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Improving candidate-based voting advice application design: The case of Finland

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Voting advice applications (VAAs) seek to strengthen democracy by assisting voters in voting-related decision-making. VAAs have become popular tools in many European democracies and their usage has been linked to real-life electoral consequences. As VAA usage has become more prominent, it has also sparked research interest toward VAA design. This article focuses on VAA design process by discussing interdependencies of VAA design choices and applies design science research methodology by setting design objectives to solve problems with existing Finnish VAA designs. The article proposes overall VAA designs that can improve existing Finnish candidate-based VAA designs, encouraging Finnish VAA developers to update their designs.

Keywords: voting advice applications, VAA design, candidate-based VAA, Finland, design science research

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Introduction

Voting advice applications, also known as VAAs, seek to enhance democracy by bolstering issue-based representation (see e.g., Fossen and Anderson 2014) and decreasing information acquisition costs related to learning about party and candidate positions, thus paving the way for electoral participation (Garzia and Marschall 2019). To achieve these objectives, VAAs match users with parties/candidates that share their views on political issues.

Fossen and Anderson (2014) note that *matching VAA* implicitly assumes that a central problem in democracy is citizens' ignorance of parties'/candidates' policy positions. According to Fossen and Anderson (2014, 226), VAAs also promote "social choice theory of democracy; a minimalistic voting-centered conception of political participation; and a delegate model of democratic representation", which are largely contested conceptions. For instance, the theory of deliberative democracy suggests that citizens' preferences can be updated via rational deliberation (see e.g., Habermas 1996; Gutmann and Thompson 1996), whereas the social choice theory of democracy perceives citizens' preferences to be fixed and democracy functions to aggregate those preferences (Setälä 2003, 40). The idea of matching voters to candidates based on pre-existing preferences is by no means the only option for providing voting advice. For instance, a *deliberative VAA* would seek to make voters contemplate stances on issues, whereas a *contestatory VAA* would challenge voters' issue priorities and bring new issues to the political agenda (Fossen and Anderson 2014). However, matching VAA is still unrivaled as the only VAA design in use.

VAAs have become an integral part of election campaigns in many European countries (Marschall and Garzia 2014). Finland has been at the forefront of VAA development and has exhibited high levels of voter engagement with VAAs (see e.g., Suojanen 2007; SVT 2019; Borg and Koljonen 2020). The high VAA usage in Finland has been explained by multiple supply- and demand-side factors, including high levels of Internet usage, suitable electoral system, the decline in party identification, etc. (Borg and Koljonen 2020, 42).

The widespread adoption of VAAs can also be linked to VAAs' core functionality, which is to be a heuristic, i.e. a short-cut, for voters in picking a party/candidate (see e.g., Gemenis and Rosema 2014). The short-cut function becomes especially important in complex electoral systems (e.g., in open-list proportional representation systems). Lau and Redlawsk (2006) note that voters tend to be more responsive to simple cues in complex settings that allow them to reduce time and effort in making the vote choice.

The design of the VAA determines the overall usefulness of the voting advice. The overall design of the VAA covers multiple interrelated design elements: user interface, statements, matching algorithm, and voting advice output (see Garzia and Marschall 2019; Isotalo 2020). A plethora of research on these individual VAA elements exists (e.g., Rosema and Louwerse 2016; Lefevere and Walgrave 2014; Mendez 2017; Bruinsma 2020), but suggestions for overall VAA designs that would assess optimal combinations of VAA design elements have been lacking (Isotalo 2020). It should be noted that the VAA research community has published the *Lausanne declaration* (Garzia and Marschall 2014, 227–228) which instructs VAA developers to ensure that VAAs are developed to be "open, transparent, impartial and methodologically sound". However, the guidelines presented in the declaration do not suggest a specific VAA design. It would also be unrealistic to have a single VAA design that would suit all political systems and election types.

Finnish VAA designs differ from the international mainstream, where party-based VAAs are most common (see Marschall and Garzia 2014). Finnish VAAs are mostly candidate-based, meaning that VAAs recommend candidates based on their self-reported answers to VAA statements, or hybrids that provide both candidate and party recommendations.

In this article, I will investigate Finnish parliamentary elections' VAA designs within the framework of matching VAA model. The aim of the article is to explore the design process of VAA development by setting suitable design objectives, making important design choices explicit and finally proposing an update to existing VAA designs. This article builds on Isotalo (2020) master's thesis, in which five major Finnish VAA designs were analyzed via qualitative content analysis. To develop optimal VAA designs for the Finnish context, I apply a design science research (DSR) methodology that seeks to solve field-specific problems by providing design propositions (see van Aken 2015; Peffers et al. 2007). Peffers et al. (2007, 84) note that DSR "process includes six steps: problem identification and motivation, objectives for a solution, design and development, evaluation, and communication." To simplify the DSR process van Aken (2015) names three parts: exploratory part, design part, and testing part. In this article, the focus will be mainly on the design and further developing VAA designs introduced in Isotalo (2020). In the article, I will be answering the following research questions:

RQ1: What design choices do VAA developers have to make regarding VAA elements?
RQ2: What VAA designs would be optimal for Finnish parliamentary elections?

To answer these questions, a researcher needs to be transparent about their own normative standpoint. As Flanagan et al. (2008) has pointed out, technological artifacts embody the values of their designers. My main values for VAA development are transparency and user empowerment, i.e. shifting power from designers to the users, and minimizing the influence of VAA designers in the process.

The article is structured as follows: the most pressing problems of Finnish VAAs will be presented and design objectives for VAA development will be set. This is followed by answering the first research question which introduces the most influential design choices that VAA developers must make regarding VAA elements. To answer the second research question, VAA design proposals for Finnish parliamentary elections are envisioned. After this, the article is concluded by a discussion.

Design objectives for VAA development

In this section, design objectives for Finnish VAA development are envisioned. Setting concrete objectives as either qualitative or quantitative helps the design development to fulfill wanted criteria (see Peffers et al. 2007). I have defined four objectives for new VAA designs for the Finnish context. The design objectives are responses to central problems related to Finnish VAAs. I will briefly introduce these problems, followed by a proposal for design objectives.

Problems in Finnish VAAs

Based on five popular Finnish VAAs that were developed for 2019 parliamentary elections Isotalo (2020) has listed five most pressing problems of Finnish VAAs: 1) lack of transparency in VAA design, 2) lack of user interactivity with the VAA, 3) problems in VAA statement structure, 4) algorithmic issues and 5) lack of candidate comparisons and visualizations.

The lack of transparency has been a long-reported issue with Finnish VAAs (see Kauppinen 2007). In Finnish VAAs, the lack of transparency takes many forms: VAA algorithms are not open for public scrutiny, users are not informed how VAA recommendations are constructed and candidate response datasets are not shared (Isotalo 2020, 66–69).

The lack of user interactivity means that VAAs can be used only in a single manner. The uniformity of VAA design is at odds with what is known about VAA users. van de Pol et al. (2014) have found that VAA users differ greatly

in terms of their political knowledge, interest in politics, usage purpose, and demographics. The heterogeneity of VAA users should be indicative that their preferred ways to use VAAs are likely different, for instance politically sophisticated users might want to explore VAA results in greater detail. Increasing interactivity could also serve as a useful reminder that VAAs are subjective tools instead of objective images of political reality (Fossen and van den Brink 2015).

Statement structure means the overall coverage and emphasis of VAA statements. If the statement structure is unbalanced, this means that some political issues and their underlying ideological dimensions have disproportionate influence in constructing the voting advice (Kauppinen 2007). Some parties might gain an advantage due to specific statement structure (see Lefevere and Walgrave 2014; Walgrave et al. 2009). One should also pay attention to the internal balance of ideological dimensions, for instance, Isotalo et al. (2020) have noted that Finnish Left–Right dimension related VAA statements do not differentiate extreme and moderate leftist positions from each other, because hardline leftist statements have not been included in the VAAs.

Algorithmic issues can be divided into two separate issues: 1) shortfalls of issue-based matching (Kauppinen 2007), and 2) the problematic nature of recommending a party based on aggregating candidate answers (Isotalo 2020). The main shortcoming of issue-based matching is that it ignores correlations between statements, ignoring underlying ideological dimensions that could serve as a more viable alternative for matching users to candidates. The second issue concerns hybrid VAAs (providing candidate and party recommendations), as they usually only collect candidate responses and aggregate them into hypothetical party positions. However, there is no single method to calculate party positions that would be more justifiable than its alternatives. Moreover, using candidate responses to infer party positions can have unwanted consequences, as parties can become incentivized to guide their candidates' answers.

The final problem concerns the VAA output, meaning the lack of candidate comparisons and visualizations. Most Finnish VAAs do not allow for comparing multiple candidates' positions to each other simultaneously (see Isotalo 2020, 79). Moreover, the overall matching scores can only be seen between a user and a candidate, not between two candidates. This means that VAA users have to settle for inspecting the VAA output from their viewpoint, while the overall structure of candidate-to-candidate matching scores remains hidden, making VAAs act as "black boxes".

Next, a design objective proposal for new VAA designs is presented.

Design objectives for Finnish VAAs

The following design objectives for VAA development are ranked in order of importance: 1) increase usefulness of VAA in making the vote choice, 2) promote honest answering behavior of candidates (and parties), 3) allow users to become designers, and 4) increase transparency of VAA. According to Flanagan et al. (2008), there is no such thing as value-neutral technology. These design objectives originate from a personal normative foundation that regards user empowerment as a central value. Letting design objectives guide VAA development will encourage developers to favor certain design choices over others.

1. Increase usefulness of VAA in making the vote choice

Firstly, to make VAAs useful for their intended purpose, i.e. assisting users in making the vote choice, VAA output and presentation of results should be comprehensive. New VAA designs could include more visualizations or present results with additional information.

Secondly, VAA design should consider users' intentions behind VAA usage. Based on survey research, the main reason for using VAAs is to find a candidate to vote for, while finding a party usually has secondary importance (Borg and Koljonen 2020; SVT 2019). Therefore, candidate-based VAAs could highlight the role of candidates instead of focusing too much on party-level voting advice.

Thirdly, VAAs should consider employing mechanisms that help to find the most suitable candidates: *filtering* and *recommending*. Filtering means removing unfitting candidates from a voter's consideration set. In contrast, recommending means that a candidate is elevated to be a part of the consideration set from which the voter picks the candidate to vote for. Finnish VAAs focus heavily on recommending, but the filtering function is mostly ignored.

2. Promote honest answering behavior of candidates (and parties)

Answering behavior of candidates/parties should not be ignored. If self-reported candidate positions are not truthful, this erodes the credibility of the voting advice. Candidates can be tempted to choose their answers due to strategic reasons or leave unpleasant questions unanswered. Moreover, certain VAA designs can incentivize parties to "guide" their candidates' answers. Next, I will present these candidate and party strategies that should be discouraged with careful VAA design.

The most well-known candidate-level answering strategy is what I call *the central answering strategy*. Previous research on answering behavior in VAAs has identified that centrist positions around the middle point of the answering scales are popular among VAA users (see Gemenis and van Ham 2014). The perception of this type of user behavior has encouraged candidates to avoid taking positions at the ends of the answering scales. An extreme manifestation of the strategy is to place oneself on all statements in the neutral middle point. Placing oneself in the middle allows candidates to minimize the overall distance to multiple groups of users that either somewhat disagree or somewhat agree. Another candidate answering strategy is to leave unpleasant statements unanswered. Both answering strategies have negative consequences on the usefulness of the VAA as they hide candidates' true opinions on issues.

Parties can potentially influence their candidates' responses by instructing candidates how to respond to VAAs. Parties have two strategies in managing their candidates' answers: *diversification* and *centralization*. Diversification means employing a "wide" range of candidate answering profiles. This approach encourages candidates to take diverse policy positions to ensure that the party's candidates match with the widest possible range of potential voters. This strategy is optimal for candidate-based VAAs that do not provide party-level voting advice. In contrast, in the centralization strategy parties take an active role in "narrowing" the range of their candidates' answering profiles by enforcing the party line. Thus, seeking to minimize internal variation within the party to dominate recommendations around specific answering profiles. This strategy is most beneficial when VAA has a hybrid design and party-level recommendations are constructed based on candidate responses. The most recent case of this strategy being utilized was in 2019 when all Feminist Party candidates answered nearly identically to all questions in Yle (2019) and HS (2019) VAAs and became the most prominent party suggestion on the left/liberal value position (see HS 13.3.2019).

To summarize, both candidate and party answering strategies have the potential to obfuscate true issue positions of candidates and parties, and thus hinder the accurate matching between users and candidates/parties. Therefore, incentives for parties and candidates to mask their true issue positions for strategic gain should be removed.

3. Allow users to become designers

The third design objective is related to the lack of user interactivity observed within the Finnish VAAs. Allowing users to customize the VAA according to their personal preferences could improve usefulness of the voting advice. This

means that users would take an active role in designing the VAA for themselves, i.e. making important design choices such as selecting the matching algorithm of the VAA, following the ideal of *participatory design*. Participatory design seeks to democratize technology by addressing power imbalances between users and designers, and it does so by allowing users to make decisions regarding design artifacts (see e.g., Lindtner and Lin 2017). However, there are boundaries to user participation in VAA design, as many VAA elements are highly technical and require expert knowledge. Therefore, users' role in designing VAAs would be more suitable for selecting designs from predetermined options that are provided by the developers. Palacin Silva et al. (2020) call this *participation by design*, where users are empowered to become decision-makers, instead of being mere data collectors which is the case with current VAA designs.

Additionally, user participation would have other positive consequences. Firstly, increasing user interactivity could serve as a reminder that VAAs are inherently subjective devices (Fossen and van den Brink 2015), as there are no objective criteria for statement selection (i.e., no normative high ground exists which would determine what politics should be about). Secondly, not all VAA users want the same experience from the VAAs, as it is known that VAA users are a heterogeneous group of voters with differing interests (van de Pol et al. 2014).

4. Increase transparency of VAA

As algorithmic decision-making has become more prevalent, so have calls for algorithmic transparency (Pascquale 2015; Diakopoulos 2016; Janssen and Kuk 2016). Transparency is seen as a mean to increase accountability of algorithmic systems (Ananny and Crawford 2018). However, recent research has pointed out that solely relying on transparency to keep algorithms accountable may not be sufficient (see Ananny and Crawford 2018; Kemper and Kolkman 2019). Kemper and Kolkman (2019) highlight the need for a critical audience that has sufficient skills to interpret algorithms in order to benefit from transparency. Ananny and Crawford (2018) note that transparency can be inconsequential or even be harmful.

Increase in transparency could still have positive effects on VAAs, specifically on user trust, as VAAs' limitations and capabilities are openly evaluated if transparency is implemented properly. Increasing transparency of the VAA could enable users to have a better understanding of VAA functions and provide them an opportunity to recognize unexpected behavior of the VAA algorithm. For this to happen, transparency should mean more than just

sharing the code of the VAA, as reading the code would be highly impractical for regular VAA users. Ananny and Crawford (2018, 979) call this kind of transparency "*resistant* transparency". Instead, transparency should be implemented broadly covering the whole development of the VAA, including data on VAAs performance, algorithm, documentation, and openness about VAA development. Also, VAA developers should encourage user feedback and implement it, otherwise, transparency will not translate into accountability. However, there are some limitations to transparency, when it comes to information that can be misused and manipulated, e.g. sharing data on how often parties are recommended to users could provoke attempts to manipulate these statistics, which in turn could be used to unjustly discredit the VAA.

Design choices

In this section, the first research question will be answered. The main design choices that VAA developers face are listed in table 1. The table is compiled based on VAA design-related literature and observations regarding Finnish VAAs in Isotalo (2020). The table is not exhaustive and does not cover all possible design choices (e.g., VAA accessibility for people with disabilities). These design choices were selected, because they have a direct impact on the voting advice, or they affect the interpretation of the advice.

Table 1. Design choices regarding VAA elements and issues related to them

VAA element	Design choice	Possible issues	Solutions
Statements	Statement formulation	Statement ambiguity can lead to differences in interpretations and render the statement unfit for matching (Gemenis 2013).	Ensure that statements relate to concrete policy issues and avoid qualifications, quantifications, double-barreledness.
	Statement selection	Different selection of statements can bias the VAA recommendations to favor certain parties/ candidates (Lefevere and Walgrave 2014).	Pay attention to the underlying ideological dimensions and try to balance their influence on the voting advice.
Answering scales	Configuration of answering scales	Different answering scales have mechanical and possibly psychological effects on voting advice (Rosema and Louwerse 2016).	No optimal scale exists, current standard is 1–5 Likert-scale. If sliders are used, show the position of the slider.
User interface	Live match tracking	Using live match tracking can bias users' answers, as users can make sure that they do not deviate from their favorite candidate's answers.	This feature can be valuable for closer inspection of certain candidate's answers. However, users should be able to turn this feature off. Alternatively, it could be disabled per default, and users could activate the feature, if they prefer so.

Algorithm	Calculating voting advice of parties from candidate responses	There is no natural way to provide party-level voting advice based on candidate answers (e.g., what aggregation method to use, what level of party responses to use).	Safest choice is to collect party answers from party headquarters. If this is not possible, multiple aggregated candidate response metrics should be used.
	Issue-based vs. ideological matching (high-dimensional vs. low-dimensional)	Issue-based matching overlooks correlations between issues, whereas ideological matching can lead to misleading results if the dimensions are not reliable (Kauppinen 2007; Germann et al. 2015).	Use issue-based matching if statements do not construct distinct dimensions, prefer ideological matching if statements correlate. Issue-based matching is preferable, if some data is missing.
	Matching method, i.e. distance matrix (proximity vs. directional vs. hybrid)	Proximity matching can encourage central answering strategy, directional matching favors candidates with extreme views.	Allowing users to choose the distance matrix should reduce benefits from using central answering strategy.
	Distance metric (Euclidean vs. Manhattan)	Recommendations might be suboptimal if distance metrics are paired up with wrong matching types (Mendez 2017).	Use Euclidean distance in combination with ideological matching, whereas Manhattan distance should be preferred with issue-based matching.
	Inclusion of salience weights	Users do not use salience weights, for they can complicate interpretation of voting advice (Wagner and Ruusuvirta 2012).	Salience weights should only be used if all statements are visible at the same time. Alternatively, place them at the end of the VAA.
	Handling missing responses	Having a high number of missing candidate/party responses can erode the capability of the matching algorithm to find the closest candidate (Agathokleous et al. 2013).	Penalize candidates/parties for missing answers or use matching that is not sensitive to missing data.

Voting advice	Giving primacy to party or candidate voting advice	Providing voting advice on parties before individual candidates can encourage parties to guide their candidates' answers.	Provide party recommendations prior to candidate recommendations only if parties' stances are collected from parties themselves.
	Visualizing user and candidate positions	User interpretations of the results vary based on the type of visualizations used (e.g., spider graphs or bar plots) (Bruinsma 2020).	Visualizations should aim to uncover differences between candidates/parties. In addition, they should showcase user positions in relation to candidates.

Table 1 reports VAA elements that are impacted by the design choices. These elements include statements, answering scales, user interface, algorithm, and the voting advice. Half of the design choices are related to the VAA algorithm. However, the impact of statement-related design choices is at least as significant as algorithm-related choices. In table 1, I have identified possible issues that can arise from poor design choices. It is worth mentioning that some design choices depend on each other, implying that design choices should not be made independently from each other, as one should be aware of the compatibility of choices. In the last column of table 1, solutions to identified issues are also provided. Next, I will present design choices' interdependencies.

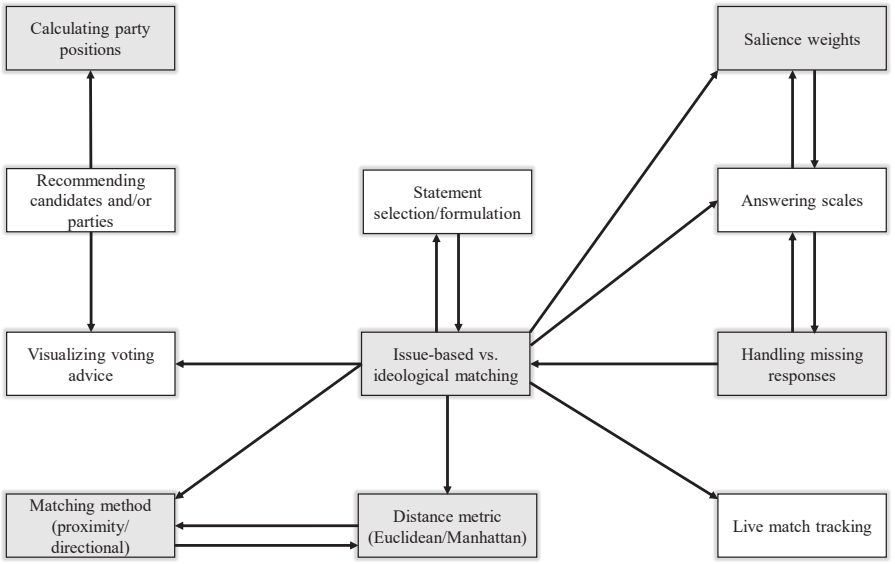

Figure 1. Interdependencies of VAA design choices. Arrows indicate the direction of dependency. In cases of double arrows, dependency works both ways. Algorithm-related design choices are marked in gray.

Figure 1 shows how VAA design choices depend on each other. Design choice regarding issue-based or ideological matching has the most central position in the design choice network, which makes it a good place for VAA developers to start. If developers choose to provide ideology-based voting advice, statement selection and formulation need to support this objective by linking each statement to some ideological dimension. Designers need to take into account that ideological matching does not work if candidate or user answering data is incomplete. In addition, long answering scales (e.g., 5-point Likert scales) instead of binary scales should be preferred, when developing ideology-based VAAs. However, issue-based design does not have similar requirements for answering scales or missing responses.

In terms of algorithm, ideology-based VAAs should apply Euclidean distance and issue-based VAAs Manhattan distance metric. This has been empirically shown by Mendez (2017). When it comes to matching method, which reflects the theoretical foundations of matching candidates and users based on issue congruence, ideology-based VAAs support proximity and directional matching methods (see more about these methods in Merrill and Grofman 1999; Downs 1957; Rabinowitz and Macdonald 1989), whereas issue-based VAAs allow more flexible matching methods.

Live match tracking and inclusion of salience weights for statements are only possible for issue-based VAAs. Visualizations of VAA output differ for ideology- and issue-based VAAs, as ideology-based VAAs rely heavily on spatial maps which indicate candidates' and users' ideological positions. Issue-based VAAs must settle for more abstract ways to present voting advice, e.g. by using network graphs presenting the links between candidates based on their level of agreement (see Isotalo 2020).

In addition to VAA element-related design choices, VAA developers also need to consider the role of the user in constructing the voting advice. Users should be allowed to customize the VAA according to their intended use, as suggested by the participatory design ideal, where users become decision-makers (Palacin Silva et al. 2020). In practice, users should be included in the processes of statement formulation prior to the launch of the VAA, which is already a standard procedure for some Finnish VAAs (Isotalo 2020). Moreover, users should be allowed to decide 1) how they want to use the VAA (e.g., show or hide live match tracking, use proximity or directional matching) and 2) what kind of voting advice they want the VAA to provide (e.g., ideology vs. issue-based, and party- or candidate-level). However, it is important that VAA developers do not overwhelm users with countless decisions. Users could choose from complete VAA designs, and additionally, users could have the option to change the default settings of individual design elements within those designs.

Design proposals

In this section, I am going to answer the second research question: "What VAA designs would be optimal for Finnish parliamentary elections?" by proposing design alternatives for candidate-based and hybrid (candidate and party voting advice) VAAs. Parts of these designs have been introduced in Isotalo (2020), but here they are further developed.

First, the overall structures of proposed VAA designs will be presented. This is followed by introducing the design of each VAA phase. After this, improvements regarding user interactivity and VAA transparency are introduced. The section is concluded by evaluating how the suggested designs meet the previously set design objectives.

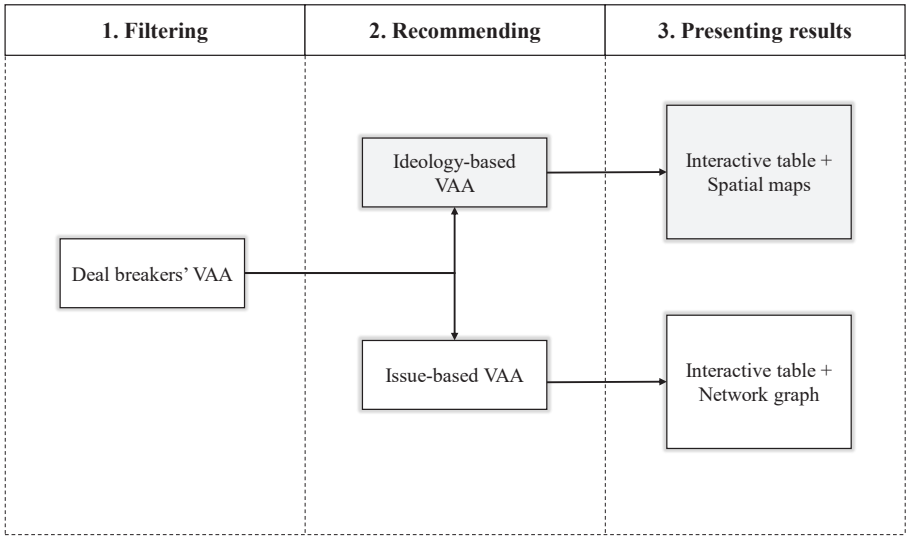

Figure 2. Design proposal with three VAA phases.

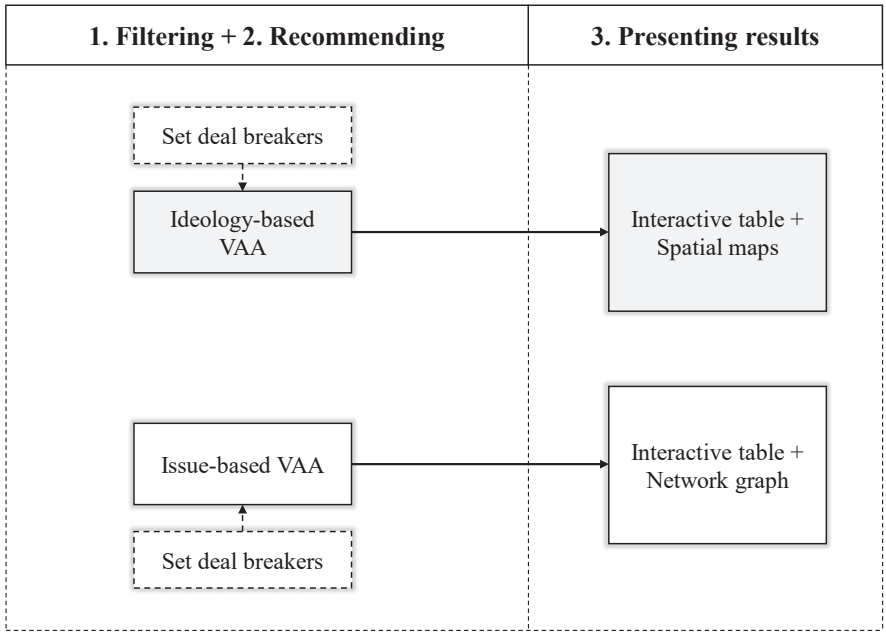

Figure 3. Design proposal with two distinct VAA phases.

I propose two alternative overall structures for Finnish parliamentary election VAAs. These two VAA structures are presented in figures 2 and 3. Figure 2 shows a VAA with three distinct phases. The first phase, *the filtering phase*, focuses on removing unfitting candidates based on a disagreement of opinion between the user and the candidate. The idea of the filtering phase is to prevent situations in which users have irreconcilable differences on specific issues with VAA's recommended candidates. For the candidate to be recommended to the user, the candidate must agree with the user on issues the user selected in the filtering phase. The filtering is performed by the user, actively searching through statements and answering only the ones that they deem important. If the user does not want to perform filtering, they may skip this phase. To make the filtering phase impactful, candidates would need to be surveyed on a high (e.g., 30) number of additional statements that are not used in the recommendation phase (the overall number of statements being for instance 30 + 30). To reduce the answering load of the candidates, candidates would not be able to comment on the additional statements of the filtering phase.

The main difference between the overall VAA structures of figures 2 and 3 is in the placement of the filtering. In figure 2, filtering is an independent phase of the VAA, having its own user interface and statements. In figure 3, filtering is a part of the recommendation phase, which means that users can set individual VAA statements in the recommendation phase to be "deal breakers", but there is no additional set of statements for filtering. The approach presented in figure 3 can be executed by adding tick boxes next to recommendation phase statements which assign the statements a deal-breaking status (i.e., removes the candidate if they do not share the same opinion with the user on the statement).

The second phase of the VAA is *the recommendation phase*, which provides the user with two options; either the user selects an ideology-based VAA or an issue-based VAA. Ideology-based VAA is preferable of the two, and it should be the default option. The differences between the two VAA approaches are listed in table 2. The main difference between the two approaches is the interpretation of voting advice from the user's perspective. The issue-based approach recommends the user the most similar candidate in terms of issue congruence. Candidates' answers are then considered to be electoral commitments. This type of interpretation of the voting advice supports the *delegate model of political representation*, where elected representatives have strict mandates to fulfill their electoral promises (see Ladner 2016). The interpretation of the ideology-based VAA's voting advice is more supportive of the *trustee model of political representation*, in which representatives can rely on their

judgment when deciding on how to vote in particular issues (Ladner 2016). Ideology-based VAA recommends the user the ideologically closest candidate, i.e. a candidate that mirrors their values, instead of focusing on individual political issues.

Another significant difference between the two VAA approaches is that ideology-based VAAs require a carefully crafted statement structure that is capable of constructing the wanted ideological dimensions. Issue-based VAAs do not have similar requirements regarding their statement selection, but this does not mean that issue-based VAAs should not maintain a balance between selected issues. Candidate answers in ideology-based VAAs need to be converted to ideological positions with the help of factor analysis, therefore ideological dimensions provide more valid recommendations (see van der Linden and Dufresne 2017). This is due to ideological recommendations' diminished sensitivity to inclusion and exclusion of individual statements, which is a much larger problem for issue-based VAAs (Walgrave et al. 2009). As ideology-based VAAs are superior in performance to issue-based VAAs their development should be prioritized.

We are still left with one important question: how should relevant ideological dimensions be identified? To answer the question, it can be done either deductively or inductively. In the deductive approach, ideological dimensions are planned with sole reliance to theoretical expectations. In the inductive approach, the dimensions are derived from the collected data directly. I propose to combine the two approaches, by carefully pre-planning the dimensional structure of the VAA and using candidate answers to test whether the dimensional structure is empirically sound. When statement structure is pre-planned, designers unavoidably have to choose which ideological dimensions are used for matching. Isotalo (2020) argues that selected ideological dimensions should be relevant to the political context, e.g. in the Finnish case, ideological dimensions or cleavages that structure party competition in Finland should be used. Paloheimo (1988; 2005; 2008) has presented seven such dimensions: 1) Left–Right, 2) Center–Periphery, 3) National–International, 4) Elite–People, 5) Finnish speaking – Swedish speaking, 6) Conservative values – Liberal values and 7) Ecological values – Materialistic values. If seven dimensions prove to be too many, according to the factor analysis, dimensions that relate to cultural issues can be combined into the so-called GAL–TAN (green-alternative-libertarian vs. traditional-authoritarian-nationalist) dimension (see Hooghe et al. 2002).

Table 2. Two VAA recommendation approaches

VAA element	Ideology-based (primary choice)	Issue-based (secondary choice)
Model of representation	Trustee model	Delegate model
Statements	- Pre-planned structure - Statements link to underlying ideological dimensions (at least 4 statements per dimension) - Balancing prevalence of ideological dimensions (e.g., Left-Right vs. Liberal-Conservative)	- More relaxed structure - Statements might form ideological dimensions, but these dimensions are not formed - Balancing prevalence of issues (e.g., immigration, economy)
Need to pre-process data	- Factor analysis is performed on candidate answers to construct the dimensions - Candidates (and parties) are placed on dimensions by calculating factor scores	No need
Party matching	Allowed	Allowed
Matching method	Proximity/directional	Proximity/directional/hybrid
Distance metric	Euclidean	Manhattan
User weights	Weights on dimensions allowed	Weights on issues allowed
Live match tracking	Not possible	Can be supported (however, default hidden)
Missing responses	Not allowed	Allowed
Response scales	At least 5-point Likert scale	No essential requirement
Output	- Value maps with marked user location - Interactive table in which candidates ranked by closeness	- Egocentric network graph displaying ties between candidates and user - Interactive table in which candidates ranked by matching score
Allowed user interactivity	- Select whether party or candidate is recommended first - Select matching method - Can ignore irrelevant dimensions for the user	- Select whether party or candidate is recommended first - Select matching method - Place user weights - Can refrain from answering all statements

The third phase is *the presentation phase* which focuses on displaying the VAA output in a suitable way. Ideology-based VAAs should present VAA output by utilizing two-dimensional spatial maps or other visualization methods that can present multidimensional data (e.g., spider graphs). Spatial maps can be effective means of self-discovery, as they show the user's own ideological

position, allowing users to learn about their political views in relation to the candidates. Issue-based VAAs are more abstract, as they do not produce coherent ideological dimensions, and are therefore difficult to visualize. However, providing spatial maps based on *ad hoc* selection of statements could be the much-needed remedy for the lacking visualization. The problem with this approach is that the presented ideological scales might not be reliable, and therefore misleading (see Germann et al. 2015). For issue-based VAAs, Isotalo (2020) has suggested using network graphs to visualize candidate-to-candidate recommendation networks.

The results of both issue- and ideology-based VAAs approaches can be presented as an interactive table. The main advantage of using a table instead of simply ranking candidates by their agreement with the user is that the table allows users to see more information at once. VAA recommendation is not the only piece of information that voters rely on when deciding who to vote for. Other important factors are candidate demographics (e.g., gender and age), local roots, and previous electoral performance (e.g., Shugart et al. 2005, Dahlgaard 2016). Therefore, it would be beneficial to have all this information presented in combination with the VAA recommendation (i.e., matching scores or ideological distance). The interactivity of the table further improves the usefulness by allowing users to filter candidates based on their own set of criteria (e.g., candidate age lower than 30 and matching score higher than 85%).

To conclude this section, table 3 presents changes to existing VAA designs that would fulfill the desired design objectives.

Table 3. Reaching design objectives with proposed VAA designs

Design objective	Changes in VAA design
1. Increase usefulness of VAA in making the vote choice	- Add filtering phase which removes unsuitable candidates - Ideology-based VAA tackles unbalanced statement structure problem - Interactive table allows users more effectively compare candidates and find candidates based on multiple criteria
2. Promote honest answering behavior of candidates (and parties)	- Allow users to select the matching method to disincentivize candidates to strategically placing their answers - Determine party positions with multiple metrics, in order to minimize party interference to candidate answers
3. Allow users to become designers	- Make filtering phase optional - Allow users to choose between ideology-based and issue-based VAAs - Allow users to choose whether parties or candidates should be prioritized in recommendations - Allow users to make algorithmic choices (e.g., matching method) - Interactive table allows users to inspect candidates based on multiple criteria
4. Increase transparency of VAA	- Provide extensive documentation on VAA development and functioning - Make algorithms public - Provide candidate/party response data for public use

Discussion

Developing a VAA is a complex task with a myriad of interdependent design choices that have implications for VAA performance. The difficulty of developing new VAA designs could be one possible explanation why candidate-based VAA designs have been mostly stagnant for the past 20 years while being riddled with old and new problems (e.g., lack of transparency, strategic answering behavior of candidates).

In this article, I introduced a design intervention to the current state of Finnish VAAs. This article was built on previous research on Finnish VAA designs conducted by Isotalo (2020). In addition to providing new VAA designs, this article's contribution was in exploring the VAA design process, pointing out important design choices for VAA developers, and setting design objectives that address problems with existing Finnish VAA designs. The proposed VAA designs were developed by utilizing the design science research (DSR) approach. Next, a summary of the answers to the research questions will be provided.

The first research question: "What design choices do VAA developers have to make regarding VAA elements?" was answered by presenting the most important design choices that have an impact on the voting advice. In total there are 12 interdependent design choices: statement formulation, statement selection, configuration of answering scales, enabling live match tracking, calculating voting advice of parties from candidate responses, issue-based vs. ideological matching, matching method, choosing distance metric, inclusion of salience weights, handling missing responses, giving primacy to party or candidate voting advice, visualizing user and candidate positions. Selecting either issue-based or ideological matching is the most central design choice, making it a prime candidate for VAA developers to start their design process. Developers should also empower users by allowing them to choose alternative VAA designs.

The second research question: "What VAA designs would be optimal for Finnish parliamentary elections?" was answered by envisioning new VAA designs that were in line with a set of design objectives: 1) Increase usefulness of VAA in making the vote choice, 2) Promote honest answering behavior of candidates (and parties), 3) Allow users to become designers and 4) Increase transparency of VAA. Two overall VAA designs were suggested. These designs consisted of three phases: filtering, recommendation, and presentation. Existing VAA designs have been focusing solely on recommendation (i.e., matching users to candidates) and presentation phases (i.e., displaying voting advice) while neglecting the idea of filtering (i.e., removing) candidates based on issue disagreement. The first overall design keeps all three phases separate, whereas the second combines filtering and recommendation phases. Ideology or issue-based approach can be selected for the recommendation phase by the user. The two approaches differ in their view of political representation: ideology-based supports the trustee model, whereas issue-based considers representatives as delegates. The ideology-based approach is more demanding for the developers to develop due to the requirement of data preprocessing. However, it is less sensitive to changes in statement selection, which makes it more reliable. Based on the recommendation approach, voting advice should be presented either by spatial maps, or candidate-to-candidate networks, along with an interactive table that displays VAA results and other relevant information for the voter regarding the candidates.

The proposed designs should be tested for their capability to fulfill design objectives, recommendation accuracy, and user satisfaction. On a general note, a lot of VAA research has been focusing on algorithms and effects of VAA usage (see e.g., Munzert and Ramirez Ruiz 2021; Mendez 2017), while only a few studies have surveyed user experiences related to specific VAA designs (see

Bruinsma 2020). I perceive this line of experimental research particularly necessary, as observing VAA usage could shed light on users' political information-seeking behavior and users' perception of political issues. Developing and testing suggested VAA designs calls for deeper collaboration between media outlets that provide VAAs and the research community.

On a final note, one should keep in mind that individual VAAs are a part of a larger VAA ecosystem. Borg and Koljonen (2020) identified at least 15 media-developed VAAs for the 2019 parliamentary election that were made available for the electorate. It would not be beneficial that all candidate-based VAAs follow the same design, because differences among VAAs (e.g., in terms of answering scales and statement selection) allow them to complement each other. However, improving current Finnish VAA designs with suggested designs would be advisable, as most of the popular Finnish VAAs have conformed to nearly identical, but flawed issue-based VAA design. These flaws in VAA design should not be overlooked as the electoral significance of VAAs is more likely to grow in the future.

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