CHAPTER 8

OPTIMAL TENURE PERIOD

The Tabu search, which is a best local search uses Tabu tenure period as its exploitation tool. The impact of tenure period over the Tabu and Tabu GA has been studied in our previous chapters. It has been confirmed that, the tenure period controls the overall operation of both Tabu and Tabu GA. In order to confirm the same, the Tabu tenure period was changed. The tenure period fixed at either high or low as these two conditions are enough for testing the impact of tenure period.

The experiments are conducted to test the impact of tenure period by fixing the tenure period using the rule of thumb or based on previous knowledge. These two methods cannot be expected to work well for all scenarios. Hence, it is planned to find a method to fix the optimal value for tenure period. If not, it will be treated as a separate problem and it will distract our focus. Hence a method has been focused and developed for finding an optimal tenure period.

8.1 IMPACT OF A SINGLE OBJECT IN A MODEL SOLUTION

Practically all search problems seem to be a multi-variable problem. In our case also, it’s a multi-variable problem. The structure of the model solution already explained in our previous chapters. Hence there is no need to repeat it again.
The previous section tested the impact of tenure period over the search space. It indirectly confirms the discrimination among the objects in the model solution. Hence all objects cannot be treated equally. In other words, there should be discrimination among the individual objects based on tenure period. Simply speaking equal tenure periods cannot be assigned to all objects present in the sample solution.

Still the decision has to be confirmed. In our previous sections, an experiment was conducted by varying the tenure period. But there were no discrimination among objects. In both these cases i.e. high and low tenure period, all the objects got the equal tenure period.

Hence it is tried to test whether that variation in the tenure period has any impact over the system’s performance. For this case, various experiments were conducted. The various combinations have different effect, were tried to be tested. The main intention is to check any particular object of the model solution has more importance than the other. If there is any, it has to be discriminated based on their importance. The discrimination can be achieved by applying different weights to the different objects. But, it is to be confirmed before assigning the weights. The following tenure period has been assigned and the results are recorded.

In order to carry out our experiments, the tenure period of one object is fixed and the others are not. The tenure period of the other objects is changed carefully. Hence, all objects present in the model solution won’t get the same tenure period. It serve our purpose. In our model solution there are three objects and they are listed as below:

1. Fusion Function
2. Retrieval Strategies
3. Weight for the Retrieval Strategies.
Out of these three, the last one i.e. weight needs to be explored rather than exploited. Hence the tenure period for the weights is fixed and there is no need to consider it further as far as the optimal tenure period is concerned.

The other two objects need to be considered. Out of these, two retrieval strategies demands equal importance. Hence, it is planned to assign equal tenure period to them. Finally, the problem of fixing the optimal tenure period is reduced to a two variable function.

In simple words, the four variable physical problem reduced into a two variable logical problem. Based on this assumption, the tenure period of fusion function and retrieval strategies were changed subject to a single constraint that the retrieval strategies should get equal tenure period as per our discussion. Our experiments were divided into two cases. The first case has a fixed tenure period for the retrieval function and second case has a fixed tenure period for retrieval strategies as these experiments aims to confirm the variation in performance due to variation in tenure period. Only limited option is available. The combination of tenure period is restricted as minimal as it is not preferred to deviate from our focus. The selected combinations for the
Table 8.2 Tenure period for testing the fusion functions importance

<table>
<thead>
<tr>
<th>Object</th>
<th>Tenure Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fusion Function</td>
<td>10,8,6,4,2</td>
</tr>
<tr>
<td>Retrieval Strategies</td>
<td>1</td>
</tr>
</tbody>
</table>

In the above two cases, no importance was given to the weights for the retrieval strategies. Hence it doesn’t the make any impact over the number of bits used to represent a solution as in other previous sections. Hence the experiments are conducted with the 12 bit encoding only. 16 bit encoding are not used as far as these experiments are concerned. The over all result obtained for the above two cases is recorded and plotted.

8.1.1 Impact of Retrieval Strategies

In this case, importance of retrieval strategies is tested, Hence the tenure period for the fusion function fixed at one. The tenure period for the retrieval strategies are derived from the Table 8.1. This case further divided into five sub cases based on the tenure period. The results for the five sub cases for plotted in the following Figures 8.1 to 8.15.
Figure 8.1 Results of ADI when the retrieval strategies’ tenure period fixed at 10
Figure 8.2  Results of ADI when the retrieval strategies’ tenure period fixed at 8
Figure 8.3  Results of ADI when the retrieval strategies’ tenure period fixed at 6
Figure 8.4  Results of ADI when the retrieval strategies' tenure period fixed at 4
Figure 8.5  Results of ADI when the retrieval strategies’ tenure period fixed at 2
Figure 8.6  Results of CISI when the retrieval strategies’ tenure period fixed at 10
Figure 8.7  Results of CISI when the retrieval strategies’ tenure period fixed at 8
Figure 8.8  Results of CISI when the retrieval strategies’ tenure period fixed at 6
Figure 8.9 Results of CISI when the retrieval strategies’ tenure period fixed at 4
Figure 8.10  Results of CISI when the retrieval strategies’ tenure period fixed at 2
Figure 8.11 Results of CRAN when the retrieval strategies’ tenure period fixed at 10
Figure 8.12 Results of CRAN when the retrieval strategies’ tenure period fixed at 8
Figure 8.13 Results of CRAN when the retrieval strategies’ tenure period fixed at 6
Figure 8.14 Results of CRAN when the retrieval strategies’ tenure period fixed at 4
Figure 8.15 Results of CRAN when the retrieval strategies’ tenure period fixed at 2
The graphs show the average variations in overall performance. As the experiments are conducted for 100 generations the overall average of average precision and their maximum and minimum difference between two successive generations need to be studied. Those values are given in the following Tables 8.3 and 8.4.

### Table 8.3 Precision value at various tenure period for retrieval strategies

<table>
<thead>
<tr>
<th>Data Set</th>
<th>Fusion Function tenure period : 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Retrieval Strategies tenure period</td>
</tr>
<tr>
<td></td>
<td>Average Precision</td>
</tr>
<tr>
<td>ADI</td>
<td>0.3809689</td>
</tr>
<tr>
<td>CISI</td>
<td>0.1883055</td>
</tr>
<tr>
<td>CRAN</td>
<td>0.1426309</td>
</tr>
</tbody>
</table>

### 8.1.2 Impact of Fusion Function

In this case, importance of the fusion function explored by fixing the tenure period of the retrieval strategies. Hence, the tenure period for the retrieval strategies are fixed at one. The various tenure periods for the fusion function are derived from the Table 8.2. This experiment divided into five sub cases as in the case of the previous subsection. The results obtained for the above mentioned five cases are of plotted in the following Figures 8.16 to 8.30.
Figure 8.16 Results of ADI when the fusion function’s tenure period fixed at 10
Figure 8.17 Results of ADI when the fusion function’s tenure period fixed at 8
Figure 8.18 Results of ADI when the fusion function’s tenure period fixed at 6
Figure 8.19   Results of ADI when the fusion function’s tenure period fixed at 4
Figure 8.20 Results of ADI when the fusion function’s tenure period fixed at 2
Figure 8.21 Results of CISI when the fusion function’s tenure period fixed at 10
Figure 8.22 Results of CISI when the fusion function’s tenure period fixed at 8
Figure 8.23 Results of CISI when the fusion function’s tenure period fixed at 6
Figure 8.24 Results of CISI when the fusion function’s tenure period fixed at 4
Figure 8.25  Results of CISI when the fusion function’s tenure period fixed at 2.
Figure 8.26  Results of CRAN when the fusion function’s tenure period fixed at 10
Figure 8.27  Results of CRAN when the fusion function’s tenure period fixed at 8
Figure 8.28 Results of CRAN when the fusion function’s tenure period fixed at 6
Figure 8.29  Results of CRAN when the fusion function’s tenure period fixed at 4
Figure 8.30  Results of CRAN when the fusion function’s tenure period fixed at 2
The overall results for the 100 generations calculated and the maximum and minimum difference between two successive generations are tabulated and it is given in the Table 8.4.

Table 8.4 Precision values at various tenure period for fusion function

<table>
<thead>
<tr>
<th>Data Set</th>
<th>Fusion Function tenure period</th>
<th>Retrieval Strategies tenure period : 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>ADI</td>
<td>0.3550241</td>
<td>0.00067</td>
</tr>
<tr>
<td>CISI</td>
<td>0.1849576</td>
<td>0.00236</td>
</tr>
<tr>
<td>CRAN</td>
<td>0.1369236</td>
<td>0.002</td>
</tr>
</tbody>
</table>

The tables show that the objects have an influence to control the exploration. Hence, the above assumption is proved to be useful and it is decided to discriminate the objects in the model solution by assigning different weights to them. The procedure for fixing the weights and the tenure period is given in the next chapter.

8.2 OPTIMAL WEIGHT AND TENURE PERIOD CALCULATION

The previous chapter proves that, each object present in the sample solution has different impact and control the sample solution. Based on that, we plan to assign weights to the individual objects present in the solution. The weights are represented as ‘\( \alpha \)’ with the subscript based on the object number. In this problem, the two important objects are represented as follows.

- Weight for the fusion function – \( \alpha_1 \)
- Weight for the retrieval strategies – \( \alpha_2, \alpha_3 \)
\( \alpha_2 \) and \( \alpha_3 \) are subject to a constraint given by

\[ \alpha_2 = \alpha_3 \]

These weights are related by a constraint which is given by

\[ \alpha_1 + \alpha_2 + \alpha_3 \leq 1 \quad (8.1) \]

Now, consider the individual tenure period of these objects. They are represented as ‘T’ with the subscript based on the object number. The values of T for these objects are fixed based on the rule of thumb.

\[ T_i = 0.1 \times \text{Number of iterations} \]

Now, both \( T_i \) and \( \alpha_i \) are related as

\[ \sum \alpha_i \cdot T_i \leq 0.5 \times \sum T_i \quad (8.2) \]

Based on the value of \( \alpha \), the tenure period will vary. If an object seems to be important, it will get high tenure period. This enables the exploitation of the particular object.

In our experiment, the number of iterations are fixed as 100. Hence, the tenure period \( T_i = 10, \forall i \). Now, by substituting this and the different combinations are obtained as follows.

1. \( \alpha_3 = 0.4 \quad \rightarrow \quad \alpha_2 = 0.3, \alpha_3 = 0.3, T_1 = 4, T_2, T_3 = 3 \)
2. \( \alpha_3 = 0.5 \quad \rightarrow \quad \alpha_2 = 0.25, T_1 = 5, T_2, T_3 = 3 \)
3. \( \alpha_3 = 0.6 \quad \rightarrow \quad \alpha_2 = 0.2, T_1 = 6, T_2, T_3 = 2 \)
4. \( \alpha_3 = 0.7 \quad \rightarrow \quad \alpha_2 = 0.15, T_1 = 7, T_2, T_3 = 1 \)
The $\alpha_1$ value can be varied from 0.4 – 0.7. If, value is decreased or increased, it will lose or hold the overall control. Hence, the value of $\alpha_1$ is selected from 0.4 – 0.7. Hence, it will have more importance then $\alpha_2$ and $\alpha_3$.

Based on the above tenure period, the experiments are conducted and the results are recorded. The results obtained for the above combination are given below in the Tables 8.5 and 8.6.

**Table 8.5** Precision value at different weights and tenure period

<table>
<thead>
<tr>
<th>Weights</th>
<th>Tenure Period</th>
<th>Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_1$</td>
<td>$\alpha_2$</td>
<td>$\alpha_3$</td>
</tr>
<tr>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>0.5</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.6</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>0.7</td>
<td>0.15</td>
<td>0.15</td>
</tr>
</tbody>
</table>

**Table 8.6** Difference in precision at various weights and tenure period.

<table>
<thead>
<tr>
<th>Weights</th>
<th>Tenure Period</th>
<th>Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_1$</td>
<td>$\alpha_2$</td>
<td>$\alpha_3$</td>
</tr>
<tr>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>0.5</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.6</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>0.7</td>
<td>0.15</td>
<td>0.15</td>
</tr>
</tbody>
</table>

The table shows the average precision, and the average difference between two successive iterations. From the table, it is concluded that, the performance and convergence are smooth at a particular combination of
weights. In other words $\alpha_1 = 0.5$ gives the better performance. This leads to the assumption that, at least one object in the model solution should get approximately 50% weight.

8.3 CONCLUSION

In this chapter, a method is proposed for finding an important object in the model solution and the method to fix the Tabu tenure period for all objects in the model solution. Based on the experiment, it is concluded that for a controlled exploitation, the tenure period of an important object is to be fixed by at least 50% of the overall or total tenure period. If an exploration and exploitation is needed the tenure period should be kept at either low or higher level. As there is a need for a controlled exploitation, it is opted for 50% tenure period for the important objects i.e. the fusion function in our model solution.