Tuning the Diversity of Open-Ended Responses From the Crowd

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Introduction
Crowdsourcing can solve problems beyond the reach of state-of-the-art fully automated systems (Bigham et al. 2010; Lasecki et al. 2011; 2012; Bernstein et al. 2011; von Ahn and Dabbish 2004; Attenberg, Ipeirotis, and Provost 2011; Aral, Ipeirotis, and Taylor 2011). A common pattern found in many such systems is for the workers to discover, in parallel, a number of candidate solutions and then vote on the best one to pass forward, often within a fixed amount of time.

Given limited human resources, then, how much effort should be spent on discovering new solutions versus deliberating over those that have already been proposed? Too many proposals and it may be too hard for the remaining workers to discriminate among them and make a clear group decision. Too few and the best answer might not be found. Clearly, the optimal balance depends on many factors specific to the crowd and the problem itself, so a flexible approach is needed to make it easy for system designers to elicit responses appropriately.

We present the propose-vote-abstain mechanism for eliciting from crowd workers the proper balance between solution discovery and selection. Each crowd worker is given a choice among proposing an answer, voting among the answers proposed so far, or abstaining, i.e., doing nothing. When a stopping condition is reached, the mechanism returns the answer with the most votes. Workers are paid a base amount, with bonuses if they propose or vote for the winning answer.

Game-Theoretic Analysis
We use game theory to get a sense of how we might expect the propose-vote-abstain mechanism to perform under ideal circumstances. In order to make the analysis tractable, we make several simplifying assumptions:

1. The game has a single turn with an indeterminate (and unknown to the workers) number of players.
2. The game does not terminate unless there is at least one answer proposed and one vote.
3. If at termination more than one candidate has the most votes, then one of these candidates is selected uniformly at random as the winner.
4. We assume that each player has equal confidence in alternatives winning, including ones proposed by the player.
5. The only information the workers know about the system are the candidate answers and the request.

Assumptions in 4–5 are, admittedly, quite strong. However, they mean that (for the purposes of analysis) the only state information we need to consider are the number of alternatives \( m_t \) proposed so far, where \( t \) is the current time.
This yields several results about the behavior of the crowd as a function of the payoffs for each response.

**Proposition 1.** Under the assumptions above:
1. If \( \alpha \geq \min\{\pi, \nu\} \), then abstaining is a dominant strategy for all players.
2. If \( \min\{\pi, \nu\} > \alpha \) then the dominant strategy for the first \( \min\{\nu/\pi, \pi/\alpha, 1\} \) workers is to propose and for the remaining workers it is to vote.

**Experimental Analysis**

To test our model’s ability to elicit different levels of response diversity from workers, we setup a simple image description task. We recruited 100 Mechanical Turk workers and asked them to view a set of 5 images (presented in random order) and either propose, vote for, or abstain from contributing to the image’s description. Our relative pricing levels between the vote and propose actions were traded off to test a range of three options between 4 and 20 cents (per image). Rewards were given based on the result of the aggregate decision at the end of our experiments. The abstain payment was fixed at 2 cents for all of the questions in our tasks.

Figure 1 shows the results of our tests. As the payment for voting becomes large relative to the proposal payment, the number of total answers generated by the system significantly decreases from an average of 7.8 responses to 1 response for all 5 pictures we saw \( (p < .0001) \). The decreasing trend was linear with \( R^2 = 0.802 \). Note that there is a disproportional drop at the break-even point when payment is equal for both options. This is consistent with what we expect because voting requires less effort than generating a response, so there is a slight bias in its favor.

While all of the images eventually converged to a single response as the vote payment increased, the number of responses generated in the opposing case (where the proposal reward is high and workers are incentivized to generate several answers) varies from 5 to 10 responses each. This is likely dependent on how subjective the image is and how many answer could be considered plausible with high confidence. This trend is seen throughout the results as each response set trends towards a single response. This suggests that the content of the task does play a role in worker trends, but in the convergent limit this can be overridden by financial incentives.

**Conclusion**

In this paper, we presented the propose-vote-abstain mechanism for eliciting answers from crowd workers. Consistent with our theoretical results (which predict no abstentions) very few abstentions occurred. The theoretical results suggest that abstention plays an important role in regulating the number of proposals, even though few participants actually abstain. Further work is needed to better understand how exactly the theoretical results translate to practice.

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**References**


