On the analysis of ant colony optimization for the maximum independent set problem

Xiaoyun XIA, Xue PENG, Weizhi LIAO

Frontiers of Computer Science, DOI: 10.1007/s11704-020-9464-7

Problems & Ideas

- Performance Analysis of ACO for the Maximum Independent Set Problem (MISP)
  - What is the upper bound on the runtime of ACO for any MISP instance?
  - What is the approximation performance of ACO on the MISP?
  - How is the performance comparison between ACO and local search algorithm on MISP instances?
- Ideas: The ACO algorithms have a strong local search ability

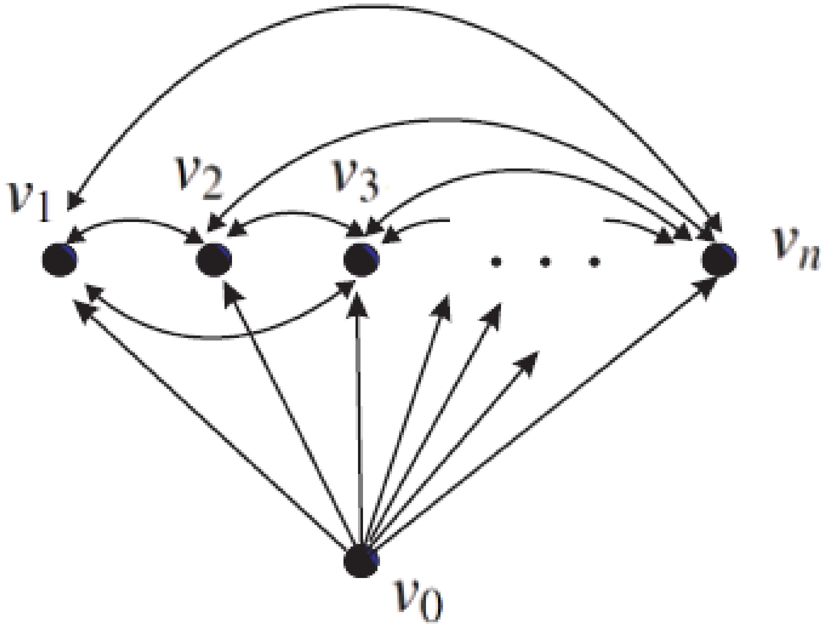

Fig. 1 The construction graph.

Main Contributions

Theorem 3.1. *Let control parameters $\alpha = 1$ and $\beta = 0$. For any MISP instance, the expected optimization time of the MMAS* is $O\left(\frac{((n-k)\frac{h}{l}+k)!}{k!}\right)$.*

Theorem 3.2. *Let control parameters $\alpha = 0$ and $\beta = 1$. For any MISP instance, the expected optimization time of the MMAS* is $O\left(\frac{n!}{k!}\right)$.*

Theorem 3.4. *For any given instance of the MISP with a bound of constant Δ on the degree of any vertex, let opt be the cardinality of vertices in the optimal solution and let $opt = \Theta(n)$. The MMAS* can find an independent set with approximation ratio of $\frac{\Delta+1}{2}$ in expected running time $O(\frac{n^5}{\ln^2 n})$.*

Theorem 4.2. *Suppose that the control parameters $\alpha = 1$ and $\beta = 0$. Starting from an any initial solution, the MMAS* can efficiently find the global optimum in expected running time $O\left(\frac{n^6}{\ln^3 n}\right)$.*

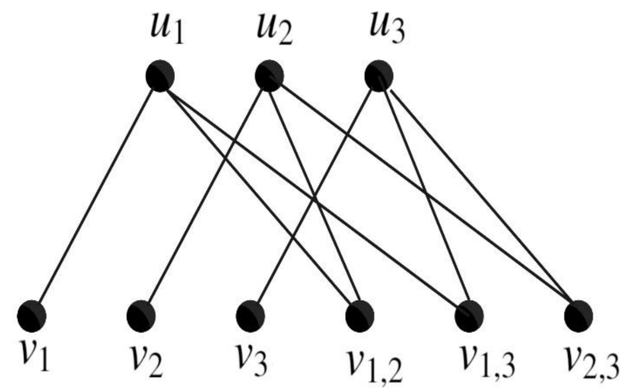

Fig. 2 Instance G_1 with $k = 3$