Should a political party form a coalition? Voters and math decide

April 15 2015

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Mathematical ideas and tools are often used to describe aspects of large macroscopic systems. Examples abound in areas as varied as finance to psychology. In a paper published last month in the *SIAM Journal on Applied Mathematics*, author Fabio Bagarello proposes mathematical models to analyze political decision-making. Using a dynamical

approach which accounts for interactions between political parties and their constituents, the model tries to deduce whether parties should form coalitions under various circumstances.

"Mathematics is important in many aspects of social behavior. Politics is just one of these aspects, sincesome of the typical behavior in politics can be characterized by suitable quantities which, usually, evolve in time," says Bagarello. "In other words, political parties are examples of dynamical systems."

Bagarello uses a Hamiltonian operator, which can describe interactions among various constituents of a system. In the model, three parties in a system are considered. Each party can make one of two choices: forming a coalition or not. This gives rise to eight different possibilities that can change over time. The time behavior of "decision functions" of political parties is then determined, which describes the likelihood of a party forming a coalition. In order to make decisions, the parties need to interact with the voters or electors. This interaction is instrumental in their final decisions, and the model considers this via an open system which accounts for voter interaction.

"Quite often, these kinds of dynamical systems are described by differential equations whose different terms describe different phenomena. In my approach the main ingredient is not the differentialequation, but a Hamiltonian operator from which the dynamics of some relevant 'observable' of the system can be deduced," explains Bagarello. "This allows an easy way to model an 'open system' in which few actors (the parties) interact with many (the voters), and we can show how voters direct the behavior of the various parties."

"Several macroscopic systems have been analyzed using such operatorial techniques. I have adopted the same general framework in the description of 'love affairs', migrations, closed ecological systems and

simplified stock markets," Bagarello continues. "Dealing with stock markets was my original interest, due to the fact that traders exchange discrete quantities which are well described by simple and well-known algebraic rules."

Future directions in research may allow parties to not only determine if they should form an alliance or not, but also suggest which parties to form coalitions with. "This is part of a possible extended version of the model, and work in progress," Bagarello says. "The model could also be improved by adding some nonlinearities in the interaction terms. These could be used, for instance, to produce a more refined model in which the parties' behaviors are significantly driven by the decisions of other parties."

More information: An Operator View on Alliances in Politics, *SIAM Journal on Applied Mathematics*, 75(2), 564–584 (Online publish date: March 19, 2015) epubs.siam.org/doi/abs/10.1137/140990747

Provided by Society for Industrial and Applied Mathematics