Mathematical Model for Minimizing Cost in Employers Training using Assignment Problem

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Abstract. Now a day’s many organizations have struggled in how to minimize the employer training cost. Consider the assignment problem for each assigning workers with their own skill set, to task which demand different skills in an efficient manner. It’s a challenging problem that often requires workers to receive additional training. The training of workers is very costly of the employee training in the world. So, in this paper we analyze and minimize the entire training cost. A numerical example is included.

Keywords: SAP, RASP, Cost Algorithm

1. Introduction

Our Indian economy has major depended on textile industry before the English colonies the details are described by Karl Marx. People convinced many farmers to switch from subsistence farming to producing and exporting vast quantity of cotton, after a extended duration of protectionism over the English textile industry. Finally, through colonization, the traditional method of artisan Textile production was destroyed, and replaced with large scale factory production. The present competitive world, many industries are like to tolerance other industries. In this regard, industrial management people expected to difference skill people working in a challenging problem and that requires workers to receive additional training. But, an industry person has to spend a large amount of money on the training of workers. Practices is said to be the achievement of awareness of skills and the competencies. For particularly one goal of improving the knowledge, capacity, capability and performance. It is clearly mentioned the labour market more than initial qualification for work and upgrade and update the skills, forceful training and development should be there in the organization. The human resource department has increase in output, quality improvement at the company. The number of job only based assigned by the training skill. In 1995 adult has observed the staff training and development is a work not an activity and it’s fully contribution to the overall effectiveness and profitability in the organization. It’s clear focus on the importance of which way gives to training for the labour, improve the quality and minimized the cost. . The rest this paper as follows (2) Mathematical formulation of GAP (3) Revised RKSP (4) Proposed algorithm of cost minimization (5) Numerical example.
2. Mathematical formulation of General Assignment Problem

The 0-1 ILP model is: (equation 1-4 as follows)

$$\text{Min } \sum_{j=1}^{m} \sum_{i=1}^{n} c_{ij} x_{ij}$$

s.t. $$\sum_{j=1}^{m} p_{ij} x_{ij} \leq b_{i}, \sum_{i=1}^{n} x_{ij} = 1, x_{ij} = 0 \text{ or } 1 \forall i, j$$

Decision Variables: $$X_{ij} = \begin{cases} 1, \text{ work } s^i \text{ is assigned to task } j \text{,} \\ 0, \text{ otherwise} \end{cases}$$

2.1. Skills Management Problem:

Mathematical formulation of SKMP as follows:

$$\text{Min } \sum_{i} \sum_{k} \sum_{m} c_{ik} s_{ik} z_{ik} s_{ik}$$

s.t. $$S_{w_{ik}} + \sum_{m} z_{ik} s_{ik} \geq R_{ik} X_{ik} \forall i, j, k$$

$$\sum_{i} X_{ij} = 1 \forall j$$

$$\sum_{i} X_{ij} \geq 1 \forall i$$

$$\sum_{i} T_{i} X_{ij} + \sum_{k} \sum_{m} E_{ik} s_{ik} z_{ik} s_{ik} \leq \phi \forall i$$

$$X_{ij}, z_{ik}, s_{ik} \in \{0, 1\} \forall i, j, k, m$$

3. Revised SKMP (0-1) model as follows:

Minimum Training Cost $$\sum_{i} \sum_{k} \sum_{m} C_{ik} s_{ik} F_{ik} s_{ik} R_{ij}$$

Subject to

$$\left(R_{ik} - S_{ik}\right) F_{ik} s_{ik} R_{ij} \geq \left(R_{ik} - S_{ik}\right) X_{ij} \forall i, j, k \in \{j\}$$

$$\sum_{i} X_{ij} = 1 \forall j$$

$$\sum_{i} X_{ij} \geq 1 \forall j$$

$$\sum_{j} T_{i} X_{ij} + \sum_{k} \sum_{m} E_{ik} s_{ik} F_{ik} s_{ik} R_{ij} \leq A_{i} \forall i$$

$$X_{ij} \in \{0, 1\}, F_{ik} s_{ik} R_{ij} \in \{0, 1\} \forall j, k, m$$

The simplified formula can help to find the efficient optimum solution and it can be combining for few variables to we get new solution and disregard the updating skill level for each training worker.

3.1. Solution Method

Our proposed algorithm to find the efficient solution of small sized problem. Initial method is implemented in an attempt to develop a good upper bound for skills management problem. Here the idea is proposed to base on heuristics method; here tasks starting from group because all group having same number of tasks. Using SAP, we easily assigned to the working point. We simulate the formula.
of some difficult constraint it can helpful to obtain the best optimal value. The mathematical model as follows:

\[ S_w a + \sum_{m=0}^{5} mZ_s a \geq R_j X_{ij} \quad \forall i, j, k \in \{ j \} \quad \text{(18)} \]

\[ w_a + \sum_{m=0}^{5} Z_s a = 1 \quad \forall i, k \quad \text{(19)} \]

\[ Z_s a = \begin{cases} 1 & \text{worker s’i receive on training skill’k’ to raise skill level from s to m} \\ 0 & \text{otherwise} \end{cases} \]

\[ w_a = \begin{cases} 1 & \text{worker does not need training skill’k’} \\ 0 & \text{otherwise} \end{cases} \]

Here, we change the decision variable due to the complexity of problem. We simplified the model it determines to increase the performance level for some task not to all.

\[ F_a S_R y = \begin{cases} 1 \text{ worker s’i receives on training skill’k’} \\ \text{raise skill from s to R_y for doing task’j’} \end{cases} (R_k - S_a)^* F_a S_R y \geq (R_k - S_a)^* X_{ij} \quad \text{(20)} \]

If assign the task for each worker i=j, then \( X_{ij} = 1 \) and required the skill level k to j is assigned the more skill level worker for ‘i’(\( S_a \)) then \( F_a S_R y = 1 \)

4. Algorithm for Cost Minimization of Total Training Cost

It does quickly solve the complex skill problem for the number of workers. Suppose the number of tasks exceeds the workers hence the solution time will take increase. But SAP problem gives us quick solution only for each worker having each task. The minimum task cost algorithm as follows:

**Step: 1** Consider the model \( n<l \) (‘n’ workers, ‘l’ tasks) and ignore the equal level, give priority to the required task and skill level to do each task and initial stage considered as the given problem.

\( R_{jk} \) Represent the required skill level of j to k

\( C_{klm} \) Represent the cost associated with skill level for \( k \) to \( l \), \( l \) to \( m \)

\( T_j \) Represent the length of task

**Step: 2** compute the total training cost for the minimum skilled worker as follows:

\[ C_j = \sum_{k}^{n} C_{k R j k} \quad \forall j \in L \quad \text{(21)} \]

**Step: 3** consider the first ‘n’ tasks with the minimum training cost and describe the length of time for new tasks as follows:

\[ T_{S_y} = (l/n)^* \sum_j^{n} T_j \quad \forall y \in N \quad \text{(22)} \]

**Step: 4** from step (3) updating new task as follows:

\[ T_{j} + T_{h} < T_{S_y} \quad \text{(23)} \quad \text{Where h is the step size from (n+1, n+2,……l)} \]

**Step: 5** compute the skill level for new group tasks the new total training cost as follows:

\[ T_{C} = \sum_{k}^{n} C_{k R j} \quad \text{(24)}, \text{ where } R_{j} = \max \left\{ R_{j}, R_{k} \right\}, h \in p \]

**Step: 6** find the difference for old cost to new cost as follows:

\[ \text{diff} = T_{C} - T_{C} \quad \forall = 1, 2, \ldots N \quad \text{(25)} \]

**Step: 7** Choose the minimum difference cost ‘d’ and update the \( d^{th} \) group task as follows: \( T_{d} = T_{d} + T_{h} \)
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Step: 8 The new total training cost as: \(ToC_{\text{d}} = \sum_{k=1}^{K} C_{\text{d}_{k}}\), where \(R_{\text{d}_{k}} = \max \{ R_{\text{d}_{k}}, R_{\text{d}_{k}} \}\), otherwise go back to step(6).

5. Numerical Method:
Consider the 7 workers assign the 18 tasks with 9 skills (the source of data collected by Sree Abirami Textiles Private Limited, Madurai, Tamilnadu). Compared with existing method for our proposed method shows a good performance because the employer skill level. The above data’s using our proposed method finally concluded that our proposed method is 5% increased the employer performance compared with the existing method that means minimized the time and cost also because depend on the employer performance.

### Table 1. Performance Level

| Workers Task | Skill | SAP | Greedy | Upper | New Method | Best Solution Value | Difference the best value in % |
|--------------|-------|-----|--------|-------|-------------|----------------------|------------------------------|
| 7            | 7     | 7   | 251    | 251   | 251         | 251                  | All                          | 0                            |
| 7            | 8     | 9   | 342    | 342   | 379         | 342                  | Except3                      | 9.0                          |
| 7            | 9     | 9   | 377    | 404   | 404         | 370                  | 4                            | 9.8                          |
| 7            | 10    | 9   | 386    | 406   | 469         | 386                  | 1.4                          | 8.2                          |
| 7            | 11    | 9   | 425    | 460   | 470         | 419                  | 4                            | 9.1                          |
| 7            | 12    | 9   | 452    | 501   | 582         | 461                  | 452                          | 1                            | 12.6                         |
| 7            | 13    | 9   | 482    | 519   | 583         | 475                  | 475                          | 4                            | 8.1                          |
| 7            | 14    | 9   | 487    | 522   | 595         | 487                  | 487                          | 1.4                          | 8.1                          |
| 7            | 15    | 9   | 514    | 568   | 629         | 506                  | 506                          | 4                            | 8.0                          |
| 7            | 18    | 9   | 551    | 675   | 690         | 554                  | 554                          | 4                            | 8.0                          |

6. Conclusion
We analyze the employer performance skill (From Table (1)) of the proposed solution algorithm for different employer and give assign the task on each employer. We set 100 small data’s these data set 7workers for 7 to 18 tasks with 9 skill level. Here we used four solution methodologies were evaluated the data’s. We concluded that our proposed method get best optimal value (16.49) of other existing method (SAP method gives 14.02, Greedy gives 12.8) because 0.5% increased the employer performance.

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