COST Action IC1205 on Computational Social Choice: STSM Report

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During this STSM we have conducted research on multiwinner voting rules. We have initiated two projects, one focused on ℓ_p-Borda rules and one on approval-based rules with a variable number of winners.

ℓ_p-Borda rules. In this project we considered a family of committee scoring rules between k-Borda and Chamberlin–Courant's rule (CC). Let β_m be the Borda scoring function for elections with m candidates (so $\beta_m(i) = m - i$). Under the k-Borda rule, the score that a voter assigns to a committee whose members it ranks on positions $i_1, \ldots, i_k$ is $f_{k\text{-Borda}}(i_1, \ldots, i_k) = \beta_m(i_1) + \cdots + \beta_m(i_k)$. Under the Chamberlin–Courant rule, the scoring function is $f_{\mathrm{CC}}(i_1, \ldots, i_k) = \max\{\beta_m(i_1), \ldots, \beta_m(i_k)\}$. It turns out that both of these functions can be seen as extreme cases of what we defined as ℓ_p-Borda rules. For $p \geq 1$, ℓ_p-Borda uses scoring function:

$$f_{\ell_p\text{-Borda}}(i_1, \ldots, i_k) = \sqrt[p]{\beta_m^p(i_1) + \cdots + \beta_m^p(i_k)}.$$

In other words, the scoring function for ℓ_p-Borda is simply the ℓ_p norm of the Borda scores of the committee members. We obtain k-Borda for $p = 1$ and CC for $p = \infty$.

During the visit, we have analyzed how the results of ℓ_p-Borda rules change as we vary p. We observed a very surprising phase transition. For small values of p (approximately, between 1 and 5), ℓ_p-Borda rules give results very similar to those of k-Borda. Then, for p between about 6 and 16, the results are quite similar to those of the Bloc rule. For larger values, the results become very similar to those of Chamberlin–Courant (for $p \approx 50$ it is already impossible to distinguish the rules).

We have analyzed the rules using the histogram technique that we recently introduced in our joint paper (E. Elkind, P. Faliszewski, J-F. Laslier, P. Skowron, A. Slinko, N. Talmon, *What Do Multiwinner Voting Rules Do? An Experiment Over the Two-Dimensional Euclidean Domain*, AAAI-2017) and we have used the earthmover distance to compare histograms.

Approval Elections with Variable Number of Winners. In addition to the above project, we have also considered the complexity of winner determination and a type of control problem for approval-based rules with variable number of winners. (These rules are described in Marc Kilgour's paper "Approval elections with a variable number of winners" (*Theory and Decision*, 2016). We have obtained preliminary results (a few polynomial-time algorithms and NP-hardness proofs).