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2410.00609v1.pdf

385.9KB

Process Document

📊 Total chunks: 67

View Document Chunks

Chunk 1

Distributed Quantum Computing: Applications and

Chunk 2

distributed quantum computing opens the way to new applica-

Chunk 3

limit. The already minuscule sizes of transistors limit the

Chunk 4

timisation [2]

🔍 RAG Application: With vs Without Cohere Rerank 3.5

Compare retrieval quality with and without Cohere Rerank 3.5 model

💬 Ask Questions

Enter your question:

what is Distributed Quantum Computing and their usecases?

Initial retrieval count (k)

Reranked top documents

10 5

🚀 Compare Responses

📌 WITHOUT Cohere Rerank

📚 Top 5 Retrieved Chunks (Vector Similarity)

Chunk 1 - Similarity Score: `0.2643`

distributed quantum computing opens the way to new
applica-
tions on the longer term. This study seeks to give an
overview
of this technology on an application-level, considering
both use

Chunk 2 - Similarity Score: `0.2962`

strengths and weaknesses of the different quantum
devices, the
quantum algorithm can be instantiated such that the
strength
of each of the devices is utilised, while avoiding each of
the weaknesses. For example, pairing a computer

Chunk 3 - Similarity Score: `0.2989`

Distributed Quantum Computing:
Applications and Challenges
Juan C. Boschero, Niels M. P. Neumann, Ward van der
Schoot, Thom Sijpesteijn, Robert Wezeman
Dept. Applied Cryptography & Quantum Algorithms
The Netherlands Organisation for Applied scientific

Chunk 4 - Similarity Score: `0.3685`

implementations and low-level optimizations.
Distributed quantum computing does introduce an additional
overhead, both in the number of required qubits, as well as
in the communication between different devices. Yet,

Chunk 5 - Similarity Score: `0.3691`

Because of this, practical large-scale algorithms are still years away, even with the current scaling of qubits and error
rates. Instead of scaling the resources on a single device, multi-
ple quantum devices can be combined to attain

😊 Generated Response

Based on the provided context, Distributed Quantum Computing (DQC) is an approach to scale quantum computers by linking different individual quantum computers together, similar to classical distributed settings used in high-performance computing (HPC).

The context identifies two main types of DQC:

1. Resource DQC - used when local quantum computation resources are insufficient
2. Data DQC - though the context doesn't fully explain this type

The use cases and benefits of DQC include:

- Providing "a possible faster path to scaling quantum hardware" when compared to scaling resources on a single device

- Enabling collaboration between different parties to "solve more complex problems than when running algorithms themselves"
- Allowing for strategic distribution of quantum algorithms across different quantum devices based on their strengths and weaknesses (e.g., "pairing a computer architecture possessing long coherence times with an architecture with fast operation times")
- Already being applied in current quantum hardware, such as "the Heron chips by IBM, which use the chiplet architecture"

The context also notes that while DQC introduces "additional overhead, both in the number of required qubits, as well as in the communication between different devices," it offers "a new path towards scaling up quantum hardware capabilities and it opens the way to novel applications of quantum computers."

Chunks Used for Response:

Top 5 chunks based on vector similarity scores

⭐ WITH Cohere Rerank 3.5

🎯 Top 5 Reranked Chunks

🟢 **Chunk 1** - Relevance Score: `0.8215`

strengths and weaknesses of the different quantum devices, the
quantum algorithm can be instantiated such that the strength
of each of the devices is utilised, while avoiding each of the weaknesses. For example, pairing a computer

Why this chunk?

High relevance (0.82): Strong semantic match with the query. Contains key information directly related to the question.

🟢 **Chunk 2** - Relevance Score: `0.8138`

implementations and low-level optimizations.
Distributed quantum computing does introduce an additional
overhead, both in the number of required qubits, as well as
in the communication between different devices. Yet,

Why this chunk?

High relevance (0.81): Strong semantic match with the query. Contains key information directly related to the question.

🟢 **Chunk 3** - Relevance Score: `0.8052`

distributed quantum computing opens the way to new
applica-
tions on the longer term. This study seeks to give an
overview
of this technology on an application-level, considering
both use

Why this chunk?

High relevance (0.81): Strong semantic match with the query. Contains key information directly related to the question.

🟢 **Chunk 4** - Relevance Score: `0.7398`

Because of this, practical large-scale algorithms are still
years away, even with the current scaling of qubits and
error
rates. Instead of scaling the resources on a single
device, multi-
ple quantum devices can be combined to attain

Why this chunk?

High relevance (0.74): Strong semantic match with the query. Contains key information directly related to the question.

🟢 **Chunk 5** - Relevance Score: `0.7284`

tum computing (DQC) and its use cases. We first
identified
two types of DQC: Resource DQC, where the local
quantum
computation resources are insufficient; and, Data DQC,
where

Why this chunk?

High relevance (0.73): Strong semantic match with the query. Contains key information directly related to the question.

Generated Response

Based on the context, Distributed Quantum Computing (DQC) refers to combining multiple quantum devices to increase computational power rather than scaling resources on a single device. The context identifies two main types of DQC:

1. Resource DQC: Used when "local quantum computation resources are insufficient" - essentially combining multiple quantum devices to gain more computational power.

2. Data DQC: Used when "relevant information is distributed over multiple parties and quantum computers are used to allow computations on the shared data."

The context mentions several use cases for DQC:

- Quantum machine learning
- Secure computing

- Breaking encryption
- Quantum interferometry

The text also notes that DQC "opens the way to new applications where different parties can collaborate and thereby solve more complex problems than when running algorithms themselves." Additionally, it mentions that the first ideas of DQC are already being applied to scale current quantum hardware, citing IBM's Heron chips which use a chiplet architecture for communication between different chips.

While DQC introduces additional overhead in terms of required qubits and communication between devices, it "offers a new path towards scaling up quantum hardware capabilities" and "opens the way to novel applications of quantum computers."

Why these chunks were selected:

Cohere Rerank 3.5 uses advanced semantic understanding to identify the most relevant chunks. The model analyzes:

- **Semantic relevance**: Deep understanding of query intent vs chunk content
- **Contextual meaning**: Beyond keyword matching to conceptual alignment
- **Information density:** Prioritizes chunks with higher answer potential
- **Query-document relationship**: Cross-attention between query and documents

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📊 Comparison Summary

Without Rerank **With Cohere Rerank 3.5**

- Method: Vector similarity (cosine)
- Chunks used: 5
- Selection: Top-k by embedding distance

- Method: Semantic reranking
- Chunks used: 5
- Selection: Relevance-scored by Cohere
- Avg relevance: 0.7817