# A REVIEW OF SCHEDULING AND OPTIMIZATION TECHNIQUES

[1] INDU S. JAISWAR, [2]VINAY B.HARSORA
[1,2] R K UNIVERSITY
Email:[1]indujaiswar@gmail.com,[2]vinay.harsora@rku.ac.in

**ABSTRACT:**
**Scheduling is repetitious process. To find optimal solution become complex one. This paper gives review of various scheduling and optimization techniques, this includes basic Local Search, Simulated Annealing, Greedy randomized constructive search procedure, Tabu search, Genetic Algorithm and Branch & bound. In this paper we presented this techniques in detail with their issues. Simulated Annealing does not provide guaranteed for the optimal solution. Tabu search is impractical in case of continuous neighborhood movement. Genetic Algorithm is Randomized Algorithm that provide different solutions for Each Independent Run. Various Variants of genetic Algorithm provide Optimal as well as feasible Solution for Scheduling Problems.**

**KEY WORDS: Scheduling and optimization, Simulated annealing, Greedy Randomized Constructive Search Procedure, Tabu Search, Genetic Algorithm**

## 1. Introduction

Scheduling is allocation of resources over time to execute set of tasks. Scheduling carries two meanings, First Scheduling is process of forming the schedule. Second, collection of techniques and principles that gives perception into the scheduling function. In general, Scheduling invloves order of perfroming collection of tasks at predefine time slots using fiexd resources.Due to development and expansion, Scheduling problem exists in Educational Institutions, manufactoring and production systems,Trasportaion distribution system and many service situations.Educational Institutions Scheduling is alloction of particular course with respect to time schedule. I.e. course time tabling, exam time tabling.Production scheduling deals with actual implementation according to the time schedule for all jobs to be processed. Any Organization or System, Scheduling process interface with many other functions.

In general, to obtain fruitful results, effective scheduling of tasks and proper allocation of resources becomes mandotory. There are several methods, principles and techniques has been developed for solving such kind of problems. This paper gives brief introduction of optimization techniques, like Local Search Algorithm, Simulated Annealing, Greedy Randomized Constructive Search Procedure, Tabu Search, Genetic algorithms. All such techniques have different application area according to the problem definition. Flow shop schduling can be effectively solved with simulated annealing and university time tabling can be solved with Genetic algorithms.

## 2. OPTIMIZATION TECHNIQUES

### LOCAL SEARCH ALGORITHM (LSA)

Local Search algorithm need initial solution to begin. It process number of times and search the solution using neighbor generation method. LSA checks whether new solution is better than familiar one then use the better one.

Searching procedure will be stopped based on following criteria

- Quality of familiar solution fulfill the need.
- Algorithm processes fixed times
- No improvement in the results during last n iterations

LSA proceeds as follwing

- Load initial Solution
- Generate neighbor solution check if it is better solution, if better solution then remember the solution and check ending criteria else generate the neighbor solution.
- Now check current solution satisfies the needs and ending criteria are satisfied then store the current soltution and terminate.One of the drawback of the LSA is sometime it reach to the local optimum. Local optimum is point where all neighbor solutions have same value.

### SIMULATED ANNEALING (SA)

The idea of SA comes from a paper published by Metropolis in 1953.SA is Analogous to physical annealing process. The annealing is a process of heating and controlled cooling of material to improve quality. During the annealing process, high temperature changes the atom positions, as temperature decreases changes likely to happen. SA does the same, SA overcomes the drawback of Local search algorithm.it allows Local search algorithm to pick a worse solution. The probability that every time worse solution is accepted is diminish with the time of algorithm. This is the main concept of annealing. The local search algorithm begins with initial temperature and it is slowly decreased. Once some criteria is satisfied the temperature is changed. The criteria that change the temperature level is same as ending criteria of LSA.Problem with the SA is it can not tell whether it has found optimal solution [3]

### Greedy Randomized Constructive Search Procedure

GRCP creates initial solution for local search heuristic.it use dynamic algorithm for implementation. GRCP generate the solution step by step. At each step it generate the candidate list. Candidate list stores the element that may be used in soltution. Parameter p ∈ (0, 1) defines the length of the list. For 0, list contains only one solution. For 1, No restriction at all and algorithm may choose one of the solution from number of possible solution. An urgency indicator is computed for each candidate, lower value means more urgent the candidate. Urgency indicator is evaluated using the number of possible time slots that each elements can be assigned to.

```
GRCP implementation
Result=Nil
do
  {
   Candidate List=generateCandidateList ()

RestrictedCandidateList=restrictCandidateList()

Candidate=pickRandomly(restrictedCandidateL
ist)
    Result = result + candidate
   Return result
  } while is Complete (result):
```

### TABU SEARCH (TS)

Tabu search was invented by idea proposed by Fred Glover between 1977 and 1986.TS is one type of local search Meta heuristic.it is improvement over the Local Search algorithm by decreasing chances of local minima. TS use the memory structure that store visited solutions and user provided rules .if potential solution has been visited early and if it violates the rule then it marked as ‘tabu’. So that algorithm does not consider that solution again. TS is impractical in case of continuous neighborhood movement in search space.[4]

### BRANCH AND BOUND

All the optimization problems can be solved with the group of algorithms. This algorithms search and evaluate the possible solution .In most of the cases,the number of solution is too

large,so it cosume much time to assess every solution.More advanced technique available that minimize amount of solution require to evaluate.One such method is Branch and bound. As the name suggest, the concept of B&B includes Branching and bounding.

- In Branching Scheme, It makes group solution in one set and provide possibility to evaluate entire collection at once.
- In Bounding Scheme, It gives way of approximation of lower and upper bound of objective function value.

If lower bound of set of solution is higher than the value of known solution, the entire collection may be discarded, else set is split into smaller one and bounding of them take place. Considering the fact that lower bound is not higher than the already known solution if set holds only one optimal solution, such set will be split until it holds only one optimal solution. One of the issue of this B&B, it is hard to implement.it is insignificant to write an algorithm that use it.

## GENETIC ALGORITHM (GA)

Genetic algorithm research launch in the late 1960 to the early 1970s by professor john holland, the University of Michigan. Genetic Algorithms works on principle of natural evolution and survival of fittest.GA use past information to explore the best solution from the previous searches, known as generations. GA includes three steps selection, crossover and random mutations.

GA works as follows.

1. Construct Initial Population.
2. Evaluate fitness value of Individuals.
3. Check Fitness value of Individual Satisfies the all Constrains. If Yes then it is 'Best Individual' else Perform Selection, Crossover and Mutation operation and generate the new population continue the procedure until the 'Best Individual' is found.

- **Crossover**
  Crossover is method that takes two solutions and mixes them to obtain new solution. Fitness function obtained by this operation may or may not be higher than the old solution.

- **Mutation**
  Mutation add or update the information random way to the search procedure and help to avoid the local minima.

## VARIANTS OF GENETIC ALGORITHM

### Simple Genetic Algorithm (SGA)

SGA is the simplest form of all other Variants. It maintain two pools of individuals. One is Parent pool and second is Child Pool. Size of both the pool kept same. Initially, Parent pool contains Initial Populations and Child Pool contain empty population. Two Individual from Parent Pool is Selected and Genetic Operations is applied which generate new Individual which are now placed in Child pool if it is better than their parents.

One of the drawback of the algorithm is child pool always start with null population. Child pool is replaced with the parent pool when it becomes full therefore old generation will not survived. So we may loss some good solutions. More resources are needed as it has to maintain two pools.

### Generation Genetic Algorithm (GGA)

GGA also uses two pools. It resolve the Problem with SGA, first best parents copied into the second pool. So it makes the group of best solution.

Although it makes group of best solution, it does not provide the feasible solution. [1]

### Steady State Genetic Algorithm (SSGA)

It uses only one pool. In SSGA, Two Individual from population is selected and GA operations are applied which produces new Individual which may or may not be better than their parents. If the fitness value of new Individual is less than their parents than it is discarded otherwise, worst individual from the population is replaced with the new one.

It uses single pool. So need less resources. Algorithm may stuck to local minima and does not come out from that point. It does not provide feasible solution. [2]

**Enhanced Steady State Genetic Algorithm (ESSGA)**

ESSGA is Enhancement over the SSGA. It applies Fuzzy Logic on Crossover and Mutation Operation. It introduce new parameter "age" to determine weather crossover or mutation applicable or not. Age of the new Individual is Zero and it is gradually incremented depending on its survival in Schedule Process**.**

To Perform Crossover and Mutation Operation, Crossover Probability (Pc) and Mutation Probability (Pm) Determined. [1]

Age € [Young, Middle-age, Old]

TABLE I. FUZZY LOGIC FOR CROSSOVER PROBABILITY

| | Individual I | | |
|---|---|---|---|
| Individual II | Young | Mid-Age | Old |
| Young | Low | Medium | Low |
| Mid-Age | Medium | Medium | Medium |
| Old | Low | Medium | High |

TABLE II. FUZZY LOGIC FOR MUTATION PROBABILITY

| Individual | | | |
|---|---|---|---|
| Age | Young | Mid-Age | Old |
| Pm | High | Medium | Low |

**Modified Enhanced Genetic Algorithm (MESSGA)**

MESSGA is Enhancement over the ESSGA, Enhancement is achieved by Introducing Fuzzy Logic during "Insertion" Process.

In Shiburaj's paper [1], It is proved that Fuzzy Logic during the Insertion Process has better convergence time compared to SSGA and ESSGA.

TABLE III. FUZZY LOGIC FOR INSERTION

| Individual | | | |
|---|---|---|---|
| Age | Young | Mid-Age | Old |
| Pi | High | Medium | Low |

MESSGA takes more time compared to SSGA and ESSGA due to additional steps in Insertion Process.

**REFERENCES:**

1. Shiburaj Pappu, K. T. Talele and K. V. Mehul, "Modified Enhanced Steady State Genetic Algorithm for Scheduling Optimization," 2013 Annual IEEE India Conference

2. AlSharafat W. S.; and AlSharafat M. S.;. Adaptive steady state genetic algorithm for scheduling university exams. In International Conference on Networking and Information Technology (ICNIT), pages 70–74, June 2010. Doi: 10.1109/ICNIT.2010.5508555.

3. M. König1 and U. Beißert2, "Construction Scheduling Optimization by Simulated Annealing", 26th International Symposium on Automation and Robotics in Construction (ISARC 2009)

4. Marek E. Skowro´nski, Paweł B. Myszkowski, Marcin Adamski, Paweł Kwiatek,"Tabu Search approach for Multi–Skill Resource–Constrained Project Scheduling Problem" Proceedings of the 2013 Federated Conference onComputer Science and Information Systems pp. 153–158

5. Arjun.K.R Dr. M. S Jayamohan, "Application of Simulated Annealing in Flow Shop Scheduling", International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization, Volume 2, Special Issue 1, December 2013

6. M. O. Odim, 2B. O. Oguntunde, 3O. O. Alli, "On the Fitness Measure of Genetic Algorithm for Generating Institutional Lecture Timetable," in Journal of Emerging Trends in Computing and Information Sciences April 2013.