MAJOR TECHNICAL PROJECT 2018

Using Bio-Inspired Solutions to solve optimization problems

Rajat Mehra, Varun Bansal
Mentor: Siddhartha Sarma

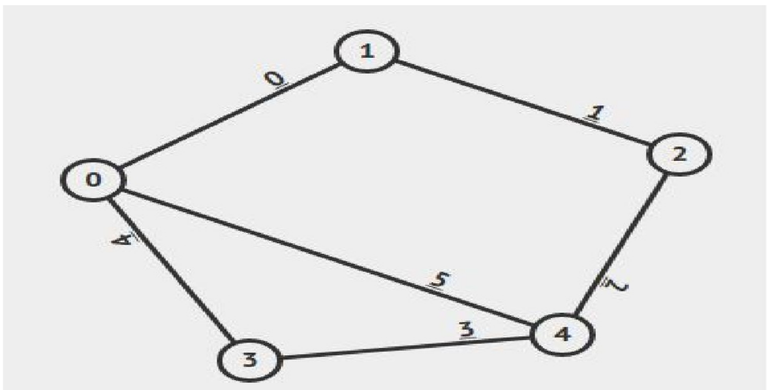
Problem Definition

TDMA(Graph Coloring) - The TDMA scheduling problem is to find minimum number of time slots so that each node delivers its packet to its destination without causing any conflict.

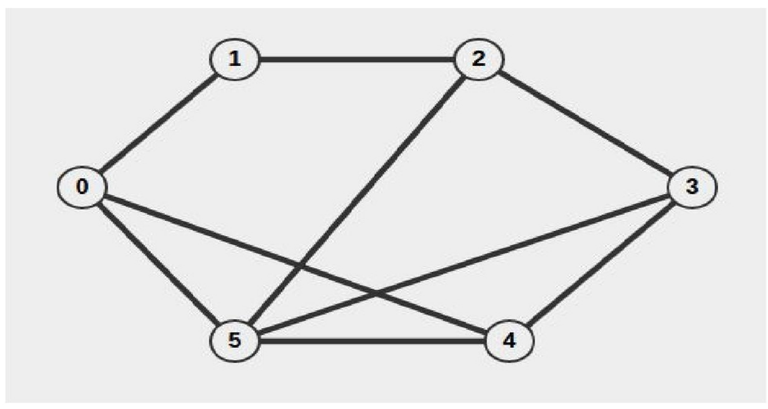
Motivation

Bio inspired heuristics are used widely to solve NP Hard Optimization problems. This is due to the fact that without any prior knowledge of the search space, these algorithms provide a good approximate solution to the problems.

TDMA scheduling Example



Input Graph



Conflict Graph for the given input graph

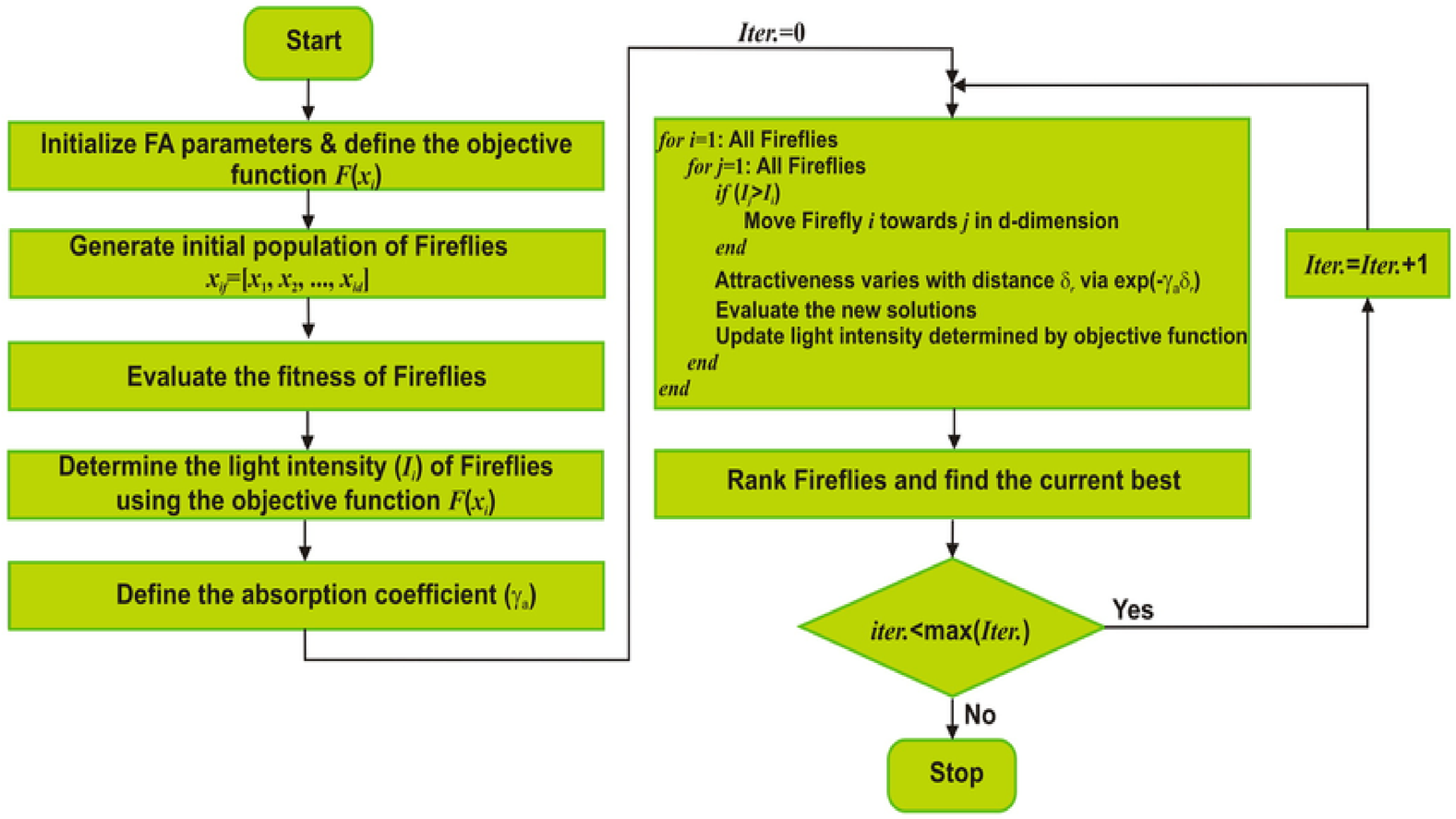
Firefly Algorithm Movement Function

The movement of the i-th firefly in any iteration is defined using the following formula:

$$X_i = X_i + \beta_0 e^{-\gamma r^2} (X_j - X_i) + \alpha (\text{rand} - 1/2)$$

- α : randomisation parameter
- β_0 : attractiveness at r = 0
- γ : Absorption coefficient
- r : Distance between the i-th and the j-th firefly
- rand : random number in range [0,1]
- X_i : i-th firefly

Firefly Algorithm Flowchart



Notations

$$Fitness(X_k) = \epsilon * Color\_Fitness(X_k) + \delta * Conflict\_Fitness(X_k)$$

$$Color\_Fitness(X_k) = 1 - \frac{Colors(X_k)}{n}$$

$$Conflict\_Fitness(X_k) = 1 - \frac{conflict(X_k)}{m}$$

$$conflict(\mathbf{x}) = \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} conflict_{ij}$$

$$conflict_{ij} = \begin{cases} 1 & color_i = color_j \text{ and } (i,j) \in E \\ 0 & otherwise \end{cases}$$

Conclusion & Future Work

Conclusion

- Performs better than other similar heuristics.
- Can be easily modified for optimization problems of different domains.

Future Work

- The input graph assumes that the nodes have only 1 packet to send to their destination.
- Working on a multigraph for multiple packets.

References

1. X.-S. Yang, "Firefly algorithms for multimodal optimization", in: Stochastic Algorithms: Foundations and Applications, SAGA 2009, Lecture Notes in Computer Sciences, Vol. 5792, pp. 169-178 (2009).
2. D. Khemani,A first course in artificial intelligence. McGraw Hill Education(India) Private Limited, 2013
3. S. C. Ergen and P. Varaiya, "tdma scheduling algorithms for wireless sensor networks," Wireless Networks, vol. 16, no. 4, pp. 985–997, 2009.
4. K. Chen and H. Kanoh, "A discrete firefly algorithm based on similarity for graph coloring problems," in Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD), 2017 18th IEEE/ACIS International Conference on,pp. 65–70, IEEE, 2017.
5. T. Back, Evolutionary algorithms in theory and practice: evolution strategies, evolutionary programming, genetic algorithms.Oxford university press, 1996.

Results for Graph Coloring

Conflict Graph		Number of Colors	
Nodes	Edges	Firefly	MIS
492	6410	**22**	**24**
505	6867	**24**	**28**
967	24522	**39**	**40**
1002	13157	**23**	**26**
1946	50218	**45**	**48**
2524	34179	**26**	**27**
4916	128448	**52**	**55**
5015	133799	**50**	**51**