



WIKIPEDIA
The Free Encyclopedia

Main page
Contents
Featured content
Current events
Random article
Donate to Wikipedia
Wikipedia store

Interaction
Help
About Wikipedia
Community portal
Recent changes
Contact page

Tools
What links here
Related changes
Upload file
Special pages
Permanent link
Page information
Wikidata item
Cite this page

Print/export
Create a book
Download as PDF
Printable version

Languages
Čeština
Esperanto
فارسی
Français
Português
Русский
 Edit links

Create account Log in

Article **Talk**

Read **Edit** View history

Search

Coppersmith–Winograd algorithm

From Wikipedia, the free encyclopedia

In **linear algebra**, the **Coppersmith–Winograd algorithm**, named after **Don Coppersmith** and **Shmuel Winograd**, was the asymptotically fastest known **algorithm** for square **matrix multiplication** until 2010. It can multiply two $n \times n$ matrices in $O(n^{2.375477})$ time ^[1] (see **Big O notation**). This is an improvement over the naïve $O(n^3)$ time algorithm and the $O(n^{2.807355})$ time **Strassen algorithm**. Algorithms with better asymptotic running time than the Strassen algorithm are rarely used in practice.^[*why?*] It is possible to improve the exponent further; however, the exponent must be at least 2 (because an $n \times n$ matrix has n^2 values, and all of them have to be read at least once to calculate the exact result).

In 2010, Andrew Stothers gave an improvement to the algorithm, $O(n^{2.374})$.^{[2][3]} In 2011, Virginia Williams combined a mathematical short-cut from Stothers' paper with her own insights and automated optimization on computers, improving the bound to $O(n^{2.3728642})$.^[4] In 2014, François Le Gall simplified the methods of Williams and obtained an improved bound of $O(n^{2.3728639})$.^[5]

The Coppersmith–Winograd algorithm is frequently used as a building block in other algorithms to prove theoretical time bounds. However, unlike the Strassen algorithm, it is not used in practice because it only provides an advantage for matrices so large that they cannot be processed by modern hardware.^[6]

Henry Cohn, **Robert Kleinberg**, **Balázs Szegedy** and **Chris Umans** have re-derived the Coppersmith–Winograd algorithm using a **group-theoretic** construction. They also showed that either of two different conjectures would imply that the optimal exponent of matrix multiplication is 2, as has long been suspected. However, they were not able to formulate a specific solution leading to a better running-time than Coppersmith–Winograd at the time.^[7]

References ^[edit]

- ↑ Coppersmith, Don; Winograd, Shmuel (1990), "Matrix multiplication via arithmetic progressions" (PDF), *Journal of Symbolic Computation* **9** (3): 251, doi:10.1016/S0747-7171(08)80013-2
- ↑ Stothers, Andrew (2010), *On the Complexity of Matrix Multiplication* (PDF).
- ↑ Davie, A.M.; Stothers, A.J. (2013), "Improved bound for complexity of matrix multiplication", *Proceedings of the Royal Society of Edinburgh* **143A**: 351–370, doi:10.1017/S0308210511001648
- ↑ Williams, Virginia (2011), *Breaking the Coppersmith–Winograd barrier* (PDF)
- ↑ Le Gall, François (2014), "Powers of tensors and fast matrix multiplication", *Proceedings of the 39th International Symposium on Symbolic and Algebraic Computation (ISSAC 2014)*, arXiv:1401.7714
- ↑ Robinson, Sara (2005), "Toward an Optimal Algorithm for Matrix Multiplication" (PDF), *SIAM News* **38** (9)
- ↑ Cohn, H.; Kleinberg, R.; Szegedy, B.; Umans, C. (2005). "Group-theoretic Algorithms for Matrix Multiplication". *46th Annual IEEE Symposium on Foundations of Computer Science (FOCS'05)*. p. 379. doi:10.1109/SFCS.2005.39 . ISBN 0-7695-2468-0.

Further reading ^[edit]

- P. Bürgisser, M. Clausen, and M.A. Shokrollahi. *Algebraic complexity theory*. Grundlehren der mathematischen Wissenschaften, No. 315 Springer Verlag 1997.

See also ^[edit]

- Computational complexity of mathematical operations
- Gauss–Jordan elimination
- Strassen algorithm

 v · t · e	Numerical linear algebra	[hide]
Key concepts	Floating point · Numerical stability	
Problems	Matrix multiplication (algorithms) · Matrix decompositions · Linear equations · Sparse problems	
Hardware	CPU cache · TLB · Cache-oblivious algorithm · SIMD · Multiprocessing	
Software	BLAS · Specialized libraries · General purpose software	

This page was last modified on 4 September 2015, at 09:30.

Text is available under the [Creative Commons Attribution-ShareAlike License](#); additional terms may apply. By using this site, you agree to the [Terms of Use](#) and [Privacy Policy](#). Wikipedia® is a registered trademark of the [Wikimedia Foundation, Inc.](#), a non-profit organization.

[Privacy policy](#) [About Wikipedia](#) [Disclaimers](#) [Contact Wikipedia](#) [Developers](#) [Mobile view](#)

