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Optimization of nurse self-scheduling at TriHealth Good Samaritan Hospital

Abstract:

In this paper, we explore an optimization model that is intended to reduce the amount of time it takes a nurse manager to balance nurse self-scheduling requests with hospital requirements. This case study uses a specific department at TriHealth's Good Samaritan Hospital (GSH) in Cincinnati for initial data and business rules. This department is one of several chosen to prototype self-scheduling.

We will show that linear optimization will work within the confines of existing work processes at TriHealth, and within the limitations of their scheduling software. Our case study uses real data from one scheduling period - imperfect data - and then we show 3 additional examples designed to force the model to make the best choice given their constraints and objective.

The timing of this project was perfect; the chief nursing officer stopped the rollout of self - scheduling until a solution could be found to reduce the balancing time. We believe we have proof-of-concept ready for the next step.

"We understand that this project report is optional for extra credit, that the amount of points awarded by this submission is solely determined by the instructor assessment, and that no requests for regrading or complaints about the number of extra points awarded will be admitted."

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1. Introduction

Why does TriHealth care about nurse self – scheduling?
A survey conducted in 2020 by the American Nurses Association's (ANA) [1] found that 71% of the 22,316 respondents felt overwhelmed due to the COVID-19 crisis and its negative effect on their physical and mental health. 47 % of those nurses who were surveyed stated that they plan to leave the nursing profession. The study further noted that 45 % of nurses surveyed planned to leave the nursing profession due to insufficient staffing ratios.

Certainly, this is not an easy problem to solve and we would be naive to think that there is a simple, one solution answer. A literature review by Koning, C [5] explored nurse job satisfaction and found that self-scheduling was *one of many factors* that impacted job satisfaction, but it also stated that *maintaining this type of program was challenging.*

This is precisely what is happening at TriHealth. In October 2020, a few nursing departments at GSH were selected to prototype a new self – scheduling feature available in TriHealth's scheduling software, Kronos©. The self - scheduling feature allows nurses to digitally enter their preferred shifts, vacations, and unavailable time, *every six weeks*. This functionality is a big win for the nurses: they love the autonomy and flexibility for modifying their schedules for each scheduling period.

However, the software does not have a lot of validation or hard-stops to ensure nurses are following agreed-to business rules for "fairly" covering undesirable days and ensuring that they have the correct number of shifts. Thus, the nurse manager must spend significant time reviewing the requests to ensure that all nurses are working the required number of Monday's, Friday's, weekends, etc. Our analytics department believes this is a great application for optimization, and this became the motivation for this project.

Unlike other optimization projects which start with a "blank page", this one is meant to be interleaved into TriHealth's current work processes for self – scheduling, because we don't have the option to change them. We also don't have the option to purchase new software. Thus, we plan to take these "givens" and find a solution that will work with what we have.

Let's start with a definition of Self – Scheduling.

Self-scheduling is the *optional* act of entering your preference:
- to work certain shifts on specific days
- to take vacation on a specific days (paid)
- to designate "unavailable time" on specific days (not paid, aka, " I prefer not to work on Tues Dec 14 ")

Balancing

Nurses have a few days to enter their requests, and immediately following this self-scheduling period, managers have approximately 1 week to balance the schedule.
This balancing involves:
(a) manually adding shifts for nurses that did not self-schedule at all, or partially self-scheduled.
(b) approving/denying vacation requests.
(c) checking to make sure all nurses are working the required number of: Sundays, Mondays, etc.
(d) ensuring that supply meets the demand.

Each scheduling period is 6 weeks. The process has a built in "fairness" methodology as follows:

- Nurses are divided into 3 groups, A,B,C.
- For any scheduling period, one of those groups will have first preference to self-schedule. The second group has a timeline after the first group to self-schedule and can only pick up shifts where the demand has not

been met by the first group. The third group has a timeline after the second group and can only schedule for remaining/leftover shifts.

- To ensure fairness, each group A,B,C will get the chance to schedule first, second, third an equal number of times throughout the year.

What can go wrong? How can optimization help?

Because self-scheduling is optional, the manager must first manually tally the number of shifts their nurses scheduled and subtract from what they need to meet basic contracted hours each week. The manager must manually enter the missing shifts into Kronos while simultaneously considering vacation requests that all of the nurses entered, to ensure that supply >= demand for that shift. Further, nurses can specify up to 3 unavailable days for each scheduling period; the software does not prevent nurses from adding more than 3, so the manager must manually disregard extraneous requests. The manager must strive to work – around those unavailable days and not schedule that nurse on that day if possible.

2. Literature Review

In the domain of operations research, the Nurse Scheduling Problem (NSP) has been well researched for the past 30 years [11]. Various methods have been used to solve NSP: linear programming, integer programming, and goal programming methods, to name a few. At first glance, this problem seems rather straightforward, as it is essentially a supply and demand problem: each department in a hospital has an ideal nursing : staff ratio that works well from a patient satisfaction standpoint as well as meets the financial obligations in the accounting office.

However, considering our current environment, it is critical that we pay attention to job satisfaction of nurses, their perception of being treated fairly, and their engagement in their own self – determination. Thus, we limited our research to specific studies that intersected these considerations.

1. Nurses indicate preferred shifts each scheduling period
2. Nurses rank order preferred vacation days
3. Nurses select preferred vacation days, no ranking
4. Survey used to understand nurse preferences and to factor findings into model
5. Skill level of nurses is taken into consideration
6. Must work minimum number of shifts
7. Maximum shifts can't be exceeded in given period
8. Nurses rotate shifts (day, night) and restrictions on rest in between rotations is considered
9. Specification of a certain number of male nurses
10. Must have minimum days off between consecutive shifts
11. Hard and soft constraints
12. Specification that nurse must work certain number of "undesirable" days, like weekends
13. Accounts for non – shift work counting toward core hours, like education.

We specifically call out DeGrano's research as it gave inspiration for the approach used in this paper. DeGrano used an auctioning & bidding system to apply weight to nurse's preferences. In that model, nurses start with a certain number of points and then they apply those points to weight preferences. In our model, we don't have the software functionality to get that granular, however, we grant points to nurses per the group they are assigned.

	1	2	3	4	5	6	7	8	9	10	11	12	13
Rerkjirattikal P, Goal Programming	X	X		X	X	X	X	X		X			
Ariyani, Goal Programming					X	X	X	X	X	X	X		
Legrain, Branch and Price					X	X	X	X		X	X		
DeGrano, Auctioning	X	X				X	X					X	x
Ronnberg, Swiss Self Sched	X	X			X	X	X				X	X	X

3. Methodology

Assumptions and Business Rules:
(a) Nurses typically work the same shifts. This optimization only considers the 12-hour day shift, 7am – 7 pm.
(b) We will assume group 1 has first preference, group 2 second preference, group 3 third preference. Nurses are assigned points corresponding their group assignment.
(c) The shift period begins on Sunday
(d) Having *more* nurses than needed for a shift is not an issue. TriHealth is contractually bound to provide nurses with their core hours each week even if it means there are more nurses working than required.
(e) If a nurse is denied his/her request excessively, even if it's mathematically legitimate, and this "shuffling" exceeds a certain threshold, we can give that nurse more priority in the next scheduling period.

3.1 Model Notation

Sets

I : days in scheduling horizon, $i \in I = \{1,2,3,\ldots,42\}$
W : weeks in scheduling horizon, $w \in W = \{1,2,3,\ldots,6\}$

G : set of groups that nurses belong to, $g \in G = \{1,2,3\}$
J : set of nurses $j \in J = \{1,2,3,\ldots,10\}$
g_j : subset of nurses j belonging to each group g
w_i : subset of days i belonging to week w. $w_1=\{1,2,3..,7\}$, $w_2=\{8,9,10,..14\}$, etc.
m : subset of Mondays in set of days , $m = \{2,9,16,23,30,37\} \in I$ (Ex: Day 2 of schedule is a Monday)
f : subset of Fridays in set of days , $f = \{6,13,20,27,34,41\} \in I$
sa : subset of Saturdays , $sa = \{7,14,21,28,35,42\} \in I$
su : subset of Sundays, $su = \{1,8,15,22,29,36\} \in I$
jr : subset of nurses that are junior (less experience) , $jr \in J$
sr : subset of nurses that are senior (more experience), $sr \in J$

Data

NR_i : nurse requirement (demand) for day I, integer :

Y_{ji} : binary, 1 if nurse j self-scheduled to work shift on day i, else 0

U_{ji} : binary, 1 if nurse j is unavailable on day i, else 0

V_{ji} : binary, 1 if nurse j is unavailable on day i, else 0

H_j : integer indicating additional weighting to correct for historical anomaly for nurse j , default is 1

P_j : points (weighting factor) allocated to nurse j

3.2 Decision Variable

X_{ji} : binary, 1 if nurse j is scheduled to work shift on day i, 0 otherwise

3.3 Objective function

Maximize nurse preferences; penalize forcing nurse to work on days he/she did not want to work

Maximize $\sum_j \sum_i (H_j * P_j * Y_{ji} * X_{ji}) - (H_j * P_j * V_{ji} * X_{ji}) - (H_j * P_j * U_{ji} * X_{ji}) + X_{ji}$

Example Nurse 1 is assigned 10000 points, (group 1). She self-schedules to *work* on day 1, (Y=1). Assume X=1
Nurse 3 is assigned 5000 points, (group 2). He self-schedules *vacation* on day 1, (V=1). Assume X=1
Nurse 9 is assigned 2500 points, (group 3). She self-schedules an *unavailable* day, (U=1). Assume X=1

Nurse 1: $(1 * 10000 * 1 * 1) - (1 * 10000 * 0 * 1) - (1 * 10000 * 0 * 1) + 1 = 10001$
Nurse 3: $(1 * 5000 * 0 * 1) - (1 * 5000 * 1 * 1) - (1 * 5000 * 0 * 1) + 1 = -4999$
Nurse 9: $(1 * 2500 * 0 * 1) - (1 * 5000 * 0 * 1) - (1 * 5000 * 1 * 1) + 1 = -2499$

The total points for Day 1 = 2503

3.3 Constraints

3.3.1 Satisfy daily demand. For each day, i, sum up all nurses j to get count of nurses

$$\sum_j X_{ji} >= NR_i \ \forall \ i \in I$$

3.3.2 Nurses are contracted to work (or be on vacation) 36 hours/wk, or, 3 shifts.
(Note, if scheduled to work on a vacation day, we must subtract that shift so not double-counted)

$$\sum_i X_{ji} + \sum_i V_{ji} - (X_{ji} * V_{ji}) <= 3 \quad \forall i \text{ in } w_i \ \forall j \text{ in } J$$

3.3.3 Nurses must work two Mondays in a 6-week period

$$\sum_j \sum_i X_{ji} >= 2 \ \forall \ i \in m$$

3.3.4 Nurses must work two Fridays in a 6-week period

$$\sum_j \sum_i X_{ji} >= 2 \ \forall \ i \in f$$

3.3.5 Nurses must work two Saturdays in a 6-week period

$$\sum_j \sum_i X_{ji} \quad >= 2 \quad \forall\, i \in sa$$

3.3.6 Nurses must work two Sundays in a 6-week period

$$\sum_j \sum_i X_{ji} \quad >= 2 \quad \forall\, i \in su$$

3.3.7 There must 2 or more senior nurses for every junior nurse working that day

$$\sum_j X_{ji} \quad \forall\ i \text{ in } I,\ \forall_j \text{ in } sr \ >= \quad \sum_j 2 * X_{ji} \quad \forall\ i \text{ in } I,\ \forall_j \text{ in } jr$$

4. Model Validation

We used Python vs 3.6 and the PuLP package. Coding was done using Jupyter Notebook IDE. The data file is included, and screenshots of the code is in Appendix. All scenarios ran in negligible time.
Each nurse is identified by their group assignment and number: Group_1_12295.

Scenario 1: "Real Data" - this actual data for shift period 10/25/21 to 12/4/21. This data includes requests for shifts, vacation & unavailable time.	Comments
day sum_shifts sum_Mon sum_Fri sum_Sat sum_Sun group_empid Group_1_12295 18.0 2.0 2.0 3.0 3.0 Group_1_31300 18.0 3.0 2.0 2.0 2.0 Group_1_31407 17.0 2.0 3.0 2.0 2.0 Group_1_38368 18.0 2.0 2.0 4.0 4.0 Group_1_59561 15.0 2.0 2.0 2.0 3.0 Group_2_105865 18.0 2.0 3.0 4.0 2.0 Group_2_14581 18.0 3.0 5.0 2.0 2.0 Group_2_36587 18.0 4.0 2.0 2.0 2.0 Group_3_18182 18.0 2.0 4.0 2.0 2.0 Group_3_99263 18.0 3.0 2.0 2.0 2.0	Each nurse should work 3 shifts each of 6 weeks = 18shifts. Two nurses did not get 18 shifts because one had one day vacation, and the other had 3 vac days. All worked at least 2 Sun, Mon, Fri, Sat
Min. #nurses working per model for days when demand must be >=3 : 3.0 Min. #nurses working per model for days when demand must be >=4 : 4.0	Demand was met for all 42 days
Junior nurse count =2 Day18 2.0 Day24 2.0 Day30 2.0 Day41 2.0 Senior nurse count >=4 nurses Day5 4.0 Day8 4.0 Day9 4.0 Day11 4.0 Day13 4.0 Day18 4.0 Day19 4.0 Day21 4.0 Day24 5.0 Day28 4.0 Day29 4.0 Day30 4.0 Day35 4.0 Day39 4.0 Day40 5.0 Day41 4.0	The minimum demand on any day is 3 nurses, and we only have 2 junior nurses, so we only need to verify that on days when there are 2 junior nurses (18,24,30,41) we have at least 4 senior nurses. This is validated.

Scenario 1: "Real Data" - this actual data for shift period 10/25/21 to 12/4/21. This data includes requests for shifts, vacation & unavailable time.	Comments
Unavailable days group_empid 1 2 3 4 5 6 7 8 9 10 11 Group_1_12295 0 0 1 1 0 0 1 1 0 0 0 Group_1_31300 0 0 0 1 1 0 1 1 0 1 1 Group_1_31407 1 1 0 1 0 0 0 0 0 0 1 Group_1_38368 1 0 0 0 1 0 1 1 1 1 0 Group_1_59561 0 0 0 0 0 0 0 1 1 0 1	Nurse 12295 self – scheduled to be unavailable on Day 2,6,11. Nurse 59561 self – scheduled to be unavailable on Day 4. On the left we see the output from the model. The model chose to NOT make the nurses work those days.

Scenario 2: "Same Request" – all nurses self-scheduled to work on the first 3 days of each week (Sun, Mon, Tues) Validation	Comments
day sum_shifts sum_Mon sum_Fri sum_Sat sum_Sun group_empid Group_1_12295 18.0 5.0 2.0 2.0 5.0 Group_1_31300 18.0 3.0 2.0 2.0 6.0 Group_1_31407 18.0 4.0 2.0 2.0 5.0 Group_1_38368 18.0 6.0 2.0 2.0 3.0 Group_1_59561 18.0 4.0 2.0 2.0 5.0 Group_2_105865 18.0 2.0 2.0 4.0 2.0 Group_2_14581 18.0 3.0 3.0 2.0 2.0 Group_2_36587 18.0 2.0 4.0 3.0 2.0 Group_3_18182 18.0 2.0 2.0 3.0 2.0 Group_3_99263 18.0 2.0 3.0 2.0 2.0	All nurses are working 18 shifts. All worked at least 2 Sun, Mon, Fri, Sat
Min. #nurses working per model for days when demand must be >=3 : 3.0 Min. #nurses working per model for days when demand must be >=4 : 4.0	Demand was met for all 42 days
Junior nurse count =2 Senior nurse count >=4 nurses Series([], dtype: float64	There were no days when 2 junior nurses were assigned, hence we meet the criteria.

Scenario 3: "Same Vacation Day" – In week1, all nurses self-scheduled vacation on Day1, and self-scheduled work on Day2,3. Subsequent weeks they all chose to work the first 3 days of week (Sun, Mon,Tues) like the previous scenario. Validation	Comments
day sum_shifts sum_Mon sum_Fri sum_Sat sum_Sun group_empid Group_1_12295 17.0 5.0 2.0 2.0 4.0 Group_1_31300 17.0 3.0 2.0 2.0 5.0 Group_1_31407 17.0 3.0 2.0 2.0 5.0 Group_1_38368 17.0 6.0 2.0 2.0 3.0 Group_1_59561 17.0 4.0 2.0 2.0 4.0 Group_2_105865 18.0 2.0 2.0 5.0 2.0 Group_2_14581 17.0 3.0 3.0 2.0 2.0 Group_2_36587 18.0 2.0 4.0 2.0 2.0 Group_3_18182 18.0 2.0 2.0 3.0 2.0 Group 3 99263 18.0 2.0 3.0 2.0 2.0 Min. #nurses working per model for days when demand must be >=3 : 3.0 Min. #nurses working per model for days when demand must be >=4 : 4.0 Junior nurse count =2 Series([], dtype: float64 Senior nurse count >=4 nurses	All nurses in Group 1 are working 17 shifts because they were granted their requested vacation day. One nurse in Group 2 was granted vacation. All nurses in Group 3 were denied vacation to meet the constraints, thus they each have 18 working shifts. All worked at least 2 Sun, Mon, Fri, Sat Demand was met for all 42 days There were no days when 2 junior nurses were assigned, hence we meet the criteria.

Scenario 4: Identical to "Same Vacation Day" with additional points for nurse 105865 because in the past 6 weeks, they crossed the allowable threshold of being shuffled. In this scenario, they receive 3 times the number of points. Validation	Comments

day	sum_shifts	sum_Mon	sum_Fri	sum_Sat	sum_Sun
group_empid					
Group_1_12295	17.0	5.0	2.0	2.0	3.0
Group_1_31300	17.0	2.0	3.0	2.0	4.0
Group_1_31407	17.0	3.0	2.0	3.0	4.0
Group_1_38368	17.0	6.0	2.0	2.0	3.0
Group_1_59561	18.0	5.0	3.0	2.0	4.0
Group_2_105865	17.0	4.0	2.0	2.0	4.0
Group_2_14581	17.0	4.0	2.0	3.0	3.0
Group_2_36587	18.0	2.0	2.0	2.0	2.0
Group_3_18182	18.0	2.0	2.0	3.0	2.0
Group_3_99263	18.0	2.0	4.0	3.0	2.0

We see the same results as above, except, nurse 105865 was granted vacation and one nurse in Group 1 was forced to work.

```
Min. #nurses working per model for days when demand must be >=3 : 3.0
Min. #nurses working per model for days when demand must be >=4 : 4.0
```

Demand was met for all 42 days

Junior nurse count =2

day	
Day37	2.0

Senior nurse count >=4

day	
Day8	6.0
Day9	4.0
Day10	4.0
Day15	4.0
Day16	5.0
Day17	5.0
Day22	4.0
Day23	6.0
Day24	4.0
Day29	4.0
Day30	5.0
Day31	5.0
Day36	5.0
Day37	6.0

On Day37 we have 2 junior nurses working, and 6 senior nurses which meets the 2:1 ratio.

5. Results

Scenario 1: “Real Data” - this used actual data for the shift period 10/25/21 to 12/4/21.

Excerpt for first two weeks

group_empid	Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	Day9	Day10	Day11	Day12	Day13	Day14
Group_1_12295	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Group_1_31300	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Group_1_31407	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Group_1_38368	1	0	0	0	0	0	0	0	1	0	0	0	0	0
Group_1_59561	0	0	0	0	0	0	-1	0	1	0	0	0	0	0
Group_2_105865	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Group_2_14581	0	0	0	0	0	1	0	0	0	1	0	0	0	0
Group_2_36587	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Group_3_18182	0	0	0	0	0	0	0	0	1	0	0	-1	0	0
Group_3_99263	0	-1	0	0	0	0	1	0	0	0	0	0	0	0

The max points for this scheduling period: 947676.0

Interpretation

In a perfect case, this result matrix would show 0’s only, which would indicate that the model matched every instance of nurse requests: the nurse request is a “1” and the model assigns a “1” so the difference is 0 and we have a perfect match.

Legend:

“1” indicates the model assigned the nurse a shift where the nurse did not have it requested. (1 – 0 = 1)

“ -1 “ indicates the nurse requested a shift and model did not agree. (0 – 1 = -1)

Net, typically, if you see “1” you would expect to see a **-**1, indicating the nurse was moved from his/her request to another day. Since that is “double counting” the adjustment, we have only chosen to highlight 1 and not both.

Consider two exceptions to what we expect to see:

“Group_1_31407”: We see on Day1 and Day14 the model assigned the nurse to work, and we don’t see a corresponding “ -1 “ in that same week. This is because this nurse did not self-schedule all their shifts, so the model assigned the additional shift to ensure the nurse met core hour requirements. In this “Real Data” scenario, this occurred frequently as you can see from this two-week excerpt.

“Group_1_59561”: We see one “ -1” and no corresponding “1”. This nurse requested vacation on Day1,2,3 and then requested to work Day7 which would have exceeded core hours. The model accurately removed the nurse from that shift.

On a macro level we can see the adjustments made for all nurses over 42 days. Group 1 should have gotten preference and hence we would expect to see fewer highlights, however, as we have seen, this is real data and not all nurses chose to self-schedule, thus, it is hard to discern if the model is giving preference to Group 1. Thus, the following scenarios are intended to validate this.

group_empid	ay	ay	ay	ay	ay	ay	ay	ay	ay	ay1	ay1	ay1	ay1	ay1	ay1	ay1	ay1	ay1	ay1	ay2	ay2	ay2	ay2	ay2	ay2	ay2	ay2	ay2	ay2	ay3	ay3	ay3	ay3	ay3	ay3	ay3	ay3	ay3	ay3	ay4	ay4	ay4
Group_1_12295	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Group_1_31300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	1	0	0	0	0	0	0	0	0
Group_1_31407	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Group_1_38368	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Group_1_59561	0	0	0	0	0	0	-1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Group_2_105865	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	1	0	0	0	1	1	1	0	0	1	0	0	0	0	1	1	0	1	0	0	0	1
Group_2_14581	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
Group_2_36587	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	1	0	0	0	0	0	0	0	0
Group_3_18182	0	0	0	0	0	0	0	0	1	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	-1	0	0	0	0	0	0	0	0	0	0
Group_3_99263	0	-1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	1	0

Results

Scenario 2: “Same Request” - all nurses self-scheduled to work on the first 3 days of each week (Sun, Mon, Tues)

Excerpt for first two weeks:

group_empid	Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	Day9	Day10	Day11	Day12	Day13	Day14
Group_1_12295	0	0	0	0	0	0	0	-1	-1	0	0	0	1	1
Group_1_31300	0	-1	0	0	0	0	1	0	-1	-1	0	0	1	1
Group_1_31407	0	-1	0	0	0	0	1	0	0	0	0	0	0	0
Group_1_38368	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Group_1_59561	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Group_2_105865	-1	-1	-1	1	1	1	0	-1	-1	-1	1	1	0	1
Group_2_14581	-1	-1	0	0	1	0	1	0	-1	0	0	0	1	0
Group_2_36587	-1	0	-1	1	0	1	0	-1	-1	-1	0	1	1	1
Group_3_18182	-1	-1	-1	0	1	1	1	0	0	-1	1	0	0	0
Group_3_99263	0	-1	-1	1	0	1	0	-1	0	-1	1	1	0	0

The max points for this scheduling period : 810180.0

Interpretation:

Compared to Scenario 1, our point value has decreased because more adjustments had to be made to meet all the constraints. We can already see in the first two weeks that Group 1 has the fewest changes. Interestingly, one nurse in Group 3 (99263) was granted their request on Day1; ahead of the 3 nurses in Group 2. This nurse is a junior nurse; since Group 1 has 5 nurses working, presumably, this was a good day to assign the two junior nurses to meet the 2:1 ratio.

On a macro level, we see Group 2 and 3 receiving the bulk of adjustments.

Group 1: Each had 4 changes.

Group 2: One had 8 changes, 2 had 14.

Group 3: Each had 14 changes

group_empid	Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	Day9	Day10	Day11	Day12	Day13	Day14	Day15	Day16	Day17	Day18	Day19	Day20	Day21	Day22	Day23	Day24	Day25	Day26	Day27	Day28	Day29	Day30	Day31	Day32	Day33	Day34	Day35	Day36	Day37	Day38	Day39	Day40	Day41	Day42	Count #1
Group_1_12295	0	0	0	0	0	0	0	-1	-1	0	0	0	1	1	1	0	0	-1	0	0	0	1	0	0	0	0	0	0	0	0	0	-1	0	0	1	0	0	0	0	0	0	0	4
Group_1_31300	0	-1	0	0	0	0	1	0	-1	-1	0	0	1	1	0	-1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Group_1_31407	0	-1	0	0	0	0	1	0	0	0	0	0	0	0	-1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	0	0	1	1	0	0	0	4
Group_1_38368	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	1	0	-1	0	0	0	0	0	1	-1	0	0	0	0	0	0	1	0	0	-1	0	0	1	4
Group_1_59561	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	1	0	-1	0	0	0	1	0	-1	0	0	0	0	1	0	0	0	-1	0	0	0	1	0	4
Group_2_105865	-1	-1	-1	1	1	1	0	-1	-1	-1	1	1	0	1	0	0	-1	0	1	0	0	-1	-1	-1	1	0	1	1	0	-1	-1	0	1	0	1	-1	0	-1	1	0	0	1	14
Group_2_14581	-1	-1	0	0	1	0	1	0	-1	0	0	1	0	-1	0	0	1	0	0	0	0	0	-1	0	0	1	0	-1	0	0	0	0	0	1	-1	-1	0	1	0	1	0		8
Group_2_36587	-1	0	-1	1	0	1	0	-1	-1	-1	0	1	1	1	0	-1	-1	1	0	0	1	-1	-1	-1	0	1	1	1	-1	0	-1	1	1	0	0	0	-1	-1	0	1	1	0	14
Group_3_18182	-1	-1	-1	0	1	1	1	0	0	-1	1	0	0	0	0	-1	-1	1	1	0	0	-1	0	-1	1	1	0	0	-1	-1	-1	1	0	1	1	-1	-1	-1	1	1	0	1	14
Group_3_99263	0	-1	-1	1	0	1	0	-1	0	-1	1	1	0	0	-1	-1	-1	0	1	1	1	-1	-1	-1	1	1	0	1	-1	-1	-1	1	1	1	0	0	0	-1	0	1	0	0	14

Results

Scenario 3: "Same Vacation Day" In week1, all nurses self-scheduled vacation on Day1, and self-scheduled work on Day2,3. Subsequent weeks they all chose to work the first 3 days of week (Sun, Mon,Tues) like the previous scenario.

Excerpt for first two weeks:

group_empid	Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	Day9	Day10	Day11	Day12	Day13	Day14
Group_1_12295	0	0	0	0	0	0	0	-1	0	-1	0	0	1	1
Group_1_31300	0	-1	0	0	0	1	0	0	-1	-1	0	0	1	1
Group_1_31407	0	-1	-1	0	0	1	1	0	0	0	0	0	0	0
Group_1_38368	0	0	-1	0	0	0	1	0	0	0	0	0	0	0
Group_1_59561	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Group_2_105865	1	-1	-1	1	1	0	0	-1	-1	-1	1	1	0	1
Group_2_14581	0	-1	-1	0	1	0	1	0	-1	0	0	0	1	0
Group_2_36587	1	-1	-1	1	0	1	0	-1	-1	0	0	0	1	1
Group_3_18182	1	-1	-1	0	1	0	1	0	0	-1	0	1	0	0
Group_3_99263	1	-1	-1	1	0	1	0	-1	0	-1	1	1	0	0

The max points for this scheduling period is: 730174.0

Interpretation: There is only one difference between the previous scenario and this one – the addition of the vacation day request for all nurses on Day1. We see the point value drop because now the model has fewer nurses to distribute over all of the days to meet the demand, and, fewer choices to meet each individual nurse constraints. All nurses in Group 1 were granted vacation, and one in Group 2, which happens to be a junior nurse (14581). Nurse 14581 could not be assigned to work because there was already a junior nurse assigned on this day (99263) and one more junior would not have met the 2:1 criterion.

On a macro level, we see Group 2 and 3 receiving the bulk of adjustments.
Group 1: Each had 4 changes.
Group 2: One had 8 changes, 1 had 13, and 1 had 14. * one less change than the scenario above
Group 3: Each had 14 changes

group_empid	Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	Day9	Day10	Day11	Day12	Day13	Day14	Count #1
Group_1_12295	0	0	0	0	0	0	0	-1	0	-1	0	0	1	1	4
Group_1_31300	0	-1	0	0	0	1	0	0	-1	-1	0	0	1	1	4
Group_1_31407	0	-1	-1	0	0	1	1	0	0	0	0	0	0	0	4
Group_1_38368	0	0	-1	0	0	0	1	0	0	0	0	0	0	0	4
Group_1_59561	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Group_2_105865	1	-1	-1	1	1	0	0	-1	-1	-1	1	1	0	1	14
Group_2_14581	0	-1	-1	0	1	0	1	0	-1	0	0	0	1	0	8
Group_2_36587	1	-1	-1	1	0	1	0	-1	-1	0	0	0	1	1	13
Group_3_18182	1	-1	-1	0	1	0	1	0	0	-1	0	1	0	0	14
Group_3_99263	1	-1	-1	1	0	1	0	-1	0	-1	1	1	0	0	14

Results

Scenario 4: Same as “Same Vacation Day” with additional points for nurse 105865 because in the past 6 weeks, they crossed the allowable threshold of being shuffled. In this scenario, they receive 3 times the number of points.

Excerpt for the first two weeks

group_empid	Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	Day9	Day10	Day11	Day12	Day13	Day14
Group_1_12295	0	0	0	0	0	0	0	-1	0	-1	0	0	1	1
Group_1_31300	0	-1	-1	1	0	0	1	0	-1	-1	0	0	1	1
Group_1_31407	0	-1	-1	0	1	0	1	0	0	0	0	0	0	0
Group_1_38368	0	0	-1	0	0	1	0	0	0	0	0	0	0	0
Group_1_59561	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Group_2_105865	**0**	**-1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Group_2_14581	0	-1	-1	0	1	0	1	0	-1	-1	1	0	1	0
Group_2_36587	1	-1	-1	1	0	1	0	-1	-1	-1	0	1	1	1
Group_3_18182	1	-1	-1	0	1	0	1	0	-1	-1	1	1	0	0
Group_3_99263	1	-1	-1	1	0	1	0	-1	0	-1	0	1	0	1

The max points for this scheduling period is: 820174.0

Interpretation: Our point value now is higher than all of the scenarios except the first one, “Real Data”. This is expected, as every time nurse 105865 is granted their request, 3x points are awarded in the objective function. We see that in the first 2 weeks nurse 105865 is doing better than most of Group 1.

On a macro level, we see nurse 105865 having the best result of all nurses, with only 4 changes.

group_empid	Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	Day9	Day10	Day11	Day12	Day13	Day14	Day15	Day16	Day17	Day18	Day19	Day20	Day21	Day22	Day23	Day24	Day25	Day26	Day27	Day28	Day29	Day30	Day31	Day32	Day33	Day34	Day35	Day36	Day37	Day38	Day39	Day40	Day41	Day42	Count #1
Group_1_12295	0	0	0	0	0	0	0	-1	0	-1	0	0	1	1	0	0	-1	0	0	0	1	0	0	0	0	0	0	0	0	0	-1	0	1	0	0	-1	0	0	0	0	1	0	5
Group_1_31300	0	-1	-1	1	0	0	1	0	-1	-1	0	0	1	1	0	-1	0	1	0	0	0	-1	0	0	0	0	1	0	0	-1	0	0	0	1	0	0	0	0	0	0	0	0	7
Group_1_31407	0	-1	-1	0	1	0	1	0	0	0	0	0	0	0	-1	0	0	0	0	1	0	0	0	0	0	0	0	0	-1	0	0	0	0	1	0	-1	-1	0	0	1	1		6
Group_1_38368	0	0	-1	0	0	1	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	1	-1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	-1	0	0	1	0		4
Group_1_59561	1	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	0	0	0	1	1	0	0	-1	0	0	1	0	-1	0	0	0	0	1	0	0	0	-1	0	0	0	1	6
Group_2_105865	**0**	**-1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-1**	**-1**	**0**	**0**	**1**	**1**	**-1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**
Group_2_14581	0	-1	-1	0	1	0	1	0	-1	-1	1	0	1	0	0	0	-1	1	0	0	0	0	0	-1	0	0	0	1	-1	0	-1	0	1	0	1	-1	0	-1	1	0	1	0	10
Group_2_36587	1	-1	-1	1	0	1	0	-1	-1	-1	0	1	1	1	0	-1	-1	1	1	0	0	-1	-1	-1	1	1	0	1	-1	0	-1	1	1	0	0	-1	0	-1	1	1	0	0	15
Group_3_18182	1	-1	-1	0	1	0	1	0	-1	-1	1	1	0	0	-1	0	-1	0	1	1	0	-1	0	-1	1	1	0	0	-1	-1	-1	1	0	1	1	-1	-1	-1	1	1	0	1	15
Group_3_99263	1	-1	-1	1	0	1	0	-1	0	-1	0	1	0	1	-1	-1	-1	0	1	1	1	-1	-1	-1	1	1	1	0	0	-1	-1	1	0	1	0	-1	0	-1	0	1	0	1	15

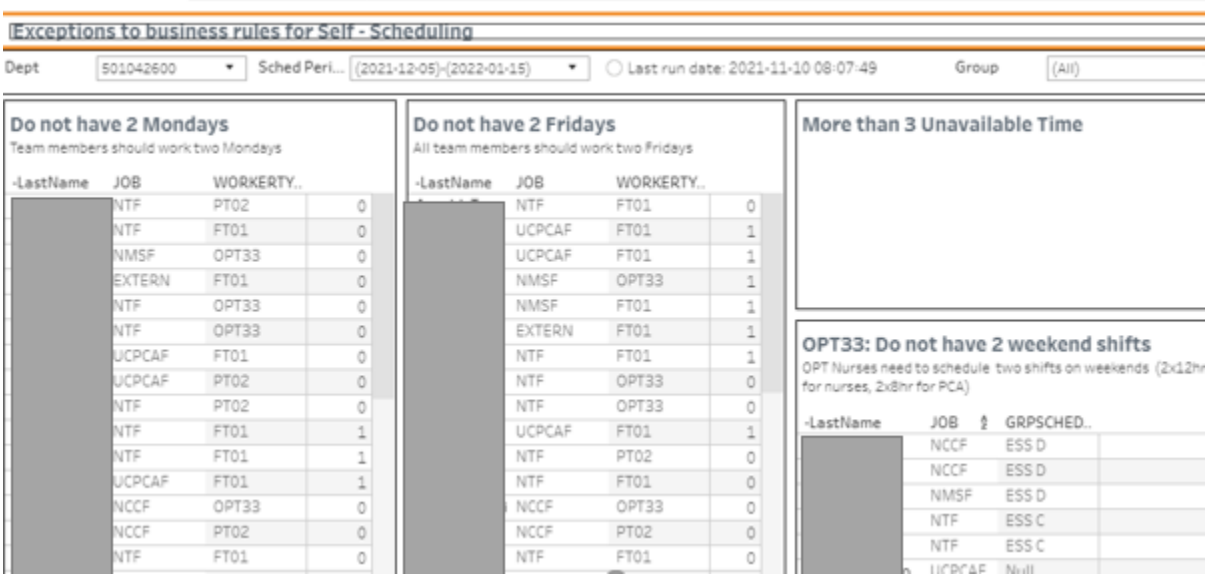
6. Model Conclusions

In this proof-of-concept study, we have demonstrated that a linear programming optimization model can accurately balance nurse preferences and hospital hard constraints. Using a point system to award and penalize, this model strove to give Group 1 their requests. We included hard constraints that were *systemic* - meeting the demand for nurses each day - as well as those that were very specific to each nurse, like working at least two Monday's. In addition, we have accounted for anomalies if a nurse was excessively shuffled in a previous scheduling period, (even though it may have been mathematically legitimate). Importantly, when we look at the results, we see that they are explainable. Using such a model not only removes the manual burden from nurse managers, but it takes subjectivity out of the equation.

As we look these results, we see opportunity for improvement.

- First, sometimes the model had to choose between two nurses in the same group with the exact same preferences. We could add additional constraints that nurses with more seniority, or a higher skill level, would be chosen first.
- We also observed that junior nurses sometimes trumped senior nurses because of the 2:1 ratio needed. We would like to discuss this with our customer to see if there are some other options as this might not seem fair to senior nurses.
- Finally, it is critical that we have good data coming into an optimization model. If nurses were encouraged/reminded to self-schedule, and there were validation checks in the software to ensure that hard constraints were met, then the optimization would be able to award more preferences and nurses expectations would align with the reality of their assignments.

Below is a dashboard that I (Delores) specifically created for this project, to alert the nurse managers of exceptions to the business rules. These insights will soon start feeding an automated texting system so each nurse will get specific, customized text message regarding the issues they need to correct.



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8. Appendix

NurseSchedOpt: Scenario: “Real Data”

Objective Function

MAXIMIZE

1*AssignToWork_(1,_'105865') + 1*AssignToWork_(1,_'12295') + 1*AssignToWork_(1,_'14581') + 2501*AssignToWork_(1,_'18182') + 1*AssignToWork_(1,_'31300') + 1*AssignToWork_(1,_'31407') + 1*AssignToWork_(1,_'36587') + 1*AssignToWork_(1,_'38368') + -9999*AssignToWork_(1,_'59561') + 2501*AssignToWork_(1,_'99263') + 1*AssignToWork_(10,_'105865') + 1*AssignToWork_(10,_'12295') + 1*AssignToWork_(10,_'14581') + 2501*AssignToWork_(10,_'18182') + 10001*AssignToWork_(10,_'31300') + 1*AssignToWork_(10,_'31407') + 1*AssignToWork_(10,_'36587') + 10001*AssignToWork_(10,_'38368') + 1*AssignToWork_(10,_'59561') + 1*AssignToWork_(10,_'99263') + 1*AssignToWork_(11,_'105865') + -9999*AssignToWork_(11,_'12295') + 1*AssignToWork_(11,_'14581') + 1*AssignToWork_(11,_'18182') + 10001*AssignToWork_(11,_'31300') + 10001*AssignToWork_(11,_'31407') + 5001*AssignToWork_(11,_'36587') + 1*AssignToWork_(11,_'38368') + 10001*AssignToWork_(11,_'59561') + 2501*AssignToWork_(11,_'99263') + 5001*AssignToWork_(12,_'105865') + 10001*AssignToWork_(12,_'12295') + 1*AssignToWork_(12,_'14581') + 2501*AssignToWork_(12,_'18182') + 1*AssignToWork_(12,_'31300') + 1*AssignToWork_(12,_'31407') + 1*AssignToWork_(12,_'36587') + 1*AssignToWork_(12,_'38368') + 1*AssignToWork_(12,_'59561') + 2501*AssignToWork_(12,_'99263') + 5001*AssignToWork_(13,_'105865') + 10001*AssignToWork_(13,_'12295') + 1*AssignToWork_(13,_'14581') + 2501*AssignToWork_(13,_'18182') + 1*AssignToWork_(13,_'31300') + 10001*AssignToWork_(13,_'31407') + 1*AssignToWork_(13,_'36587') + 1*AssignToWork_(13,_'38368') + 1*AssignToWork_(13,_'59561') + 2501*AssignToWork_(13,_'99263') + 1*AssignToWork_(14,_'105865') + 1*AssignToWork_(14,_'12295') + 5001*AssignToWork_(14,_'14581') + 1*AssignToWork_(14,_'18182') + 1*AssignToWork_(14,_'31300') + 1*AssignToWork_(14,_'31407') + 5001*AssignToWork_(14,_'36587') + 1*AssignToWork_(14,_'38368') + 1*AssignToWork_(14,_'59561') + 1*AssignToWork_(14,_'99263') + 1*AssignToWork_(15,_'105865') + 1*AssignToWork_(15,_'12295') + 5001*AssignToWork_(15,_'14581') + 1*AssignToWork_(15,_'18182') + 1*AssignToWork_(15,_'31300') + 1*AssignToWork_(15,_'31407') + 5001*AssignToWork_(15,_'36587') + 1*AssignToWork_(15,_'38368') + 1*AssignToWork_(15,_'59561') + 1*AssignToWork_(15,_'99263') + 1*AssignToWork_(16,_'105865') + 10001*AssignToWork_(16,_'12295') + 1*AssignToWork_(16,_'14581') + 1*AssignToWork_(16,_'18182') + 10001*AssignToWork_(16,_'31300') + 10001*AssignToWork_(16,_'31407') + 1*AssignToWork_(16,_'36587') + 1*AssignToWork_(16,_'38368') + 1*AssignToWork_(16,_'59561') + 2501*AssignToWork_(16,_'99263') + 1*AssignToWork_(17,_'105865') + 10001*AssignToWork_(17,_'12295') + 1*AssignToWork_(17,_'14581') + 1*AssignToWork_(17,_'18182') + 10001*AssignToWork_(17,_'31300') + 1*AssignToWork_(17,_'31407') + 5001*AssignToWork_(17,_'36587') + 1*AssignToWork_(17,_'38368') + 1*AssignToWork_(17,_'59561') + 2501*AssignToWork_(17,_'99263') + 1*AssignToWork_(18,_'105865') + 1*AssignToWork_(18,_'12295') + 1*AssignToWork_(18,_'14581') + 2501*AssignToWork_(18,_'18182') + 1*AssignToWork_(18,_'31300') + 1*AssignToWork_(18,_'31407') + 5001*AssignToWork_(18,_'36587') + 1*AssignToWork_(18,_'38368') + 10001*AssignToWork_(18,_'59561') + 2501*AssignToWork_(18,_'99263') + 1*AssignToWork_(19,_'105865') + 1*AssignToWork_(19,_'12295') + 1*AssignToWork_(19,_'14581') + 2501*AssignToWork_(19,_'18182') + 1*AssignToWork_(19,_'31300') + 10001*AssignToWork_(19,_'31407') + 1*AssignToWork_(19,_'36587') + 10001*AssignToWork_(19,_'38368') + 10001*AssignToWork_(19,_'59561') + 1*AssignToWork_(19,_'99263') + 1*AssignToWork_(2,_'105865') + -9999*AssignToWork_(2,_'12295') + 5001*AssignToWork_(2,_'14581') + 1*AssignToWork_(2,_'18182') + 1*AssignToWork_(2,_'31300') + 10001*AssignToWork_(2,_'31407') + 5001*AssignToWork_(2,_'36587') + 1*AssignToWork_(2,_'38368') + -9999*AssignToWork_(2,_'59561') + 2501*AssignToWork_(2,_'99263') + 1*AssignToWork_(20,_'105865') + 1*AssignToWork_(20,_'12295') + 5001*AssignToWork_(20,_'14581') + 1*AssignToWork_(20,_'18182') + 10001*AssignToWork_(20,_'31300') + 10001*AssignToWork_(20,_'31407') + 1*AssignToWork_(20,_'36587') + 10001*AssignToWork_(20,_'38368') + 1*AssignToWork_(20,_'59561') + 1*AssignToWork_(20,_'99263') + 1*AssignToWork_(21,_'105865') + 10001*AssignToWork_(21,_'12295') + 1*AssignToWork_(21,_'14581') + 2501*AssignToWork_(21,_'18182') + 1*AssignToWork_(21,_'31300') + 1*AssignToWork_(21,_'31407') + 1*AssignToWork_(21,_'36587') + 1*AssignToWork_(21,_'38368') + 1*AssignToWork_(21,_'59561') + 1*AssignToWork_(21,_'99263') + 1*AssignToWork_(22,_'105865') + 10001*AssignToWork_(22,_'12295') + 1*AssignToWork_(22,_'14581') + 2501*AssignToWork_(22,_'18182') + 1*AssignToWork_(22,_'31300') + 1*AssignToWork_(22,_'31407') + 1*AssignToWork_(22,_'36587') + 1*AssignToWork_(22,_'38368') + 1*AssignToWork_(22,_'59561') + 1*AssignToWork_(22,_'99263') + 1*AssignToWork_(23,_'105865') + 1*AssignToWork_(23,_'12295') + 1*AssignToWork_(23,_'14581') + 1*AssignToWork_(23,_'18182') + 10001*AssignToWork_(23,_'31300') + 1*AssignToWork_(23,_'31407') + 5001*AssignToWork_(23,_'36587') + 10001*AssignToWork_(23,_'38368') + 1*AssignToWork_(23,_'59561') + 1*AssignToWork_(23,_'99263') + 1*AssignToWork_(24,_'105865') + 1*AssignToWork_(24,_'12295') + 1*AssignToWork_(24,_'14581') + 1*AssignToWork_(24,_'18182') + 10001*AssignToWork_(24,_'31300') + 10001*AssignToWork_(24,_'31407') + 5001*AssignToWork_(24,_'36587') + 1*AssignToWork_(24,_'38368') + 10001*AssignToWork_(24,_'59561') + 2501*AssignToWork_(24,_'99263') + 1*AssignToWork_(25,_'105865') + 10001*AssignToWork_(25,_'12295') + 1*AssignToWork_(25,_'14581') + 1*AssignToWork_(25,_'18182') + 1*AssignToWork_(25,_'31300') + 1*AssignToWork_(25,_'31407') + 5001*AssignToWork_(25,_'36587') + 1*AssignToWork_(25,_'38368') + 1*AssignToWork_(25,_'59561') + 2501*AssignToWork_(25,_'99263') + 1*AssignToWork_(26,_'105865') + 1*AssignToWork_(26,_'12295') + 5001*AssignToWork_(26,_'14581') + 2501*AssignToWork_(26,_'18182') + 1*AssignToWork_(26,_'31300') + 10001*AssignToWork_(26,_'31407') + 1*AssignToWork_(26,_'36587') + 1*AssignToWork_(26,_'38368') + 1*AssignToWork_(26,_'59561') + 2501*AssignToWork_(26,_'99263') + 1*AssignToWork_(27,_'105865') + 1*AssignToWork_(27,_'12295') + 5001*AssignToWork_(27,_'14581') + 2501*AssignToWork_(27,_'18182') + 1*AssignToWork_(27,_'31300') + 1*AssignToWork_(27,_'31407') + 1*AssignToWork_(27,_'36587') + 1*AssignToWork_(27,_'38368') + 1*AssignToWork_(27,_'59561') + 1*AssignToWork_(27,_'99263') + 1*AssignToWork_(28,_'105865') + 10001*AssignToWork_(28,_'12295') + 1*AssignToWork_(28,_'14581') + 1*AssignToWork_(28,_'18182') + 10001*AssignToWork_(28,_'31300') + 1*AssignToWork_(28,_'31407') + 1*AssignToWork_(28,_'36587') + 10001*AssignToWork_(28,_'38368') + 10001*AssignToWork_(28,_'59561') + 1*AssignToWork_(28,_'99263') + 1*AssignToWork_(29,_'105865') + 10001*AssignToWork_(29,_'12295') + 1*AssignToWork_(29,_'14581') + 1*AssignToWork_(29,_'18182') + 10001*AssignToWork_(29,_'31300') + 1*AssignToWork_(29,_'31407') + 1*AssignToWork_(29,_'36587') + 10001*AssignToWork_(29,_'38368') + 10001*AssignToWork_(29,_'59561') + 1*AssignToWork_(29,_'99263') + 1*AssignToWork_(3,_'105865') + 10001*AssignToWork_(3,_'12295') + 1*AssignToWork_(3,_'14581') + 1*AssignToWork_(3,_'18182') + 1*AssignToWork_(3,_'31300') + 1*AssignToWork_(3,_'31407') + 5001*AssignToWork_(3,_'36587') + 1*AssignToWork_(3,_'38368') + -9999*AssignToWork_(3,_'59561') + 2501*AssignToWork_(3,_'99263') + 1*AssignToWork_(30,_'105865') + 1*AssignToWork_(30,_'12295') + 5001*AssignToWork_(30,_'14581') + 1*AssignToWork_(30,_'18182') + 1*AssignToWork_(30,_'31300') + -9999*AssignToWork_(30,_'31407') + 5001*AssignToWork_(30,_'36587') + 1*AssignToWork_(30,_'38368') + 1*AssignToWork_(30,_'59561') + 2501*AssignToWork_(30,_'99263') + 1*AssignToWork_(31,_'105865') + 1*AssignToWork_(31,_'12295') + 1*AssignToWork_(31,_'14581') + 2501*AssignToWork_(31,_'18182') + 1*AssignToWork_(31,_'31300') + 1*AssignToWork_(31,_'31407') + 5001*AssignToWork_(31,_'36587') + 1*AssignToWork_(31,_'38368') + 10001*AssignToWork_(31,_'59561') + 2501*AssignToWork_(31,_'99263') + 1*AssignToWork_(32,_'105865') + 10001*AssignToWork_(32,_'12295') + 1*AssignToWork_(32,_'14581') + 2501*AssignToWork_(32,_'18182') + 10001*AssignToWork_(32,_'31300') + 10001*AssignToWork_(32,_'31407') + 1*AssignToWork_(32,_'36587') + 1*AssignToWork_(32,_'38368') + 1*AssignToWork_(32,_'59561') + 2501*AssignToWork_(32,_'99263') + 5001*AssignToWork_(33,_'105865') + 10001*AssignToWork_(33,_'12295') + 1*AssignToWork_(33,_'14581') + 1*AssignToWork_(33,_'18182') + 10001*AssignToWork_(33,_'31300') + 1*AssignToWork_(33,_'31407') + 1*AssignToWork_(33,_'36587') + 1*AssignToWork_(33,_'38368') + 1*AssignToWork_(33,_'59561') + 1*AssignToWork_(33,_'99263') + 1*AssignToWork_(34,_'105865') + 1*AssignToWork_(34,_'12295') + 1*AssignToWork_(34,_'14581') + 2501*AssignToWork_(34,_'18182') + 1*AssignToWork_(34,_'31300') + 1*AssignToWork_(34,_'31407') + 1*AssignToWork_(34,_'36587') + 1*AssignToWork_(34,_'38368') + 1*AssignToWork_(34,_'59561') + 1*AssignToWork_(34,_'99263') + 1*AssignToWork_(35,_'105865') + 1*AssignToWork_(35,_'12295') + 5001*AssignToWork_(35,_'14581') + 1*AssignToWork_(35,_'18182') + 1*AssignToWork_(35,_'31300') + 1*AssignToWork_(35,_'31407') + 5001*AssignToWork_(35,_'36587') + 10001*AssignToWork_(35,_'38368') + 1*AssignToWork_(35,_'59561') + 1*AssignToWork_(35,_'99263') + 1*AssignToWork_(36,_'105865') + 1*AssignToWork_(36,_'12295') + 5001*AssignToWork_(36,_'14581') + 1*AssignToWork_(36,_'18182') + 1*AssignToWork_(36,_'31300') + 1*AssignToWork_(36,_'31407') + 5001*AssignToWork_(36,_'36587') + 1*AssignToWork_(36,_'38368') + 1*AssignToWork_(36,_'59561') + 1*AssignToWork_(36,_'99263') + 1*AssignToWork_(37,_'105865') + 10001*AssignToWork_(37,_'12295') + 1*AssignToWork_(37,_'14581') + 1*AssignToWork_(37,_'18182') + 10001*AssignToWork_(37,_'31300') + 1*AssignToWork_(37,_'31407') + 1*AssignToWork_(37,_'36587') + 1*AssignToWork_(37,_'38368') + 1*AssignToWork_(37,_'59561') + 2501*AssignToWork_(37,_'99263') + 1*AssignToWork_(38,_'105865') + 1*AssignToWork_(38,_'12295') + 5001*AssignToWork_(38,_'14581') + 1*AssignToWork_(38,_'18182') + 1*AssignToWork_(38,_'31300') + 10001*AssignToWork_(38,_'31407') + 5001*AssignToWork_(38,_'36587') + 1*AssignToWork_(38,_'38368') + 1*AssignToWork_(38,_'59561') + 2501*AssignToWork_(38,_'99263') + 1*AssignToWork_(39,_'105865') + 10001*AssignToWork_(39,_'12295') + 1*AssignToWork_(39,_'14581') + 2501*AssignToWork_(39,_'18182') + 10001*AssignToWork_(39,_'31300') + 1*AssignToWork_(39,_'31407') + 5001*AssignToWork_(39,_'36587') + 1*AssignToWork_(39,_'38368') + 1*AssignToWork_(39,_'59561') + 1*AssignToWork_(39,_'99263') + 1*AssignToWork_(4,_'105865') + 10001*AssignToWork_(4,_'12295') + 5001*AssignToWork_(4,_'14581') + 1*AssignToWork_(4,_'18182') + 10001*AssignToWork_(4,_'31300') + 10001*AssignToWork_(4,_'31407') + 1*AssignToWork_(4,_'36587') + 1*AssignToWork_(4,_'38368') + -9999*AssignToWork_(4,_'59561') + 1*AssignToWork_(4,_'99263') + 1*AssignToWork_(40,_'105865') + 1*AssignToWork_(40,_'12295') + 1*AssignToWork_(40,_'14581') + 2501*AssignToWork_(40,_'18182') + 10001*AssignToWork_(40,_'31300') + 10001*AssignToWork_(40,_'31407') + 1*AssignToWork_(40,_'36587') + 10001*AssignToWork_(40,_'38368') + 10001*AssignToWork_(40,_'59561') + 1*AssignToWork_(40,_'99263') + 1*AssignToWork_(41,_'105865') + 10001*AssignToWork_(41,_'12295') + 1*AssignToWork_(41,_'14581') + 1*AssignToWork_(41,_'18182') + 1*AssignToWork_(41,_'31300') + 10001*AssignToWork_(41,_'31407') + 1*AssignToWork_(41,_'36587') + 10001*AssignToWork_(41,_'38368') + 10001*AssignToWork_(41,_'59561') + 1*AssignToWork_(41,_'99263') + 1*AssignToWork_(42,_'105865') + 1*AssignToWork_(42,_'12295') + 1*AssignToWork_(42,_'14581') + 2501*AssignToWork_(42,_'18182') + 1*AssignToWork_(42,_'31300') + 1*AssignToWork_(42,_'31407') + 1*AssignToWork_(42,_'36587') + 1*AssignToWork_(42,_'38368') + 1*AssignToWork_(42,_'59561') + 2501*AssignToWork_(42,_'99263') + 5001*AssignToWork_(5,_'105865') + 1*AssignToWork_(5,_'12295') + 1*AssignToWork_(5,_'14581') + 2501*AssignToWork_(5,_'18182') + 10001*AssignToWork_(5,_'31300') + 1*AssignToWork_(5,_'31407') + 1*AssignToWork_(5,_'36587') + 10001*AssignToWork_(5,_'38368') + 1*AssignToWork_(5,_'59561') + 1*AssignToWork_(5,_'99263') + 5001*AssignToWork_(6,_'105865') + -9999*AssignToWork_(6,_'12295') + 1*AssignToWork_(6,_'14581') + 2501*AssignToWork_(6,_'18182') + 1*AssignToWork_(6,_'31300') + 1*AssignToWork_(6,_'31407') + 5001*AssignToWork_(6,_'36587') + 1*AssignToWork_(6,_'38368') + 1*AssignToWork_(6,_'59561') + 1*AssignToWork_(6,_'99263') + 1*AssignToWork_(7,_'105865') + 10001*AssignToWork_(7,_'12295') + 1*AssignToWork_(7,_'14581') + 1*AssignToWork_(7,_'18182') + 10001*AssignToWork_(7,_'31300') + 1*AssignToWork_(7,_'31407') + 1*AssignToWork_(7,_'36587') + 10001*AssignToWork_(7,_'38368') + 10001*AssignToWork_(7,_'59561') + 1*AssignToWork_(7,_'99263') + 1*AssignToWork_(8,_'105865') + 10001*AssignToWork_(8,_'12295') + 1*AssignToWork_(8,_'14581') + 1*AssignToWork_(8,_'18182') + 10001*AssignToWork_(8,_'31300') + 1*AssignToWork_(8,_'31407') + 1*AssignToWork_(8,_'36587') + 10001*AssignToWork_(8,_'38368') + 10001*AssignToWork_(8,_'59561') + 1*AssignToWork_(8,_'99263') + 1*AssignToWork_(9,_'105865') + 1*AssignToWork_(9,_'12295') + 5001*AssignToWork_(9,_'14581') + 1*Assig

nToWork_(9,_'18182') + 1*AssignToWork_(9,_'31300') + 1*AssignToWork_(9,_'31407') + 5001*AssignToWork_(9,_'36587') + 1*AssignToWork_(9,_'38368') + 1*AssignToWork_(9,_'59561') + 1*
AssignToWork_(9,_'99263') + 0

SUBJECT TO

C1: AssignToWork(1,_'105865') + AssignToWork_(1,_'12295')
+ AssignToWork_(1,_'14581') + AssignToWork_(1,_'18182')
+ AssignToWork_(1,_'31300') + AssignToWork_(1,_'31407')
+ AssignToWork_(1,_'36587') + AssignToWork_(1,_'38368')
+ AssignToWork_(1,_'59561') + AssignToWork_(1,_'99263') >= 4

C2: AssignToWork(2,_'105865') + AssignToWork_(2,_'12295')
+ AssignToWork_(2,_'14581') + AssignToWork_(2,_'18182')
+ AssignToWork_(2,_'31300') + AssignToWork_(2,_'31407')
+ AssignToWork_(2,_'36587') + AssignToWork_(2,_'38368')
+ AssignToWork_(2,_'59561') + AssignToWork_(2,_'99263') >= 3

C3: AssignToWork(3,_'105865') + AssignToWork_(3,_'12295')
+ AssignToWork_(3,_'14581') + AssignToWork_(3,_'18182')
+ AssignToWork_(3,_'31300') + AssignToWork_(3,_'31407')
+ AssignToWork_(3,_'36587') + AssignToWork_(3,_'38368')
+ AssignToWork_(3,_'59561') + AssignToWork_(3,_'99263') >= 3

C4: AssignToWork(4,_'105865') + AssignToWork_(4,_'12295')
+ AssignToWork_(4,_'14581') + AssignToWork_(4,_'18182')
+ AssignToWork_(4,_'31300') + AssignToWork_(4,_'31407')
+ AssignToWork_(4,_'36587') + AssignToWork_(4,_'38368')
+ AssignToWork_(4,_'59561') + AssignToWork_(4,_'99263') >= 3

C5: AssignToWork(5,_'105865') + AssignToWork_(5,_'12295')
+ AssignToWork_(5,_'14581') + AssignToWork_(5,_'18182')
+ AssignToWork_(5,_'31300') + AssignToWork_(5,_'31407')
+ AssignToWork_(5,_'36587') + AssignToWork_(5,_'38368')
+ AssignToWork_(5,_'59561') + AssignToWork_(5,_'99263') >= 3

C6: AssignToWork(6,_'105865') + AssignToWork_(6,_'12295')
+ AssignToWork_(6,_'14581') + AssignToWork_(6,_'18182')
+ AssignToWork_(6,_'31300') + AssignToWork_(6,_'31407')
+ AssignToWork_(6,_'36587') + AssignToWork_(6,_'38368')
+ AssignToWork_(6,_'59561') + AssignToWork_(6,_'99263') >= 4

C7: AssignToWork(7,_'105865') + AssignToWork_(7,_'12295')
+ AssignToWork_(7,_'14581') + AssignToWork_(7,_'18182')
+ AssignToWork_(7,_'31300') + AssignToWork_(7,_'31407')
+ AssignToWork_(7,_'36587') + AssignToWork_(7,_'38368')
+ AssignToWork_(7,_'59561') + AssignToWork_(7,_'99263') >= 4

C8: AssignToWork(8,_'105865') + AssignToWork_(8,_'12295')
+ AssignToWork_(8,_'14581') + AssignToWork_(8,_'18182')
+ AssignToWork_(8,_'31300') + AssignToWork_(8,_'31407')
+ AssignToWork_(8,_'36587') + AssignToWork_(8,_'38368')
+ AssignToWork_(8,_'59561') + AssignToWork_(8,_'99263') >= 4

C9: AssignToWork(9,_'105865') + AssignToWork_(9,_'12295')
+ AssignToWork_(9,_'14581') + AssignToWork_(9,_'18182')
+ AssignToWork_(9,_'31300') + AssignToWork_(9,_'31407')
+ AssignToWork_(9,_'36587') + AssignToWork_(9,_'38368')
+ AssignToWork_(9,_'59561') + AssignToWork_(9,_'99263') >= 3

C10: AssignToWork(10,_'105865') + AssignToWork_(10,_'12295')
+ AssignToWork_(10,_'14581') + AssignToWork_(10,_'18182')
+ AssignToWork_(10,_'31300') + AssignToWork_(10,_'31407')
+ AssignToWork_(10,_'36587') + AssignToWork_(10,_'38368')
+ AssignToWork_(10,_'59561') + AssignToWork_(10,_'99263') >= 3

C11: AssignToWork(11,_'105865') + AssignToWork_(11,_'12295')
+ AssignToWork_(11,_'14581') + AssignToWork_(11,_'18182')
+ AssignToWork_(11,_'31300') + AssignToWork_(11,_'31407')
+ AssignToWork_(11,_'36587') + AssignToWork_(11,_'38368')
+ AssignToWork_(11,_'59561') + AssignToWork_(11,_'99263') >= 3

C12: AssignToWork(12,_'105865') + AssignToWork_(12,_'12295')
+ AssignToWork_(12,_'14581') + AssignToWork_(12,_'18182')
+ AssignToWork_(12,_'31300') + AssignToWork_(12,_'31407')
+ AssignToWork_(12,_'36587') + AssignToWork_(12,_'38368')
+ AssignToWork_(12,_'59561') + AssignToWork_(12,_'99263') >= 3

C13: AssignToWork(13,_'105865') + AssignToWork_(13,_'12295')
+ AssignToWork_(13,_'14581') + AssignToWork_(13,_'18182')
+ AssignToWork_(13,_'31300') + AssignToWork_(13,_'31407')
+ AssignToWork_(13,_'36587') + AssignToWork_(13,_'38368')
+ AssignToWork_(13,_'59561') + AssignToWork_(13,_'99263') >= 4

C14: AssignToWork(14,_'105865') + AssignToWork_(14,_'12295')
+ AssignToWork_(14,_'14581') + AssignToWork_(14,_'18182')
+ AssignToWork_(14,_'31300') + AssignToWork_(14,_'31407')
+ AssignToWork_(14,_'36587') + AssignToWork_(14,_'38368')
+ AssignToWork_(14,_'59561') + AssignToWork_(14,_'99263') >= 4

C15: AssignToWork(15,_'105865') + AssignToWork_(15,_'12295')
+ AssignToWork_(15,_'14581') + AssignToWork_(15,_'18182')
+ AssignToWork_(15,_'31300') + AssignToWork_(15,_'31407')
+ AssignToWork_(15,_'36587') + AssignToWork_(15,_'38368')
+ AssignToWork_(15,_'59561') + AssignToWork_(15,_'99263') >= 4

C16: AssignToWork(16,_'105865') + AssignToWork_(16,_'12295')
+ AssignToWork_(16,_'14581') + AssignToWork_(16,_'18182')
+ AssignToWork_(16,_'31300') + AssignToWork_(16,_'31407')
+ AssignToWork_(16,_'36587') + AssignToWork_(16,_'38368')
+ AssignToWork_(16,_'59561') + AssignToWork_(16,_'99263') >= 3

C17: AssignToWork(17,_'105865') + AssignToWork_(17,_'12295')
+ AssignToWork_(17,_'14581') + AssignToWork_(17,_'18182')
+ AssignToWork_(17,_'31300') + AssignToWork_(17,_'31407')
+ AssignToWork_(17,_'36587') + AssignToWork_(17,_'38368')
+ AssignToWork_(17,_'59561') + AssignToWork_(17,_'99263') >= 3

C18: AssignToWork(18,_'105865') + AssignToWork_(18,_'12295')
+ AssignToWork_(18,_'14581') + AssignToWork_(18,_'18182')
+ AssignToWork_(18,_'31300') + AssignToWork_(18,_'31407')
+ AssignToWork_(18,_'36587') + AssignToWork_(18,_'38368')
+ AssignToWork_(18,_'59561') + AssignToWork_(18,_'99263') >= 3

C19: AssignToWork(19,_'105865') + AssignToWork_(19,_'12295')
+ AssignToWork_(19,_'14581') + AssignToWork_(19,_'18182')
+ AssignToWork_(19,_'31300') + AssignToWork_(19,_'31407')
+ AssignToWork_(19,_'36587') + AssignToWork_(19,_'38368')
+ AssignToWork_(19,_'59561') + AssignToWork_(19,_'99263') >= 3

C20: AssignToWork(20,_'105865') + AssignToWork_(20,_'12295')
+ AssignToWork_(20,_'14581') + AssignToWork_(20,_'18182')
+ AssignToWork_(20,_'31300') + AssignToWork_(20,_'31407')
+ AssignToWork_(20,_'36587') + AssignToWork_(20,_'38368')
+ AssignToWork_(20,_'59561') + AssignToWork_(20,_'99263') >= 4

C21: AssignToWork(21,_'105865') + AssignToWork_(21,_'12295')
+ AssignToWork_(21,_'14581') + AssignToWork_(21,_'18182')
+ AssignToWork_(21,_'31300') + AssignToWork_(21,_'31407')
+ AssignToWork_(21,_'36587') + AssignToWork_(21,_'38368')
+ AssignToWork_(21,_'59561') + AssignToWork_(21,_'99263') >= 4

C22: AssignToWork(22,_'105865') + AssignToWork_(22,_'12295')
+ AssignToWork_(22,_'14581') + AssignToWork_(22,_'18182')
+ AssignToWork_(22,_'31300') + AssignToWork_(22,_'31407')
+ AssignToWork_(22,_'36587') + AssignToWork_(22,_'38368')
+ AssignToWork_(22,_'59561') + AssignToWork_(22,_'99263') >= 4

C23: AssignToWork(23,_'105865') + AssignToWork_(23,_'12295')
+ AssignToWork_(23,_'14581') + AssignToWork_(23,_'18182')
+ AssignToWork_(23,_'31300') + AssignToWork_(23,_'31407')
+ AssignToWork_(23,_'36587') + AssignToWork_(23,_'38368')
+ AssignToWork_(23,_'59561') + AssignToWork_(23,_'99263') >= 3

C24: AssignToWork(24,_'105865') + AssignToWork_(24,_'12295')
+ AssignToWork_(24,_'14581') + AssignToWork_(24,_'18182')
+ AssignToWork_(24,_'31300') + AssignToWork_(24,_'31407')
+ AssignToWork_(24,_'36587') + AssignToWork_(24,_'38368')
+ AssignToWork_(24,_'59561') + AssignToWork_(24,_'99263') >= 3

C25: AssignToWork(25,_'105865') + AssignToWork_(25,_'12295')
+ AssignToWork_(25,_'14581') + AssignToWork_(25,_'18182')
+ AssignToWork_(25,_'31300') + AssignToWork_(25,_'31407')
+ AssignToWork_(25,_'36587') + AssignToWork_(25,_'38368')
+ AssignToWork_(25,_'59561') + AssignToWork_(25,_'99263') >= 3

C26: AssignToWork(26,_'105865') + AssignToWork_(26,_'12295')
+ AssignToWork_(26,_'14581') + AssignToWork_(26,_'18182')
+ AssignToWork_(26,_'31300') + AssignToWork_(26,_'31407')
+ AssignToWork_(26,_'36587') + AssignToWork_(26,_'38368')
+ AssignToWork_(26,_'59561') + AssignToWork_(26,_'99263') >= 3

C27: AssignToWork(27,_'105865') + AssignToWork_(27,_'12295')
+ AssignToWork_(27,_'14581') + AssignToWork_(27,_'18182')
+ AssignToWork_(27,_'31300') + AssignToWork_(27,_'31407')
+ AssignToWork_(27,_'36587') + AssignToWork_(27,_'38368')
+ AssignToWork_(27,_'59561') + AssignToWork_(27,_'99263') >= 4

C28: AssignToWork(28,_'105865') + AssignToWork_(28,_'12295')
+ AssignToWork_(28,_'14581') + AssignToWork_(28,_'18182')
+ AssignToWork_(28,_'31300') + AssignToWork_(28,_'31407')
+ AssignToWork_(28,_'36587') + AssignToWork_(28,_'38368')
+ AssignToWork_(28,_'59561') + AssignToWork_(28,_'99263') >= 4

C29: AssignToWork(29,_'105865') + AssignToWork_(29,_'12295')
+ AssignToWork_(29,_'14581') + AssignToWork_(29,_'18182')
+ AssignToWork_(29,_'31300') + AssignToWork_(29,_'31407')
+ AssignToWork_(29,_'36587') + AssignToWork_(29,_'38368')

+ AssignToWork_(29,_'59561') + AssignToWork_(29,_'99263') >= 4

C30: AssignToWork(30,_'105865') + AssignToWork_(30,_'12295')
+ AssignToWork_(30,_'14581') + AssignToWork_(30,_'18182')
+ AssignToWork_(30,_'31300') + AssignToWork_(30,_'31407')
+ AssignToWork_(30,_'36587') + AssignToWork_(30,_'38368')
+ AssignToWork_(30,_'59561') + AssignToWork_(30,_'99263') >= 3

C31: AssignToWork(31,_'105865') + AssignToWork_(31,_'12295')
+ AssignToWork_(31,_'14581') + AssignToWork_(31,_'18182')
+ AssignToWork_(31,_'31300') + AssignToWork_(31,_'31407')
+ AssignToWork_(31,_'36587') + AssignToWork_(31,_'38368')
+ AssignToWork_(31,_'59561') + AssignToWork_(31,_'99263') >= 3

C32: AssignToWork(32,_'105865') + AssignToWork_(32,_'12295')
+ AssignToWork_(32,_'14581') + AssignToWork_(32,_'18182')
+ AssignToWork_(32,_'31300') + AssignToWork_(32,_'31407')
+ AssignToWork_(32,_'36587') + AssignToWork_(32,_'38368')
+ AssignToWork_(32,_'59561') + AssignToWork_(32,_'99263') >= 3

C33: AssignToWork(33,_'105865') + AssignToWork_(33,_'12295')
+ AssignToWork_(33,_'14581') + AssignToWork_(33,_'18182')
+ AssignToWork_(33,_'31300') + AssignToWork_(33,_'31407')
+ AssignToWork_(33,_'36587') + AssignToWork_(33,_'38368')
+ AssignToWork_(33,_'59561') + AssignToWork_(33,_'99263') >= 3

C34: AssignToWork(34,_'105865') + AssignToWork_(34,_'12295')
+ AssignToWork_(34,_'14581') + AssignToWork_(34,_'18182')
+ AssignToWork_(34,_'31300') + AssignToWork_(34,_'31407')
+ AssignToWork_(34,_'36587') + AssignToWork_(34,_'38368')
+ AssignToWork_(34,_'59561') + AssignToWork_(34,_'99263') >= 4

C35: AssignToWork(35,_'105865') + AssignToWork_(35,_'12295')
+ AssignToWork_(35,_'14581') + AssignToWork_(35,_'18182')
+ AssignToWork_(35,_'31300') + AssignToWork_(35,_'31407')
+ AssignToWork_(35,_'36587') + AssignToWork_(35,_'38368')
+ AssignToWork_(35,_'59561') + AssignToWork_(35,_'99263') >= 4

C36: AssignToWork(36,_'105865') + AssignToWork_(36,_'12295')
+ AssignToWork_(36,_'14581') + AssignToWork_(36,_'18182')
+ AssignToWork_(36,_'31300') + AssignToWork_(36,_'31407')
+ AssignToWork_(36,_'36587') + AssignToWork_(36,_'38368')
+ AssignToWork_(36,_'59561') + AssignToWork_(36,_'99263') >= 4

C37: AssignToWork(37,_'105865') + AssignToWork_(37,_'12295')
+ AssignToWork_(37,_'14581') + AssignToWork_(37,_'18182')
+ AssignToWork_(37,_'31300') + AssignToWork_(37,_'31407')
+ AssignToWork_(37,_'36587') + AssignToWork_(37,_'38368')
+ AssignToWork_(37,_'59561') + AssignToWork_(37,_'99263') >= 3

C38: AssignToWork(38,_'105865') + AssignToWork_(38,_'12295')
+ AssignToWork_(38,_'14581') + AssignToWork_(38,_'18182')
+ AssignToWork_(38,_'31300') + AssignToWork_(38,_'31407')
+ AssignToWork_(38,_'36587') + AssignToWork_(38,_'38368')
+ AssignToWork_(38,_'59561') + AssignToWork_(38,_'99263') >= 3

C39: AssignToWork(39,_'105865') + AssignToWork_(39,_'12295')
+ AssignToWork_(39,_'14581') + AssignToWork_(39,_'18182')
+ AssignToWork_(39,_'31300') + AssignToWork_(39,_'31407')
+ AssignToWork_(39,_'36587') + AssignToWork_(39,_'38368')
+ AssignToWork_(39,_'59561') + AssignToWork_(39,_'99263') >= 3

C40: AssignToWork(40,_'105865') + AssignToWork_(40,_'12295')
+ AssignToWork_(40,_'14581') + AssignToWork_(40,_'18182')
+ AssignToWork_(40,_'31300') + AssignToWork_(40,_'31407')
+ AssignToWork_(40,_'36587') + AssignToWork_(40,_'38368')
+ AssignToWork_(40,_'59561') + AssignToWork_(40,_'99263') >= 3

C41: AssignToWork(41,_'105865') + AssignToWork_(41,_'12295')
+ AssignToWork_(41,_'14581') + AssignToWork_(41,_'18182')
+ AssignToWork_(41,_'31300') + AssignToWork_(41,_'31407')
+ AssignToWork_(41,_'36587') + AssignToWork_(41,_'38368')
+ AssignToWork_(41,_'59561') + AssignToWork_(41,_'99263') >= 4

C42: AssignToWork(42,_'105865') + AssignToWork_(42,_'12295')
+ AssignToWork_(42,_'14581') + AssignToWork_(42,_'18182')
+ AssignToWork_(42,_'31300') + AssignToWork_(42,_'31407')
+ AssignToWork_(42,_'36587') + AssignToWork_(42,_'38368')
+ AssignToWork_(42,_'59561') + AssignToWork_(42,_'99263') >= 4

C43: AssignToWork(1,_'12295') + AssignToWork_(2,_'12295')
+ AssignToWork_(3,_'12295') + AssignToWork_(4,_'12295')
+ AssignToWork_(5,_'12295') + AssignToWork_(6,_'12295')
+ AssignToWork_(7,_'12295') <= 3

C44: AssignToWork(10,_'12295') + AssignToWork_(11,_'12295')
+ AssignToWork_(12,_'12295') + AssignToWork_(13,_'12295')
+ AssignToWork_(14,_'12295') + AssignToWork_(8,_'12295')

+ AssignToWork_(9,_'12295') <= 3

C45: AssignToWork(15,_'12295') + AssignToWork_(16,_'12295')
+ AssignToWork_(17,_'12295') + AssignToWork_(18,_'12295')
+ AssignToWork_(19,_'12295') + AssignToWork_(20,_'12295')
+ AssignToWork_(21,_'12295') <= 3

C46: AssignToWork(22,_'12295') + AssignToWork_(23,_'12295')
+ AssignToWork_(24,_'12295') + AssignToWork_(25,_'12295')
+ AssignToWork_(26,_'12295') + AssignToWork_(27,_'12295')
+ AssignToWork_(28,_'12295') <= 3

C47: AssignToWork(29,_'12295') + AssignToWork_(30,_'12295')
+ AssignToWork_(31,_'12295') + AssignToWork_(32,_'12295')
+ AssignToWork_(33,_'12295') + AssignToWork_(34,_'12295')
+ AssignToWork_(35,_'12295') <= 3

C48: AssignToWork(36,_'12295') + AssignToWork_(37,_'12295')
+ AssignToWork_(38,_'12295') + AssignToWork_(39,_'12295')
+ AssignToWork_(40,_'12295') + AssignToWork_(41,_'12295')
+ AssignToWork_(42,_'12295') <= 3

C49: AssignToWork(1,_'14581') + AssignToWork_(2,_'14581')
+ AssignToWork_(3,_'14581') + AssignToWork_(4,_'14581')
+ AssignToWork_(5,_'14581') + AssignToWork_(6,_'14581')
+ AssignToWork_(7,_'14581') <= 3

C50: AssignToWork(10,_'14581') + AssignToWork_(11,_'14581')
+ AssignToWork_(12,_'14581') + AssignToWork_(13,_'14581')
+ AssignToWork_(14,_'14581') + AssignToWork_(8,_'14581')
+ AssignToWork_(9,_'14581') <= 3

C51: AssignToWork(15,_'14581') + AssignToWork_(16,_'14581')
+ AssignToWork_(17,_'14581') + AssignToWork_(18,_'14581')
+ AssignToWork_(19,_'14581') + AssignToWork_(20,_'14581')
+ AssignToWork_(21,_'14581') <= 3

C52: AssignToWork(22,_'14581') + AssignToWork_(23,_'14581')
+ AssignToWork_(24,_'14581') + AssignToWork_(25,_'14581')
+ AssignToWork_(26,_'14581') + AssignToWork_(27,_'14581')
+ AssignToWork_(28,_'14581') <= 3

C53: AssignToWork(29,_'14581') + AssignToWork_(30,_'14581')
+ AssignToWork_(31,_'14581') + AssignToWork_(32,_'14581')
+ AssignToWork_(33,_'14581') + AssignToWork_(34,_'14581')
+ AssignToWork_(35,_'14581') <= 3

C54: AssignToWork(36,_'14581') + AssignToWork_(37,_'14581')
+ AssignToWork_(38,_'14581') + AssignToWork_(39,_'14581')
+ AssignToWork_(40,_'14581') + AssignToWork_(41,_'14581')
+ AssignToWork_(42,_'14581') <= 3

C55: AssignToWork(1,_'18182') + AssignToWork_(2,_'18182')
+ AssignToWork_(3,_'18182') + AssignToWork_(4,_'18182')
+ AssignToWork_(5,_'18182') + AssignToWork_(6,_'18182')
+ AssignToWork_(7,_'18182') <= 3

C56: AssignToWork(10,_'18182') + AssignToWork_(11,_'18182')
+ AssignToWork_(12,_'18182') + AssignToWork_(13,_'18182')
+ AssignToWork_(14,_'18182') + AssignToWork_(8,_'18182')
+ AssignToWork_(9,_'18182') <= 3

C57: AssignToWork(15,_'18182') + AssignToWork_(16,_'18182')
+ AssignToWork_(17,_'18182') + AssignToWork_(18,_'18182')
+ AssignToWork_(19,_'18182') + AssignToWork_(20,_'18182')
+ AssignToWork_(21,_'18182') <= 3

C58: AssignToWork(22,_'18182') + AssignToWork_(23,_'18182')
+ AssignToWork_(24,_'18182') + AssignToWork_(25,_'18182')
+ AssignToWork_(26,_'18182') + AssignToWork_(27,_'18182')
+ AssignToWork_(28,_'18182') <= 3

C59: AssignToWork(29,_'18182') + AssignToWork_(30,_'18182')
+ AssignToWork_(31,_'18182') + AssignToWork_(32,_'18182')
+ AssignToWork_(33,_'18182') + AssignToWork_(34,_'18182')
+ AssignToWork_(35,_'18182') <= 3

C60: AssignToWork(36,_'18182') + AssignToWork_(37,_'18182')
+ AssignToWork_(38,_'18182') + AssignToWork_(39,_'18182')
+ AssignToWork_(40,_'18182') + AssignToWork_(41,_'18182')
+ AssignToWork_(42,_'18182') <= 3

C61: AssignToWork(1,_'31300') + AssignToWork_(2,_'31300')
+ AssignToWork_(3,_'31300') + AssignToWork_(4,_'31300')
+ AssignToWork_(5,_'31300') + AssignToWork_(6,_'31300')
+ AssignToWork_(7,_'31300') <= 3

C62: AssignToWork(10,_'31300') + AssignToWork_(11,_'31300')

+ AssignToWork_(12,_'31300') + AssignToWork_(13,_'31300')
+ AssignToWork_(14,_'31300') + AssignToWork_(8,_'31300')
+ AssignToWork_(9,_'31300') <= 3

C63: AssignToWork(15,_'31300') + AssignToWork_(16,_'31300')
+ AssignToWork_(17,_'31300') + AssignToWork_(18,_'31300')
+ AssignToWork_(19,_'31300') + AssignToWork_(20,_'31300')
+ AssignToWork_(21,_'31300') <= 3

C64: AssignToWork(22,_'31300') + AssignToWork_(23,_'31300')
+ AssignToWork_(24,_'31300') + AssignToWork_(25,_'31300')
+ AssignToWork_(26,_'31300') + AssignToWork_(27,_'31300')
+ AssignToWork_(28,_'31300') <= 3

C65: AssignToWork(29,_'31300') + AssignToWork_(30,_'31300')
+ AssignToWork_(31,_'31300') + AssignToWork_(32,_'31300')
+ AssignToWork_(33,_'31300') + AssignToWork_(34,_'31300')
+ AssignToWork_(35,_'31300') <= 3

C66: AssignToWork(36,_'31300') + AssignToWork_(37,_'31300')
+ AssignToWork_(38,_'31300') + AssignToWork_(39,_'31300')
+ AssignToWork_(40,_'31300') + AssignToWork_(41,_'31300')
+ AssignToWork_(42,_'31300') <= 3

C67: AssignToWork(1,_'31407') + AssignToWork_(2,_'31407')
+ AssignToWork_(3,_'31407') + AssignToWork_(4,_'31407')
+ AssignToWork_(5,_'31407') + AssignToWork_(6,_'31407')
+ AssignToWork_(7,_'31407') <= 3

C68: AssignToWork(10,_'31407') + AssignToWork_(11,_'31407')
+ AssignToWork_(12,_'31407') + AssignToWork_(13,_'31407')
+ AssignToWork_(14,_'31407') + AssignToWork_(8,_'31407')
+ AssignToWork_(9,_'31407') <= 3

C69: AssignToWork(15,_'31407') + AssignToWork_(16,_'31407')
+ AssignToWork_(17,_'31407') + AssignToWork_(18,_'31407')
+ AssignToWork_(19,_'31407') + AssignToWork_(20,_'31407')
+ AssignToWork_(21,_'31407') <= 3

C70: AssignToWork(22,_'31407') + AssignToWork_(23,_'31407')
+ AssignToWork_(24,_'31407') + AssignToWork_(25,_'31407')
+ AssignToWork_(26,_'31407') + AssignToWork_(27,_'31407')
+ AssignToWork_(28,_'31407') <= 3

C71: AssignToWork(29,_'31407') + 0 AssignToWork_(30,_'31407')
+ AssignToWork_(31,_'31407') + AssignToWork_(32,_'31407')
+ AssignToWork_(33,_'31407') + AssignToWork_(34,_'31407')
+ AssignToWork_(35,_'31407') <= 2

C72: AssignToWork(36,_'31407') + AssignToWork_(37,_'31407')
+ AssignToWork_(38,_'31407') + AssignToWork_(39,_'31407')
+ AssignToWork_(40,_'31407') + AssignToWork_(41,_'31407')
+ AssignToWork_(42,_'31407') <= 3

C73: AssignToWork(1,_'36587') + AssignToWork_(2,_'36587')
+ AssignToWork_(3,_'36587') + AssignToWork_(4,_'36587')
+ AssignToWork_(5,_'36587') + AssignToWork_(6,_'36587')
+ AssignToWork_(7,_'36587') <= 3

C74: AssignToWork(10,_'36587') + AssignToWork_(11,_'36587')
+ AssignToWork_(12,_'36587') + AssignToWork_(13,_'36587')
+ AssignToWork_(14,_'36587') + AssignToWork_(8,_'36587')
+ AssignToWork_(9,_'36587') <= 3

C75: AssignToWork(15,_'36587') + AssignToWork_(16,_'36587')
+ AssignToWork_(17,_'36587') + AssignToWork_(18,_'36587')
+ AssignToWork_(19,_'36587') + AssignToWork_(20,_'36587')
+ AssignToWork_(21,_'36587') <= 3

C76: AssignToWork(22,_'36587') + AssignToWork_(23,_'36587')
+ AssignToWork_(24,_'36587') + AssignToWork_(25,_'36587')
+ AssignToWork_(26,_'36587') + AssignToWork_(27,_'36587')
+ AssignToWork_(28,_'36587') <= 3

C77: AssignToWork(29,_'36587') + AssignToWork_(30,_'36587')
+ AssignToWork_(31,_'36587') + AssignToWork_(32,_'36587')
+ AssignToWork_(33,_'36587') + AssignToWork_(34,_'36587')
+ AssignToWork_(35,_'36587') <= 3

C78: AssignToWork(36,_'36587') + AssignToWork_(37,_'36587')
+ AssignToWork_(38,_'36587') + AssignToWork_(39,_'36587')
+ AssignToWork_(40,_'36587') + AssignToWork_(41,_'36587')
+ AssignToWork_(42,_'36587') <= 3

C79: AssignToWork(1,_'38368') + AssignToWork_(2,_'38368')
+ AssignToWork_(3,_'38368') + AssignToWork_(4,_'38368')
+ AssignToWork_(5,_'38368') + AssignToWork_(6,_'38368')
+ AssignToWork_(7,_'38368') <= 3

C80: AssignToWork(10,_'38368') + AssignToWork_(11,_'38368')
+ AssignToWork_(12,_'38368') + AssignToWork_(13,_'38368')
+ AssignToWork_(14,_'38368') + AssignToWork_(8,_'38368')
+ AssignToWork_(9,_'38368') <= 3

C81: AssignToWork(15,_'38368') + AssignToWork_(16,_'38368')
+ AssignToWork_(17,_'38368') + AssignToWork_(18,_'38368')
+ AssignToWork_(19,_'38368') + AssignToWork_(20,_'38368')
+ AssignToWork_(21,_'38368') <= 3

C82: AssignToWork(22,_'38368') + AssignToWork_(23,_'38368')
+ AssignToWork_(24,_'38368') + AssignToWork_(25,_'38368')
+ AssignToWork_(26,_'38368') + AssignToWork_(27,_'38368')
+ AssignToWork_(28,_'38368') <= 3

C83: AssignToWork(29,_'38368') + AssignToWork_(30,_'38368')
+ AssignToWork_(31,_'38368') + AssignToWork_(32,_'38368')
+ AssignToWork_(33,_'38368') + AssignToWork_(34,_'38368')
+ AssignToWork_(35,_'38368') <= 3

C84: AssignToWork(36,_'38368') + AssignToWork_(37,_'38368')
+ AssignToWork_(38,_'38368') + AssignToWork_(39,_'38368')
+ AssignToWork_(40,_'38368') + AssignToWork_(41,_'38368')
+ AssignToWork_(42,_'38368') <= 3

C85: 0 AssignToWork(1,_'59561') + 0 AssignToWork_(2,_'59561')
+ 0 AssignToWork_(3,_'59561') + AssignToWork_(4,_'59561')
+ AssignToWork_(5,_'59561') + AssignToWork_(6,_'59561')
+ AssignToWork_(7,_'59561') <= 0

C86: AssignToWork(10,_'59561') + AssignToWork_(11,_'59561')
+ AssignToWork_(12,_'59561') + AssignToWork_(13,_'59561')
+ AssignToWork_(14,_'59561') + AssignToWork_(8,_'59561')
+ AssignToWork_(9,_'59561') <= 3

C87: AssignToWork(15,_'59561') + AssignToWork_(16,_'59561')
+ AssignToWork_(17,_'59561') + AssignToWork_(18,_'59561')
+ AssignToWork_(19,_'59561') + AssignToWork_(20,_'59561')
+ AssignToWork_(21,_'59561') <= 3

C88: AssignToWork(22,_'59561') + AssignToWork_(23,_'59561')
+ AssignToWork_(24,_'59561') + AssignToWork_(25,_'59561')
+ AssignToWork_(26,_'59561') + AssignToWork_(27,_'59561')
+ AssignToWork_(28,_'59561') <= 3

C89: AssignToWork(29,_'59561') + AssignToWork_(30,_'59561')
+ AssignToWork_(31,_'59561') + AssignToWork_(32,_'59561')
+ AssignToWork_(33,_'59561') + AssignToWork_(34,_'59561')
+ AssignToWork_(35,_'59561') <= 3

C90: AssignToWork(36,_'59561') + AssignToWork_(37,_'59561')
+ AssignToWork_(38,_'59561') + AssignToWork_(39,_'59561')
+ AssignToWork_(40,_'59561') + AssignToWork_(41,_'59561')
+ AssignToWork_(42,_'59561') <= 3

C91: AssignToWork(1,_'99263') + AssignToWork_(2,_'99263')
+ AssignToWork_(3,_'99263') + AssignToWork_(4,_'99263')
+ AssignToWork_(5,_'99263') + AssignToWork_(6,_'99263')
+ AssignToWork_(7,_'99263') <= 3

C92: AssignToWork(10,_'99263') + AssignToWork_(11,_'99263')
+ AssignToWork_(12,_'99263') + AssignToWork_(13,_'99263')
+ AssignToWork_(14,_'99263') + AssignToWork_(8,_'99263')
+ AssignToWork_(9,_'99263') <= 3

C93: AssignToWork(15,_'99263') + AssignToWork_(16,_'99263')
+ AssignToWork_(17,_'99263') + AssignToWork_(18,_'99263')
+ AssignToWork_(19,_'99263') + AssignToWork_(20,_'99263')
+ AssignToWork_(21,_'99263') <= 3

C94: AssignToWork(22,_'99263') + AssignToWork_(23,_'99263')
+ AssignToWork_(24,_'99263') + AssignToWork_(25,_'99263')
+ AssignToWork_(26,_'99263') + AssignToWork_(27,_'99263')
+ AssignToWork_(28,_'99263') <= 3

C95: AssignToWork(29,_'99263') + AssignToWork_(30,_'99263')
+ AssignToWork_(31,_'99263') + AssignToWork_(32,_'99263')
+ AssignToWork_(33,_'99263') + AssignToWork_(34,_'99263')
+ AssignToWork_(35,_'99263') <= 3

C96: AssignToWork(36,_'99263') + AssignToWork_(37,_'99263')
+ AssignToWork_(38,_'99263') + AssignToWork_(39,_'99263')
+ AssignToWork_(40,_'99263') + AssignToWork_(41,_'99263')
+ AssignToWork_(42,_'99263') <= 3

C97: AssignToWork(1,_'105865') + AssignToWork_(2,_'105865')
+ AssignToWork_(3,_'105865') + AssignToWork_(4,_'105865')

+ AssignToWork_(5,_'105865') + AssignToWork_(6,_'105865')
+ AssignToWork_(7,_'105865') <= 3

C98: AssignToWork(10,_'105865') + AssignToWork_(11,_'105865')
+ AssignToWork_(12,_'105865') + AssignToWork_(13,_'105865')
+ AssignToWork_(14,_'105865') + AssignToWork_(8,_'105865')
+ AssignToWork_(9,_'105865') <= 3

C99: AssignToWork(15,_'105865') + AssignToWork_(16,_'105865')
+ AssignToWork_(17,_'105865') + AssignToWork_(18,_'105865')
+ AssignToWork_(19,_'105865') + AssignToWork_(20,_'105865')
+ AssignToWork_(21,_'105865') <= 3

C100: AssignToWork(22,_'105865') + AssignToWork_(23,_'105865')
+ AssignToWork_(24,_'105865') + AssignToWork_(25,_'105865')
+ AssignToWork_(26,_'105865') + AssignToWork_(27,_'105865')
+ AssignToWork_(28,_'105865') <= 3

C101: AssignToWork(29,_'105865') + AssignToWork_(30,_'105865')
+ AssignToWork_(31,_'105865') + AssignToWork_(32,_'105865')
+ AssignToWork_(33,_'105865') + AssignToWork_(34,_'105865')
+ AssignToWork_(35,_'105865') <= 3

C102: AssignToWork(36,_'105865') + AssignToWork_(37,_'105865')
+ AssignToWork_(38,_'105865') + AssignToWork_(39,_'105865')
+ AssignToWork_(40,_'105865') + AssignToWork_(41,_'105865')
+ AssignToWork_(42,_'105865') <= 3

C103: AssignToWork(16,_'12295') + AssignToWork_(2,_'12295')
+ AssignToWork_(23,_'12295') + AssignToWork_(30,_'12295')
+ AssignToWork_(37,_'12295') + AssignToWork_(9,_'12295') >= 2

C104: AssignToWork(16,_'14581') + AssignToWork_(2,_'14581')
+ AssignToWork_(23,_'14581') + AssignToWork_(30,_'14581')
+ AssignToWork_(37,_'14581') + AssignToWork_(9,_'14581') >= 2

C105: AssignToWork(16,_'18182') + AssignToWork_(2,_'18182')
+ AssignToWork_(23,_'18182') + AssignToWork_(30,_'18182')
+ AssignToWork_(37,_'18182') + AssignToWork_(9,_'18182') >= 2

C106: AssignToWork(16,_'31300') + AssignToWork_(2,_'31300')
+ AssignToWork_(23,_'31300') + AssignToWork_(30,_'31300')
+ AssignToWork_(37,_'31300') + AssignToWork_(9,_'31300') >= 2

C107: AssignToWork(16,_'31407') + AssignToWork_(2,_'31407')
+ AssignToWork_(23,_'31407') + AssignToWork_(30,_'31407')
+ AssignToWork_(37,_'31407') + AssignToWork_(9,_'31407') >= 2

C108: AssignToWork(16,_'36587') + AssignToWork_(2,_'36587')
+ AssignToWork_(23,_'36587') + AssignToWork_(30,_'36587')
+ AssignToWork_(37,_'36587') + AssignToWork_(9,_'36587') >= 2

C109: AssignToWork(16,_'38368') + AssignToWork_(2,_'38368')
+ AssignToWork_(23,_'38368') + AssignToWork_(30,_'38368')
+ AssignToWork_(37,_'38368') + AssignToWork_(9,_'38368') >= 2

C110: AssignToWork(16,_'59561') + AssignToWork_(2,_'59561')
+ AssignToWork_(23,_'59561') + AssignToWork_(30,_'59561')
+ AssignToWork_(37,_'59561') + AssignToWork_(9,_'59561') >= 2

C111: AssignToWork(16,_'99263') + AssignToWork_(2,_'99263')
+ AssignToWork_(23,_'99263') + AssignToWork_(30,_'99263')
+ AssignToWork_(37,_'99263') + AssignToWork_(9,_'99263') >= 2

C112: AssignToWork(16,_'105865') + AssignToWork_(2,_'105865')
+ AssignToWork_(23,_'105865') + AssignToWork_(30,_'105865')
+ AssignToWork_(37,_'105865') + AssignToWork_(9,_'105865') >= 2

C113: AssignToWork(13,_'12295') + AssignToWork_(20,_'12295')
+ AssignToWork_(27,_'12295') + AssignToWork_(34,_'12295')
+ AssignToWork_(41,_'12295') + AssignToWork_(6,_'12295') >= 2

C114: AssignToWork(13,_'14581') + AssignToWork_(20,_'14581')
+ AssignToWork_(27,_'14581') + AssignToWork_(34,_'14581')
+ AssignToWork_(41,_'14581') + AssignToWork_(6,_'14581') >= 2

C115: AssignToWork(13,_'18182') + AssignToWork_(20,_'18182')
+ AssignToWork_(27,_'18182') + AssignToWork_(34,_'18182')
+ AssignToWork_(41,_'18182') + AssignToWork_(6,_'18182') >= 2

C116: AssignToWork(13,_'31300') + AssignToWork_(20,_'31300')
+ AssignToWork_(27,_'31300') + AssignToWork_(34,_'31300')
+ AssignToWork_(41,_'31300') + AssignToWork_(6,_'31300') >= 2

C117: AssignToWork(13,_'31407') + AssignToWork_(20,_'31407')
+ AssignToWork_(27,_'31407') + AssignToWork_(34,_'31407')
+ AssignToWork_(41,_'31407') + AssignToWork_(6,_'31407') >= 2

C118: AssignToWork(13,_'36587') + AssignToWork_(20,_'36587')
+ AssignToWork_(27,_'36587') + AssignToWork_(34,_'36587')
+ AssignToWork_(41,_'36587') + AssignToWork_(6,_'36587') >= 2

C119: AssignToWork(13,_'38368') + AssignToWork_(20,_'38368')
+ AssignToWork_(27,_'38368') + AssignToWork_(34,_'38368')
+ AssignToWork_(41,_'38368') + AssignToWork_(6,_'38368') >= 2

C120: AssignToWork(13,_'59561') + AssignToWork_(20,_'59561')
+ AssignToWork_(27,_'59561') + AssignToWork_(34,_'59561')
+ AssignToWork_(41,_'59561') + AssignToWork_(6,_'59561') >= 2

C121: AssignToWork(13,_'99263') + AssignToWork_(20,_'99263')
+ AssignToWork_(27,_'99263') + AssignToWork_(34,_'99263')
+ AssignToWork_(41,_'99263') + AssignToWork_(6,_'99263') >= 2

C122: AssignToWork(13,_'105865') + AssignToWork_(20,_'105865')
+ AssignToWork_(27,_'105865') + AssignToWork_(34,_'105865')
+ AssignToWork_(41,_'105865') + AssignToWork_(6,_'105865') >= 2

C123: AssignToWork(14,_'12295') + AssignToWork_(21,_'12295')
+ AssignToWork_(28,_'12295') + AssignToWork_(35,_'12295')
+ AssignToWork_(42,_'12295') + AssignToWork_(7,_'12295') >= 2

C124: AssignToWork(14,_'14581') + AssignToWork_(21,_'14581')
+ AssignToWork_(28,_'14581') + AssignToWork_(35,_'14581')
+ AssignToWork_(42,_'14581') + AssignToWork_(7,_'14581') >= 2

C125: AssignToWork(14,_'18182') + AssignToWork_(21,_'18182')
+ AssignToWork_(28,_'18182') + AssignToWork_(35,_'18182')
+ AssignToWork_(42,_'18182') + AssignToWork_(7,_'18182') >= 2

C126: AssignToWork(14,_'31300') + AssignToWork_(21,_'31300')
+ AssignToWork_(28,_'31300') + AssignToWork_(35,_'31300')
+ AssignToWork_(42,_'31300') + AssignToWork_(7,_'31300') >= 2

C127: AssignToWork(14,_'31407') + AssignToWork_(21,_'31407')
+ AssignToWork_(28,_'31407') + AssignToWork_(35,_'31407')
+ AssignToWork_(42,_'31407') + AssignToWork_(7,_'31407') >= 2

C128: AssignToWork(14,_'36587') + AssignToWork_(21,_'36587')
+ AssignToWork_(28,_'36587') + AssignToWork_(35,_'36587')
+ AssignToWork_(42,_'36587') + AssignToWork_(7,_'36587') >= 2

C129: AssignToWork(14,_'38368') + AssignToWork_(21,_'38368')
+ AssignToWork_(28,_'38368') + AssignToWork_(35,_'38368')
+ AssignToWork_(42,_'38368') + AssignToWork_(7,_'38368') >= 2

C130: AssignToWork(14,_'59561') + AssignToWork_(21,_'59561')
+ AssignToWork_(28,_'59561') + AssignToWork_(35,_'59561')
+ AssignToWork_(42,_'59561') + AssignToWork_(7,_'59561') >= 2

C131: AssignToWork(14,_'99263') + AssignToWork_(21,_'99263')
+ AssignToWork_(28,_'99263') + AssignToWork_(35,_'99263')
+ AssignToWork_(42,_'99263') + AssignToWork_(7,_'99263') >= 2

C132: AssignToWork(14,_'105865') + AssignToWork_(21,_'105865')
+ AssignToWork_(28,_'105865') + AssignToWork_(35,_'105865')
+ AssignToWork_(42,_'105865') + AssignToWork_(7,_'105865') >= 2

C133: AssignToWork(1,_'12295') + AssignToWork_(15,_'12295')
+ AssignToWork_(22,_'12295') + AssignToWork_(29,_'12295')
+ AssignToWork_(36,_'12295') + AssignToWork_(8,_'12295') >= 2

C134: AssignToWork(1,_'14581') + AssignToWork_(15,_'14581')
+ AssignToWork_(22,_'14581') + AssignToWork_(29,_'14581')
+ AssignToWork_(36,_'14581') + AssignToWork_(8,_'14581') >= 2

C135: AssignToWork(1,_'18182') + AssignToWork_(15,_'18182')
+ AssignToWork_(22,_'18182') + AssignToWork_(29,_'18182')
+ AssignToWork_(36,_'18182') + AssignToWork_(8,_'18182') >= 2

C136: AssignToWork(1,_'31300') + AssignToWork_(15,_'31300')
+ AssignToWork_(22,_'31300') + AssignToWork_(29,_'31300')
+ AssignToWork_(36,_'31300') + AssignToWork_(8,_'31300') >= 2

C137: AssignToWork(1,_'31407') + AssignToWork_(15,_'31407')
+ AssignToWork_(22,_'31407') + AssignToWork_(29,_'31407')
+ AssignToWork_(36,_'31407') + AssignToWork_(8,_'31407') >= 2

C138: AssignToWork(1,_'36587') + AssignToWork_(15,_'36587')
+ AssignToWork_(22,_'36587') + AssignToWork_(29,_'36587')
+ AssignToWork_(36,_'36587') + AssignToWork_(8,_'36587') >= 2

C139: AssignToWork(1,_'38368') + AssignToWork_(15,_'38368')
+ AssignToWork_(22,_'38368') + AssignToWork_(29,_'38368')
+ AssignToWork_(36,_'38368') + AssignToWork_(8,_'38368') >= 2

C140: AssignToWork(1,_'59561') + AssignToWork_(15,_'59561')
+ AssignToWork_(22,_'59561') + AssignToWork_(29,_'59561')
+ AssignToWork_(36,_'59561') + AssignToWork_(8,_'59561') >= 2

C141: AssignToWork(1,_'99263') + AssignToWork_(15,_'99263')
+ AssignToWork_(22,_'99263') + AssignToWork_(29,_'99263')
+ AssignToWork_(36,_'99263') + AssignToWork_(8,_'99263') >= 2

C142: AssignToWork(1,_'105865') + AssignToWork_(15,_'105865')
+ AssignToWork_(22,_'105865') + AssignToWork_(29,_'105865')
+ AssignToWork_(36,_'105865') + AssignToWork_(8,_'105865') >= 2

C143: AssignToWork(1,_'105865') + AssignToWork_(1,_'12295')
- 2 AssignToWork_(1,_'14581') + AssignToWork_(1,_'18182')
+ AssignToWork_(1,_'31300') + AssignToWork_(1,_'31407')
+ AssignToWork_(1,_'36587') + AssignToWork_(1,_'38368')
+ AssignToWork_(1,_'59561') - 2 AssignToWork_(1,_'99263') >= 0

C144: AssignToWork(2,_'105865') + AssignToWork_(2,_'12295')
- 2 AssignToWork_(2,_'14581') + AssignToWork_(2,_'18182')
+ AssignToWork_(2,_'31300') + AssignToWork_(2,_'31407')
+ AssignToWork_(2,_'36587') + AssignToWork_(2,_'38368')
+ AssignToWork_(2,_'59561') - 2 AssignToWork_(2,_'99263') >= 0

C145: AssignToWork(3,_'105865') + AssignToWork_(3,_'12295')
- 2 AssignToWork_(3,_'14581') + AssignToWork_(3,_'18182')
+ AssignToWork_(3,_'31300') + AssignToWork_(3,_'31407')
+ AssignToWork_(3,_'36587') + AssignToWork_(3,_'38368')
+ AssignToWork_(3,_'59561') - 2 AssignToWork_(3,_'99263') >= 0

C146: AssignToWork(4,_'105865') + AssignToWork_(4,_'12295')
- 2 AssignToWork_(4,_'14581') + AssignToWork_(4,_'18182')
+ AssignToWork_(4,_'31300') + AssignToWork_(4,_'31407')
+ AssignToWork_(4,_'36587') + AssignToWork_(4,_'38368')
+ AssignToWork_(4,_'59561') - 2 AssignToWork_(4,_'99263') >= 0

C147: AssignToWork(5,_'105865') + AssignToWork_(5,_'12295')
- 2 AssignToWork_(5,_'14581') + AssignToWork_(5,_'18182')
+ AssignToWork_(5,_'31300') + AssignToWork_(5,_'31407')
+ AssignToWork_(5,_'36587') + AssignToWork_(5,_'38368')
+ AssignToWork_(5,_'59561') - 2 AssignToWork_(5,_'99263') >= 0

C148: AssignToWork(6,_'105865') + AssignToWork_(6,_'12295')
- 2 AssignToWork_(6,_'14581') + AssignToWork_(6,_'18182')
+ AssignToWork_(6,_'31300') + AssignToWork_(6,_'31407')
+ AssignToWork_(6,_'36587') + AssignToWork_(6,_'38368')
+ AssignToWork_(6,_'59561') - 2 AssignToWork_(6,_'99263') >= 0

C149: AssignToWork(7,_'105865') + AssignToWork_(7,_'12295')
- 2 AssignToWork_(7,_'14581') + AssignToWork_(7,_'18182')
+ AssignToWork_(7,_'31300') + AssignToWork_(7,_'31407')
+ AssignToWork_(7,_'36587') + AssignToWork_(7,_'38368')
+ AssignToWork_(7,_'59561') - 2 AssignToWork_(7,_'99263') >= 0

C150: AssignToWork(8,_'105865') + AssignToWork_(8,_'12295')
- 2 AssignToWork_(8,_'14581') + AssignToWork_(8,_'18182')
+ AssignToWork_(8,_'31300') + AssignToWork_(8,_'31407')
+ AssignToWork_(8,_'36587') + AssignToWork_(8,_'38368')
+ AssignToWork_(8,_'59561') - 2 AssignToWork_(8,_'99263') >= 0

C151: AssignToWork(9,_'105865') + AssignToWork_(9,_'12295')
- 2 AssignToWork_(9,_'14581') + AssignToWork_(9,_'18182')
+ AssignToWork_(9,_'31300') + AssignToWork_(9,_'31407')
+ AssignToWork_(9,_'36587') + AssignToWork_(9,_'38368')
+ AssignToWork_(9,_'59561') - 2 AssignToWork_(9,_'99263') >= 0

C152: AssignToWork(10,_'105865') + AssignToWork_(10,_'12295')
- 2 AssignToWork_(10,_'14581') + AssignToWork_(10,_'18182')
+ AssignToWork_(10,_'31300') + AssignToWork_(10,_'31407')
+ AssignToWork_(10,_'36587') + AssignToWork_(10,_'38368')
+ AssignToWork_(10,_'59561') - 2 AssignToWork_(10,_'99263') >= 0

C153: AssignToWork(11,_'105865') + AssignToWork_(11,_'12295')
- 2 AssignToWork_(11,_'14581') + AssignToWork_(11,_'18182')
+ AssignToWork_(11,_'31300') + AssignToWork_(11,_'31407')
+ AssignToWork_(11,_'36587') + AssignToWork_(11,_'38368')
+ AssignToWork_(11,_'59561') - 2 AssignToWork_(11,_'99263') >= 0

C154: AssignToWork(12,_'105865') + AssignToWork_(12,_'12295')
- 2 AssignToWork_(12,_'14581') + AssignToWork_(12,_'18182')
+ AssignToWork_(12,_'31300') + AssignToWork_(12,_'31407')
+ AssignToWork_(12,_'36587') + AssignToWork_(12,_'38368')
+ AssignToWork_(12,_'59561') - 2 AssignToWork_(12,_'99263') >= 0

C155: AssignToWork(13,_'105865') + AssignToWork_(13,_'12295')
- 2 AssignToWork_(13,_'14581') + AssignToWork_(13,_'18182')
+ AssignToWork_(13,_'31300') + AssignToWork_(13,_'31407')
+ AssignToWork_(13,_'36587') + AssignToWork_(13,_'38368')

+ AssignToWork_(13,_'59561') - 2 AssignToWork_(13,_'99263') >= 0

C156: AssignToWork(14,_'105865') + AssignToWork_(14,_'12295')
- 2 AssignToWork_(14,_'14581') + AssignToWork_(14,_'18182')
+ AssignToWork_(14,_'31300') + AssignToWork_(14,_'31407')
+ AssignToWork_(14,_'36587') + AssignToWork_(14,_'38368')
+ AssignToWork_(14,_'59561') - 2 AssignToWork_(14,_'99263') >= 0

C157: AssignToWork(15,_'105865') + AssignToWork_(15,_'12295')
- 2 AssignToWork_(15,_'14581') + AssignToWork_(15,_'18182')
+ AssignToWork_(15,_'31300') + AssignToWork_(15,_'31407')
+ AssignToWork_(15,_'36587') + AssignToWork_(15,_'38368')
+ AssignToWork_(15,_'59561') - 2 AssignToWork_(15,_'99263') >= 0

C158: AssignToWork(16,_'105865') + AssignToWork_(16,_'12295')
- 2 AssignToWork_(16,_'14581') + AssignToWork_(16,_'18182')
+ AssignToWork_(16,_'31300') + AssignToWork_(16,_'31407')
+ AssignToWork_(16,_'36587') + AssignToWork_(16,_'38368')
+ AssignToWork_(16,_'59561') - 2 AssignToWork_(16,_'99263') >= 0

C159: AssignToWork(17,_'105865') + AssignToWork_(17,_'12295')
- 2 AssignToWork_(17,_'14581') + AssignToWork_(17,_'18182')
+ AssignToWork_(17,_'31300') + AssignToWork_(17,_'31407')
+ AssignToWork_(17,_'36587') + AssignToWork_(17,_'38368')
+ AssignToWork_(17,_'59561') - 2 AssignToWork_(17,_'99263') >= 0

C160: AssignToWork(18,_'105865') + AssignToWork_(18,_'12295')
- 2 AssignToWork_(18,_'14581') + AssignToWork_(18,_'18182')
+ AssignToWork_(18,_'31300') + AssignToWork_(18,_'31407')
+ AssignToWork_(18,_'36587') + AssignToWork_(18,_'38368')
+ AssignToWork_(18,_'59561') - 2 AssignToWork_(18,_'99263') >= 0

C161: AssignToWork(19,_'105865') + AssignToWork_(19,_'12295')
- 2 AssignToWork_(19,_'14581') + AssignToWork_(19,_'18182')
+ AssignToWork_(19,_'31300') + AssignToWork_(19,_'31407')
+ AssignToWork_(19,_'36587') + AssignToWork_(19,_'38368')
+ AssignToWork_(19,_'59561') - 2 AssignToWork_(19,_'99263') >= 0

C162: AssignToWork(20,_'105865') + AssignToWork_(20,_'12295')
- 2 AssignToWork_(20,_'14581') + AssignToWork_(20,_'18182')
+ AssignToWork_(20,_'31300') + AssignToWork_(20,_'31407')
+ AssignToWork_(20,_'36587') + AssignToWork_(20,_'38368')
+ AssignToWork_(20,_'59561') - 2 AssignToWork_(20,_'99263') >= 0

C163: AssignToWork(21,_'105865') + AssignToWork_(21,_'12295')
- 2 AssignToWork_(21,_'14581') + AssignToWork_(21,_'18182')
+ AssignToWork_(21,_'31300') + AssignToWork_(21,_'31407')
+ AssignToWork_(21,_'36587') + AssignToWork_(21,_'38368')
+ AssignToWork_(21,_'59561') - 2 AssignToWork_(21,_'99263') >= 0

C164: AssignToWork(22,_'105865') + AssignToWork_(22,_'12295')
- 2 AssignToWork_(22,_'14581') + AssignToWork_(22,_'18182')
+ AssignToWork_(22,_'31300') + AssignToWork_(22,_'31407')
+ AssignToWork_(22,_'36587') + AssignToWork_(22,_'38368')
+ AssignToWork_(22,_'59561') - 2 AssignToWork_(22,_'99263') >= 0

C165: AssignToWork(23,_'105865') + AssignToWork_(23,_'12295')
- 2 AssignToWork_(23,_'14581') + AssignToWork_(23,_'18182')
+ AssignToWork_(23,_'31300') + AssignToWork_(23,_'31407')
+ AssignToWork_(23,_'36587') + AssignToWork_(23,_'38368')
+ AssignToWork_(23,_'59561') - 2 AssignToWork_(23,_'99263') >= 0

C166: AssignToWork(24,_'105865') + AssignToWork_(24,_'12295')
- 2 AssignToWork_(24,_'14581') + AssignToWork_(24,_'18182')
+ AssignToWork_(24,_'31300') + AssignToWork_(24,_'31407')
+ AssignToWork_(24,_'36587') + AssignToWork_(24,_'38368')
+ AssignToWork_(24,_'59561') - 2 AssignToWork_(24,_'99263') >= 0

C167: AssignToWork(25,_'105865') + AssignToWork_(25,_'12295')
- 2 AssignToWork_(25,_'14581') + AssignToWork_(25,_'18182')
+ AssignToWork_(25,_'31300') + AssignToWork_(25,_'31407')
+ AssignToWork_(25,_'36587') + AssignToWork_(25,_'38368')
+ AssignToWork_(25,_'59561') - 2 AssignToWork_(25,_'99263') >= 0

C168: AssignToWork(26,_'105865') + AssignToWork_(26,_'12295')
- 2 AssignToWork_(26,_'14581') + AssignToWork_(26,_'18182')
+ AssignToWork_(26,_'31300') + AssignToWork_(26,_'31407')
+ AssignToWork_(26,_'36587') + AssignToWork_(26,_'38368')
+ AssignToWork_(26,_'59561') - 2 AssignToWork_(26,_'99263') >= 0

C169: AssignToWork(27,_'105865') + AssignToWork_(27,_'12295')
- 2 AssignToWork_(27,_'14581') + AssignToWork_(27,_'18182')
+ AssignToWork_(27,_'31300') + AssignToWork_(27,_'31407')
+ AssignToWork_(27,_'36587') + AssignToWork_(27,_'38368')
+ AssignToWork_(27,_'59561') - 2 AssignToWork_(27,_'99263') >= 0

C170: AssignToWork(28,_'105865') + AssignToWork_(28,_'12295')
- 2 AssignToWork_(28,_'14581') + AssignToWork_(28,_'18182')

+ AssignToWork_(28,_'31300') + AssignToWork_(28,_'31407')
+ AssignToWork_(28,_'36587') + AssignToWork_(28,_'38368')
+ AssignToWork_(28,_'59561') - 2 AssignToWork_(28,_'99263') >= 0

C171: AssignToWork(29,_'105865') + AssignToWork_(29,_'12295')
- 2 AssignToWork_(29,_'14581') + AssignToWork_(29,_'18182')
+ AssignToWork_(29,_'31300') + AssignToWork_(29,_'31407')
+ AssignToWork_(29,_'36587') + AssignToWork_(29,_'38368')
+ AssignToWork_(29,_'59561') - 2 AssignToWork_(29,_'99263') >= 0

C172: AssignToWork(30,_'105865') + AssignToWork_(30,_'12295')
- 2 AssignToWork_(30,_'14581') + AssignToWork_(30,_'18182')
+ AssignToWork_(30,_'31300') + AssignToWork_(30,_'31407')
+ AssignToWork_(30,_'36587') + AssignToWork_(30,_'38368')
+ AssignToWork_(30,_'59561') - 2 AssignToWork_(30,_'99263') >= 0

C173: AssignToWork(31,_'105865') + AssignToWork_(31,_'12295')
- 2 AssignToWork_(31,_'14581') + AssignToWork_(31,_'18182')
+ AssignToWork_(31,_'31300') + AssignToWork_(31,_'31407')
+ AssignToWork_(31,_'36587') + AssignToWork_(31,_'38368')
+ AssignToWork_(31,_'59561') - 2 AssignToWork_(31,_'99263') >= 0

C174: AssignToWork(32,_'105865') + AssignToWork_(32,_'12295')
- 2 AssignToWork_(32,_'14581') + AssignToWork_(32,_'18182')
+ AssignToWork_(32,_'31300') + AssignToWork_(32,_'31407')
+ AssignToWork_(32,_'36587') + AssignToWork_(32,_'38368')
+ AssignToWork_(32,_'59561') - 2 AssignToWork_(32,_'99263') >= 0

C175: AssignToWork(33,_'105865') + AssignToWork_(33,_'12295')
- 2 AssignToWork_(33,_'14581') + AssignToWork_(33,_'18182')
+ AssignToWork_(33,_'31300') + AssignToWork_(33,_'31407')
+ AssignToWork_(33,_'36587') + AssignToWork_(33,_'38368')
+ AssignToWork_(33,_'59561') - 2 AssignToWork_(33,_'99263') >= 0

C176: AssignToWork(34,_'105865') + AssignToWork_(34,_'12295')
- 2 AssignToWork_(34,_'14581') + AssignToWork_(34,_'18182')
+ AssignToWork_(34,_'31300') + AssignToWork_(34,_'31407')
+ AssignToWork_(34,_'36587') + AssignToWork_(34,_'38368')
+ AssignToWork_(34,_'59561') - 2 AssignToWork_(34,_'99263') >= 0

C177: AssignToWork(35,_'105865') + AssignToWork_(35,_'12295')
- 2 AssignToWork_(35,_'14581') + AssignToWork_(35,_'18182')
+ AssignToWork_(35,_'31300') + AssignToWork_(35,_'31407')
+ AssignToWork_(35,_'36587') + AssignToWork_(35,_'38368')
+ AssignToWork_(35,_'59561') - 2 AssignToWork_(35,_'99263') >= 0

C178: AssignToWork(36,_'105865') + AssignToWork_(36,_'12295')
- 2 AssignToWork_(36,_'14581') + AssignToWork_(36,_'18182')
+ AssignToWork_(36,_'31300') + AssignToWork_(36,_'31407')
+ AssignToWork_(36,_'36587') + AssignToWork_(36,_'38368')
+ AssignToWork_(36,_'59561') - 2 AssignToWork_(36,_'99263') >= 0

C179: AssignToWork(37,_'105865') + AssignToWork_(37,_'12295')
- 2 AssignToWork_(37,_'14581') + AssignToWork_(37,_'18182')
+ AssignToWork_(37,_'31300') + AssignToWork_(37,_'31407')
+ AssignToWork_(37,_'36587') + AssignToWork_(37,_'38368')
+ AssignToWork_(37,_'59561') - 2 AssignToWork_(37,_'99263') >= 0

C180: AssignToWork(38,_'105865') + AssignToWork_(38,_'12295')
- 2 AssignToWork_(38,_'14581') + AssignToWork_(38,_'18182')
+ AssignToWork_(38,_'31300') + AssignToWork_(38,_'31407')
+ AssignToWork_(38,_'36587') + AssignToWork_(38,_'38368')
+ AssignToWork_(38,_'59561') - 2 AssignToWork_(38,_'99263') >= 0

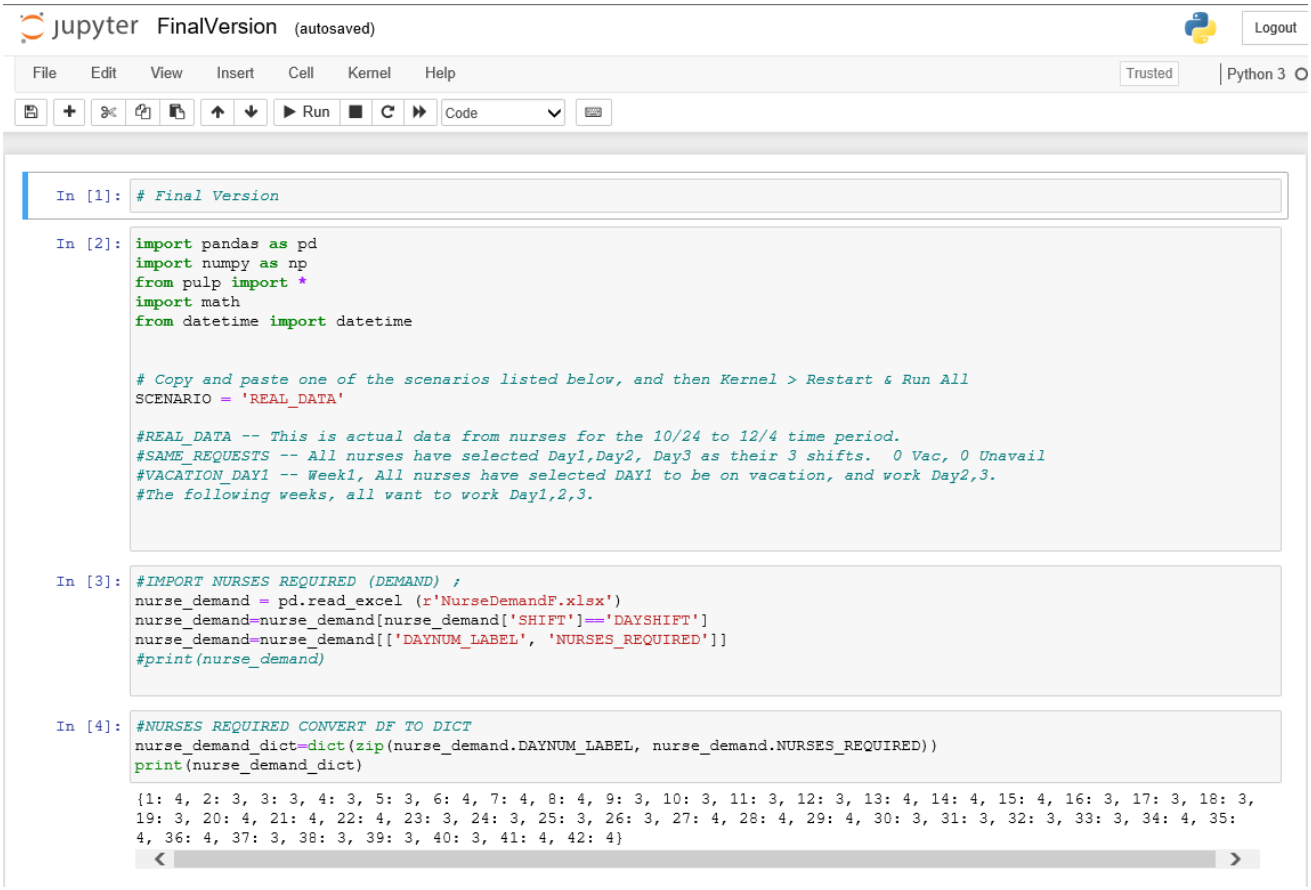
C181: AssignToWork(39,_'105865') + AssignToWork_(39,_'12295')
- 2 AssignToWork_(39,_'14581') + AssignToWork_(39,_'18182')
+ AssignToWork_(39,_'31300') + AssignToWork_(39,_'31407')
+ AssignToWork_(39,_'36587') + AssignToWork_(39,_'38368')
+ AssignToWork_(39,_'59561') - 2 AssignToWork_(39,_'99263') >= 0

C182: AssignToWork(40,_'105865') + AssignToWork_(40,_'12295')
- 2 AssignToWork_(40,_'14581') + AssignToWork_(40,_'18182')
+ AssignToWork_(40,_'31300') + AssignToWork_(40,_'31407')
+ AssignToWork_(40,_'36587') + AssignToWork_(40,_'38368')
+ AssignToWork_(40,_'59561') - 2 AssignToWork_(40,_'99263') >= 0

C183: AssignToWork(41,_'105865') + AssignToWork_(41,_'12295')
- 2 AssignToWork_(41,_'14581') + AssignToWork_(41,_'18182')
+ AssignToWork_(41,_'31300') + AssignToWork_(41,_'31407')
+ AssignToWork_(41,_'36587') + AssignToWork_(41,_'38368')
+ AssignToWork_(41,_'59561') - 2 AssignToWork_(41,_'99263') >= 0

C184: AssignToWork(42,_'105865') + AssignToWork_(42,_'12295')
- 2 AssignToWork_(42,_'14581') + AssignToWork_(42,_'18182')
+ AssignToWork_(42,_'31300') + AssignToWork_(42,_'31407')
+ AssignToWork_(42,_'36587') + AssignToWork_(42,_'38368')
+ AssignToWork_(42,_'59561') - 2 AssignToWork_(42,_'99263') >= 0

Code (Jupyter Notbook, Python)



In [5]:
```
#NURSES REQUESTS: IMPORT
NURSE_SHIFT_REQUESTS_ORIG = pd.read_excel(r'NurseShiftRequests6WksF.xlsx')

# FILTER FOR SCENARIO
NURSE_SHIFT_REQUESTS=NURSE_SHIFT_REQUESTS_ORIG[NURSE_SHIFT_REQUESTS_ORIG['SCENARIO']==SCENARIO].copy()
#print(NURSE_SHIFT_REQUESTS)

# convert EMPLOYEEID to string
NURSE_SHIFT_REQUESTS['EMPLOYEEID']= NURSE_SHIFT_REQUESTS['EMPLOYEEID'].map(str)

# get just the cols we need
NURSE_SHIFT_REQUESTS=NURSE_SHIFT_REQUESTS[NURSE_SHIFT_REQUESTS.columns[~NURSE_SHIFT_REQUESTS_ORIG.columns.isin(['SCENARI
#print(NURSE_SHIFT_REQUESTS)

# MAKE EMPID THEINDEX
NURSE_SHIFT_REQUESTS.set_index('EMPLOYEEID', inplace=True)
#print(NURSE_SHIFT_REQUESTS)

#CONVERT DF TO DICT
nurse_shift_req_dictnew=NURSE_SHIFT_REQUESTS.to_dict()
#print(nurse_shift_req_dictnew)
```

In [6]:
```
# NURSE LIST -- NEED LIST TO LOOP OVER

nurse_list = NURSE_SHIFT_REQUESTS.index.tolist()
#print(nurse_list)
```

In [7]:
```
#NURSE VAC -- GET DATA AND CONVERT TO DICT
NURSES_VAC = pd.read_excel (r'NurseVacation6WksF.xlsx')

# FILTER FOR SCENARIO
NURSES_VAC=NURSES_VAC[NURSES_VAC['SCENARIO']==SCENARIO].copy()


NURSES_VAC['EMPLOYEEID']= NURSES_VAC['EMPLOYEEID'].map(str)
NURSES_VAC=NURSES_VAC[NURSES_VAC.columns[~NURSES_VAC.columns.isin(['SCENARIO','JOB','NURSEGROUP','SHIFTABBR'])]]

# MAKE EMPID THEINDEX
NURSES_VAC.set_index('EMPLOYEEID', inplace=True)

#CONVERT DF TO DICT
nurse_vac_dictnew=NURSES_VAC.to_dict()
#print(nurse_vac_dictnew)
```

In [8]:
```
#NURSE UNAVAIL -- GET DATA AND CONVERT TO DICT
NURSES_UNAVAIL = pd.read_excel (r'NurseUnavailable6WksF.xlsx')

# FILTER FOR SCENARIO
NURSES_UNAVAIL=NURSES_UNAVAIL[NURSES_UNAVAIL['SCENARIO']==SCENARIO].copy()

NURSES_UNAVAIL['EMPLOYEEID']= NURSES_UNAVAIL['EMPLOYEEID'].map(str)
NURSES_UNAVAIL=NURSES_UNAVAIL[NURSES_UNAVAIL.columns[~NURSES_UNAVAIL.columns.isin(['SCENARIO','JOB','NURSEGROUP','SHIFTA

# MAKE EMPID THEINDEX
NURSES_UNAVAIL.set_index('EMPLOYEEID', inplace=True)

#NURSE UNAVAIL:  CONVERT DF TO DICT
nurse_unavailable_dictnew=NURSES_UNAVAIL.to_dict()
#print(nurse_unavailable_dictnew)
```

In [9]:
```
# NURSE GROUPS -- get list of empid's assigned to each group (df), and then put in dict via grouping series
# FILTER FOR SCENARIO
NURSE_SHIFT_REQUESTS_ORIG=NURSE_SHIFT_REQUESTS_ORIG[NURSE_SHIFT_REQUESTS_ORIG['SCENARIO']==SCENARIO].copy()
#print(NURSE_SHIFT_REQUESTS)

# convert EMPLOYEEID to string
NURSE_SHIFT_REQUESTS_ORIG['EMPLOYEEID']= NURSE_SHIFT_REQUESTS_ORIG['EMPLOYEEID'].map(str)
nurse_group = NURSE_SHIFT_REQUESTS_ORIG[['NURSEGROUP', 'EMPLOYEEID']]
#print(nurse_group)

nurse_group=nurse_group.groupby('NURSEGROUP')['EMPLOYEEID'].apply(list)
#print(nurse_group)
#print(type(nurse_group))

nurse_group_dict=nurse_group.to_dict()
#print(nurse_group_dict)
```

In [10]:
```
# NURSE POINT DICT
nurse_point_dict =  {'12295':10000, '31300':10000, '31407':10000, '38368':10000, '59561':10000 , '14581':5000, '36587':5

#print(nurse_point_dict['12295'])
```

In [11]:
```
# NURSE HISTORY DICT -- IF NURSE SHUFFLED >3X IN PREV SCHEDULING PERIOD TRIPLE POINTS
nurse_history_dict = {'12295':1, '31300':1, '31407':1, '38368':1, '59561':1 , '14581':1, '36587':1, '105865':3,'18182':1
```

In [12]:
```
# JUNIOR NURSES / SENIOR NURSES
junior_nurse_list = ['99263','14581']
senior_nurse_list = ['12295',  '18182', '31300', '31407', '36587', '38368', '59561',  '105865']
```

In [13]:
```
# DAYS LIST -- need a list of days to loop over.  There are col headings in NURSE_SHIFT_REQUESTS_ORIG so need
# to get into list
# remove cols in df that are not like 'DayX', then convert the series to a list
daylistdf = NURSE_SHIFT_REQUESTS_ORIG[NURSE_SHIFT_REQUESTS_ORIG.columns[~NURSE_SHIFT_REQUESTS_ORIG.columns.isin(['SCENAR

#print(daylist)
day_list = list(daylistdf.columns)
#print(day_list)
```

In [14]:
```
# MONDAYS:  Identify days that are Mondays; Nurses must work 2 Mndays
Mon = [2, 9, 16, 23, 30, 37 ]
```

In [15]:
```
# FRIDAYS: Identify days that are Fridays; Nurses must work 2
Fri = [6, 13, 20, 27, 34, 41 ]
```

In [16]:
```
# SATURDAYS: Identify days that are SATURDAYS; Nurses must work 2
Sat = [7, 14, 21, 28, 35, 42 ]
```

In [17]:
```
# SUNDAYS: Identify days that are SUNDAYS; Nurses must work 2
Sun = [1, 8, 15, 22, 29, 36 ]
```

In [18]:
```
WEEK = ['Week_1', 'Week_2', 'Week_3', 'Week_4', 'Week_5', 'Week_6']
```

In [19]:
```
# Map days to weeks
WEEK_DAY_MAP ={
'Week_1': [1,  2, 3, 4, 5, 6, 7],
'Week_2': [8,  9, 10,11, 12, 13, 14],
'Week_3': [15, 16, 17,18, 19, 20, 21],
'Week_4': [22, 23, 24,25, 26, 27, 28],
'Week_5': [29, 30, 31,32, 33, 34, 35],
'Week_6': [36, 37, 38,39, 40, 41, 42]
}
```

In [20]:
```
# DECISION VARIABLE:  NURSE ASSIGNED SHIFT, YES/NO
X=pulp.LpVariable.dicts('AssignToWork',[(i,j) for i in day_list
                                              for j in nurse_list], 0,1,LpBinary)
```

In [21]:
```
# PROBLEM INSTANTIATION
#
prob=LpProblem("NurseSchedOpt", LpMaximize)
```

In [22]:
```
# OBJECTIVE FUNCTION
# Reward shifts that nurses self scheduled and penalize scheduling them when they requested vac or unavil time

prob+=lpSum(nurse_history_dict[j]*nurse_point_dict[j]*nurse_shift_req_dictnew[i][j]*X[(i,j)] - nurse_history_dict[j]*nu
```

In [23]:
```
# CONSTRAINT:  for each day, number of nurses must be >= demand
for i in day_list:
    prob+=lpSum(X[(i,j)] for j in nurse_list ) >= nurse_demand_dict[i]
```

In [24]:
```
# CONSTRAINT: for each nurse, core hours must be at least 3 shifts per week for vac and shift work

for j in nurse_list:
    for w in WEEK:

        # need to handle when X =1, V=1 do not double count
        prob+= lpSum(   X[i,j] +  nurse_vac_dictnew[i][j]  - X[i,j]*nurse_vac_dictnew[i][j] for i in WEEK_DAY_MAP[w] )
```

In [25]:
```
# CONSTRAINT: each nurse must work 2 Mondays
for j in nurse_list:
     prob+=lpSum(X[i,j]  for i in day_list if i in Mon   ) >=2
```

In [26]:
```
# CONSTRAINT: each nurse must work 2 Fridays
for j in nurse_list:
     prob+=lpSum(X[i,j]  for i in day_list if i in Fri   ) >=2
```

In [27]:
```
# CONSTRAINT: each nurse must work 2 Saturdays
for j in nurse_list:
     prob+=lpSum(X[i,j]  for i in day_list if i in Sat   ) >=2
```

In [28]:
```
# CONSTRAINT: each nurse must work 2 Sundays
for j in nurse_list:
     prob+=lpSum(X[i,j]  for i in day_list if i in Sun   ) >=2
```

In [29]:
```
# CONSTRAINT: On any given day, must have ratio of 2 senior nurses to every one jr nurses

for i in day_list:
    lhs = lpSum( X[i,j] for j in senior_nurse_list )
    rhs = lpSum( X[i,j] for j in junior_nurse_list )
    prob+=  lhs >= 2* rhs
```

In [30]:
```
# Solve
prob.solve()
print("Status:", LpStatus[prob.status])
```

```
Status: Optimal
```