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Communities in multislice voting networks

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Network representations can be used to study numerous complex systems. *Communities* in networks consist of sets of nodes that are relatively densely connected to each other.^{1,2} Recently, we have developed a community detection method for *multislice* (multiplex, multiscale, and/or time-dependent) networks in which we optimize a single quality function that generalizes modularity using an appropriate null model.³ Multislice networks are described by stacks of adjacency matrices (slices), where each slice represents a single set of connections between nodes (e.g., at a specified time in longitudinal data). Here, each slice quantifies voting similarities between U.S. Senators in a two-year Congress.⁴ Any Senator appearing in successive Congresses is assigned an interslice connection of selected strength between these instances (with the same value for each individual).

The figures indicate multislice community structure at three values of interslice coupling strength. Each appearance of a Senator in a Congress is shown by a dot placed horizontally in time and vertically by the represented state and is assigned to a community (which is indicated by color). Larger values of interslice coupling strength encourage common community assignment of the same Senator across Congresses. We detected communities using a Louvain method⁵ with a multislice null model and subsequent Kernighan–Lin node swaps.⁶

Communities identify party-like groups in voting (cf. the nominal party affiliations in each community; see the figures). Transitions arise amidst the simultaneous appearance of three communities and in conjunction with historically important periods (e.g., Missouri Compromise, Compromise of 1850, Civil War, Great Depression, and Civil Rights Era). The middle figure identifies the Civil Rights Era as the most significant political transition—with respect to community assignments—since the Civil War. Except for the major shock of the Civil War, a robust two-party system with drifting labels appears at large coupling: Pro-Administration (PA), Federalist (F), Anti-Jackson (AJ), Adams (A), Whig (W), and Republican (R) Senators on one side and Anti-Administration (AA), Democratic-Republican (DR), Jackson (J), and Democrat (D) Senators on the other.⁷

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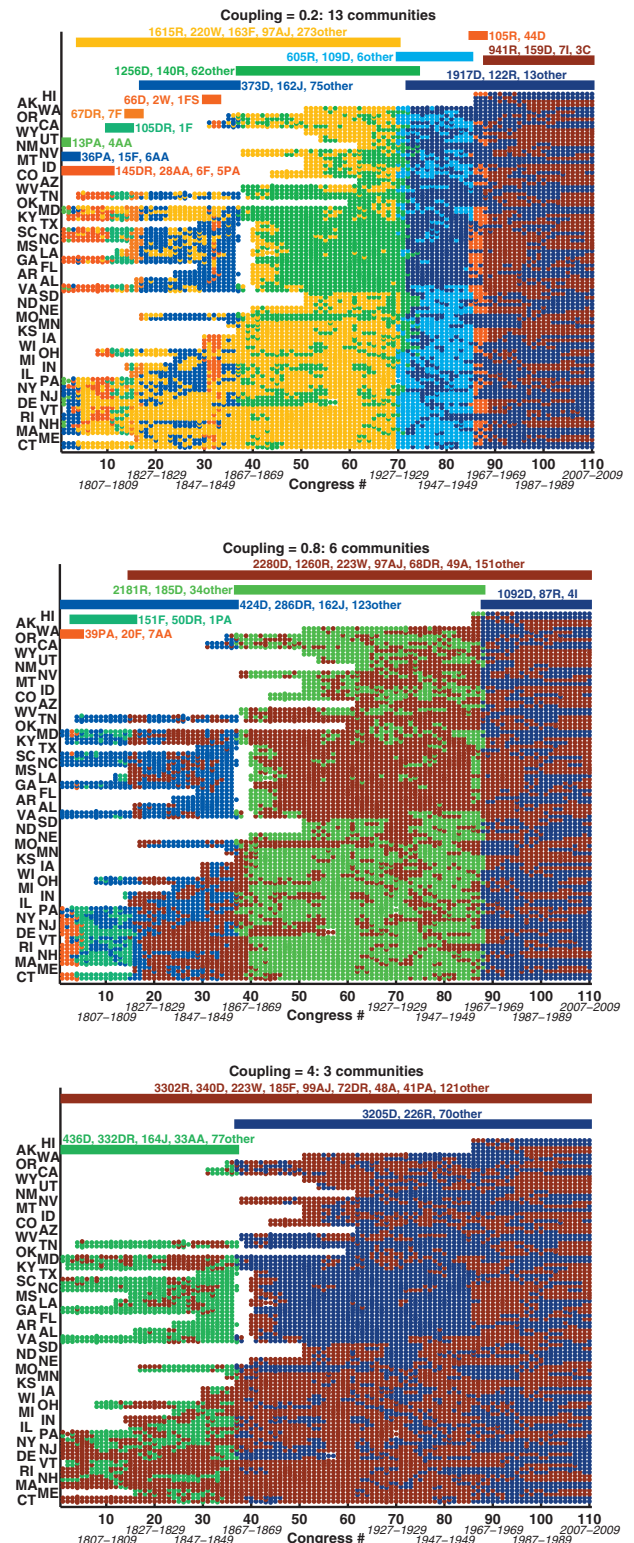


FIG. 1. (Color)

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⁷We are grateful to our co-authors of Ref. 3, on which the present calculations were based. We obtained the Congressional roll call data from vote-view.com.