Quantum-enhanced Load Balancing

Description

In distributed computing systems, incoming jobs must be efficiently allocated across multiple computing nodes to optimize resource utilization and minimize processing time. This is particularly challenging when jobs arrive simultaneously at different entry points and have interdependencies.

Consider a data center with multiple computing nodes and two entry points that must coordinate job placement decisions. Without communication between entry points, suboptimal allocation may occur - especially for interdependent jobs. By sharing entanglement, entry points can make correlated decisions by performing measurements in bases determined by job characteristics (e.g., computing load, resource requirements).

This quantum coordination protocol enables better resource utilization compared to classical approaches, particularly when communication between entry points is costly or impractical. The protocol is based on the framework of continuous input nonlocal games and provides a provable advantage over classical coordination strategies.

Quantum advantage

Using shared entanglement, entry points can achieve provably better coordination than possible with classical strategies alone. This translates to measurable improvements in average job processing time and resource utilization, particularly under high load conditions.