A Flexible Voting Approach for Supporting more Accurate Decisions

**Keywords:** Traditional voting, flexible voting, linguistic summaries, fuzzy logic.

# Introduction

Traditional referendum respectively voting system with binary values (yes/no) is a broadly used way for reaching decisions in direct democracy, where citizens participate by providing their opinions with the answers “yes” or “no”. The option with the most answers wins. This bipolar scale is also used in (question blocks of) surveys. But, people cannot always clearly express their opinion in a binary way; we percept more than only “black or white” i.e., we do not always know if we fully agree or disagree to something [1]. The same applies in voting processes. Indecisive voters or voters which slightly incline to the one or other pole might not participate or, if voting is mandatory, just mark one of the two answers, even if they are not fully convinced of the option to be voted on. Thus, response rates are often not high and moreover using a bipolar scale it is not possible to collect and analyse the intensities of voters’ inclinations to extreme poles.

 In data collection tasks, the low response rates are not favourable. In the context of a smart city, for instance, to enable the city to design the processes in a way that is in the best interests of its inhabitants, the opinions of the high number of citizens must be gathered.

Based on a design science approach [2], this work is devoted to covering flexible voting and analysis of results by the quantified sentences of natural language. In general, flexible referendum type voting might bring to National Statistical Institutes and local authorities the important insights about various aspects in our society. Mathematicians, experts on political science and information technologies have already recognized the benefit of flexible voting and have started to create the foundation for this field, e.g., [3]. This contribution presents a possible solution of a flexible voting system, provides data analyses, and discusses the potentials of flexible voting.

# Motivation

In classical referendum, we divide votes into two classes (see Fig. 1). However, as mentioned before, people often do not think binary. They also consider the intensities of inclinations, for example, “rather yes”, “more or less” or “rather no” [1, 3]. For instance, when 50.5% of people rather incline to “yes” than “no” and 49.5% are clearly for “no”, the option proposed will be accepted. But does it reflect the reality correctly?

For instance, confronted with the increasing urbanization, in a city referendum, a question in the field of “smart living” might be: “Do you agree for building five blocks of flats of 10 floors each on location L?”. If there are only two answer options, it is difficult to sense the citizens and therefore to reach the best possible decision in a certain context for the city. However, if there would be a flexible voting, with intensities, the votes could give more information about the opinions and perceptions of the citizens. For instance, a slight disagreement might indicate that the investment plan is acceptable, but with reduced building density, whereas high disapproval indicates that citizens are against the investment plan in general.



Figure 1. Two classes in a classical referendum

# The Proposed Solution

This section illustrates technical background, experiments and data analyses.

## The voting environment

Nowadays, voting is moving from traditional modes to e-Voting. In the case of e-Voting, instead of marking “yes” or “no”, the respondent or voter is able to indicate its inclination to one of two poles. The position of the slider shows the intensity of inclination of the voter, as is shown in Figure 2.



Figure 2. Scale for flexible voting

Thus, we assign 0 to “no”, 1 to “yes” and 0.5 to the maximal indecisiveness. Other scaling like an interval [-1,1] is also conceivable. The outcome of this flexible voting system is the aggregated value by the arithmetic mean (considered as a logically neutral aggregation function). If the value is higher than 0.5, the result is “yes”, otherwise the result is “no”. In the rarest cases, it could happen that the voting systems outputs exactly 0.5 for a question. In such a case, the situation is the same as when traditional voting collects exactly the same number of “yes” and “no” answers. But if you consider several decimal values, it is more likely that there will be an inclination to one side, even if only minimally.

Couper et al (2006) [4] show in a review of previous empirical research that, in terms of the reliability or validity of measurement, there appears to be no great gain, but neither disadvantage, in the quality or precision of measurement using a continuous scale. However, people have gotten more and more used to digital formats, which calls for new research on the matter.

On the best way to assure that respondents (voters) attain the intrinsic benefits from voting (and thus increasing response rates and data quality) is to have a pleasant survey / voting experience through a well-constructed survey or voting system that is easy for respondents to complete [5, 6]. We hypothesize that a scale for flexible voting would increase a pleasant voting experience as opposed to a bipolar scale.

## Explaining mined information from votes

In flexible voting we have more space for analyses. For analysing and disseminating results we can apply natural language processing, e.g., short quantified sentences of natural language. The interpretation by linguistic summaries (LSs) not only reveal additional valuable knowledge, but it is also understandable at first glance [7].

The basic structure of LS [8] is *Q records have S*. Quantifier *Q* and summarizer *S* are usually formalized by fuzzy sets, e.g., *most of the voters are very indecisive* (answer around 0.5, see Fig. 2). The proportion of voters that fully and partially satisfies the predicate *S* is

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| --- | --- |
| $$y\_{LSb}\left(X\right)= \frac{1}{n}\sum\_{i=1}^{n}μ\_{S}\left(x\_{i}\right)$$ | (1) |

where *n* is the number of voters and the membership function $μ$ formalizes summarizer *S*. As we cannot sharply define term around 0.5, we formalized it as fuzzy set:

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| --- | --- |
| $$μ\_{S}\left(x\right)=\left\{\begin{array}{c}(x-0.35)/0.15 \& 0.35<x<0.65\\1 \& x=0.5\\(0.65-x)/0.15 \& 0.5<x<0.65\\0 \& otherwise\end{array}\right.$$ | (2) |

The validity (truth value) of the summary is calculated as

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| --- | --- |
| $$v\_{LSb}\left(X\right)=μ\_{Q}\left(y\_{LSb}\left(X\right)\right)$$ | (3) |

where the function $μ$ formalizes quantifier *Q* for the summary. Both $y\_{LSb}\left(X\right)$ and $v\_{LSb}\left(X\right)$ assume values in the interval [0, 1]. Quantifier *most of* is expressed as

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| $$μ\_{Qm}\left(x\right)=min\left[1,max\left(0,\frac{y\_{LSb}\left(X\right)-0.5}{0.3}\right)\right]$$ | (4) |

whereas quantifier about half is expressed as

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| --- | --- |
| $$μ\_{Qah}\left(x\right)=min\left[1,max\left(0,\frac{y\_{LSb}\left(X\right)-0.4}{0.1},\frac{0.6-y\_{LSb}\left(X\right)}{0.1}\right)\right]$$ | (5) |

## Illustrative example and interpretation

In our small-scale experiment, we generated answers in the unit interval for 1 000 hypothetical voters. The aggregated value or solution by arithmetic mean from this data was 0.41. It means that the option “no” wins, but quite close to 0.5. Next, the summarized sentence with the highest validity (3) is “*about half of the voters are indecisive”*. It means for instance, that we have significant number of indecisive voters, and more voters are inclining to “no” than “yes”.

When most of the voters are indecisive, it is a feedback that either the question was not posed in an understandable way, or it is irrelevant for people. However, the summarized sentences “*about half of voters are for a strong ‘yes’”* and “*about half of voters are for a strong ‘no’”* indicate the polarization of the society.

Next, adding demographic questions (e.g., age), might shed a light regarding subsets of respondents or voters. In this way, it is possible to present results by linguistic summaries focused on the subcategories and their quality measures [7]. In our example, the summarized sentence is *“the most of young voters inclines significantly to ‘yes’ answer”.* This option is more acceptable for surveys than referendum, but it might be interesting speculation for the future to examine answers by diverse categories.

# Conclusions and Outlook

The application of a flexible referendum system cannot be done immediately and substitute the classical way we know since ever. Nevertheless, we should think about new ways, and the flexible voting system presents for our society, in the opinions of the authors, a better solution to get the real opinions. This proposed solution does not aim to change the government process and related documents regarding (classical) voting, but rather to make them aware of the opportunities and advantages of this extended flexible voting method.

We recognize the importance of such a framework, because today's developments indicate that there is no longer an "either/or" in decisions. For instance, when most of young people clearly wanted one solution, while the majority of older people wanted rather the opposite, a flexible voting could have provided a solution more clearly reflecting reality. Thus, we should start to introduce this approach into different fields to get acceptance and feedbacks how to improve. A promising application field is in smart cities. For such experimental study, we can recognize benefits and drawbacks which would be valuable for the future work and large-scale referendums. The solution of a possible flexible voting is still in progress. First iterations were made, and further iterations for improvements are planned.

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