Optimizing Diversity in the Bowdoin College Tour Guide Schedule

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My project tackled a well-known computer science problem of scheduling in a Bowdoin-specific context. Scheduling problems address the need to assign certain crews to specific tasks given a list of restraints. Managing Bowdoin College’s tour guides directly corresponds to a classic scheduling problem. Bowdoin College tours are given Monday through Friday at 9:30 AM, 11:30 AM, 1:30 PM, and 3:30 PM time slots. Three tour guides are assigned to each slot which constitutes a “team.” Given a set of these slots and a set of guides with their availabilities, my project set out to make a schedule such that each slot has been assigned three tour guides, each guide is assigned to at most one slot, and to maximize a team’s diversity for each slot.

For Bowdoin College Tour Guide scheduling and optimization, the problem can be represented using graph theory techniques. In order to find an initial schedule, I implemented the Ford-Fulkerson algorithm to create a maximum-cardinality matching of a bipartite graph. In this case, a perfect matching equates to a valid tour guide schedule. The number of possible weekly schedules for the tour guides is astounding and far beyond the current capability of a modern computer to process all of these permutations. Thus it was necessary to find a locally optimal solution in order to maximize diversity in the schedule. I accomplished this by implementing local optimization techniques on the matching such as finding even cycles and swapping directed edges along the cycle’s path.

To determine whether a swap should occur, I defined specific metrics on how to measure the diversity of a team. I used eight different diversity categories in which to compare and contrast guides: major, class year, hometown, gender, ethnicity, if the guide studied abroad, if the guide went to a public or private high school, and if the guide is a varsity athlete. In one metric, a team receives a score of 1 if there exists at least one difference in all eight categories or a score of 0 if there exists at least one category where all guides are the same. Swapping guides between teams would only occur if it improved the overall diversity of the schedule.

While experimenting with different metrics, a few interesting trends appeared. If the schedule is optimized such that a team must be diverse in all eight categories, the algorithm will make it such that the final schedule will have 10 diverse teams. If each team must be diverse in only seven out of eight categories, the final schedule will contain all diverse teams. Now, consider a scenario where teams are optimized disregarding ethnicity but must be diverse in the remaining seven categories. The algorithm will produce a schedule of 17 diverse teams. In a similar manner, when disregarding class year, for example, the algorithm produces a schedule of just 11 diverse teams. This implies that ethnicity is a bottleneck for the algorithm in diversifying the tour guide schedule. Different metrics can be used to pinpoint which diversity attributes are over or underrepresented among the tour guides, which could prove useful for hiring future tour guide classes.

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