A Comparative Analysis of Parallel Louvain Algorithms for Community Detection



- complex networks and extract information in graph mining
- community detection
- Emerging size of social networks, increased amount of data over time require parallelization of algorithms
- Parallel algorithms are necessary to deal with networks [1] of billions of vertices and edges
- We provide a comparative analysis of Parallel Louvain Algorithms
- We present a hybrid parallel algorithm using both OpenMP and MPI



- Detects community based on modularity optimization [2]

$$Q = \frac{1}{2m} \sum_{ij} \left[A_{ij} - \frac{k_i k_j}{2m} \right] \delta(c_i c_j)$$

Here,

Q = Modularity

 A_{ii} = Link weight between nodes i and j

m = Total link weight in the network

 $k_i =$ Sum of the link weights attached to node i

 c_i = Community to which node i is assigned

assigned to the same community. Otherwise, the value is 0 **2** Phases

- local optimization of modularity
- nodes



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- 1. "Stanford Large Network Dataset Collection", Snap.stanford.edu. [Online]. Available: https://snap.stanford.edu/data/index.html.
- 2. V. Blondel, J. Guillaume, R. Lambiotte and E. Lefebvre, "Fast unfolding of communities in large networks", Journal of Statistical Mechanics: Theory and Experiment, vol. 2008, no. 10, p. P10008, 2008.

nmunity Size	No. of Community		Percentage (%)		
	Sequential	Parallel (MPI)	Sequential	Parallel (MPI)	
	108877	108877	99.80	99.17	
	46	266	0.042	0.242	
00	40	530	0.037	0.483	
1000	51	88	0.0467	0.080	
-10000	82	25	0.075	0.023	
1-22000	3	2	0.0027	0.002	

References

- Dynamics On and Of Complex Networks, Volume 2, Springer New York, 2013, pp. 111124.
- Large Graphs", in High Performance Extreme Computing Conference (HPEC), 2014.





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Sequential	OpenMP		MPI		OpenMP+MPI	
Community No.	Community No.	Deviation (%)	Community No.	Deviation (%)	Community No.	Deviation (%)
1213	1213	0	1216	0.042	1163	0.71
109104	109102	.0006	109441	0.106	104668	1.39

3. S. Bhowmick and S. Srinivasan, A Template for Parallelizing the Louvain Method for Modularity Maximization, in 4. C. Wickramaarachchi, M. Frincuy, P. Small and V. Prasannay, "Fast Parallel Algorithm For Unfolding Of Communities In