

Desirable tie-breaking rules in collective decision-making

Extended Abstract

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A panel of experts is a group of people selected and assembled for some service such as investigation, arbitration, generation of guidelines etc. We consider a panel of experts which has to form a collective view in favor or against a certain issue. The panel is required to provide adequate reasons to support their view, as well as make explicit what the connection rule between the reasons and the issue is. We assume that every member has to propose a decision rule and corresponding relevant reasons. For example, for an issue i and a decision rule $(r_1 \wedge r_2) \leftrightarrow i$, r_1 and r_2 are referred to as *relevant reasons*. Hence, the agenda is constituted by the following items: the original issue which the panel needs to decide on, the decision rules that each member proposed and all the corresponding relevant reasons. The outcome of the panel deliberation consists of a collective decision on the issue together with a unique decision rule and corresponding relevant reasons.

It is realistic to expect that the experts in the panel will not have a unanimous view on the items of the agenda. Furthermore, they may have contradictory opinions on some of the items in the agenda. In case of contradictory opinions, in practice, the panel members have to further deliberate and reach a consensus.

We are interested in investigating the problem of automated aggregation of the individual opinions into a collective opinion which the panel can endorse. Consensus is not always easy to reach. The aggregation procedure can be used as a guideline for the panel. The advantage of aggregation over consensus reached by negotiation is that the final result, being procedurally obtained, can not be "pushed" by influential individuals.

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Consider for example a panel of experts from independent institutions which has been assembled to decide if a new environmental regulation is to be enforced (proposition f). Assume that it has been unanimously accepted that a regulation should be enforced if and only if the panel finds that the regulation will be well accepted by the members of the community (proposition a) and the results of the regulation are expected to be satisfactory (s). A group of panel members may believe that the regulation should be enforced because both a and s are satisfied. Another group of members (equally as many as the previous one) deems that the regulation should not be enforced ($\neg f$) because, while agreeing that the regulation will be well accepted (a), they think that the effect of the regulation will be negligible ($\neg s$). Given that the experts belong to independent institutions, are equally reliable and divided in their opinions, the challenging task is to accept one group over the other, or aggregate the opinions of the individual groups into a unique panel opinion (which still have to abide by the accepted decision rule). The task is further complicated if there was no unanimously accepted decision rule.

Judgment aggregation is a research area in economics [3] that studies how the individual opinions of an agent, which are opinions on logically interconnected propositions, can be mapped into a collective judgment on the same propositions. The classical example of a judgment aggregation problem is a three-jury court where the judges have to decide whether a defendant is liable by using a certain law.

Unlike in judgment aggregation, we do not assume the existence of a unique decision rule nor that all panel members have to say yes or no (respectively 1 or 0) to each proposition. In our framework we require individuals to state their view on the final decision (what is called conclusion in judgment aggregation). Each member of the panel can propose a decision rule and opinions for corresponding relevant reasons. A member is not required to give an opinion for a reason introduced by another member.

As argued in [4], model-based approaches to belief merging [2, 1] are appropriate to aggregate individual belief bases in the context of group-decision making. This was originally suggested as a method to avoid paradoxical outcomes in judgment aggregation problems.

Model-based belief fusion is based on the selection of preferred models of the individual bases (and eventually of additional integrity constraints). Each individual base is mapped to a set of models. A total pre-order is defined over the models by using a suitable distance measure. A majoritarian operator, for example, selects as collective outcome the belief base(s) that minimize the distance with the collection of the individual bases. On the other hand, an arbitration operator aims at equally taking into account the individuals' opinion in the final outcome.

Unfortunately, as ties are possible when fusion operators are applied, the group will not always be able to determine a unique collective opinion on the items of the agenda using this method. The presence of a tie indicates that the individuals' opinions are not

enough polarized for the group to make a decision. A solution must be found for breaking the ties. Arbitrary tie-breaking rules effectively make the panel assembly redundant – arbitrarily choosing one opinion on the agenda items is equivalent to randomly hiring only one expert instead of a panel.

We assume that we have a panel of equally reliable individuals that needs to produce a collective opinion on the agenda items. We take into consideration that the deliberation over the issue may not be a one time event. The panel is responsible for its decision and has to be able to defend the reasons behind that decision in case of re-deliberation. Namely, they should be prepared to provide reasons for choosing one opinion over another in the case of a tie. We illustrate the motivation for this assumption with two examples.

Consider the case of a panel making a decision on financing the construction of a new community building. In this case, it is not expected that their decision will be re-examined. However, they (or another panel) may be assembled after the construction of the building to evaluate whether the project has met the expectations. Given that the funds spent on the building are unrecoverable, it is in the interest of the first panel to make sure that their selected collective opinion on the items of the agenda is as unquestionable as possible.

In another situation, if a panel is assembled to decide over a permit for the release of a new drug, it is reasonable to expect that new information regarding the performance of the drug will become available with time. Consequently, the panel should expect that they (or another panel) will have to re-deliberate over the issue. Here, they would be interested in "keeping their options open" and this should be taken into consideration when choosing the collective opinions.

In our we focus on addressing the following research questions:

- How can the belief fusion approach be extended to incorporate the aggregation of the individual decision rules.
- What are desirable properties for an aggregation procedure? For example, it is intuitively desirable that if an opinion on an agenda item is unanimously held, that opinion has to be preserved on the collective level.
- What are the desirable conditions that a tie breaking rule should satisfy and how previous group decisions can affect future deliberations? For instance, in the case of the construction of the new building, the panel should aim at the most robust outcome. On the other hand, in the example of the panel that has to decide whether a certain drug can be released, individuals want to agree on a collective opinion that is open to revision in case of future new findings.

References

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