

Cover Letter

I have completed my Ph.D. under the guidance of Dr. Shyam Sundar from National Institute of Technology (NIT) Raipur, Raipur, India in December, 2019. NIT Raipur is an autonomous public institute of higher education and is of national importance recognized by the Government of India. Our research focuses on developing heuristic and metaheuristic techniques for the solution of **NP-Hard Combinatorial Optimization Problems**, especially, our research interests lie in designing problem-specific genetic/neighborhood operators for the metaheuristic techniques that can effectively tackle hard and large combinatorial optimization problems.

My Ph.D. work based on the development of either problem-specific heuristic and metaheuristic technique or metaheuristic/hybrid metaheuristic technique for the solutions of six different **NP-Hard Combinatorial Optimization Problems** – Min-degree Constrained Minimum Spanning Tree (md-MST) Problem, Maximally Diverse Grouping Problem (MDGP), Degree-constrained Minimum Spanning Tree (dc-MST) Problem, Dominating Tree Problem (DTP); Tree t -Spanner Problem; and Bounded Diameter Minimum Spanning Tree (BDMST) Problem. All these problems find practical relevance in real-world. To develop robust and effective metaheuristic technique(s) for these problems, we have focused on unravelling the structure of these problems and incorporated problem-specific knowledge in designing problem-specific genetic operators/neighbourhood operators. In case of md-MST, MDGP and dc-MST problem, we have designed and developed problem-specific genetics operators, whereas in case of DTP, Tree t -Spanner problem and BDMST problem, we have designed and developed problem-specific neighborhood operators. We have proposed a hybrid approach for the md-MST and dc-MST, and MDGP problems, where a hybrid approach combines a steady-state genetic algorithm and problem-specific local search operator. We have designed problem-specific local search operator for the md-MST and dc-MST problems. For each problem, we have compared our proposed approach with state-of-the-art approaches on large size of standard benchmark instances. For example, in case of MDGP, the performance of our proposed hybrid approach has been tested on up to 3000 vertices of the complete graph and has shown superior to state-of-the-art approaches (**such as Iterated maxima search for the maximally diverse grouping problem proposed by Xiangjing Lai and Jin-Kao Hao in 2016**), particularly on large size instances.

Moreover, we have developed one problem-specific heuristic for the DTP, two different problem-specific heuristic for the dc-MST, and one problem-specific heuristic for the BDMST problem. These works have been published in peer-reviewed high quality SCI journals such as:

1. Kavita Singh and Shyam Sundar (2018): Two new heuristics for the dominating tree problem *Applied Intelligence, Springer-Verlag*, Volume-48, Issue 8, pp 2247-2267 [**SCI Journal Impact Factor: 3.325**] (**Published**) <https://doi.org/10.1007/s10489-017-1075-0>.
2. Kavita Singh and Shyam Sundar (2018): Artificial bee colony algorithm using problem-specific neighborhood strategies for the tree t -spanner problem *Applied Soft Computing, Elsevier*, Volume-62, pp 110-118, [**SCI Journal Impact Factor: 5.472**] (**Published**) <https://doi.org/10.1016/j.asoc.2017.10.022>.
3. Kavita Singh and Shyam Sundar (2019): A new hybrid genetic algorithm for the maximally diverse grouping problem *International Journal of Machine Learning and Cybernetics*,

Springer Berlin Heidelberg, pp 1-20 [SCI Journal Impact Factor: 3.753] (Published) <https://doi.org/10.1007/s13042-018-00914-1>.

4. Kavita Singh and Shyam Sundar (2019): A hybrid steady-state genetic algorithm for the min-degree constrained minimum spanning tree problem *European Journal of Operational Research, Elsevier*, Volume-276, pp 88-105, [SCI Journal Impact Factor: 4.213] (Published) <https://doi.org/10.1016/j.ejor.2019.01.002>.
5. Kavita Singh and Shyam Sundar (2019): A hybrid genetic algorithm for the degree-constrained minimum spanning tree problem *Soft Computing, Springer Berlin Heidelberg*, pp 1-18 [SCI Journal Impact Factor: 3.050] (Published) <https://doi.org/10.1007/s00500-019-04051-x>.
6. Kavita Singh and Shyam Sundar: Artificial Bee Colony Algorithm using Permutation Encoding for the Bounded Diameter Minimum Spanning Tree Problem (Communicated)].

List of Conference papers:

1. Kavita Singh and Shyam Sundar (2017): A Heuristic for the Degree-Constrained Minimum Spanning Tree Problem. 2nd International Conference on Soft Computing: Theories and Applications (SoCTA 2017), *Springer*, 22-24 December 2017, Jhansi- India (Published) https://doi.org/10.1007/978-981-13-0589-4_33.
2. Kavita Singh and Shyam Sundar (2017): A New Heuristic for Degree-Constrained Minimum Spanning Tree Problem. International Conference on Computational Intelligence: Theories, Applications and Future Directions (ICCI 2017), *Springer*, 6-8 December 2017, IIT Kanpur- India (Published) https://doi.org/10.1007/978-981-13-1132-1_12.
3. Kavita Singh and Shyam Sundar (2018): A Heuristic for the Bounded Diameter Minimum Spanning Tree Problem. 2nd International Conference on Intelligent Systems, Metaheuristics & Swarm Intelligence (ISMSI 2018), *ACM Digital Library*, March 24-25, 2018, Phuket, Thailand (Published) doi>10.1145/3206185.3206202.

During my Ph.D. studies, I have also worked as Project Staff on the Science and Engineering Research Board sponsored project entitled “**Metaheuristics techniques for NP-Hard Minimum Spanning Tree Problem**” under the supervision of Dr. Shyam Sundar in NIT Raipur from May 2017 to January 2019.

I have completed my postgraduation in Computer Science in 2012 from Pt. Ravishankar Shukla University Raipur, India. As a part of the award of final master's degree, I worked on a project of National Informatics Centre (NIC) Raipur – a premier science and technology organization of the Government of India in informatics services and information and communication technology applications. Continuing this project, I worked as a programmer in NIC Raipur, India from 2012 to 2015. During this period, I was a part of the team that developed software for Directorate of Treasury of Chhattisgarh, India (State-government of Chhattisgarh). This software was designed to provide an integrated solution covering all the levels in treasury viz. Directorate, Divisional Joint Director Offices, District Treasuries including City Treasury and Sub Treasuries in the control of District Treasuries. There are various processes involved in different levels of sub-systems like Payments, Receipts, Accounting and Deposit Accounts which are largely inter-related. By this means, the entire process of working procedure in the Treasury

at different levels would be normalized and easy access.

I believe that having sound knowledge of combinatorial optimization problems and heuristics methods such as evolutionary algorithms and swarm intelligent techniques; and good programming skills, I have become very interested in the prospect of working as part of your university. Simultaneously, this opportunity would provide me a congenial platform to further explore a research area of my interest in the company of highly knowledgeable and motivated research group of yours.

Thank you for your consideration. I look forward to hearing positive response from you.

Yours Sincerely,

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