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MOBILITY MANAGEMENT IN CELLULAR NETWORK

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ABSTRACT

The enormous increase in mobile subscribers in recent years has resulted in exploitation of wireless network resources, in particular, the bandwidth available. For the efficient use of the limited available bandwidth and to increase the capacity of the network, frequency re-use concept is adopted in cellular networks which led to increased number of cells in the network. This led to difficulty in finding the location of a mobile user in the network and increase in the signalling cost. Location management deals with keeping track of an active mobile terminal in a specific area while minimizing the cost incurred in finding the mobile terminal. The existing location management is done by grouping the cells based on subscriber density. Location management strategies are based on user mobility and incoming call arrival rate to a mobile terminal, which implies that the location management cost comprises of location update cost and paging cost. Reporting cell planning is an efficient location management scheme wherein few cells in the network as assigned as reporting cells, which take the responsibility of managing the location update and paging procedures in the network. Therefore, the need of the hour is to determine an optimal reporting cell configuration where the location management cost is reduced and thereby maintaining a trade-off between location update and paging cost. The reporting cell discrete optimization problem is solved using genetic algorithm, swarm intelligence technique and differential evolution. A comparative study of these techniques with the algorithms implemented by other researchers is done. It is observed that binary differential evolution outperforms other optimization techniques used for cost optimization. The current work can be extended to dynamic location management to assign and manage reporting cells in real-time implementable fashion.

INTRODUCTION

Day to day increase in mobile subscribers in recent years has resulted in exploitation of wireless network resources, in particular, the bandwidth available. This is due to the consumption of a large bandwidth by the numerous broadcast signals. For the efficient use of the limited available bandwidth and to increase the capacity of the network, frequency re-use concept is adopted in cellular networks which led to increased number of cells in the network [1]. This made it difficult to keep track of the mobile user in the network and also led to increased signalling cost. Also, the network should provide constant service to the consumers using mobile phones irrespective of the time and current location.

Mobile wireless networks are versatile in nature as they facilitate user mobility. They aim to provide uninterrupted communication at anytime and anywhere with a good quality of service and less delay in locating the target mobile terminal (MT)[2]. Every mobile terminal is connected to a cellular network via a wireless link. Mobility in the context of wireless networks is of two types: user mobility and terminal mobility. User mobility refers to the ability of mobile users to make and receive calls and access other wireless services irrespective of the MT's location. Terminal mobility is the ability of a mobile terminal to access telecommunication services from any location while in motion, and the capability of the network to locate and identify the mobile terminal as it moves within the coverage area. This project concentrates on network mobility which consists of location management in terms of total cost reduction in location update and paging. Location management is an important issue in wireless cellular networks because wireless devices are free to move and can change location while connected to the network [3]. Mobile terminals should be able to send and receive calls or data, while maintaining the quality of service. Hence, it is required to keep constant track of the location of a mobile terminal with a network. In these circumstances, location management seems to be a problem because mobile terminals change their location while being connected to a specific network. Location management strategies are based on user movement rate and incoming call arrival rate to a mobile terminal.

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OPTIMIZATION OF LOCATION MANAGEMENT COST USING EVOLUTIONARY COMPUTING TECHNIQUES

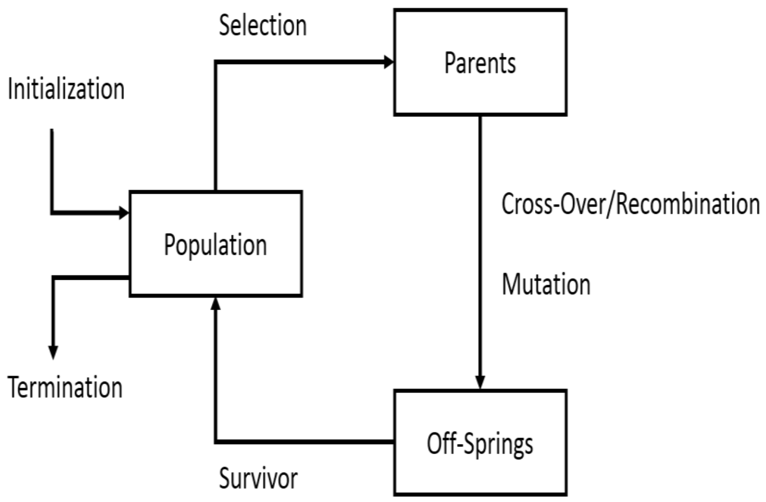
Optimization is a process of finding a best solution for a given problem. RCC is a discrete optimization problem, where the location management cost has to be minimized and the corresponding optimal set of reporting cells are to be determined. Genetic algorithm, binary particle swarm optimization and binary differential evolution algorithms are used to solve RCP problem. Each of these algorithms discussed in detail below.

Genetic Algorithm

Genetic Algorithm (GA) is an adaptive heuristic search algorithm based on the biological evolutionary mechanism of natural selection and genetics. GA is an evolutionary algorithm which can find good, possibly optimal solutions, to optimization problems with huge state spaces to be searched. It is a global probabilistic search method. GA is inspired by Darwin's theory about evolution -" survival of the fittest".

Evolutionary Computing is a major research area in the field of artificial intelligence. Evolutionary algorithms use randomness and genetic inspired operations. These algorithms start with an initial potential solution set called as population. Each solution in the population is called as a chromosome or an individual. Each chromosome consists of a set of genes. In accordance with the problem statement, each RCC solution is a chromosome and individual cell is a gene. Major operations involved in evolutionary algorithms are selection, crossover, mutation and competition of the individuals in the population. The general evolutionary process is show in the figure Algorithm Outline for Cost Minimization

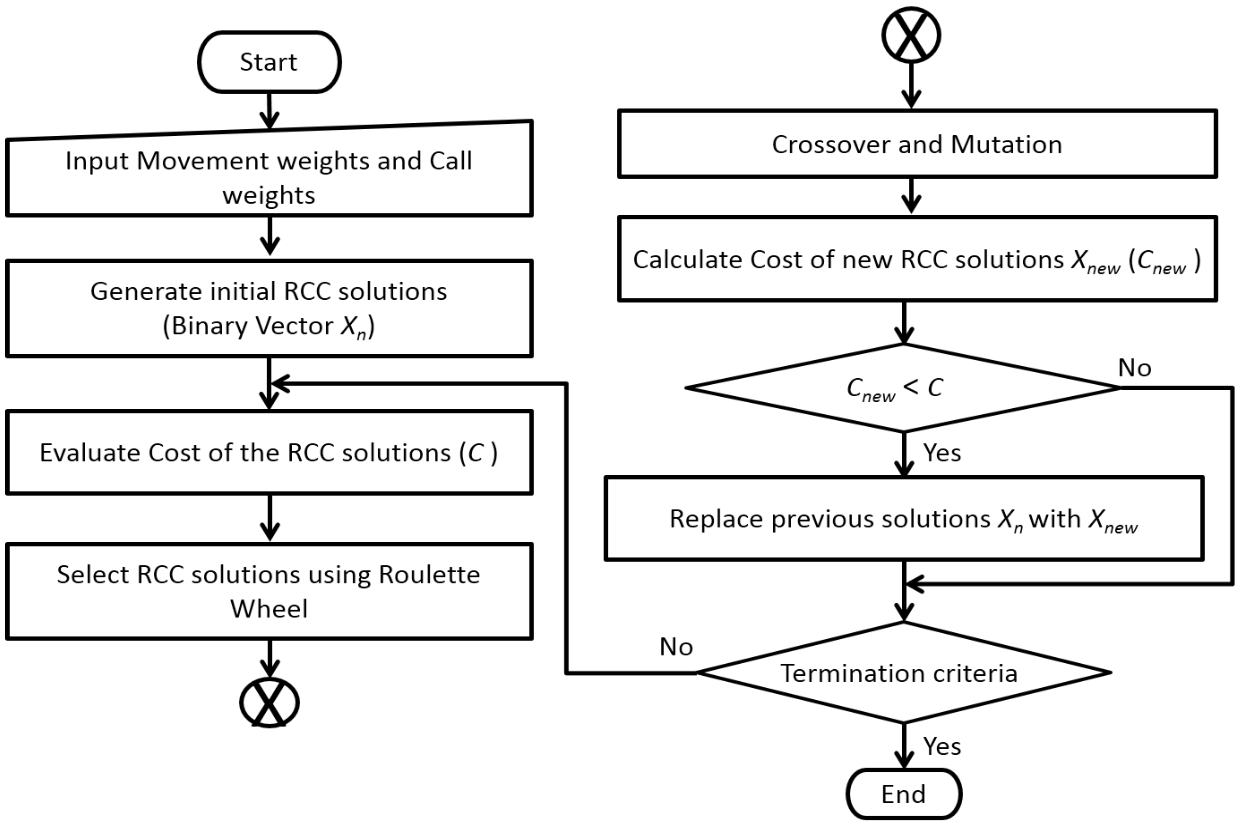
1. Random *n* number of RCC solutions is generated.
2. The total location management cost per call arrival of each RCC solution is evaluated.
3. New RCC solutions are created by repeating the following steps for *n* (number of solutions) times:
   - Selection - RCC solutions are selected using roulette wheel selection.
   - Crossover – Two RCC solutions are selected using roulette wheel and combined to form new RCC solutions.
   - Mutation - Mutation is performed if a random number generated is greater than the defined mutation probability. With a mutation probability, (taken as 0.8) the new solutions at random cell positions are mutated in the binary RCC solution vectors.
4. Updating the RCC solutions – If the cost of the new RCC solution is lesser than the cost of the previous RCC solution, the previous RCC solution is replaced with the new RCC solution.
5. If the end condition is satisfied i.e. maximum number of iterations, the process is terminated and the best RCC solution in the updated RCC solution vector set with the least cost value is returned.
6. Loop – The process is repeated from step 2.



Comparative Study of the Implementation Strategies

Test networks 6x6, 8x8, 10x10 and 15x15 are used for implementing the reporting cell planning and their cost function behaviour to different optimization algorithms is shown in the figures below. Simulations were executed in MATLAB. The simulation results show the plot of overall best reporting cell configuration cost in each iteration. Each simulation is run for 500 iterations. For each of the three algorithms used, minimum location cost achieved in every iteration is plotted against total number of iterations.

RESULT ANALYSIS



In all the results shown in Fig 4.1 and Fig 4.2, GA seems to be a weak algorithm for the discrete location cost optimization problem. It is observed that the optimum cost value is the same in BPSO and BDE, for smaller networks such as 6 X 6 network.

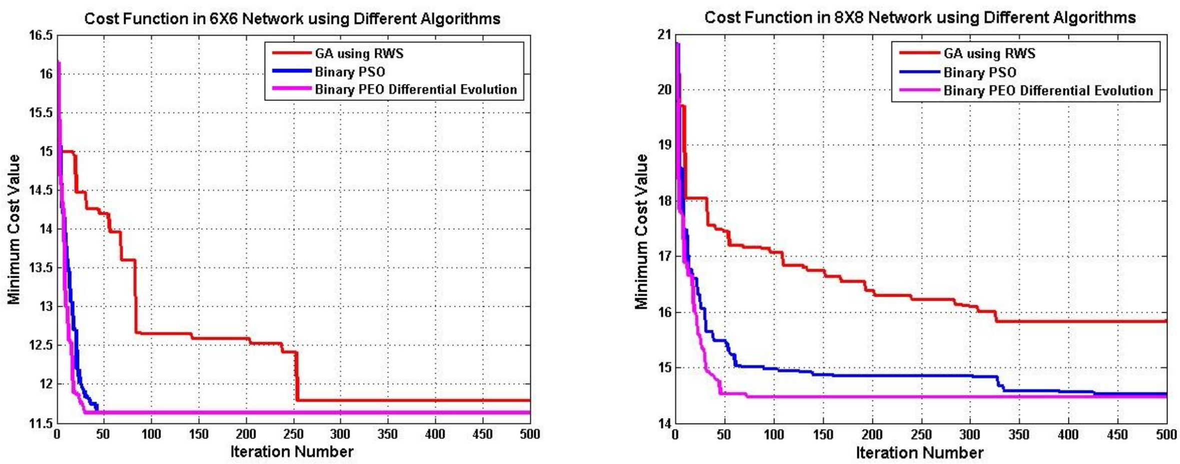


Figure 4.1(a): Cost Minimization in Different Networks for Different Algorithms

As the network size increases, BDE gives the best optimum results compared to BPSO and GA. Average standard deviation of BPSO increases with the network size. The convergence of BDE is observed to be faster than GA and BPSO.

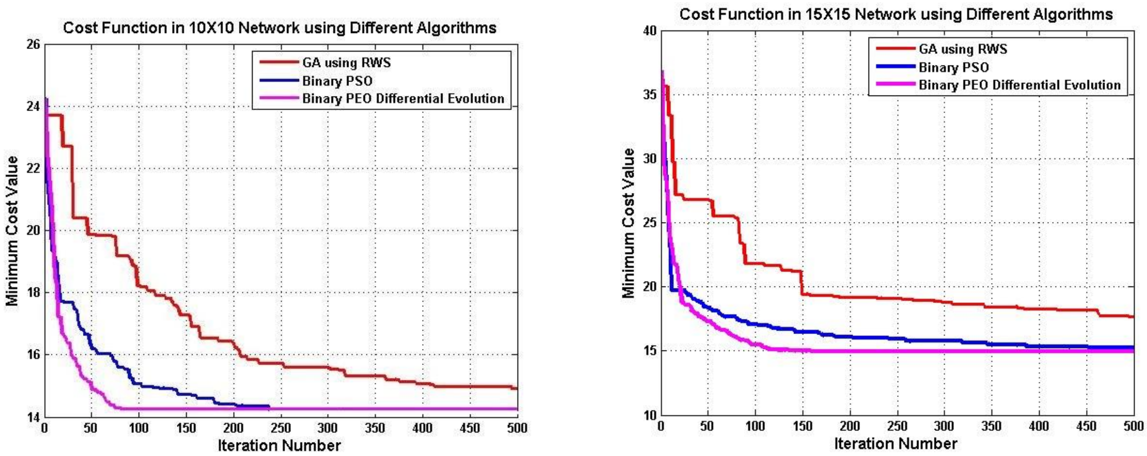


Figure 4.1 (b): Cost Minimization in Different Networks for Different Algorithms

BDE consumes the least computation time and GA consumes the maximum computation time. The computation time taken by GA is four the computation time of BDE. The computation time taken by BPSO is 2 times the computation time of BDE. The convergence of BDE and BPSO is faster than GA. BDE has comparatively faster convergence than BPSO.

CONCLUSION

- The location management optimization problem has been generalized for any size *N* of a cellular network.
- Genetic algorithm, binary particle swarm optimization and binary differential evolution optimization techniques have been used to minimize the location cost and to determine the optimal reporting cell set in a given cellular network of size *N*.
- To the best of our knowledge, binary differential evolution has been implemented for the first time to optimize location management cost in reporting cell planning.
- Various parameters involved with the implemented algorithms have been analysed and fine-tuned to obtain optimal results.

As observed from the simulation results, binary differential evolution outperforms other algorithms that have been used and compared with. Binary differential evolution gives the best results compared with the other optimization techniques used.

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