Computing Stable Outcomes in Congress and Beyond: A New Approach

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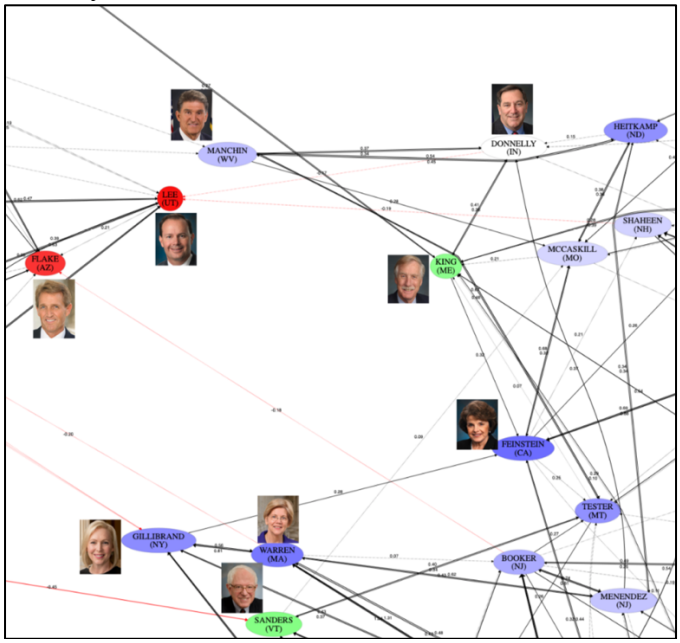
My task this summer was to build a new, more efficient algorithm for predicting voting behaviors in the U.S. Senate. I built upon previous work by Professor Mohammad Irfan and others, who built a networked multiagent influence model of the Senate which can be used to calculate Pure Strategy Nash Equilibria (PSNE)—a game-theoretic term for one or more "stable" outcome(s) in which each senator is content with their yes or no vote on a particular bill with respect to other others' votes. Their algorithm uses a Backtracking search to search for PSNE within the scope of all possible outcomes [1]. This model has already proven to be fairly predictive of actual outcomes in the Senate. However, their process is computationally expensive, taking hours in general to find all equilibria.

I underwent an exhaustive review of contemporary literature on modern AI search techniques in an effort to improve the speed of equilibria computation. Ultimately, I settled on Tabu search, a local search algorithm that dynamically maintains a list of previously explored states and forbids the search from returning to them for a given amount of time [2]. My implementation of Tabu search in C is now capable of finding a single PSNE in the Senate up to 50 times faster than Backtracking. This result is encouraging, but I hope to expand my code's capacity in future research so that it is capable of finding all PSNE with the same efficiency.



A Visual Representation of the Senate Influence Game Model [1]

Faculty Mentor: Mohammad Irfan
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References:

[1] Irfan, M.T., Ortiz, L.E.: *On Influence, Stable Behavior, and the Most Influential Individuals in Networks: A Game-Theoretic Approach.* Artificial Intelligence 215, 79-119 (2014).

[2] Sureka, A., Wurman, P. *Using Tabu Best-Response Search to find Pure Strategy Nash Equilibria in Normal Form Games.* AAMAS '05, 1023-1029 (2005).