

# Application of Shuffled Frog Leaping Algorithm in Determining Optimal Manpower Size

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**Abstract**— Shuffled frog leaping algorithm (SFLA) is a recently introduced meta-heuristic algorithm to find near optimal solutions for large scale problems in optimization. SFLA combines the features of two other popular search techniques namely ‘PSO’ while performing local search and ‘shuffled complex evolution’ during mixing of information. In this study we have applied basic SFLA to determine optimal manpower size optimization problem. The results prove the efficacy of SFLA in handling such type of problems.

**Keywords**— Shuffled frog leaping algorithm, SFLA, metaheuristic, optimization, human resource management.

## I. INTRODUCTION

Choosing the best solution from the given set of solutions is termed as optimization. In our day to daily life we entertain number of optimization problems with the set of constraints. Some optimization problems are easy and can be solved by using traditional or deterministic methods. But the real world problems or large-scale problems arising in almost every discipline of Science, Management and Engineering are sometimes not possible to solve using traditional methods. To handle these types of problems non-traditional or metaheuristic techniques are required. Non-traditional methods don't require any auxiliary knowledge about the problem. Genetic Algorithm (GA) [1], Differential Evolution (DE) [2], Particle Swarm Optimization (PSO) [3], Artificial Bee Colony (ABC) [4] etc are some non-traditional methods or techniques. Shuffled Frog Leaping Algorithm (SFLA) introduced by Eusuff and Lansey in 2003 [5] is a recent addition to the family of non-traditional methods. These methods into various domains have already proved their efficacy to solve almost every type of optimization problems [6] – [14].

SFLA, mimics the social and natural behaviour of species. SFLA is formulated on the concept of evolution of memplexes in Frogs. SFLA combines the advantages of local search process of PSO and

information exchanging of the shuffled complex evolution.

In this paper we have applied SFLA to determine the optimal human resource in an organization. The main objective of human resource planning in an organization is to optimize the cost or profit with respect to the set of restraints in terms of budget, time, production, and demand etc.

The planning of human resource seems to be tedious and tough task for nay organization. We have taken a example from the literature to show the efficacy of SFLA a non-traditional method.

The paper consists of four sections including introduction. In the next section a brief about SFLA is discussed. Section 3 and 4 describes the problem definition and results. Finally paper concludes with section 5.

## II. SFLA

SFLA is a population based metaheuristic for solving discrete optimization problems. SFLA also, like others, is inspired by natural memetics. In SFLA, during the local exploitation process, the frogs use to share and inform the ideas to one another. The local searching process in each memplexes is similar to that of PSO local search process. After exploitation process in each memplexes the information is shuffled among different memplexes, and thus local search process moves towards global search process (exploration). Thus, the benefits of GA as well as PSO are combined in SFLA.

SFLA consists of a population of frogs partitioned into different Memplexes. In each memplex a local independent search is performed by the set of frogs. This local searching process is influenced by PSO. Later on exploration or diversification is performed by exchanging information among each memplexes. This phase is inspired by evolution process of GA. SFLA has fewer numbers of parameters to be set and is as:

- a. No. of frogs called population size ( $P$ ) or initial solutions.,
- b. number of Memplexes ( $m$ ), and
- c. number of frogs in each memplex ( $n$ ).

Fig. 1 depicts the searching process of SFLA in a search space.

The steps of SFL algorithm are as follows:

1. The population of frogs ( $P$  solutions) for  $D$  – dimension is generated randomly, a frog (solution) “ $i$ ” is represented as  $X_i = (x_{i1}, x_{i2}, \dots, x_{iD})$ .
2. Fitness function value is calculated for each solution (frog).
3. Arrange the solutions (frogs based on their of their fitness values) in a descending order
4. Then population of solutions (frogs) is divided into “ $m$ ” number of memplexes, each containing “ $n$ ” frogs. Thus,  $P = m * n$ .
5. Assign the frogs to the Memplexes in such a way that first goes to the first memplex, the second frog goes to the second memplex, ..., frog “ $m$ ” goes to the  $m^{\text{th}}$  memplex, and frog “ $m+1$ ” goes back to the first memplex, etc.
6. Then in each memplex, the frogs (solutions) with worst and best positions are identified.

7. In each memplex the local search is performed using the equation (1):

$$X_{i+1} = X_i + r \times (X_b - X_w) \quad (1)$$

$r$  is a randomly generated number between 0 and 1. If fitness value of “ $X_{i+1}$ ” is superior to “ $X_i$ ”, reinstate current frog position “ $X_i$ ” with new position “ $X_{i+1}$ ”. Else proceed to Step 8.

8. The frog with the global best fitness ( $X_g$ ) is identified and global search is done using equation (2):

$$X_{i+1} = X_i + r \times (X_g - X_w) \quad (2)$$

If “ $X_{i+1}$ ” fitness value is better than the fitness value “ $X_i$ ”, replace current frog position “ $X_i$ ” with new position “ $X_{i+1}$ ”. Else go to Step 9.

9. Generate new frog position “ $X_i$ ” randomly to replace the worst frog.

$$X_{i+1} = X_{\min} + r \times (X_{\max} - X_{\min}) \quad (3)$$

$$X_{\min} = (x_{\min 1}, x_{\min 2}, x_{\min 3}, \dots, x_{\min S}) \text{ and}$$

$$X_{\max} = (x_{\max 1}, x_{\max 2}, x_{\max 3}, \dots, x_{\max S})$$

10. Does the termination criteria met? If yes then stop. Else go to Step 2.

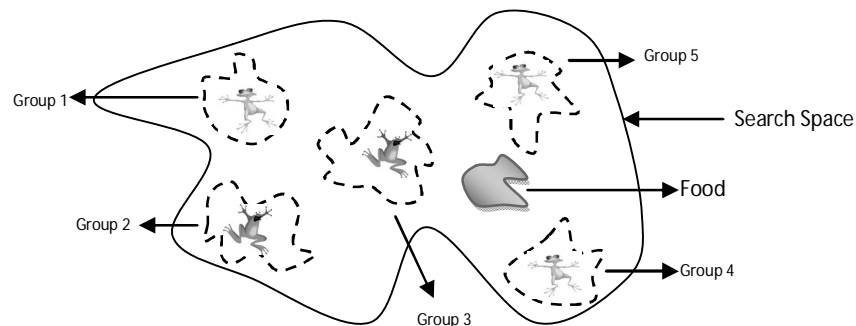


Fig. 1. Searching process in SFLA (initially locally then performs information exchange)

### III. MODELLING OF MANPOWER PROBLEM

In any organization the manpower plays a vital role, as the organizational facilities are being exploited by only manpower to achieve organizational goal or objective.

Manpower was defined by Armstrong (1996) as human resource used in carrying out jobs on any organization while in Fajana (2002) it was defined as process intended to assure an organization that it would have the proper number of properly qualified and motivated employees in its workforce at some specific future time to carry on the work that would then have to be done.

In this study we have applied basic SFLA to solve the manpower size problem. All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

#### A. Problem Definition [15]

There was a maintenance job shop, which engaged in maintenance of various parts of machine (industrial).

The maintenance personnel were grouped into high performance (category-A) and low performance (category-B). Both categories were found to be highly competent in diagnosing various defective parts brought. The data related to production capacity per day, time (h) of operation per day, costs and revenues are given in Table I – III.

TABLE I  
 OPERATION TIME DATA

Staff category	Operation time (h)
Category – A staff	2
Category – B staff	3
Maximum operation Time (h) day	8

TABLE III  
 PRODUCTION CAPACITY DATA

Staff category	Quantity produced/time/staff
Category – A staff	2
Category – B staff	1

TABLE IIIII  
 COSTS AND REVENUE OF STAFF

Staff category	Cost/staff	Revenue
Category – A staff	3000	5000
Category – B staff	2000	3000

The linear programming (LP) problem based on the above data can be formulated as:

$$\text{Maximize: } F = (C_i - R_i) \times S_i$$

Subject to constraints

- Constraint on operation duration  $\sum O_i S_i \leq 8$
- Constraint on production capacity  $\sum P_i S_i \leq 5$
- Non-negativity constraint  $S_i \geq 0$  and integers

TABLE VII  
 COMPARATIVE RESULTS OF THE PROBLEM

Models	Staff – $S_1$	Staff – $S_2$	Total Optimal Staff	Total Optimal Revenue	NFE	Time (sec)
LP	1.75	1.5	2.25	5	NA	NA
IP	2	1	3	5	NA	NA
SFLA	2	1	3	5	52	5

## V. CONCLUSIONS

In this study we have applied SFLA a recent metaheuristic algorithm to solve manpower size identification problem in an organization. SFLA is simple, requires less parameters to be tuned and easy to implement. SFLA proved that it can be used to solve these types of optimization problems with fewer number of function evaluations and time as well. In future we will modify SFLA and implement it on some more complex real life problems.

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Where C, R, S, OS, PS represents cost, revenue, staff, operation data, and production data respectively.

## B. Parameter Setting

The SFLA is executed in Dev C++. The population of frogs is generated using inbuilt *rand()* function. Parameter settings are given in Table IV.

TABLE IVV  
 PARAMETER SETTINGS

Population Size of Frogs	50
Memplexes ( <i>m</i> )	5
Local Explorations iterations in each Memplexes	10
Number of Function Evaluations (NFE)	500
$D_{max}$	100% of variable range

## IV. RESULTS

The simulated comparative results for the manpower size problem are given in Table V. To check the validity of the non-traditional method, SFLA we have also solved the problem using graphical method of LP and Integer programming (IP) method as well. The result shows that the SFLA perform 52 function evaluations to compute the result for the problem just in 5 seconds with the same quality of the solution as given by other two models.

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