Operations Research, Spring 2016
Case Assignment 1

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IEDO Airlines is a big airline company based in Taiwan. Most of flights operated by IEDO connect TPE (Taiwan Taoyuan international airport) and another airport somewhere in the world. The Ground Service Department (GSD) of IEDO is responsible for managing all the customer-related affairs at TPE. In GSD, the most critical resource is of course the agents, and the most critical task in GSD is agent scheduling, i.e., to assign agents the right tasks to do at the right time. With hundreds of agents, 24 hours a day and 7 days a week service, and various kinds of tasks, agent scheduling is a big challenge.

Robin was hired into IEDO two weeks ago as the head of the Operations Research team. She was asked to help GSD improve the efficiency of agent scheduling. In the past two weeks, she found that GSD heads are not helpful: The director of GSD, Brook, plays violin all the days, and the vice director, Zoro, only cares about drinking and fighting. Moreover, the head of the agent group, Sanji, spends all his time improving his cooking skill. The three managers together made agents scheduled in a very bad way: Sometimes a lot of customers are served by no agent while sometimes a lot of agents have nothing to do. That is why the president of IEDO, Luffy, needs Robin to take over the job. The good news is that Brook, Zoro, and Sanji completely trust her and will not make any suggestion (which will most likely be useless).

A senior agent Vivi is quite experienced and knowledgeable. She knows all the rules and objectives about agent scheduling. Vivi explained all she knows to Robin as follows.

1 Basics of agent scheduling

Boarding and check-in. There are two missions in GSD: *boarding* and *check-in*. Boarding is for agents to help customers board their flights at boarding gates right before airplanes take off. Check-in is for agents to verify the validity of customers' passport and tickets, issue boarding passes, and check customers' luggage, etc., at check-in counters. GSD currently has 1000 agents. These agents are split into two divisions, one for boarding and one for check-in. The boarding division owns 300 agents while the check-in division owns 700 agents. An agent in one division does not do the tasks in the other division.

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Skills and groups. IEDO helps three foreign airline companies (to earn money, of course) for serving their customers in TPE. They are ANTS airlines, SVVRL airlines, and KMM airlines. Boarding tasks for different airlines are similar. However, check-in is more complicated because it requires an agent to operate information systems that are different from airlines to airlines. An agent must be trained to operate an airline's system before she can do the check-in tasks for that airlines company. Agents who can operate the same set of airlines check-in systems are said to be in the same *group*. Following this logic, we say that all agents in the boarding division are in the same group.

Currently, all check-in agents knows either the IEDO system only or the IEDO system plus one additional system. Therefore, we have four check-in groups and one boarding groups. The Chief Human Resource Officer (CHRO) Usopp has prepared the table "Group" to record the information of groups. For example, there are 170 agents who are able to operate the systems of IEDO airlines and ANTS airlines.

Shifts and day offs. IEDO divides each day into three *shifts*: 6–14, 14–22, and 22–6. If an agent works on a day, she/he will work in one of the three shifts; otherwise she/he will has a *day off*. One cannot work in two shifts in the same day. However, unless otherwise noticed, one may be assigned to work in shift 22–6 in a day and then in shift 6–14 in the next day. Flights and agents are scheduled in a weekly basis. One must have two days off in a week.

Tasks and demands. There are five kinds of *tasks*: Check-in for the four airlines companies and boarding. Before each season starts, the schedule of flights will be determined. According to the number of flights, the capacities of airplanes, their destinations, etc., the number of agents needed for a task can be calculated for each shift in each day.

Calculating all these agent *demands* is of course uneasy. Fortunately, the Chief Information Officer (CIO) Franky has built a powerful information system to do this. Before Robin schedules agents, she will get the table "Demand" recording agent demands. For example, we need 100 agents at IEDO's check-in counters in shift 6–14 on Sunday. Note that even if an agent who can operate two types of systems works in a shift, she/he can be assigned to only one of the airlines companies.

Wages and agent hiring. If the current 1000 full-time agents are not enough to satisfy all agent demands, more agents may be hired. IEDO may hire either full-time or part-time agents. A full-time agent works five days a week, one shift in a day. The wages for a boarding agent and an IEDO-only check-in agent are different. Moreover, knowing one additional check-in system gives an agent a higher wage. A part-time agent can work for any number of shifts in a week. However, a part-time agent can only be trained to operate the IEDO check-in system or do the boarding task. The number of new agents, full-time or part-time, that can be hired is unlimited.

The Chief Financial Officer (CFO) Nami provides the salary table "Wage" to Robin. In the table, the "Full-time" column records weekly wages while the "Part-time" column records the wage per shift. For example, a full-time agent who is able to operate the IEDO and one another check-in systems earns $280 per week.

Finally, note that an extra compensation $80 must be given to full-time agents whose two off days are separated (Sunday and Tuesday, Wednesday and Saturday, etc.). If a full-time agent's two off days are consecutive (Sunday and Monday, Tuesday and Wednesday, Saturday and Sunday, etc.), she/he does not get the compensation.

2 Objectives of agent scheduling

Robin, Nami, and Usopp spent a few hours to come up with several restrictions and objectives of agent scheduling. The current 1000 agents cannot be fired. Their skills are also fixed and cannot be changed. In fact, Usopp believes that the current 1000 agents are far from enough to satisfy all the agent demands. Usopp really wants to hire more agents (if possible, he actually wants 8000 agents!), but he needs to convince Nami that new agents are really needed.

Robin is here to do the job. If an optimal (or at least near-optimal) schedule still cannot satisfy all the agent demands, new agents are really needed. Robin needs to find an optimal/near-optimal schedule and convince Nami that it is indeed optimal/near-optimal. Therefore, Robin's agent scheduling should answer the following questions.

1. If no new agent is hired, is it possible to satisfy all the demands?
2. If, beside the current 1000 agents, IEDO can hire new full-time agents, how to satisfy all demands while minimizing the total wages? How about part-time agents?
3. If, beside the current 1000 agents, IEDO can hire both full-time and part-time agents, how to satisfy all demands while minimizing the total wages? How is this plan better than hiring only full-time or part-time agents?

Please note that for a schedule to be executable, it must be detailed enough to tell each single agent when to work and which task to work for. Suggesting only a number of additional agents to hire is not sufficient.

IEDO has a special position, Chief Medicine Officer (CMO). The CMO Chopper suggests that if an agent works in the 22–6 shift in a day, she/he should not work in the 6–14 in the next day. If Robin adds this restriction into her agent scheduling problem, how will the answers of the above four questions change? What is the amount of wages brought by this restriction?

3 The task for this assignment

1. (50 points) For each of the following task, use whatever method you like to make a suggestion to Robin by telling her how to schedule agents. Make sure that by reading your schedule, Robin can really decide how many agents should do what task at what

time. For all the tasks below, please ignore the no-consecutive-shift constraint (therefore, a full-time agent may work on Monday 22–6 and then Tuesday 6–14). For each task, please also clearly indicate the total wage resulted from your schedule.

(a) (10 points) Schedule agents in the boarding division to minimize the total wage while satisfying all demands. You may only hire new full-time agents.

(b) (10 points) Schedule agents in the boarding division to minimize the total wage while satisfying all demands. You may only hire new part-time agents.

(c) (10 points) Schedule agents in the boarding division to minimize the total wage while satisfying all demands. You may hire new full-time or part-time agents.

(d) (20 points) Schedule agents in the check-in division to minimize the total wage while satisfying all demands. You may hire new full-time or part-time agents. Note that some full-time agents have multiple skills. You need to decide what one should do in a shift that he or she is on duty.

Of course, you may have no idea about how to find an optimal solution (i.e. a wage-minimizing schedule). In this case assignment, you only need to try your best to make your schedule as good as possible. The points you earn for each task is $n(\frac{z^*}{z})$, where z is the total wage of your schedule, z^* is that of a wage-minimizing schedule, and n is 6 for the first three tasks and 12 for the last task. DO NOT describe your method; leave that to Problem 2. Write down ONLY your hiring plan, agent schedule, and the resulting total wage. For each of the first three tasks, 4 points are based on the presentation of your solution; for the last task, presentation counts for 8 points.

2. (50 points) Describe the methods you design for the tasks in Problem 1. For each of tasks (a), (b), and (c), 5 points will be based on how logical your method is. Please note that the problems may become of a larger scale, i.e., with more customers, orders, and items, in the future. The values of parameters may also become different. Therefore, your method will also be graded by considering its extendability to large-scale problems. Finally, please explain your method in an easy-to-understand way. 5 points will be based on your presentation. For task (d), 10 points will be for the logic and 10 points will be fore the presentation.

4 Submission rules

The deadline of this homework is 2pm, March 1 (Tuesday), 2015. Please put a hard copy of the work into the instructor's mailbox on the first floor of the Management Building 2 by the due time. Works submitted between 2pm and 3pm will get 10 points deducted as a penalty. Submissions later than 3pm will not be accepted. Each team, which should consist of one to four students, only needs to submit one copy. Limit the report (including everyone) to have at most eight pages. Discussions among teams are welcome; copying is disallowed. This case assignment counts for 6% of your semester grades.