Scheduling for Multi-Skill Call Center

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Consider a scheduling problem for a Call center that operates from 8 am to 5 pm; the working day is divided into 36, 15-minute periods and 74 shifts that range from 7:30 to 9 hours are considered (detailed in Table 1). Each shift has a 30 minute “lunch break” and two 15-minute “coffee breaks”.

Table 1: Shifts considered

<table>
<thead>
<tr>
<th>Length</th>
<th>Start</th>
<th>First Break</th>
<th>Second Break</th>
<th>Third Break</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:30</td>
<td>8:00, 9:00</td>
<td>10:00, 10:15</td>
<td>12:00, 13:00</td>
<td>14:15, 14:30</td>
</tr>
<tr>
<td>8:00</td>
<td>8:00, 8:30, 9:00</td>
<td>10:30, 10:45</td>
<td>12:00, 13:00</td>
<td>14:30, 15:00</td>
</tr>
<tr>
<td>8:30</td>
<td>8:00, 8:30</td>
<td>10:15, 10:45</td>
<td>12:00, 13:00</td>
<td>14:30, 14:45</td>
</tr>
<tr>
<td>9:00</td>
<td>8:00</td>
<td>10:30, 11:00</td>
<td>12:30, 13:00, 13:30</td>
<td>15:00, 15:15, 15:30</td>
</tr>
</tbody>
</table>

$K$ types of calls are received, which arrive according to a stationary Poisson process with rate $\lambda_{jk}$ during period $j$; call arrivals are independent across periods and types of calls. Agents, which are divided into $I$ groups, have different skills and preference for different types of calls. Routing is done according to a rank matrix $R$, which assigns a priority $R_{ik}$ for calls of type $k$ to be answered by agents of group $i$; the lower the value of $R_{ik}$ the higher the preference for group $i$ to take calls of type $k$. When there is a tie, the agent group with the smaller number ($i$) takes the call. $R_{ik} = \infty$ whenever group $i$ cannot serve calls of type $k$.

Service and patience times are exponentially distributed with means $\mu = 8$ and $\rho = 10$, respectively.

Agents are paid according to

$$c_{iq} = (1 + (\eta_i - 1) \varsigma) \frac{l_q}{30}$$

where $\eta_i$ is the cardinality of $S_i$, i.e. the number of call types that agents of group $i$ are able to take; $\varsigma$ is the cost per agent’s skill and $l_q$ is length of shift $q$. In order to ensure good service, it is required that at least 80% of calls per period and call type are answered in less than 20 seconds.

With this in mind, our goal is to find $x = \{x_{11}, \ldots, x_{iq}, \ldots, x_{I74}\}$, i.e. the number of agents of each group and shift that should be hired in order to minimize the expected total cost while satisfying the service level constraints.
**Recommended parameter settings:** The following two problems are proposed:

- A small problem: take $K = 2$, $\varsigma = 0.2$, $S_1 = \{1\}$ and $S_2 = \{1, 2\}$. Agents in set 2 prefer calls of type 2. Service and patience times as discussed above ($\mu = 8$ and $\rho = 10$) and call arrival rates, shown in Figure 1, as detailed in “ArrivalRatesSmall.csv”.

- A larger problem: take $K = 20$, $I = 35$, $\varsigma = 0.1$, $\mu = 8$ and $\rho = 10$. The routing policy and agent groups as detailed in “routing.csv”. The call arrival rates, shown in Figure 2, are detailed in “ArrivalRatesLarge.csv”.

**Starting Solutions:**

- For the small problem, take $x_{1,57} = x_{1,68} = 20$ and $x_{2,57} = x_{2,68} = 10$. If multiple solutions are needed, distribute 40 agents of type 1 and 20 agents of type 2 uniformly across all 9-hour shifts (57 - 74), i.e. each agent has a 1/18 chance of being assigned to each 9-hour shift, independently of all other agents.

- For the large problem, take $x_{i,57} = x_{i,68} = 3$, $\forall i$. To generate multiple starting solutions, distribute 6 agents of each type uniformly across all 9-hour shifts (57-74).

**Measurement of Time:** Number of days simulated.

**Optimal Solution:** Unknown

![Figure 1: Arrival rates per hour of small call center](image1)

![Figure 2: Arrival rates per hour of large call center](image2)