



Efficient Multi-Resource, Multi-Unit VCG Auction



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The Problem

Multi-resource VCG auction is computationally hard and thus inapplicable in a real system for resource allocation.

About VCG Auctions

- **Truthful:** incentivizes clients to reveal their true valuation of the resources, which helps cloud providers accurately price their services.
- Maximizes the **social welfare:** the aggregate valuation the clients assign to the chosen resource allocation.
- Named after William Vickrey, Edward H. Clarke, and Theodore Groves.

Existing Solutions

- **Restricted** valuation types (e.g., single resource and concave).
- **Approximated** solutions.
- **Branch-and-bound** algorithms.

Resource-as-a-Service

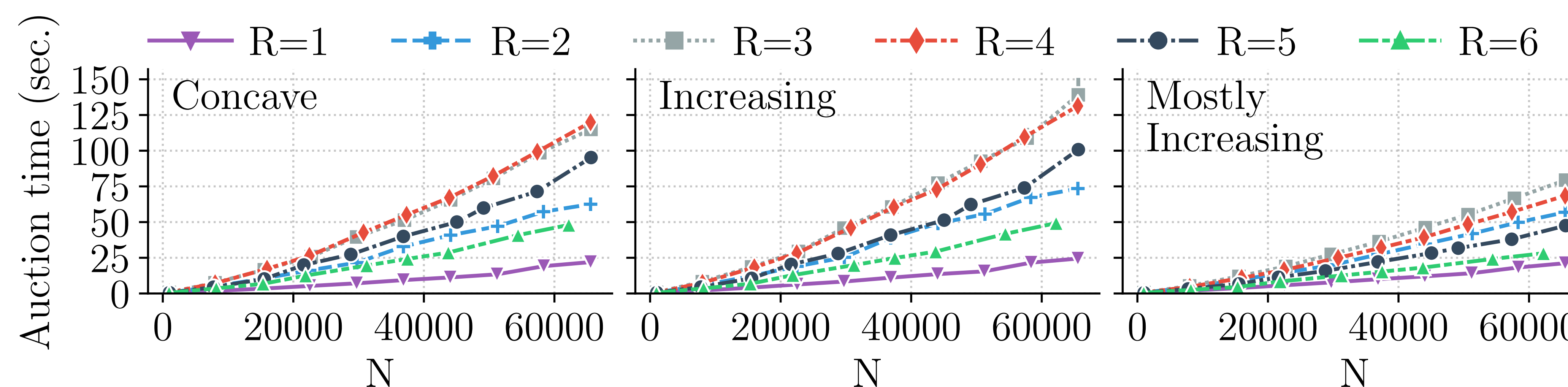
- The Resource-as-a-Service (RaaS) cloud is a vertically elastic cloud model that allows clients to rent adjustable quantities of individual resources for short time intervals.
- It characterized by:
 - Fine resource granularity
 - Fine time granularity
 - Market-driven resource pricing

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Our Solution: Joint Valuation Algorithm

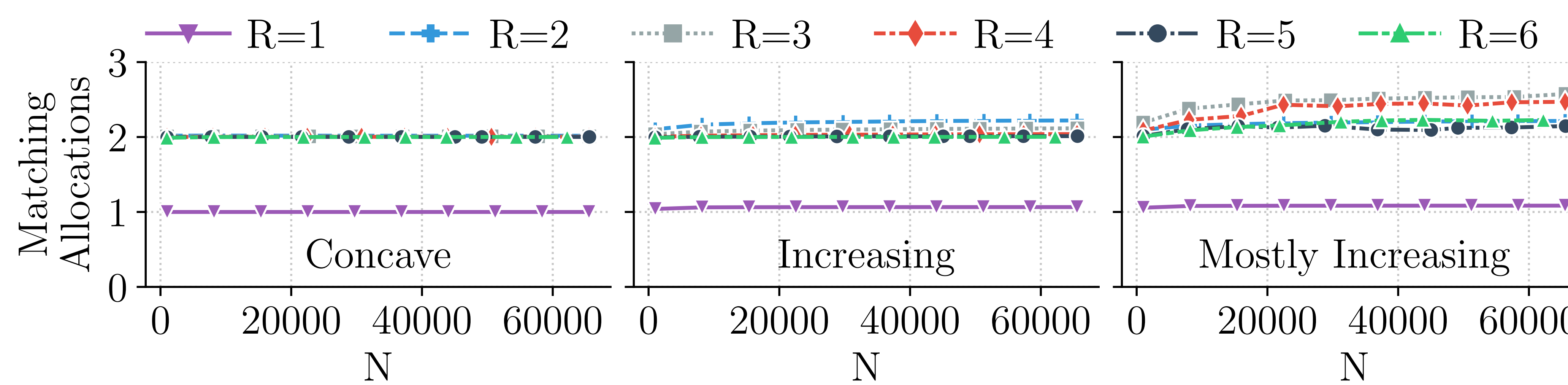
- Two valuations are combined into one joint valuation function.
- Then another valuation is joined, and then another, etc.
- The last valuation's maximal value is the maximal social welfare.
- A naïve implementation of this algorithm has $O(n \cdot N^2)$ time complexity.
- Our solution has near-linear complexity with respect to N .

Runtime



Runtime of a full auction and payment calculation for 256 clients.

Ideal Case Analysis

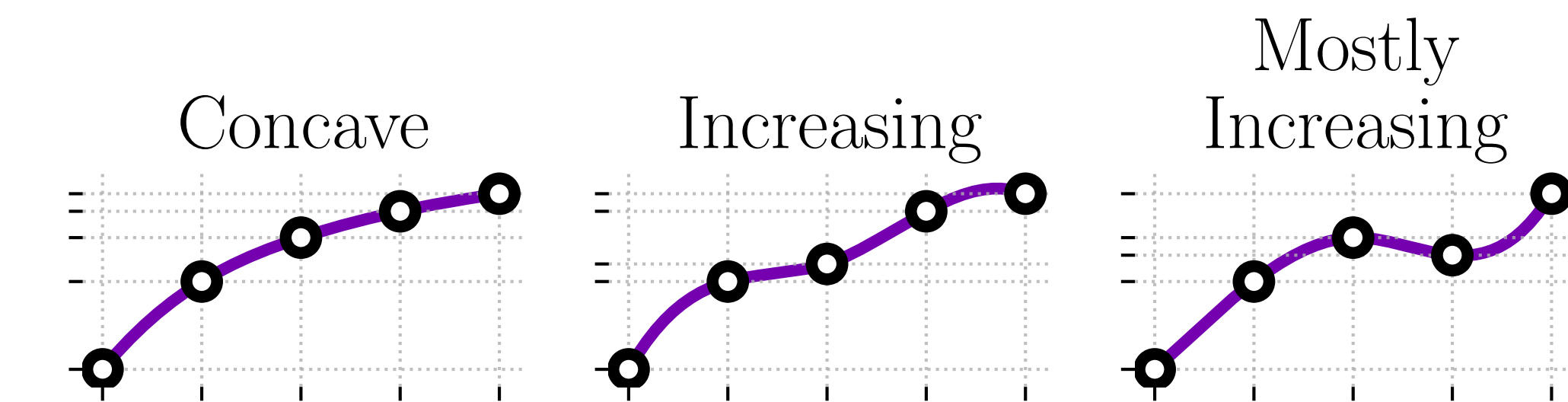


The average number of matching allocations for each query.

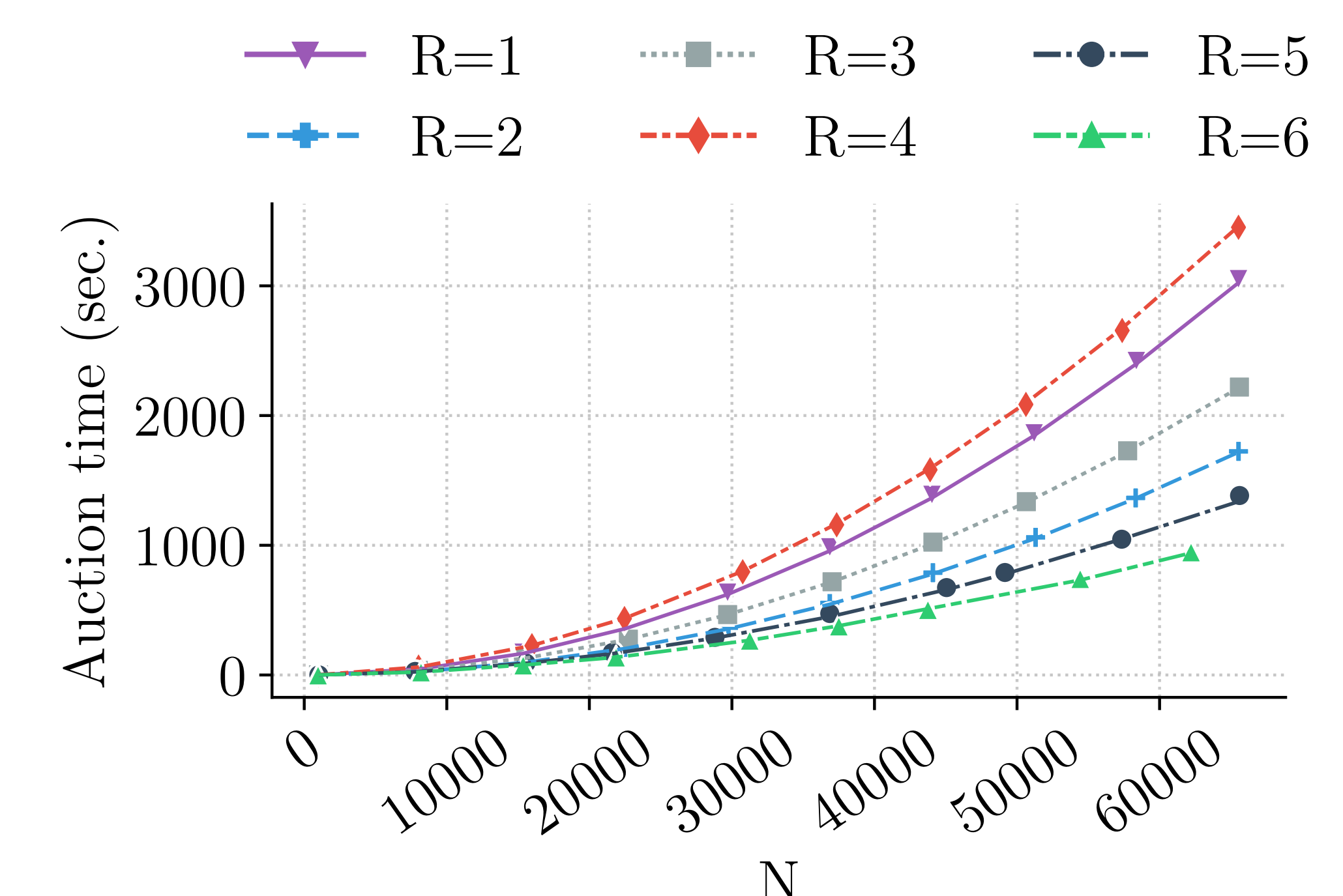
Conclusions

- Our algorithm allows deployment of multi-resource VCG auction for allocation of additional resources in an existing VM every two minutes for up to 256 clients.
 - Over 20 times faster compared with the original algorithm.
- It has no restrictions on the valuation functions.
- It allows cloud providers to implement the RaaS model.

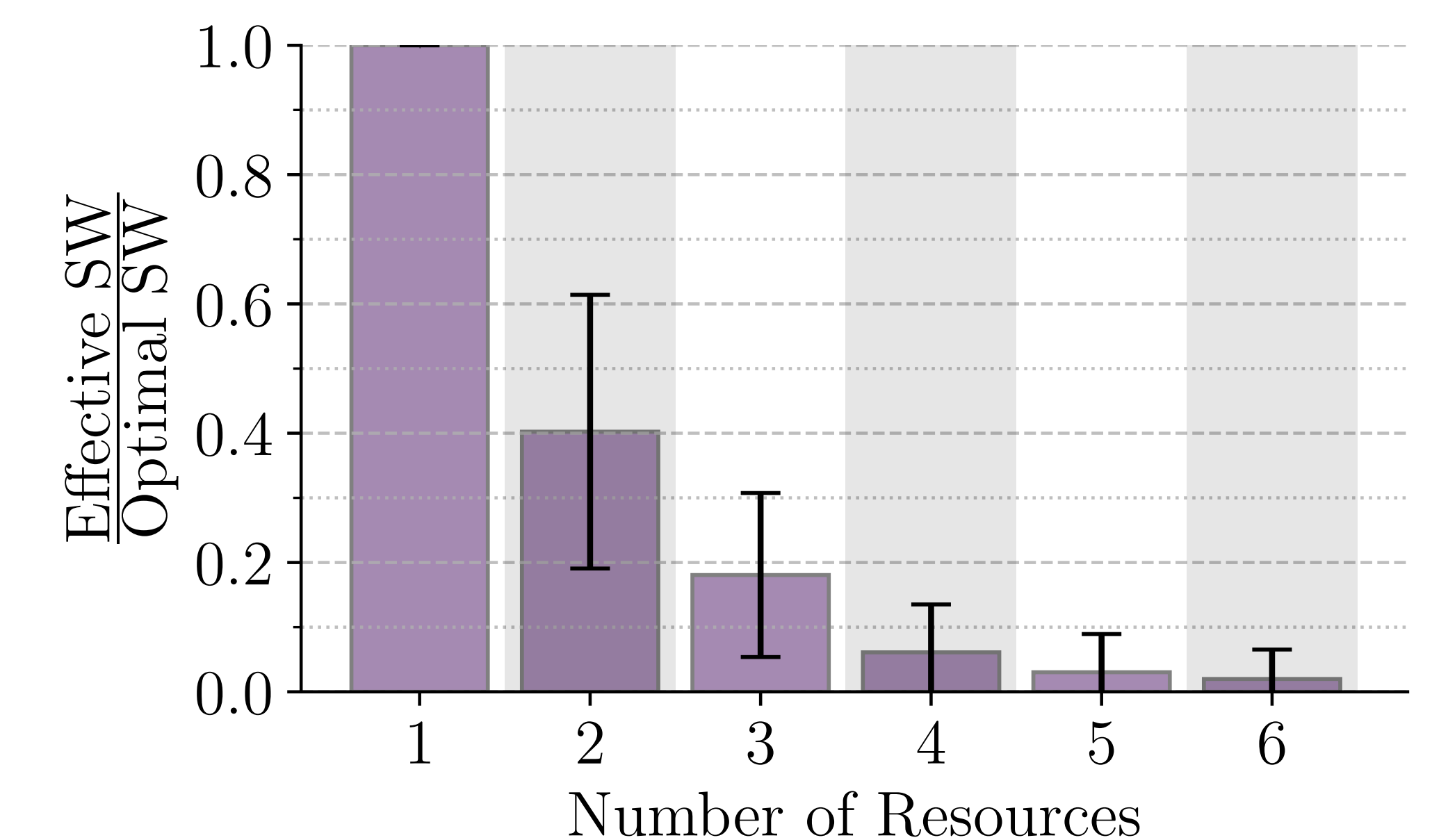
Valuation Functions



Naïve Approach



Single Resource Auction



Open Source

Our implementation is available from:
<https://bitbucket.org/funaro/vecfunc-vcg>