A Hybrid-Order Local Search Algorithm for Set k-Cover Problem in Wireless Sensor Networks

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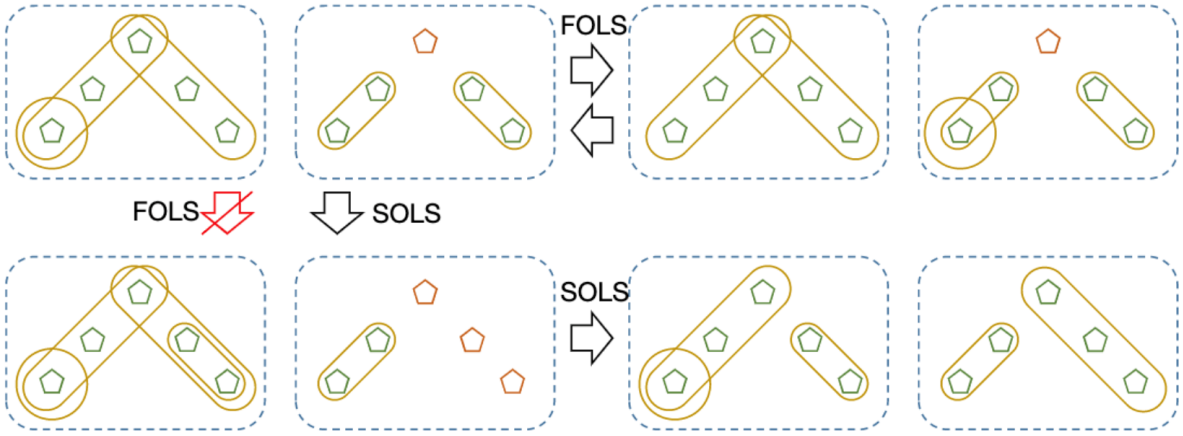
Problems & Ideas

- Set k-Cover Problem in Wireless Sensor Networks:
  - The lifetime of Wireless Sensor Networks (WSNs) is restricted by the limited energy of battery-powered sensor devices.
  - A practical way to extend the lifetime of a WSN is to partition the sensors into k subsets that can cover all the targets and activate them one by one. The problem of finding the maximal k is abstracted as the Set k-Cover problem.
- Local search algorithm
  - First-Order Local Search (FOLS) can easily get trapped in local optimum.
  - Second-Order Local Search (SOLS) alleviates this issue but is too slow.



An example to show the advantage of SOLS over FOLS. The green pentagons indicate the targets that are covered by sensors, which is illustrated by yellow ovals. The red pentagons indicate that are not covered.

Main Contributions

- Contributions:
  - We introduce an Approximated Second-Order Local Search (ASOLS) algorithm to help the searching process escape from local minimums, while is much more efficient than SOLS;
  - We propose Hybrid-Order Local Search, which interleaves between FOLS and the proposed ASOLS to achieve a better balance between exploitation and exploration.
- Experiments:
  - Compared with existing works, the proposed HOLS algorithm can find comparable or better solutions within significantly less time.

n	m	r	UB	TS	GMA	iMA	HOLS
90	10	100	4.13	4.13	4.13	4.13	**4.13**
90	10	150	9.84	9.82	9.84	9.84	**9.84**
90	10	200	16.77	16.70	16.77	16.77	**16.77**
300	500	300	84.71	-	84.65	84.71	**84.71**
300	500	400	151.24	-	150.63	151.08	**151.09**
300	500	500	209.04	-	209.04	209.04	**209.24**
90	30	250	21.13	-	21.13	21.13	**21.13**
90	50	250	19.41	-	19.41	19.41	**19.41**
90	75	250	18.58	-	18.58	18.58	**18.58**
300	100	400	161.61	-	161.26	161.59	**161.60**
300	150	400	159.13	-	158.12	159.03	**159.05**
300	200	400	157.09	-	156.21	157.00	**157.03**

The average number of covers of different algorithms.

n	m	r	TS	GMA	iMA	HOLS
90	10	100	0.140	1.370	0.002	**0.000**
90	10	150	0.760	1.600	0.004	**0.000**
90	10	200	1.120	1.770	0.006	**0.001**
300	500	300	-	189.8	1.267	**0.187**
300	500	400	-	201.8	7.078	**3.077**
300	500	500	-	212.2	13.13	**0.014**
90	30	250	-	2.860	0.018	**0.002**
90	50	250	-	3.550	0.017	**0.002**
90	75	250	-	5.820	0.022	**0.002**
300	100	400	-	39.66	1.934	**0.851**
300	150	400	-	56.94	3.039	**0.943**
300	200	400	-	87.37	4.003	**1.373**

The average running time of different algorithms.