**A Linearized Approach to Improving Dickinson First-Year Seminar Assignment Program**

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**Abstract**

The first-year seminar is fundamental coursework at Dickinson College where every incoming first-year student is required to take a seminar course. In the summer before the students arrive at Dickinson, they select six seminar choices from available options. Dr. Richard Forrester developed mathematical techniques to assign the students to their selected seminar choices targeting to balance the gender and student-type ratio in each seminar course.

This study aims to enhance the performance of the first-year seminar assignment program at Dickinson College, developed by Dr. Richard Forrester. This research involves generating multiple versions of the program with enhanced features and new mathematical techniques and evaluating each to identify the most efficient program that successfully accomplishes the desired balance of gender and student-type ratios in each seminar. Furthermore, we aim to implement linearized convex quadratic programming algorithms when constructing objective functions for gender and student type to improve program runtime efficiency. The original program that was built with convex quadratic objectives took 5-6 minutes to run, and this is one of the primary aspects that I am able to contribute.

**Acknowledgments**

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**Conclusion**

We have developed three versions of Python programs that improved the original program developed by Dr. Forrester for assigning Dickinson first-year students to First-Year Seminars. The first version converted an original Mosel assignment program to a Python program using the Gurobi solver, and we discovered that the Python Gurobi solver provided better optimal and utopian points, smaller local optimal points. We then enhanced this feature by successfully normalizing the scale of objectives precisely by including nadir points in computing normalized objectives as the original program did not include nadir points. As Thanh To’s Honors research with Dr. Forrester indicated, nadir points were necessary to normalize the scales between three objective functions, which were rank, gender, and citizenship. The results displayed slightly more balanced outcomes in terms of gender and student-type distribution in the classroom. However, both of those implementations were hindered by long program run times. Therefore, we tackled this problem by linearizing the nonlinear gender and citizenship objectives. We accomplished this by replacing the quadratic sum-squared differences method to the absolute value of the differences between males and females and U.S. and international students in the classroom to construct gender and citizenship objective functions. To linearize the nonlinear absolute value function, we used a fair allocation technique introduced in operations research studies. Due to the linearized gender and citizenship objectives, the empirical analysis of these linearized objectives result in taking approximately one second to run which is a significant improvement compared to the first two versions of the program which took around five minutes to execute.