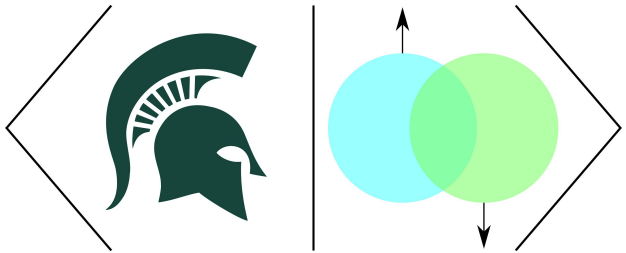
Resource estimates for error-corrected quantum algorithms



QuIC Seminar 55
Tuesday Nov. 24, 2020

Review of https://arxiv.org/abs/2011.04149

Focus beyond quadratic speedups for error-corrected quantum advantage

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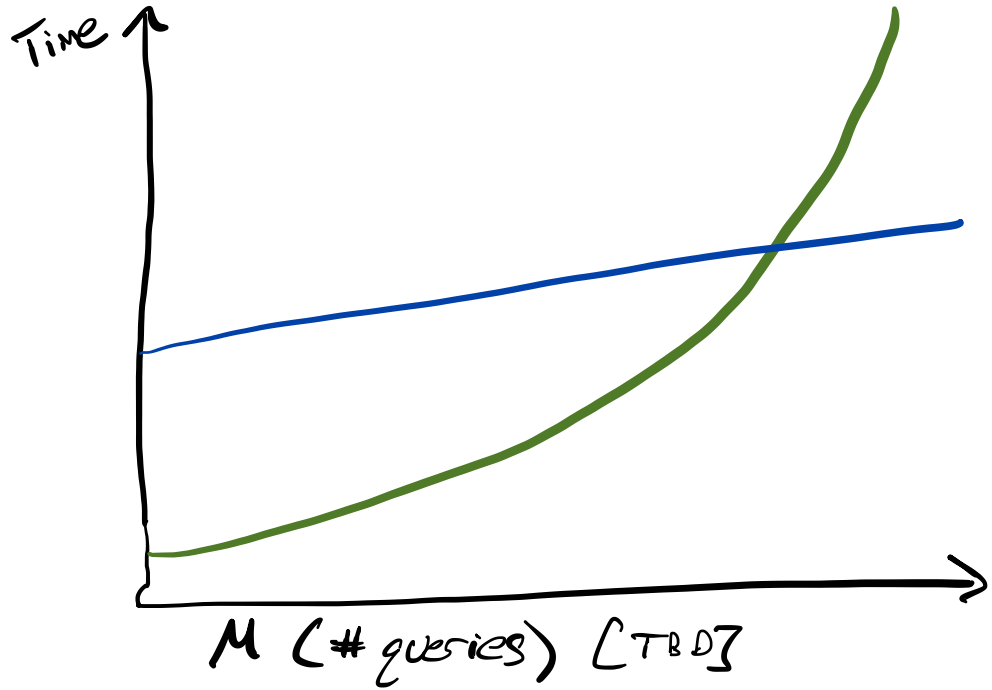
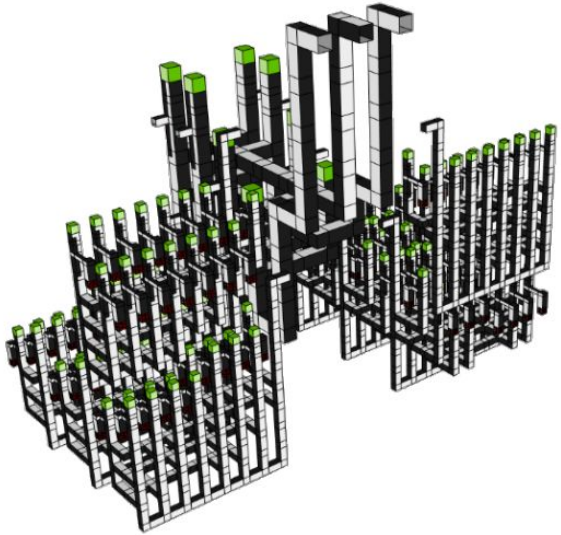
(Dated: November 10, 2020)

Big picture

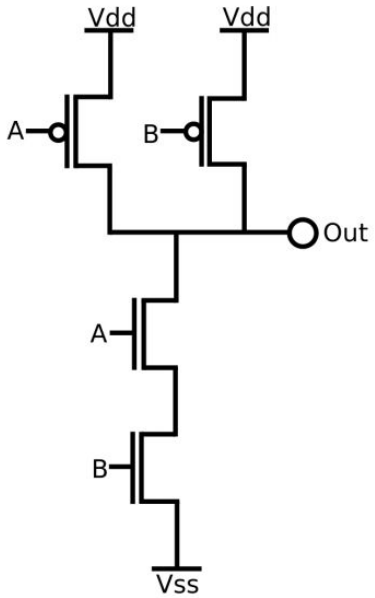


Classical $O(M^d)$ algorithm

Quantum $O(M)$ algorithm



(a) "Quantum NAND"
> 10 qubitseconds



(b) "Classical NAND"
$< 10^{-9}$ transistorseconds

polynomial degree d	parallelism speedup S	resource "lower bound"		simulated annealing	
		iterations M	runtime $\mathcal{T}^\star$	iterations M	runtime $\mathcal{T}^\star$
Quadratic, $d = 2$	1	5.2×10^5	2.4 hours	6.3×10^7	320 days
	10^3	5.2×10^8	100 days	6.3×10^{10}	880 years
	10^6	5.2×10^{11}	280 years	6.3×10^{13}	880 millennia
Cubic, $d = 3$	1	7.2×10^2	12 seconds	7.9×10^3	58 minutes
	10^3	2.3×10^4	6.4 minutes	2.5×10^5	1.3 days
	10^6	7.2×10^5	3.4 hours	7.9×10^6	40 days
Quartic, $d = 4$	1	8.0×10^1	1.4 seconds	4.0×10^2	2.9 minutes
	10^3	8.0×10^2	14 seconds	4.0×10^3	29 minutes
	10^6	8.0×10^3	2.3 minutes	4.0×10^5	4.9 hours

speedup factor	resource "lower bound"		simulated annealing	
	iterations M	runtime $\mathcal{T}^\star$	iterations M	runtime $\mathcal{T}^\star$
$R = 10^1$	5.2×10^7	1.0 day	6.3×10^9	8.8 years
$R = 10^2$	5.2×10^6	15 minutes	6.3×10^8	32 days
$R = 10^3$	5.2×10^5	8.8 seconds	6.3×10^7	7.7 hours