JAYPEE INSTITUTE OF INFORMATION TECHNOLOGY, NOIDA

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING & INFORMATION TECHNOLOGY

MINOR PROJECT SUMMARY SHEET

Title – Multi-Objective Community Detection

Submitted By -

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Motivation behind the project

The significance of community detection in multi-objective lies in its ability to provide a more comprehensive understanding of complex networks by uncovering multiple structures within a single network. It also allows for the identification of communities that satisfy multiple objectives, which can provide valuable insights into the underlying mechanisms that govern the network's behavior.

Type of project

Development cum Research Project.

Critical Analysis of Research Paper

TITLE	SUMMARY
Community detection in social networks	- *Social network* : Graph G consisting of n number of nodes denoting n individuals or the participants in the network. - Directed and undirected graphs - *Community:* Group of entities closer to each other. - *Clustering* :process of grouping a set of similar items together in structures known as clusters. - Community detection algorithms : 1. *Graph Partitioning-based Community Detection* 2. *Clustering-based Community Detection* - Datasets : karateclub , football, dolphins
An Improved PSO algorithm for community detection	- The core idea of the PSO is to simulate the process of optimal in solution space as birds hunting. - In this paper, different kinds of particle swarm algorithms are implemented and compared. - Modularity is a traditional metric to evaluate the result of community detection. - The value of modularity is defined from 0 to 1. The larger modularity is, the better communities are detected. - Comparison of the communities of datasets of karate club and dolphins.
A Brief Review on Particle Swarm Optimization: Limitations & Future Directions	- In PSO, the behavior of a flock of birds is used as a metaphor to optimize a problem. - Each particle corresponds to a bird, which moves through the search space to find the best position to obtain food - Bird adjusts its direction based on two things: 1. Pbest

	2. Gbest - Limitations: To optimize the solution using global best there is chance to trapped in local area. No suggestion is provided for such situation.
A multi-objective particle swarm optimization algorithm for community detection in complex networks.	- Multi-objective community detection based on a modified version of PSO is proposed. - Applied in many practical applications like cancer detection, product recommendation, link prediction etc. - Novel approach of MOPSO is introduced. - In MOPSO-Net, we adopted the Pareto dominance concept to PSO to solve multi-objective tasks. - Two objective functions Kernel K-means and the Ratio Cut is minimised.
Multi-Objective Particle Swarm Optimizers: A Survey of the State-of-the-Art	- There is no single solution for optimization problems. - We aim to find good "trade-off" solutions that represent the best possible compromises among the objectives. - In multi-objective optimization, we aim to find a set of different solutions (the so-called Pareto optimal set). - Every nondominated solution as a new leader and then, just one leader has to be selected. - Leader – quality measure which is related to density measure - Two important density measures- 1. Nearest neighbor density estimator 2. Kernel density estimator

Overall design of the project

Multi-objective community detection is a technique used to identify communities or clusters in a network, where multiple objectives or criteria are considered simultaneously. These objectives can include factors such as network modularity, edge density, node similarity, and community size balance. The goal of multi-objective community detection is to find a set of solutions, known as the Pareto-optimal set, that represents the best trade-offs between the different objectives. These solutions are not dominated by any other solutions in the set, meaning that no other solution performs better in all objectives simultaneously. PSO(Particle Swarm Optimization)algorithm is used to achieve this goal.

Multi-objective community detection has applications in various fields, such as social network analysis, bioinformatics, and transportation network analysis. It can help identify meaningful communities in a network that have different characteristics and can be used for various purposes.

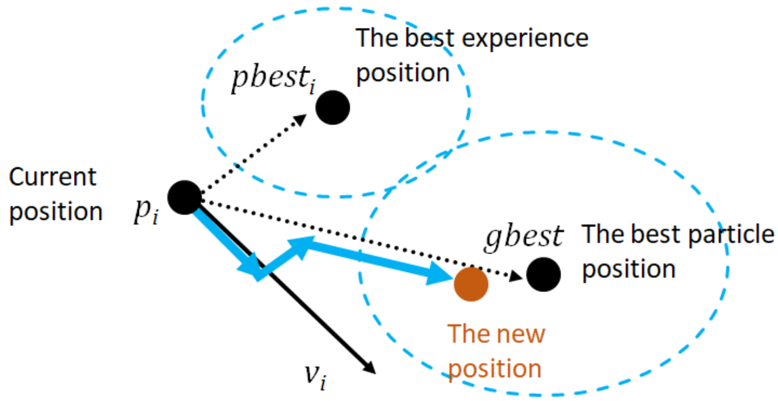

Fig -1 : PSO approach

Features Build

- Partioning the datasets
- Making community
- Testing the accuracy using objective functions

Language Used

Python(Jupyter Notebook and Google Colab)

Proposed Methodology

Particle Swarm Optimization (PSO) is a population-based stochastic optimization algorithm that is inspired by the behavior of social organisms, such as bird flocks and fish schools. In PSO, a population of candidate solutions, called particles, moves through the search space to find the optimal solution to an optimization problem. Each particle is characterized by its position and velocity, which are updated based on its own best-known position and the best-known position of the entire swarm. The PSO algorithm can be customized by adjusting several parameters, such as the number of particles and the acceleration coefficients, and it is particularly effective for problems with multiple local optima or non-linear fitness landscapes.

Algorithm/Description of the Work

PSO (Particle Swarm Optimization) :

i. Each particle in a swarm represents a candidate solution for the community detection problem.

ii. Given a swarm (set of particles) , first initialize the position and velocity variables with the help of two random variables r1 and r2 .
iii. Calculate the fitness of the current particle.
iv. The global best and local best are then calculated for each particle.
v. The new velocity is computed and then its used to calculate the new position of the particles.
vi. This process is iterated till all particles are covered.
vii. Local best of that generation is compared with global best for more optimized solution .
viii. This process can be repeated for n number of generations.
ix. After nth generation global best provides the best optimized solution whose fitness value is maximum/minimum according to need.

Conclusion

Overall, multi-objective community detection has been successfully applied to a wide range of real-world problems, including social networks, biological networks, and transportation networks. It can help researchers and practitioners gain insights into the underlying structure of complex systems and can inform decision-making processes in a variety of domains.

References

1. Bedi, P., & Sharma, C. (2016). Community detection in social networks. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, *6*(3), 115-135.
2. Wu, C., Li, T., Teng, F., & Chen, X. (2015, November). An improved PSO algorithm for community detection. In *2015 10th International Conference on Intelligent Systems and Knowledge Engineering (ISKE)* (pp. 138-143). IEEE.
3. Aote, S. S., Raghuwanshi, M. M., & Malik, L. (2013). A brief review on particle swarm optimization: limitations & future directions. *International Journal of Computer Science Engineering (IJCSE)*, *14*(1), 196-200.
4. Rahimi, S., Abdollahpouri, A., & Moradi, P. (2018). A multi-objective particle swarm optimization algorithm for community detection in complex networks. *Swarm and Evolutionary Computation*, *39*, 297-309.
5. Reyes-Sierra, M., & Coello, C. C. (2006). Multi-objective particle swarm optimizers: A survey of the state-of-the-art. *International journal of computational intelligence research*, *2*(3), 287-308.