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# Diverse Hamiltonian Cycles

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**Abstract**

In this talk, we consider a variant of the classical Hamiltonian Cycle problem that incorporates *diversity* constraints. An instance of the problem consists of a complete graph equipped with an edge coloring, and our goal is to find a Hamiltonian cycle that maximizes the cycle's diversity, meaning that we seek a fair representation of the colors from the instance in our solution. For this purpose, we employ two diversity measures from the literature: *Richness*, that accounts for the number of distinct colors in the solution, and *Hill diversity*, that balances the frequency distribution of the colors in the solution.

We study the complexity landscape of both problems, proving that finding diverse Hamiltonian cycles is NP-hard even with very low Hill diversity requirements. For the case of Richness, we prove that the problem is equivalent to finding sufficiently large *Rainbow Linear forests* in the graph, and provide NP-hardness results and parameterized algorithms to find them. In particular, our results show that the problem is no harder than the classical Longest Path problem in terms of fixed-parameter tractability [1].

We also outline future research directions for special variants of the problem, such as when the graph is equipped with a proper edge coloring, when we seek for a properly colored Hamiltonian cycle, or when edges have weights and we aim to minimize or maximize the total weight subject to diversity constraints. These versions show interesting connections with well-established results in the literature such as Andersen's conjecture [2], the characterization by Bánkfalvi and Bánkfalvi for the existence of alternating Hamiltonian cycles in 2-edge colored graphs [3], and reconfiguration of Hamiltonian cycles [4].

Joint work with:

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