it among candidates in whatever ratios make sense to them?

Figure 2 illustrates one way this might be accomplished. Each user is given an equal amount of virtual voting liquid, which they can divide into any number of equal “parts” for allocation to the candidates. Clicking the up-arrow for a candidate adds one part to that candidate, decreasing the proportion of liquid represented by each part. In Figure 2(b), for example, the voter has created just one part, assigning all his virtual voting liquid to option 3. In Figure 2(c), the voter has assigned two parts to option 2 and one part to option 5, expressing support for these two options, the former twice as much as the latter. Tallying the vote simply amounts to adding up all the liquid portions from all voters according to candidate, as illustrated in Figure 2(f).

Voters no longer need to translate their preferences into coarse-grained units arbitrarily determined by the voting authority (e.g., 10 or 100 votes each). Instead, each voter independently decides the number of parts to divide his voting liquid into, while fairness is preserved by the fact that each voter gets the same amount of liquid. In practice the electronic voting system may need to reduce these voter-defined fractions at some point down into some minimum-granularity unit for tallying, but this granularity can be arbitrarily small to ensure high precision (e.g., “microwotes”), without users ever needing to be aware of it.

While an electronic “liquid simulation” voting interface like in Figure 2 might be a powerful and intuitive way to allow users to subdivide their vote by parts, a similar effect could be approximated with conventional paper ballots. Consider the example ballot in Figure 3, which looks exactly like a conventional paper ballot except with several fillable ovals next to each candidate instead of just one. The ballot instructs voters to fill any number of ovals next to whichever candidate or candidates they support. The voter’s total voting power is divided into equal parts according to the total number of ovals filled, and distributed to the candidates in those proportions. With this approach, it remains trivial for voters to “plump” all their voting power onto one candidate as in conventional voting: simply fill in one oval (or all) next to the single most-preferred candidate. But voters can also spread their voting power by intuitive ratios, e.g., filling two ovals for A and one for B, to express that they support both but consider A twice as desirable.

### 2.3 Quadratic Voting: Vote Spreading with Attenuated Cost

The recently-proposed idea of quadratic voting [64, 52] ties voting to economic theory even more closely. Like cumulative voting, quadratic voting assumes each voter has a pool of voting “coins” or tokens: perhaps apportioned in equal measure to each voter, in proportion to the amount of stock held in a company, or even purchased directly for real money, depending on the variation. Also like cumulative voting, voters can express strength of preference by spending all their voting tokens on one candidate or issue, or spread it among multiple different candidates or issues.

In quadratic voting, however, the voter pays the square of the number of votes cast for or against a given candidate or issue: e.g., casting one vote costs one coin, but casting two votes for the same candidate or issue costs four coins. Thus, casting more votes for a given candidate or issue costs not just more coins but progressively more coins per vote. In a certain rational model of voting behavior, there is an argument that quadratic voting incentivizes voters to reveal their true strength of voting preferences, by being willing to pay more per vote on candidates or issues they care more about, and little or nothing on choices for which they have weak or no preference.

In practice, many ordinary human voters are likely to be unaware what “quadratic” even means, let alone understand the sophisticated incentive-compatibility argument behind it – or make the complex probabilistic strategy calculations of the ideal rational voter it assumes. The liquid voting power analogy might offer a way to make quadratic voting slightly more intuitively comprehensible, however.

**Liquid Quadratic Voting:** Consider Figure 4, illustrating a liquid quadratic voting analog of the liquid cumulative voting example above. As before, each voter is given an equal amount of virtual voting liquid, which they may divide into any number of parts and assign to candidates or issues. However, in this case the “containers” they are filling are not vertical beakers as above, but rather elastic “water balloons” in two-dimensional space. Adding
more liquid to one candidate’s balloon expands its two-dimensional area proportionately, but it is the balloon’s height (circular diameter) that determines how much the vote affects the corresponding option. As illustrated in Figure 4(f), the resulting votes are tallied by “stacking” the water balloons (in a perfect virtual world with no squashing due to gravity) and measuring the total height of each candidate’s stack.

Viewed in this way, quadratic voting represents an interesting intermediate point between approval and cumulative voting. Recall that approval voting imposes no cost to the voter for approving more candidates rather than fewer: voting liquid is not “scarce” at all, and each approved candidate is “helped” the same amount regardless of how many other candidates the voter also approves. Cumulative voting imposes a high cost on vote spreading: e.g., a voter who expresses equal support for two candidates will help each of those candidates half as much as a plumping voter.

Quadratic voting, in contrast, effectively incentivizes vote spreading by imposing some cost – but a moderate, attenuated cost – on supporting more options. A voter who plumps all of his liquid on only one candidate maximizes the amount he helps that single candidate but loses “cost-efficiency” in doing so. A voter who spreads his liquid among two or more candidates helps each candidate less but maximizes the aggregate amount he helps all the candidates he supports. In Figure 4, for example, voter (c) uses all of his voting liquid to help option 3, maximizing the amount he helps that option (2.2 × the baseline balloon height in (b)), whereas voter (e) provides less help to each of the four option he supports but while helping all of them more in aggregate (4.4 × the baseline).

Risks of Coercion and Illegal Vote-Buying: While QV has certain appeal, it also comes with risks. For example,
Election for Mayor of Liquitopia

| Candidate Name 1 | Party Name |
|------------------|------------|
|                  |            |

| Candidate Name 2 | Party Name |
|------------------|------------|
|                  |            |

| Candidate Name 3 | Party Name |
|------------------|------------|
|                  |            |

Fill any number of ovals next to one or more candidates you support. Your voting power will be split into equal parts according to the number of ovals filled and awarded to the respective candidates.

Figure 3: Example paper ballot for liquid cumulative voting

QV assumes that voters exercise their free choice independently and cannot collude with other voters outside the electoral system. If voters can secretly coerce or collude with each other, they can secretly buy or trade votes at only linear cost per vote rather than the quadratic cost that QV intends to impose. Suppose for example that Eve has four QV coins or tokens with which to cast a vote for an issue or candidate she cares about. If she votes honestly, she will be able to buy and cast two votes. If she can secretly find four apathetic voters willing to cast one vote each on her behalf in exchange for an equivalent of one coin each on some black market, then she can effectively cast four votes through these co-conspirators, and sell the use of her four coins on the same black market, exactly recovering her cost while doubling its effective power.

In practice it seems unlikely that any implementation of QV could prevent secret coercion and collusion risks entirely, short of pervasively surveiling all voters’ interactions with each other and eliminating their privacy and free choice in the process. These risks could be mitigated by coercion-resistance mechanisms such as “receipt-freeness” in properly-designed voting systems, however, ensuring that if Eve tries to buy votes from co-conspirators, she has no way of verifying that they “stayed bought” and actually cast the votes she paid them to. For this reason, implementing proper coercion-resistance mechanisms in systems implementing QV may be even more important than in more traditional elections.

Risks of Rewarding Apathy and Distraction Politics:
Another important risk stems from the difference in information and understanding between the “perfectly-informed rational voter” that QV theory assumes and the decidedly-imperfect, often poorly-informed and non-rational character of real-world voters. In particular, QV’s theoretical analysis makes no account for the gap between the perfect rational voter’s understanding and a real voter’s understanding of their situation: e.g., the difference between issues the voter doesn’t much care about because those issues in fact don’t greatly affect him, and issues the voter doesn’t much care about because he doesn’t understand how much they affect him when in fact they do. A voter in the latter situation, who lacks sufficient understanding of and appreciation for the extent to which a given issue actually affects them in reality, will “under-spend” on that issue when making choices in a pure QV system, investing little or nothing on this issue and saving their coin for other issues she knows she cares about.

Thus, QV presents a risk of incentivizing and even rewarding voters to be apathetic and not cast any vote on issues they know little about, even if in reality it is in their best interests to know about and vote on those issues. It is hard enough in practice to get voters to show up and vote at all, let alone ask them to pay – even with special-purpose voting “coin” or liquid – to vote on candidates or issues of vague and uncertain significance to them!

Further, deploying QV naively in public elections could greatly compound the already-serious problem of distraction politics [45, 84, 55]. To whatever extent powerful or moneyed interests can distract voters’ attention toward “bright shiny objects” such as political scandals, divisive social issues (e.g., immigration) or divisive moral controversies (e.g., abortion), and cause voters to invest most of their voting power in votes for or against these controversial candidates or issues, special interests can thereby draw the bulk of the public’s voting power away from matters the special interests actually care about and ensure that votes they care about meet little public resistance. Whereas conventional distraction politics merely relies on voters not paying close enough attention to notice and vote against special interests, quadratic voting could give the practitioner of distraction politics an even stronger economic weapon with which to sap the voting power of potential public opposition.

3 Liquidity in Proportional Representation via Transferable Voting

In addition to being subdivisible, another important property of a physical liquid is that it flows, changing its position and shape easily while preserving a nearly-constant total volume. A liquid’s flow can easily be directed (e.g., by channels or tubes), much more easily than solids for
example. In viewing democratic voting power as a virtual liquid, we can consider the “flow” property as enabling users to direct their voting power in more flexible ways while preserving the democratic principle of equality, meaning in this case that everyone has the same voting power (the same volume of liquid) regardless of what they do with it. We can find precedent for legitimate transfer of voting power in many well-established systems for democracy, and in some cases visualizing these transfers of power as “flows” of a virtual liquid may potentially help people understand these systems.

One precedent for treating democratic voting power as liquid flows may be found in transferable voting systems such as Instant Runoff Voting (IRV) and Single Transferable Vote (STV), discussed next. IRV and STV ask voters not just to pick a single choice but to rank their choices in preference order, and automatically transfers votes down this sequence as candidates are eliminated or elected in the vote-tallying process.

3.1 Single-Winner Elections: Instant Runoff Voting (IRV)

A basic, long-recognized problem with single-winner elections in which there are more than two candidates or choices is that none of the candidates might obtain a majority of the votes. In fact it’s quite possible for the candidate least favored by a majority of the population to win, if that candidate’s minority support is focused but the majority’s vote is split among two or more similar candidates. This is the source of the “spoiler effect”, the threat of which pressures voters to vote strategically for a “lesser of two evils” instead of expressing their true preferences, when their preferred candidate has little chance of winning.

This conflict between strategy and true expression of preferences is the reason many countries schedule a separate runoff election if no majority winner emerges from the initial multi-candidate election. However, runoff elections are costly in many ways including additional time...
required, election administration expenses, and attrition of voter attention.

This problem motivated instant runoff voting, which essentially asks voters to cast ballots only once but provide on those ballots all the information the voting authority needs to perform a virtual runoff election “instantly,” if needed, without voters’ further immediate involvement in each round. The key is to ask voters to indicate not just first-choice candidates but to rank any or all of the candidates in preference order. After collecting these rank-order ballots, the election authority uses them in a multi-round elimination process in which the weakest candidate in each round is eliminated and that candidate’s votes transferred to next-choice candidates on the respective voters’ ballots.

One way to visualize this process of automatically transferring voting power to next-choice candidates on a ranked ballot is to consider voting power as a liquid whose flow can be guided and pumped, as illustrated in Figure 5. In this simple IRV example, eight voters total cast ballots with three different preference orders (3×AB, 3×BC, and 2×CB). Each voter’s ballot starts with an equal allotment of imaginary voting liquid, initially in a container representing the voter’s first-choice candidate. In the first IRV round, each ballot’s liquid flows to a larger container that accumulates the aggregate “political support” of the voters’ first-choice candidates. If one of the candidates’ “fluid level” reaches the quota line representing majority support, that candidate wins the election.

In the Figure 5 example, however, there is no majority, so the weakest candidate C is eliminated. Since C no longer has a chance to win the election or make use of the voting power conferred by C’s immediate supporters, IRV “pumps” C’s accumulated voting liquid back to the supporters’ ballots, where the respective beakers for C are likewise closed, allowing each affected voter’s liquid to flow to the next-choice candidate. In this example, the two supporters of C picked B as their second choice, enabling B to reach a majority and win the election in the second round.

While the liquid analogy is by no means necessary or the only easy way to explain and understand IRV, it is appealing in several ways. First, it directly embodies the basic democratic principles of “rule by the people” (liquid power flowing from voters’ ballots to their chosen candidates) and equality (every voter having an equal volume of voting liquid, which is preserved wherever and however it flows). More specifically to IRV, this analogy illustrates how a single-winner candidate can obtain a majority of the population’s delegated political power (represented by B’s accumulation of a majority of total voting liquid), and thus can lay claim to legitimate representation of the majority, even if the population’s first-choice votes are split among many candidates. Finally, this visualization uses the capacity of liquid to “flow” in two important respects: first in terms of explicitly representing the delegation of power from “the people” to their representatives, and second in terms of representing the automatic transfer of power to next-choice candidates across rounds as weak candidates are eliminated.

The liquid analogy becomes even more relevant, however, as we extend it to multi-winner elections.

3.2 Multi-Winner Elections: Single Transferable Vote (STV)

Single Transferable Vote (STV) is a generalization of IRV’s principles to multi-winner elections in which there are both multiple candidates and multiple seats to be filled. STV’s goals are not only to avoid votes being wasted, but also to achieve proportional representation, ensuring that any sufficiently-large minority group can elect a number of representatives in approximate proportion to the group’s size.

Like IRV, STV’s goal is to encourage voters to express their true preferences instead of being pressured to vote strategically, and to minimize the number of “wasted” votes that do not help elect (or contribute to the perceived legitimacy of) a winning candidate in the end. When there are not just one but n seats to be filled, STV observes that under suitable conditions it is possible to assure that fewer than 1/(n+1) votes are “wasted,” a fraction that decreases toward zero (no waste) as the number of seats n increases. To achieve this goal, however, STV must address not just one but two reasons why votes might be “wasted”: first, as in IRV, votes for first-choice candidates not popular enough to win; and second, unlike IRV, “extra” votes for choice candidates who received more votes than necessary to win.

Consider a naïve multi-winner extension to IRV, for example, in which we simply eliminate the weakest candidates in succession, transferring their votes to next-choice candidates according to the ballots, and halt this process when there are n candidates not yet eliminated. Suppose that the most-popular first-choice candidate received twice the number of votes needed to win a seat, typically defined by the Droop quota: \( Q = \lceil v/(n+1) \rceil + 1 \), where \( v \) is the total number of valid ballots. In this case, half of this popular candidate’s votes are effectively “wasted” in that they were not needed (in retrospect) to elect this candidate, and they did not help elect any other (perhaps closely-aligned) candidates either in the end, because IRV
only ever transfers votes from eliminated candidates. It might have been strategically preferable for this popular candidate to encourage some (up to half) of her voters to vote for another allied but less popular candidate – but this reintroduces the strategy conundrum, and may be risky if the popular candidate has overestimated her support.

Mature STV systems, therefore, transfer not only the votes of eliminated candidates but also the “extra” votes of elected candidates, so that a maximum number of votes eventually apply toward electing some candidate to one of the $n$ seats. In particular, STV follows an iterative process as in IRV, but at each step we first check whether any current “hopeful” candidate has passed the vote quota $Q$ needed to win a seat. If so, we mark that candidate “elected” rather than “hopeful,” transfer any extra votes for that candidate beyond $Q$ to next-choice candidates, and then proceed to the next iteration without eliminating any candidate. STV eliminates candidates (transferring all of their votes as in IRV) only when it reaches a stage where no hopeful candidate has yet reached the quota $Q$ but there are still more than $n$ uneliminated candidates.

The Difficulty of Transferring “Extra” Ballots from Elected Candidates: This refinement creates a significant second-order difficulty, however: since only some votes for elected candidates are to be transferred, which specific ballots are to be transferred? This question matters, and can affect the election’s outcome for the remaining candidates, because each ballot may have a different rank-ordering. For example, suppose the election authority takes the extra ballots from the “top of the pile,” those tend to be ballots cast most recently, and A’s late-voting supporters tend to rank their ballots ABC whereas a similar number of A’s earlier-voting supporters tend to vote ACB. Then candidate B may have a significant advantage over C and benefit from many ABC ballots being transferred and most ACB ballots left behind.

As a result, many STV systems require that the choice of the ballots to be transferred be random. Introducing randomness into the vote-counting process brings further problems, however: it is harder (and perhaps impossible) to perform a precise recount without the outcome varying purely due to a change in the random choices; it is hard to verify independently that the randomness used was truly random and unbiased; and in general voters may rightfully question whether and why part of the election process should be run like a lottery.

Here again, taking the perspective of voting power as a liquid may be helpful, this time in a way that leverages both the divisibility and flow properties of physical liquids. Some STV variants, such as Meek’s [57, 42] and Warren’s [83], rather than transferring a selected fraction of (whole) ballots from elected candidates, instead transfer all of the ballots from elected candidates but at a fraction of their original voting power. This refinement allows STV to operate with no randomness except in the typically-rare case of perfect ties – but the mechanisms are complex, subtle, difficult to explain to ordinary voters, and even the experts have trouble agreeing on the precise rules [41].

While the liquid analogy by no means makes STV “simple,” nevertheless it may be helpful in intuitively understanding, and explaining, the fractional ballot-transfer in STV variants like Meek’s and Warren’s. Consider the example in Figure 6 of an STV election with eight ballots, three candidates, and two seats. In the first round, popular candidate A easily wins one seat, accumulating voting liquid from four ballots despite needing only three to win.

![Figure 5: Instant Runoff Voting (IRV) example illustrated via “liquid flows” of voting power](image)

(a) First round: voting power from all ballots flows to each voter’s first-choice candidate.

(b) Second round: weakest candidate $C$ eliminated; $C$’s voting power “pumped” back to voters’ ballots, then “flows” (i.e., is transferred) to $C$ voters’ second-choice candidates.

Figure 5: Instant Runoff Voting (IRV) example illustrated via “liquid flows” of voting power
(a) First round: voting power from all ballots flows to each voter’s first-choice candidate. Popular candidate A with four first-choice votes exceeds the 3-vote quota needed to win a seat.

(b) Second round: the extra $\frac{1}{4}$ of A’s voting power is “pumped” back to refill A-voter ballots partially, allowing their second-choice preferences to help elect B.

Figure 6: Single Transferable Vote (STV) example illustrated via subdivisible liquid flows of voting power

To avoid wasting this extra voting liquid, A retains only the 3-vote quota needed to win a seat, and the extra voting liquid is “pumped” back and distributed evenly among the ballots that had voted for A, only partially refilling each ballot. This excess voting power of A’s voters then flows to each ballot’s next-choice candidate, in this case B, who then has enough aggregate liquid to win the second seat.

The liquid analogy may thus help clarify why it makes sense for Meek’s or Warren’s versions of STV to transfer fractions of votes. In this analogy, all three interesting properties of liquids are relevant: the fact that liquid flows (voting power is both delegable to candidates and transferable to next choices), that liquid is subdivisible (an elected candidate retains only the required fraction of voting power they received), and that liquid is volume-preserving (each voter’s equal amount of voting liquid always “goes somewhere” and is neither lost nor artificially expanded, and most of it goes toward electing the $n$ winning candidates). In these ways, the mature versions of STV seem to represent a strong, established precedent for key elements of liquid democracy.

Of course, the liquid analogy is not perfect, and in particular does not precisely reflect some of the subtleties of either Meek’s or Warren’s systems – but those subtleties tend to be corner-cases likely to affect outcomes extremely rarely in practice. Further, the liquid democracy perspective might in fact suggest further potentially-interesting tweaks to STV, such as eliminating the need to calculate the winning quota as an integral number of votes as in the Droop quota: the “floor” and final +1 parts of the quota calculation are probably unnecessary since a non-integral “amount of voting liquid” is not nearly the problem that a non-integral “number of votes” may sound like.

3.3 Risks and Disadvantages of Ranked Voting Systems

While IRV and STV hold considerable appeal, they also have well-known disadvantages. Asking voters to rank the candidates is arguably more complex than simply asking voters to pick one, or even to mark whichever ones they support as in Approval voting. Paper IRV and STV ballots with many candidates can require large $N \times N$ square matrices of ovals to fill, scaling poorly to elections with many candidates.

In addition, IRV and STV are often criticized as tending to prefer extremists over moderates, because middle-of-the-road candidates who may be many voters’ second choice but not many voters’ first choice will be eliminated early, leaving a contest between more extreme candidates with focused bases of first-choice support. To avoid early elimination, centrist candidates must defend themselves “on both sides” from more extreme competitors, while the extremists might need to defend only one front – and if the first-choice voter support for centrist candidates is split, then all of them may well be eliminated before transferred votes start having an impact. For this reason, an informal “rule of thumb” in IRV/STV campaigning is that only first-choice votes matter: if you can’t convince the voter to make you their first choice, move on. It is thus questionable whether IRV or STV truly enable voters to avoid strategic thinking and “vote their conscience” by supporting a first-choice candidate who has little chance of winning.

Besides the risk of overloading voters with “too much choice,” which we will address further below, the information-richness of ranked voting creates a more subtle risk of coercion and vote-buying. Since the mature STV implementations typically require computers to per-
form the nontrivial “flow” calculations, for transparency it is desirable for the “raw” list of anonymized ballots to be published in full so that anyone can independently repeat and verify the STV calculations. However, even if all IRV ballots are fully anonymized and disconnected from their voters’ identities, either physically (via shuffling in a ballot box) or electronically (via verifiable cryptographic shuffle), each ballot’s rank-choice list carries enough information to make ballots potentially uniquely-identifiable.

An STV ballot asking voters to rank only 10 candidates, for example, offers 3.6 million (10 factorial) possible complete rankings. A vote-buyer might ask a voter to cast an STV ballot with a particular ranking of all 10 candidates, the first one or two of which the vote-buyer chooses according to his preferences and the remaining ones randomly, which will effectively “watermark” the requested ballot by making it unique with high probability. The vote-buyer then simply watches for this specific ranking to appear in the published election outcome, and pays the voter only if it does.

3.4 Cumulative Transferable Vote (CTV): Proportional Representation with Vote Spreading

Viewing existing voting systems such as those above through the lens and framework of the liquid voting power analogy, for purposes of both vote spreading (approval, cumulative, quadratic voting) and vote transfer (IRV, STV), makes other potentially-interesting variations more readily-apparent. Observe that IRV and STV maintain a “winner-take-all” approach to interpreting ballots in each round, in that each voter’s ballot can help only “one candidate at a time”; vote transfer merely allows a ballot to help different candidates in different rounds. There appears to be nothing fundamentally essential about this “serial winner-take-all” approach, however. We could readily combine the vote-spreading mechanisms of approval, cumulative, or quadratic voting with the transfer mechanisms of IRV and STV, and there may be interesting advantages to doing so.

First consider a variant we’ll call cumulative transferable vote or CTV, a combination of cumulative voting we propose with STV-like vote transfer for multiwinner elections. In this variation, voters conceptually divide a fixed amount of “voting liquid” into parts and assign them to candidates as they prefer, exactly as in Figure 2. Elections could also use the paper ballot approach in Figure 3 with multiple fillable ovals per candidate, in which voters may fill any set of ovals to divide and assign their voting power in that many parts.

Given a set of cast ballots expressed this way, however, we use a multi-round process as in STV to tally them and choose winners. In each round, we first check if any candidates have more than a winning quota of \(1/(k+1)\) fraction of the total voting liquid in play, where \(k\) is the number of candidates not yet elected or eliminated. If so, each candidate above this threshold is marked elected, and exactly as in Meek’s STV [57, 42], any surplus voting liquid above this threshold is returned to the supporting voters’ ballots in proportion to the voters’ respective contributions. That surplus voting liquid is then redistributed to any other candidates still in play (neither elected nor eliminated) on the respective voters’ ballots, while preserving the voter-specified allocation ratios among those remaining candidates in play. If in some round there is no candidate over the \(1/(k+1)\) threshold, then the candidate with the least support (voting liquid) is eliminated, exactly as in STV, and all the liquid that went to supporting this candidate is returned to the supporters’ ballots for proportional redistribution among other candidates still in play as above.

This variation has several attractive features. It assures proportional representation while minimizing “wasted votes” and reducing strategic voting incentives as in STV, with a ballot structure nearly as simple as in plurality or approval voting – or even just as simple, if we reduce it to a “one fillable oval per candidate” ballot. By allowing voters to assign multiple parts to candidates as in Figure 3, we give voters the ability to express both equal and unequal amounts of support to different candidates, whereas IRV and STV only meaningfully allow voters to express unequal levels of support through ranking. Thus, CTV combines the ballot simplicity of approval voting, the richness of expression of cumulative voting, and the proportional representation properties of STV.

Another potentially appealing property of CTV is that voters who split their support among multiple candidates will be helping all of them (at least some) in early rounds, which may help moderate candidates with broad but diffuse support avoid early elimination before vote transfer can start helping them. Consider for example a voter who splits his vote at a 2:1 ratio (3 parts total) between most-preferred specialty candidate A who is unlikely to win and a more mainstream candidate B with broader but less-focused support. In CTV, even though specialty candidate A gets more of the voter’s power in the initial round, mainstream candidate B gets some of it from the start, reducing B’s risk of early elimination if many voters spread their vote between different specialty candidates and mainstream candidate B. If specialty candidate
A is eliminated, then *all* of the example voter’s power is transferred toward helping B in subsequent rounds. And if either A or B is elected before the other is eliminated, then any excess voting power is transferred to helping the other.

A third appeal in CTV is the simplicity of its vote-tallying calculations in relation to state-of-the-art STV variants. In Meek’s STV, for example, the vote transfer process for each round is a complex calculation that itself requires an iterative successive approximation process amounting to solving a Linear Programming (LP) problem [81]. CTV, in contrast, has no need either for random selections of ballots to transfer or for iterative approximations; all the relevant voting power or “liquid transfer” adjustments can be done with a single straightforward pass through the ballots in each candidate election/elimination round.

These appealing characteristics of CTV are only informal and intuitive, of course. We make no pretense of being able to perform a thorough analysis of CTV here; such an analysis and comparison with other alternatives remains for future work.

### 3.5 Quadratic Transferable Vote (QTV): Rewarding Vote Spreading

A similar combination of the liquid elements of quadratic voting and STV suggest another intriguing hybrid we’ll call quadratic transferable vote or QTV. In this variant, we give each voter an equal measure of virtual liquid, which they can divide into parts and use to fill virtual “water balloons” for the candidates they support, as illustrated in Figure 4. The simplified paper ballot structure of Figure 3 is also possible here, since QTV identical to CTV in the way voters express preferences but differs only in the way the results are calculated.

As in STV and CTV, we calculate the results in multiple rounds, electing candidates whose stack of virtual water balloons exceeds the relevant $1/(k+1)$ height threshold when $k$ candidates are in play, or eliminating the weakest candidate if no candidate is above the threshold. When a candidate is elected, we “deflate” all the balloons in the winning candidate’s stack so that their aggregate height exactly matches the threshold. In this deflation process, we preserve the proportions among the balloons’ respective heights (diameters), *i.e.*, preserving the percentage of total height each voter contributed toward electing the candidate. The liquid we recover from deflating the elected candidates’ balloons this way returns to the supporting voters’ ballots, just as in CTV, for redistribution to other candidates still in play according to the user’s expressed preferences.

As in quadratic voting, QTV effectively rewards voters for spreading their vote — especially in early rounds when many candidates remain in play — because the aggregate stack-height impact of a vote spread widely is greater than the stack-height impact of a vote plumped onto one balloon. This property effectively encourages voters to allocate at least one part of their vote to each candidate they support at all, while allowing them to “pay more” (at an efficiency cost) to help their most-preferred candidates more than others. We may also expect QTV to help candidates with a broad base of support, even if many of their supporters spread their vote among several candidates, perhaps further reducing the risk of early elimination to moderates with a broad but diffuse support base.

If a voter decides to support two candidates equally instead of just one, for example, then each of those candidates still individually get $\sqrt{1/2}$, or about 70%, of the “help” they would get if the voter supported them alone. A voter who splits his vote equally among four candidates helps each one 50% as much as he would by plumping on one alone, and thus helps the four candidates $2 \times$ as much in aggregate. Because a coalition of candidates receives more aggregate help from voters who spread support among all of them, this effect may incentivize candidates to “be civil,” build or join coalitions, and encourage voters to support other candidates they consider reasonable in addition to themselves.

A voter who strongly prefers specialty candidate A but also supports more mainstream candidate B at a 3:1 ratio helps A 82% as much as by plumping, while also helping B 50% as much. If the voter’s preferred candidate A is eliminated, then all the voter’s liquid transfers to support B at 100% rather than 50%. If A is elected, then only the excess voting liquid that “wasn’t needed” to help A gets transferred to B, subsequently supporting B at some level between 50% and 100% of a plumping vote.

In summary, QTV appears attractive in that it allows and encourages users to support multiple reasonable candidates, enables users to express both equal and unequal strength of preference, ensures proportional representation and avoids wasting votes as in STV, and like CTV is much simpler to calculate than non-random STV variants such as Meek’s. To whatever (perhaps limited) extent that real voters match the ideal rational model that quadratic voting assumes, QTV should incentivize voters to express their “true strength of preference” in deciding which candidates to support and by how much. These features suggest QTV is promising, but we leave many questions and subtleties for future work, such as precise analysis of QTV’s properties in comparison with other systems.
and the handling of subtleties such as the negative votes that quadratic voting proposes to allow.

# 4 Liquidity in Delegation to Simplify or Aid in Choice

The above sections have discussed precedents that increase the richness of voter choice, to allow splitting vote power and expressing (relative) strength of preference (Section 2), to avoid “wasting” votes in majoritarian or proportional elections (Section 3). Increased richness of choice also place a burden on voters, however, many of whom may have little time or inclination to study carefully and come to an informed understanding of the choices available.

For this reason, many voting and ballot schemes make provisions to simplify, manage, and perhaps even decrease the richness of choice available, often by enabling (or even requiring) voters to delegate many details of their choices, most commonly to their preferred party. Taking the liquid analogy, we can view such delegation as transitive flows of voting power: e.g., from voters to parties, then from parties to candidates, and finally from elected representatives to decisions on specific laws or issues.

## 4.1 Precedents for Delegation to Simplify and Manage Choice

We observe two clear precedents for delegation of democratic power as a way to simplify or manage choice: first, the basic structure of representative democracy, and second, political parties.

### 4.1.1 Representative Democracy:

Small communities sometimes practice direct democracy, in which ideally all eligible voters discuss, deliberate on, and participate in decisions on all significant decisions affecting the community. Because the complexity of governance and the total number of decisions to be made tends to grow proportionally with the size of community, however, the pure ideal of direct democracy rarely functions well beyond small communities of tens or at most hundreds of participants. This scaling challenge, caused by the inevitably limited time and attention of ordinary citizens, necessitated the now far-more-common representative form of democracy, in which voters only periodically elect representatives who specialize in carrying out the day-to-day tasks of political decision-making.

Although pure direct democracy does not readily scale to large democracies, elements of direct democracy such as popular initiatives and referenda became a fixture of the Swiss federal constitution in the 19th century, and have since been adopted in many governments around the world. In this hybrid approach, while elected representatives still handle most decision-making, the electorate is directly involved in select decisions on major issues. In effect, the people delegate their political power for most day-to-day governance decisions to their representatives, but retain direct involvement in certain decisions, including the potential ability to override decisions of their representatives. This general notion of power delegation with a possibility of override is a recurring idea we also see in party systems, discussed next, and generalized further in today’s liquid democracy ideas, which we will return to later.

### 4.1.2 Political Parties and Straight-Ticket or Party-List Voting:

While political parties in practice serve many functions, one of them is to simplify the choices of voters who may not have sufficient time or interest to keep up with the many candidates or issues on a ballot individually, but feel a close-enough affiliation with some political party to leave many of the details of their decisions to their party: e.g., by voting for candidates mainly because of their party affiliation.

In most governmental elections it is typical for ballots to display party affiliation prominently alongside candidates’ names, and making it easy and fairly common (though by no means universal) for voters simply to vote for all the candidates from their preferred party if they choose. Certainly it is common in many elections for ballots to list many candidates across multiple open positions, about whom many voters are likely to know little to nothing. Thus, many of the votes that go toward electing “down-ballot” candidates are likely to be party-line votes, whose candidates may benefit substantially from the “coattail effect” from voters showing up mainly to vote for some other more prominent candidate or issue.

Historical US elections even used ballot designs in which each each party had its own differently-colored ballot, making voting easy for straight-ticket voters but more difficult and confusing for split-ticket voters, who would need to mark and cast two or more differently-colored ballots. Even today, a number of states use ballot designs allowing voters to cast a straight-ticket ballot for all their party’s candidates by marking a single option. Texas not only provides this option, but also allows voters to override the party-line vote for specific races by marking a candidate from another party for that race.

Many European election systems take this philosophy
of simplifying choice through party delegation even further, in the form of party-list proportional representation. In such designs, voters choose only parties, each of which has published a ranked list of that party’s candidates for the available seats. After ballots are counted, each party that reaches a minimum popular vote threshold is awarded a number of seats in proportion to the total vote for that party, in the ranked order defined by the party. Party-list proportional representation can thus be viewed as a constrained variant of STV, in which voters cannot specify their own candidate ranking but must instead choose among a small number of predefined rankings, one per party.

In summary, allowing – or even requiring – voters to delegate many or all specific details of their choice to their preferred party is a common and accepted practice, if not without many potential strengths and weaknesses.

### 4.2 Few Versus Many Parties: Countering or Merely Obscuring Extremes?

Political parties have become a ubiquitous structural mechanism not only to organize races for power in democracies, but also to simplify voters’ choices by enabling (and sometimes requiring) them to delegate details of their decisions to their preferred party. The number of parties people have to choose from, however, is usually severely limited for structural reasons. Two-party systems such as the US based on “winner-take-all” elections strongly discourage the rise of third parties due in part to fear of the spoiler effect [5, 66]. While the proportional representation systems common in Europe more readily accommodate multiple parties, to be politically relevant they must have enough direct support to obtain at least one representative seat. Further, to obtain any representation parties must often pass a legal threshold (e.g., 5%), typically imposed out of fear of extremist parties [15].

These structural constraints favoring large parties force them to aggregate and effectively hide the complex organizational and activist structures within parties, the issue-centric campaigns and influence structures outside of parties, and the vast constellation of actual reasons people cast the votes they do. How many people voted for a particular party due to general alignment with the party’s platform or ideology, how many due to alignment on a single issue the voter considers most critical, how many due to personal attraction to a particular candidate, and how many solely because the opposing party or candidate seems worse? After an effective local activist or issue-focused organization successfully persuades a citizen to turn out and vote for their cause, the electoral system obfuscates that fact in an anonymous statistical bump, aggregated with all the other distinct reasons that other voters turned out (or didn’t) to vote for particular candidates or issues. This aggregation leaves the actual causes of influence to be merely guessed at by pundits and journalists, or estimated via bias- and error-prone opinion and exit polls [19, 9].

Limiting choice obscures not only the motivations of voters but also the motivations of non-voters: the often-sizeable percentage of the eligible electorate who do not actually vote. For example, does the silence of a non-voter express lack of interest in general, lack of time to go vote or meet associated registration or identity process requirements, or does silence represent a vote for “none of the above”—merely a disapproval of those few particular choices that were laid before the voter? How many of today’s non-voters might become voters if they were given the choices they actually desire? While online digital forums can obscure the motivations of silent communities [31, 6], offline political structures set far earlier precedent for such exclusion.

We have many reasons to suspect that structural limitations on the breadth of party choice may not so much prevent extremism so much as sweep it into a corner and temporarily out of sight, until it suddenly bursts through or circumvents the structural barriers intended to contain it [15, 34]. Even if the US’s two-party structure prevented the Tea Party from technically being a true political “party,” it did not prevent the movement from fundamentally shifting the Republican party’s positions and discourse [1, 74].

When partisan competition gives rise to cultural polarization and tribalism, identity politics can lead people to vote against their own interests [77]. When the working structures of political organization must reach large population segments to win votes, they become dependent on money to achieve those scales, incentivizing representatives to exploit cultural divisions and fears to win votes while quietly sculpting their policy choices around the interests of their elite donors [33, 75, 76].

In short, large-scale political organization inevitably relies on vast networks of fine-grained structures both within and around the few major parties in a country, and leaving those structures outside of the electoral system and their effects hidden in aggregate election results both deprives us of important information and exposes those structures to corruption. Can we, and perhaps should we, bring these fine-grained structures into the sunlight and make them both visible and accountable?
4.3 Revealing Choice Structures through Transparent Delegation

Since accepted democratic structures already embody multiple transitive levels of decision delegation – e.g., from voters to parties to representatives – it is not such a stretch to envision allowing further levels of delegation, allowing voters to express their preferences in terms of more fine-grained organizational structures. Instead of parties and partisan voters appearing to the electoral system as a monolithic mass of undifferentiated votes as they do now, major parties might then represent masses of voting power collected and aggregated from many smaller organizational structures by delegation more explicitly and transparently via the electoral system.

Giving voters the power to delegate their choices is central to many conceptions of liquid democracy. But if we were to embrace and expand this power of delegation beyond a choice between a few large parties, what – or who – should we allow voters delegate to? We explore four potential alternatives: delegation to finer-grained parties or microparties, delegation to issue-centric organizations, delegation to individuals, and delegation to algorithms.

4.4 Delegation to Microparties: Expanded Choice among Political Parties

One way to allow for more fine-grained structures might be to embrace the concept of microparties. We informally define a microparty as an organization representing a group of voters that may be too small and narrowly-focused to have a realistic chance of obtaining even one seat in a large-scale public election. A microparty might instead, for example, wield a (smaller amount of) power by selectively delegating its supporters’ votes to, and thereby influencing, larger parties. Microparties might naturally specialize to narrower demographic audiences, smaller geographic regions, or more specific party platforms or ideologies than a major party can. Microparties along some of these lines have formed spontaneously in Australia in recent years, in fact, though as more of an unintended and not-always-welcome side-effect of unrelated electoral reform rather than by design [50], and thus not necessarily taking a form that we might prefer by design.

An essential attraction of microparties is that they can be “closer” to their relevant segment of voters, both in terms of responsiveness to their voters’ interests and in terms of assisting and guiding the choices of their supporting voters. By giving formal and explicit “recognition” to microparties in the electoral system, we might not only expand the breadth of party choice voters have, but also make it an explicit and transparent part of the public record when they delegate their choices to a microparty.

Suppose, for example, that a microparty cannot realistically find many candidates of its own to run for national political offices, let alone hope to win those races. However, the microparty can nevertheless campaign among its target population, and explicitly delegate the votes it receives to major-party candidates who are most closely aligned to the microparty on the issues most important to the microparty. In a Party List Proportional Representation system, this might in principle be achieved simply by permitting microparties to publish lists that include candidates from other parties when they are not running enough – or perhaps any – candidates of their own.

In a Single Transferable Vote system, microparties can in effect do this in any case, simply by handing out “voter advice” cards to their supporters showing the microparty’s recommended rank-ordering of the available candidates regardless of party affiliation. (It may be little coincidence that microparties in some form emerged spontaneously in Australia, which depends heavily on STV.) In a multi-election ballot for multiple races for local and regional offices, a microparty could provide its supporters a recommended selection of down-ballot candidates for all those offices, cherry-picking from its own and other parties’ candidates according to the microparty’s judgment of best alignment with its position.

4.4.1 Election System Design for Delegation Transparency:

With appropriate ballot design or electronic voting user interfaces, microparty supporters might be able to adopt the microparty’s choices in “straight ticket” fashion or selectively override particular choices, just as Texas ballots already permit in straight-ticket voting for major parties (see Section 4.1.2). If we allow for a large number of microparties in the interest of choice, we should not expect – or promise – that all microparties would be listed explicitly on limited-size printed ballots.

E-voting environments can easily solve the ballot scalability problem, however, by allowing voters to look up the microparty by the first few letters of its name, or by scanning a QR code printed on the microparty’s printed voter-advice card. The net effect on the actual electoral outcome would be identical to that if the voter simply brought along the microparty’s voter-advice card to the ballot box and entered manually entered the recommended choices (overriding them as desired), which voters can do anyway in most any election system. However, besides offering the voter the convenience of automation, we might hope to ensure that the fact that a specific number of voters fol-
allowed the microparty’s recommendations would be tallied and appear in the election’s official outcome, giving everyone clear information on each microparty’s influence structure: both how many people are following its recommendations and where (e.g., to which major-party candidates) its influence is flowing to.

If it were not only accepted but expected that microparties wield voting power mainly by delegating it transitively to other parties large enough to win seats, then microparties could use the official, public information about their power to negotiate and form alliances with larger parties, the microparty offering formal support for some of the major party’s candidates or issues, in exchange for the major party’s consideration of the microparty’s interests. This type of inter-party dance is already standard procedure between larger and smaller parties in the coalition-building stages of multi-party governments. Delegation through microparties might merely give large and medium-size parties more choice of “dance partners” of more wide-ranging sizes. Some microparties might form stable, long-term, exclusive associations with larger parties, effectively becoming subsidiaries, while other microparties might retain greater independence, switching alliances regularly or choosing major-party candidates to support on purely a basis of alignment with individual candidates’ positions.

4.5 Delegation to Single-Issue Organizations – Exclusively or Jointly via Vote Spreading

As mentioned above, one “limit case” of a microparty is one that might make no pretense of representing an entire ideology or platform, but instead is organized around a single issue or cause: e.g., a particular position on health care, environment, human rights, jobs, etc. The existence of such single-issue microparties might seem slightly absurd and dysfunctional in an election system that allows voters to choose only one candidate or party for a particular office: how could we reasonably expect anyone to choose an organization representing only one issue to represent them and guide their choices?

One reason that allowing single-issue microparties might be desirable, however, is to reveal the prevalence (or lack thereof) of “single-issue voting.” If a certain segment of voters cares about one issue above all else, and decides to support this microparty (and, by delegation, the candidates it recommends) in preference to all the broader platform-based parties or microparties, then it may be useful for the major parties, and the general public, to know this: i.e., to understand the perceived importance of that issue. We cannot in any case prevent voters from choosing a particular candidate because of their stance on a single issue, but we can hope to gain understanding of how often that happens and on which issues. Allowing voters to delegate through issue-based microparties would enable that.

As we explored earlier in Section 2, however, there is no fundamental reason we must force voters to make only one choice in an election, and the same is true for delegation. Suppose we design an election system allowing voters not only to delegate their vote but also to subdivide and spread it among multiple microparties they support, perhaps with the ability to express strength of preference as well as with cumulative (2.2) or quadratic voting (2.3). This would effectively allow voters the freedom to “construct their own platform” if they choose.

For example, if a voter strongly supports the position of issue-based microparty A and weakly supports the positions of issue-based microparties B and C, she might delegate her vote power to them at a 2:1:1 ratio. With liquid cumulative voting, for example, a candidate supported only by party B will receive 1/4 of the voter’s delegated vote. A candidate who for whatever reasons is aligned with and supported by all three of these microparties A, B, and C will receive all of the voter’s delegated vote, but via different paths. If the electoral system statistically reveals all of these delegations, then the major parties and the public obtain valuable information about not only the extent to which different candidates are supported, but also why they received support: i.e., through which delegation paths in which amounts.

Of course, no voter would be obligated to “build their own platform” this way: voters would still be free to delegate to more conventional parties or microparties representing platforms bundling many issues together. And once again, obtaining accurate information through the electoral system about how many voters choose a bundled platform or ideology, versus building their own platform through vote-splitting, might represent a valuable public good.

4.6 Delegation of Decisions to Individuals

Delegation of voting power to an arbitrary designated individual has long been accepted practice in corporate governance structures allowing proxy voting [67, 22, 2]. The idea of allowing voters to delegate to individuals of their choice in general political processes has been a recurring idea suggested by many people including Heinlein [40], Tullock [79], Miller [58], Lanphier [54], Ford [29], Sayke [69, 70], Green-Armytage [35, 36, 37],
Alger [3], Boldi et al [11], and others. Taken to its limit, this approach in essence gives voters complete freedom to choose individually who will represent them politically, rather than being constrained to a few official candidates or major parties — or even to a large but still-limited range of microparties.

Many of these proposals envision electronic deliberation systems reducing the costs of direct participation in legislative processes enough that anyone who wants to can serve as a legislator, participating in legislative debates and committees while wielding the power of whatever arbitrarily large or small group of voters delegated their vote to them. As Alger suggests, “we could have legislatures that could allow quite large numbers and still work well, possibly even allowing individuals that represent only themselves” [3].

Even with suitable electronic systems, however, it is not easy to reduce the costs of direct participation to zero. In any real-time deliberative public forum there tends to be a limited amount of total “speaking time” whether the forum is physical or virtual, and even in a message-based online forum (e.g., Twitter) there is a limit budget of total human attention to messages being sent. Ford [29] and Alger [3] propose apportioning speaking time and other scarce resources to delegates in proportion to the delegated votes they wield, and Alger suggests that this objective “pecking order” also be used instead of seniority to decide organizational matters such as to prioritize selection of legislators to committees. If despite these provisions it proves necessary to limit direct participation, both Ford and Alger propose STV-inspired methods of eliminating delegates with the least support from direct legislative participation, while still allowing eliminated delegates to influence the decision process by transitively “re-delegating” their voting power (Ford) or filling out incomplete preference lists of their supporting voters (Alger).

4.6.1 The Risk of Accidental Dictators:

Another issue with delegation to individuals is the potential risk that voting power might become overly concentrated if many people delegate their vote to a popular celebrity or ideologue. The German Pirate Party’s internal experiments with liquid democracy, in which one professor happened to accumulate a large amount of voting power, anecdotally confirm the plausibility of such risks of creating “accidental dictators” through delegation [10]. Ford’s proposal anticipated this risk, allowing voters to split their voting power and spread it among multiple delegates [29].

To mitigate this risk further, we could use Liquid Quadratic Voting (Section 2.3) to incentivize voters to “spread out” their delegated voting power and actively reward them for doing so. For example, a voter who splits her voting power in equal parts to delegates A and B would increase each delegate’s voting power by $\sqrt{1/2}$, or 71% of the amount of power either A or B would receive if the voter delegated to them alone — but in combination the two delegates receive $2\sqrt{1/2}$ or 141% of the baseline amount of voting power. Voters who spread their delegated voting power more widely receive even more of an effective “bonus” in aggregate voting power: e.g., a voter delegates equally to four delegating helps each of them 1/2 as much as with single delegation, but helps the group of them 2× as much in aggregate. Stated another way, a celebrity or ideologue whose voters support only her would need twice the number of total supporters to wield the same voting power as a coalition of four delegates whose supporters spread their power evenly among the four.

4.6.2 The Anonymity Versus Accountability Conundrum:

Another problem with delegation to individuals is that we generally want an individual voter’s choices to be private and anonymous, to mitigate the risk of coercion or vote-buying — but it seems that delegates who wields the voting power of others need to vote publicly in order to be accountable to their supporters. If we allow anyone to become a delegate with no required threshold of support or other barriers to entry, then anyone who wants to coerce a voter or buy their vote can simply require them to become a delegate (perhaps representing only themselves) and thus vote publicly, allowing the coercer or vote-buyer to verify that the voter “stayed bought.” [30].

One way to mitigate this coercion risk might be to require a delegate to pass a certain threshold of voter support before being allowed to wield delegated votes and cast votes publicly. It is not clear how best to set such a support threshold, however: setting it too high would eliminate the voter freedom and breadth of choice that makes delegation to individuals attractive in the first place. On the other hand, it is not clear there is any support threshold “high enough” to make a delegate impervious to coercion or vote-buying, as suggested by evidence that national representatives in today’s most well-established democracies are often much more responsive to moneymed interests and lobbyists than to their electorate [73, 75, 17, 28].

Perhaps a better way to address the coercion risk is to keep each individual’s roles as voter and potential delegate strictly separate in designing an electoral system supporting delegation. An individual’s actions in the voter role would always be private, and her actions in the del-
gate role always public and hence accountable. In her delegate role, a voter could publicly wield the delegated votes of her followers (if any) in one way, but in her voter role privately cast a vote different from – perhaps even opposite of – her public stance, i.e., secretly declining to support her own public position. A potential coercer or vote-buyer can ensure that she takes the coercer’s stance publicly, but cannot ensure that she actually casts her vote that way privately. If she doesn’t, then her delegate role will wield no actual voting power unless other voters independently choose to delegate to and support her public platform. Since all of these original votes are likewise private and anonymous, the would-be-coercer can buy the coercee’s public platform but cannot actually coerce anyone (even the coercee herself) to support it: if it receives any delegated support at all, it is through the free choice of individual voters casting their delegation choices anonymously. The coercer is then “coerced” only in the non-necessarily-harmless but standard and familiar mode of a celebrity whose face and participation is purchased in an advertising campaign: the coercer can do no more than try to make the purchased platform attractive.

Viewed another way, from a “microparty” perspective, we might in principle allow anyone to create a microparty regardless of support, and to publish a corresponding “microparty platform” with recommended choices on candidates and issues in an election. This public microparty platform may be vulnerable to coercion or buying, by virtue of being public as is required for accountability. However, no one – not even the “leader” of the microparty who registered it – can actually be coerced to vote according to the party’s public platform.

To ensure that a coercer can’t determine whether a delegate or microparty leader actually votes for her own public platform, the electoral system must be designed not to publish exact support statistics for delegates or microparties who receive a small amount of support (e.g., zero, one, or a few votes). This could be accomplished either by publishing voter support statistics only for delegates or microparties that achieve some threshold of support, or by deliberately adding noise to the published statistics or microparties that achieve some threshold of support, by publishing voter support statistics only for delegates or microparty leaders. This could be accomplished either privately and anonymously, the would-be-coercer can buy the coercee’s public platform but cannot actually coerce anyone (even the coercee herself) to support it: if it receives any delegated support at all, it is through the free choice of individual voters casting their delegation choices anonymously. The coercer is then “coerced” only in the non-necessarily-harmless but standard and familiar mode of a celebrity whose face and participation is purchased in an advertising campaign: the coercer can do no more than try to make the purchased platform attractive.

4.7 Delegation to Tools or Algorithms

As an alternative to delegating decisions to organizations or individuals, voters may wish to delegate some of their decisions to, or “take advice” from, automated tools or algorithms. In fact this is already occurring in practice, through voters’ growing use of voting advice applications or VAAs [32, 56, 43]. These tools often take the form of convenient web sites that ask voters questions about their opinions, and use algorithms to advise them about how well- or poorly-matched particular candidates are to their positions. A 2012 survey found that 20–40% of the electorate had used VAAs in recent elections in several European countries [32]. On the one hand, such applications appear attractive as tools to empower voters and help them make more well-informed decisions. On the other hand, such tools present significant risks, as the algorithms they implement are often non-transparent, not readily understandable or explainable to most of their users, and the advice they give can be affected (intentionally or not) by many subtle design factors.

Even among the larger population of voters not consciously seeking algorithmic advice on their decisions, however, a high percentage of voters are unquestionably relying on and indirectly influenced by the algorithms underlying their social network newsfeeds to select, filter, learn about, and discuss events, and to inform their political opinions [63, 53]. Sensationalistic but false news stories, produced either by ideologically- or advertising-profit-motivated actors, can spread more effectively via social media and potentially influence voters’ opinions [4, 61]. The fact that these influence-mediating algorithms are typically proprietary, controlled and understood only by a few engineers in tech giants, has sparked considerable concern about algorithmic transparency [23, 21, 71]. Fake accounts operated by social bots can further amplify the spread of misleading or fake information [87, 26, 88, 13, 72].

Given the clear and considerable potential risks inherent in empowering voters to delegate parts of their thinking to algorithms, we must proceed with extreme caution in even approaching the idea of endorsing such practices, let alone incorporating such capabilities into electoral systems. Nevertheless, the issue may in the end boil down to one of transparency. We ultimately cannot prevent users from taking voting advice from algorithms, either consciously (e.g., through VAAs) or unconsciously (e.g., through social media newsfeeds), without also taking away their freedoms of privacy and choice. Given this impossibility of prohibition, could we at least design future electronic voting and decision systems to use more transparent and less risky methods of following algorith-
mic advice when they choose to do so?

One way we might envision supporting transparent algorithmic delegation is by designing an electoral system supporting advice-giving algorithms implemented in a fashion similar to smart contracts in blockchain systems such as Ethereum [86]. Such a system might offer users the convenience of being able to use chosen VAA-like tools available directly within the e-voting system, like programmable “plug-ins” for the voting system. In exchange for this convenience, however, the election system would enforce transparency of both code and usage. By transparency of code we mean that, like Ethereum smart contracts, in order to operate at all, the code (software) implementing these VAA plug-ins would have to be publicly registered (perhaps “on the blockchain” if the voting system is blockchain-based) and open to anyone to inspect for potential bugs or hidden malicious behavior (e.g., algorithmic bias or influence manipulation attempts). By transparency of usage we mean that when users do elect to invoke such plug-in tools, the electoral system automatically gathers and publishes accurate statistics on the prevalence of their usage, ensuring that the public and experts alike can focus appropriate levels of attention to analyzing the most popular tools that could potentially influence significant voting power.

Even if we take the position that voters “should” think for themselves, it may be worth viewing delegation of choice to algorithms as a human vice not entirely unlike drug abuse or prostitution: a behavior that creates important risks – to democratic health rather than public health – that may most readily be mitigated not by either ignoring or banning the practice outright, but rather by bringing it out of the shadows where it can be monitored and tightly regulated.

5 Liquidity in Scaling Direct Democracy through Specialization

We have explored above how a liquid notion of voting power can potentially enhance a voter’s choice in answering a given ballot question: e.g., spreading, transferring, or delegating choice among candidates running for an office or parliament. An important complementary issue, however, is how many and what kinds of questions a given election or ballot asks voters to weigh in on. The ideal of direct democracy is to involve voters directly in deciding important policy questions that concern them, typically through initiatives and referenda.

5.1 The Ballot and Voter Attention Scalability Problems of Direct Democracy

Even in countries like Switzerland where direct democracy is deeply rooted, however, the extent to which citizens can in practice be directly involved in decisions is severely constrained by the limited time and attention of the electorate. Even while holding votes far more often than in most countries (typically four times per year), and localizing many direct decisions to cantons or municipalities, Switzerland must impose fairly high barriers (e.g., 100,000 signatures for popular initiatives in a country of only 8 million) to keep the number of questions on each ballot – and the magnitude of the task of informing the voters about those questions – manageable.

The critical tension between the desire to involve voters directly in decisions, and the need to limit the number of such decisions on the ballot, stems from one basic premise in traditional designs for direct democracy: that every voter needs to be asked, and expected, to weigh in on every question in each election. Constrained by this premise, direct democracy faces a fundamental scalability limitation. Since the number and breadth of policy questions affecting a society is likely to scale in proportion to the size and complexity of that society, a “pure” direct democracy would require a linear $O(n)$ number of voters each to answer a number of questions at each election that may similarly grow linearly $O(n)$ with population size, resulting in an unscalable quadratic $O(n^2)$ overall decision workload. But could we circumvent this fundamental decision scalability barrier if we relaxed the presumption that all voters should be expected to answer all questions? This is a central goal of a number of liquid democracy proposals, particularly Ford’s [29], which gives voters a “meta” level of choice to answer some questions directly while delegating others to a representative.

5.2 Inspiration: Hierarchically Structured Online Discussion Forums such as UseNet

Concurrent with the early evolution of the Internet, the first global, decentralized, public electronic discussion forum emerged in the form of UseNet [38]. A precursor to today’s popular discussion platforms like Slashdot and Reddit, UseNet enabled millions of users from thousands of organizations to post messages in subject-oriented newsgroups that anyone elsewhere in the world could read and respond to in followup debate. At its height of popularity in the 1990s, UseNet inspired the publication of dozens nonfiction guides to UseNet, studies
of its users’ behavior [59, 48, 27, 80], and even interstellar analogs in science fiction [82]. Most relevant to our purposes, UseNet offered a censorship-resistant forum open to anyone to speak or debate, but also proved scalable by virtue of allowing each user to choose which subset of the roughly 150,000 newsgroups to read and participate in organized into a deep hierarchy of topics.

UseNet never pretended to offer a forum for rigorous democratic deliberation, and the censorship-resistance of its decentralized structure eventually enabled spammers to overrun it [18], sending most of its users scurrying away to more closed or controlled forums. Nevertheless, many of UseNet’s “netizens” [38] were inspired by the perceived “democratizing” potential of a technology platform offering anyone the freedom to speak online as much or little as they choose, on any topic that interests them – and to give readers the necessary corresponding freedom to manage their limited time and attention by choosing which topics to follow closely and which to ignore or leave to others. This perceived democratizing potential of scalable online forums doubtless inspired many of the variants of liquid democracy that were proposed in the early 2000s. This leads to a question that is still as relevant as ever despite UseNet’s failure: is it possible to enable open, public debate and deliberation, akin to the processes of direct democracy, that would scale in richness, participation, and user choice like UseNet did at its height? And could such a forum be created that both offers strong freedom of speech without being overrun by spam, trolling, and other forms of abuse [89, 16, 53]?

5.3 Scalable Direct Democracy via Topic Specialization and Delegation

Let us now take it as given that we cannot lower the barriers to voters proposing questions for direct democratic debate and decisions (e.g., initiatives and referenda), and thereby vastly expanding the potential number of questions “on the ballot” at any given time, without also giving users a choice of which (typically small) subset of those questions to pay attention to, debate, and vote on directly. We could certainly manage a large number of topics for direct democratic discussion by organizing them UseNet-style into a hierarchy of topics, giving each user free choice of which to follow and which to ignore. So let us suppose such a topic hierarchy exists, and for simplicity assume for now that actual deliberation and choice occurs only in the bottommost “leaf” subtopics that are not further subdivided.

If only the users with enough time and interest to follow a particular subtopic closely actually wield votes on decisions related to that topic, however, then each small subtopic will behave as a special-interest group, narrowly representing the interests and opinions of the specific sub-population of voters for whom that topic is of prime importance. For legitimacy, democratic debate and decisions on a topic somehow need to represent and account for the interests of the whole population the topic affects, not just those few with the time to make that topic their focus. Healthcare policy affects everyone, not just doctors and healthcare industry experts; economic policy affects everyone, not just bankers and economists. This need for representativeness remains applicable, and perhaps becomes even more important, as we descend in our hypothetical topic hierarchy to narrower subtopics: e.g., from healthcare as a “level 1” topic to a health insurance subtopic at level 2 underneath it, from there to a subtopic on pre-existing conditions policy at level 3, and to a subtopic on pre-existing conditions policy specifically for cancer patients at level 4. A tiny percentage of the total population will likely be able to follow debates and participate directly in decisions on such a low-level subtopic, but nevertheless these decisions affect everyone, because everyone is exposed to the risk that they might get cancer and need insurance coverage if they do.

Representative democracy addresses this legitimate representation challenge by delegating all these decisions to a handful of elected representatives, at the cost of effectively overloading that handful of representatives with so many complex policy decisions that the representatives themselves can’t hope to become experts in any of them. These representatives thus focusing instead on the profession of politics itself – being good at campaigning and getting (re-)elected, rather than being good at making good policy decisions on any one topic. These professional politicians then necessarily build and rely on increasingly-vast unelected bureaucracies to examine and decide policy on most meaningful questions requiring domain expertise. This structure necessarily focuses tremendous pressures on the representatives and the bureaucracies they oversee, exposing them to strong incentives to corruption through processes such as professional lobbying and regulatory capture.

Ford’s proposal [29] addresses this tension between topic specialization and representation by ensuring that all voters can wield voting on all topics, and hence are represented in decisions on those topics. Since most voters will not have time to follow most of those topics directly, they instead delegate their vote to a representative, analogous in principle to the tradition of delegating choices to parties (Section 4), but with the greater freedom to delegate to microparties (Section 4.4) or individ-
uals (Section 4.6). Further, instead of having to choose just one [micro]party or individual to represent them generally, voters could delegate decisions on different topics to different representatives: e.g., delegating their vote on healthcare decisions to a doctor or local medical expert they trust to represent their interests, and separately delegating their vote on economy decisions to a local economist or small-business owner whose opinion they trust. If a voter’s immediate delegate cannot follow all aspects (e.g., sub-topics) of the given topic directly either, the delegate can transitivity re-delegate decisions on those sub-topics to other more-specialized experts on those topics.

In a UseNet-like hierarchy of deliberative forums, each active participant in a given topic would thus wield the accumulated power of all voters who delegated to them directly or indirectly, as in Algér’s proxy voting scheme [3]. Representatives could actually focus on and specialize in particular topics rather than on the generic profession of politics, accumulating considerable voting power in their topics of specialty while remaining accountable to and hence legitimately representative of all the voters who had delegated to them. Since a representative who is widely-recognized as a specialist in one topic (e.g., healthcare) is unlikely to be similarly widely-recognized as a specialist in another (e.g., economy), the outsize influence of these specialists on decisions in their focus topic should not generally translate to outsize voting power on other topics, thereby reducing the amount of generic power any one representative has, and mitigating both the opportunity and incentive for corrupting influences.

Scalability and Power Spreading from Topic Delegation: To illustrate concretely how topic-specialized delegation could enable direct democracy to scale, suppose for simplicity that an online liquid democracy forum is organized into 1,000 unique topic-focused forums organized in a hierarchy consisting of ten top-level level 1 topics (health, economy, etc.), each of those subdivided into ten level 2 subtopics (health insurance, etc.), and each of those in turn subdivided into ten level 3 subtopics (pre-existing conditions, etc.). Suppose that in a city of 100,000 voters, the “average” voter has time to follow and deliberate directly in only one leaf-level subtopic or group in this hierarchy. Assuming (unrealistically but also unnecessarily) that the voters’ interests are relatively balanced among topics, this implies that on average about 100 voters will follow and participate in each level 3 subtopic, with about 1000 voters following each level 2 subtopic, and about 10,000 voters following each level 1 topic. In order to be represented in all of the 999 level 3 sub-topics they can’t follow directly, each voter needs to make at most nine delegation choices at each level: who to delegate their vote to in the nine level 1 topics outside their focus area, who to delegate their vote to in each of the nine level 2 sub-topics outside their focus but within their level 1 focus area, and so on. Voters need not necessarily make each of these nine choices at each level separately, either: providing their delegates have power to re-delegate transitivity, many voters might simply delegate their voting power outside their focus area to a “generic” delegate they trust to choose specialty delegations for them.

In short, the total amount of decision-making effort demanded of each voter for “complete” participation and representation in this fashion is logarithmic $O(\log n)$ in the total number of topics $n$, and hence scalable to large populations and topic hierarchies. Consider an even-more-ambitious future in which a country of one billion voters implemented such an online liquid democracy forum with a million ($10^6$) topics, subdivided by factors of 10 similar to the example above. Then if the average voter directly follows and specializes in only one of the million level 6 topics, there could be a healthy “parliament” of about 1,000 participants in each, and each voter could still be represented in each of the other 999,999 topics by making at most $6 \times 9$ delegation decisions. In practice, voters seem likely to simplify their choice further by delegating to the same semi-generic friend or colleague in several of the sub-topics at a given level, perhaps making only one generic delegation choice at one or more levels, thereby delegating to their chosen generic representative the task of deciding which specialists to delegate to on particular subtopics. Regardless of how fine- or coarse-grained a voter’s delegation choices are, they are also likely to keep many of these delegation choices “persistent” across time and direct democracy election events, rather than re-evaluating them before each new decision, amortizing the decision costs of making even fairly complex delegation choices.

Because each of these “average” voters may accumulate considerable delegated voting power in their specialty but is unlikely to accumulate much delegated power far from their specialty, the incentive and vulnerability to corruption among these specialized delegates may be many orders of magnitude less than in a comparable society in which (say) a single traditional parliament of 1,000 members generically represented a million users each on all policy matters in this billion-voter country. While each representative of the generic parliament would wield one million times the political power of an ordinary individual on all matters – a tremendous power concentration – a specialized representative in each of the million liquid
democracy topics would wield a million times the voting power of a single individual but only on about \textit{one millionth} of the issues being debated and decided, exercising little to no delegated power in other specialties. Even accounting for the fact that in practice we can expect balances of delegated voting power to be considerably less even (e.g., outsize amounts of generic power perhaps going to some celebrities), nevertheless the spread of power across a multitude of specialized topics seems likely to result in far less concentration of power in general, and hence perhaps susceptibility to corruption, than in a traditional representative government at large scale.

5.4 Scalable Choice at Varying Levels of Specialization

We assumed above that online deliberation and democratic decision-making occur only at the bottommost leaf levels of the topic hierarchy, but this constraint is probably neither strictly necessary nor desirable. Within each low-level subtopic, issues are likely to arise that appear particularly important or contentious, which may merit pushing those issues “up the hierarchy” to less-specialized subtopics or topics that more voters follow. For example, a contentious policy decision on pre-existing conditions for cancer patients might start in the corresponding low-level subtopic but then “bubble upwards” to become an initiative or referendum presented directly to, and inviting debate and decision participation from, voters in higher-level topics such as insurance policy or healthcare policy in general.

Since issues that bubble up the topic hierarchy this way demand the attention, enlightened understanding, and decision capacity of progressively larger numbers of voters (10× per level in our hypothetical examples above), we must impose barriers or thresholds on this upward propagation to ensure that each voter needs to examine and decide on only a manageable few issues at each hierarchy level in each time period. A few such issues each cycle might capture particularly broad interest, surmounting the highest thresholds, and as a result propgating all the way up to the topmost level, where such issues are presented to the entire voting population for consideration and decision. Issues that propagate all the way to the top in this way are thus precisely analogous to popular initiatives in today’s working direct democracies such as Switzerland, where only a few issues passing high signature thresholds go onto the ballot that all voters see. Some issues are indeed important or of broad enough interest that it is worth presenting them to the whole electorate – but since the number of these necessarily must be limited, a topic hierarchy with liquid delegation of choice could enable a much larger number of direct democratic deliberations to occur while preserving representativeness at all levels and allowing each issue to “bubble up” to the level of specialization corresponding to the breadth of voting population that considers the issue worthy and important enough for consideration at that level.

5.5 Choice and Management of the Topic Hierarchy

The above discussion has assumed that a suitable topic hierarchy is somehow given, but the organization of this hierarchy is of course another topic that would have to be decided somehow. A simple approach would be to delegate the task of tending this hierarchy to representatives elected at large, e.g., a traditional parliament. While feasible, this approach would present the risk that representatives interested in their own re-election might be strongly tempted to structure the topic hierarchy in favor of their interests, in an analog of the real present-day problem of gerrymandering. Does a low-level subtopic related to the link between air quality and cancer belong under the topic of Healthcare or Environment?

This choice matters, because the location of the subtopic in the hierarchy will affect how voting power gets delegated and hence distributed to direct participants in that subtopic. An elected representative with strong ties to the healthcare industry might benefit from tweaking the hierarchy so that his healthcare-specialist friends get as much delegated voting power as possible in decisions on the subtopic, while a representative with stronger ties to environmentalist groups might have the opposite preference and fight to re-locate the subtopic under Environment. While contention around such hierarchy-management issues is probably unavoidable given the human judgment and subjective preferences ultimately involved, it generally seems preferable if possible to avoid hierarchy management becoming yet another political football – like districting choice – to incentivize and attract corruptive tendencies.

A safer alternative, therefore, might for the electorate at large to decide the manage hierarchy directly, using the same proportional-representation tools we already commonly use for electing parliaments for example. Suppose we stipulate by design that there shall be at most ten top-level topics at level 1, ten level 2 subtopics under each level 1 topic, etc. We might allow anyone to propose keywords they think should be level 1 topics, and periodically use a multi-winner proportional-representation system such as STV, CTV, or QTV (Section 3) to “elect"
proposed keywords (instead of human candidates) into the 10 available “positions” of level 1 topic status. The election system’s proportionality measures ensure that the ten chosen level 1 topics represent those of broadest interest to the electorate at large, while ensuring that each voter’s choice counts and as few votes as possible are “wasted.” Once level 1 topics have been chosen this way, a similar multi-winner proportional election may be held within each of these level 1 topics to its level 2 subtopics, and so on. Since not every voter will likely be even aware of, let alone interested in or knowledgeable about, all of the detailed topics at the lower levels of the hierarchy, enabling users to delegate their power to specialists at these lower levels will be just as important to setting up the lower levels of the hierarchy as to facilitating representative decisions within them subsequently.

No single topic hierarchy, once chosen, will remain “perfect” forever, of course, so processes for revising and evolving the hierarchy will be just as essential. One simple approach is again to treat elections of keywords to topic status much like electing candidates to parliamentary seats: namely, ensure that each keyword’s status goes “up for re-election” periodically (e.g., once every few years), giving the electorate the opportunity to “promote” topics to higher levels and to “demote” topics whose interest has shrunk to lower, more specialized levels underneath other broader topics. A change in topic status at a high level may need to trigger an automatic “re-election” at lower levels containing related subtopics, to ensure that deliberation and decisions that used to occur in a newly-demoted topic have a suitable place to move to in the lower levels of the hierarchy, for example.

5.6 Expressing Strength of Interest: Quadratic Voting in Participation Scalability

Given that the intended purpose of quadratic voting (QV) is to enable and incentivize people to express their true strength of preference in decision-making [64, 52], an obvious question is whether QV could address the scalability challenge to expanding direct democracy. Suppose, for example, we lower the traditional barriers to getting popular initiatives and referenda on the ballot, allowing perhaps hundreds or thousands of questions onto the ballot each cycle rather than just a few. Can we then just give each voter an equal amount of virtual “coin” with which to buy votes on the particular issues they care about, as the QV theory suggests?

Deploying QV this way might be attractive from an economic purist’s perspective, but could be profoundly dangerous and counterproductive in practice, due to the gap between the “perfectly rational voter” QV theory assumes and the imperfect understanding of human voters. As discussed earlier in Section 2.3, a realistic voter who is unaware how much a moderately-subtle policy issue affects him will “underspend” on that issue, perhaps investing nothing at all to vote either for or against many such issues that he is not adequately informed about. Furthermore, the practice of distraction politics [45, 84, 55] could deliberately draw voting power away from meaningful but subtle issues toward “bright shiny objects” and sensationalistic controversies, effectively handing most decision power on most special-interests to the special interests that care about them.

Quadratic voting therefore does not by itself address the scalability problem that delegation in liquid democracy addresses, although the two could potentially be used in complementary ways. One obvious approach is to use QTV (Section 3.5) to enable voters in choosing and maintaining the topic hierarchy, as discussed above. In this case, we use quadratic voting only to choose the (e.g., ten) topics of broadest interest to form the first-level topics, and similarly using separate QTV instances within each topic to choose up to ten sub-topics to flesh out the hierarchy. It is much more reasonable to assume average voters are well-equipped to make reasonable judgments on the ten broad policy topics of most importance to them, than to make reasonable judgments on the importance of – let alone actual decisions on – hundreds or thousands of narrow specialized topics. Provided delegation is permitted and in effect in the QTV instances that decide on sub-topics of an already-specialized topic, we have at least some hope that the bulk of voting power used to decide those subtopics is by then (through delegation) in the hands of people who are both specialized enough to follow the topic in question, and representative of and accountable to those whose voting power they wield.

Another way it might be useful and arguably “safe” to use quadratic voting in this context is to allow users to assign different levels of importance among a small number of different “peer” topics or subtopics relative to each other in the hierarchy, and adjust the user’s “voting weight” in each of those subtopics accordingly. Suppose for example that the ten top-level topics include Healthcare and Environment, and Alice cares much more strongly about healthcare-related policy than about environmental policy. Instead of automatically giving her equal voting power in both topics, as we normally would expect by default, we might give her the option to divide her voting power by parts and allow her to assign it either evenly or unevenly to the topics using QV according
to her judgment of their relative importance to her. For example, if we consider Healthcare far more important than Environment, she might assign four parts of her voting power to the former and only one to the latter, and thereby wield a vote on Healthcare issues having $4 \times$ the power as her vote on Environment issues. Within a particular lower-level topic she follows and is particularly interested in (e.g., health insurance policy), she might similarly have an option to redistribute her voting power among the subtopics (e.g., more to pre-existing conditions policy and less to pediatrics insurance policy).

The critical point is that in this approach, she would be using quadratic voting to redistribute her voting power only among a small number of closely-related subtopics, in one small local area of the hierarchy, where we can plausibly expect the voter to have some genuine understanding of those subtopics and their “true” importance to her relative to each other, given that she is taking the trouble to perform this redistribution at all. Thus, local redistribution of voting weight using QV among a few alternatives we have reason to expect the user to know about may plausibly safe and valuable, whereas global redistribution of voting weight among a large number of options mostly unfamiliar to the voter would seem extremely dangerous and fraught with risk.

6 Liquid Democracy and Time

In preparation.

7 Considerations for Systems Implementing Liquid Democratic Choice

In preparation.

8 Conclusion

In preparation.

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