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Adding a Degree of Freedom to Opinion Dynamics Models

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Abstract : Within agent-based modeling, opinion dynamics is the field that focuses on modeling people's opinions. In this prolific field, most of the literature is dedicated to the exploration of the two 'degrees of freedom' and how they impact the model's properties (e.g., the average final opinion, the number of final clusters, etc.). These degrees of freedom are (1) the interaction rule, which determines how agents update their own opinion, and (2) the network topology, which defines the possible interaction among agents. In this work, we show that the third degree of freedom exists. This can be used to change a model's output up to 100% of its initial value or to transform two models (both from the literature) into each other. Since opinion dynamics models are representations of the real world, it is fundamental to understand how people's opinions can be measured. Even for abstract models (i.e., not intended for the fitting of real-world data), it is important to understand if the way of numerically representing opinions is unique; and, if this is not the case, how the model dynamics would change by using different representations. The process of measuring opinions is non-trivial as it requires transforming real-world opinion (e.g., supporting most of the liberal ideals) to a number. Such a process is usually not discussed in opinion dynamics literature, but it has been intensively studied in a subfield of psychology called psychometrics. In psychometrics, opinion scales can be converted into each other, similarly to how meters can be converted to feet. Indeed, psychometrics routinely uses both linear and non-linear transformations of opinion scales. Here, we analyze how this transformation affects opinion dynamics models. We analyze this effect by using mathematical modeling and then validating our analysis with agent-based simulations. Firstly, we study the case of perfect scales. In this way, we show that scale transformations affect the model's dynamics up to a qualitative level. This means that if two researchers use the same opinion dynamics model and even the same dataset, they could make totally different predictions just because they followed different renormalization processes. A similar situation appears if two different scales are used to measure opinions even on the same population. This effect may be as strong as providing an uncertainty of 100% on the simulation's output (i.e., all results are possible). Still, by using perfect scales, we show that scales transformations can be used to perfectly transform one model to another. We test this using two models from the standard literature. Finally, we test the effect of scale transformation in the case of finite precision using a 7-points Likert scale. In this way, we show how a relatively small-scale transformation introduces both changes at the qualitative level (i.e., the most shared opinion at the end of the simulation) and in the number of opinion clusters. Thus, scale transformation appears to be a third degree of freedom of opinion dynamics models. This result deeply impacts both theoretical research on models' properties and on the application of models on real-world data.

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