The research project is aimed at investigating the **political effects of (common) electoral systems** in their quantitative aspects. This question has been usually approached from the empirical perspective, by treating the electoral system as one of the explanatory variables in a statistical model or by fitting some function to electoral data. Yet it is essentially a mathematical problem of how a function (the electoral system) maps the voting result to seat allocation (or to some other parameter of interest). For that reason, we seek to analyze the problem using **formal methods**, first postulating a **probabilistic model** of the distribution of voter preferences, and then deriving the results through analytical or Monte Carlo methods.

We plan to focus on **five primary categories of political effects**: **the relation between seats and votes** (mathematically expressed through the seats-votes curve), **proportionality** (the closeness of fit between vote and seat distributions), the **expected number of parliamentary parties** (and its relation to other parameters, such as the district magnitude and electoral thresholds), **susceptibility to chaotic behavior** (small changes, like crossing the electoral threshold, that have disproportionately high impact on the ultimate seat allocation), and the **expected proportion of wasted votes** (i.e., votes case for the losing candidates). Most of those questions have been investigated before, but the results consist mostly of statistical regularities or heuristics that still lack solid background in formal theory (i.e., there is no known and realistic formal model by which they can be explained). It should be noted that all five research questions are closely connected, with later questions building on the results obtained for earlier ones.

The **significance of the effects described above** goes beyond their importance to the theoretical study of electoral systems. Their quantitative models have an obvious significance for **institutional design**. For instance, the **tradeoff between representativeness and efficiency** is fundamental to the debate between the proponents of proportional and majoritarian systems, yet we are often unable to score various electoral systems on these scales by measuring the difference in proportionality or in legislative dispersion between, say, FPTP and the D'Hondt system, or largest remainders and STV. Our results could provide such information, thereby separating the technical issue of the properties of the various systems from fundamental political value judgments.

Other areas of theoretical applications for our research include the assessment of **predictability** of the process for translating votes into parliamentary representation (which is usually theorized to affect voter trust), **voter satisfaction**, and susceptibility to efforts aimed at **voter manipulation**. In addition, the results we expect to obtain have numerous **applications** in such fields as building **predictive electoral models** on the basis of polls, detecting **gerrymandering** and other forms of electoral bias, and modeling **counterfactuals**.

The project's main distinguishing feature lies in its unique, **highly interdisciplinary methodological approach**, involving elements of political science, mathematics, statistics, sociology, computer science, and statistical physics. We will employ methods from various fields of **applied mathematics**, including probability theory, combinatorial analysis, game theory, and approximation theory, as well as from applied computer science (**Monte Carlo simulations**).