Distributed Quantum Advantage

When and how does quantum computation and communication speed up problem solving in large computer networks?

Three flavors of quantum advantage in computer networks

Local computation

Less work done ***between*** communication steps

Intuition: one quantum computer is more powerful than one classical computers

Communication bandwidth

Less work done ***during*** communication steps

Intuition: sending one qubit is more useful than sending one classical bit

Communication rounds

Smaller ***number*** of communication steps

Intuition: extra power that you cannot implement with classical networks, *no matter how powerful computers you have, no matter how much bandwidth you have!*

Formalism: quantum-LOCAL

Gavoille et al. (DISC 2009): model + first results

Le Gall et al. (STACS 2019): the first ***global*** graph problem with a distributed quantum advantage!

But problems studied in distributed graph algorithms are usually defined with local constraints (e.g. graph coloring)

Key question: is there any ***local*** graph problem with a distributed quantum advantage?

Connection between distributed and online graph algorithms

ICALP 2023
Akbari, Eslami, Lievonen, Melnyk, Särkijärvi, Suomela
"Locality in online, dynamic, sequential, and distributed graph algorithms"

Quantum can be sandwiched between classical distributed and online!

STOC 2025
Akbari, Coiteux-Roy, d'Amore, Le Gall, Lievonen, Melnyk, Modanese, Pai, Renou, Rozhoň, Suomela
"Online locality meets distributed quantum computing"

STOC 2024
Coiteux-Roy, d'Amore, Gajjala, Kuhn, Le Gall, Lievonen, Modanese, Renou, Schmid, Suomela
"No distributed quantum advantage for approximate graph coloring"

No quantum advantage for local problems of the form "*c*-color *k*-colorable graphs"

STOC 2025
Balliu, Brandt, Coiteux-Roy, d'Amore, Equi, Le Gall, Lievonen, Modanese, Olivetti, Renou, Suomela, Tendick, Veeren
"Distributed quantum advantage for local problems"

The first local problem with distributed quantum advantage!

ICALP 2025
Balliu, Ghaffari, Kuhn, Modanese, Olivetti, Rabie, Suomela, Uitto
"Shared randomness helps with local distributed problems"

Shared randomness helps, and therefore also shared quantum state helps