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Observability and Controllability of Nonlinear Networks: The Role of Symmetry[1] STEVEN SCHIFF, ANDREW WHALEN, SEAN BRENNAN, Penn State University, TIMOTHY SAUER, George Mason University — Observability and controllability are essential concepts to the design of predictive observer models and feedback controllers of networked systems. For example, non-controllable mathematical models of real systems may have subspaces that influence model behavior, but cannot be controlled by an input. Such subspaces are difficult to determine in complex nonlinear networks. Since most of the present theory was developed for linear networks without symmetries, here we present a numerical and group representational framework, to quantify the observability and controllability of nonlinear networks with explicit symmetries that shows the connection between symmetries and measures of observability and controllability. We numerically observe and theoretically predict that not all symmetries have the same effect on network observation and control. We find that the presence of symmetry in a network may decrease observability and controllability, although networks containing only rotational symmetries remain controllable and observable. These results alter our view of the nature of observability and controllability in complex networks, change our understanding of structural controllability, and affect the design of mathematical models to observe and control such networks.

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