Efficiently achieving consensus by using your time wisely

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On March 23, 1989, Fleischmann and Pons announced that they had discovered electrochemically-induced cold fusion [1]. The news sent shock-waves throughout the scientific community as it was believed that fusion could only occur at extremely high temperatures. Additionally, the news caught the attention of policy makers and the general public as the discovery could have huge implications for future energy concerns. Two months later, however, Petrasso *et al*. reported that the cold fusion results were flawed [2], and debate ensued [3, 4]. Faced with these two competing claims, it was crucial for the scientific community to determine which results were correct so that scientists could identify future research directions, and policy makers could appropriate funds and resolve ethical issues. In this case, the scientific community rapidly agreed with Petrasso *et al*. in less than one year. How did the scientific community reach a consensus on this matter so quickly when very few scientists understood the subject in great detail?

The debate over cold fusion is not an isolated incident. Many problems currently under debate also have a broad scientific consensus despite incomplete understanding of the phenomena or a “golden experiment” that single-handedly identifies the correct answer. These intrinsically difficult problems, such as mechanisms to control global warming [5] or ecosystem biodiversity [6], will likely have a large impact on human society in the future. To deduce the proper course of action for policy makers, scientists form educated opinions on what they believe to be the correct answer. How can policy makers and the general public be sure that the scientific community has reached the *correct* consensus despite the lack of comprehensive technical understanding?

Previous attempts at answering these questions have focused on opinion spreading models. In particular, researchers have used voter [7], Ising [8, 9], herding [10], segregation [11], and even disease spreading [12, 13] models to describe how ideas flow within a community of individuals. These models, however, have several drawbacks. First, most of these models do not take the topology of social interactions into account. Social interaction is particularly important in opinion spreading models because people generally do not “force” their opinions on others unless they are somehow socially acquainted. Second, the models typically implement the same interaction rule for all agents. This restriction does not account for human idiosyncrasies, but rather assumes that each individual responds to stimuli identically. Third, the models neglect to account for the fact that many individuals have a “natural” tendency to resist change or that some people, rebels perhaps, are more hesitant to go along with the popular opinion. Finally, the models do not examine problems of varying difficulty. For instance, scientists have been debating anthropogenic climate effects for decades whereas the cold fusion discovery was discarded in less than a year. Here, we propose a new model that overcomes the deficiencies of current modeling approaches and enables us to answer the aforementioned questions.

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