Introduction

In addressing homelessness with limited resources, it is crucial to optimize the allocation of housing interventions to maximize successful exits from homelessness. However, ensuring fairness is equally important to prevent any disproportionate benefit or disadvantage to specific sub-populations. Thus, our optimization model integrates fairness by adjusting resource distribution across various groups, aligning with the dual objectives of maximizing efficiency and promoting equity. This approach aims to enhance the effectiveness and fairness of the homeless response system, reflecting a balanced consideration of both outcomes and equity.

Procedure for Optimization Including Fairness Weight

1. **Problem Understanding and Data Collection:**
    - Collect data on households requiring housing services, including IDs, enrollment dates, sub-population identifiers, and probabilities of exiting homelessness under different interventions.
    - Gather information on the weekly availability of various housing intervention types.
2. **Optimization Setup:**
    - Define x_{ijt} as an indicator variable that represents whether household i in week t is assigned intervention j.
    - Use p_{ijt} to represent the probability that household i exits homelessness in week t if assigned intervention j.
    - Define C_{jt} as the number of available slots for intervention j in week t.
3. **Initial Optimization Problem:**
    - Formulate and solve the optimization problem to maximize the sum of probabilities p_{ijt} across all assignments, ensuring that each household is assigned to exactly one intervention per week, and the assignment does not exceed the available intervention slots.
4. **Incorporating Fairness:**
    - Introduce weights to address potential disproportionate assignments across sub-populations.
    - Define α_g as the proportion of group g in the total homeless population, based on historical data.
    - Calculate γ_{gt^*}, the proportion of group g assigned to some treatment up to time t^*, and compare it with α_g to assess disproportionality.

- Adjust the optimization objective to include a fairness term that penalizes or rewards assignments based on the difference between actual and expected proportions.

Execution, Evaluation, and Long-Term Monitoring

5. **Weekly Optimization Execution:**
    - Execute the optimization process weekly, adjusting the weights based on the previous weeks' results to improve fairness over time.
6. **Evaluation and Adjustment:**
    - At the end of a predefined period, evaluate the outcomes in terms of both the number of successful exits from homelessness and fairness across sub-populations.
    - Adjust the weight (C) based on the evaluation to better balance the trade-off between maximizing successful exits and ensuring equitable treatment allocation.
7. **Long-term Implementation and Monitoring:**
    - Implement the optimized assignment process as a standard operational procedure.
    - Continually monitor and adjust the weighting factor to respond to changes in the population or intervention effectiveness, ensuring ongoing optimization of both exit rates and fairness.