LocalSolver : Modélisation et résolution de problèmes d'optimisation difficiles

Ce sujet est inspiré d'une compétition Kaggle (https://www.kaggle.com/c/santa-workshop-tour-2019) légèrement simplifiée pour les besoins du TP.

Description

Santa has exciting news! For 100 days before Christmas, he opened up tours to his workshop. Because demand was so strong, and because Santa wanted to make things as fair as possible, he let each of the 5,000 families that will visit the workshop choose a list of dates they'd like to attend the workshop.

Now that all the families have sent Santa their preferences, he's realized it's impossible for everyone to get their top picks, so he's decided to provide extra perks for families that don't get their preferences. In addition, Santa's accounting department has told him that, depending on how families are scheduled, there may be some unexpected and hefty costs incurred.

Santa needs the help of the Kaggle community to optimize which day each family is assigned to attend the workshop in order to minimize any extra expenses that would cut into next years toy budget! Can you help Santa out?

Evaluation

Your submission is scored according to the penalty cost to Santa for suboptimal scheduling. The constraints and penalties are as follows:

- The total number of *people* attending the workshop each day must be between **125 - 300**; if even one day is outside these occupancy constraints, the submission will error and will not be scored.
- Santa provides consolation gifts (of varying value) to families according to their assigned day relative to their preferences. These sum up per family, and the total represents the $PreferenceCost$

    - `choice_0`: *no consolation gifts*
    - `choice_1`: one **$50** gift card to Santa's Gift Shop
    - `choice_2`: one **$50** gift card, and 25% off Santa's Buffet (value **$9**) for each family member
    - `choice_3`: one **$100** gift card, and 25% off Santa's Buffet (value **$9**) for each family member
    - `choice_4`: one **$200** gift card, and 25% off Santa's Buffet (value **$9**) for each family member
    - `choice_5`: one **$200** gift card, and 50% off Santa's Buffet (value **$18**) for each family member

    - `choice_6`: one **$300** gift card, and 50% off Santa's Buffet (value **$18**) for each family member
    - `choice_7`: one **$300** gift card, and free Santa's Buffet (value **$36**) for each family member
    - `choice_8`: one **$400** gift card, and free Santa's Buffet (value **$36**) for each family member
    - `choice_9`: one **$500** gift card, and free Santa's Buffet (value **$36**) for each family member, and 50% off North Pole Helicopter Ride tickets (value **$199**) for each family member
- Santa's accountants have also developed an empirical equation for cost to Santa that arise from many different effects such as reduced shopping in the Gift Shop when it gets too crowded, extra cleaning costs, a very complicated North Pole tax code, etc. This cost in in addition to the consolation gifts Santa provides above, and is defined as:

$$accountingPenalty = \sum_{d=100}^{1} \frac{(N_d - 125)}{400} N_d^{(\frac{1}{2} + \frac{|N_d - N_{d+1}|}{50})}$$

where N_d is the occupancy of the current day, and N_{d+1} is the occupancy of the *previous* day (since we're counting backwards from Christmas!). For the initial condition of $d = 100$, $N_{101} = N_{100}$.

.To be clear on the above summation, it starts on the date 100 days before Christmas and ends on Christmas Eve.

And finally :

$$score = preferenceCost + accountingPenalty$$

Your task is to schedule the families to Santa's Workshop in a way that minimizes the penalty cost to Santa

Data

Each family has listed their top 10 preferences for the dates they'd like to attend Santa's workshop tour. Dates are integer values representing the days *before* Christmas, e.g., the value 1 represents Dec 24, the value 2 represents Dec 23, etc. Each family also has a number of people attending `n_people`.

Every family must be scheduled for one and only one `assigned_day`.