**Latent Structure of Political Cultures in Swiss Referendum Election Results**
**Finn McGannon, Class of 2023**

This project operates under the working hypothesis that political opinion in stable governmental systems is comprised of a finite number of *political cultures*—reasonably consistent sets of principles and beliefs that guide political engagement, found as mixtures in local voting districts. Our research was motivated by the desire to begin examining the structure of those cultures within a country, analyzing how the latent structure of a nation's voting data changes or remains consistent over time and space through an exploratory cluster analysis. Additionally, we set out to demonstrate that the data we examined was suitable for a more complex analysis using a mixture distribution model developed by Professor O'Brien, following the success of that model in demonstrating the structure of Maine referendum election results.

Our project uses the raw vote totals of Swiss referendum data ranging from March 2010-May 2022. During that period, Switzerland balloted 110 federal referendum questions for consideration by the population This large data pool, as well as the nation's high-quality voting records, make Switzerland an ideal candidate for this form of analysis. Additionally, referendums produce stronger models of political culture than more common representative elections, as the data are not affected by party affiliation, primaries, or complex election rules. While Switzerland contains over 2100 communes, we focused our analysis on the 778 that typically saw turnout upwards of 500 voters.

Using the computing language R, we began with the goal of creating a pairwise distance between the vote totals of each pair of communities to estimate how distinct their political cultures are from one another. We then use that distance to cluster groups so that communities with closer distances (i.e. more similar vote totals) belong to the same group. As a distance, we used the Jensen-Shannon divergence—a method of measuring the similarity between two probability distributions—to measure the relative distance between the voting totals for each given referendum question and added the distances for each referendum together to get a final pairwise distance. We then used a *k*-medoids clustering algorithm to develop preliminary groupings, both annually and globally, based on this "closeness" of voting behavior. The algorithm starts with a predetermined number of clusters and groups together the communes closest to one another as determined by the J-S divergence.

As a result of this process, we observed the clear presence of at least six clusters in the Swiss data; however, increasing the k-value showed the potential presence of up to 20 political cultures, indicating there may be multiple levels of substructure within the data. When we clustered questions individually and ordered the plots by the overall structure of their year, results indicated a hierarchy of questions that reflected culture groups. Furthermore, when plotted geographically, yearly global clusters show significant overlap in voting culture distribution year-to-year (Fig.1). These early cluster structures and maps confirm that the Swiss data is well-suited for the more complex Beta-Binomial mixture model.

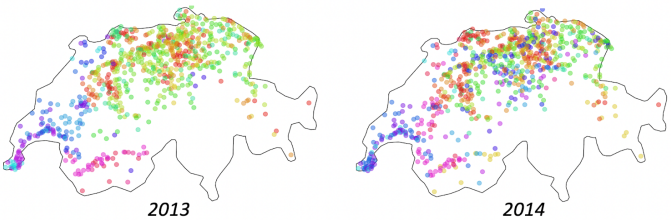


*Fig. 1: These 20-cluster groupings show considerable regional consistency between years.*

**Faculty Mentor: Prof. Jack O'Brien**
**Funded by the Surdna Foundation Undergraduate Research Fellowship**