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Reputation-based joint optimization of user satisfaction and resource utilization in a computing force network

Key words: Computing force network; Resource scheduling; Performance-based reputation; User satisfaction

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Motivation

- It has gradually become a new trend to consider the computing and network resources of multiple providers as a whole; it differs from traditional optimization to achieve individual optimality by each provider separately, and can achieve overall optimization in a global perspective through unified scheduling and trading at the global level.
- In existing scheduling, the scheduling center and resource providers are often in a trusted environment and there is no malicious competition of misrepresented information. However, for computing force network (CFN), there are multiple resource providers, and since there are competitive relationships among multiple resource providers and each resource provider considers its own interest, the situation of misrepresenting performance information to compete for resource requests may occur. Thus, in CFN, the evaluation of reliability of resource providers is essential.
- On the other hand, CFN has different roles, including resource users, resource providers, and scheduling centers. Different roles have different goals; resource providers want to maximize their resource utilization and utility, and users want to meet their resource requirements. It is essential to consider how to balance the different requirements of these two roles.

Main idea

- Facing multiple users and multiple computing and network resource providers (CNRPs), we adopt a reputation model based on the beta distribution function to measure the credibility of CNRPs and update the reputation according to the actual performance.
- Then, we try to find trade-off between user satisfaction and resource utilization to satisfy user requirements and CNRPs' interest. We formalize the problem into a constrained multi-objective optimization problem and find the Pareto set using a modified fast and elitist non-dominated sorting genetic algorithm (NSGA-II). A large number of solutions in the Pareto set provide more choices of the matching decision for users and CNRPs according to the actual situation in CFN, which is the largest difference between our work and previous studies.

Framework

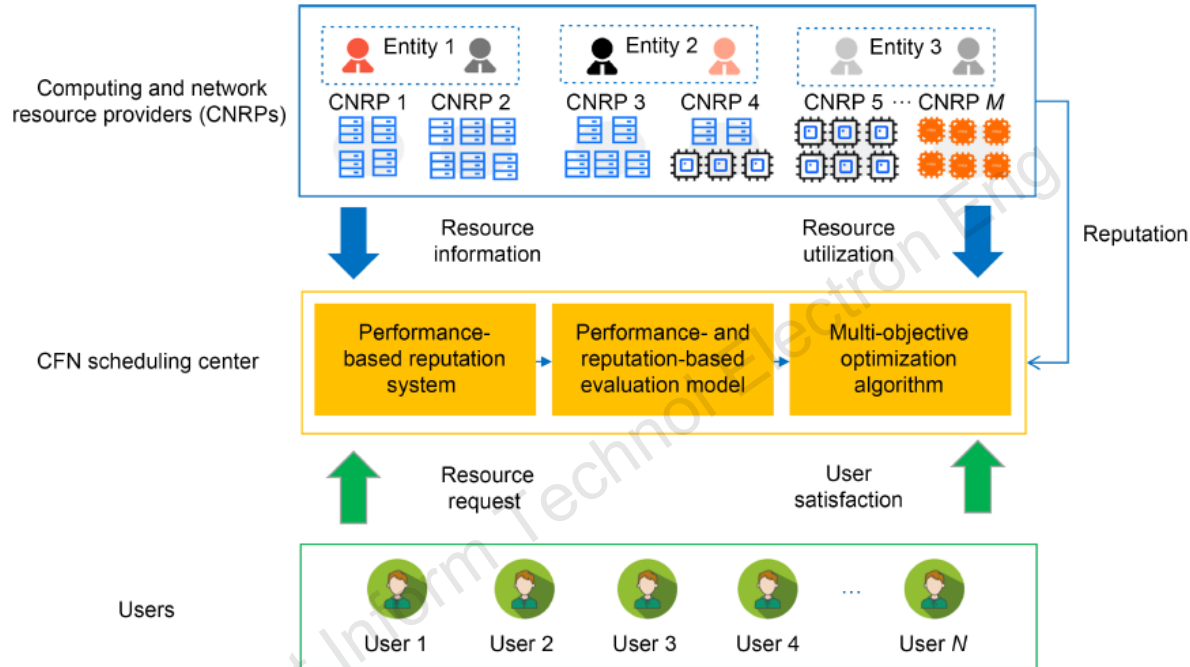


Fig. 2 Framework of reputation-based joint optimization of user satisfaction and resource utilization in a computing force network (CFN)

The users act as computing and network resource consumers. CNRPs provide computing and network resources with various performances and they may belong to different entities and compete with each other to provide the required resources to users with limited resources. When users put forward resource demands, CNRPs report the current resource information to the CFN scheduling center, and then the CFN scheduling center matches the multiple CNRPs and multiple users to meet the users' needs under the resource constraints.

Method

We adopt a reputation model based on the beta distribution function to measure the credibility of CNRPs and propose a performance-based reputation update model. Then, we formalize the problem into a constrained multi-objective optimization problem and find feasible solutions using NSGA-II.

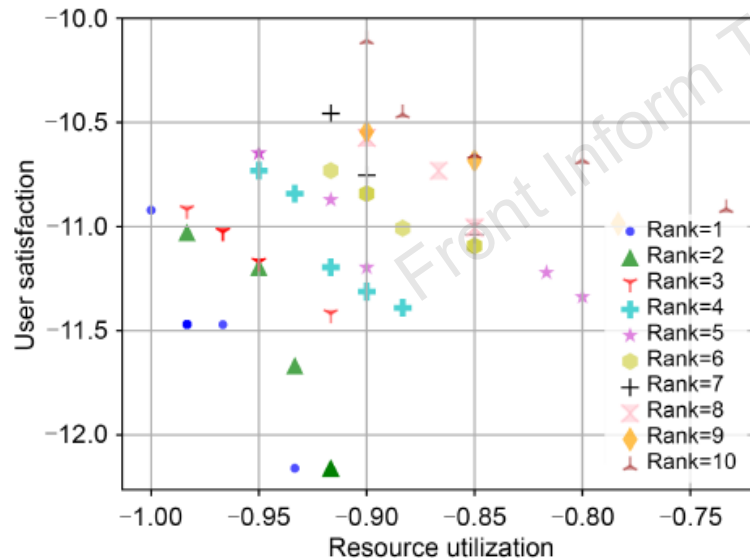


Fig. 4 Pareto fronts of user satisfaction and resource utilization

Simulation results demonstrate that the proposed model and the problem formulation are valid, and the NSGA-II is effective and can find the Pareto set of CFN, which increases user satisfaction and resource utilization. Moreover, a set of solutions provided by the Pareto set give us more choices of the many-to-many matching of users and CNRPs according to the actual situation.

Conclusions

In this paper, we presented a reputation-based joint optimization framework to balance user satisfaction and resource utilization in CFN. First, we introduced the reputation system and proposed a weighted and performance-based reputation update model to evaluate the reliability degree of CNRPs, and developed a performance- and reputation-based comprehensive evaluation model of CNRP towards different numbers of users. Second, we formulated the many-to-many matching decision process between users and CNRPs as a constrained multi-objective optimization problem, and leveraged NSGA-II to accommodate user satisfaction and resource utilization jointly. Last, the simulation results showed that the proposed model, problem formulation, and the NSGA-II are valid to obtain the Pareto set to jointly optimize user satisfaction and resource utilization, considering the reputation metric.



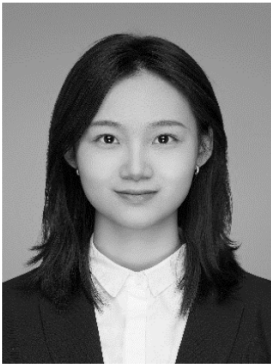
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