Community Structure in Multislice Voting Networks

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MULTISLICE COMMUNITY DETECTION IS A METHOD TO ANALYZE MULTIPLEX, MULTISCALE, AND TIME-DEPENDENT NETWORKS THROUGH THE OPTIMIZATION OF A SINGLE QUALITY FUNCTION—A GENERALIZATION OF THE USUAL MODULARITY—BY DERIVING NULL MODELS THAT RESPECT THESE PROPERTIES OF THE NETWORK. EACH ADJACENCY TENSOR IN A MULTISLICE NETWORK IS COMPOSED OF MULTIPLE SLICES OF ADJACENCY MATRICES.

Each network slice connects Senators by voting similarities in a two-year Congress. When the same Senator is in two consecutive Congresses, an interslice identification edge of specified Coupling is included. The resulting communities, found by a modified Louvain method using this null model and Kernighan-Lin node swaps, are identified by colors.

Coupling = 0.2

Communities give voting-based identification of party-like groups (nominal affiliations as indicated; e.g., "D" and "R"). Transitions often occur amidst simultaneous appearance of three communities and around periods of historical political importance: e.g., the Missouri Compromise, Compromise of 1850, Civil War, Great Depression, and the era of Civil Rights legislation.

Coupling = 0.5

Increased coupling identifies the Civil Rights era as the most significant political transition (with respect to community membership) since the Civil War.

Coupling = 0.8

Demonstrating that the obtained structures can significantly differ, the community of historical Republicans disappears during the Civil Rights era, and historical Democrats are affiliated with the modern Republican party.

Coupling = 4

Large cross-Senate coupling recovers a dynamically robust two-party system with drifting names, except for the major shock of the Civil War: with Pro-Administration, Federalist, Anti-Jackson, Adams, Whig, and Republican Senators on one side; and Anti-Administration, Democratic-Republican, Jackson, and Democrat Senators on the other.

Coupling = 0.2: 13 communities
1615R, 220W, 163F, 97AJ, 273other
605R, 109D, 6other
1256D, 140R, 62other
373D, 162J, 75other
105R, 44D
941R, 159D, 7I, 3C
1917D, 122R, 13other
66D, 2W, 1FS
67DR, 7F
105DR, 1F
13PA, 4AA
36D, 15F, 6AA
145DR, 28AA, 6F, 5PA

Coupling = 0.5: 8 communities
3270R, 328D, 43W, 63other
1997D, 159R, 72other
384D, 162J, 72other
179W, 135DR, 97AJ, 78D, 49A, 69other
1194D, 99R, 4I
153F, 103DR, 1PA
39PA, 15F, 8AA
151DR, 30AA, 14PA, 6F

Coupling = 0.8: 6 communities
2280D, 1260R, 223W, 97AJ, 68DR, 49A, 151other
2181R, 185D, 34other
151F, 50DR, 1PA
424D, 286DR, 162J, 123other
1092D, 87R, 4I
39PA, 20F, 7AA

Coupling = 4: 3 communities
3302R, 340D, 223W, 185F, 99AJ, 72DR, 48A, 41PA, 121other
436D, 332DR, 164J, 33AA, 77other
3205D, 226R, 70other

References

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Acknowledgements
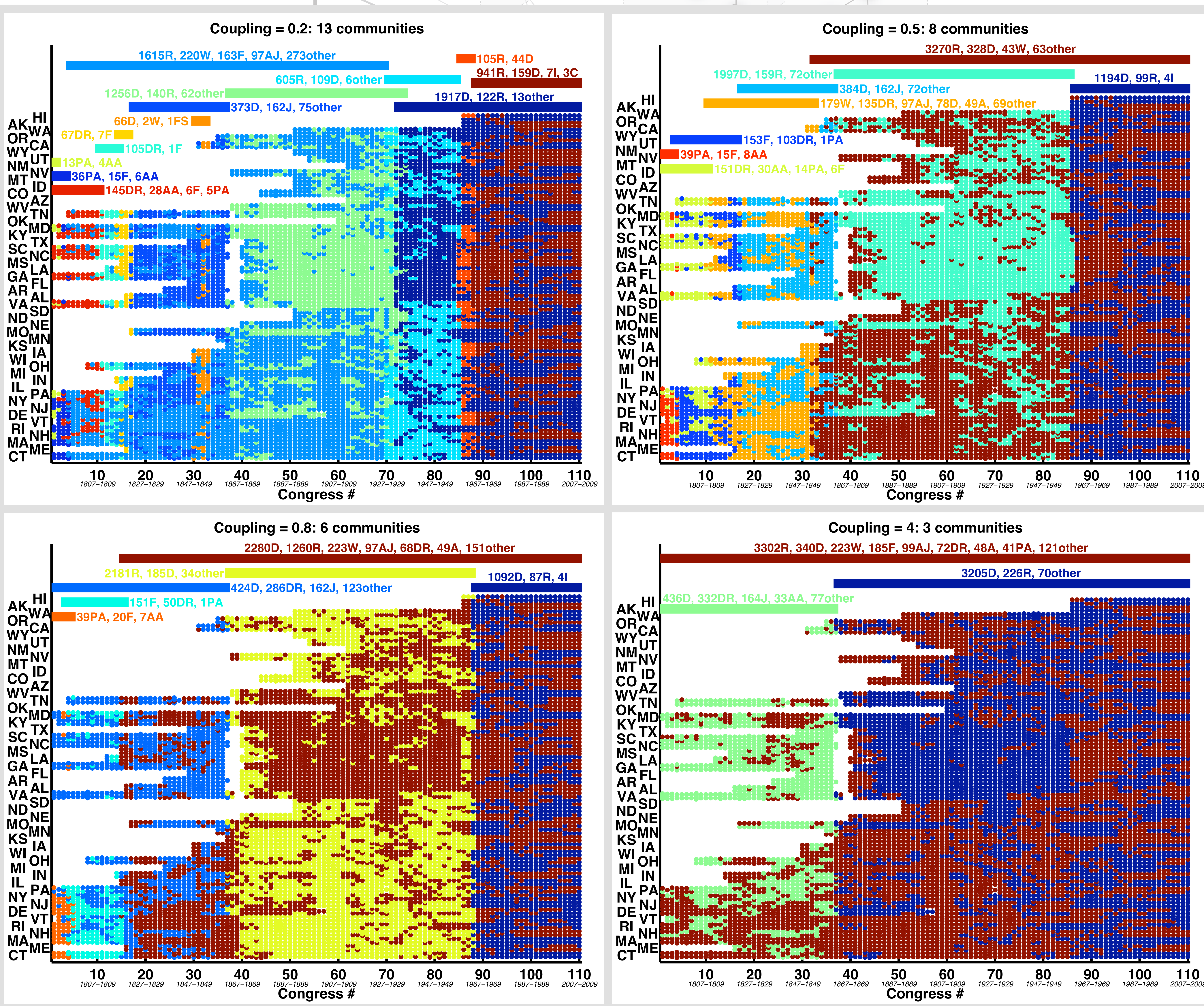
MULTISLICE COMMUNITY DETECTION APPLIED TO THE LONGITUDINAL SENATE ROLL CALL DATA DEMONSTRABLY IDENTIFIES PERIODS OF LEGISLATIVE CRISIS AND TRANSITION.