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Data structures for quantum circuit verification and how to compare them

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Citation

Vinkhuijzen, L. T. (2025, February 25). *Data structures for quantum circuit verification and how to compare them*. IPA Dissertation Series. Retrieved from <https://hdl.handle.net/1887/4208911>

Version: Publisher's Version

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Propositions belonging to the dissertation

Data Structures for Quantum Circuit Verification and How To Compare Them

1. Quantum Multiple-Valued Decision Diagrams are exponentially less succinct, and exponentially less rapid, than Matrix Product States and indeed can be considered a proper subset. (Chapter 5)
2. Rapidity provides a unifying perspective to fairly compare the computational capabilities of knowledge compilation data structures, in contrast to succinctness and tractability. (Chapter 5)
3. The disjoint support decomposition, which makes the Disjoint Support Decomposition Binary Decision Diagram exponentially more succinct, and likely more rapid, than other decision diagrams, can be integrated into the designs of many other decision diagrams. (Chapter 6)
4. The biggest challenge in effectively employing dynamic variable reordering for Sentential Decision Diagrams in model checking is that the currently available vtree operations – rotations and swaps – render many metaheuristics, such as greedy search, ineffective, because they are “global” rather than “local” operations. (Chapter 7)
5. When designing a new data structure, a good rule of thumb is that a design is worth investigating further if this design solves a set of instances exponentially faster than existing work, and if it introduces only a modest (e.g., polynomial) amount of overhead on the remaining instances.
6. For many use cases, a large corpus of example and benchmarking problems is available, containing both easy and difficult problems. Unfortunately, many publications provide experimental results on only a small benchmark set, thereby underselling their proposed solutions.
7. There are currently no quantum computers that can perform useful tasks faster than conventional computers, and we should not expect them before the end of this decade.
8. There are remarkably few natural problems whose best algorithm runs slower than polynomially, but faster than exponentially. It is at present unclear why: Is Nature such that its problems fall neatly into these two categories, or is it an artefact, an idiosyncrasy of human creativity and the way we come up with problems and design their solutions?
9. Whereas the most powerful quantum computers are developed and owned by only four large companies, and against the backdrop of a quantum algorithm for financial portfolio optimization, there are currently no viable plans to prevent oligopolization of this market or, more broadly, to ensure that the benefits of this largely taxpayer-funded technology accrue to the general public.
10. Article page limits imposed by publishers undermine an author’s ability to provide a clear, comprehensible exposition of their work.