1 Introduction

Optimization algorithms are being used widely now a days. However, they don't give exact results rather they provide approximate results but still their importance can't be denied. Where exact algorithms consume polynomial time to give results, optimization algorithms take linear time to solve complex problems. Optimization algorithms has proved their worth in many real-world applications like: scheduling, ship routing, vehicle routing, automotive design, welded beam design, gaming, data analysis, search engines, power operation systems, web information retrieval, risk and trading analysis, training of neural networks and many more. Mentioned problems, if would've solved by extract algorithms, might have taken plenty of time comparatively.

Optimization have many sub-fields. Meta-heuristics is one of them. Heuristic is a Greek word which means "to solve". It pertains to trial-and-error method of problem solving used when an exact algorithmic approach is impractical. Main characteristic of meta-heuristics is that they are problem independent. Meta-heuristics give us a way to solve complex problems that are not solvable in polynomial time (NP-Hard Problems). Although they don't give exact solution of a particular problem, meta-heuristics provide guidelines that can give best solution available.

Metaheuristic algorithms have three major characteristics: exploration, exploitation and convergence. Exploration is process of visiting entirely new regions of search space [1] . It is the ability to evaluate candidate solutions that are not neighbor to the current solution (or solutions). This operation serves to escape from a local optimum. Exploitation is the process of visiting those regions of a search space within the neighborhood of previously visited points[1]. It is when a search is done in the neighborhood of the current solution (or solutions). It can be implemented as a local search. Convergence is often called termination condition of algorithm. More precisely, it stops the algorithm because each individual of population becomes identical as far as their fitness is concerned. In order to be successful, metaheuristic algorithm needs to establish a good ratio between exploration and exploitation [1]

Precise definition of metaheuristics couldn't be shaped in earlier stages (1940s). And still undecided today. In this chapter, we adopt the definition of Sorensen and Glover (2013).

> *A metaheuristic is a high-level problem-independent algorithmic framework that provides a set of guidelines or strategies to develop heuristic optimization algorithms. The term is also used to refer to a problem-specific implementation of a heuristic optimization algorithm according to the guidelines expressed in such a framework." [2]*

Researchers have divided meta-heuristic history into five chronological periods [2]:

1. Pre-historic period (- 1940)
2. Early period (1940-1980)
3. Method centric period (1980-2000)
4. Framework centric period (2000-now)
5. Method centric period (1980-2000)
6. Scientific period (future)

In pre-historic period, metaheuristics were applied but not formally studied. There was no reference or base literature available that could provide information about metaheuristics. It is argued that humans work naturally heuristically. They don't go for exact solution for their problems. For humans, to solve heuristic problems may not require background knowledge. They naturally try to find out appropriate solutions.

In early period of metaheuristics, several high level ideas were introduced. This period was formal beginning for study of metaheuristics. Writings of prehistoric periods were taken as references to study this area. During this period, Simon and Newell (1958) see heuristics specifically as to solve what they call ill-structured" problems. Contrary to well-structured problems, such problems cannot be formulated explicitly or solved by known and feasible computational techniques. Their predictions in 1958 have turned out to be slightly optimistic, but it cannot be denied that heuristics have turned out to be more flexible problem-solving strategies than exact methods. Pattern search, random search, evolution strategies, simplex method, evolutionary programming, genetic algorithms, scatter search, tuning control parameters were introduced.

The field of metaheuristics was truly elevated in method centric period. In this period, simulated annealing, artificial immune systems, tabu search, genetic programming, ant colony optimization, multi objective genetic algorithm, no free lunch theorem, particle swarm optimization, differential evolution, cross entropy were introduced. It would be accurate to declare is period as the fundamental period of metaheuristics.

There has been a drastic change in this field as far as framework centric period is concerned. Swarm based metaheuristics has dominated over other techniques. Although particle swarm optimization was the fundamental swarm-based algorithm, this period introduced many swarm based algorithms.

Hybridization of two or more concepts also took place in this period. Some of major achievements were: pop music, harmony search, multi objective NSGAII, bee colony optimization, glowworm swarm optimization, artificial bee colony, intelligent water drops algorithm, firefly optimization, monkey search optimization, cuckoo search, bat algorithm, spiral optimization, TLBO etc. we are still living in this period.

There would be scientific period of metaheuristics in future in which metaheuristics would be taken as a science rather than art.

In section II, literature review is discussed, in section III proposed methodology is explained, in section IV, mathematical mapping is discussed, in section V, experiments and their results are discussed. In the last section, conclusions are written.